U.S. Department of Energy

ALASKA LNG PROJECT

Final
Supplemental Environmental Impact Statement

January 2023

Volume 2 of 2
Appendices

DOE/EIS-0512-S1

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U.S. Department of Energy

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Alaska LNG Project

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ACHP	Advisory Council on Historic Preservation
BLM	Bureau of Land Management
DOE	Department of Energy
DOT	Department of Transportation
FECM	Office of Fossil Energy and Carbon Management
FERC	Federal Energy Regulatory Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
PHMSA	Pipeline and Hazardous Materials Safety Administration
SEIS	Supplemental Environmental Impact Statement
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

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APPENDIX A AGENCY AND ALASKA NATIVE COORDINATION

A.1 INTRODUCTION

During preparation of the Draft Supplemental Environmental Impact Statement (SEIS), the United States (U.S.) Department of Energy (DOE), Office of Fossil Energy and Carbon Management (FECM) actively maintained communication with Federal, State, and Alaska Native tribal governments. This appendix summarizes the records of formal consultation between the DOE and these government agencies and Alaska Native Tribes.

A.2 FEDERAL AGENCY NOTIFICATION

DOE invited the following agencies to be Cooperating Agencies for this SEIS as these agencies participated as cooperating agencies in the preparation of the Federal Energy Regulatory Commission's (FERC) 2020 EIS; however, no agencies accepted the invitation. Refer to Chapter 8, Distribution List, for a detailed list of agencies and other entities contacted about this SEIS.

- Advisory Council on Historic Preservation (ACHP)
- U.S. Air Force
- U.S. Army Corps of Engineers (USACE)
- U.S. Coast Guard (USCG)
- U.S. Department of Interior, Bureau of Land Management (BLM)
- U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Federal Energy Regulatory Commission (FERC)
- U.S. Fish and Wildlife Service (USFWS)
- National Oceanic and Atmospheric Administration (NOAA)
- National Marine Fisheries Service (NMFS)
- National Park Service (NPS)

The following letter provides a sample of the letter used to notify agencies of the availability of the Alaska LNG Project Draft SEIS.

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY
Albany, OR • Morgantown, WV • Pittsburgh, PA

NATIONAL ENERGY TECHNOLOGY LABORATORY

June 24, 2022

Name
Title
Organization
Address
Address

Dear Name,

Under the authority of the National Environmental Policy Act (NEPA) and its implementing regulations, the U.S. Department of Energy (DOE) prepared a Draft Supplemental Environmental Impact Statement (SEIS) to evaluate the potential environmental impacts associated with authorizing Alaska LNG Project LLC (Alaska LNG) to export liquefied natural gas (LNG) as part of the Alaska Gasline Development Corporation's (AGDC) proposed Alaska LNG Project (Project) in Docket No. 14-96-LNG.[1] Through the NEPA process, DOE evaluates the potential direct, indirect, and cumulative effects of the Project; invites public participation; and informs current and future agency planning and decision making related to the Project. This letter serves as notification that the Draft SEIS for the proposed Alaska LNG Project will be available online at DOE's website https://www.energy.gov/nepa/doeeis-0512-s1-supplemental-environmental-impact-statement-alaska-lng-project for public review and comment beginning on July 1, 2022, and ending on August 15, 2022.

DOE is in the process of rehearing DOE/Office of Fossil Energy (FE) Order No. 3643-A, issued in August 2020 (Alaska LNG Order), which authorized exports of LNG from the proposed Alaska LNG Project to countries that do not have a free trade agreement (FTA) requiring national treatment for trade in natural gas, and with which trade is not prohibited by U.S. law or policy (non-FTA countries). DOE issued the Rehearing Order on April 15, 2021. Subsequently, on July 2, 2021, DOE published in the *Federal Register* a "Notice of Intent to Prepare a Supplemental Environmental Impact Statement for the Alaska LNG Project" (86 Fed. Reg. 35,280). The Draft SEIS supplements the Final Environmental Impact Statement (EIS) for the Alaska LNG Project published by the Federal Energy Regulatory Commission (FERC) on March 6, 2020, and adopted by DOE on March 16, 2020 (DOE/EIS-0512).

The Draft SEIS, in accordance with NEPA, has been prepared in furtherance of DOE's Rehearing Order to evaluate potential upstream and downstream environmental impacts of exporting LNG from the proposed Project to non-FTA countries, including evaluation consistent with two recent Executive Orders: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,* and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad.* Specifically, the Draft SEIS will inform DOE's consideration of potential environmental impacts associated with natural gas production on the North Slope of Alaska. In addition, the Draft SEIS will evaluate the global nature of greenhouse gas (GHG) emissions associated with Alaska LNG's export of LNG to markets in Asia (the markets targeted for export from Alaska) from a life cycle perspective.

In the Notice of Schedule for the SEIS, issued on August 24, 2021, DOE stated that, based on the findings from the SEIS (including the associated public process), DOE intends to issue an order under section 3(a) of the Natural Gas Act in which DOE presents its findings and

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[1] For all DOE documents referenced herein, please see the Alaska LNG docket at: https://www.energy.gov/fecm/articles/alaska-lng-project-llc-fe-dkt-no-14-96-lng.

3610 Collins Ferry Road, P.O. Box 880, Morgantown, WV 26507
mark.lusk@netl.doe.gov Phone (304) 285-4145 www.netl.doe.gov

Figure A-1. Sample Draft SEIS Notification Letter

conclusions. DOE stated that it may decide to reaffirm, modify, or set aside the Alaska LNG Order in whole or in part.

Comments on the Draft SEIS

DOE invites Federal, state, tribal, and local entities; non-profit organizations; businesses; interested parties; and the general public to review the Draft SEIS and to submit comments on the Draft SEIS during the 45-day public comment period.

The open comment period will begin when the Notice of Availability (NOA) is published in the *Federal Register* on July 1, 2022 and end on August 15, 2022. DOE will post the Draft SEIS to the following website: https://www.energy.gov/nepa/doeeis-0512-s1-supplemental-environmental-impact-statement-alaska-lng-project. Comments on the Draft SEIS may be submitted online at https://www.regulations.gov/ by entering "Alaska LNG" into the search field and following the prompts, or by mail addressed to:

U.S. Department of Energy, National Energy Technology Laboratory,
ATTN: Mark Lusk, NEPA Compliance Officer
3610 Collins Ferry Rd
Morgantown, WV 26505

Comments by mail should be identified as intended for the Draft SEIS for the Alaska LNG Project. Comments received or postmarked by August 15, 2022 will be considered in preparing the Final SEIS.

Virtual Public Meeting

DOE invites you to the virtual public meeting, currently scheduled for Wednesday July 20, 2022 from 4 to 6 PM AKDT (8 to 10 PM EDT). The virtual public meeting will begin with a presentation on the NEPA process and the proposed Project. Following the presentation, there will be a moderated session during which members of the public can provide verbal comments on the Draft SEIS. All comments provided during the virtual public meeting will be transcribed and become part of the formal record.

You may join the public meeting from your personal computer or compatible mobile device through the Zoom app, clicking 'Join a Meeting', and entering the following information - Meeting ID: 944 3452 6764. The Zoom app may also be launched from the Zoom website at http://zoom.us/join, entering the Meeting ID, and following the prompts. For members of the public who do not have access to an internet connection, they may join the meeting audio by dialing the following number: 301-715-8592. When prompted, enter the following information: Meeting ID – 944 3452 6764. Then press the pound (#) key.

Written comments on the Draft SEIS may also be submitted during the public comment period as indicated above. All comments, whether verbal or written, will be considered by DOE as the SEIS is finalized. If you have any questions or require additional information, please contact Mark Lusk via email to mark.lusk@NETL.DOE.gov. We look forward to your feedback and participation in the NEPA process.

Sincerely,

Mark Lusk, NEPA Compliance Officer

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Figure A-1. Sample Draft SEIS Notification Letter (continued)

A.3 ALASKA NATIVE COORDINATION

DOE contacted each of the 78 Alaska Native Tribes (124 coordination letters hard-mailed on December 10, 2021) involved in the 2020 EIS process, notifying them of DOE's decision to prepare an SEIS and to inquire about their interest. Additionally, DOE requested the Alaska Natives provide any traditional knowledge regarding resources on the North Slope potentially affected by upstream development. To date, DOE has not received any responses from any Alaska Natives. This appendix contains a representative letter used for Alaska Native correspondence with the following Alaska Native Tribes.

- Athna, Inc.
- Alaska Eskimo Whaling Commission
- Alatna Village
- Alexander Creek Inc.
- Allakaket Village and Tribal Council
- Anderson Village
- Arctic Village Council
- Atqasuk Corporation
- Baan-O-Yeel-Kon Corporation
- Bean Ridge Corporation
- Beaver Village
- Bristol Bay Native Corporation
- Calista Corporation
- Central Council Tlingit & Haida Indian Tribes of Alaska
- Cheesh-Na Tribe
- Chenega Corporation
- Chickaloon Native Village
- Chilkat Tribal Court
- Chilkoot Indian Association
- Chugach Alaska Corporation
- Chugachmiut, Inc.
- Circle Native Community
- Cook Inlet Region, Inc.
- Cook Inlet Tribal Council
- Copper River Native Association
- Douglas Indian Association
- Doyon Limited
- Eklutna Inc.
- Eklutna Native Village

- Evansville Village and Tribal Council
- Denali Borough
- Gulkana Village
- Gwichyaa Zhee Gwichni'in Tribal Government
- Inupiat Community of the Arctic Slope
- Kaktovik Inupiat Corporation
- Kenai Natives Association, Inc.
- Kenaitze Indian Tribe
- Knik Tribal Council
- Knikatnu, Inc.
- K'oyitl'ots'ina, Limited
- Kuukpik Corporation
- Manley Hot Springs Village
- Mendas Cha-as Native Corporation
- Minto Village Council
- NANA Regional Corporation
- Native Village of Barrow Inupiat Traditional Government
- Native Village of Cantwell
- Native Village of Eyak
- Native Village of Fort Yukon
- Native Village of Gakona
- Native Village of Kaktovik
- Native Village of Kluti-Kaah
- Native Village of Nanwalek (English Bay)
- Native Village of Nuiqsut
- Native Village of Port Graham
- Native Village of Stevens
- Native Village of Tatitlek
- Native Village of Tyonek
- Nenana Native Association
- Ninilchik Traditional Council
- Nunamiut Inupiat Corporation
- Rampart Village Council
- Salamatof Native Association, Inc.
- Seldovia Village Tribe
- Seth-De-Ya-Ah Corporation

- Talkeetna
- Tanana Chiefs Conference
- Tanana Tribal Council
- The Tatitlek Corporation
- Toghotthele Corporation
- Tozitna, Limited
- Tyonek Native Corporation
- Ukpeagvik Inupiat Corporation
- Valdez Native Tribe
- Village of Anaktuvuk Pass
- Village of Salamatof
- Village of Venetie

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY
Albany, OR • Morgantown, WV • Pittsburgh, PA

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

December 10, 2021

NAME
TITLE
ORGANIZATION
ADDRESS
ADDRESS

SUBJECT: Advanced Notice Regarding the U.S. Department of Energy's Preparation of a Supplemental Environmental Impact Statement for the Proposed Alaska Liquified Natural Gas Project, and Request for Information

Dear NAME:

In August 2020, the U.S. Department of Energy (DOE) issued an order authorizing the export of liquefied natural gas (LNG) by Alaska LNG Project LLC (Alaska LNG) for a period of 30 years. The proposed Alaska LNG Project[1] would allow for the export of LNG to non-free trade agreement countries under the Natural Gas Act.[2] Sierra Club requested rehearing of that order, which DOE granted in part on April 15, 2021.

Previously in March 2020, the Federal Energy Regulatory Commission (FERC) published a Final Environmental Impact Statement (EIS) for the proposed Alaska LNG Project under the National Environmental Policy Act (NEPA).[3] DOE adopted the EIS in March 2020. In July 2021, DOE published a Notice of Intent (NOI) to Prepare a Supplemental EIS for the Alaska LNG Project in the *Federal Register* (refer to Attachment 1 of this letter).

The NOI explains that as part of DOE's rehearing process DOE is preparing a Supplemental EIS that will be comprised of two studies: (1) an assessment of potential environmental impacts associated with natural gas production on the North Slope of Alaska, and (2) a life cycle analysis calculating the greenhouse gas emissions for LNG exported from the proposed Alaska LNG Project.

In preparing the EIS, FERC collected traditional knowledge from Alaska Native communities concerning the characteristics of Alaskan natural resources and use or

[1] The Alaska LNG Project includes: (1) producing natural gas on the North Slope of Alaska, (2) transporting the natural gas on a proposed 800-mile long pipeline, and (3) liquefying the natural gas for export at a proposed liquefaction facility, to be built in the Nikiski area of the Kenai Peninsula in south central Alaska.

[2] *See Alaska LNG Project LLC*, DOE/FE Order No. 3643-A, FE Docket 14-96-LNG, Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations (Aug. 20, 2020), *available at*: https://www.energy.gov/sites/default/files/2020/08/f77/ord3643a.pdf.

[3] Federal Energy Regulatory Comm'n, Alaska LNG Project Final Environmental Impact Statement, Docket No. CP17-178-000 (Mar. 6, 2020), available at: https://www.ferc.gov/industries-data/natural-gas/final-environmentalimpact-statement-0.

3610 Collins Ferry Road, P.O. Box 880, Morgantown, WV 26507
mark.lusk@netl.doe.gov Phone (304) 285-4145 www.netl.doe.gov

Figure A-2. Sample Alaska Native Coordination

management practices that are passed down from generation to generation and contribute to the cultural, social, and spiritual identity of Alaska Native communities. DOE will incorporate this information, as relevant, into the Supplemental EIS. In particular, DOE will focus on resources within the North Slope of Alaska that may be affected by the production and export of LNG from the proposed Alaska LNG Project.

DOE currently plans to issue the Draft Supplemental EIS for public review and comment on May 2, 2022.[4] If you have additional information related to Alaska North Slope resources and greenhouse gas emissions that was not previously considered as part of FERC's EIS, we request that you provide it to my office within 30 days from the receipt of this letter.

As a recipient of this letter, you will receive the Notice of Availability for the release of the Draft Supplemental EIS and will also have an opportunity to comment at that time. Based on DOE's findings from the Supplemental EIS and any comments received, DOE may decide to modify, set aside, or affirm the Alaska LNG order.[5]

If you have any questions, please do not hesitate to contact me.

Sincerely,

Mark W. Lusk

Mark W. Lusk
NEPA Compliance Officer

1 Attachment: Notice of Intent To Prepare a Supplemental Environmental Impact Statement for the Alaska LNG Project (Federal Register / Vol. 86, No. 125 / Friday, July 2, 2021)

cc:
NAME

[4] *See* U.S. Dep't of Energy, Notice of Schedule for Supplemental Environmental Impact Statement, Docket No. 14-96-LNG (Aug. 24, 2021), *available at*: https://www.energy.gov/sites/default/files/2021-08/Alaska%20LNG%20-%20Notice%20of%20Schedule%20for%20SEIS.pdf.
[5] DOE is planning to issue the Final Supplemental EIS on September 15, 2022, and the final order on December 14, 2022. *See id.*

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Figure A-2. Sample Alaska Native Coordination (continued)

Attachment 1

35280 **Federal Register** / Vol. 86, No. 125 / Friday, July 2, 2021 / Notices

Abstract: This is a request for a new information collection. The Rural, Insular, and Native Achievement Programs (RINAP) administers Section 1121 of Title I, Part A of the ESEA; Title II of Public Law 108–118 (Supplemental Education Grant (SEG)), CARES Act—Outlying Areas; Title III of CRRSA—Outlying Areas, Sections 2005 and 11006(2–3) of the ARP; Title V, Part B of the ESEA (Rural Education Achievement Program), Title VI, Part B of the ESEA (Native Hawaiian Education); and Title VI, Part C of the ESEA (Alaska Native Education). Periodic progress updates, phone, virtual, or in-person conversations during a fiscal year with authorized representatives and project directors help ensure grantees are making progress toward meeting program goals and objectives. The information shared with RINAP helps inform the selection and delivery of technical assistance to grantees and aligns structures, processes, and routines so RINAP can monitor the connection between grant administration and intended outcomes.

Dated: June 29, 2021.

Kate Mullan,

PRA Coordinator, Strategic Collections and Clearance Governance and Strategy Division, Office of Chief Data Officer, Office of Planning, Evaluation and Policy Development.

[FR Doc. 2021–14186 Filed 7–1–21; 8:45 am]

BILLING CODE 4000–01–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplemental Environmental Impact Statement for the Alaska LNG Project

AGENCY: Office of Fossil Energy, Department of Energy.

ACTION: Notice of intent.

SUMMARY: On April 15, 2021, the U.S. Department of Energy's Office of Fossil Energy (DOE/FE) granted a request for rehearing of a final order issued to Alaska LNG Project LLC (Alaska LNG) for the export of liquefied natural gas (LNG) produced from Alaskan sources to non-free trade agreement countries, pursuant to the Natural Gas Act (NGA). In the Rehearing Order, DOE stated that it was granting rehearing for the purpose of conducting two Alaska-specific environmental studies (collectively, the Alaska environmental study proceeding). To this end, DOE intends to prepare a supplemental environmental impact statement (SEIS) for the Alaska environmental study proceeding (DOE/EIS–0512–S1), consistent with the National Environmental Policy Act (NEPA). The SEIS will include analysis of potential environmental impacts associated with natural gas production on the North Slope of Alaska and a life cycle analysis (LCA) calculating the greenhouse gas (GHG) emissions for LNG exported from the proposed Alaska LNG Project.

ADDRESSES: Documents related to the SEIS process will be posted at: *https://energy.gov/nepa/doeeis-0512-s1-supplemental-environmental-impact-statement-alaska-lng-project.*

FOR FURTHER INFORMATION CONTACT: Questions concerning the SEIS or requests to be placed on the SEIS distribution list should be sent to: Brian Lavoie, U.S. Department of Energy (FE–34), Office of Regulation, Analysis, and Engagement, Office of Fossil Energy, Forrestal Building, Room 3E–042, 1000 Independence Avenue SW, Washington, DC 20585; (202) 586–2459; *brian.lavoie@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

Background

On August 20, 2020, DOE issued DOE/FE Order No. 3643–A (the Alaska LNG Order) [1] to Alaska LNG Project LLC (Alaska LNG) under section 3(a) of the NGA.[2] DOE/FE authorized Alaska LNG to export LNG produced from Alaskan sources to any country with which the United States has not entered into a free trade agreement (FTA) requiring national treatment for trade in natural gas, and with which trade is not prohibited by U.S. law or policy (non-FTA countries). Alaska LNG is authorized to export LNG in a volume equivalent to 929 billion cubic feet per year (Bcf/yr) of natural gas (2.55 Bcf per day), for a term of 30 years, with export operations required to commence within 12 years of the date that the Alaska LNG Order was issued. Exports will occur by vessel from a liquefaction facility to be constructed in the Nikiski area of the Kenai Peninsula in south central Alaska (Liquefaction Facility), which will be part of the proposed Alaska LNG Project.[3]

Alaska Gasline Development Corporation (AGDC), an independent, public corporation of the State of Alaska, applied to the Federal Energy Regulatory Commission (FERC) for authorization to site, construct, and operate the Alaska LNG Project. As approved by FERC on May 21, 2020,[4] the Alaska LNG Project includes the following three elements:

(i) Producing natural gas from stranded resources on the North Slope of Alaska at a proposed natural gas treatment plant to be located on the North Slope;

(ii) Transporting the natural gas on a proposed 800-mile long pipeline; and

(iii) Liquefying the natural gas for export from the proposed Liquefaction Facility, which has a planned liquefaction capacity of 20 million metric tons per year of LNG (equivalent to approximately 929 Bcf/yr of natural gas).[5]

In sum, AGDC holds the FERC authorization for the Alaska LNG Project, and Alaska LNG holds the DOE authorization to export LNG from the Alaska LNG Project. Both the DOE and FERC authorizations have been challenged in the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit).[6] Those lawsuits are ongoing and are currently subject to various pending procedural motions.

To fulfill its obligations under NEPA,[7] DOE/FE participated as a cooperating agency in FERC's review of the Alaska LNG Project.[8] FERC issued the final environmental impact statement (EIS) for the Alaska LNG Project on March 6, 2020,[9] and DOE/FE adopted the final EIS on March 16, 2020 (DOE/EIS–0512).[10] Subsequently, DOE/FE issued the Alaska LNG Order, conditioning it on Alaska LNG's compliance with the 165 environmental conditions adopted in the FERC Order (*see supra* note 4), among other requirements.[11]

[1] *Alaska LNG Project LLC*, DOE/FE Order No. 3643–A, FE Docket 14–96–LNG, Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations (Aug. 20, 2020), *available at: https://www.energy.gov/sites/default/files/2020/08/f77/ord3643a.pdf* [hereinafter Alaska LNG Order].

[2] 15 U.S.C. 717b(a). The authority to regulate the imports and exports of natural gas, including liquefied natural gas, under section 3 of the NGA (15 U.S.C. 717b) has been delegated to the Assistant Secretary for FE in Redelegation Order No. S4–DEL–FE1–2021, issued on March 25, 2021.

[3] *See Alaska LNG Project LLC*, DOE/FE Order No. 3643–B, FE Docket 14–96–LNG, Order on Rehearing (Apr. 15, 2021), *available at: https://www.energy.gov/sites/default/files/2021-04/ord3643b.pdf* [hereinafter Rehearing Order].

[4] *Alaska Gasline Dev. Corp.*, Order Granting Authorization Under Section 3 of the Natural Gas Act, 171 FERC ¶ 61,134, ¶¶ 1–2 (May 21, 2020) [hereinafter FERC Order].

[5] Rehearing Order at 3.

[6] *See Sierra Club* v. *U.S. Dep't of Energy*, Petition for Review, Case No. 20–1503 (D.C. Cir. Dec. 16, 2020); *Center for Biological Diversity, et al.*, v. *Federal Energy Regulatory Comm'n*, Petition for Review, Case No. 20–1379 (D.C. Cir. Sept. 21, 2020); *see also* Rehearing Order at 5–6.

[7] 42 U.S.C. 4321 *et seq.*

[8] *See* Alaska LNG Order at 23, 32.

[9] Federal Energy Regulatory Comm'n, *Alaska LNG Project Final Environmental Impact Statement*, Docket No. CP17–178–000 (Mar. 6, 2020), *available at: https://www.ferc.gov/industries-data/natural-gas/final-environmental-impact-statement-0* [hereinafter final EIS].

[10] Letter from Amy Sweeney, DOE/FE, to Julie Roemele, U.S. Envtl. Prot. Agency (Mar. 16, 2020) (adoption of final EIS), *available at: https://www.energy.gov/nepa/downloads/doeeis-0512-notice-adoption.*

[11] *See* Alaska LNG Order at 42 (Ordering Para. H).

1

Figure A-2. Sample Alaska Native Coordination (continued)

Attachment 1

Federal Register / Vol. 86, No. 125 / Friday, July 2, 2021 / Notices **35281**

Sierra Club filed a Request for Rehearing of the Alaska LNG Order, and AGDC filed a Motion for Leave to Answer and Answer to Sierra Club's Request for Rehearing.[12] On April 15, 2021, DOE/FE issued the Rehearing Order in which DOE/FE: (i) Granted AGDC's Motion for Leave to Answer; (ii) granted Sierra Club's Rehearing Request for the purpose of conducting the Alaska environmental study proceeding; and (ii) denied Sierra Club's request for DOE/FE to withdraw the Alaska LNG Order, without prejudice to Sierra Club's ability to request relief in the future, should circumstances change.[13]

DOE/FE explained that, since the issuance of the Alaska LNG Order and while DOE/FE's action on Sierra Club's Rehearing Request was pending, the President had issued two Executive Orders (E.O.) relevant to the Alaska LNG proceeding: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*,[14] and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*.[15] Consistent with these Executive Orders and to address Sierra Club's arguments on rehearing, DOE stated that it was appropriate to further evaluate the environmental impacts of exporting LNG from the proposed Alaska LNG Project to non-FTA countries. Therefore, DOE/FE announced that it was commissioning the Alaska environmental study proceeding.[16]

Supplemental EIS (SEIS)

DOE/FE intends to prepare a SEIS for the Alaska environmental study proceeding. The SEIS will include an upstream analysis of potential environmental impacts associated with natural gas production on the North Slope of Alaska. This analysis will examine potential upstream impacts associated with incremental natural gas production on the North Slope of Alaska due to Alaska LNG's exports of LNG.

In addition, the SEIS will include a LCA calculating the GHG emissions for LNG exported from the proposed Alaska LNG Project, taking into account unique issues relating to production, pipeline transportation, and liquefaction in Alaska.[17] Specifically, the LCA will examine the life cycle GHG emissions for LNG exported from Alaska by vessel to import markets in Asia (the markets targeted for exports from Alaska) and potentially in other regions.

DOE/FE has commissioned DOE's National Energy Technology Laboratory (NETL) to conduct both studies.

Potential Areas of Environmental Analysis

For the upstream production study, DOE/FE has tentatively identified the following resource areas for analysis (although the following list is not intended to be comprehensive or to predetermine the potential impacts to be analyzed): Land use and visual resources; geology and soils; water resources; air quality and noise; ecological resources; cultural and paleontological resources; infrastructure; waste management; occupational and public health and safety; socioeconomics; transportation; and environmental justice. For the LCA, DOE/FE will examine the global nature of GHG emissions associated with exports of LNG from Alaska from a life cycle perspective, as stated previously.

NEPA Process and Public Participation in the SEIS

DOE/FE will prepare the SEIS in accordance with the Council on Environmental Quality (CEQ) regulations at 40 CFR parts 1500–1508 and DOE NEPA implementing procedures at 10 CFR part 1021. In accordance with 10 CFR 1021.311(f), a public scoping process is not required for a DOE-issued SEIS. DOE/FE will issue a notice in the **Federal Register** detailing the release of the draft SEIS, dates of one or more internet-based public hearings, and instructions for submitting public comments.

Signing Authority

This document of the Department of Energy was signed on June 28, 2021, by Jennifer Wilcox, Ph.D., Acting Assistant Secretary for Fossil Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE **Federal Register** Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on June 29, 2021.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

[FR Doc. 2021–14188 Filed 7–1–21; 8:45 am]

BILLING CODE 6450–01–P

[12] *See* Rehearing Order at 5–6 (providing additional background on DOE's rehearing proceeding). Sierra Club's and AGDC's arguments on rehearing are summarized in the Rehearing Order at 6–10.

[13] *See id.* at 2.

[14] Exec. Order 13990 of Jan. 20, 2021, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, 86 FR 7037 (Jan. 25, 2021), *available at: https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis*. E.O. 13990 directs agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change.

[15] Exec. Order No. 14008 of Jan. 27, 2021, Tackling the Climate Crisis at Home and Abroad, 86 FR 7619 (Feb. 1, 2021), *available at: https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad*. E.O. 14008 sets forth additional policies to address climate change—specifically to "organize and deploy the full capacity of [Federal] agencies to combat the climate crisis"—and requires the "Federal Government [to] drive assessment, disclosure, and mitigation of climate pollution and climate-related risks in every sector" of the U.S. economy.

[16] *See* Rehearing Order at 12–13.

[17] DOE/FE previously has explained that a LCA is a method of accounting for cradle-to-grave GHG emissions over a single common denominator. DOE considers GHG emissions from all processes in the LNG supply chains—from the "cradle" when natural gas is extracted from the ground, to the "grave" when electricity is used by the consumer. *See* U.S. Dep't of Energy, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas From the United States: 2019 Update—Response to Comments, 85 FR 72, 76 (Jan. 2, 2020); *see also* Rehearing Order at 14 n.90.

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. EL21–83–000]

PJM Interconnection, L.L.C.; Notice of Filing

Take notice that on June 10, 2021, pursuant to section 206 of the Federal Power Act, 16 U.S.C. 824e, and Rule 206 of the Federal Energy Regulatory Commission's (Commission) Rules of Practice and Procedure, 18 CFR 385.206, PJM Interconnection, L.L.C. (PJM), made a filing identifying an unjust and unreasonable aspect of the formula for determining the Regulation market performance-clearing price credit, as stated in PJM Open Access Transmission Tariff Attachment K-Appendix, section 3.2.2(g) and the Amended and Restated Operating Agreement of PJM Interconnection, L.L.C., Schedule 1, section 3.2.2(g). PJM submitted this filing to establish a refund effective date for the replacement calculation of the formula, which is currently under development in the PJM stakeholder process, as more fully explained in the filing.

Any person desiring to intervene or to protest this filing must file in accordance with Rules 211 and 214 of

2

Figure A-2. Sample Alaska Native Coordination (continued)

U.S. Department of Energy

DOE/EIS-0512-S1

Alaska LNG Project

Final
Supplemental Environmental Impact Statement

APPENDIX B
NORTH SLOPE PRODUCTION STUDY

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B.3 PRODUCTION REPORT 3 – ALASKA LNG UPSTREAM STUDY REPORT 3: STORING BYPRODUCT CO_2 FROM THE ALASKA LNG GAS TREATMENT PLANT AT THE PRUDHOE BAY UNIT (APRIL 5, 2022)

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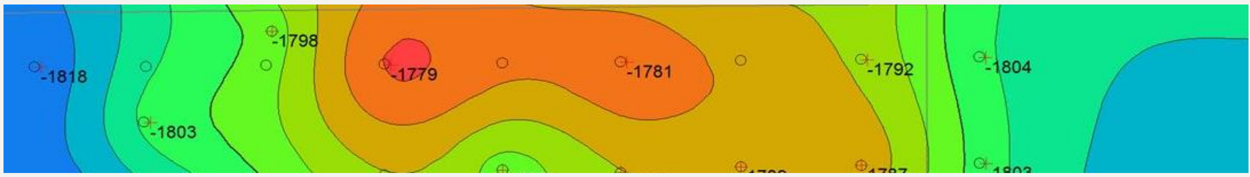
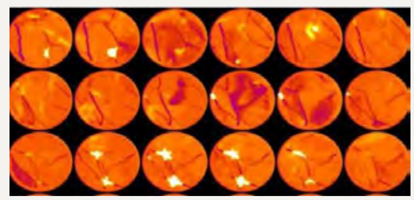
NATIONAL ENERGY TECHNOLOGY LABORATORY





Alaska LNG Upstream Study Report 1: Establishing the Sources of Natural Gas Supply for the Alaska LNG Project

May 20, 2022
DOE/NETL-2022/3785

Vello Kuuskraa[1]
Matt Wallace[1]
Donald Remson[2*]

The authors wish to acknowledge the excellent guidance, contributions, and cooperation of:

Tim Skone[2]
Alana Sheriff[3]
Timothy R. Carr, Ph.D.[4]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Conservation
AGDC	Alaska Gasline Development Corporation
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollutant Discharge Elimination System
B, bbl	Barrel
B/D	Barrels per day
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
cf	Cubic feet
cfd	Cubic feet per day
CCP	Central Compressor Plant
CGF	Central Gas Facility
CO_2	Carbon dioxide
cp	Centipoise
CWA	Clean Water Act
d, D	Day
DOE	U.S. Department of Energy
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Study
EOR	Enhanced oil recovery
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
ft	Foot
GCWI	Gas cap water injection
GPMA	Greater Point McIntyre Area
GTP	Gas Treatment Plant
H_2S	Hydrogen sulfide
IPA	Initial Participating Area
LNG	Liquefied natural gas
m	Meter
M	Thousand
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
mD	Millidarcy
MGSP	Major Gas Sales Project
MI	Miscible injectant
MIST	Miscible injectant sidetrack
MM	Million
MMBO	Million barrels oil
MMcfd	Million cubic feet per day
mol%	Mole percent
MW, MWe	Megawatt electric
n/a	Not available/applicable
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
OGIP	Original gas in-place
OOIP	Original oil in-place
PAVE	Pressure and Vaporization Program
PBU	Prudhoe Bay Unit
POD	Plan of Development
POP	Prudhoe Oil Pool
psi	Pounds per square inch
PTTL	Point Thomson Transmission Line
PTU	Point Thomson Unit
scf	Standard cubic feet
scf/B	Standard cubic feet per barrel
SPCC	Spill Prevention, Control, and Countermeasure
SWOP	Seawater Optimization Plan
TAPS	Trans Alaska Pipeline System
Tcf	Trillion cubic feet
tonne	Metric ton (1,000 kg)
U.S.	United States
UIC	Underground Injection Control
VSM	Vertical support member
WAG	Water-alternating-gas
°API	Degrees API (American Petroleum Institute)
°C	Degrees Celsius
°F	Degrees Fahrenheit

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EXECUTIVE SUMMARY

BACKGROUND

The Alaska LNG Project has received authorization to export 2.55 billion cubic feet per day (Bcfd) of natural gas for 30 years from its LNG facility in Nikiski to overseas markets.

In addition to the authorized volumes of natural gas exports, notable volumes of natural gas will need to be produced for lease fuel, local sales, gas reinjection fuel by the existing Central Compressor Plant (CCP) and the Central Gas Facility (CGF), extraction of natural gas liquids (NGLs), and other uses. Additional fuel will also be needed to operate the Gas Treatment Plant (GTP), the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove carbon dioxide (CO_2) from the gas stream.

STUDY PURPOSE

This report is the first in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together these three reports comprise the "Upstream Study" of oil and natural gas resources and CO_2 utilization and storage potential at the Prudhoe Bay Unit (PBU) and surrounding areas.

The purpose of this report, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is to evaluate the capacity of natural gas supply from the PBU and the Point Thomson Unit (PTU) on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

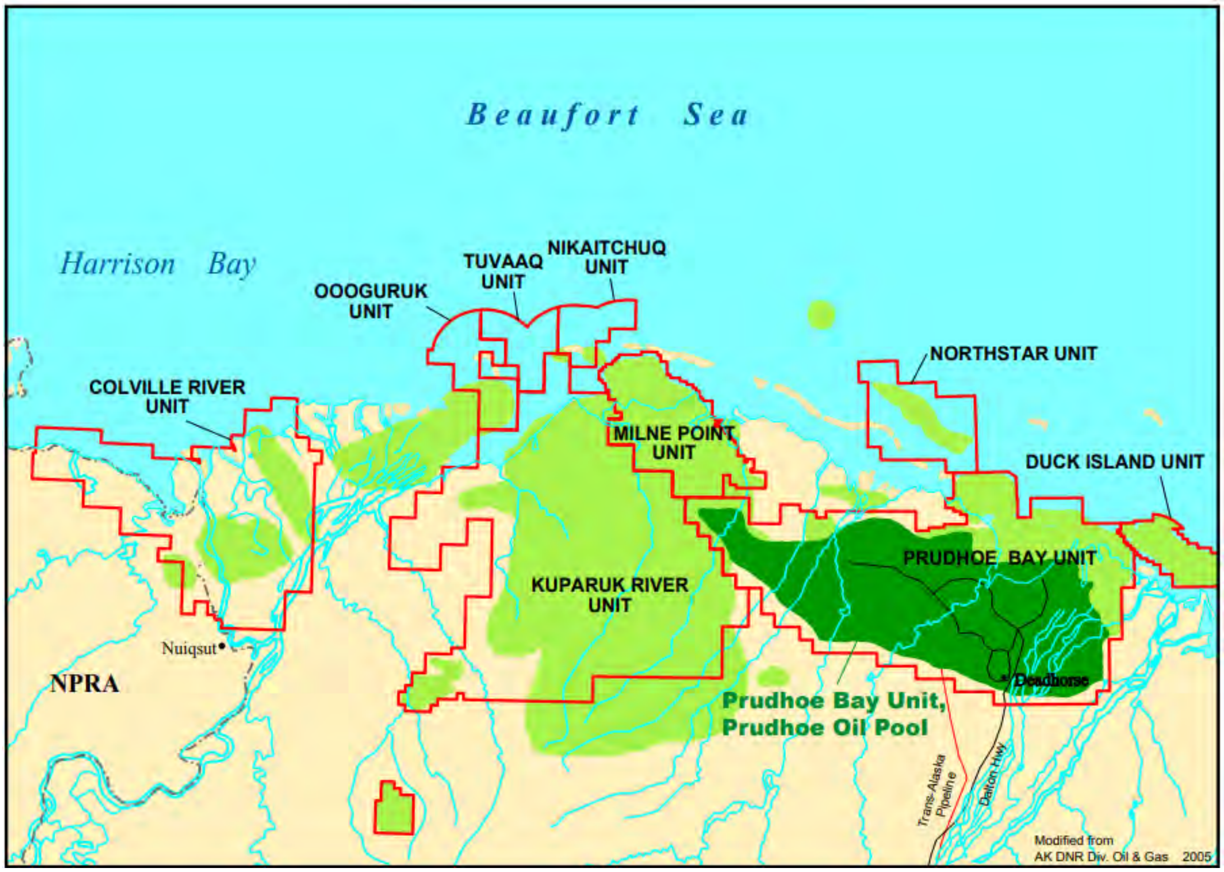
The second of the three Upstream Study reports, "Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential," examines the impacts of the Alaska LNG Project on oil production at the PBU and discusses options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP for CO_2 enhanced oil recovery (EOR) operations on the North Slope.

The third of the three Upstream Study reports, "Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit," identifies and assesses the viability of storing byproduct CO_2 from the GTP facility in a deep saline reservoir at the PBU.

SOURCES OF NATURAL GAS SUPPLY

Exhibit ES-1 provides a location map for the primary North Slope of Alaska fields addressed by this study. The PBU, consisting of the Prudhoe Oil Pool (POP) and a series of satellite fields, is expected to provide 75 percent of the natural gas supply. The PTU, located 60 miles to the east of the PBU, is expected to provide approximately 25 percent of the natural gas supply.

Exhibit ES-1. North Slope field location map



Used with permission from Alaska Oil and Gas Conservation Commission (AOGCC) [1]

REQUIRED NATURAL GAS SUPPLY

To provide a baseline for establishing the volumes of natural gas needed for export and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the Appendices in the Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supplies for the Alaska LNG Project.

The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility. As shown in Exhibit ES-2, a delivery of 3.36 Bcfd is required at the GTP to have 2.55 Bcfd of natural gas available for export. [2]

Exhibit ES-2. Natural gas supply material balance: from input to GTP to output from LNG facility

Primary Supply Delivery Nodes	Natural Gas Supply (Bcfd)	
1 Delivery to Gas Treatment Plant		**3.36**
Less: Fuel Use	(0.21)	
Extraction of CO_2/H_2S	(0.35)	
2 Delivery to Mainline Pipeline		**2.80**
Less: Fuel Use	(0.07)	
In-State Sales	n/a	
3 Delivery to LNG Facility		**2.73**
Less: Fuel Use	(0.18)	
4 Available for LNG Export		**2.55**

To provide 30 years of gas supply to the GTP will require 34.2 trillion cubic feet (Tcf) of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4) and reduced volumes of exports during Year 30. This volume of natural gas will support 22.9 Tcf of gas exports, after deduction of fuel use and extraction of CO_2 from the produced gas stream. In addition, the study estimates the need for 2.9 Tcf of residual gas resources[a] to support the delivery of natural gas supply to the GTP in Year 30. As such, the total required natural gas resources for the Alaska LNG Project is 37.1 Tcf (Exhibit ES-3).

Exhibit ES-3. Required natural gas resources: 30 years of LNG exports

Time Period	Required Resources (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	0.8
Total	**34.2**
Residual Gas Resources*	2.9
Total	**37.1**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

[a] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during years 31–40.

AVAILABLE NATURAL GAS RESOURCES

Two fields are expected to be the primary sources of natural gas supply for the LNG facility—the PBU and the PTU. Other fields adjoining the PBU could also provide natural gas supply to the GTP, if needed.

The study's estimate of available natural gas resources draws on the U.S. Department of Energy (DOE)/National Energy Technology Laboratory (NETL) report entitled "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" The estimate adjusts the natural gas resources numbers in this report for reserve growth at PBU/PTU and for higher fuel consumption due to a later LNG export start date of 2029. With these adjustments, these two fields have estimated natural gas resources of 41.1 Tcf, with 30.7 Tcf from PBU and 10.4 Tcf from PTU. [3] A portion of this gas resource, estimated at 3.0 Tcf, would be consumed for fuel, local sales, NGL extraction, and other uses, leaving 38.1 Tcf available for delivery to the GTP (Exhibit ES-4). This volume of natural gas resources is sufficient to meet the gas supply requirements of 37.1 Tcf, shown previously in Exhibit ES-3.

Exhibit ES-4. Summary of available natural gas resources, PBU/PTU

	PBU (Tcf)	PTU (Tcf)	Total (Tcf)
Available Resources	28.7	9.1	37.8
Reserve Growth	2.0	1.3	3.3
Total	**30.7**	**10.4**	**41.1**
Less: Lease Fuel, Sales/Other	2.7	0.3	3.0
Total	**28.0**	**10.1**	**38.1**

POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the PBU and the PTU will entail some additional development, as discussed in the Federal Energy Regulatory Commission (FERC) Environmental Impact Study (EIS). [4] More specifically, the FERC EIS states that the activities set forth in its report for the PBU Major Gas Sales Project (MGSP) and the PTU Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to the Alaska LNG Project rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by vertical support members (VSMs), permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the PTU marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to the Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at PTU, as well as camps at PBU and Badami.

The Alaska Gasline Development Corporation (AGDC) indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clean Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

STUDY FINDINGS

The study, “Establishing the Sources of Natural Gas Supply for the Alaska LNG Project,” finds that sufficient volumes of natural gas resources are available from PBU and PTU to meet the expected volumes of natural gas exports by the Alaska LNG Project.

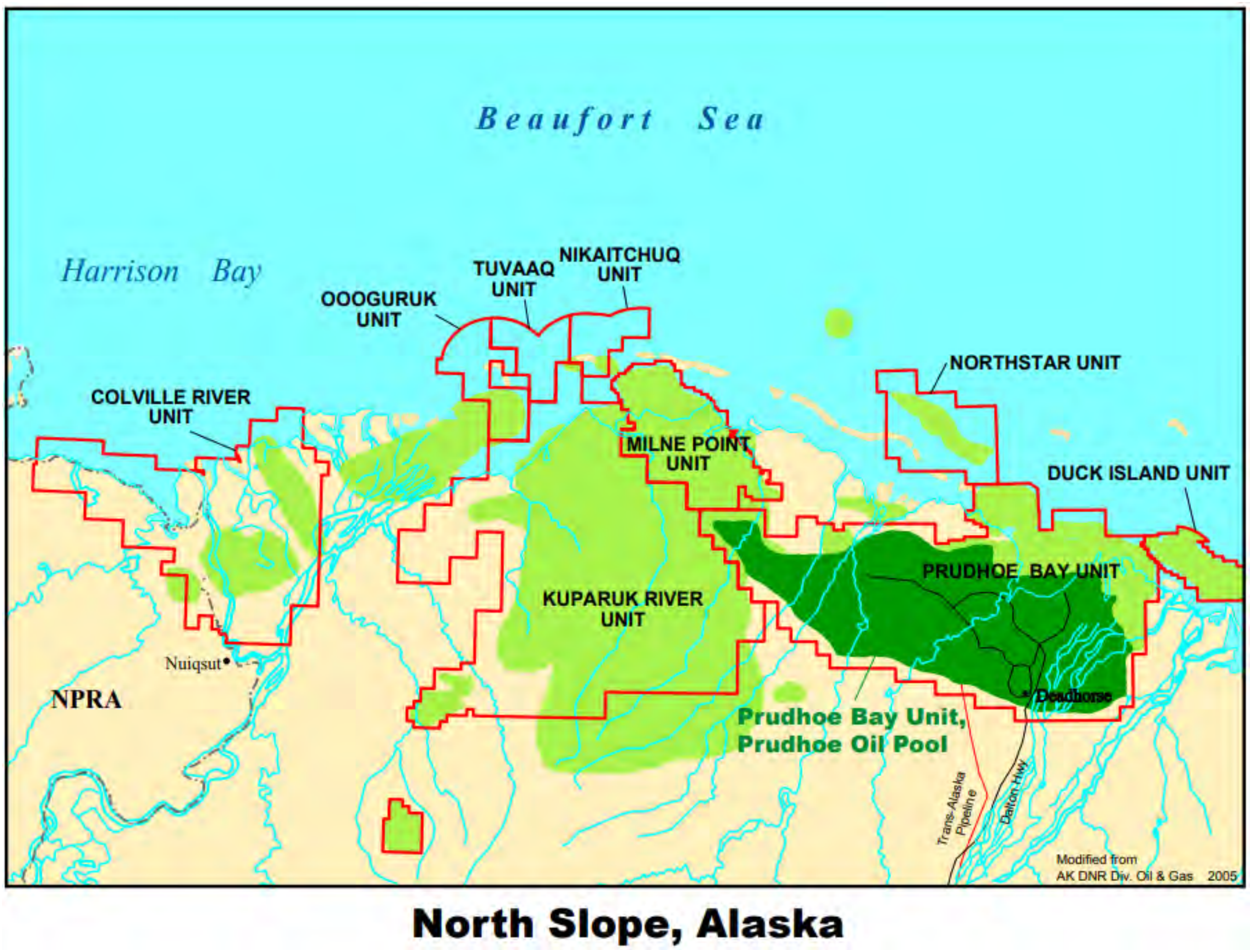
The PBU and PTU, with 38.1 Tcf of available resources, would meet the required 37.1 Tcf of natural gas for the Alaska LNG Project.

1 PRUDHOE BAY FIELD

1.1 BACKGROUND

The Prudhoe Bay oil field, also called the Prudhoe Bay Unit (PBU), covers an area of about 213,000 acres on the North Slope of Alaska along the coastline of the Beaufort Sea (Exhibit 1-1). The PBU contains the Prudhoe Oil Pool (POP) and a series of satellite oil fields, such as Aurora, Borealis, Midnight Sun, Lisburne, and Point McIntyre, among others. These satellite fields are located within the boundaries of the PBU and are being developed using PBU production and processing facilities.

Exhibit 1-1. Prudhoe Bay oil field location map



Used with permission from AOGCC [1]

1.2 DISCOVERY AND DEVELOPMENT

The PBU was discovered in 1968 with the Prudhoe Bay State No. 1 exploratory well. The discovery well added both the POP and the Lisburne Oil Pool. Subsequent exploratory drilling in the eastern portion of the PBU discovered the Point McIntyre Oil Pool in 1988, the Niakuk Oil

Pool in 1993, and the Raven Oil Pool in 2001. These four fields, along with currently inactive North Prudhoe Bay and West Beach Oil Pools, have been combined into the Greater Point McIntyre Area (GPMA), also called the Eastern Satellite fields. [1]

Exploratory drilling in the western portion of the PBU led to the discovery and development of the Midnight Sun and Polaris Oil pools in 1997, followed by the discovery and development of the Aurora Oil Pool in 2000 and the Borealis and Orion Oil pools in 2001. These five oil pools are combined into the Western Satellite Participating Areas, also called the Western Satellite fields. [1]

Large-scale oil production from the POP began in 1977 with the completion of the Trans Alaska Pipeline System (TAPS) from the North Slope to Valdez in southern Alaska. The POP has been developed with a host of technically innovative hydrocarbon recovery practices, as further discussed in this report.

Production from the Eastern Satellite fields (GPMA) started first at Lisburne in 1982, followed by Point McIntyre in 1993 and Niakuk in 1994. These oil fields are being developed using waterflooding, with gas injection/gravity drainage underway in Lisburne and Point McIntyre, and gas cap water injection also used in the Lisburne field. [5]

Production from the Western Satellite fields started at Midnight Sun in 1998, followed by Polaris in 1999, Aurora in 2000, and Borealis and Orion in 2001. These five oil fields are being produced with miscible injectant (MI) involving water-alternating-gas (WAG) technology. [6]

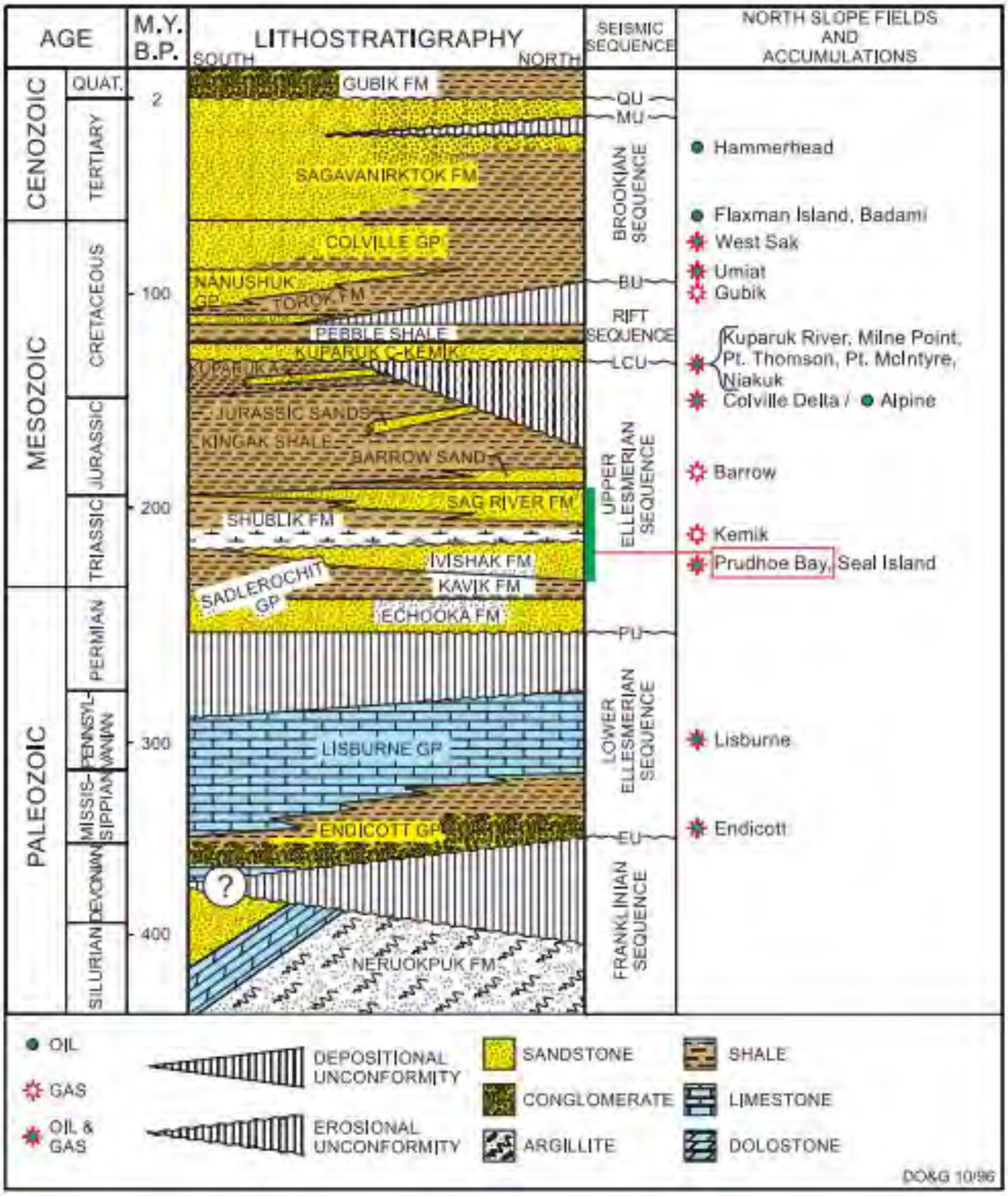
1.3 GEOLOGIC AND RESERVOIR SETTING

1.3.1 Prudhoe Oil Pool

The POP contains three deep Permian/Triassic-age sandstone formations—Sag River, Shublik, and Ivishak. The Ivishak, also called the Sadlerochit, is the major producing formation, as shown in the Generalized North Slope stratigraphic column (Exhibit 1-2). The reservoir is a combination structural and stratigraphic trap, bounded on the north by major faults and on the east by a Lower Cretaceous truncation (Exhibit 1-3). [1]

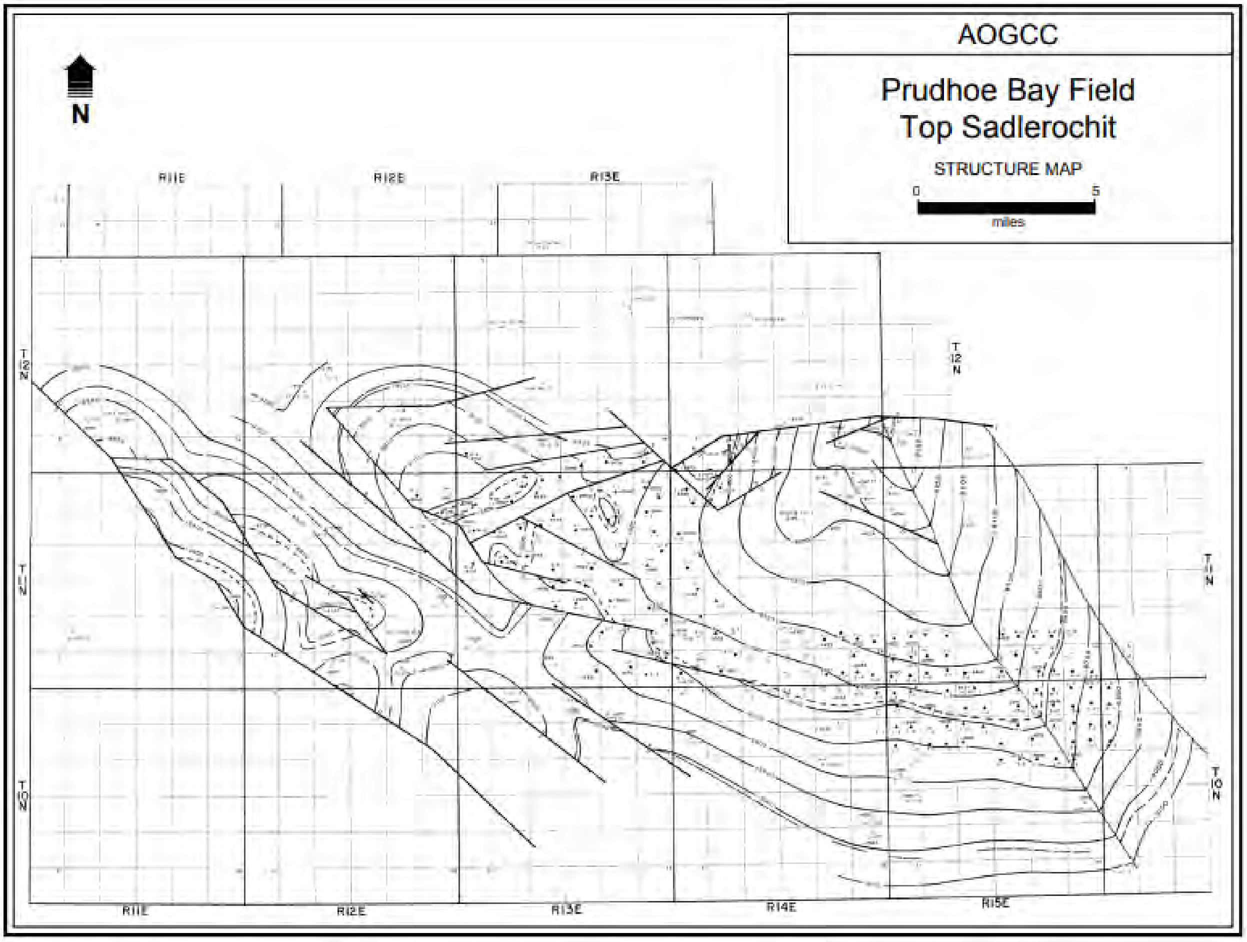
The high productivity of the reservoirs in the POP, with initial flows of 10,000 barrels per day (B/D) per well, is supported by a thick oil column of nearly 500 feet (ft), high permeability that averages nearly 300 millidarcy (mD), strong initial reservoir pressure of 4,335 pounds per square inch (psi), and a low oil viscosity of 0.8 centipoise (cp). [1]

Exhibit 1-2. Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations



Used with permission from AOGCC [1]

Exhibit 1-3. Prudhoe Bay oil field structure map

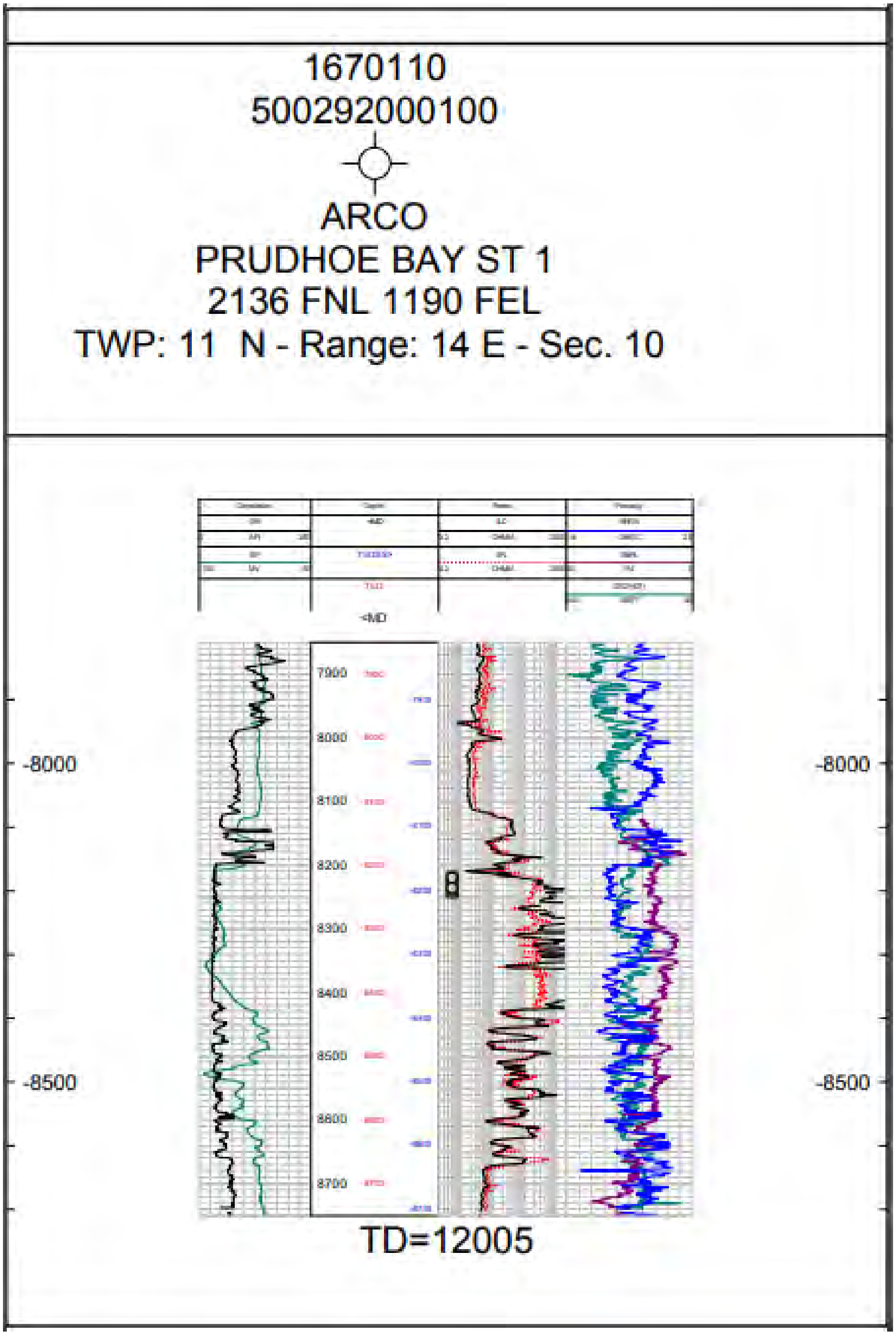


Used with permission from AOGCC [1]

A type-log for the POP, the ARCO Prudhoe Bay State No. 1 well, the field discovery well, is shown in Exhibit 1-4. [1]

The primary oil recovery mechanisms include gravity drainage (below the large gas cap), solution-gas drive, and a weak water drive. The primary oil recovery mechanisms have been augmented with reinjection of produced gas to maintain reservoir pressure and to produce a portion of the residual oil in the gas cap. More recently, the field operator has undertaken injection of water into the gas cap (gas cap water injection [GCWI]) using reinjection of produced water augmented by seawater injection (the Seawater Optimization Plan [SWOP]). In addition, the operator is continuing the world-scale miscible enhanced oil recovery (EOR) program at the POP. [7] [8] [9]

Exhibit 1-4. Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations



Used with permission from AOGCC [1]

1.3.2 Western Satellite Fields

The Western Satellite oil fields produce from the Early Cretaceous-age Kuparuk River Formation, a stratigraphically complex quartz-rich sandstone with interbedded siltstone and mudstone. The Kuparuk reservoir contains three to four stratigraphic intervals, with the "C" interval the primary oil formation. The oil gravity in these fields ranges from 24–27°API. The original reservoir pressure ranges from 4,450–4,480 psi, with reservoir temperatures of about 180°F. The original solution gas-oil ratios range from 500–800 standard cubic feet per barrel (scf/B). [1]

1.3.3 Eastern Satellite Fields

In the eastern portion of the PBU (the location of the Eastern Satellite oil fields), the Lisburne Oil Pool produces from the deeper Lisburne Group, a limestone and dolomite formation interbedded with shaly and silty beds. The Lisburne Oil Pool has a gas cap and solution gas in the reservoir with an original gas-oil ratio of 830 scf/B. The oil gravity is 27°API and the reservoir has an original pressure of 4,490 psi and a temperature of 183°F. The second notable Eastern Satellite oil field, the Point McIntyre Oil Pool, produces from the Cretaceous-age Kuparuk and Kalubik formations. Point McIntyre has an oil gravity of 27°API with an original reservoir pressure of about 4,380 psi and a reservoir temperature of 180°F. [1]

1.4 OIL AND GAS RESOURCES

1.4.1 Oil and Condensate Resources

The Prudhoe Bay Field, the largest oil field in North America, is estimated to contain about 25 billion barrels of original oil in-place (OOIP). The application of new technologies and improved understanding of the key oil displacement mechanisms have increased the initial estimated oil recovery factor of about 40 percent of OOIP to more than 60 percent of OOIP. The condensate recovery factor is estimated at 80 percent of original condensate in-place. This has raised the expected oil recovery at the Prudhoe Bay Field from an initial estimate of 9.6 billion barrels of oil to a range of 14–15 billion barrels of oil. [10]

As of the end of 2020, approximately 13 billion barrels of oil have been recovered from the PBU, with about 12 billion barrels from the POP and the remainder from Satellite fields. [1]

1.4.2 Natural Gas Resources

Total original gas in-place (OGIP) for the PBU is estimated at 47.4 trillion cubic feet (Tcf). [3] The oil field is overlain by a major gas cap and the reservoir oil contains gas in solution with an original solution gas-oil ratio of 735 scf/B.

1.4.2.1 Prudhoe Bay Unit

According to an earlier North Slope of Alaska resource study conducted by the U.S. Department of Energy/National Energy Technology Laboratory (U.S. DOE/NETL) [3], as well as adjustments made by this study, 28.7 Tcf of natural gas resources will be available from the PBU at the start of the Alaska LNG Project in 2029. This estimate is based on an initial recoverable natural gas resource of 35.9 Tcf, less 7.2 Tcf consumed for fuel and other gas uses before the start of the Alaska LNG Project. Subtracting 2.7 Tcf for fuel and other uses (including gas shrinkage from extraction of natural gas liquids [NGLs]) at the field site during the 30-year Alaska LNG Project, 26.0 Tcf of natural gas resources is available from the PBU for delivery to the Gas Treatment Plant (GTP) (Exhibit 1-5).

Exhibit 1-5. Prudhoe Bay Unit natural gas resources

Area	Recoverable Resources (Tcf)	Lease Fuel/Other (Tcf)	Available Resources for GTP (Tcf)
Total	**28.7**	**(2.7)**	**26.0**
Prudhoe Oil Pool	24.8	(2.4)	22.4
PBU Satellite Fields	3.9	(0.3)	3.6

Modified with permission from U.S. DOE/NETL, 2007 [3] and BP Exploration (Alaska), 2015 [11] by Advanced Resources International, 2021

1.4.2.2 Prudhoe Oil Pool

Based on information provided by BP Exploration (Alaska) Inc. to the Alaska Oil and Gas Conservation Commission (AOGCC), the POP could produce 24.8 Tcf during 30 years of the Alaska LNG Project. Subtracting fuel and other uses of 2.4 Tcf, approximately 22.4 Tcf would be available for delivery to the GTP over a 30-year period. [11]

1.4.2.3 PBU Satellite Fields

Subtracting the recoverable natural gas resources at the POP (24.8 Tcf) from the total resources at PBU (28.7 Tcf) leaves 3.9 Tcf of natural gas resources available from PBU Satellite fields, notably Lisburne and Point McIntyre. Subtracting 0.3 Tcf of natural gas for fuel and other uses leaves a net volume of 3.6 Tcf available from PBU Satellite fields for delivery to the GTP (Exhibit 1-5).

1.4.2.4 Reserve Growth

Better understanding of reservoir geology and structure with use of seismic, improved characterization of reservoir properties with modern-day logs, and application of more effective recovery technologies such as horizontal wells have enabled the recoverable oil and gas reserves at the PBU to increase substantially, as shown in Exhibit 1-6. [3]

Exhibit 1-6. Change in recoverable reserves from discovery or onset of production to end of 2004

Producing Field		Original Reserve Estimate (MMBO)	Estimated Ultimate Recovery (MMBO)	Change (MMBO)
Prudhoe Bay Unit				
1.	Prudhoe Oil Pool	9,560	13,841	+4,251
2.	Point McIntyre	300	591	+291
3.	Lisburne	400	192	(208)

The changes in recoverable reserves (reserve growth) for the fields shown in Exhibit 1-6 are from discovery to end of Year 2004. Additional reserve growth in these fields since the publication of this data would be expected, particularly from the more recently discovered fields.

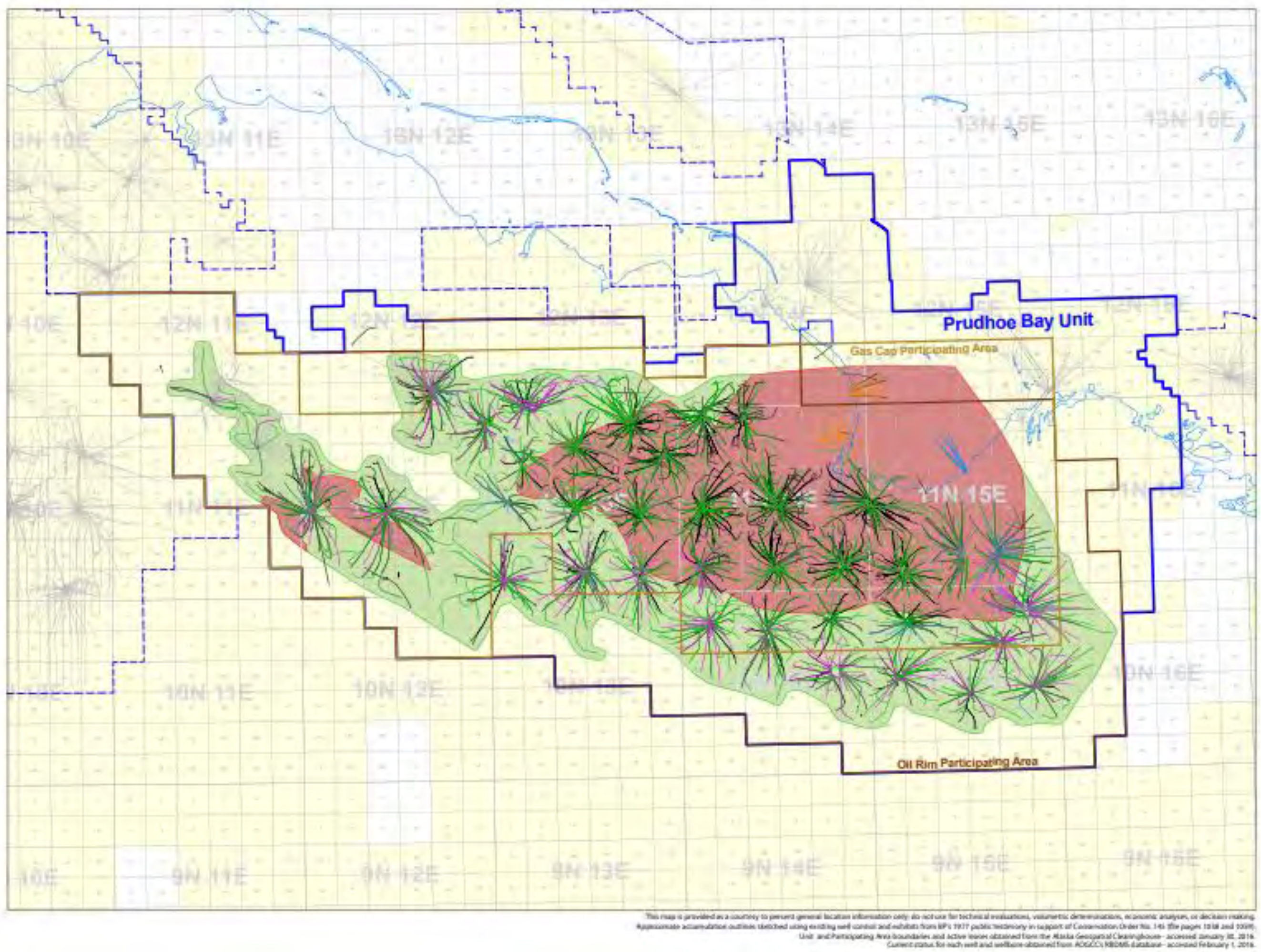
The initial recoverable natural gas resources estimate of 35.9 Tcf for PBU assumed 75.7 percent recovery of OGIP (47.4 Tcf * 0.757 = 35.9 Tcf). [3] This study estimates that with reserve growth, the ultimate natural gas recovery efficiency for PBU will be consistent with the 80 percent of OOIP recovery efficiency expected for condensate. [12] The technical literature discusses that high-permeability natural gas reservoirs will have recovery efficiencies of 80 percent or higher. [13] This would provide an estimated 2.0 Tcf of reserve growth from the PBU.

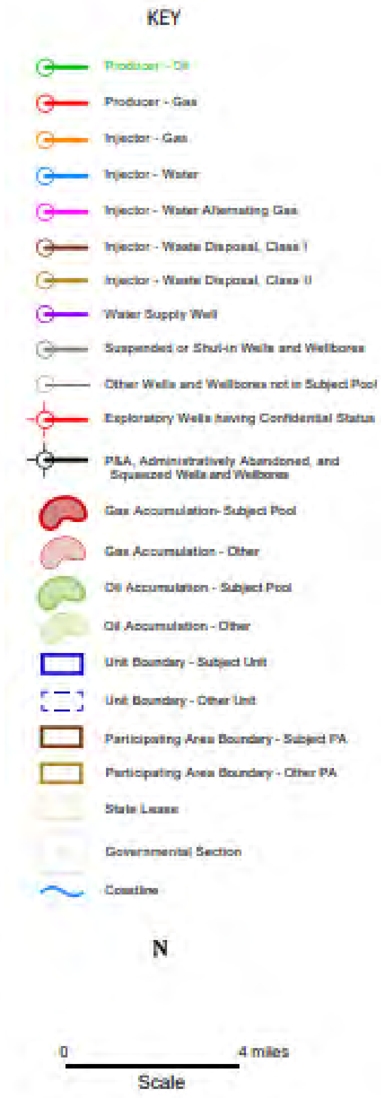
1.5 FIELD DEVELOPMENT

1.5.1 Current Status

Oil development at the POP involves large-scale (7.68 billion cubic feet per day [Bcfd]) reinjection of the produced gas, primarily into the gas cap for gravity drainage. [14] In addition, the POP is the site of one of the largest waterflood and EOR projects in the world. Currently, the field has more than 800 active oil-producing wells, along with about 220 gas, water, and MI wells. These wells have been drilled and produce from a series of central well pads (Exhibit 1-7).

Exhibit 1-7. Prudhoe Bay Unit Prudhoe Oil Pool location map





Used with permission from AOGCC [1]

1.5.2 Year 2020 and 2021 Development

Year 2020 and 2021 development at the PBU focused primarily on maintaining and increasing oil recovery, not the development of the natural gas resources. However, because so much of the oil production brings associated gas, the oil development activities underway in the PBU will also contribute to increased future natural gas supply.

The 2020 drilling program at the POP focused mainly on the development of the miscible injectant sidetrack (MIST) program at Drill Site 03, involving drilling three new sidetracked production wells and two new sidetracked injection wells in the waterflooded area to expand the MIST program. Additional sidetracked production and injection wells were drilled in the gravity drainage area. Drilling activity at the POP was halted in April 2020 due to the COVID-19 pandemic and was not scheduled to resume for the remainder of 2020. [14]

A two-well-workover effort was implemented in early 2020 at the POP and then placed on hold for the remainder of the year. For 2021, the field operator, Hilcorp North Slope LLC, had planned to conduct about 15 well workovers in the POP, enhancing productivity and returning idle wells to production.

Modifications to the SWOP were implemented in mid-2020. The existing seawater injection at Flow Station 1 (FS1, Drill Sites 01 and 12) was shut in and diverted to the GCWI project to improve the gas vaporization oil recovery process at the POP.

For the longer-term, Hilcorp plans to evaluate new drilling opportunities, examine the potential for undeveloped resources, and appraise and potentially expand the performance of their Pressure and Vaporization (PAVE) Program. [15]

Due to challenging conditions related to COVID-19, the PBU working interest owners did not approve a drilling or development program for the PBU Satellite fields for 2021.

1.5.3 Modified 2021 Development Plan

In June 2021, Hilcorp North Slope filed its new 2021 Plan of Development (POD) for the Eastern Satellite fields in the PBU. [15] The plan includes drilling four new oil and associated gas wells and completing up to three well workovers at Lisburne and Point McIntyre. Subsequently, in September 2021, Hilcorp North Slope also provided a revised POD for the Western Satellite fields in the PBU. This POD proposes the drilling of four new wells in 2021 and up to 10 new wells in 2022 at Orion, drilling up to five new wells at Polaris, drilling up to four new wells at Borealis, and drilling a new well and conducting a robust well workover program at Aurora. [16]

1.6 ANNUAL PRODUCTION

1.6.1 Crude Oil and Condensate

Prudhoe Oil Pool. The PBU Initial Participating Area (IPA) (also called the POP) provided 166,797 B/D of crude oil and condensate production in 2020, up from 164,715 B/D in 2019. The PBU Satellite fields (Aurora, Borealis, Orion, Midnight Sun, Polaris, and Point McIntyre, among others) and three small oil pools produced 48,411 B/D in 2020 and 44,562 B/D in 2019. As such, the total 2020 oil/condensate production from the PBU was 215,208 B/D of crude oil and condensate, up from 209,277 B/D in 2019 (Exhibit 1-8). [1]

Exhibit 1-8. Crude oil/condensate and natural gas production, Prudhoe Oil Pool and Satellite fields*

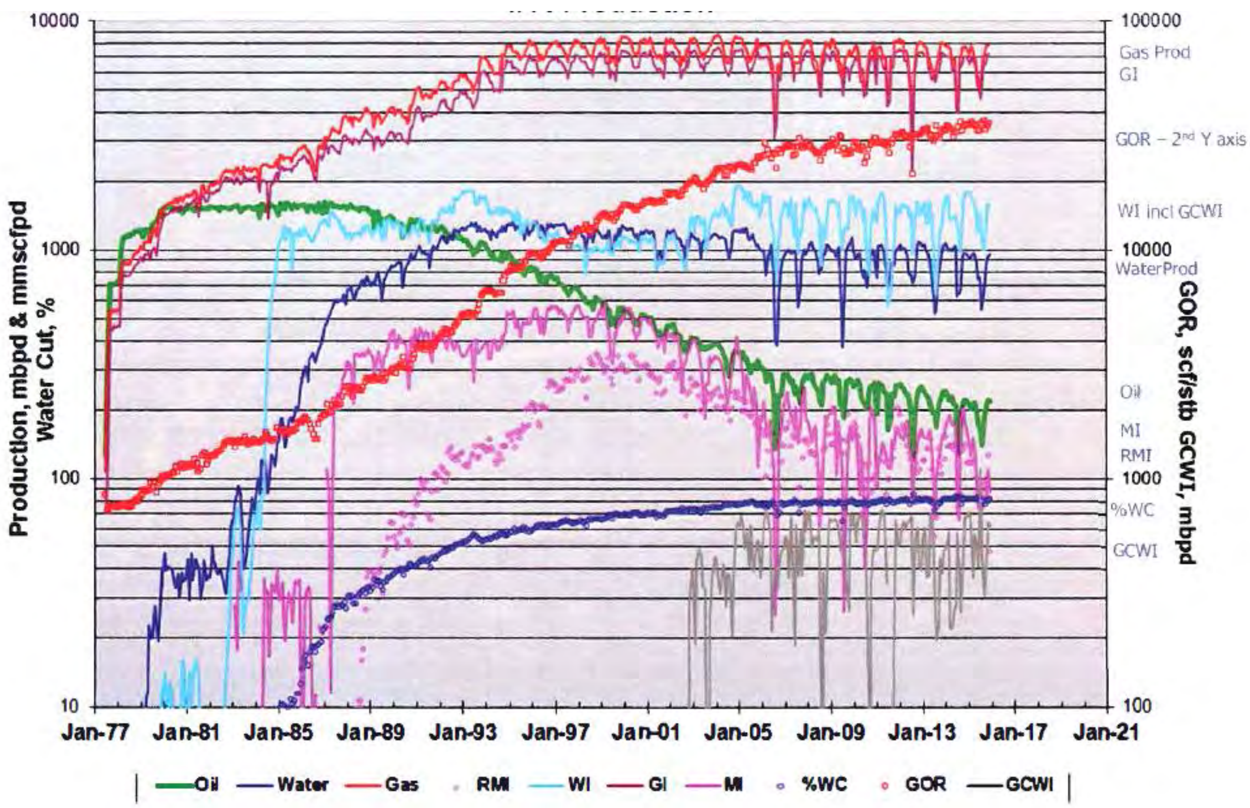
		Oil/Liquids Production				Gross Gas Production			
		2019		2020		2019		2020	
		MB	B/D	MB	B/D	MMcf	Mcfd	MMcf	Mcfd
Western Satellites	Aurora	1,712	4,690	1,945	5,329	4,571	12,523	4,897	13,416
	Borealis	1,920	5,260	2,034	5,573	6,847	18,759	5,713	15,652
	Midnight Sun	408	1,118	356	975	3,226	8,838	2,433	6,666
	Orion	1,609	4,408	1,438	3,940	2,642	7,238	2,882	7,896
	Polaris	1,303	3,570	2,267	6,211	1,442	3,951	3,246	8,893
	Total	6,952	19,047	8,040	22,027	18,728	51,310	19,171	52,523
Eastern Satellites	Lisburne	3,494	9,573	3,701	10,140	81,028	221,995	77,887	213,389
	Niakuk	320	877	294	805	428	1,173	425	1,164
	Pt. McIntyre	4,857	13,307	5,152	14,115	58,145	159,301	65,059	178,244
	Raven	307	841	176	482	916	2,510	661	1,811
	Total	8,978	24,597	9,323	25,542	140,517	384,978	144,032	394,608
Other	Put River	99	271	53	145	672	1,841	493	1,351
	Sag River	220	603	220	603	1,042	2,855	826	2,263
	Put River U	16	44	34	93	236	647	1,723	4,721
	Total	335	918	307	841	1,950	5,342	3,042	8,334
Subtotal		**16,265**	**44,562**	**17,670**	**48,411**	**161,195**	**441,630**	**166,245**	**455,466**
Prudhoe Oil Pool		**60,121**	**164,715**	**60,881**	**166,797**	**2,565,775**	**7,029,521**	**2,726,025**	**7,468,562**
Total		**76,386**	**209,277**	**78,551**	**215,208**	**2,726,970**	**7,471,151**	**2,892,270**	**7,924,027**

*Please note that the oil and gas production volume derived from the AOGCC database is sometimes of variance with the oil and gas production data provided by field operators.

Based on information derived from the Annual Reservoir Surveillance Reports for 2020 and the 2021 POD for the IPA of the PBU, approximately 73,300 B/D of oil production in 2020 was from the Waterflood/MI area, with 93,500 B/D produced from the gravity drainage area.

As shown in Exhibit 1-9, oil production from the PBU IPA, after reaching a 10-year plateau of about 1.5 million B/D between the late 1970s and late 1980s, has been steadily declining for the past 30 years. The field saw a relatively steep drop in the annual oil production during the initial years after the production plateau, declining to about 1.29 million B/D in 1990 and then to about 0.51 million B/D in 2000.

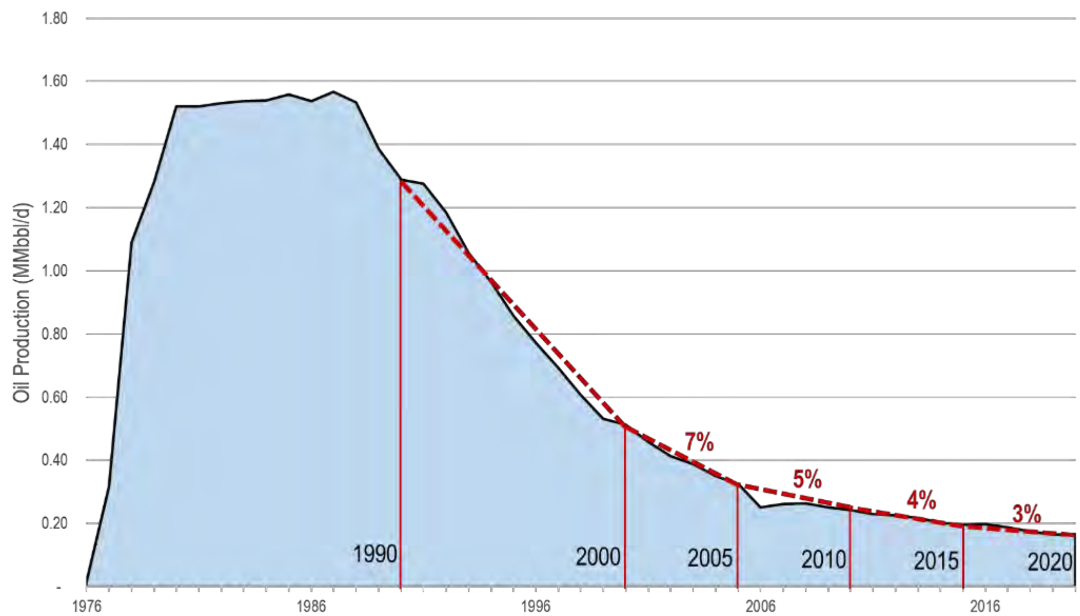
Exhibit 1-9. PBU IPA historical production



Used with permission from AOGCC [1]

However, during the past 20 years, from 2000–2020, the decline in oil production has steadily slowed, to about 7 percent per year between 2000–2005, about 5 percent per year between 2005–2010, about 4 percent per year between 2010–2015, and finally to about 3 percent per year between 2015–2020 (Exhibit 1-10).

Exhibit 1-10. PBU IPA oil production decline



Used with permission from AOGCC [1]

As shown in Exhibit 1-11, the historic pressure decline at the PBU POP has been stabilized and has moderately increased in the gravity drainage area due to GCWI. In addition, the reservoir pressure in the PBU POP Miscible Gas Project has also been stabilized and moderately increased in recent years. [17]

Exhibit 1-11. Prudhoe Bay Unit IPA—areal average pressure

Used with permission from Hilcorp [17]

1.6.2 Natural Gas

Along with oil and condensate production, the PBU produced 7.92 Bcfd of natural gas in 2020 (with 7.47 Bcfd from the PBU IPA), up from 7.47 Bcfd in 2019 (with 7.03 Bcfd from the PBU POP) when production was limited by constraints at the Central Gas Facility (CGF).

Prudhoe Oil Pool. In 2020, reinjection of the gas produced at PBU IPA was 6.93 Bcfd, equal to about 93 percent of the produced gas stream. Approximately 0.39 Bcfd of the produced gas was used for fuel, NGL extraction, and gas sales/other, with 0.15 Bcfd extracted and used for MI (Exhibit 1-12.). [17]

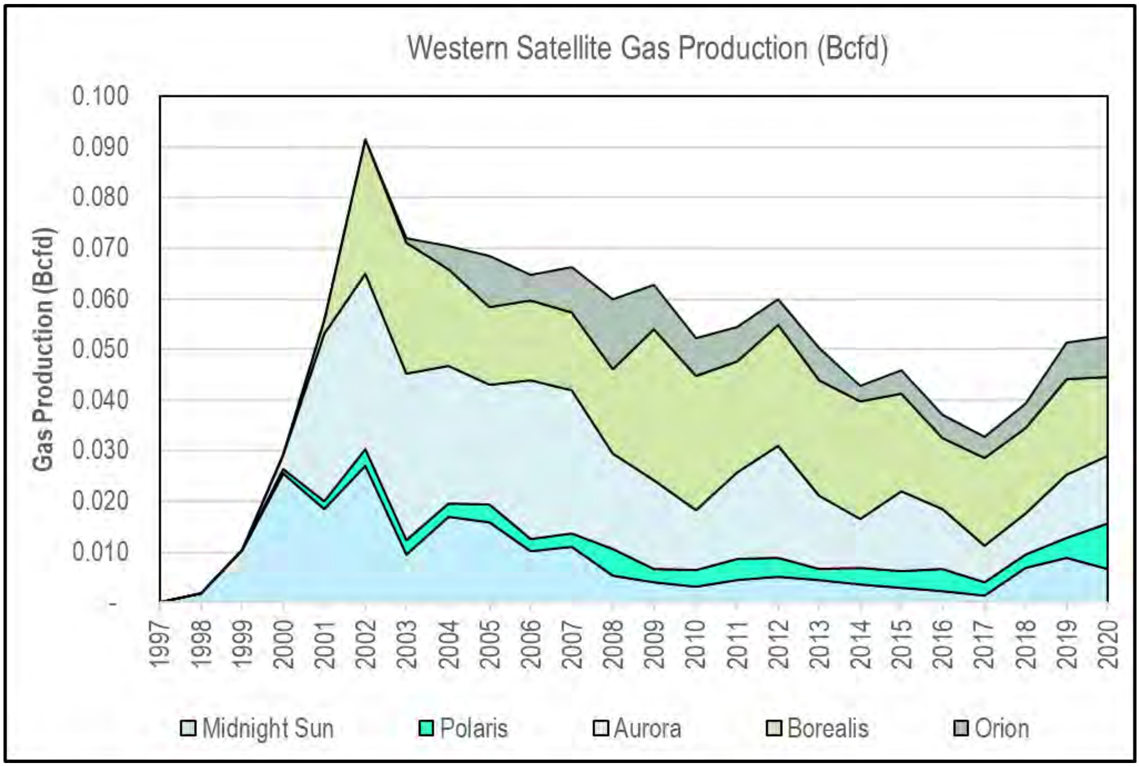
Exhibit 1-12. Gross gas production, gas use, and gas reinjection: PBU IPA

	2020 Daily Production (MMcfd)
Gas Production	**7,470**
Fuel Use (e)	(310)
▪ Gas Reinjection	(220)
▪ Other	(90)
Miscible Injectant	(150)
NGL Extraction *	(50)
Gas Sales/Other *	(30)
Subtotal	(540)
Reinjected Gas	**6,930**

*The volumes of gas shrinkage due to NGL extraction and Gas Sales/Other are extrapolated from data for 2019 with adjustments.

PBU Western Satellite Fields. The five Western Satellite fields provided 53 million cubic feet per day (MMcfd) of natural gas production in 2020, primarily from Aurora and Borealis fields, essentially the same as in 2019 (Exhibit 1-13). Approximately 64 MMcfd of gas (labeled as MI) was reinjected into these five satellite fields, enabling oil production to increase in 2020 (Exhibit 1-14). [5] [6] A portion of the MI was provided from other fields. Note the recent increase in natural gas production after a long prior period of decline for the Western Satellite fields.

Exhibit 1-13. Western Satellite gas production



Used with permission from AOGCC [1]

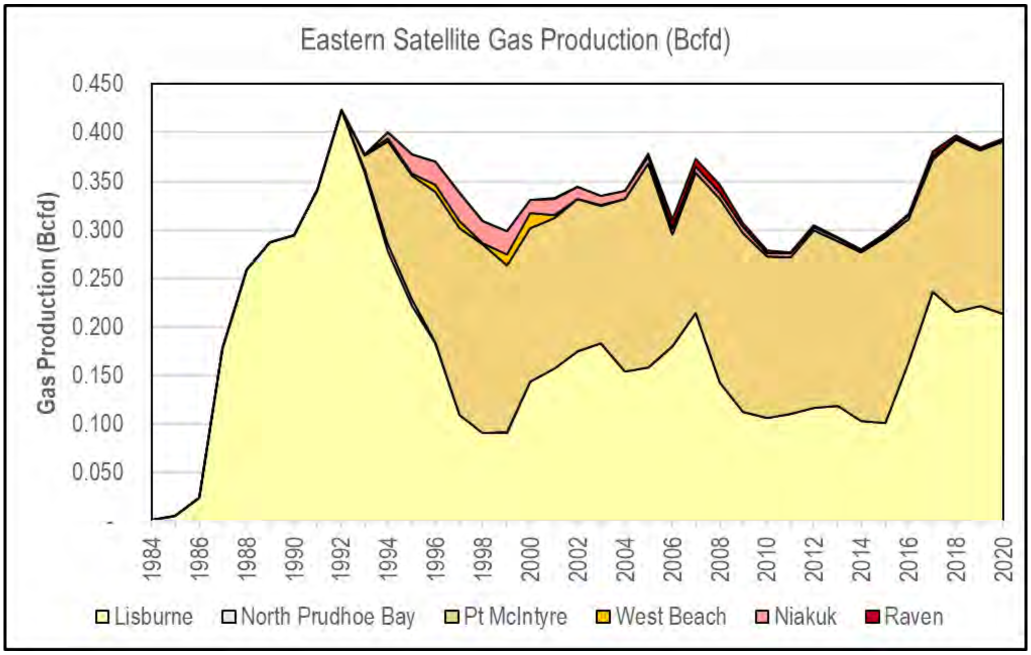
Exhibit 1-14. Gross gas production, gas use, and gas reinjection: satellite fields

	2020 Daily Production (MMcfd)	
	Western Satellites	**Eastern Satellites (Lisburne & Pt McIntyre)**
Gas Production	53	400
Gas/Miscible Injection	64	329

The current operator of Western Satellite fields has targeted returning idle wells to service, identifying portions of the fields that have been under-developed, and maximizing the use of MI. [6]

PBU Eastern Satellite Fields. The Eastern Satellite fields (also called GPMA) produced approximately 400 MMcfd of natural gas in 2020, primarily from Lisburne and Point McIntyre fields, up slightly from 2019 (Exhibit 1-15). Of this total gas production, approximately 329 MMcfd was reinjected into the Lisburne and Point McIntyre fields, shown previously in Exhibit 1-14.

Exhibit 1-15. Eastern Satellite gas production



Used with permission from AOGCC [1]

The current operator of the Eastern Satellite fields has focused on returning idle wells to service, optimizing surface facilities, targeting reservoirs that have been under-developed, improving reservoir voidage replacement, and improving operational efficiencies. [5]

1.6.3 Natural Gas Liquids: Prudhoe Oil Pool

The PBU IPA also produced 45,280 B/D of NGLs in 2020, up from 43,600 B/D in 2019. In 2019, approximately 10,400 B/D of NGLs were taken to the Kuparuk River Unit for their MI Program, with the 33,200 B/D delivered to the TAPS. [17] The NGL volumes are in addition to the oil production volumes reported previously in Exhibit 1-8 and Exhibit 1-10.

1.6.4 Water: Prudhoe Oil Pool

The PBU IPA averaged 1,149,000 B/D of water production in 2020 for a water cut of about 87 percent. Produced water of 667,000 B/D was reinjected into the oil formations. Approximately 632,000 B/D of seawater was injected into the waterflood, the WAG project, and the gas cap (GCWI). [17]

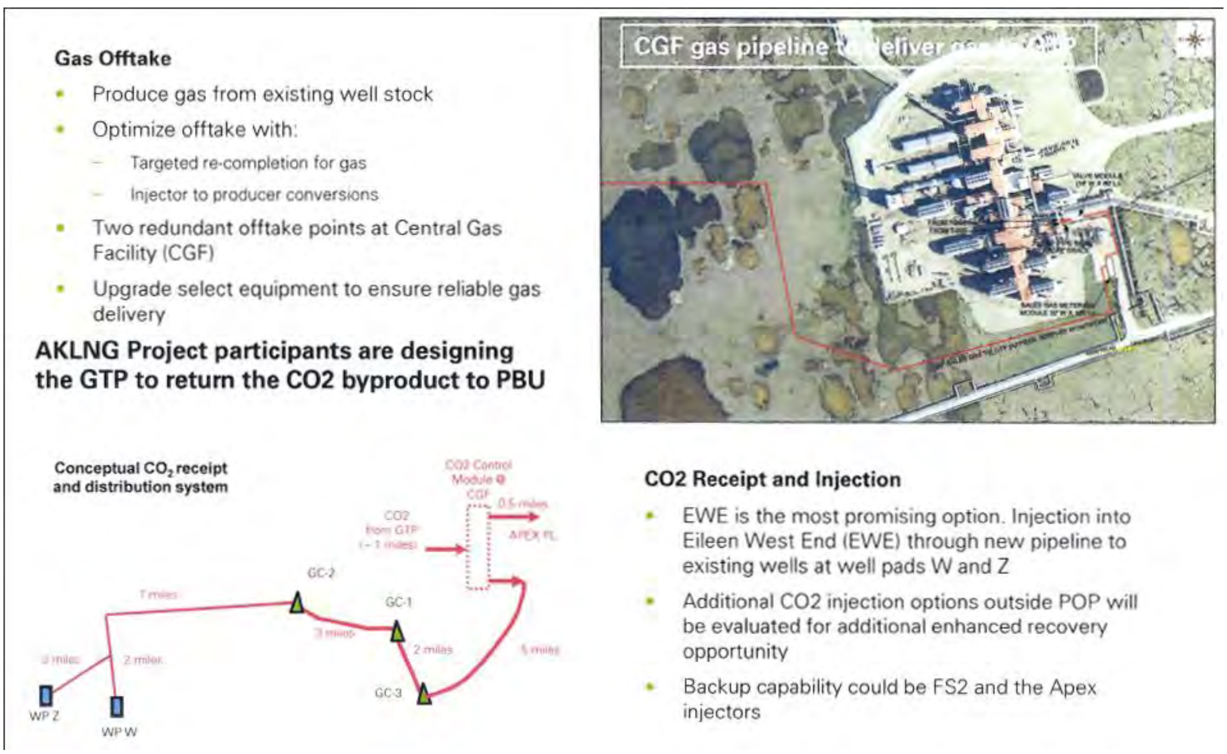
1.7 PRUDHOE BAY AND THE ALASKA LNG PROJECT

The PBU is expected to provide approximately 75 percent of the natural gas supply for the Alaska Gasline Development Corporation's (AGDC) Alaska LNG Project, requiring 2.5 Bcfd to be delivered to the GTP (Exhibit 1-16). [17] This means that the PBU would need to produce a gross natural gas volume ranging 2.67–2.81 Bcfd to account for gas reinjection fuel, other fuel, NGL extraction, and other uses, as shown in Exhibit 1-16. This would enable the PBU to deliver 2.5 Bcfd to the GTP for gas offtake and carbon dioxide (CO_2) extraction (Exhibit 1-17).

Exhibit 1-16. Gross natural gas production, Prudhoe Bay Unit

			2029–2038 (MMcfd)	2039–2048 (MMcfd)	2049–2058 (MMcfd)
1		**Gas Delivery to GTP**	**2,500**	**2,500**	**2,500**
	Plus:	Gas Reinjection Fuel	150	60	40
		Other Fuel	90	90	90
		Extraction of NGLs	40	20	10
		Local Sales/Other	30	30	30
		Subtotal	310	200	170
2		**Gross Production**	**2,810**	**2,700**	**2,670**

Exhibit 1-17. Gas offtake and CO_2 handling



Used with permission from BPXA [11]

1.7.1 Available Natural Gas Resources

The study estimates that 30.7 Tcf of recoverable natural gas resources would be available from the POP and the PBU satellite fields at the start of the Alaska LNG Project in 2029. Of this, approximately 2.7 Tcf would be consumed for lease use, local sales, and gas shrinkage during the 30-year Alaska LNG Project.

As such, 28.0 Tcf of natural gas resources would be available from PBU for delivery to the GTP, as shown in Exhibit 1-18.

Exhibit 1-18. Available natural gas resources, Prudhoe Bay Unit

	(Tcf)
Available Resources	28.7
Reserve Growth	2.0
Total	**30.7**
Less: Lease Fuel, Sales/Other	(2.7)
Total	**28.0**

1.7.2 Meeting the Gas Supply Requirements: Prudhoe Bay Unit

Exhibit 1-19 illustrates the annual requirements for natural gas supplies at the GTP from the PBU. Exhibit 1-20 provides the tabulation of total natural gas supply requirements of 25.5 Tcf at the GTP from the PBU by period.

The 28.0 Tcf of available natural gas resources from the PBU, shown in Exhibit 1-18, are sufficient to meet the total 25.5 Tcf of gas supply requirements at the GTP, plus the need for residual gas resources at the end of 30 years of natural gas exports.

Exhibit 1-19. Annual required natural gas supply, Prudhoe Bay Unit

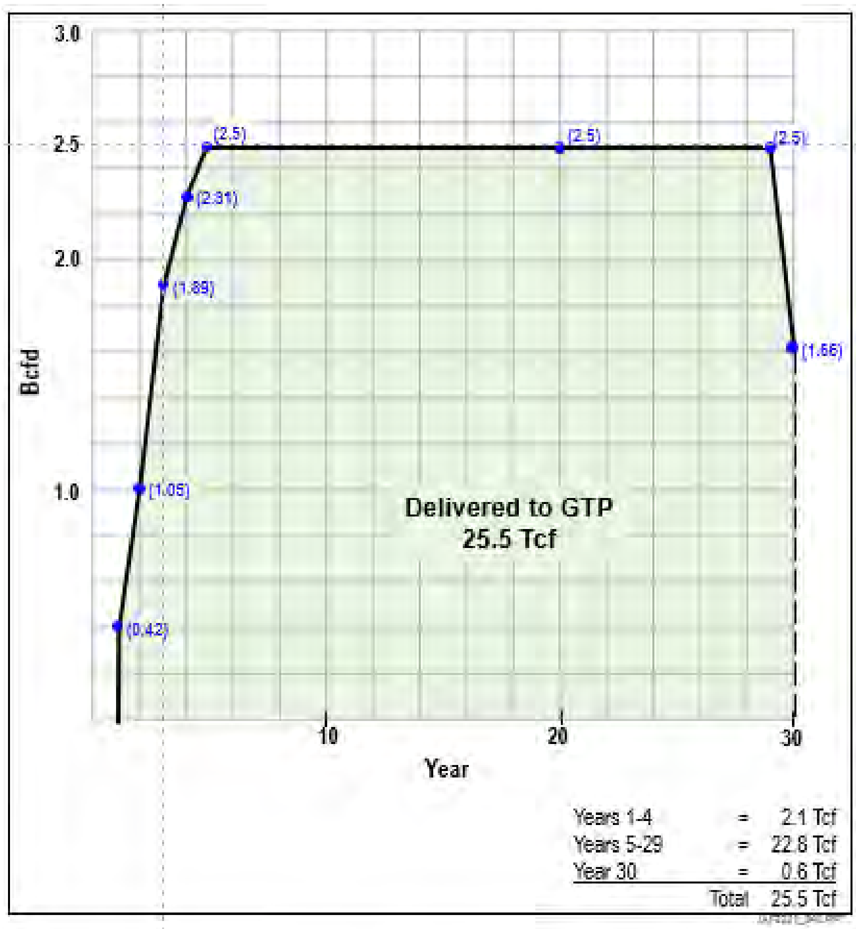


Exhibit 1-20. Total required natural gas supply, Prudhoe Bay Unit

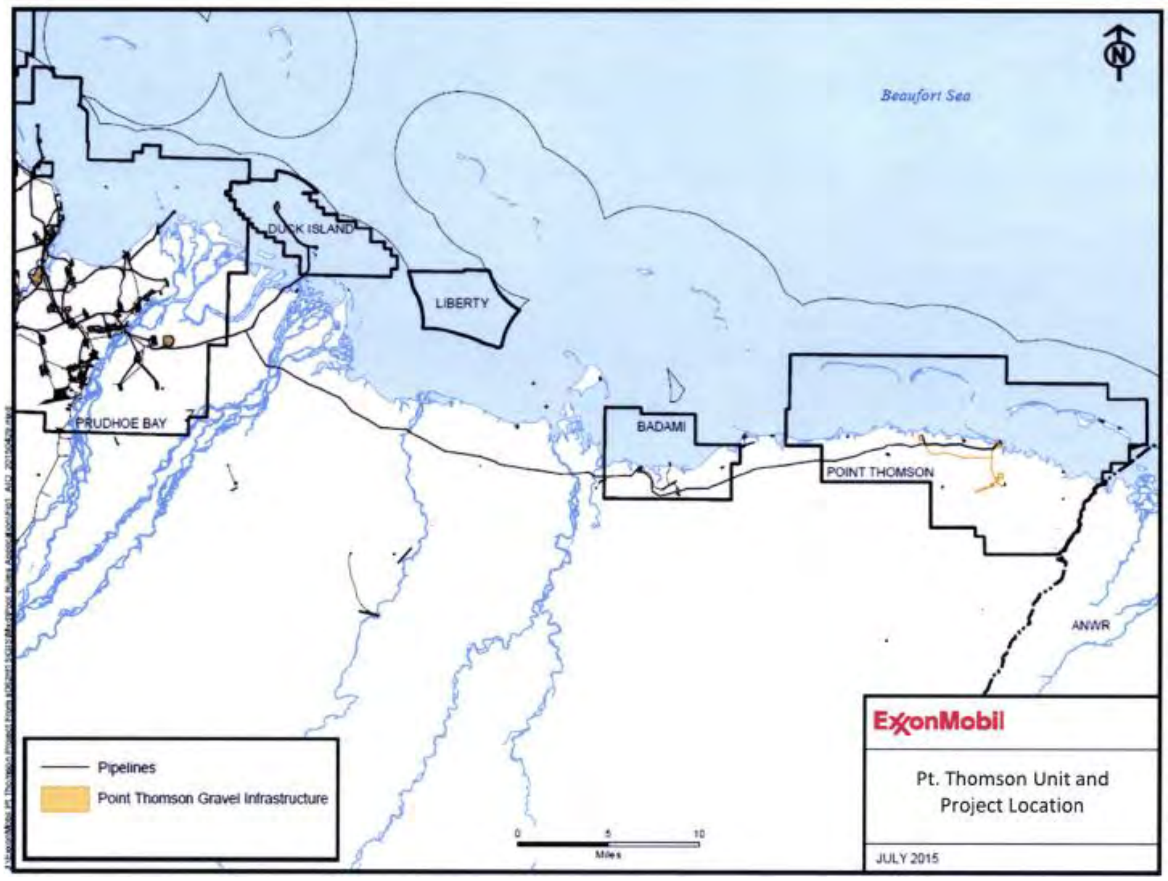
Time Period	Required Resources (Tcf)
Years 1–4	2.1
Years 5–29	22.8
Year 30	0.6
Total	**25.5**

2 POINT THOMSON

2.1 BACKGROUND

The PBU, encompassing an area of about 93,000 acres, is located on the North Slope of Alaska, adjacent to the Arctic National Wildlife Refuge and approximately 60 miles east of Prudhoe Bay (Exhibit 2-1). Point Thomson is scheduled to be one of the two primary sources of natural gas for the Alaska LNG Project. The field is projected to provide about 25 percent of the 3.36 Bcfd of natural gas to arrive and be processed by the GTP, and then be transported by the 809-mile Mainline Pipeline from the North Slope to the LNG facility at Nikiski.

Exhibit 2-1. Point Thomson location

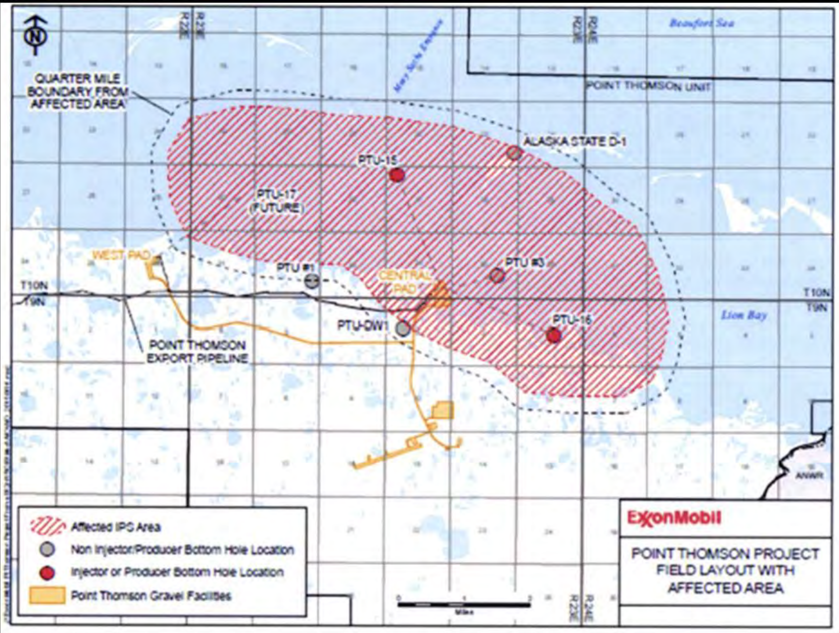


Used with permission from ExxonMobil [18]

2.2 DISCOVERY AND DEVELOPMENT

Point Thomson was discovered by Exxon Corp's Point Thompson Unit (PTU) No. 1 exploration well in 1977 and further defined by the PTU No. 2 and No. 3 wells in 1978 and 1979. [19] In 2010, ExxonMobil drilled two new delineation wells, PTUs No. 15 and No. 16, to test the production potential of the reservoir for a gas-cyclic and condensate recovery project (Exhibit 2-2).

Exhibit 2-2. Point Thomson adjacent wells



- DW-1: Class I UIC Disposal Well, drilled in 2015. Authorized by US EPA for injection of waste.
- PTU-1, PTU-3, AK State D-1: Exploration wells drilled in 1970s and 1980s. Permanently abandoned per Applications for Sundry Approvals by AOGCC.

JAF2021_036.PPT

Used with permission from ExxonMobil [18]

2.3 GEOLOGIC AND RESERVOIR SETTING

The Early Cretaceous-age Thomson Sand, at a depth of about 12,700 ft, is the primary hydrocarbon producing interval in the PTU (Exhibit 2-3). The Thomson Sand is abnormally pressured, with an average reservoir pressure of about 10,100 psi and a pressure gradient of about 0.8 psi/ft. The high reservoir pressure, along with other favorable reservoir properties (e.g., a net sand of 200–300 ft, porosity of 5–34 percent, and permeability that reaches more than 10 darcies in portions of the field), enable the one current production well, PTU No. 17, to flow at about 200 MMcfd (Exhibit 2-4). [18]

Exhibit 2-3. Point Thomson geologic description

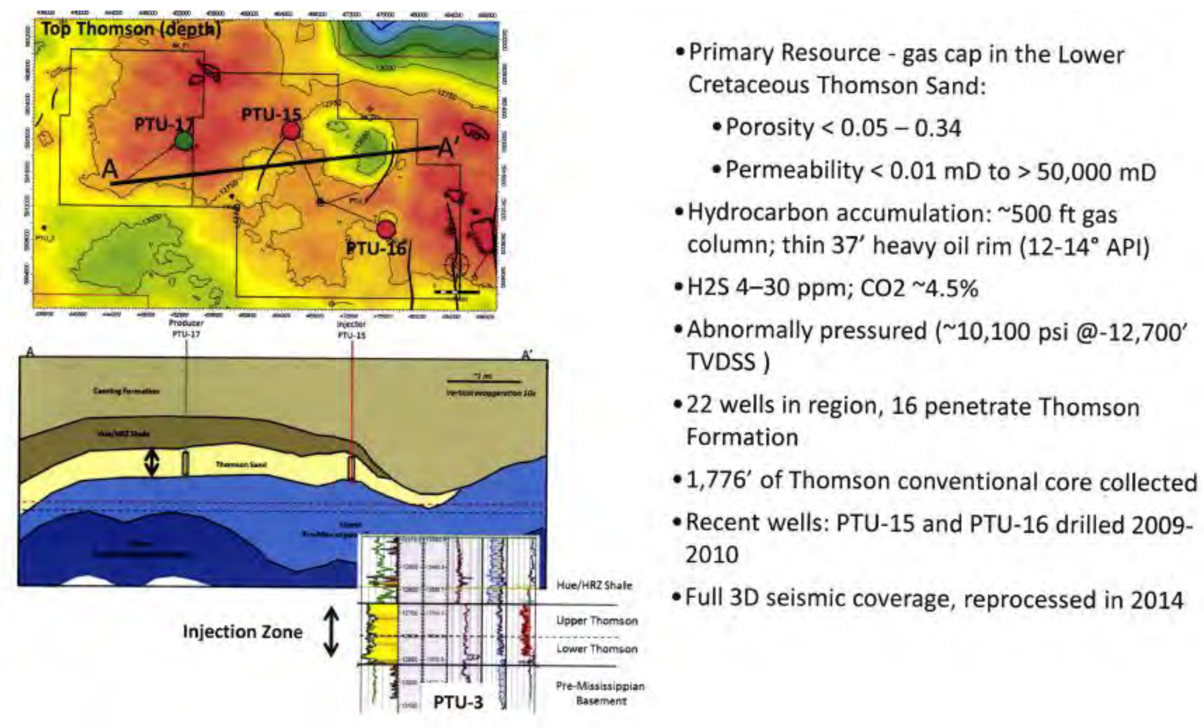


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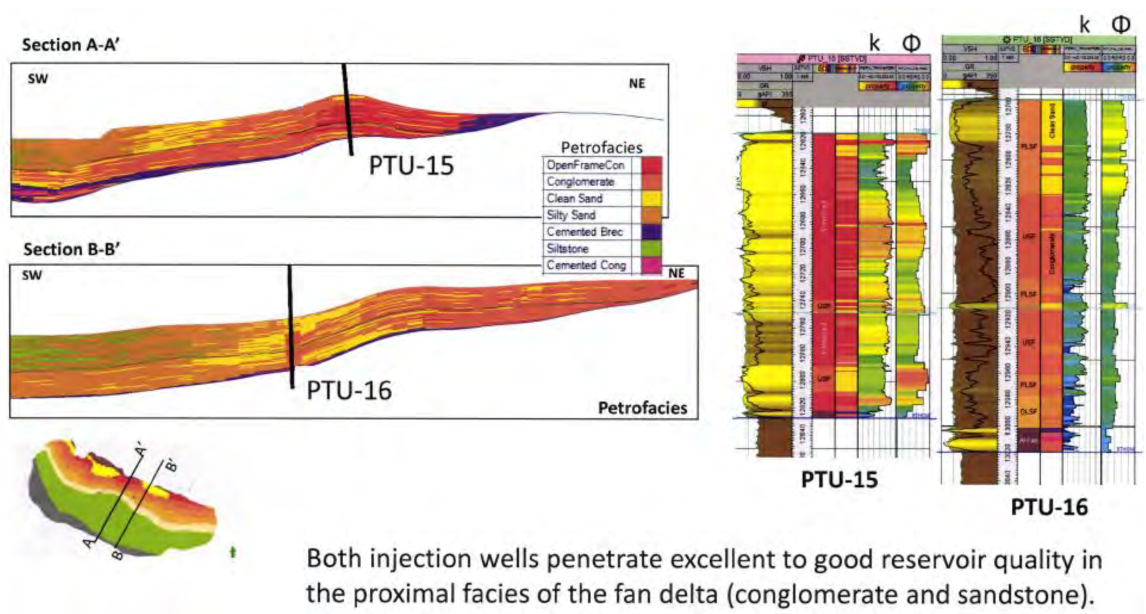
Exhibit 2-4. Point Thomson injection zone



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2.4 NATURAL GAS RESOURCES

2.4.1 Initial Resources

According to a previous North Slope of Alaska resource study conducted by DOE/NETL [3], as well as adjustments made by this study, 9.1 Tcf of natural gas resources is available from the PTU at the start of the Alaska LNG Project in 2029. This is based on an initial recoverable natural gas resources of 9.2 Tcf, less 0.1 Tcf consumed for fuel and other gas uses before the start of the Alaska LNG Project. Approximately 0.3 Tcf of the recoverable natural gas resources would be consumed at the field site for fuel and other uses during the 30-year Alaska LNG Project.

2.4.2 Reserve Growth

Additional resources of natural gas at Point Thomson would derive from reserve growth. The initial recoverable natural gas resources estimate of 9.2 Tcf for PTU assumed 70 percent recovery of OGIP (13.2 Tcf * 0.7 = 9.2 Tcf). [3] The PTU contains a highly over-pressured natural gas formation that typically has notably higher gas recovery efficiency. This study estimates that the ultimate natural gas recovery efficiency for PTU will reach 80 percent of OGIP, providing 1.3 Tcf of reserve growth. The technical literature discusses that high-pressure, high-permeability natural gas reservoirs will have recovery efficiencies of 80 percent or higher. [13]

As such, 10.1 Tcf of natural gas resources would be available from Point Thomson for delivery to the GTP associated with the Alaska LNG Project (Exhibit 2-5).

Exhibit 2-5. Point Thomson natural gas resources

Recoverable Resources (Tcf)	Reserve Growth (Tcf)	Lease Fuel/Other (Tcf)	Available Resources for GTP (Tcf)
9.1	1.3	(0.3)	10.1

Modified with permission from U.S. DOE/NETL [3] by Advanced Resources International, 2021

2.5 CURRENT AND ANTICIPATED PRODUCTION AND TRANSPORTATION

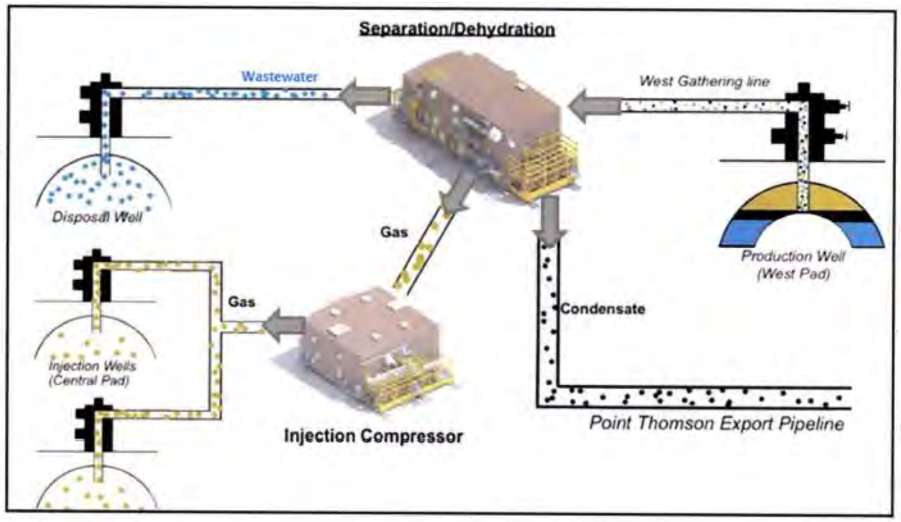
2.5.1 Current Gas-Cycling Project

At Point Thomson, the current gas-cycling project that started in 2016 consists of three wells, with PTU No. 17 serving as the gas producer and PTUs No. 15 and No. 16 serving as the gas injectors (Exhibit 2-4). A fourth well, PTU DW-1, serves as the produced water disposal well for the gas-cycling project.

The gas-cycling project is designed to produce 200 MMcfd of natural gas transported to ExxonMobil's gas treatment facilities, where approximately 10,000 B/D of condensate would be extracted from the gas production stream. After deduction for condensate and fuel gas, approximately 194 MMcfd would be reinjected into the Thomson Sand of the PTU to maintain reservoir pressure. The gas-cycling project is estimated to reduce the initial reservoir pressure by only approximately 4 percent over 30 years. [19] The recovered condensate is transported by pipeline to the TAPS (Exhibit 2-6 and Exhibit 2-7).

Exhibit 2-6. Point Thomson Project overview

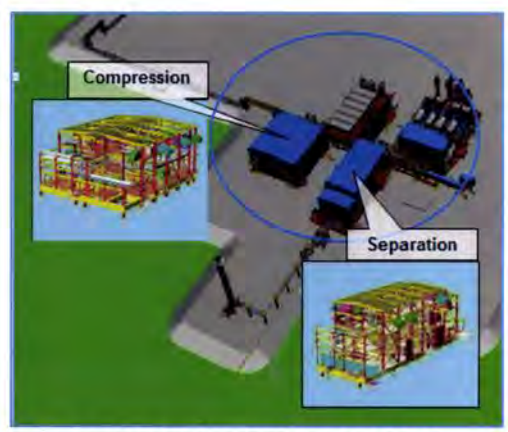
- Establish key infrastructure
- Drill and complete four wells
  - **1 production well** (PTU-17, also known as West Pad Well)
  - **2 injection wells** (PTU-15 and PTU-16)
  - **1 disposal well** (PTU-DW1)
- Develop facilities designed to produce 10 KBD condensate and cycle 200 MCFD of gas



Used with permission from ExxonMobil [18]

Exhibit 2-7. Point Thomson operations—injection rates and pressures

- **Designed injection rate is 194 million standard cubic feet per day (MMSCFD)**
  - Injected gas is gas from produced fluid minus condensate, water, and fuel gas
  - Injected gas split between PTU-15 and PTU-16 at approximately equal rates
- **Injection pressures for PTU-15 and PTU-16 at the wellhead range from 9,800 psi to 10,000 psi**
  - Sandface pressure approximately 10,150 psi
  - Wells equipped with downhole gauges for reservoir pressure and temperature monitoring. Annulus pressure of injection wells PTU-15/16 will also be monitored
  - Sandface pressure gradient (~0.80 psi/ft) is less than the Thomson fracture gradient and confining zone fracture gradient (~0.91 psi/ft)



Central Pad Processing Facilities

Used with permission from ExxonMobil [18]

Several constraints, particularly involving high-pressure gas compression, have limited achieving the gas-cycling project's design of 200 MMcfd of natural gas production and 10,000 B/D of condensate production. During the first seven months of 2021, the project has averaged 155

MMcfd of natural gas and 8,630 B/D of condensate, with higher rates of 166 MMcfd of natural gas and 9,430 B/D of condensate produced during June/July 2021. [1]

2.5.2 Natural Gas Production and Transportation

Point Thomson produced about 159.5 MMcfd (55 billion cubic feet [Bcf]) of natural gas in 2020, up from 110 MMcfd (40 Bcf) in 2019, from the PTU No. 17 well drilled from the West Pad. Two additional pads, the Central Pad and the East Pad, provide the sites for the two injection wells—PTU No. 15 and PTU No. 16. [20]

A new 62.5-mile, 32-inch diameter pipeline, the Point Thomson Transmission Line (PTTL), would transport the natural gas from Point Thomson to the GTP for further processing to remove CO_2 and natural gas liquids before delivering the processed pipeline quality gas to the Mainline Pipeline.

2.5.3 Natural Gas Composition

The composition of the reinjected gas, after removal of condensate, water, and fuel gas, is primarily methane (87.40 percent), ethane (4.22 percent), propane (1.64 percent), butane (0.86 percent), and CO_2 (4.46 percent) (Exhibit 2-8).

Given the above noted composition of the natural gas at Point Thomson, the study estimates that the GTP would extract approximately 40 MMcfd of CO_2 from the Point Thomson gas stream. The plan is for the extracted CO_2 (and trace components of hydrogen sulfide [H_2S]) to be used as MI for EOR. [18]

Exhibit 2-8. Point Thomson operations—fluid types and sources

- **Injected gas is the produced fluid with condensate, water, and fuel gas removed**
  - Contains mainly methane (C1), ethane (C2), and carbon dioxide (CO2)
  - Trace components such as H2S (<30ppm) also present
- **Injected gas originated in the reservoir and is compatible with the reservoir fluid and formation**

Estimated Composition of Injected Gas Stream

Component	Mole %
C1	87.397
C2	4.2190
C3	1.6440
IC4	0.3200
NC4	0.5450
IC5	0.1890
NC5	0.1920
C6	0.1860
C7	0.0960
C8	0.0430
C9	0.0160
C12	0.0050
C17	0
C27	0
C42	0
C65	0
C86+	0
H20	0
N2	0.6640
CO2	4.4600

Used with permission from ExxonMobil [18]

2.5.4 Condensate Production and Transportation

The condensate from the gas-cycling project is transported by a 22-mile, 12-inch diameter insulated pipeline to the existing Badami pipeline that connects to the TAPS. Once the higher natural gas production volumes of about 870 MMcfd are produced for the Alaska LNG Project, Point Thomson will produce about 40,000 B/D of condensate that will be transported using existing facilities to the TAPS. The liquids pipeline is designed to accommodate 70,000 B/D of condensate. [19]

2.6 POINT THOMSON AND THE ALASKA LNG PROJECT

Point Thomson is expected to provide approximately 25 percent of the gas supply for AGDC's Alaska LNG Project. This means that Point Thomson would need to produce about 0.89 Bcfd of natural gas. After extraction of condensate and fuel gas, approximately 0.86 Bcfd would be available for the GTP.

2.6.1 Available Natural Gas Resources

The study estimates that 10.4 Tcf of recoverable natural gas resources would be available from Point Thomson at the start of the Alaska LNG Project in 2029. Of this, approximately 0.3 Tcf would be consumed for lease use, local sales, gas shrinkage, and other uses during the 30-year Alaska LNG Project.

As such, 10.1 Tcf of natural gas resources would be available from PTU for delivery to the GTP, as shown in Exhibit 2-9.

Exhibit 2-9. Available natural gas resources, Point Thomson Unit

	(Tcf)
Recoverable Resources	9.1
Reserve Growth	1.3
Total	**10.4**
Less: Lease Fuel, Sales/Other	(0.3)
Total	**10.1**

2.6.2 Meeting the Gas Supply Requirements: Point Thomson

Exhibit 2-10 illustrates the annual natural gas supply requirements at the GTP from the PTU. Exhibit 2-11 shows that Point Thomson would need to deliver a total of 8.7 Tcf of natural gas to the GTP.

The 10.1 Tcf of available natural gas resources from the PTU, shown in Exhibit 2-9, are sufficient to meet the total 8.7 Tcf of gas supply requirements of the GTP, plus the need for residual gas resources.

Exhibit 2-10. Annual required natural gas supply, Point Thomson Unit

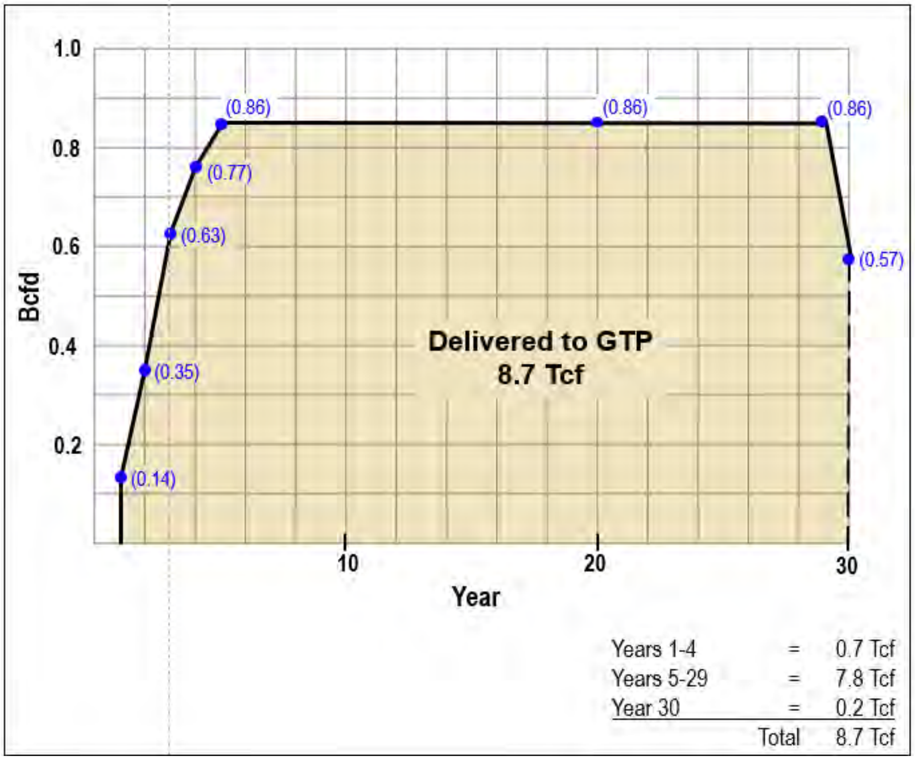


Exhibit 2-11. Total required natural gas resources, Point Thomson Unit

Time Period	Required Resources (Tcf)
Years 1–4	0.7
Years 5–29	7.8
Year 30	0.2
Total	**8.7**

3 MEETING THE NATURAL GAS SUPPLY REQUIREMENTS OF THE ALASKA LNG PROJECT: ALTERNATIVE #1 NATURAL GAS SUPPLY CASE

3.1 BACKGROUND AND PURPOSE

The Alaska LNG Project has received authorization to export 2.55 Bcfd of natural gas for 30 years from its LNG facility in Nikiski to overseas markets. (Alaska LNG Project, Application of Alaska Gasline Development Corporation (AGDC) for Authorization under Section 3 of the Natural Gas Act) [21] (Alaska LNG Resource Report 1 (Resource Report 1 (RR1)) (Alaska LNG Project, 2017b) [22]

In addition to the above authorized volumes of natural gas exports, additional volumes of natural gas will need to be produced for lease fuel, gas reinjection fuel by the existing Central Compressor Plant (CCP) and CGF, extraction of NGLs, and other uses. Additional fuel will also be needed to operate the GTP, the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove CO_2 from the gas stream.

The purpose of this section of the report is to determine to what extent the natural gas production requirements set forth in the Alternative #1 Natural Gas Supply Case can be met by natural gas resources from the PBU and PTU.

3.2 ESTABLISHING REQUIRED NATURAL GAS SUPPLY AND RESOURCES

To provide a baseline for required volumes of natural gas supply and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the appendices included in the Alaska LNG Resource Report 1 [22] and Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supply, Exhibit 3-1. The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility.

Exhibit 3-1. Material Balance assessment: from input to GTP to output from LNG facility

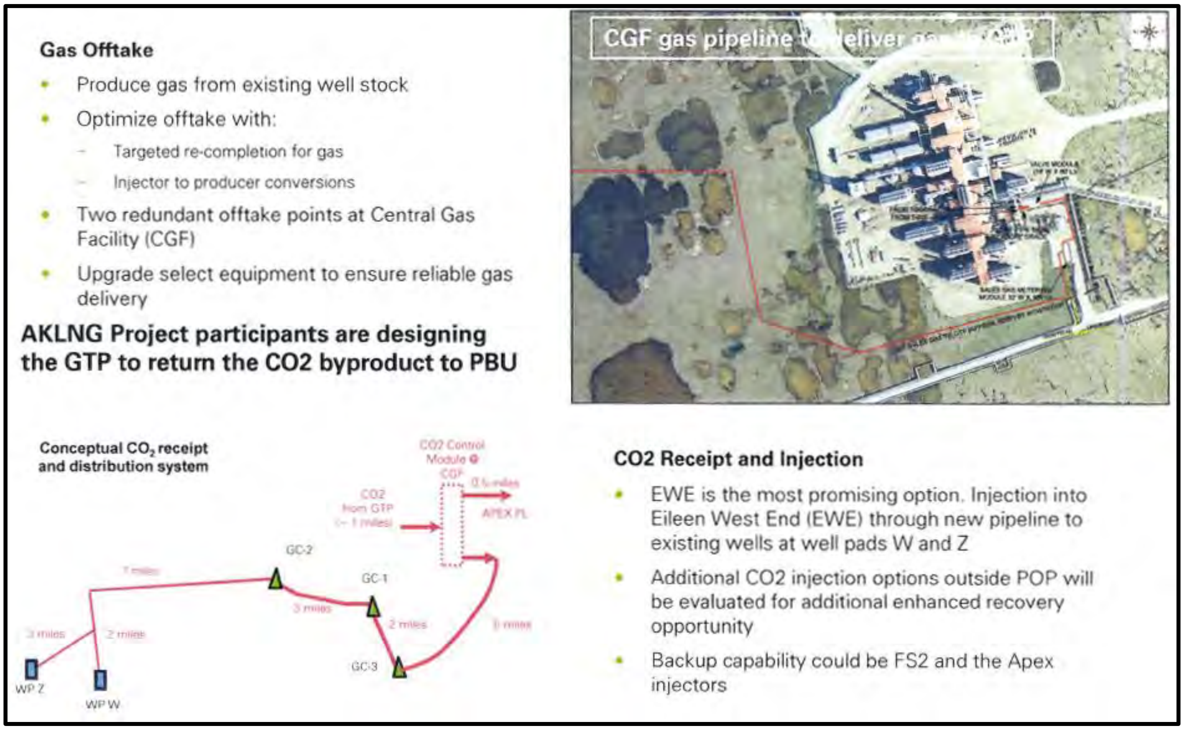
Primary Supply Delivery Nodes			Natural Gas Supply (Bcfd)	
1	**Delivery to Gas Treatment Plant**			**3.36**
	Less:	Fuel Use	(0.21)	
		Extraction of CO_2/H_2S	(0.35)	
2	**Delivery to Mainline Pipeline**			**2.80**
	Less:	Fuel Use	(0.07)	
		In-State Sales	n/a	
3	**Delivery to LNG Facility**			**2.73**
	Less:	Fuel Use	(0.18)	
4	**Available for LNG Export**			**2.55**

Input and Output: GTP. Once all three of the LNG units are in full operation, the GTP would need to receive 3.36 Bcfd of natural gas supply, with about 2.5 Bcfd from the PBU [23] and about 0.86 Bcfd from Point Thomson. [24] These numbers are within the maximum allowable gas production volumes (3.9 Bcfd peak) set forth in the AOGCC Conservation Orders.

The GTP will use 0.21 Bcfd for fuel [2], Application of Alaska Gasline Development Corporation for Authorization Under Section 3 of the Natural Gas Act, Appendix F) Gas Treatment Plant Air Quality Modeling Report) and will process and remove approximately 0.35 Bcfd of CO_2 from the gas stream [23], Exhibit 3-2. The 0.35 Bcfd of CO_2 consists of 0.31 Bcfd from the Prudhoe Bay gas stream, and its 12 percent CO_2 content, and 0.04 Bcfd from the Point Thomson gas stream, and its 4.4 percent CO_2 content. [3] As such, 2.80 Bcfd of natural gas would exit the GTP as input to the Mainline Pipeline.

Input and Output: Mainline Pipeline. The Mainline Pipeline will consume 0.07 Bcfd of natural gas for fuel. [25] As such, 2.73 Bcfd of natural gas would exit the Mainline Pipeline as input to the LNG facility.

Exhibit 3-2. Gas offtake and CO_2 handling



Used with permission from BPXA [11]

Input and Output: LNG Facility. The LNG facility will consume 0.18 Bcfd of natural gas for fuel. [26] As such, 2.55 Bcfd of natural gas would be available for LNG export to overseas markets.

Required Natural Gas Supply at the GTP. To provide 30 years of gas supply to the GTP will require 34.2 Tcf of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4) and reduced volumes of exports during Year 30. In addition, the study estimates the need for 2.9 Tcf of residual gas resources[b] to support the delivery of natural gas supply to the GTP in Year 30. As such, the total required natural gas supply for the Alaska LNG Project is 37.1 Tcf at the GTP, tabulated in Exhibit 3-3 and illustrated in Exhibit 3-4.

Summary of LNG Exports. After subtraction of CO_2 extraction and fuel use by the GTP, the Mainline Pipeline and the LNG facility, a total of 26.0 Tcf of natural gas is exported during the 30 years of the Alaskan LNG Project, Exhibit 3-5.

[b] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during Years 31–40.

Exhibit 3-3. Total required natural gas supply: 30 years of LNG exports

Time Period	Required Resources at the GTP (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	0.8
Total	**34.2**
Residual Gas Resources*	2.9
Total	**37.1**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

Exhibit 3-4. Annual required natural gas supply: 30 years of LNG exports

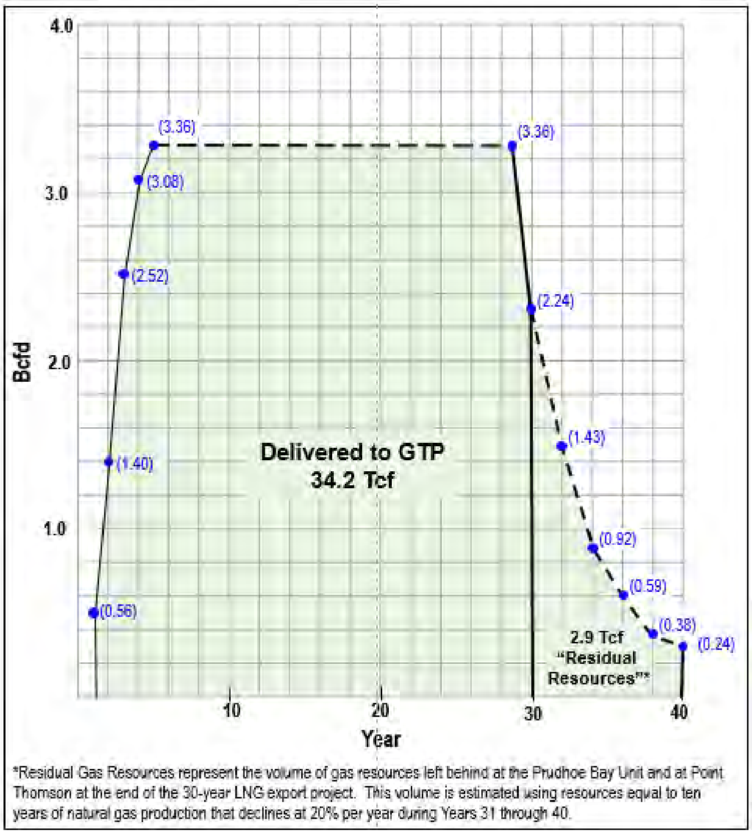


Exhibit 3-5. Total LNG Exports: 30 years of LNG exports

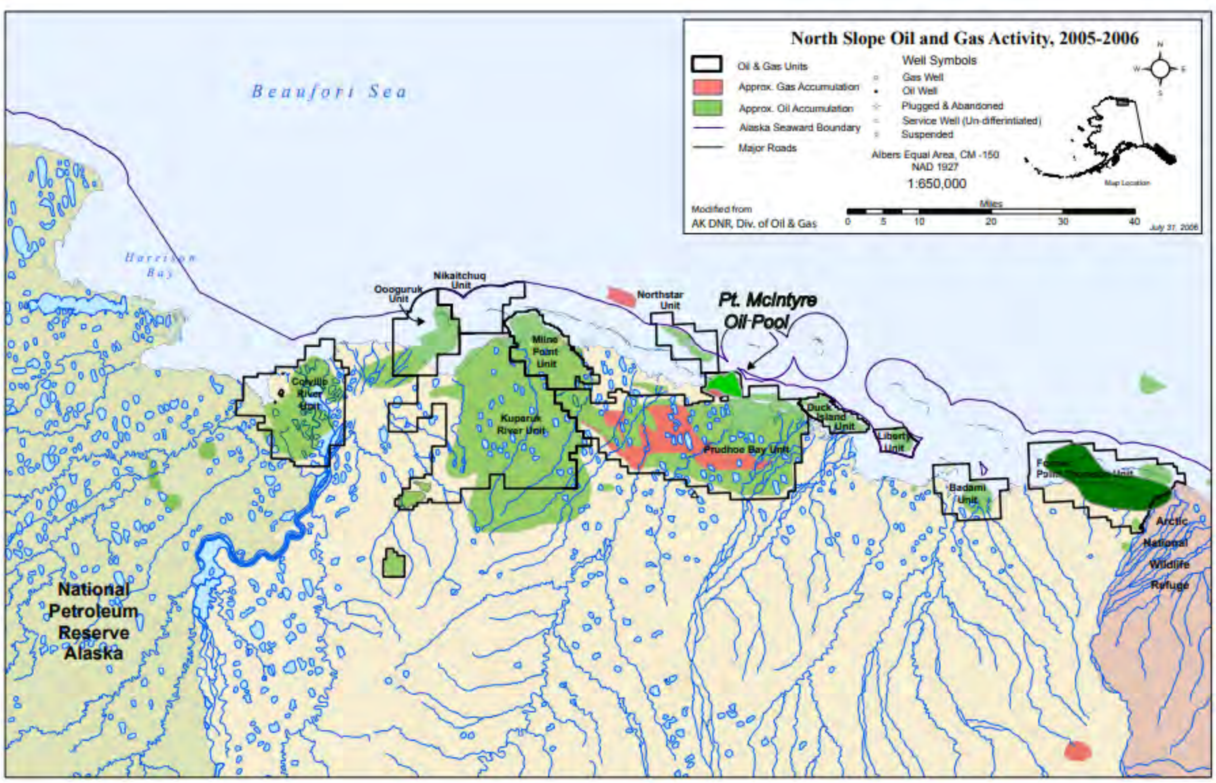
Time Period	Required Resources at the LNG Facility (Tcf)
Years 1–4	2.1
Years 5–29	23.3
Year 30	0.6
Total	**26.0**

3.3 AVAILABLE NATURAL GAS RESOURCES

3.3.1 Prudhoe Bay and Point Thomson Units

As discussed in the previous chapters, two fields are expected to be the primary sources of natural gas supply for the LNG facility—the PBU and the PTU (Exhibit 3-6).

Exhibit 3-6. Location of PBU satellite and other fields



Used with permission from AOGCC [1]

As set forth in the DOE/NETL report entitled “Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?” and adjusted for reserve growth at PBU/PTU and higher fuel consumption due to a later LNG export start date of 2029, these two fields have estimated natural gas resources of 41.1 Tcf, with 30.7 Tcf from PBU and 10.4 Tcf from PTU. [3] A portion of this gas resource, estimated at 3.0 Tcf, would be consumed for fuel, local sales, NGL extraction, and other uses, leaving 38.1 Tcf available for delivery to the GTP (Exhibit 3-7). This volume of resource is sufficient to meet the gas supply requirements at the GTP of 37.1 Tcf, shown previously in Exhibit 3-3.

Exhibit 3-7. Summary of available natural gas resources, PBU/PTU

	PBU (Tcf)	PTU (Tcf)	Total (Tcf)
Available Resources	28.7	9.1	37.8
Reserve Growth	2.0	1.3	3.3
Total	**30.7**	**10.4**	**41.1**
Less: Lease Fuel, Sales/Other	2.7	0.3	3.0
Total	**28.0**	**10.1**	**38.1**

3.4 POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU) will entail some additional development, as discussed in the FERC EIS. (FERC, 2020) [4] More Specifically, the FERC EIS states that the activities set forth in its report for the Prudhoe Bay Unit P and the Point Thomson Unit (PTU) Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

3.4.1 PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to Alaska LNG rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by

VSMs, permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

3.4.2 PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the Point Thomson marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at Point Thomson, as well as camps at Prudhoe Bay and Badami.

AGDC indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC Program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clear Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

3.5 STUDY FINDINGS: ALTERNATIVE #1 NATURAL GAS SUPPLY CASE

The study, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," finds that sufficient natural gas resources are available from PBU and PTU on the North Slope of Alaska to meet the expected volumes of natural gas exports by the Alaska LNG Project set forth for the Alternative #1 Natural Gas Supply Case.[c] The PBU and PTU, with 38.1 Tcf of available resources, would meet the required 37.1 Tcf of natural gas supply at the Gas Treatment Plant of the Alaska LNG Project. This would enable the LNG facility in the Alternative #1 Natural Gas Supply Case to export 26.0 Tcf of natural gas, after subtraction of fuel use by the GTP Plant, by the Mainline Pipeline and the LNG facility, and after the extraction of CO_2, as shown previously on Exhibit 3-5.

[c] The study entitled "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is a comprehensive natural gas resource study that incorporates proved reserves, reserve growth, and undeveloped resources. In mid-January 2022, following FERC's approval of the Alaska LNG Project, the U.S. Energy Information Administration (EIA), in its publication "U.S. Crude Oil and Natural Gas Proved Reserves, Year-End 2020," (USEIA, 2020) [27] significantly increased its recognition of natural gas-proved reserves for Alaska, stating: "Approval of this project means that a large volume of previously stranded Alaskan natural gas resources now meets the definition of proved reserves. The annual total of natural gas proved reserves in Alaska increased in 2020 by 27 Tcf, quadrupling the state's total from 9 Tcf to 36 Tcf. Additional upstream production facilities will add more proved reserves in years to come."

4 MEETING THE NATURAL GAS SUPPLY REQUIREMENTS OF THE ALASKA LNG PROJECT: ALTERNATIVE #2 NATURAL GAS SUPPLY CASE

4.1 BACKGROUND AND PURPOSE

The Alaska LNG Project has received authorization to export 2.55 Bcfd of natural gas for 30 years from its LNG facility in Nikiski to overseas markets. (Alaska LNG Project, Application of Alaska Gasline Development Corporation (AGDC) for Authorization under Section 3 of the Natural Gas Act) [21] (Alaska LNG Resource Report 1 (Resource Report 1 (RR1)) (Alaska LNG Project, 2017b) [22] export for a total authorization of 27.87 Tcf of natural gas exports. To the extent the Alaska LNG Project has not fully meet its full export authorization during its initial 30 years of operation, the Alaska LNG Project has the option of adding three years to its initially authorized time schedule for catch-up with authorized volumes.

In addition to the above authorized volumes of natural gas exports, additional volumes of natural gas will need to be produced for lease fuel, gas reinjection fuel by the existing Central Compressor Plant (CCP) and CGF, extraction of NGLs, and other uses. Additional fuel will also be needed to operate the GTP, the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove CO_2 from the gas stream.

The purpose of this section of the report is to determine to what extent the natural gas production requirements set forth in Alternative #2 Natural Gas Supply Case can be met by natural gas resources from the PBU and PTU for the initial 30 years of the project plus three years of catch-up with authorized LNG export volumes.

4.2 ESTABLISHING REQUIRED NATURAL GAS SUPPLY AND RESOURCES

To provide a baseline for required volumes of natural gas supply and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the appendices included in the Alaska LNG Resource Report 1 [22] and Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supply, Exhibit 4-1. The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility.

Exhibit 4-1. Material Balance assessment: from input to GTP to output from LNG facility

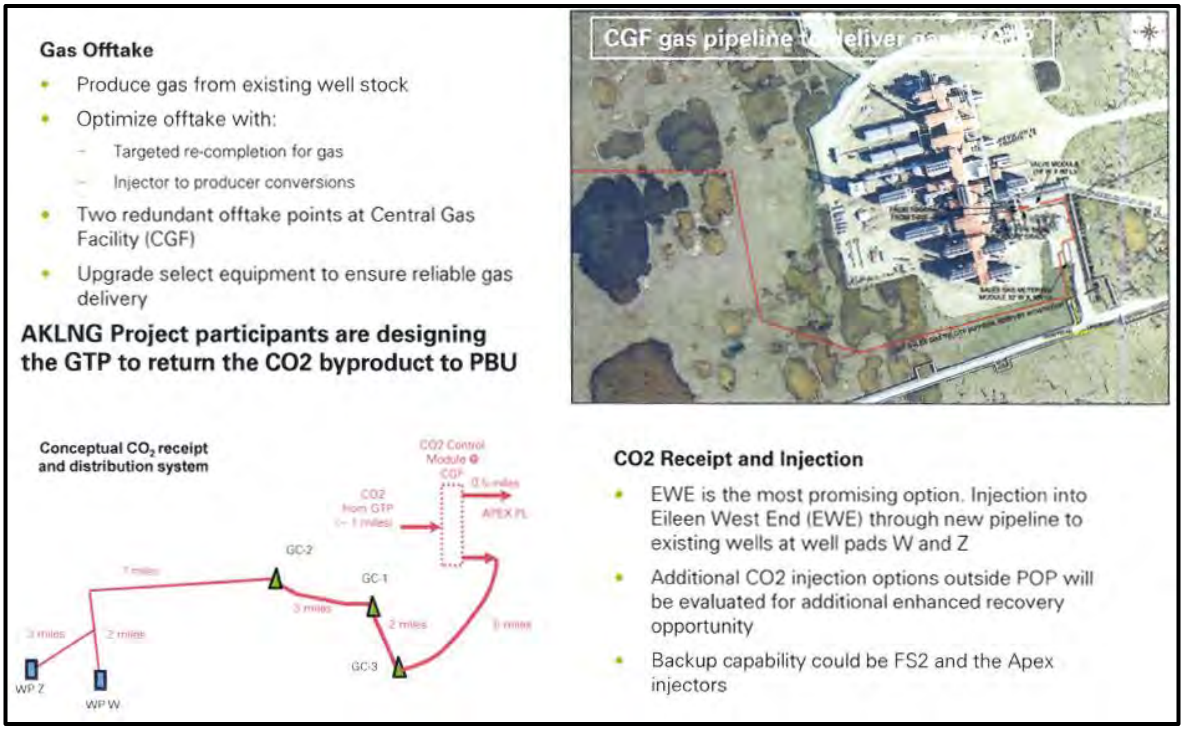
Primary Supply Delivery Nodes			Natural Gas Supply (Bcfd)	
1	**Delivery to Gas Treatment Plant**			**3.36**
	Less:	Fuel Use	(0.21)	
		Extraction of CO_2/H_2S	(0.35)	
2	**Delivery to Mainline Pipeline**			**2.80**
	Less:	Fuel Use	(0.07)	
		In-State Sales	n/a	
3	**Delivery to LNG Facility**			**2.73**
	Less:	Fuel Use	(0.18)	
4	**Available for LNG Export**			**2.55**

Input and Output: GTP. Once all three of the LNG units are in full operation, the GTP would need to receive 3.36 Bcfd of natural gas supply, with about 2.5 Bcfd from the PBU [23] and about 0.86 Bcfd from Point Thomson. [24] These numbers are within the maximum allowable gas production volumes (3.9 Bcfd peak) set forth in the AOGCC Conservation Orders.

The GTP will use 0.21 Bcfd for fuel [2], Application of Alaska Gasline Development Corporation for Authorization Under Section 3 of the Natural Gas Act, Appendix F) Gas Treatment Plant Air Quality Modeling Report) and will process and remove approximately 0.35 Bcfd of CO_2 from the gas stream [23] (Exhibit 4-2). The 0.35 Bcfd of CO_2 consists of 0.31 Bcfd from the Prudhoe Bay gas stream, and its 12 percent CO_2 content, and 0.04 Bcfd from the Point Thomson gas stream, and its 4.4 percent CO_2 content. [3] As such, 2.80 Bcfd of natural gas would exit the GTP as input to the Mainline Pipeline.

Input and Output: Mainline Pipeline. The Mainline Pipeline will consume 0.07 Bcfd of natural gas for fuel. [25] As such, 2.73 Bcfd of natural gas would exit the Mainline Pipeline as input to the LNG facility.

Exhibit 4-2. Gas offtake and CO_2 handling



Used with permission from BPXA [11]

Input and Output: LNG Facility. The LNG facility will consume 0.18 Bcfd of natural gas for fuel. [26] As such, 2.55 Bcfd of natural gas would be available for LNG export to overseas markets.

Required Natural Gas Supply at the GTP. To provide 33 years of gas supply to the GTP will require 38.4 Tcf of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4), reduced volumes of exports during Year 30, and three years of catch-up LNG exports to reach total authorized LNG export volumes. In addition, the study estimates the need for 1.7 Tcf of residual gas resources[d] to support the delivery of natural gas supply to the GTP in Years 31 through 33. As such, the total required natural gas supply for the Alaska LNG Project is 38.4 Tcf at the GTP, tabulated in Exhibit 4-3 and illustrated in Exhibit 4-4.

Summary of LNG Exports. After subtraction of CO_2 extraction and fuel use by the GTP, the Mainline Pipeline and the LNG facility, a total of 27.83 Tcf is available for export during the 33 years of the Alaska LNG Project, Exhibit 4-5.

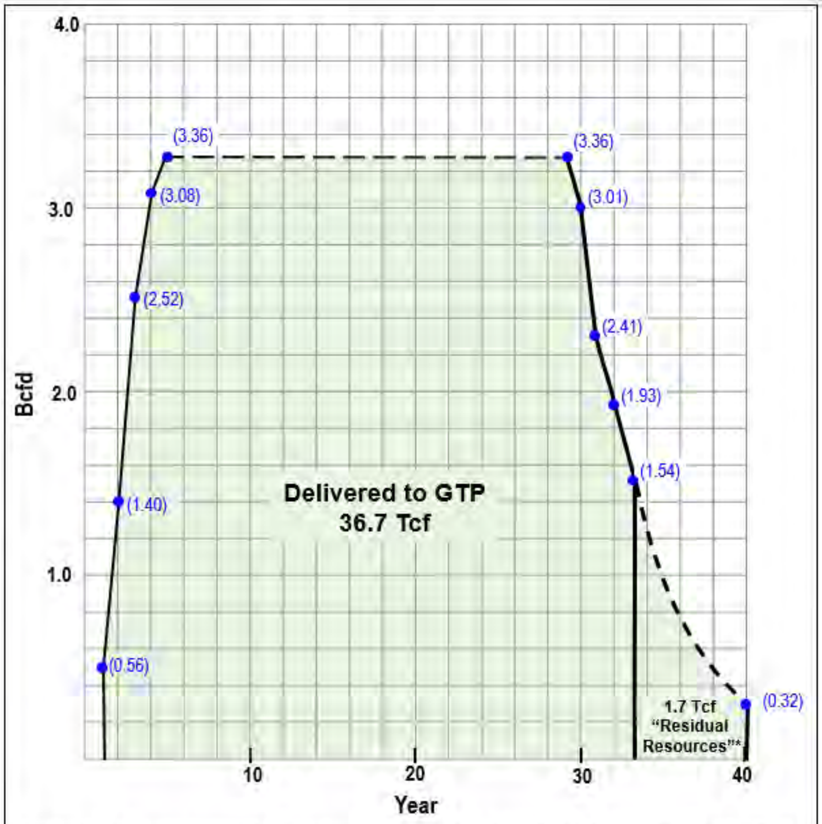
[d] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 33-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during Years 31–40.

Exhibit 4-3. Total required natural gas supply: 33 years of LNG exports

Time Period	Required Resources at the GTP (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	1.1
Years 31-33	2.1
Total	**36.7**
Residual Gas Resources*	1.7
Total	**38.4**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 33-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

Exhibit 4-4. Annual required natural gas supply at the GTP: 33 years of LNG exports



*Residual Gas Resources represent the volume of gas resources left behind at the Prudhoe Bay Unit and at Point Thomson at the end of the 33-year LNG export project. This volume is estimated using resources equal to ten years of natural gas production that declines at 20% per year during Years 31 through 40.

Exhibit 4-5. Total LNG Exports: 33 years of LNG exports

Time Period	Required Resources at the LNG Facility (Tcf)
Years 1–4	2.10
Years 5–29	23.27
Year 30	0.83
Years 31-33	1.63
Total	**27.83**

4.3 POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU) will entail some additional development, as discussed in the FERC EIS. (FERC, 2020) [4] More Specifically, the FERC EIS states that the activities set forth in its report for the Prudhoe Bay Unit P and the Point Thomson Unit (PTU) Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

4.3.1 PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to Alaska LNG rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by VSMs, permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

4.3.2 PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the Point Thomson marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at Point Thomson, as well as camps at Prudhoe Bay and Badami.

AGDC indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC Program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clear Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

4.4 STUDY FINDINGS: ALTERATIVE #2 NATURAL GAS SUPPLY CASE

The study, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," finds that sufficient natural gas resources will be available from PBU and PTU on the North Slope of Alaska to meet the authorized volumes of natural gas exports by the Alaska LNG Project set forth in this report.[e]

Specifically, the PBU and PTU have available natural gas resources to provide essentially all - - 27.83 Tcf of the 27.87 Tcf - - of the natural gas resources authorized for export, Exhibit 4-5. Given the conservative nature of the natural gas resources portion of the study, the recently recognized improved operating practices at the PBU (not included in the natural gas resources study), and inherent uncertainties during the authorized export term, the study determines that sufficient natural gas resources will be available to meet the authorized volumes of LNG exports.

Attachment A: "Annual Volumes of Natural Gas Available for LNG Export by the Alaska LNG Project" to this report provides the annual volumes of gross gas production, fuel/other gas use, gas reinjection, and gas delivery to the GTP from PBU and PTU. It also provides annual data on extraction of CO_2 and fuel use by the GTP, the Mainline Pipeline and the LNG facility, ending with natural gas available for LNG export, as discussed above and shown previously on Exhibit 4-5.

[e] The study entitled "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is a comprehensive natural gas resource study that incorporates proved reserves, reserve growth, and undeveloped resources. In mid-January 2022, following FERC's approval of the Alaska LNG Project, the U.S. Energy Information Administration (EIA), in its publication "U.S. Crude Oil and Natural Gas Proved Reserves, Year-End 2020," (USEIA, 2020) [27] significantly increased its recognition of natural gas-proved reserves for Alaska, stating: "Approval of this project means that a large volume of previously stranded Alaskan natural gas resources now meets the definition of proved reserves. The annual total of natural gas proved reserves in Alaska increased in 2020 by 27 Tcf, quadrupling the state's total from 9 Tcf to 36 Tcf. Additional upstream production facilities will add more proved reserves in years to come."

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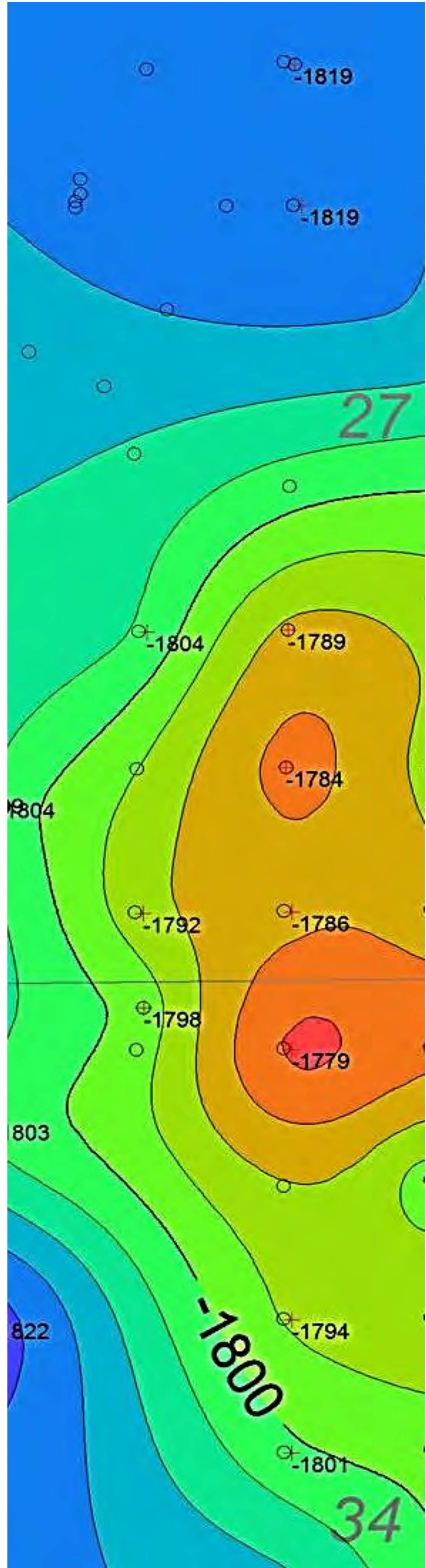
ATTACHMENT A: ANNUAL VOLUMES OF NATURAL GAS AVAILABLE FOR LNG EXPORT BY THE ALASKA LNG PROJECT

		Gross Gas Gas Production			Fuel Use for Compression/Other			Gas	Gas Delivery to GTP			Fuel Use/ Extraction of CO_2	Available Gas for LNG Export	
		PBU	PTU	Total	PBU	PTU	Total	PBU	PBU	PTU	Total			
Year		(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcf)
1	2029	7.95	0.14	8.09	0.31	0.00	0.31	7.22	0.42	0.14	0.56	0.13	0.43	155
2	2030	7.81	0.36	8.17	0.31	0.01	0.32	6.45	1.05	0.35	1.40	0.34	1.06	388
3	2031	7.70	0.65	8.36	0.31	0.02	0.33	5.50	1.89	0.63	2.52	0.61	1.91	698
4	2032	7.50	0.80	8.29	0.31	0.03	0.34	4.88	2.31	0.77	3.08	0.74	2.34	853
5	2033	7.21	0.89	8.10	0.31	0.03	0.34	4.40	2.50	0.86	3.36	0.81	2.55	931
6	2034	6.92	0.89	7.81	0.31	0.03	0.34	4.11	2.50	0.86	3.36	0.81	2.55	931
7	2035	6.63	0.89	7.52	0.31	0.03	0.34	3.82	2.50	0.86	3.36	0.81	2.55	931
8	2036	6.34	0.89	7.23	0.31	0.03	0.34	3.53	2.50	0.86	3.36	0.81	2.55	931
9	2037	6.05	0.89	6.94	0.31	0.03	0.34	3.24	2.50	0.86	3.36	0.81	2.55	931
10	2038	5.76	0.89	6.65	0.31	0.03	0.34	2.95	2.50	0.86	3.36	0.81	2.55	931
11	2039	5.47	0.89	6.36	0.20	0.03	0.23	2.77	2.50	0.86	3.36	0.81	2.55	931
12	2040	5.19	0.89	6.08	0.20	0.03	0.23	2.49	2.50	0.86	3.36	0.81	2.55	931
13	2041	4.91	0.89	5.80	0.20	0.03	0.23	2.21	2.50	0.86	3.36	0.81	2.55	931
14	2042	4.63	0.89	5.52	0.20	0.03	0.23	1.93	2.50	0.86	3.36	0.81	2.55	931
15	2043	4.35	0.89	5.24	0.20	0.03	0.23	1.65	2.50	0.86	3.36	0.81	2.55	931
16	2044	4.07	0.89	4.96	0.20	0.03	0.23	1.37	2.50	0.86	3.36	0.81	2.55	931
17	2045	3.79	0.89	4.68	0.20	0.03	0.23	1.09	2.50	0.86	3.36	0.81	2.55	931
18	2046	3.52	0.89	4.41	0.20	0.03	0.23	0.82	2.50	0.86	3.36	0.81	2.55	931
19	2047	3.24	0.89	4.13	0.20	0.03	0.23	0.54	2.50	0.86	3.36	0.81	2.55	931
20	2048	2.96	0.89	3.85	0.20	0.03	0.23	0.26	2.50	0.86	3.36	0.81	2.55	931
21	2049	2.68	0.89	3.57	0.17	0.03	0.20	0.01	2.50	0.86	3.36	0.81	2.55	931
22	2050	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
23	2051	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
24	2052	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
25	2053	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
26	2054	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
27	2055	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
28	2056	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
29	2057	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
30	2058	2.39	0.80	3.19	0.15	0.03	0.18	0.00	2.24	0.77	3.01	0.73	2.28	834
31	2059	1.91	0.64	2.55	0.12	0.02	0.14	0.00	1.79	0.62	2.41	0.58	1.83	668
32	2060	1.53	0.51	2.04	0.10	0.02	0.11	0.00	1.44	0.49	1.93	0.47	1.46	535
33	2061	1.22	0.41	1.63	0.08	0.01	0.09	0.00	1.15	0.39	1.54	0.37	1.17	427
Total														27,828

		Gross Gas Gas Production			Fuel Use for Compression/Other			Gas	Gas Delivery to GTP			Fuel Use/	Available Gas
		PBU	PTU	Total	PBU	PTU	Total	PBU	PBU	PTU	Total	Extraction of CO_2	for LNG Export
Year		(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)
1	2029	2,902	53	2,955	113	2	115	2,635	153	51	204	49	155
2	2030	2,850	132	2,982	113	4	118	2,353	383	128	511	123	388
3	2031	2,812	238	3,050	113	8	121	2,009	690	230	920	222	698
4	2032	2,736	291	3,027	113	10	123	1,780	843	281	1,124	271	853
5	2033	2,631	325	2,956	113	11	124	1,605	913	314	1,226	296	931
6	2034	2,525	325	2,850	113	11	124	1,499	913	314	1,226	296	931
7	2035	2,419	325	2,744	113	11	124	1,393	913	314	1,226	296	931
8	2036	2,313	325	2,638	113	11	124	1,287	913	314	1,226	296	931
9	2037	2,207	325	2,532	113	11	124	1,182	913	314	1,226	296	931
10	2038	2,101	325	2,426	113	11	124	1,076	913	314	1,226	296	931
11	2039	1,995	325	2,320	73	11	84	1,010	913	314	1,226	296	931
12	2040	1,894	325	2,219	73	11	84	908	913	314	1,226	296	931
13	2041	1,792	325	2,117	73	11	84	806	913	314	1,226	296	931
14	2042	1,690	325	2,015	73	11	84	705	913	314	1,226	296	931
15	2043	1,588	325	1,913	73	11	84	603	913	314	1,226	296	931
16	2044	1,487	325	1,812	73	11	84	501	913	314	1,226	296	931
17	2045	1,385	325	1,710	73	11	84	399	913	314	1,226	296	931
18	2046	1,283	325	1,608	73	11	84	298	913	314	1,226	296	931
19	2047	1,181	325	1,506	73	11	84	196	913	314	1,226	296	931
20	2048	1,080	325	1,405	73	11	84	94	913	314	1,226	296	931
21	2049	978	325	1,303	62	11	73	3	913	314	1,226	296	931
22	2050	975	325	1,299	62	11	73	0	913	314	1,226	296	931
23	2051	975	325	1,299	62	11	73	0	913	314	1,226	296	931
24	2052	975	325	1,299	62	11	73	0	913	314	1,226	296	931
25	2053	975	325	1,299	62	11	73	0	913	314	1,226	296	931
26	2054	975	325	1,299	62	11	73	0	913	314	1,226	296	931
27	2055	975	325	1,299	62	11	73	0	913	314	1,226	296	931
28	2056	975	325	1,299	62	11	73	0	913	314	1,226	296	931
29	2057	975	325	1,299	62	11	73	0	913	314	1,226	296	931
30	2058	873	291	1,164	56	10	65	0	817	281	1,099	265	834
31	2059	699	233	932	45	8	52	0	654	225	880	212	668
32	2060	560	187	746	36	6	42	0	524	180	704	170	535
33	2061	447	149	596	28	5	33	0	418	144	562	135	427
Total		52,224	9,695	61,919	2,584	327	2,911	22,344	27,296	9,368	36,664	8,836	27,828



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PRODUCTION REPORT 2: ALASKA LNG UPSTREAM STUDY REPORT 2: IMPACTS OF PBU MAJOR GAS SALES ON OIL PRODUCTION AND CO_2 STORAGE POTENTIAL (MAY 20, 2022)

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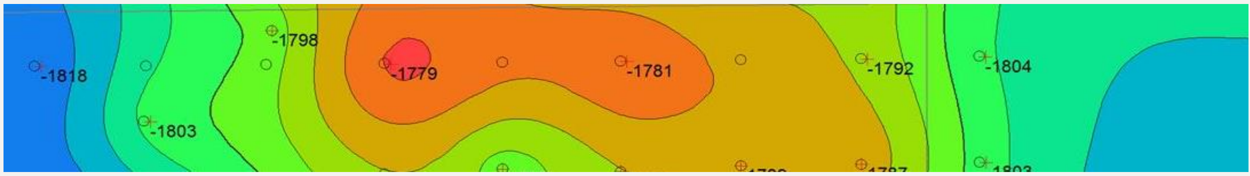

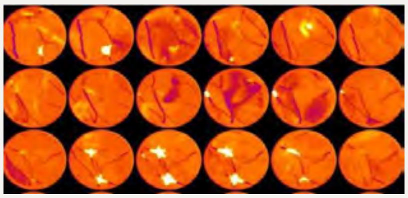

Alaska LNG Upstream Study Report 2: Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential

May 20, 2022

DOE/NETL-2022/3784

Disclaimer

All images in this report were created by NETL, unless otherwise noted

Matt Wallace[1]
Vello Kuuskraa[1]
Donald Remson[2*]

The authors wish to acknowledge the excellent guidance, contributions, and cooperation of:

Tim Skone[2]
Alana Sheriff[3]
Timothy R. Carr, Ph.D.[4]
Srijana Rai[3]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

AOGCC	Alaska Oil and Gas Conservation Commission
API	American Petroleum Institute
ARI	Advanced Resources International
B, bbl	Barrel
B/D	Barrels per day
BAU	Business as usual
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
CCUS	Carbon capture, utilization, and storage
cf	Cubic feet
cfd	Cubic feet per day
CO_2	Carbon dioxide
DNR	Department of Natural Resources
DOE	U.S. Department of Energy
EOR	Enhanced oil recovery
EUR	Estimated ultimate recovery
FFM	Full-field model
ft	Foot
GTP	Gas treatment plant
HCPV	Hydrocarbon pore volume
KRU	Kuparuk River Unit
LNG	Liquefied natural gas
M	Thousand
Mbbl	Thousand barrels
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
mD	Millidarcies
MI	Miscible injectant
MGS	Major gas sales
MM	Million
MMbbl	Million barrels
MMcf	Million cubic feet
MMcfd	Million cubic feet per day
MMmt	Million metric tons
MMP	Minimum miscibility pressure
MWAG	Miscible water-alternating-gas
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
OOIP	Original oil in-place
PBU	Prudhoe Bay Unit
POD	Plan of Development
POP	Prudhoe Oil Pool
psi	Pounds per square inch
PTU	Point Thomson Unit
SEIS	Supplemental Environmental Impact Statement
Tcf	Trillion cubic feet
U.S.	United States
WAG	Water-alternating-gas
°API	Degrees API (American Petroleum Institute)

1 INTRODUCTION

The U.S. Department of Energy (DOE) is preparing a Supplemental Environmental Impact Statement (SEIS) following the authorization to export 2.55 billion cubic feet per day (Bcfd) of natural gas from the North Slope of Alaska for the Alaska LNG Project. The natural gas to be exported is projected to come from the Prudhoe Bay Unit (PBU), consisting of the Prudhoe Bay Oil Pool (POP) and its Satellite fields (75 percent), and Point Thomson (25 percent). The project has been authorized for an oversight period of 30 years beginning in 2029, which is the first year gas exports are expected for the Alaska LNG Project. Additionally, the project may elect to operate an additional three years (for a total of 33 years) to reach the total authorized natural gas export volume, if needed.

The export of natural gas will mark a significant change in PBU field management, as oil production has, so far, been the primary objective. The demand for natural gas produced on the North Slope of Alaska is very limited, with only small quantities sold for in-state use. Currently, most of the produced gas is reinjected for pressure management or used for miscible gas injection (MI). The start of the Alaska LNG Project will lead to lower volumes of gas for reinjection, causing the reservoir pressure and the oil production to decline. Additionally, the processing of the natural gas at the new Gas Treatment Plant (GTP) associated with the Alaska LNG Project will create a byproduct stream of CO_2 of approximately 350 million cubic feet per day (MMcfd) that will need to be managed.

1.1 THREE STUDY CASES

Three study cases were developed to evaluate potential impacts of the Alaska LNG Project on oil production from the PBU, including:

1. **Case 1. "Business As Usual" (BAU) Gas Reinjection**—This case examines the remaining oil production potential from the PBU given no Alaska LNG Project and thus no major gas sales (MGS). In Case 1, the produced gas and its CO_2 content will continue to be reinjected into the PBU for pressure maintenance and MI.
2. **Case 2. Reduced Gas Reinjection**—This case examines the reduction in oil production from the PBU given the decreasing volumes of gas injection and the steady decline in reservoir pressure due to the Alaska LNG Project.
3. **Case 3. Use and Storage of Byproduct CO_2**—This case examines the potential for utilization and storage of the byproduct CO_2 using CO_2 enhanced oil recovery (EOR). Injection of the byproduct CO_2 into the nearby Kuparuk River Field is modeled to examine the capacity to store CO_2 and obtain incremental oil production.

2 STUDY PURPOSE

This report is the second in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together, these three reports comprise the “Upstream Study” of oil and natural gas resources and CO_2 utilization and storage potential at the PBU and surrounding areas.

The purpose of this report, “Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential,” is to examine the impacts of the Alaska LNG Project on oil production at the PBU and to discuss options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP for CO_2 EOR operations on the North Slope. Injection of CO_2 into the POP will not be possible during MGS due to the need to reduce pressure to achieve optimum natural gas recovery from the POP. As such, this report examines the potential for CO_2 storage with CO_2 EOR in the Kuparuk River Unit (KRU) next to the PBU.

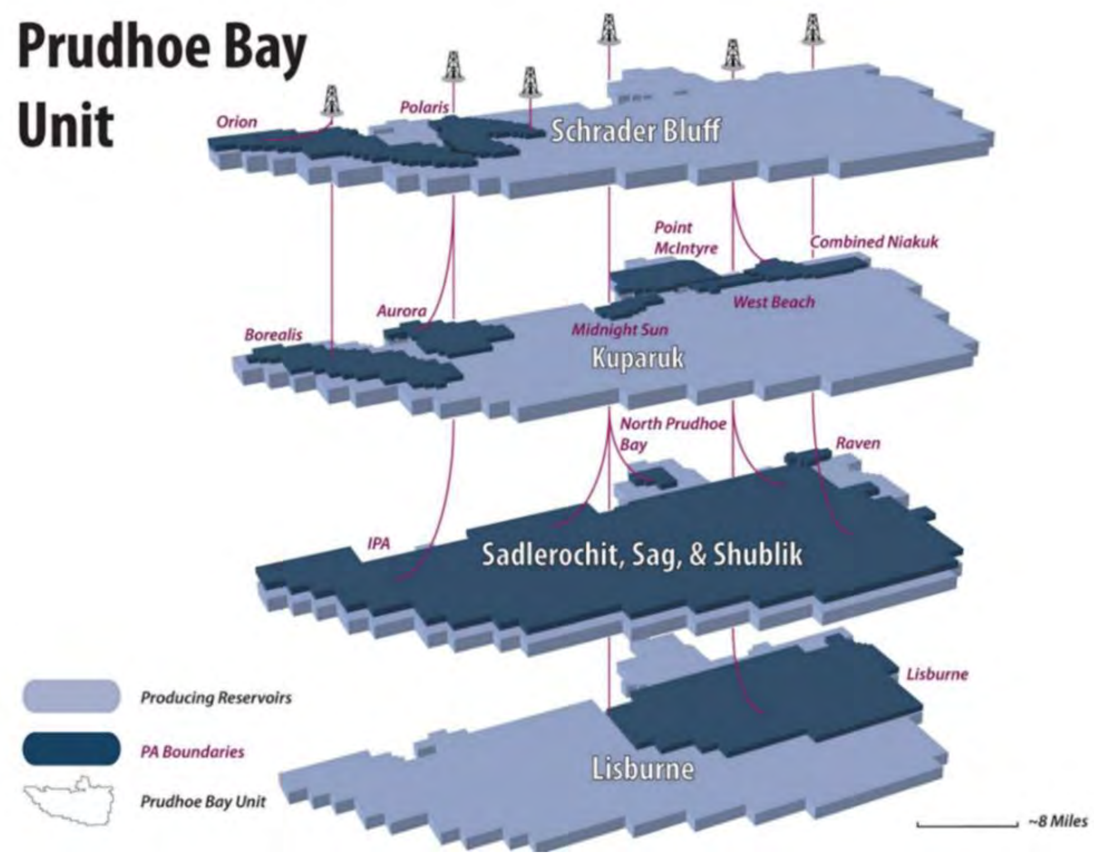
The first of the three Upstream Study reports, “Establishing the Sources of Natural Gas Supply for the Alaska LNG Project,” evaluates the capacity of natural gas supply from the PBU and Point Thomson Unit (PTU) on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

The third of the three Upstream Study reports, “Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit,” identifies and assesses the viability of storing byproduct CO_2 from the GTP facility in a deep saline reservoir at the PBU.

3 PRUDHOE BAY UNIT OIL PRODUCTION

The PBU is comprised of the large POP, plus its Eastern and Western Satellite fields. The Eastern Satellite fields include the Point McIntyre, Lisburne, Niakuk, and Raven oil pools. The Western Satellite fields include the Aurora, Borealis, Midnight Sun, Polaris, and Orion oil pools. These fields produce from four main reservoir intervals—Schrader Bluff, Kuparuk, Sadlerochit, and Lisburne (Exhibit 3-1).

Exhibit 3-1. Prudhoe Bay Unit reservoirs and participating area boundaries



Used with permission from Alaska DNR, 2012 [1]

Total original oil in-place (OOIP) for the PBU is estimated at 31.6 billion barrels. [2] The POP, the largest oil field in North America, is estimated to contain about 25 billion barrels of OOIP [3], leaving 6.6 billion barrels of OOIP for the Eastern and Western Satellite fields.

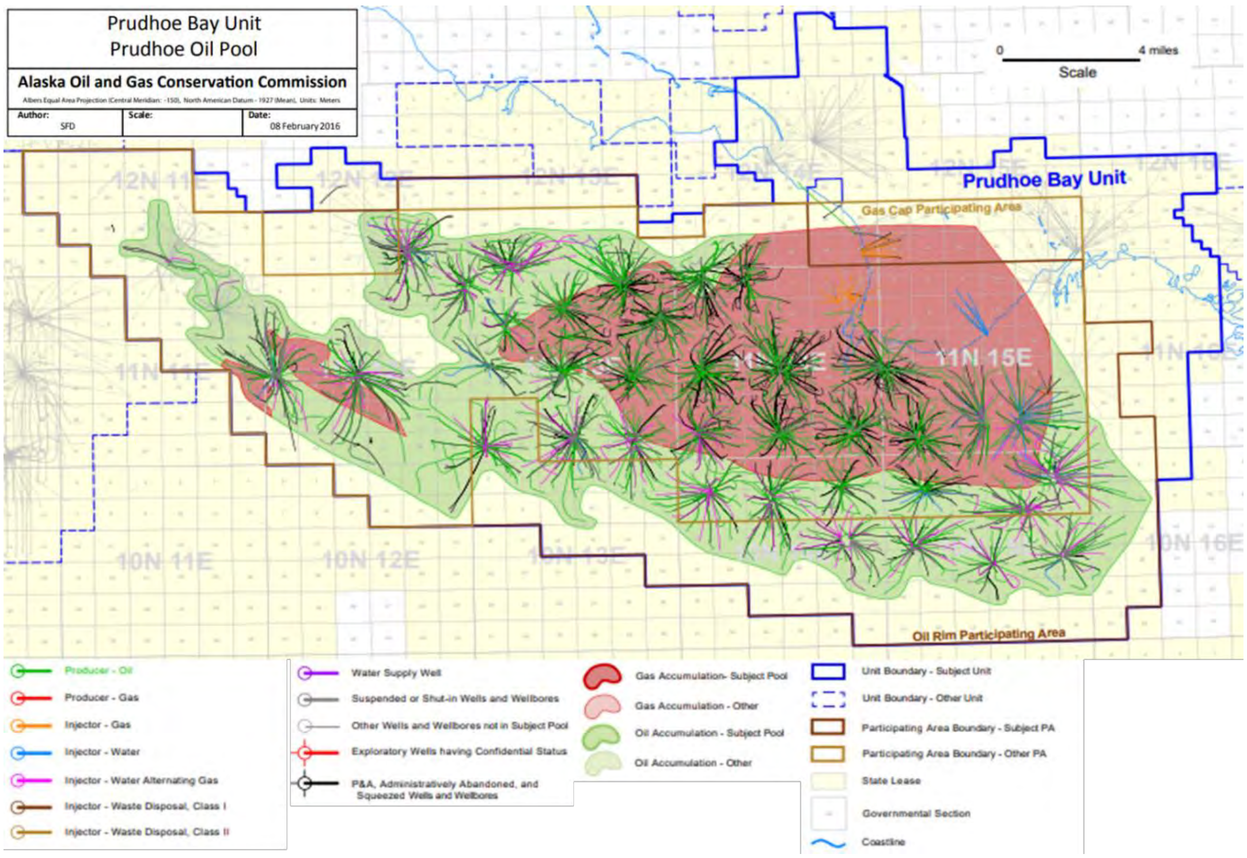
3.1 HISTORY OF IMPROVED OIL RECOVERY PRACTICES

Operation of the POP has included extensive improved oil recovery practices since 1981. These practices, which include waterflooding, MI, and water-alternating-gas injection (WAG), have helped maintain reservoir pressure and increase the efficiency of oil recovery.

The central portion of the POP field has been produced by gravity drainage enhanced by lean gas reinjection. Water injection into the gas cap has been used in recent years to assist with pressure maintenance. The perimeter of the POP field is produced primarily by MI and WAG injection.

Waterflooding has been used for pressure maintenance and oil recovery at each of the 11 Eastern and Western Satellite fields. In most cases, waterflooding was initiated at the field within one to two years of first oil production to maintain reservoir pressure. MI has been used at the five Western Satellite fields, while WAG has been used at Lisburne and Point McIntyre in the Eastern Satellite fields (Exhibit 3-2).

Exhibit 3-2. PBU reservoir and well map



Used with permission from the Alaska Oil and Gas Conservation Commission (AOGCC), 2021 [4]

Enhanced recovery operations at the Eastern Satellite fields occurred intermittently between the late 1980s and early 1990s at Lisburne and Point McIntyre. The enhanced recovery efforts in the Western Satellite fields started between 2000–2010 (Exhibit 3-3).

Exhibit 3-3. PBU enhanced recovery start dates

PBU Area		Reservoir	First Prod	WI	MI/WAG
Prudhoe Oil Pool		Sadlerochit	1969	1981	1986
Western Satellites	Aurora	Kuparuk	2000	2001	2003
	Borealis	Kuparuk	2001	2002	2004
	Midnight Sun	Kuparuk	1998	2000	2016
	Polaris	Schraeder Bluff	1999	2003	2009
	Orion	Schraeder Bluff	2002	2003	2006
Eastern Satellites	Niakuk	Kuparuk	1994	1995	-
	Lisburne	Lisburne	1982	1987-1989	1987
	Pt. McIntyre	Kuparuk/Kalubik	1993	1994	2000
	Raven	Sadlerochit/Sag	2007	2007	-

3.2 FIELD DEVELOPMENT AND OIL PRODUCTION

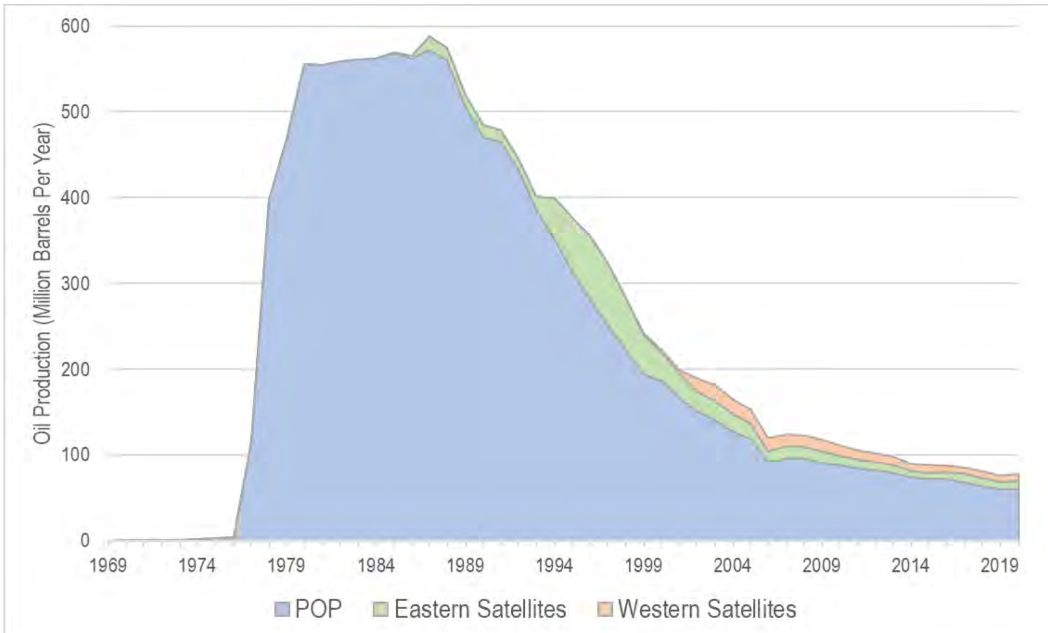
The PBU has produced approximately 13 billion barrels of oil through the end of 2020. The majority of this production, approximately 12 billion barrels, has been from the POP. The Eastern Satellite fields have produced approximately 770 million barrels (MMbbl) of oil and the Western Satellite fields have produced approximately 230 MMbbl of oil.

Major development of the POP began in 1977, leading to an oil production peak of 572 MMbbl (1.57 MMbbl per day) in 1987. The latest oil production at the POP was approximately 61 MMbbl (167,000 barrels per day [B/D]) in 2020.

Development of the Eastern Satellite fields began in 1981 at the Lisburne Oil Pool, followed by the development of Point McIntyre in 1993. Production from the Eastern Satellite fields peaked in 1996 at 73.6 MMbbl (approximately 200,000 B/D). Oil production at the Eastern Satellite fields was approximately 9.5 MMbbl (26,000 B/D) in 2020.

The five Western Satellite fields were developed between 1998–2002, with oil production peaking in 2003 at 18.6 MMbbl (approximately 51,000 B/D). Oil production at the Western Satellite fields was approximately 8 MMbbl (22,000 B/D) in 2020 (Exhibit 3-4).

Exhibit 3-4. Annual oil production—POP and Satellite fields

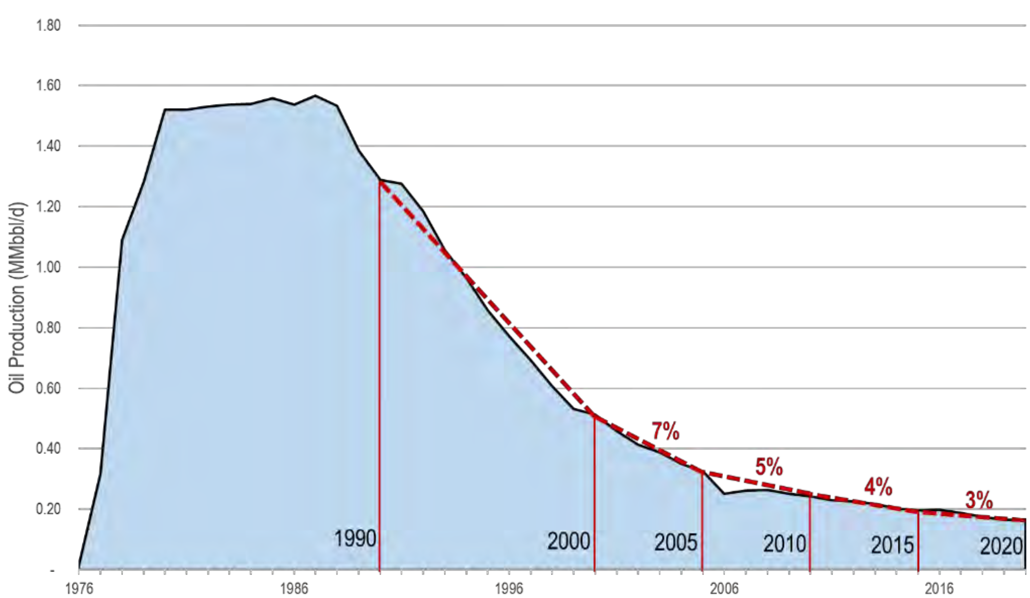


Modified with permission from AOGCC, 2021 [5]

3.3 METHODOLOGY FOR ESTIMATING FUTURE OIL PRODUCTION

Advanced Resources International (ARI) used historical oil production data for the POP and the Satellite fields to conduct production decline analysis to assess future expected oil production at PBU. The historical production data shows that the oil production decline rate has decreased steadily in the past few years (Exhibit 3-5).

Exhibit 3-5. PBU oil production decline



Modified with permission from AOGCC, 2021 [5]

The oil production decline rate of approximately 3 percent per year for the POP was first carried out to 2029 (the first year of expected gas sales for the Alaska LNG Project) to provide a starting point for examining the impact of the MGS on future oil production. The decline analysis was then extended to the end of 2058 for Case 1 to establish the baseline for oil production without the Alaska LNG Project. A steeper oil production decline rate was used in Case 2 to estimate the loss of potential oil production from the POP and Satellite fields due to the Alaska LNG Project.

The decline analysis methodology was calibrated against a detailed full-field model (FFM) of the impact of MGS on oil production from the POP from 2025–2054, conducted by BP. [6]. The FFM evaluated potential oil production for both a "baseline" case (future oil production with no gas sales) and a "gas reference" case (starting the MGS project in 2025). The BP "baseline" case provided an oil production volume of 1.07 billion barrels for the POP over a 30-year period if no MGS project was initiated. The BP FFM study also showed a lower volume of 0.79 billion barrels of oil production under the "gas reference" case. The reduced oil production in the MGS case is due to declining reservoir pressure resulting from reduced gas reinjection.

The oil production decline curve models for Case 1 and Case 2 were then calibrated to the BP FFM models. The POP decline curve oil production from 2025–2054 was matched to the BP model production totals—1.07 billion barrels for the "baseline" case and 0.79 billion barrels for the "gas reference" case. The calibrated decline curve models were used to calculate the oil production decline at the POP and the Satellite fields, first from 2020–2029, and then to 2058. The results from these analyses are discussed in more detail in Section 3 and Section 4.

4 CASE 1—"BUSINESS AS USUAL"

Case 1 provides the BAU oil production case for the POP and Satellite fields within the PBU, assuming no MGS project. A decline curve-based assessment of oil production was projected out to 2058, which includes eight years of development leading up to the MGS project in 2029, and then for 30 years until the end of 2058.

4.1 CASE 1 OIL PRODUCTION

Case 1 started with oil production in 2020 of 61 MMbbl for the POP, 9.3 MMbbl for the Eastern Satellites, and 8.0 MMbbl for the Western Satellites. The POP was assumed to continue its current oil production decline of 3 percent per year to an estimated oil production of 47.8 MMbbl in 2028. The Satellite fields, using a 1 percent decline in oil production per year, resulted in estimated oil production of 8.6 MMbbl for the Eastern Satellite fields and 7.4 MMbbl for the Western Satellite fields in 2028.

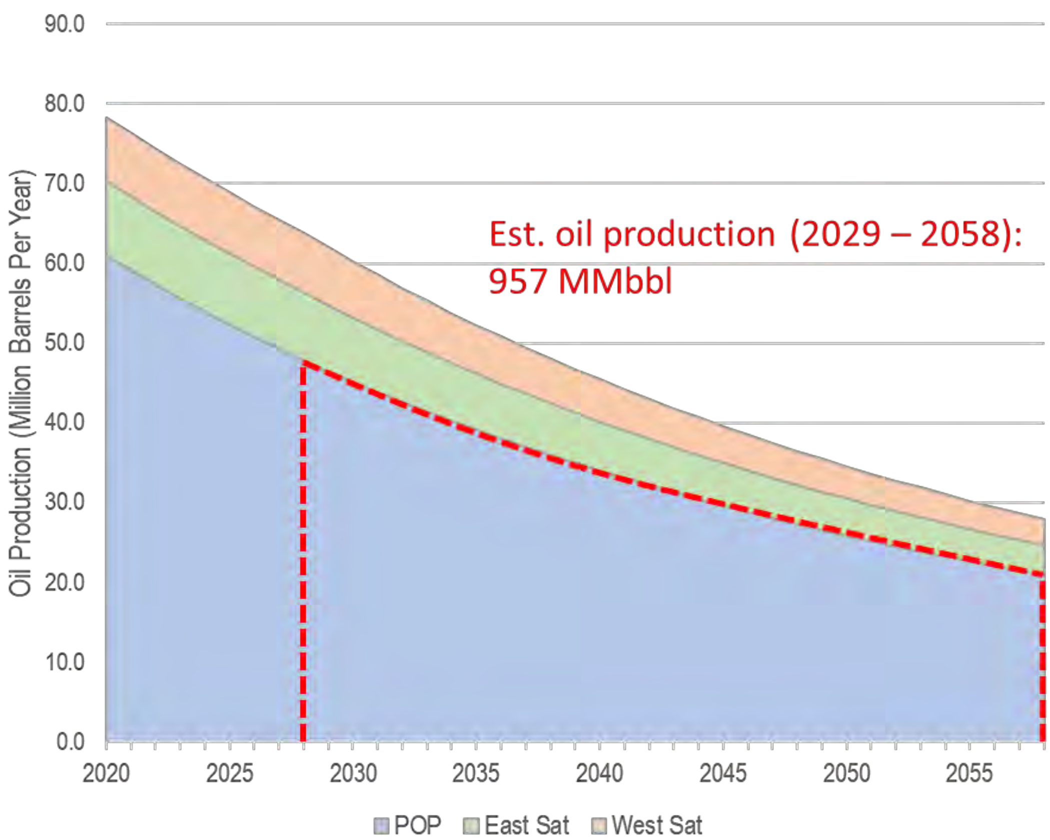
Small adjustments were made to the incremental decline rates from 2029–2058 for Case 1 to match the "baseline" BP model. The overall oil production decline curve for the POP gradually flattens from 2.85 percent in year 2029 to 2.61 percent in year 2055. Similar decline rates were used to estimate future oil recovery from the Eastern and Western Satellite fields (Exhibit 4-1).

Exhibit 4-1. Case 1 annual decline rates

Project Years	Decline Rate		
	POP	Eastern Satellites	Western Sattelites
2020 to 2028	3%	1%	1%
2029	2.85%	2.85%	2.85%
2030 to 2034	2.81%	2.81%	2.81%
2035 to 2039	2.77%	2.77%	2.77%
2040 to 2044	2.73%	2.73%	2.73%
2045 to 2049	2.69%	2.69%	2.69%
2050 to 2054	2.65%	2.65%	2.65%
2055 to 2058	2.61%	2.61%	2.61%

Case 1 total oil production from the POP from 2029–2058 is 957 MMbbl (Exhibit 4-2).

Exhibit 4-2. Case 1 BAU oil production



4.2 CASE 1 IMPACTS

The sections below outline the oil production impacts for Case 1 for an operational period of both 30 years and 33 years.

Management of byproduct CO_2 is not required for Case 1 since the produced gas (including its CO_2 content) from the PBU is reinjected under the BAU scenario. A table of the PBU annual oil production, gross gas production, gas consumption, and gas reinjection for Case 1 is included in Exhibit A-1 of Appendix A.

4.2.1 30 Year Project Impacts

The results of the oil production decline analysis for Case 1 show that total oil production from 2029–2058 for the PBU is 1,277 MMbbl. This includes 957 MMbbl from the POP, 148 MMbbl from the Western Satellite fields, and 172 MMbbl from the Eastern Satellite fields (Exhibit 4-3).

Exhibit 4-3. Case 1 PBU estimated oil production (2029–2058)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	957
Western Satellites	148
Eastern Satellites	172
Prudhoe Bay Unit	1,277

4.2.2 33 Year Project Impacts

Assuming Alaska LNG elects to extend the project by three years, the results of the oil production decline analysis for Case 1 show that total oil production from 2029–2061 for the PBU is 1,355 MMbbl. This includes 1,016 MMbbl from the POP, 157 MMbbl from the Western Satellite fields, and 182 MMbbl from the Eastern Satellite fields (Exhibit 4-3).

Exhibit 4-4. Case 1 PBU estimated oil production (2029–2061)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	1,016
Western Satellites	157
Eastern Satellites	182
Prudhoe Bay Unit	1,355

5 CASE 2—REDUCED GAS REINJECTION

Case 2 analysis of oil production potential for the POP and Satellite fields assumes a steady decline in pressure in the PBU due to the start of the MGS project. It also assumes a switch in priority from production of oil to production of gas for export as part of the Alaska LNG Project. The volumes of natural gas and CO_2 that are currently reinjected would now be produced. The oil production estimates for Case 2 are calibrated against the oil production estimated by the detailed BP model for MGS. The same rates of oil production decline were used for both the POP and Satellite fields. Management and utilization of the byproduct CO_2 produced as part of MGS is addressed in Case 3 of this report and in Upstream Study Report 3.

5.1 CASE 2 OIL PRODUCTION

Case 2 provides a projection of oil production to 2058, which includes eight years of development leading up to MGS beginning in 2029 and 30 years of MGS operation until the end of 2058. Case 2 includes the same beginning oil production data points for 2029 and the same initial decline rates (3 percent and 1 percent, respectively) for the POP and Satellite fields as in Case 1.

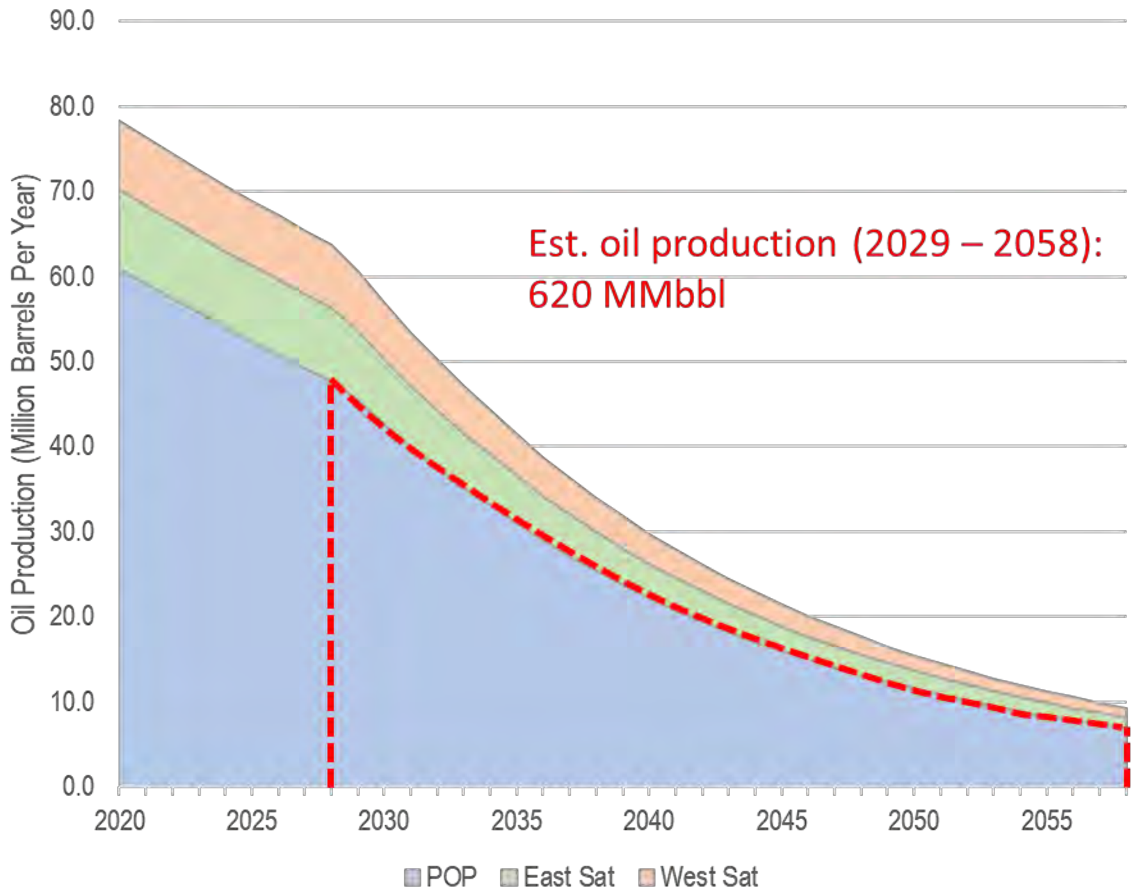
Oil production for Case 2 has a steeper decline than Case 1 due to the reduction in reservoir pressure from reduced gas reinjection. The initial decline rates increase from 5 percent in 2029 to 6.5 percent in 2031 as the GTP trains are brought online and less gas is reinjected at the PBU. The decline rate then gradually decreases from 6.44 percent in 2035 to 6.2 percent in 2055. The oil production decline rates used for the Eastern and Western Satellite fields were the same as the decline rates for the POP (Exhibit 5-1).

Exhibit 5-1. Case 2 "pressure depletion" decline rates

Project Years	Decline Rate		
	POP	Eastern Satellites	Western Sattelites
2020 to 2028	3%	1%	1%
2029	5.00%	5.00%	5.00%
2030	6.00%	6.00%	6.00%
2030 to 2034	6.50%	6.50%	6.50%
2035 to 2039	6.44%	6.44%	6.44%
2040 to 2044	6.38%	6.38%	6.38%
2045 to 2049	6.32%	6.32%	6.32%
2050 to 2054	6.26%	6.26%	6.26%
2055 to 2058	6.20%	6.20%	6.20%

In Case 2, the total oil production for the POP from 2029–2058 is 620 MMbbl (Exhibit 5-2).

Exhibit 5-2. Case 2 "pressure depletion" oil production decline curve



5.2 CASE 2 IMPACTS

The sections below outline the oil production impacts for Case 2 for an operational period of both 30 years and 33 years.

A table of the PBU annual oil production, gross gas production, gas consumption, gas delivery to the GTP, gas reinjection, and gas-oil ratio for Case 2 is included in Exhibit A-2 of Appendix A.

5.2.1 30 Year Project Impacts

Applying the oil production decline methodology in Case 2 shows that total future oil production from 2029–2058 for the PBU is 825 MMbbl. This includes 620 MMbbl for the POP, 95 MMbbl for the Western Satellite fields, and 110 MMbbl for the Eastern Satellite fields (Exhibit 5-3).

Exhibit 5-3. Case 2 "pressure depletion" PBU EUR (2029-2058)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	620
Western Satellites	95
Eastern Satellites	110
Prudhoe Bay Unit	825

As such, given the BAU (Case 1) volume of oil production of 1,277 MMbbl and the MGS (Case 2) volume of oil production of 825 MMbbl, initiating the Alaska LNG Project in 2029 reduces total PBU oil production by 452 MMbbl (Exhibit 5-4).

Exhibit 5-4. Comparison of Case 1 and Case 2

Development Case	Oil Prod. (MMbbl)
Case 1 (BAU)	1,277
Case 2 (MGS)	825
Oil Production Impact	452

5.2.2 33 Year Project Impacts

Assuming Alaska LNG elects to extend the project by three years, applying the oil production decline methodology in Case 2 shows that total future oil production from 2029–2061 for the PBU is 849 MMbbl. This includes 638 MMbbl for the POP, 97 MMbbl for the Western Satellite fields, and 113 MMbbl for the Eastern Satellite fields (Exhibit 5-5).

Exhibit 5-5. Case 2 "pressure depletion" PBU EUR (2029-2061)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	638
Western Satellites	97
Eastern Satellites	113
Prudhoe Bay Unit	849

As such, given the BAU (Case 1) volume of oil production of 1,355 MMbbl and the MGS (Case 2) volume of oil production of 849 MMbbl, extending the Alaska LNG Project to 2061 reduces total PBU oil production by 506 MMbbl (Exhibit 5-6).

Exhibit 5-6. Comparison of Case 1 and Case 2

Development Case	Oil Prod. (MMbbl)
Case 1 (BAU)	1,355
Case 2 (MGS)	849
Oil Production Impact	506

6 CASE 3—STORAGE AND USE OF BYPRODUCT CO_2

Case 3 investigates the option of storing byproduct CO_2 captured at the GTP during the 30-year Alaska LNG Project using CO_2 EOR. This scenario is one of several likely options for storing CO_2 with CO_2 EOR on the North Slope of Alaska.

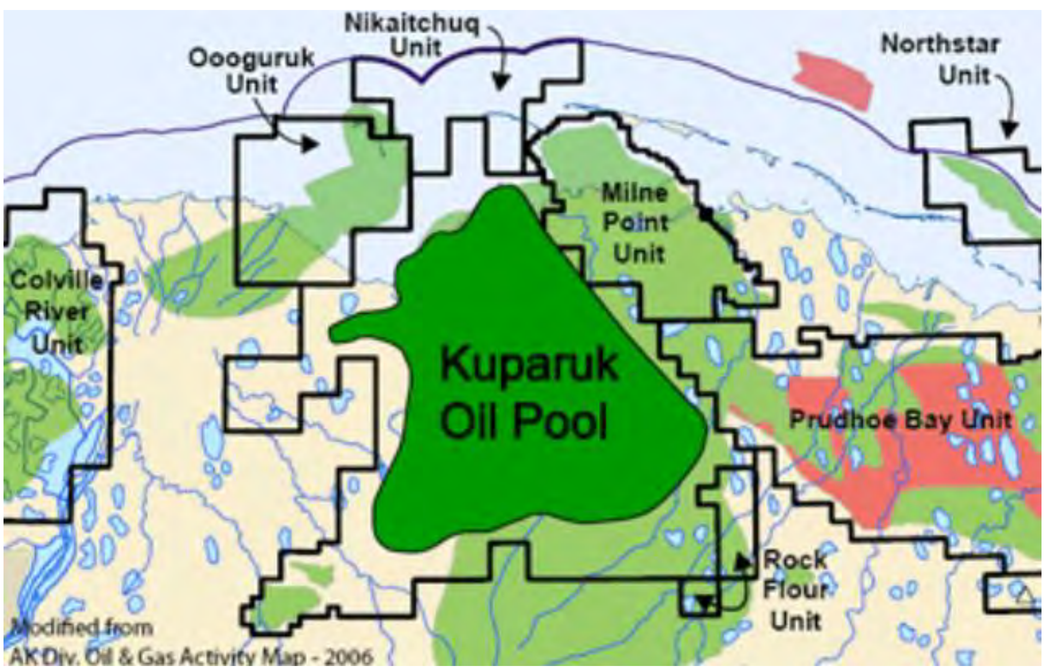
The large Kuparuk River oil field, adjacent to the PBU, is the subject of the CO_2 Storage and EOR Project for Case 3. The field was selected for Case 3 due to its proximity to the PBU and its reservoir capacity for utilizing the byproduct CO_2 from the Alaska LNG project. Approximately 350 MMcfd of CO_2 from the GTP associated with the Alaska LNG Project would be injected for CO_2 storage and EOR. The total volume of CO_2 that would be captured from the GTP and transported for CO_2 EOR at Kuparuk would be 190 million metric tons over 30 years, or 202 million metric tons over the extended 33-year project period.

Extensive studies of the operation of miscible gas injection have been performed at the Kuparuk River oil field, providing a precedent for evaluating the viability of a CO_2 flood at Kuparuk. In addition, existing pipeline corridors exist between Kuparuk River and the PBU.

6.1 KUPARUK RIVER UNIT

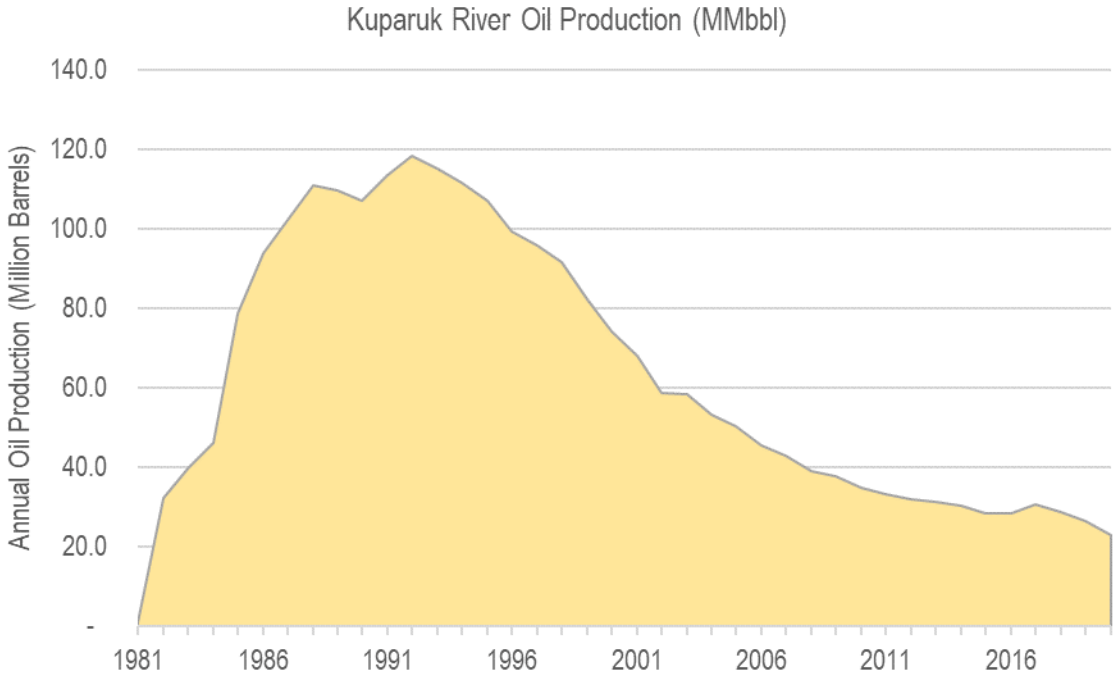
The KRU oil field is located approximately 30 miles west of the PBU's central facilities on Alaska's North Slope. It is the second largest oil field in Alaska after Prudhoe Bay (Exhibit 6-1). Oil production at Kuparuk River began in 1981 and increased until reaching a peak of nearly 120 MMbbl per year (330,000 B/D) in 1992. Oil production has declined steadily to a current total of 23 MMbbl in 2020 (63,000 B/D). Total oil production from the KRU is approximately 2.5 billion barrels as of the end of 2020 (Exhibit 6-2).

Exhibit 6-1. Kuparuk oil field location



Used with permission from AOGCC, 2021 [5]

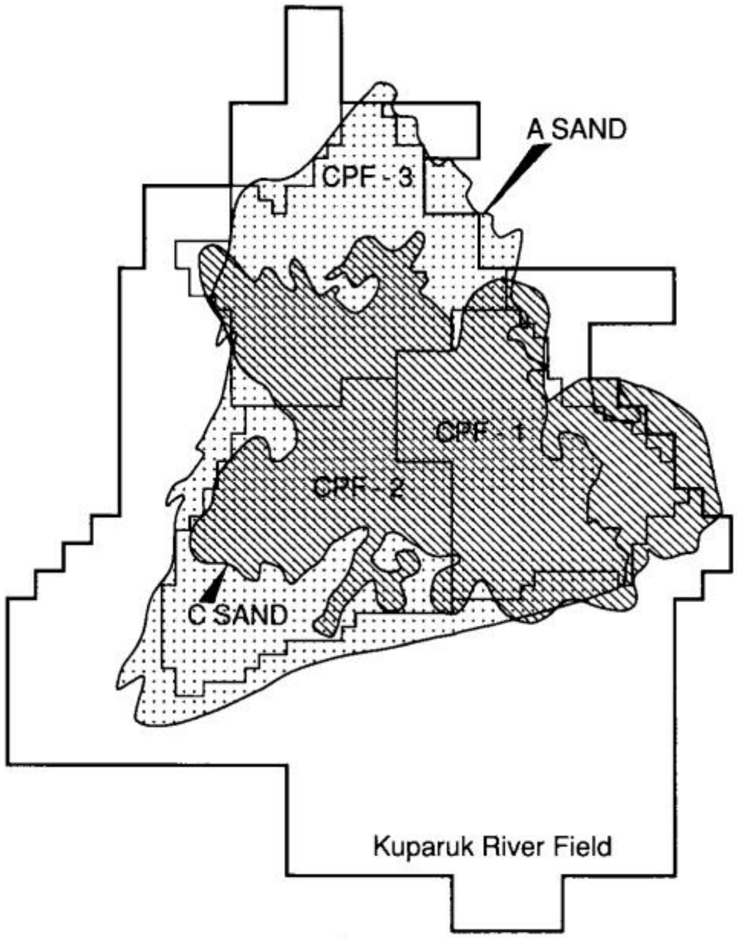
Exhibit 6-2. KRU oil production to 2020



The Kuparuk River oil field produces primarily from two major sandstone reservoirs—the A Sand and C Sand. The previous evaluation of the Kuparuk River oil field established an OOIP of approximately 3.95 billion barrels for the A Sand and 2.31 billion barrels for the C Sand. The C Sand, located above the A Sand, has a slightly smaller areal extent than the A Sand (Exhibit 6-3).

The KRU has field-wide average permeability of 150 millidarcies (mD) and an average porosity of 22 percent, with an average API oil gravity of 24°.

Exhibit 6-3. KRU C Sand and A Sand orientation



Used with permission from BP Alaska, 1990 [7]

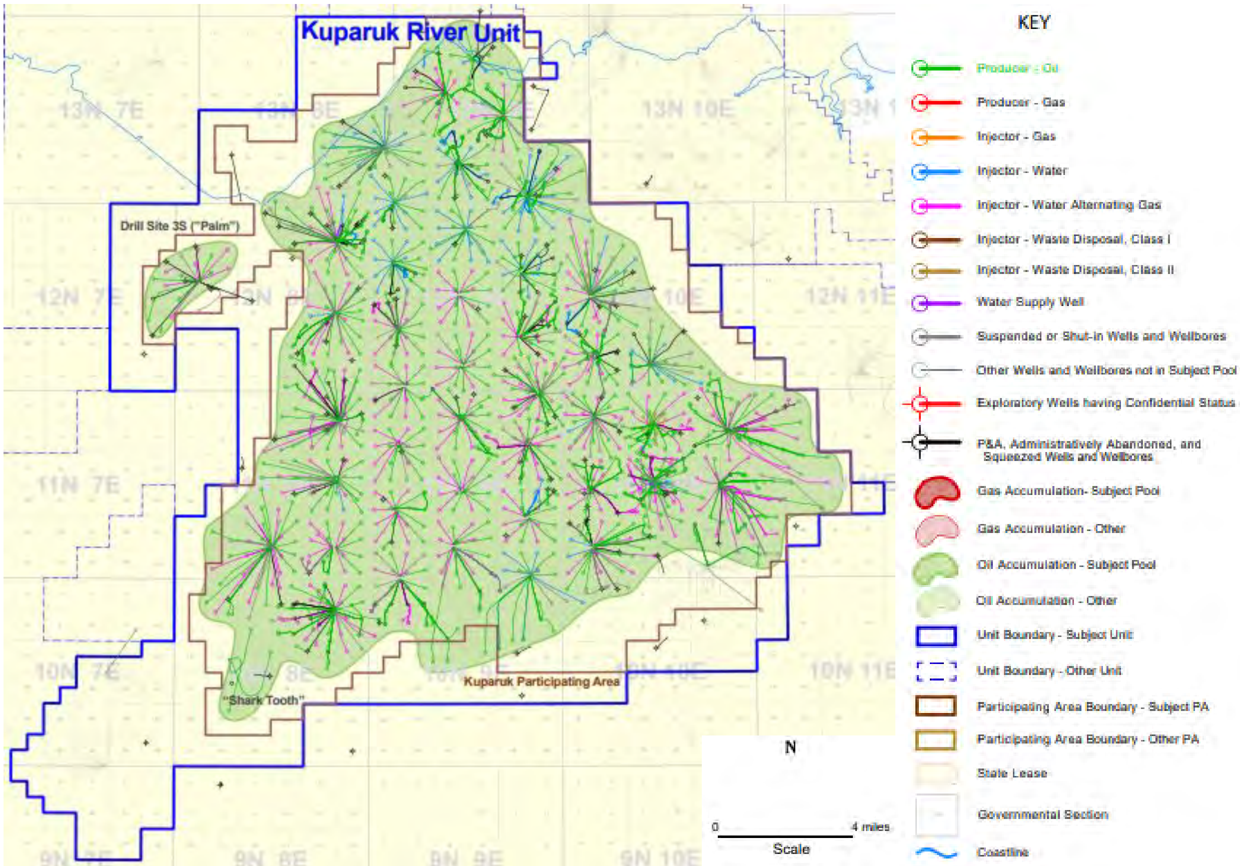
6.2 KRU OPERATIONS

Significant EOR activities, in the form of miscible water-alternating-gas (MWAG), have been underway at Kuparuk for several decades. The first MWAG pilot was performed at two drill sites in 1988, and a third pilot was undertaken in 1993. Following the pilots, large-scale implementation of MWAG was started in 1996.

The broader application of MWAG at Kuparuk River has been constrained by the limited supply of miscible injectant (natural gas liquids [NGLs]). The miscible injectant is limited by what is produced at Kuparuk and what can be supplied for the project from the PBU. The KRU received an average of 65.8 MMcfd of miscible injectant in 2020, which was utilized at 71 injection wells on 24 drill pads. [8] Overall, the KRU currently has approximately 740 active wells, including 406 production wells and 334 injection wells.

Exhibit 6-4 shows the water injection, MI, and WAG injection well locations at the KRU.

Exhibit 6-4. KRU well locations



Used with permission from AOGCC, 2021 [5]

While injection of CO_2 as a miscible injectant has not been used at the KRU, a number of pilot studies and modeling of EOR potential have been performed for the field. Detailed geocellular modeling of the KRU A Sand and C Sand was performed to evaluate the options for improving MI injectivity and throughput in these reservoirs. [9] Additional studies, including slim tube experiments, showed a high correlation between the estimated minimum miscibility pressure (MMP) value and the observed MMP value of the oil in the Kuparuk River reservoir. [10] The calculations used by this study suggest that the oil reservoirs at the KRU should meet the technical criteria for miscible CO_2 injection, as discussed in Section 6.3 of this report.

6.3 KRU TYPE PATTERNS

Representative "type" patterns for the C Sand and the A Sand were developed for modeling CO_2EOR at the KRU. These type patterns included average reservoir properties for the C Sand and A Sand, as well as CO_2 EOR project parameters, such as:

1. <u>CO_2 Flood Pattern Size</u>—Each project is developed using a pattern size of 320 acres, which is consistent with the pattern development at the KRU.
2. <u>Fluid Injection Rate</u>— CO_2 and water injection rates are calculated for the C Sand and A Sand based on the pattern size, fluid properties, and reservoir characteristics. The

project is modeled using stacked injection intervals, with each injection well completed into both the C Sand and A Sand.

3. <u>CO_2 Flood Design</u>—A total of 1.5 hydrocarbon pore volume (HCPV) of CO_2 is injected into the KRU using WAG injection. The pattern is oriented as a line-drive configuration using one injection well and one production well per pattern, similar to the pattern configuration used at the KRU.

6.3.1 Reservoir Properties

Reservoir property data for the C Sand and A Sand were obtained from the AOGCC pool statistic reports, as well as technical research papers on the KRU. [11] [10]

The C Sand OOIP was calculated to be approximately 2.24 billion barrels based on an estimated area of 107,400 acres and an average net pay of 23.4 feet. The OOIP for the A Sand was calculated to be 3.66 billion barrels based on an estimated area of approximately 150,000 acres and an average net pay of 25 feet.

Exhibit 6-5 includes additional reservoir property data for the type patterns.

Exhibit 6-5. KRU type pattern reservoir properties

Reservoir Data		C Sand	A Sand
Volumetric Data	OOIP (MMbbl)	2,242	3,658
	Area (ac)	107,400	149,700
	Net Pay (ft)	23.4	25.0
	Porosity (%)	21%	23%
	Soi (%)	69%	69%
	Boi	1.26	1.26
Reservoir Properties	Permeability (md)	130	100
	Depth (ft)	6,000	6,250
	Temperature (F)	158	162
	API Gravity	24	24
	Oil Viscosity (cp)	1.62	1.57
	Initial Pressure (psi)	3,135	3,135

6.3.2 CO_2 Miscibility

MMP at Kuparuk was studied using a range of miscible injectants from low to high molecular weights. [10] The study showed that most of the low to mid molecular weight injectants had MMP of about 3,000 pounds per square inch (psi). In general, the MMP for CO_2 is typically lower than for low molecular weight hydrocarbon injectants, such as methane.

The following equation was used in this study to estimate the MMP for the C Sand and A Sand reservoirs [12]:

$$C5 + MW = 4{,}247.98641 * (API\ Gravity^{\wedge} - 0.87022)$$

The MMP was calculated to be 3,083 psi for the C Sand and 3,164 psi for the A Sand, both of which satisfy criteria for MMP based on the reservoir depths.

6.3.3 Injectivity

The fluid injection rate was calculated for each reservoir to determine the maximum allowable rate of injection into the reservoir. The following equation was used to estimate the rate of water injection for the type patterns:

$$q = 3.541 * kh\Delta P \,/\, \mu[\ln\left(\frac{a}{r_w}\right) - 0.619]$$

Where:

- k is the average permeability of the reservoir, in mD.
- h is the average net pay of the reservoir, in ft.
- ΔP is the difference between the estimated maximum allowable injection pressure (equal to depth * 0.6 psi/ft) and the reservoir pressure at the production well (equal to 1,000 psi).
- μ is the reservoir water viscosity, in centipoise.
- a is the distance between the injection well and production well, in ft.
- r_w is injection wellbore radius, in ft.

A water injection rate of 2,971 B/D was calculated for the C Sand and 2,644 B/D was calculated for the A Sand. A rate of 2,644 B/D was used for both type patterns.

To estimate the equivalent CO_2 injection rate, the water injection rate was converted to a CO_2 injection rate using a CO_2 conversion factor of 2.3 thousand cubic feet per barrel. Therefore, a CO_2 injection rate of 6.081 MMcfd was used in each type pattern.

6.3.4 Reservoir Heterogeneity

The Dykstra-Parsons coefficient was used to assess the heterogeneity of the Kuparuk River oil reservoir. ARI estimated the Dykstra-Parsons value based on the correlation between reservoir sweep efficiency and mobility ratio, which is used to calculate the Dykstra-Parsons for oil fields that have experienced waterflooding, as described by Hirasaki, et al (SPE 13415). [13]

The ARI model calculated Dykstra-Parsons values of 0.77 for the C Sand and 0.79 for the A Sand type patterns.

6.4 CO_2 PROPHET MODEL

Reservoir modeling of the CO_2 EOR project at the KRU was performed using the CO_2 Prophet model. The CO_2 Prophet model is a finite difference stream-tube model that identifies how key reservoir variables influence CO_2 storage effectiveness and oil recovery with CO_2 EOR. The model performs three essential functions:

1. First, the model generates streamlines for fluid flow between injection and production wells.
2. Next, the model performs oil displacement and recovery calculations using fluid injectivity and reservoir property data.
3. Then, the model calculates the volume of CO_2 stored in the reservoirs.

The model generates a set of annual output data for oil, CO_2, and water production from the reservoir. These data are used to assess the technically viable CO_2 storage and incremental oil production for the project.

6.4.1 CO_2 Prophet Input Data

The exhibits below include the input data used to model the C Sand and A Sand type patterns with the CO_2 Prophet model. The input data includes relative permeability data, reservoir property data, fluid injection data, and CO_2 flood parameters (Exhibit 6-6 and Exhibit 6-7).

Exhibit 6-6. C Sand CO_2 Prophet input sheet

```
'AK Kuparuk C Sand CO2 PROPHET INPUT |'
'********** 'WELL AND PATTERN DATA ********'
'PATTERN'
'LD'
'NWELLS       NOINJ'
2,             1
'WELLS        WELLY        WELLQ'
0,            0,            1
1,            1,           -1
'NBNDPT'
 5
'BOUNDX       BOUNDY'
0,             0
0,             1
1,             1
1,             0
0,             0
'*************  PROGRAM CONTROLS  ********'
'LWGEN        OUTTIM'
'N',           1
'**** RELATIVE PERMEABILITY PARAMETERS ***'
'SORW         SORG         SORM'
0.335,         0.3,        0.08
'SGR          SSR'
0.3,          0.3
'SWC          SWIR'
0.3,           0.3
'KROCW        KWRO         KRSMAX       KRGCW'
0.8,          0.2,         0.4,          0.45
'EXPOW        EXPW         EXPS         EXPG         EXPOG'
2,            2,           2,           2,           2
'KRMSEL       W'
1,             0.999
'***************  FLUID DATA  ************'
'VISO         VISW'        CO2SOL 0 REDFAC 0.15 CO2INJ
2.5,          0.43
'BO           RS           API          SALN         GSG'
1.1,          465,          24,         30000,       0.75
'************** RESERVOIR DATA ***********'
'TRES         P            MMP'
158,          3607,        3083
'DPCOEF       PERMAV       THICK        POROS        NLAYERS'
0.77,         130,         23.4,         0.21,        10
'SOINIT       SGINIT       SWINIT'
0.335,        0,           0.665
'AREA         XKVH'
13939200,      1
'********** INJECTION PARAMETERS *********'
'NTIMES       WAGTAG'
3,            'T'
'HCPVI        WTRRAT       SOLRAT       TMORVL'
0.375,         2644,        6.081,       0.35
0.525,         2644,        6.081,       0.45
0.6,           2644,        6.081,       0.5
```

Exhibit 6-7. A Sand CO_2 Prophet input sheet

```
'AK Kuparuk A Sand CO2 PROPHET INPUT '
'********** 'WELL AND PATTERN DATA ********'
'PATTERN'
'LD'
'NWELLS       NOINJ'
2,             1
'WELLS        WELLY         WELLQ'
0,            0,             1
1,            1,            -1
'NBNDPT'
 5
'BOUNDX       BOUNDY'
0,             0
0,             1
1,             1
1,             0
0,             0
'*************  PROGRAM CONTROLS  ********'
'LWGEN        OUTTIM'
'N',           1
'**** RELATIVE PERMEABILITY PARAMETERS ***'
'SORW         SORG          SORM'
0.335,         0.3,         0.08
'SGR          SSR'
0.3,          0.3
'SWC          SWIR'
0.3,           0.3
'KROCW        KWRO          KRSMAX        KRGCW'
0.8,          0.2,          0.4,           0.45
'EXPOW        EXPW          EXPS          EXPG          EXPOG'
2,            2,            2,            2,            2
'KRMSEL       W'
1,             0.999
'***************  FLUID DATA  ************'
'VISO         VISW'         CO2SOL 0 REDFAC 0.15 CO2INJ
2.5,          0.43
'BO           RS            API           SALN          GSG'
1.1,          465,           24,          30000,        0.75
'************** RESERVOIR DATA ***********'
'TRES         P             MMP'
162,          3758,         3164
'DPCOEF       PERMAV        THICK         POROS         NLAYERS'
0.79,         100,          25.0,         0.23,         10
'SOINIT       SGINIT        SWINIT'
0.335,        0,            0.665
'AREA         XKVH'
13939200,      1
'********** INJECTION PARAMETERS *********'
'NTIMES       WAGTAG'
3,            'T'
'HCPVI        WTRRAT        SOLRAT        TMORVL'
0.375,         2644,         6.081,         0.35
0.525,         2644,         6.081,         0.45
0.6,           2644,         6.081,         0.5
```

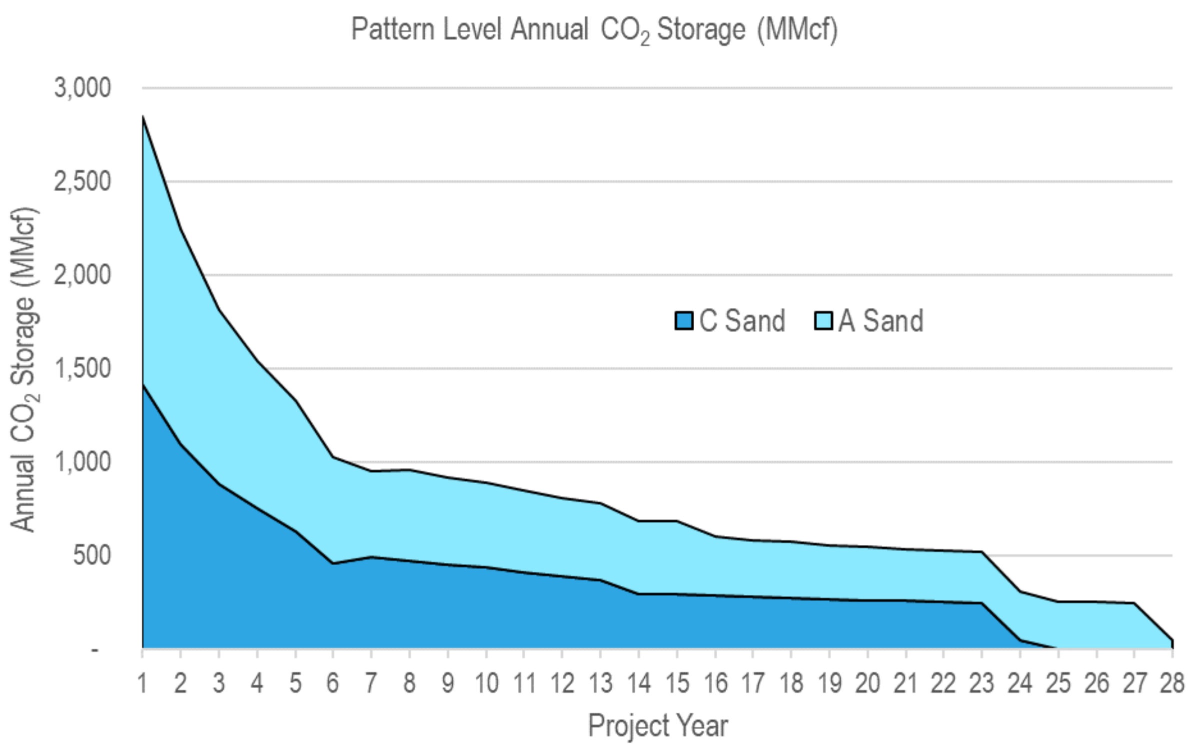
6.4.2 Pattern Results

The results of the CO_2 Prophet model simulation showed that a total of 11.1 billion cubic feet (Bcf) of CO_2 could be stored in the C Sand over 25 years of injection and a total of 12.9 Bcf of CO_2 could be stored in the A Sand over 28 years of injection per 320-acre pattern in the KRU.

Total CO_2 storage potential per pattern is approximately 24.0 Bcf (1.25 million metric tons [MMmt]) of CO_2.

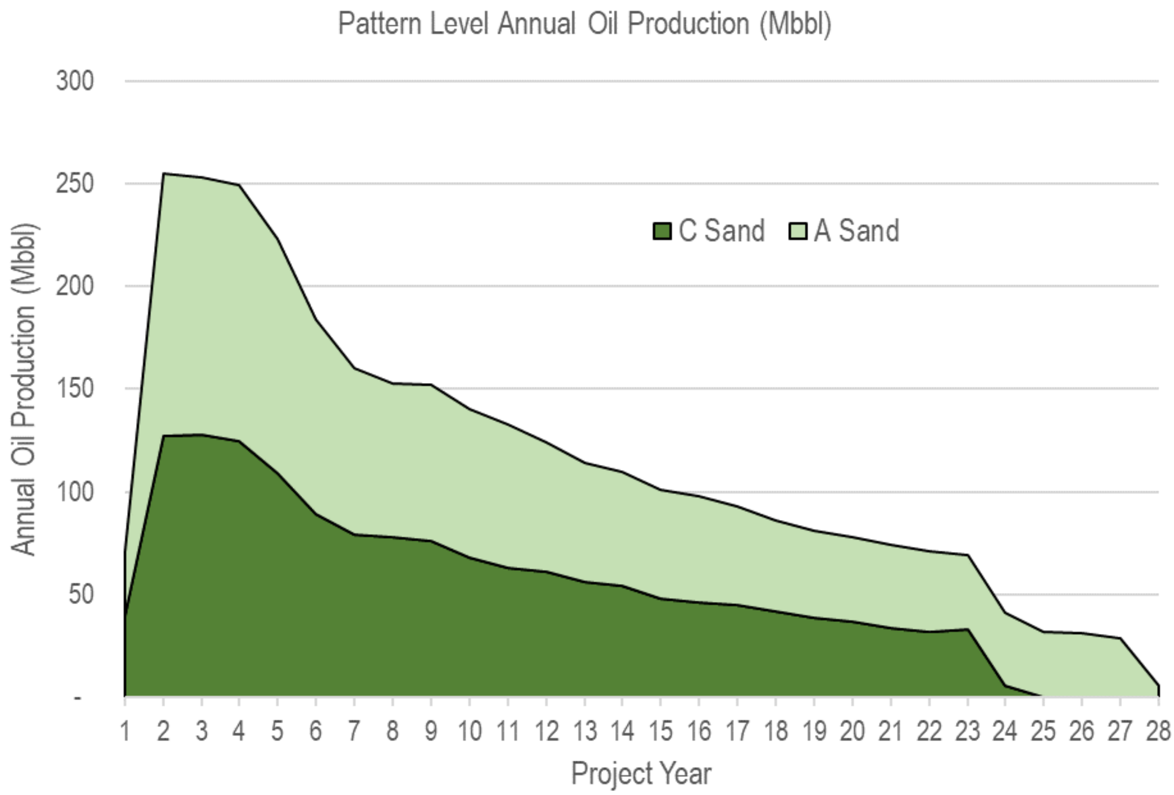
Exhibit 6-8 shows the annual rate of CO_2 storage for the 320-acre type pattern at the KRU EOR project.

Exhibit 6-8. CO_2 Prophet pattern level CO_2 storage



Oil production from the type pattern is approximately 1.5 MMbbl for the C Sand over 25 years and 1.7 MMbbl for the A Sand over 28 years. Total incremental oil production potential is approximately 3.2 MMbbl per 320-acre pattern (Exhibit 6-9).

Exhibit 6-9. CO_2 Prophet pattern level oil production



6.5 KRU CO_2 EOR DEVELOPMENT

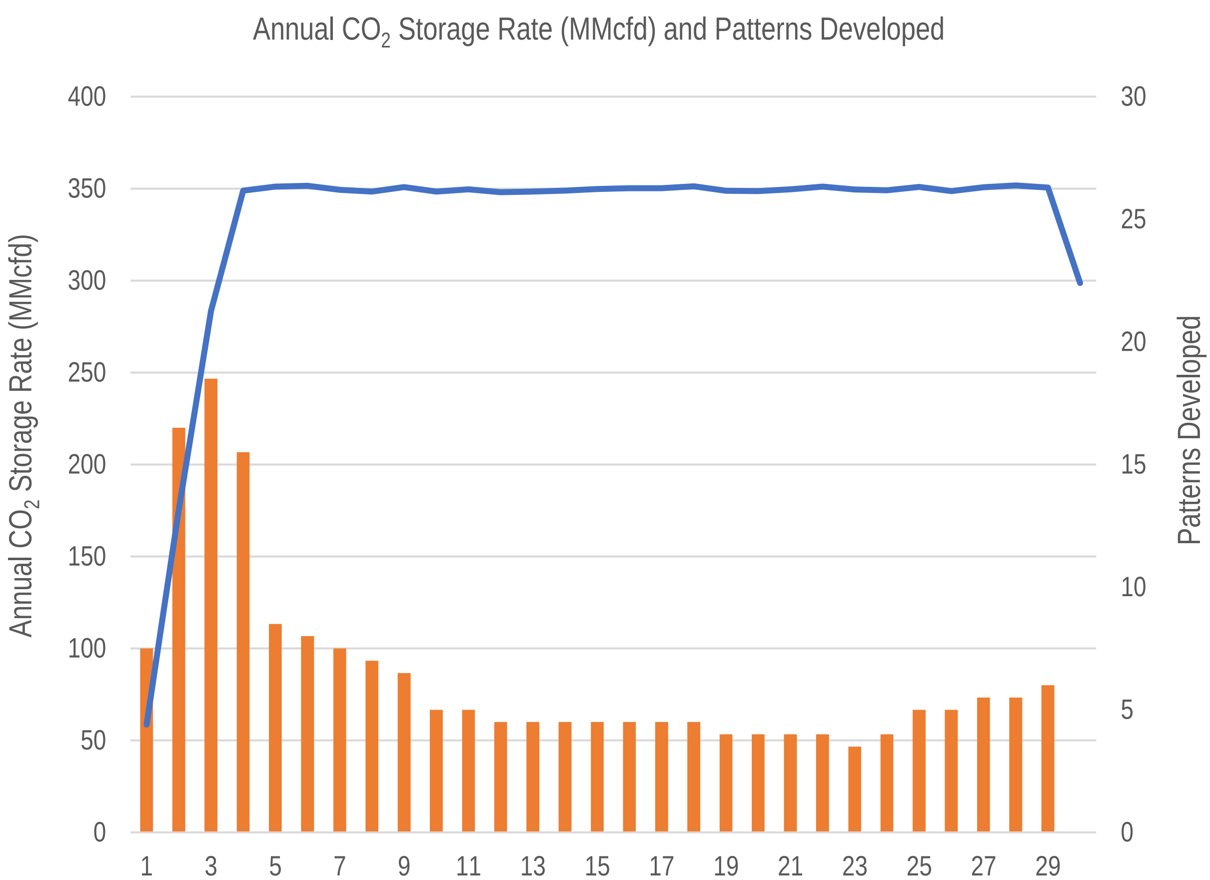
The CO_2 Prophet type pattern results were used to develop a full-field CO_2 storage model at the KRU for the 30-year CO_2 storage and oil recovery project. The rate of pattern development was calculated such that the total annual CO_2 storage was equal to the volume of CO_2 byproduct offtake from the Alaska LNG GTP. This volume of CO_2 byproduct increases in the initial years as the GTP trains come online. This volume equals 58 MMcfd in Year 1, 175 MMcfd day in Year 2, 283 MMcfd in Year 3, and 350 MMcfd in Years 4–29. CO_2 supply decreases in Year 30 to 233 MMcfd. Based on a review of the current development of the KRU, it is assumed that an adequate number of injection wells exist to develop a CO_2 EOR project at the KRU, without the need to drill any additional new injection wells. Existing wells would undergo retrofitting, as needed, in order to inject both CO_2 and water into the reservoirs. Additionally, a new CO_2 distribution system would be constructed at the KRU to deliver CO_2 to the injection wells in the field. This would require construction of approximately 19 miles of small volume CO_2 distribution pipelines to be installed in the field. Exact configuration and specifications of the CO_2 EOR project would be determined by the project operator.

6.5.1 CO_2 Storage

The CO_2 storage model for the KRU includes 188 patterns developed over the 30-year MGS project time frame. New patterns are brought online for the first 29 of the 30 years of MGS to meet the demand for storing the CO_2 byproduct.

A total of 3.62 trillion cubic feet (Tcf) (190 MMmt) of CO_2 is stored in the C Sand and A Sand of the KRU over the 30-year MGS period (Exhibit 6-10).

Exhibit 6-10. KRU field-wide CO_2 storage development



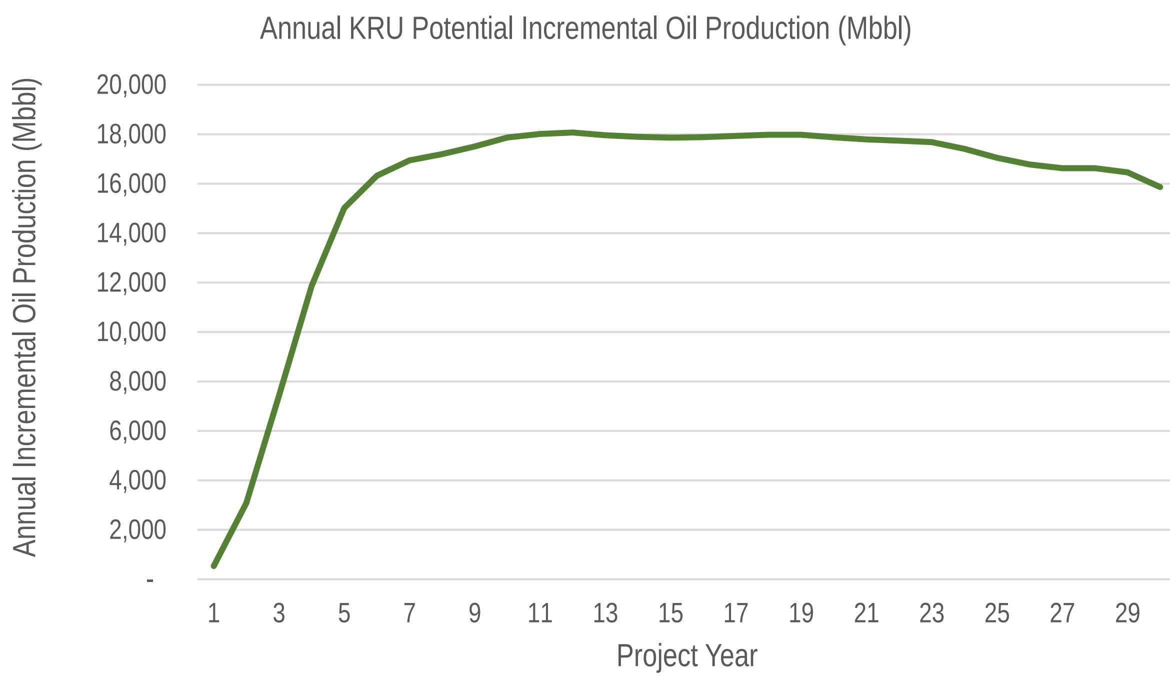
The 188 patterns developed for CO_2 storage encompass a total field area of just over 60,000 acres, or about 60 percent of the C Sand area and about 40 percent of the A Sand area. With more than 300 active injection wells currently in the field, the operator could be selective in pattern development to identify the optimal pattern configuration and existing wells to use for CO_2 EOR.

6.5.2 Incremental Oil Production

The CO_2 Prophet model shows that potential incremental oil production increases steadily in the first 10 years of the project to an average of about 18 MMbbl per year (50,000 BPD). Production declines slowly over the last five years of the project, to about 16 MMbbl per year (44,000 BPD).

Total incremental oil production potential for the CO_2 EOR project at the KRU is 473 MMbbl over the 30-year project period (Exhibit 6-11). Given the steady decline in oil production from the PBU between now and the start of the MGS, and the even steeper oil production decline once the MGS comes online, this study shows that the existing oil processing infrastructure at the PBU would easily accommodate the increased oil production from the KRU.

Exhibit 6-11. KRU field-wide incremental oil production potential



6.6 CASE 3 IMPACTS

The sections below outline the oil production and CO_2 storage impacts for Case 3 for an operational period of both 30 years and 33 years. The results of the CO_2 EOR model show a demand for CO_2 that matches the 190 million metric tons of CO_2 that would be supplied from the GTP over 30 years. The results of the 33-year CO_2 EOR model show a demand for 205 million metric tons of CO_2, however all of the 202 million metric tons of CO_2 supplied from the GTP would be utilized for CO_2 EOR at Kuparuk.

A table of the KRU annual oil production, CO_2 injection, CO_2 production, and CO_2 storage for Case 3 is included in Exhibit A-3 of Appendix A.

6.6.1 30 Year Project Impacts

The results of the Case 3 study show that utilizing the byproduct CO_2 from the Alaska LNG Project for CO_2 EOR for 30 years on the Alaska North Slope could provide incremental oil production of 473 MMbbl. The project would also store approximately 3.62 Tcf (190 MMmt) of byproduct CO_2, or an annual average of 120 Bcf (6.3 MMmt) over the 30-year life of the project (Exhibit 6-12).

Exhibit 6-12. Case 3 impacts (2029-2058)

Development Case	Oil Production (MMbbl)	CO2 Storage (Tcf)	CO2 Storage (MMmt)
Case 3 Use and Storage of By-Product CO2	473	3.62	190

6.6.2 33 Year Project Impacts

The results of the Case 3 study show that utilizing the byproduct CO_2 from the Alaska LNG Project for CO_2 EOR for 33 years on the Alaska North Slope could provide incremental oil production of 512 MMbbl. The project would also store approximately 3.87 Tcf (205 MMmt) of byproduct CO_2, or an annual average of 117 Bcf (6.2 MMmt) over the 33-year life of the project (Exhibit 6-12).

Exhibit 6-13. Case 3 impacts (2029-2061)

Development Case	Oil Production (MMbbl)	CO2 Storage (Tcf)	CO2 Storage (MMmt)
Case 3 Use and Storage of By-Product CO2	512	3.87	205

7 OBSERVATIONS AND NEXT STEPS

7.1 MAINTAINING OIL PRODUCTION ON THE ALASKA NORTH SLOPE

The sections below outline the impacts of the MGS project (Case 2) and the CO-EOR project at Kuparuk (Case 3) to North Slope oil production for both a 30 year project and a 33 year project.

7.1.1 30 Year Project Impacts

Case 2 shows that initiation of the MGS project will lead to a significant reduction in oil production from the PBU. Total oil production for Case 2 is 825 MMbbl compared to 1,277 MMbbl for Case 1 (BAU), for a net loss of 452 MMbbl of oil due to the Alaska LNG Project.

However, utilizing the byproduct CO_2 as part of a carbon capture, utilization, and storage (CCUS) operation could offset the loss in oil production while also effectively managing the CO_2. The results of Case 3 show potential incremental oil production of 473 MMbbl, which provides a total oil production potential of 1,298 MMbbl for Case 3 compared to 1,277 MMbbl for Case 1.

The potential geologic storage of byproduct CO_2 was determined to be 3.62 Tcf for Case 3 (Exhibit 7-1.). The geologic storage of the CO_2 by-product produced as part of Case 2 is further investigated in Alaska LNG Upstream Study Report 3: Storing By-Product CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit.

Exhibit 7-1. Comparison of oil production and CO_2 storage impacts (2029-2058)

Development Case	Oil Production (MMbbl)	KRU CO2 Storage (Tcf)	PBU CO2 Storage (Tcf)
Case 1 Business As Usual	1,277	NA	NA
Case 2 Reduced Gas Injection	825	NA	3.62
Loss Due to Alaska LNG	(452)	NA	NA
Gain from CO2 EOR at KRU	473	3.62	NA
Impact of Alaska LNG Project	1,298	3.62	3.62

7.1.2 33 Year Project Impacts

Over 33 years, the total oil production for Case 2 is 849 MMbbl compared to 1,355 MMbbl for Case 1 (BAU), for a net loss of 506 MMbbl of oil due to the Alaska LNG Project.

The results of Case 3 show potential incremental oil production of 512 MMbbl over 33 years, which provides a total oil production potential of 1,361 MMbbl for Case 3 compared to 1,361 MMbbl for Case 1.

The potential geologic storage of byproduct CO_2 over 33 years was determined to be 3.87 Tcf for Case 3 (Exhibit 7-1.).

Exhibit 7-2. Comparison of oil production and CO_2 storage impacts (2029-2061)

Development Case	Oil Production (MMbbl)	KRU CO2 Storage (Tcf)	PBU CO2 Storage (Tcf)
Case 1 Business As Usual	1,355	NA	NA
Case 2 Reduced Gas Injection	849	NA	3.87
Loss Due to Alaska LNG	(506)	NA	NA
Gain from CO2 EOR at KRU	512	3.87	NA
Impact of Alaska LNG Project	1,361	3.87	3.87

7.2 FURTHER MODELING OF CO_2 STORAGE POTENTIAL USING CO_2 EOR

The Case 3 study for the KRU is one example of utilizing the byproduct CO_2 for CO_2 EOR and CO_2 storage on the Alaska North Slope. It is likely that CCUS is viable in other nearby oil fields, as well as the KRU. This study represents a “high-level” evaluation of CO_2 EOR potential, whereas operators will utilize more in-depth compositional modeling simulations to determine the potential for CO_2 storage and incremental oil production in this region.

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APPENDIX A

CASE 1 ANNUAL DATA

Exhibit A-1. Case 1 annual PBU oil production, gross gas production, gas consumption, gas reinjection, and gas-oil ratio (33 years)

		PBU Oil Production	Gross PBU Gas Production	PBU Gas Consumption	PBU Gas Reinjection	Gas-Oil Ratio
Year		(MMbbl)	(Tcf)	(Tcf)	(Tcf)	(Mcf/bbl)
1	2029	62.0	2.89	0.23	2.66	47
2	2030	60.2	2.87	0.22	2.64	48
3	2031	58.5	2.84	0.22	2.62	49
4	2032	56.9	2.82	0.22	2.60	50
5	2033	55.3	2.80	0.22	2.58	51
6	2034	53.7	2.78	0.22	2.56	52
7	2035	52.2	2.75	0.22	2.54	53
8	2036	50.8	2.73	0.21	2.52	54
9	2037	49.4	2.71	0.21	2.50	55
10	2038	48.0	2.69	0.21	2.48	56
11	2039	46.7	2.67	0.21	2.46	57
12	2040	45.4	2.64	0.21	2.44	58
13	2041	44.2	2.62	0.21	2.42	59
14	2042	43.0	2.60	0.20	2.40	61
15	2043	41.8	2.58	0.20	2.38	62
16	2044	40.7	2.56	0.20	2.36	63
17	2045	39.6	2.54	0.20	2.34	64
18	2046	38.5	2.52	0.20	2.32	65
19	2047	37.5	2.50	0.20	2.30	67
20	2048	36.5	2.48	0.19	2.28	68
21	2049	35.5	2.46	0.19	2.27	69
22	2050	34.5	2.44	0.19	2.25	71
23	2051	33.6	2.42	0.19	2.23	72
24	2052	32.7	2.40	0.19	2.21	73
25	2053	31.9	2.38	0.19	2.19	75
26	2054	31.0	2.36	0.18	2.18	76
27	2055	30.2	2.34	0.18	2.16	78
28	2056	29.4	2.32	0.18	2.14	79
29	2057	28.7	2.30	0.18	2.12	80
30	2058	27.9	2.28	0.18	2.11	82
31	2059	27.2	2.27	0.18	2.09	83
32	2060	26.5	2.25	0.18	2.07	85
33	2061	25.8	2.23	0.17	2.06	87
Total		1,355.4	84.03	6.58	77.45	62

CASE 2 ANNUAL DATA

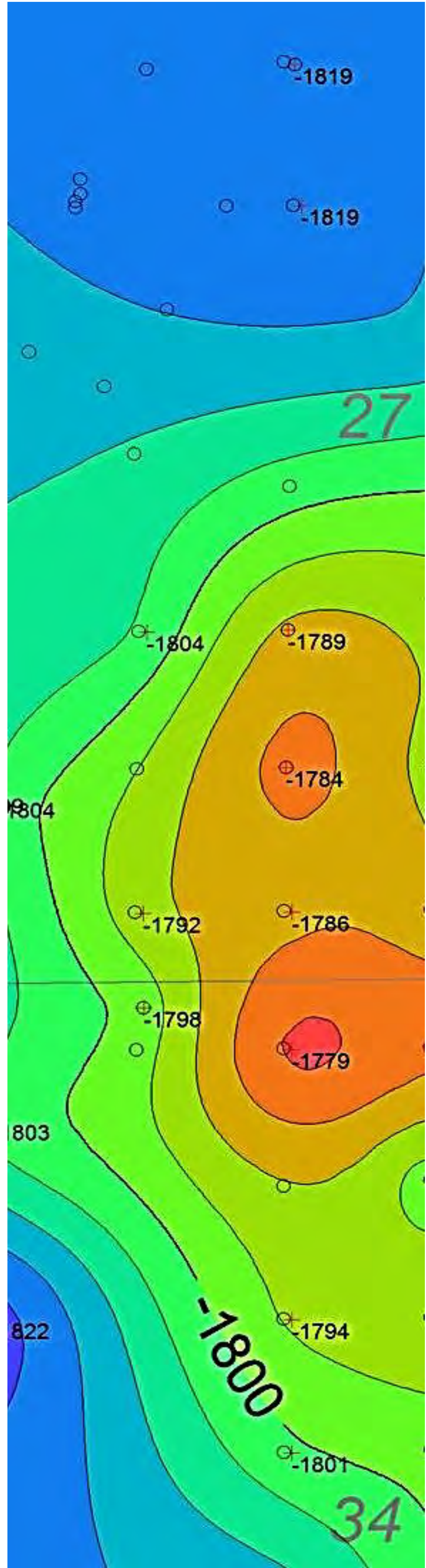
Exhibit A-2. Case 2 annual PBU oil production, gross gas production, gas consumption, gas delivery to the GTP, gas reinjection, and gas-oil ratio (33 years)

		PBU Oil Production	Gross PBU Gas Production	PBU Gas Consumption	PBU Gas Delivery to GTP	PBU Gas Reinjection	Gas-Oil Ratio
Year		(MMbbl)	(Tcf)	(Tcf)	(Tcf)	(Tcf)	(Mcf/bbl)
1	2029	60.6	2.90	0.11	0.15	2.6	48
2	2030	56.9	2.85	0.11	0.38	2.4	50
3	2031	53.3	2.81	0.11	0.69	2.0	53
4	2032	50.0	2.74	0.11	0.84	1.8	55
5	2033	46.9	2.63	0.11	0.91	1.6	56
6	2034	44.1	2.52	0.11	0.91	1.5	57
7	2035	41.2	2.42	0.11	0.91	1.4	59
8	2036	38.6	2.31	0.11	0.91	1.3	60
9	2037	36.1	2.21	0.11	0.91	1.2	61
10	2038	33.8	2.10	0.11	0.91	1.1	62
11	2039	31.6	2.00	0.07	0.91	1.0	63
12	2040	29.6	1.89	0.07	0.91	0.9	64
13	2041	27.7	1.79	0.07	0.91	0.8	65
14	2042	25.9	1.69	0.07	0.91	0.7	65
15	2043	24.3	1.59	0.07	0.91	0.6	65
16	2044	22.7	1.49	0.07	0.91	0.5	65
17	2045	21.3	1.38	0.07	0.91	0.4	65
18	2046	19.9	1.28	0.07	0.91	0.3	64
19	2047	18.7	1.18	0.07	0.91	0.2	63
20	2048	17.5	1.08	0.07	0.91	0.1	62
21	2049	16.4	0.98	0.06	0.91	0.0	60
22	2050	15.4	0.97	0.06	0.91	-	63
23	2051	14.4	0.97	0.06	0.91	-	68
24	2052	13.5	0.97	0.06	0.91	-	72
25	2053	12.7	0.97	0.06	0.91	-	77
26	2054	11.9	0.97	0.06	0.91	-	82
27	2055	11.1	0.97	0.06	0.91	-	88
28	2056	10.4	0.97	0.06	0.91	-	93
29	2057	9.8	0.97	0.06	0.91	-	100
30	2058	9.2	0.87	0.06	0.82	-	95
31	2059	8.53	0.70	0.04	0.65	-	82
32	2060	7.9	0.56	0.04	0.52	-	71
33	2061	7.27	0.45	0.03	0.42	-	61
Total		848.8	52.22	2.58	27.30	22.34	62

CASE 3 ANNUAL DATA

Exhibit A-3. Case 3 annual KRU oil production, CO_2 injection, CO_2 production, and CO_2 storage (33 years)

		Oil Production	CO_2 Injection	CO_2 Production	CO_2 Storage
Year		(MMbbl)	(Bcf)	(Bcf)	(Bcf)
1	2029	0.5	21.7	0.3	21.4
2	2030	3.1	69.3	5.4	63.9
3	2031	7.4	122.7	19.2	103.5
4	2032	11.9	167.5	40.1	127.3
5	2033	15.0	191.8	63.7	128.2
6	2034	16.3	212.7	84.3	128.3
7	2035	16.9	228.4	100.9	127.5
8	2036	17.2	240.8	113.7	127.2
9	2037	17.5	252.4	124.3	128.0
10	2038	17.9	261.9	134.7	127.2
11	2039	18.0	272.7	145.1	127.6
12	2040	18.1	282.3	155.3	127.0
13	2041	18.0	292.1	164.9	127.2
14	2042	17.9	301.3	174.0	127.3
15	2043	17.9	310.0	182.4	127.7
16	2044	17.9	318.1	190.3	127.8
17	2045	17.9	325.7	197.9	127.8
18	2046	18.0	333.8	205.6	128.2
19	2047	18.0	340.6	213.3	127.3
20	2048	17.9	348.2	220.9	127.3
21	2049	17.8	356.1	228.5	127.6
22	2050	17.7	364.1	235.9	128.2
23	2051	17.7	370.8	243.3	127.6
24	2052	17.4	372.6	245.1	127.4
25	2053	17.0	367.8	239.7	128.1
26	2054	16.8	359.3	232.0	127.3
27	2055	16.6	354.5	226.5	128.0
28	2056	16.6	350.1	221.7	128.4
29	2057	16.5	339.4	211.4	128.0
30	2058	15.9	307.8	198.8	109.0
31	2059	14.2	278.8	184.8	94.0
32	2060	12.8	257.2	174.1	83.1
33	2061	11.4	238.9	164.4	74.5
Total		511.7	9,211.3	5,342.5	3,868.8



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ALASKA LNG UPSTREAM STUDY REPORT 3: STORING BYPRODUCT CO_2 FROM THE ALASKA LNG GAS TREATMENT PLANT AT THE PRUDHOE BAY UNIT (APRIL 5, 2022)

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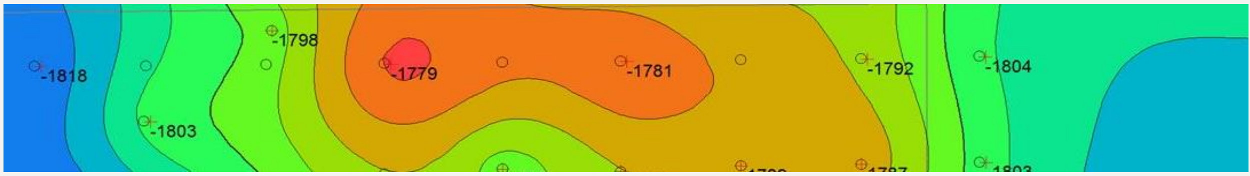

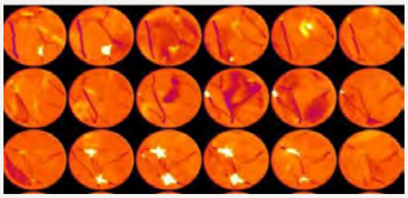

Alaska LNG Upstream Study Report 3: Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit

April 5, 2022

Disclaimer

Vello Kuuskraa[1]
Matt Wallace[1]
Donald Remson[2*]

The authors wish to acknowledge the excellent guidance, contributions, and cooperation of:

Tim Skone[2]
Alana Sheriff[3]
Srijana Rai[3]
Timothy R. Carr, PhD[4]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

AGDC	Alaska Gasline Development Corporation
AOGCC	Alaska Oil and Gas Conservation Commission
B, bbl	Barrel
Bcf	Billion cubic feet
CO_2	Carbon dioxide
cp	Centipoise
cu ft	cubic foot
EOR	Enhanced Oil Recovery
ft	Foot
GTP	Gas Treatment Plant
In	Inches
Lb, lbs	pound(s)
LNG	Liquefied Natural Gas
mD	Millidarcy
Mcf	Thousand cubic feet
MM	Million
MMcf	Million cubic feet
MMcfd	Million cubic feet per day
MMmt	million metric tons
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
PBU	Prudhoe Bay Unit
POP	Prudhoe Oil Pool
ppm	Parts per million
psi	Pounds per square inch
PTU	Point Thomson Unit
Sq mi	square mile
U.S.	United States
USGS	United States Geological Survey
°API	Degrees API (American Petroleum Institute)
°F	Degrees Fahrenheit

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1 BACKGROUND

The natural gas resources in the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU), the two sources of natural supplies for the Alaska LNG Project, contain notable volumes of carbon dioxide (CO_2). These volumes of CO_2 are planned to be removed from the natural gas production stream by a newly constructed Gas Treatment Plant (GTP) to meet pipeline specifications before entering the 800-mile Mainline Pipeline connecting the sources of natural gas supplies on the North Slope with the liquefied natural gas (LNG) export facility at Nikiski on the Kenai Peninsula (Exhibit 1-1). [1]

Exhibit 1-1: Alaska LNG Pipeline route from Prudhoe Bay to Nikiski

Used with permission from Alaska Gasline Development Corporation (AGDC), 2022 [1]

The volume of byproduct CO_2 projected to be separated by the GTP Facility from the gross natural gas production stream from PBU and PTU is estimated at 350 million cubic feet per day (MMcfd). This volume of CO_2 would need to be placed into a deep underground storage setting to reduce the greenhouse gas emissions impact of the Alaska LNG Project.

2 PURPOSE OF REPORT

This report is the third in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together these three reports comprise the "Upstream Study" of oil and natural gas resources and CO_2 utilization and storage potential at the PBU and surrounding areas.

The purpose of this report, "Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit", is to identify and assess the viability of storing byproduct CO_2 from the GTP Facility in a deep saline reservoir at the PBU.

The first of the three Upstream Study reports "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project" is to evaluate the capacity of natural gas supply from the PBU and the PTU on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

The second of the three Upstream Study reports "Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential" examines the impacts of the Alaska LNG Project on oil production at the PBU, and discusses options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP as part of CO_2 enhanced oil recovery (EOR) operations on the North Slope.

3 STUDY METHODOLOGY

Only a limited amount of rigorous geologic and reservoir information exists in the published technical literature on the viability of storing CO_2 in deep saline formations on the North Slope of Alaska. Fortunately, some fundamental geological information has been published in the technical literature following past oil and gas exploration and resource studies. [2][3][4][5] In addition, the US Geological Survey (USGS) has conducted a geologic framework study that identified and characterized, at a regional level, some of the geologic formations that could provide carbon dioxide storage options in Alaska. [6]

To develop more site-specific information on alternative underground storage options for the byproduct CO_2 from the GTP Facility associated with the proposed Alaska LNG Project, the study obtained and analyzed a series of deep well logs at the PBU. These included well logs from the PBU Western Satellite oil fields and from the Prudhoe Oil Pool (POP). Based on these log analyses, the Staines Tongue of the Sagavanirktok Formation at the POP emerged as the preferred saline formation option for storing CO_2.

To further define and quantify this CO_2 storage option, the study constructed a regional geological cross-section across the PBU for the Staines Tongue of the Sagavanirktok Formation and its overlying reservoir seal, the Mikkelsen Tongue of the Canning Formation.

Based on the geological cross-section and other information, the potential CO_2 storage site was located near the existing PBU gas processing plant. The geological model for the Staines Tongue interval at the potential CO_2 storage site was populated with key geological and reservoir properties from analyzed well logs and from other sources. Using this data, a static CO_2 storage capacity estimate was then prepared for the potential storage site.

Next, a more detailed geologic and reservoir model (sector model) was constructed and populated for the potential storage site. This sector model was placed into a full-scale reservoir simulator (GEM) to assess CO_2 injectivity per well, to establish dynamic CO_2 storage capacity, and to establish the areal extent of the CO_2 plume. This enabled the study to estimate the size of the CO_2 storage site, the number of CO_2 storage wells that would need to be drilled, and the spatial location of these CO_2 injection wells.

The sector model also enabled the study to assess the viability of the Staines Tongue saline formation at the PBU to serve as a long-term option for storing about 6.2 million metric tons of CO_2 per year for thirty years.

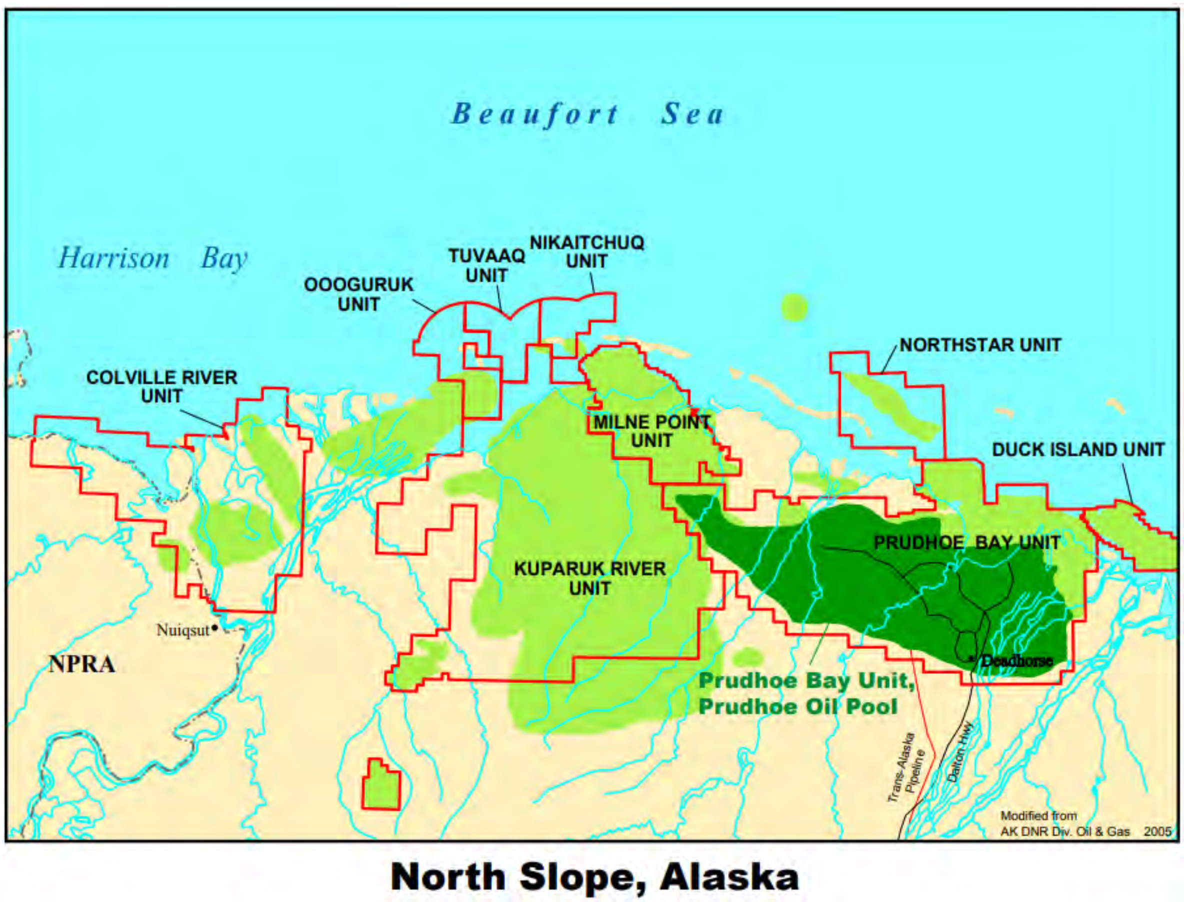
The construction of the geologic model and the results of the reservoir simulation performed by the study for storing CO_2 in the saline waters of the Staines Tongue of the Sagavanirktok Formation at the PBU are discussed in the following sections of the report.

4 THE PRUDHOE BAY OIL FIELD

4.1 PRUDHOE BAY FIELD

The Prudhoe Bay oil field, also called the Prudhoe Bay Unit (PBU), covers an area of about 213,000 acres on the North Slope of Alaska along the coastline of the Beaufort Sea (Exhibit 4-1). [7] The PBU contains the POP and a series of Satellite oil fields, such as Aurora, Borealis, Midnight Sun, Lisburne, and Point McIntyre, among others. These Satellite oil fields are located within the boundaries of the PBU and are being developed using PBU production and processing facilities.

Exhibit 4-1: Prudhoe Bay oil field location map

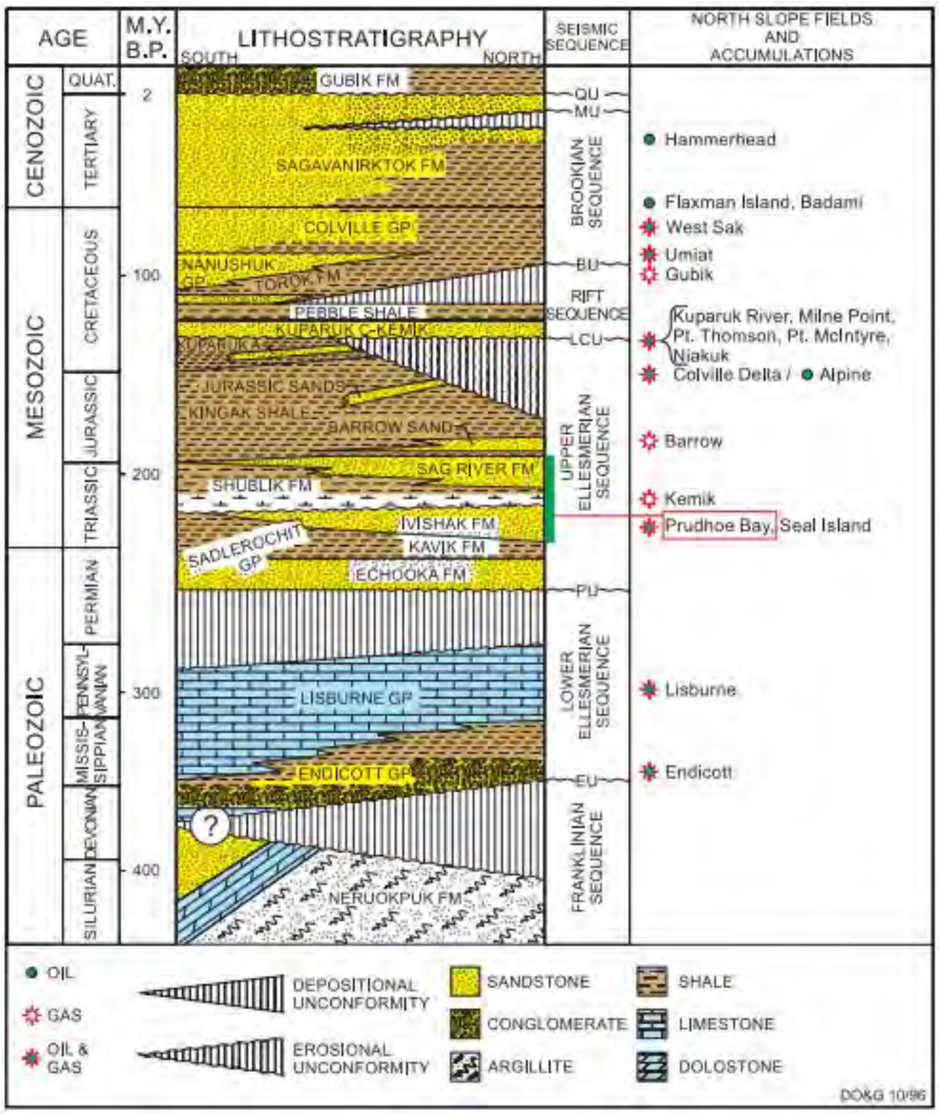


Used with permission from Alaska Oil and Gas Conservation Commission (AOGCC) [6]

4.2 PRUDHOE OIL POOL

The POP contains three deep Permian/Triassic-age sandstone formations—Sag River, Shublik, and Ivishak. The Ivishak, also called the Sadlerochit, is the major producing formation, as shown on the Generalized North Slope Stratigraphic Column (Exhibit 4-2). [7]

Exhibit 4-2: Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations



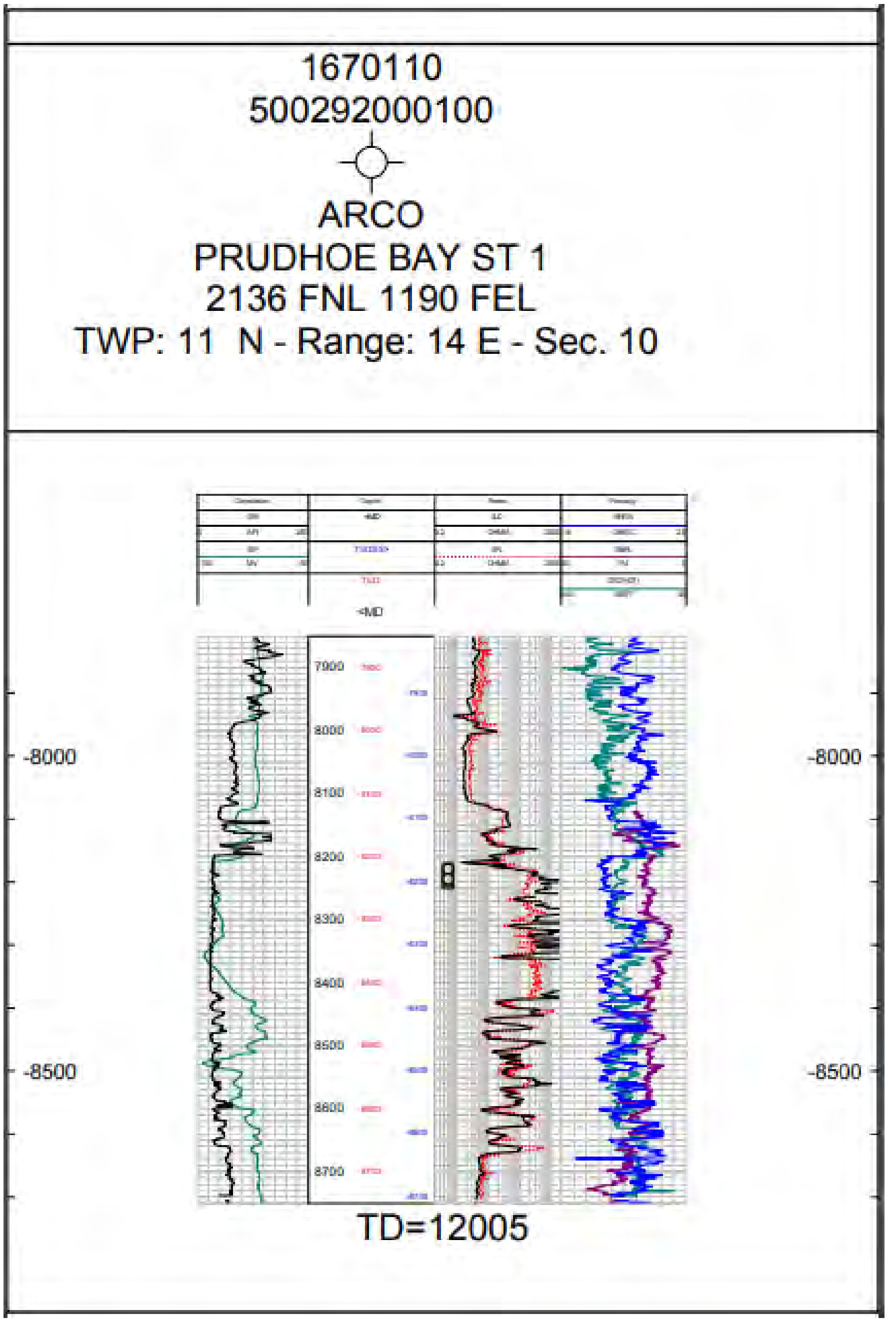
Used with permission from AOGCC, 2021 [7]

The favorable productivity of the reservoirs in the POP, with high initial flows of oil and associated natural gas, is supported by a thick oil column of nearly 500 ft., high permeability that averages nearly 300 millidarcy (mD), strong initial reservoir pressure of 4,335 pounds per square inch (psi), and a low oil viscosity of 0.8 centipoise (cp).

A type-log for the POP, the ARCO Prudhoe Bay State No.1 well, the field discovery well, is shown on Exhibit 4-3. [7]

The primary oil recovery mechanisms at the POP include gravity drainage (below the large gas cap), solution-gas drive, and a weak water drive. These primary oil recovery mechanisms have been augmented with reinjection of the produced associated natural gas to maintain reservoir pressure and to recover a portion of the residual oil in the gas cap. In addition, water is being injected along the periphery of the oil field for secondary recovery of oil and associated natural gas.

Exhibit 4-3: Type-log for the POP, the ARCO Prudhoe Bay State No.1 well

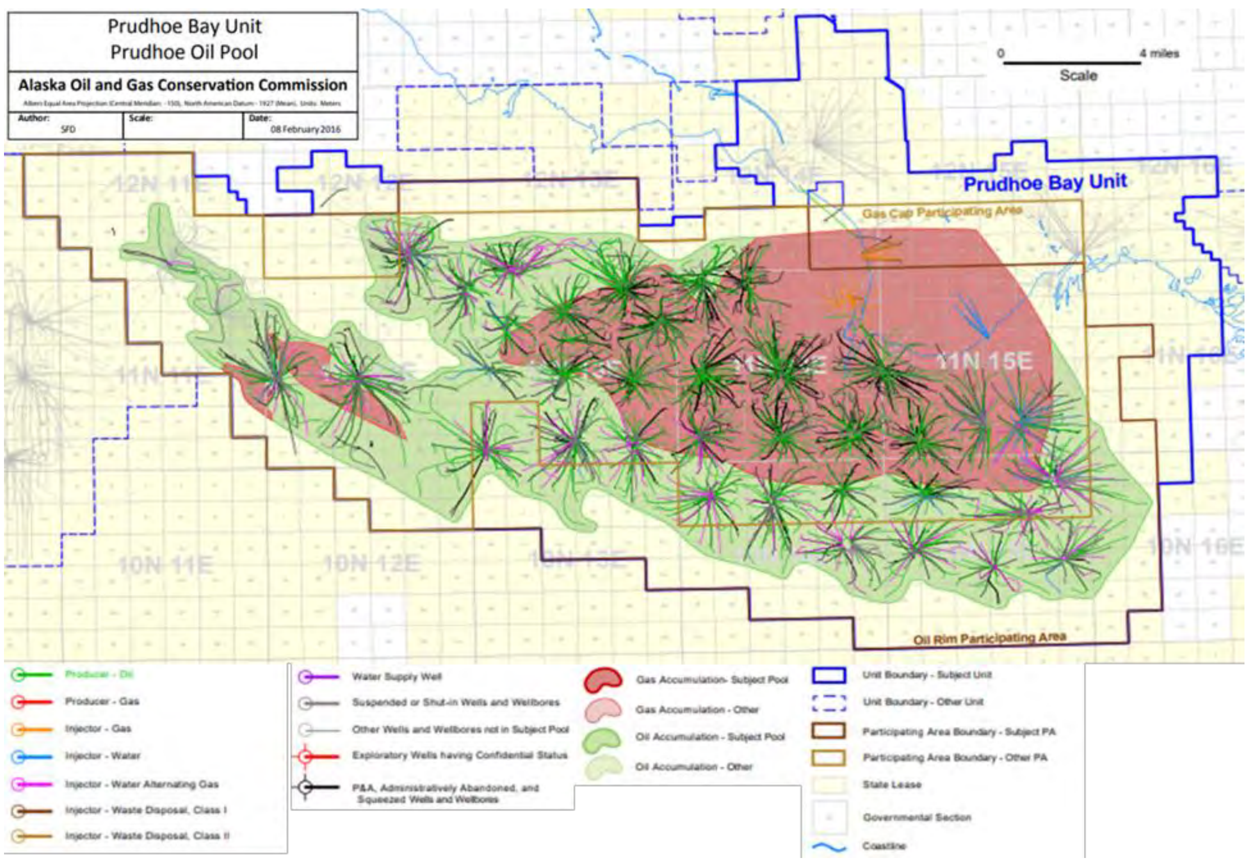


Used with permission from AOGCC, 2021 [7]

4.3 FIELD DEVELOPMENT

Oil development at the POP involves large-scale production of associated natural gas that contains CO_2. The associated gas produced at the POP is processed for extraction of natural gas liquids (NGLs), and is used for fuel for operations and for local gas sales. The bulk of the produced associated natural gas, approximately 7.68 billion cubic feet per day including its CO_2 content, is reinjected into the gas cap for enhancing oil recovery with gravity drainage. [8] Currently, the field has more than 800 active oil-producing wells along with about 220 gas, water, and miscible gas injection wells. These wells have been drilled and produce from a series of central drill sites (Exhibit 4-4). [7]

Exhibit 4-4: Prudhoe Bay Unit Prudhoe Oil Pool location map



Used with permission from AOGCC, 2021 [7]

5 GEOLOGIC SETTING FOR STORING CO_2 AT THE PBU

5.1 STAINES TONGUE CO_2 STORAGE HORIZON

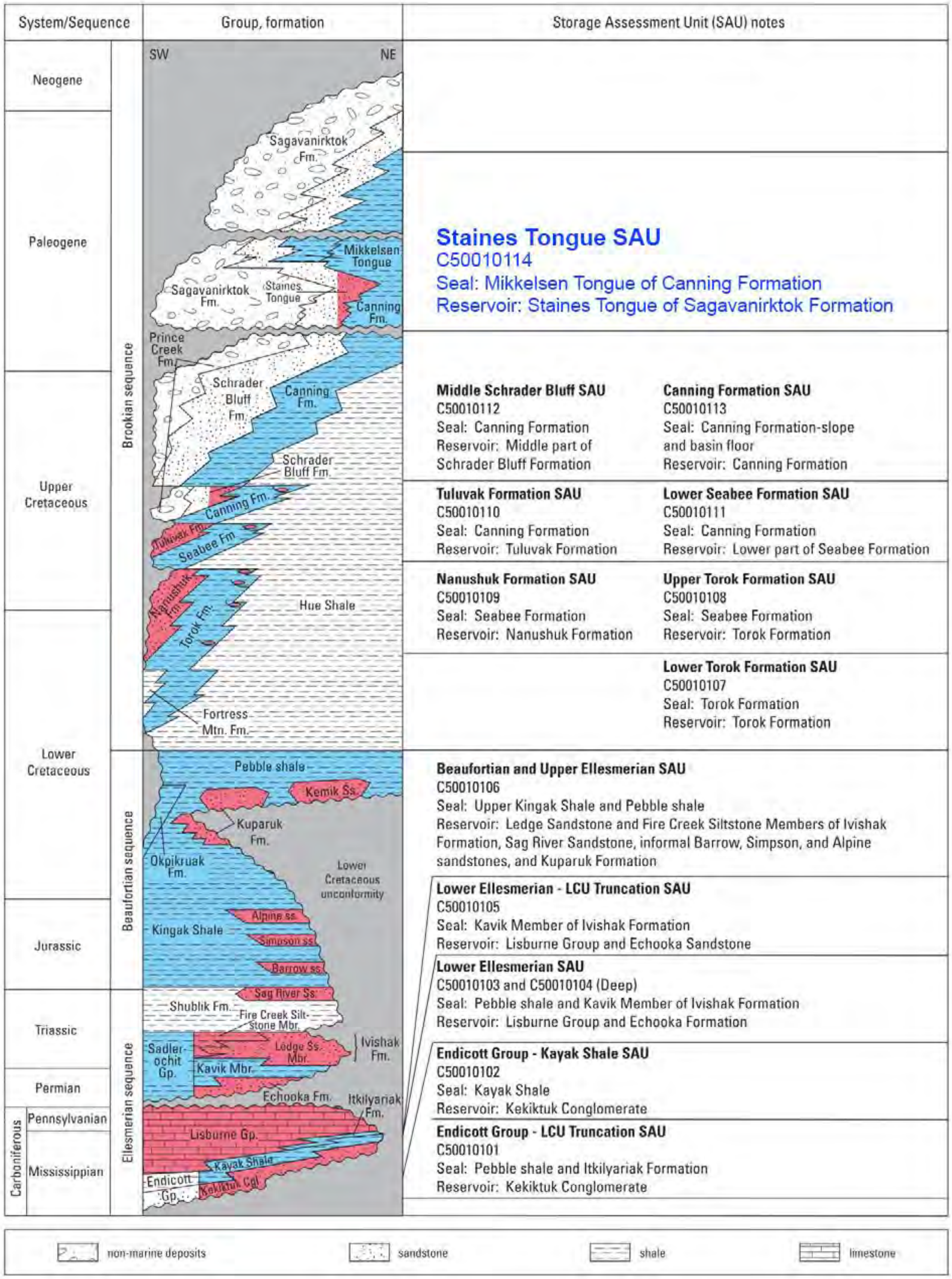
The primary geologic horizon identified by this study for storing the byproduct CO_2 from the GTP Facility is the Tertiary-age Sagavanirktok Formation within the Brookian Sequence and its Staines Tongue and Mikkelsen Tongue members (Exhibit 5-1). [6]

A more detailed look at the proposed storage horizon, the Staines Tongue interval, and the overlying Mikkelsen Tongue interval that would serve as the reservoir seal, is shown on

Exhibit 5-2. [4]

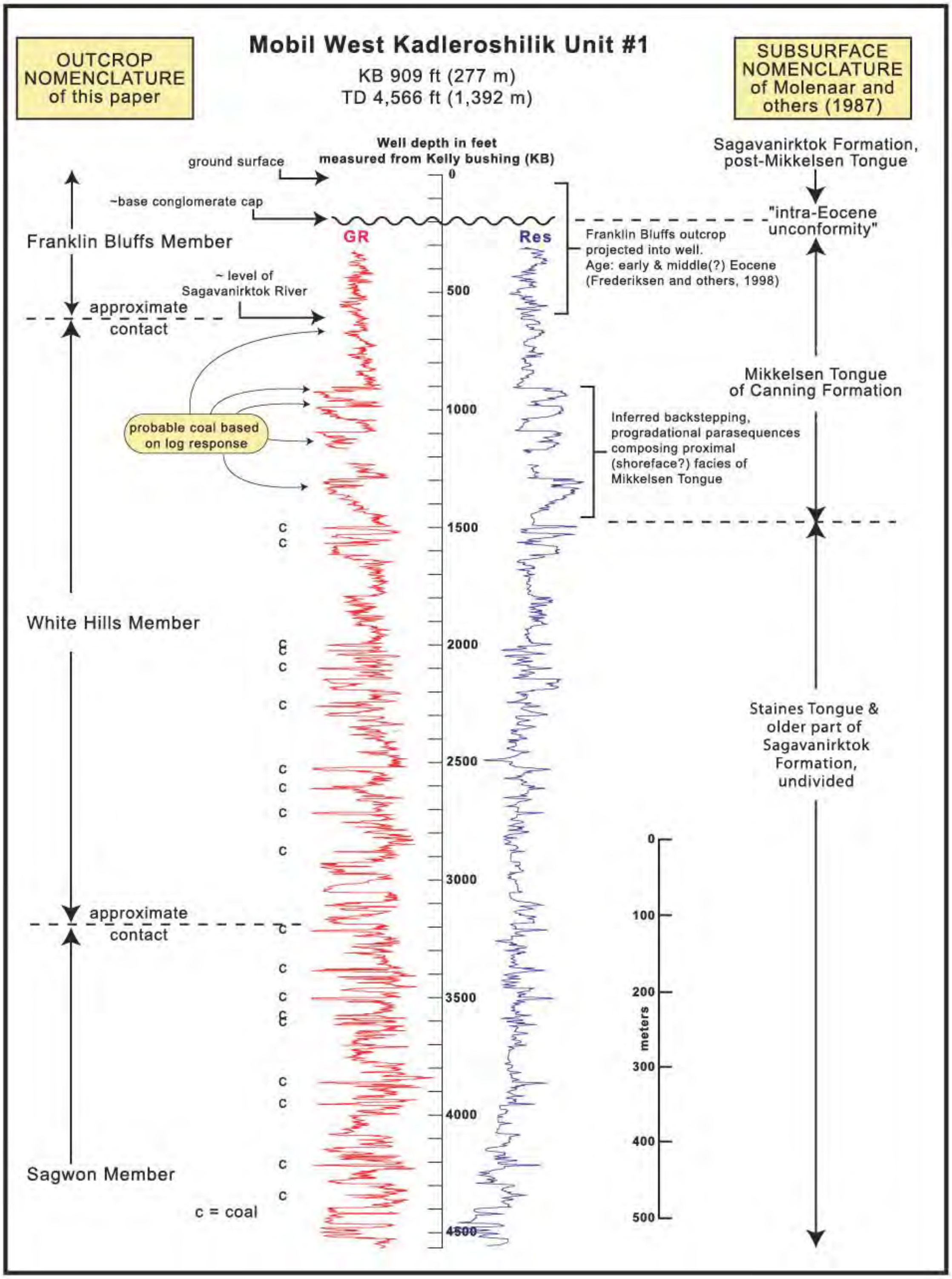
The Staines Tongue of the Sagavanirktok Formation overlies the Prince Creek Formation and underlies the Mikkelsen Tongue of the Canning Formation. The Staines Tongue contains sediments that were deposited on a marine shelf in associated deltaic and fluvial environments. [2] The overlying Mikkelsen Tongue is a major transgressive deposit consisting of a massive shale section and minor sandstone units that serves as the regional seal for the Staines Tongue saline reservoir. [9]

Exhibit 5-1: Generalized stratigraphic column of geologic units of the Alaska North Slope



Used with permission from USGS, 2012 [6]

Exhibit 5-2: Wireline Log Mobil West Kadleroshilik Unit #1 Well



Used with permission from USGS/ADNR, 2003 [4]

5.2 AREAL EXTENT OF STAINES TONGUE CO_2 STORAGE HORIZON

The areal extent of the Staines Tongue interval at the Prudhoe Bay Unit was defined by the USGS (Exhibit 5-3). [6] An overburden contour map establishing the depth of the Staines Tongue interval was also generated from a borehole-penetrations database of the Brookian sequence. [6]

Exhibit 5-3: Areal extent of the Staines Tongue assessment unit in the Alaska North Slope study area

Used with permission from USGS, 2012 [6]

6 CHARACTERIZING THE STAINES TONGUE SALINE FORMATION

6.1 BACKGROUND

Only limited, regional level information on the geologic setting and reservoir properties exists for the Staines Tongue of the Sagavanirktok Formation in the technical literature, as discussed above.

As such, the study obtained a series of well logs within and beyond the PBU area. These well logs were analyzed to develop more site-specific information for the Staines Tongue at the PBU, including information on its depth, gross and net pay, porosity, and other reservoir properties.

These data were used to assess the potential CO_2 storage capacity offered by the Staines Tongue saline formation. The log analysis also included defining and characterizing the important reservoir seal, the overlying Mikkelsen Tongue of the Canning Formation.

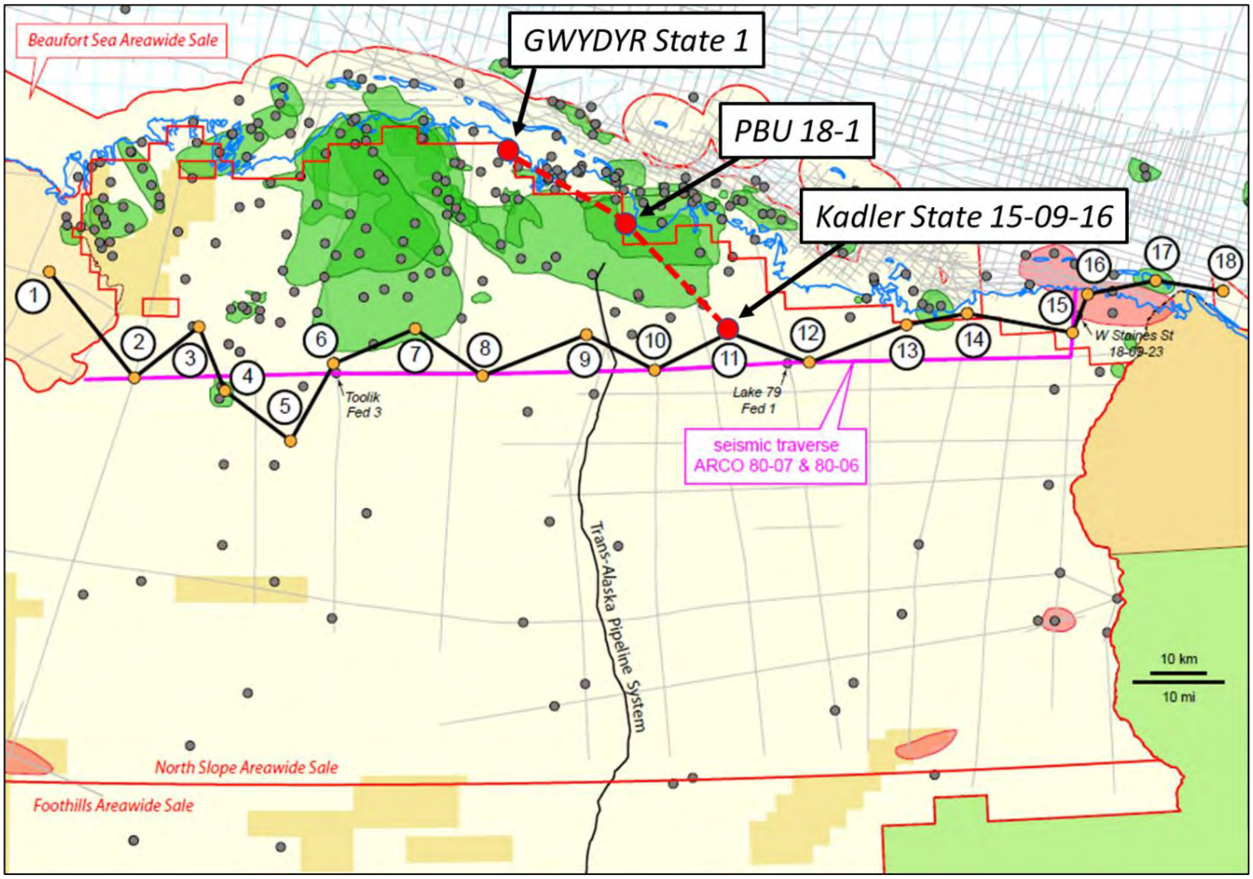
6.2 REGIONAL CROSS-SECTION

A three well regional cross-section was constructed to identify the depth and areal extent of the Staines Tongue saline reservoir at the PBU. The three wells used for the cross-section included:

- The PBU 18-1 well in the center of the PBU,
- The GWYDYR State 1 well on the northwestern border of the PBU, and
- The Kadler State 15-09-16 well on the southeastern border of the PBU.

The Kadler State 15-09-16 well ties to the major regional east to west cross-section prepared for the Brookian Sequence of the Alaska Norths Slope by Decker (Exhibit 6-1). [2]

Exhibit 6-1: Staines Tongue cross-section map



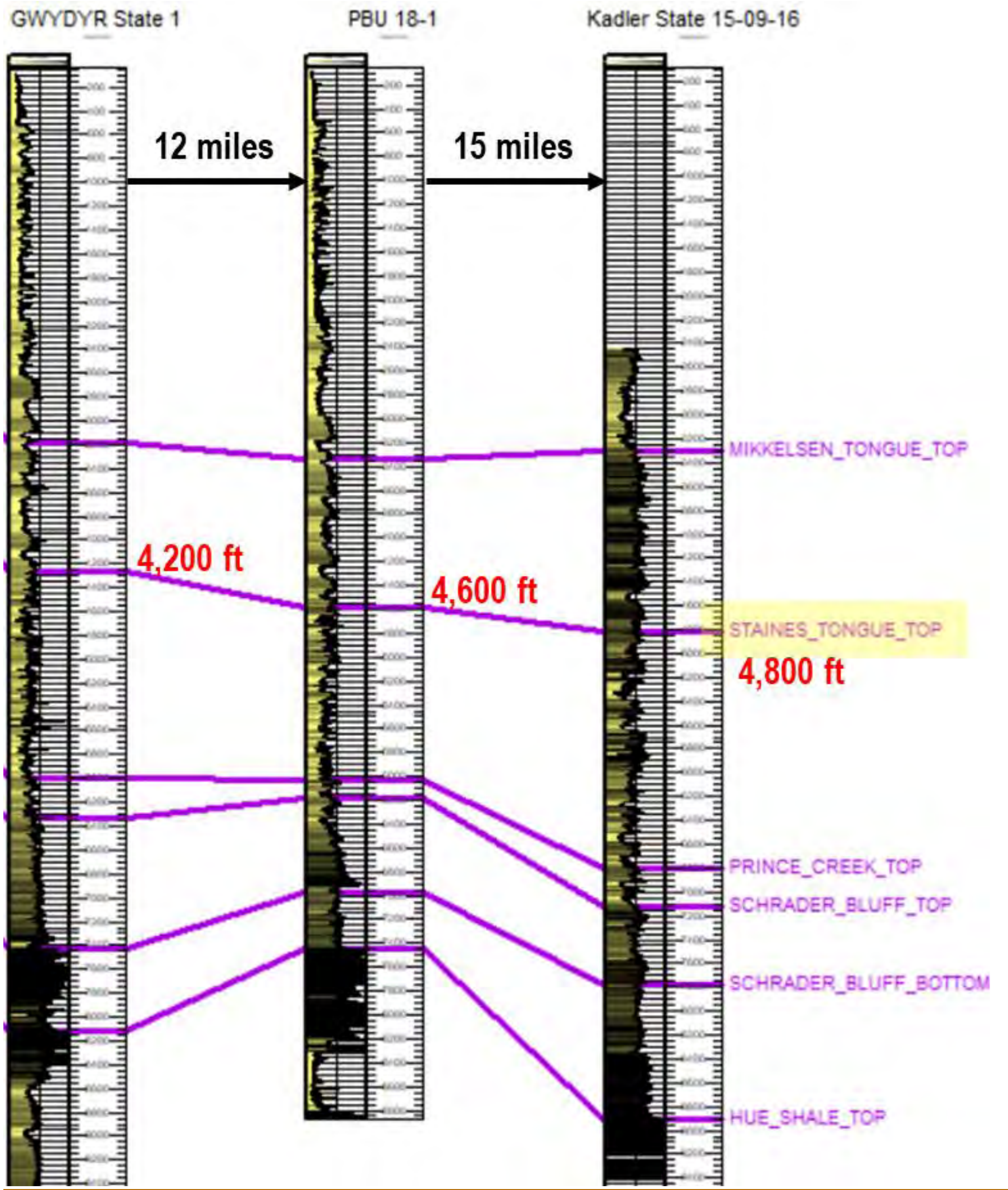
Modified with permission from Decker, 2010 [2] by Advanced Resources International

The three well cross-section bisects the eastern portion of the PBU and covers a total of 27 miles. The distance from the GWYDYR State 1 well to the PBU 18-1 well is 12 miles, and the distance from the PBU 18-1 well to the Kadler State 15-09-16 well is 15 miles (Exhibit 6-2).

Exhibit 6-2: Staines Tongue cross-section map

The well logs and the cross-section confirm the presence of the Staines Tongue saline reservoir at the PBU. The top of the Staines Tongue reservoir exists between 4,200 ft and 4,800 ft for the area covered by the GWYDYR State 1, PBU 18-1, and Kadler State 15-09-16 wells. This provides a favorable depth with sufficient pressure for storing CO_2 in a dense phase (Exhibit 6-3).

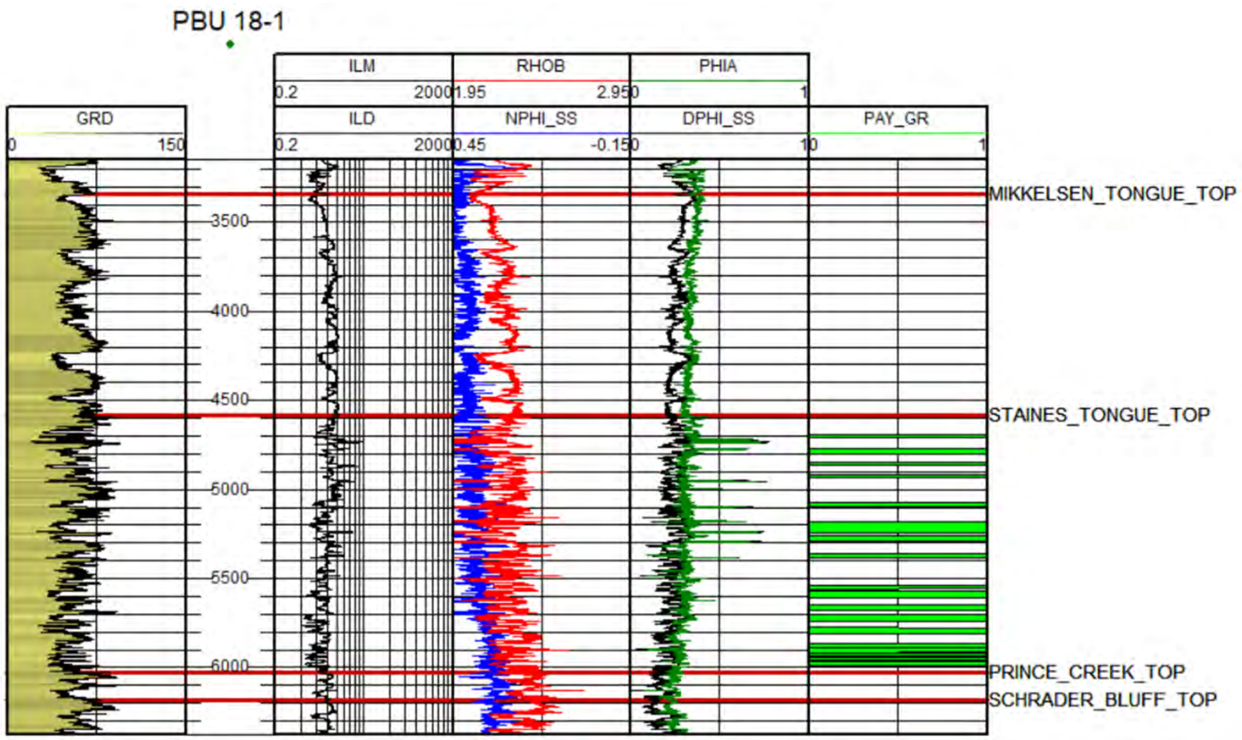
Exhibit 6-3: Staines Tongue well log cross-section



6.3 STAINES TONGUE WELL LOG ANALYSIS

The PBU 18-1 well log was used as the type well to determine the Staines Tongue reservoir characteristics for the CO_2 storage area (Exhibit 6-4).

Exhibit 6-4: PBU 18-1 well log

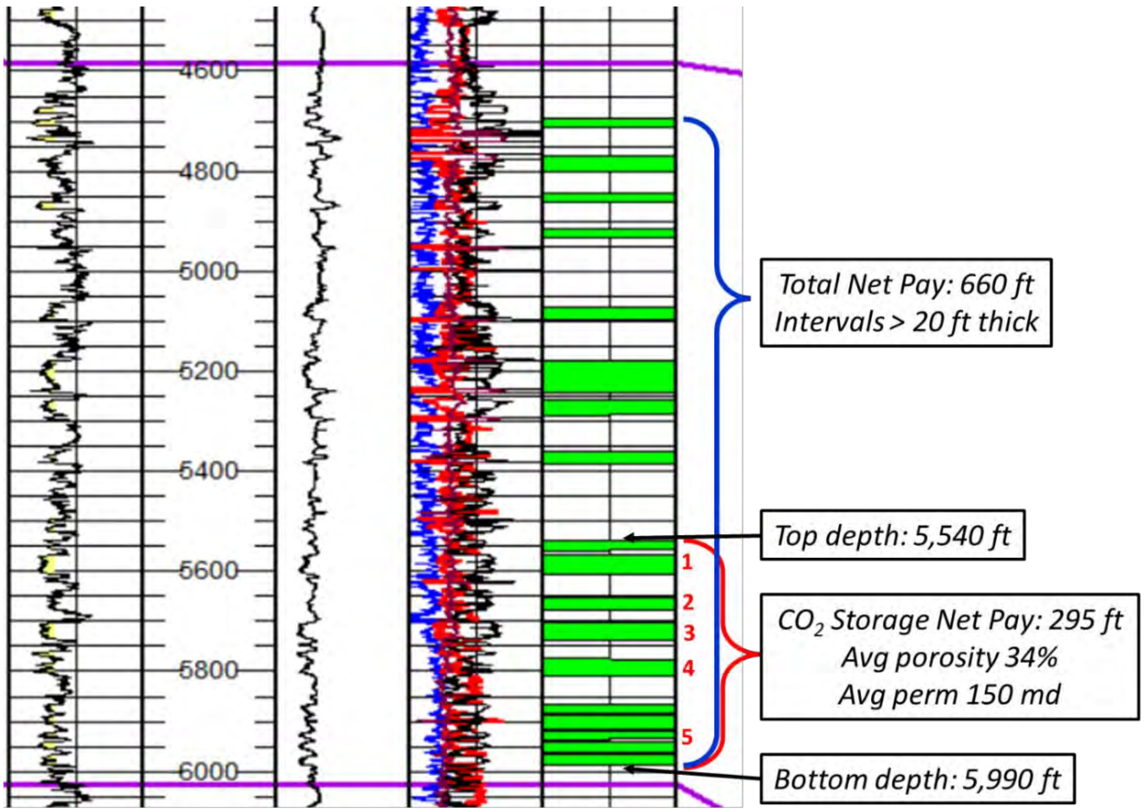


The Staines Tongue reservoir consists of interbedded sandstone and mud/siltstone. Analysis of the gamma ray log data using pay cut-off values above 60° API were used to determine the gross and net pay of the Staines Tongue reservoir. The gamma ray log showed the top of the Staines Tongue at approximately 4,590 ft and the bottom of the formation at 6,035 ft for a gross interval of 1,445 ft. The net pay was determined by combining continuous sandstone intervals of at least 20 ft or greater within this interval. The total net pay for the Staines Tongue was calculated to be 660 ft.

The PBU 18-1 log also shows a gross interval of 1,250 ft for the Mikkelsen Tongue between 3,340 and 4,590 ft above the Staines Tongue. More detailed log analysis established a minimum net shale thickness between 500 and 900 feet for this area, which provides a significant seal overlying the CO_2 storage formation

This CO_2 storage study focused on the bottom portion of the Staines Tongue interval that contained a series of thick sandstone units. This provided a net pay of 295 ft between 5,540 and 5,990 ft of depth. The selection of this net pay offered a relatively compact interval for well perforations and subsequent CO_2 injection (Exhibit 6-5).

Exhibit 6-5: PBU 18-1 Staines Tongue CO_2 storage interval



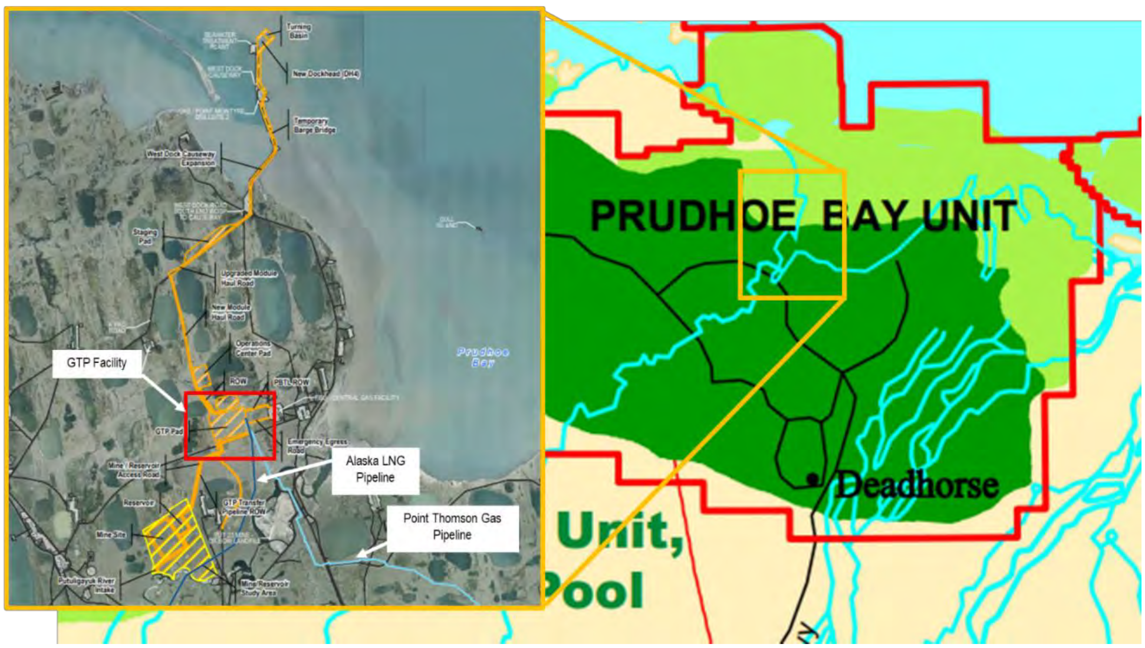
Porosity values were determined by taking an average of the density and neutron porosity curves in the sandstone units. The porosity log analysis showed an average porosity of 34 percent for the net pay portion of the Staines Tongue reservoir.

7 CO_2 STORAGE POTENTIAL IN THE STAINES TONGUE FORMATION

7.1 STORAGE DESIGN AND LOCATION

A potential CO_2 storage area is located adjacent to the existing PBU gas processing plant and is near the future site of the proposed GTP Facility. This location would reduce the need for new pipeline construction and infrastructure for the CO_2 storage operation (Exhibit 7-1).

Exhibit 7-1: Staines Tongue CO_2 storage project location



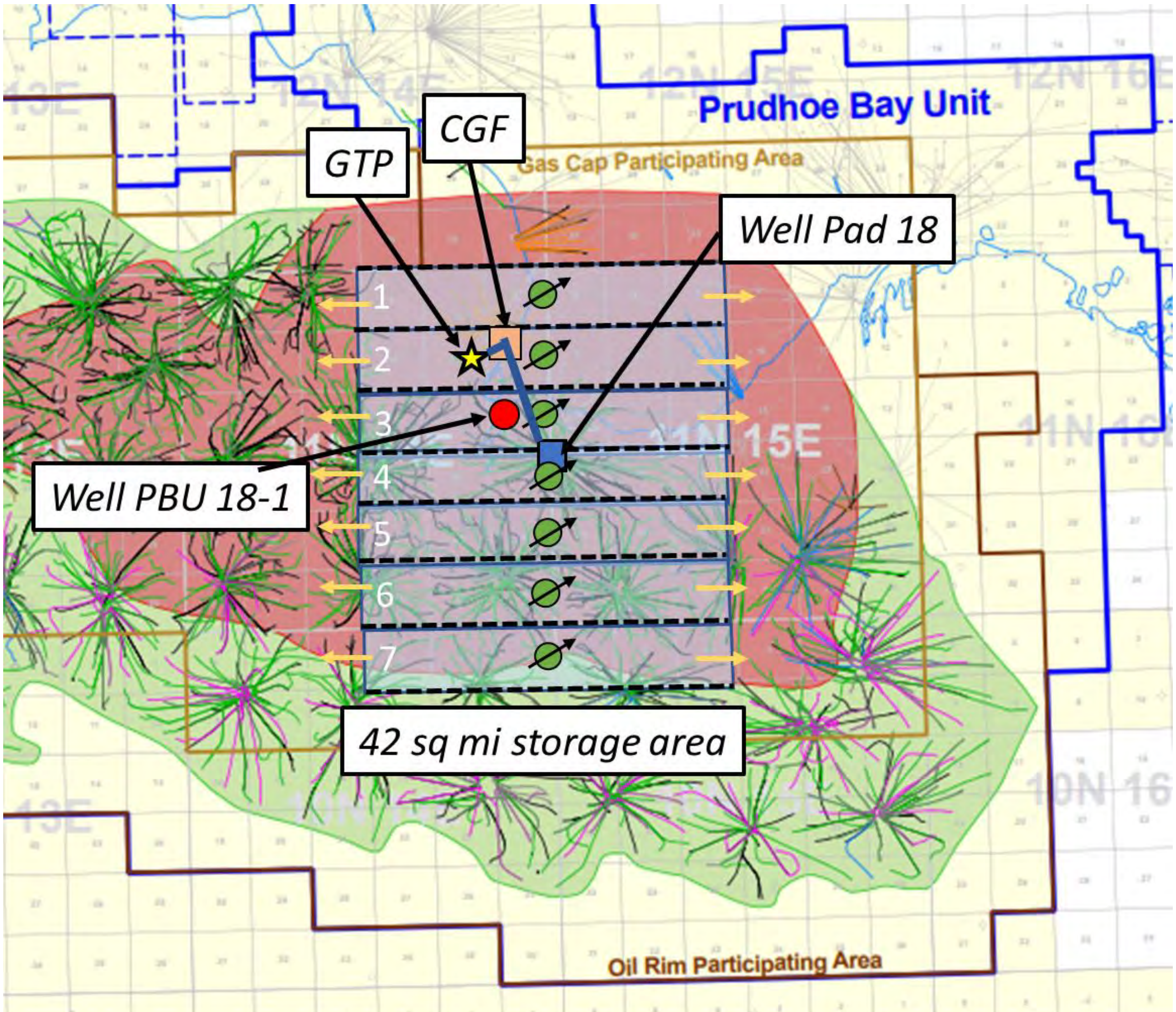
Modified with permission from AGDC, 2017 [10] and AOGCC, 2021 [7] by Advanced Resources international

To evaluate the Staines Tongue CO_2 storage site, a design of seven patterns that encompass six square miles each (a total of six sections) for a total storage area of 42 square miles was considered. This includes location of a CO_2 injection well at the center of each pattern. Each well would inject up to 50 million cubic feet of CO_2 per day, for a combined total daily injection volume of 350 MMcfd. This volume matches the estimated volume of byproduct CO_2 that will be produced by the Alaska LNG GTP Facility.

The study assumed the seven CO_2 injection wells will be drilled from the existing Drill Site 18. Laterally drilled injection wells #1 and #7 would extend up to 2.5 miles from Drill Site 18. CO_2 captured from the GTP would first be sent to the existing Central Gas Facility (CGF) via pipeline.

From there a 3-mile CO_2 delivery pipeline would deliver CO_2 to the CO_2 injection wells at Drill Site 18 (Exhibit 7-2).

Exhibit 7-2: Staines Tongue CO_2 storage project field design



Modified with permission from AOGCC, 2021 [7] by Advanced Resources International

7.2 INJECTIVITY CALCULATION

The injectivity rate for the Staines Tongue formation was calculated to establish the number of CO_2 injection wells required for the CO_2 storage project.

The following equation was used to estimate the rate of water injection per well into the Staines Tongue reservoir, where q is the water injection rate per well:

$$q = 3.541 * \ kh\Delta P \ / \ \mu[\ln\left(\frac{a}{r_w}\right) - 0.619].$$

Where:

- k is the average permeability (150 md),
- h is the average net pay of the reservoir (295 ft),
- ΔP is the difference between the estimated maximum allowable injection pressure (3,700 psi -- equal to mid-depth * 0.65 psi/ft) and the hydrostatic reservoir pressure (equal to 2,410 psi),
- μ is the reservoir water viscosity (0.46 cp),
- a is the distance between the injection well and production well (3,840 ft), and
- r_w is injection wellbore radius (2.4 in, or 0.2 ft).

The equation calculated an injection rate of approximately 18,900 barrels of water per day.

To estimate the equivalent CO_2 injection rate a conversion factor of 2.65 mcf/bbl was used based on the reservoir temperature and pressure. This provided a CO_2 injection rate of approximately 50 million cubic feet of CO_2 per day.

7.3 STATIC STORAGE CAPACITY CALCULATION

A static CO_2 storage capacity model was used to estimate the volume of CO_2 that could be stored in the Staines Tongue formation at the PBU.

The static storage capacity model was populated with reservoir properties for one section (one square mile) of the Staines Tongue formation. These properties included a net pay of 295 ft, a porosity of 34 percent, and a storage efficiency of 14 percent. The CO_2 density of 42 lbs/cu ft was calculated based on a reservoir pressure of 2,844 psi and a reservoir temperature of 145°F. Using this data, the static storage capacity model calculated that one section of the Staines Tongue formation could store 7.7 million metric tons (MMmt) of CO_2 (Exhibit 7-3).

Exhibit 7-3: Staines Tongue static CO_2 storage calculation

1 Section (MM sq ft)	27.9
Net Pay (ft)	295
Porosity (%)	34
Res. Capactiy (MM cu ft)	2,798
Storage Efficiency (%)	14
Storage Capacity (MM cu ft)	392
CO2 Density (lb/cu ft)	43.4
CO2 Storage Vol. (MM lbs)	17000
CO2 Storage Vol. (MM mt)	7.7
Field Area (sq mi)	42
Total CO2 Storage Vol. (MM mt)	325

Based on the static storage capacity model, the study established a CO_2 storage field area of 42 square miles that would have a total CO_2 storage volume of 325 million metric tons. As such, this storage site would provide approximately 75 percent more CO_2 storage capacity than the 190 MMmt of byproduct CO_2 that will need to be stored by the Alaska LNG Project.

8 DYNAMIC STAINES TONGUE STORAGE CAPACITY MODEL

8.1 BACKGROUND

The "static CO_2 storage capacity model" for the Staines Tongue, discussed above, provides an initial estimate for the extent of the CO_2 plume, the area required for storing CO_2, and other information for designing the CO_2 storage facility. However, a "dynamic CO_2 storage capacity model" is needed for establishing more rigorous values for the required storage area, for understanding the evolution of the CO_2 plume with time, and for making a more rigorous estimate for the number of CO_2 injection wells required for disposing the byproduct CO_2 from the GTP Facility associated with the Alaska LNG Project.

This section of the report discusses the construction of the "dynamic CO_2 storage capacity model" and its application at the Staines Tongue CO_2 storage site at the PBU.

8.2 SECTOR MODEL DESIGN

The first step for establishing dynamic CO_2 storage capacity for the Staines Tongue storage site at the PBU was to characterize and model one representative sector (type area) of the storage site. As such, a sector model was constructed to represent one of the seven CO_2 storage patterns. The sector model encompasses an area of 6 square miles and a gross vertical interval of 450 ft (see Exhibit 7-3). The three-dimensional model included 7,326 individual reservoir blocks (18 x 37 x 11). The storage reservoir in the sector model was placed at a depth between 5,550 ft and 6,000 ft and the reservoir horizon was assumed to be flat (Exhibit 8-1).

8.3 SECTOR MODEL REPRESENTATION OF THE STAINES TONGUE CO_2 STORAGE RESERVOIR

The vertical interval of 450 ft in the sector model was divided into nine different layers, five sandstone storage layers totaling 295 feet alternated with four shale layers totaling 155 feet (Exhibit 8-2). This sector model design enabled the Staines Tongue CO_2 storage site to properly capture the benefits of "reservoir architecture" that would limit the vertical override of the CO_2 as it flowed through the storage reservoir.

Exhibit 8-1: Staines Tongue sector model dimensions and reservoir depth

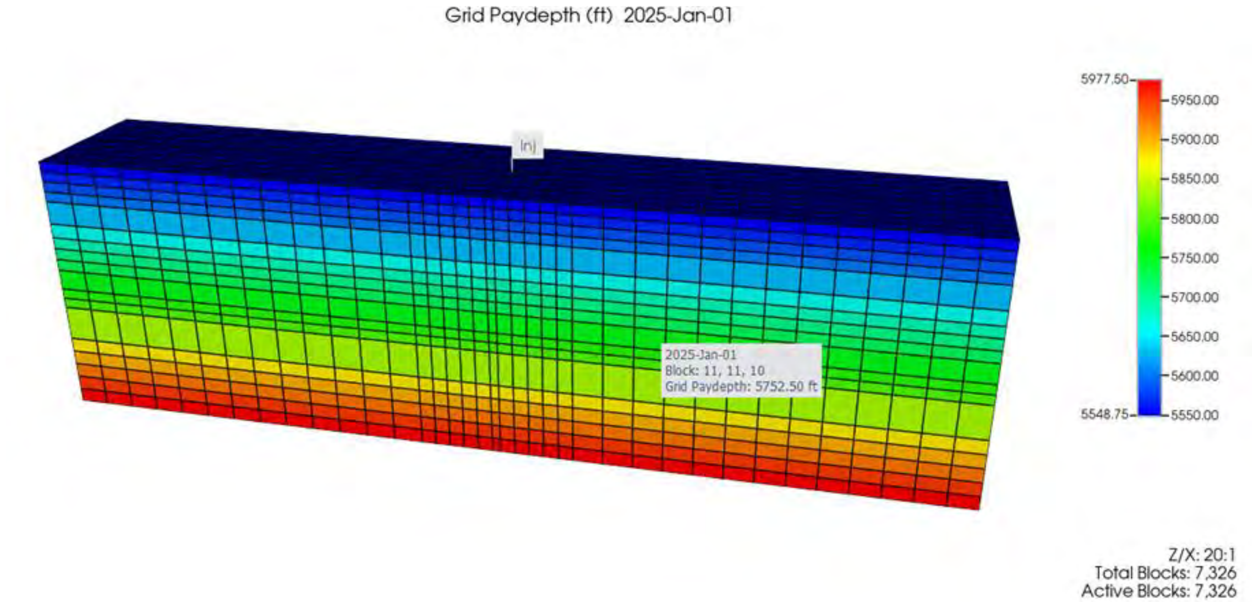


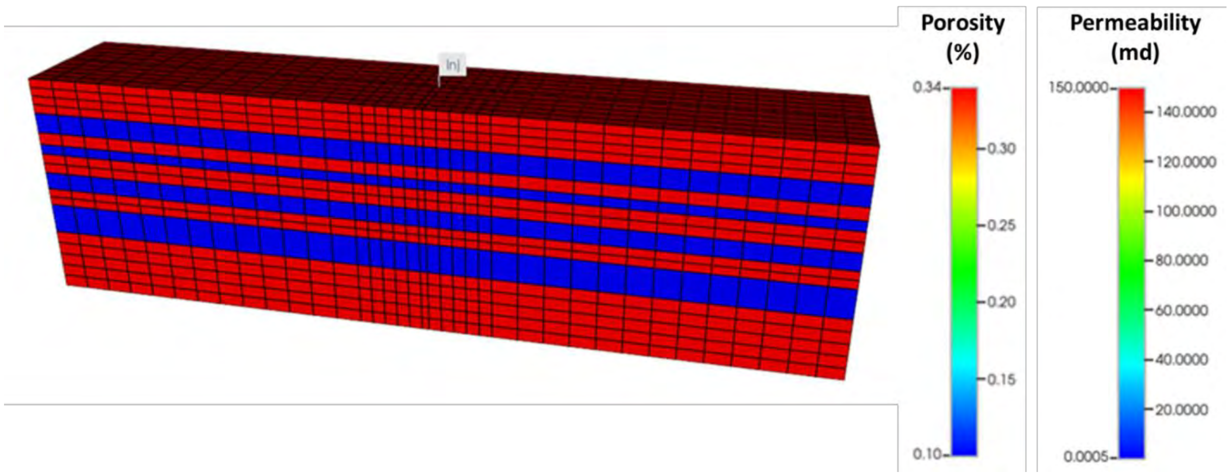
Exhibit 8-2: Staines Tongue sector model layers

Reservoir Layer	Lithology	Pay
1	Sandstone	70
2	Shale	40
3	Sandstone	25
4	Shale	20
5	Sandstone	40
6	Shale	35
7	Sandstone	35
8	Shale	60
9	Sandstone	125
	Total Sandstone Pay	295
	Total Shale Pay	155
	Total	450

The sector model assumed a porosity of 34 percent and an average permeability of 150 mD for each block in the sandstone layers, and a porosity of 5 percent and an average permeability of

50e-5 mD for each block in the shale layers. The vertical to horizontal permeability ratio was assumed to be 0.1 (Exhibit 8-3).

Exhibit 8-3: Staines Tongue sector model porosity and permeability



8.4 GEM CO_2 INJECTION SIMULATION

The Computer Modeling Group's GEM compositional simulator was used to run the Staines Tongue sector model. The initial conditions of the sector model assumed for the GEM simulator were:

- Initial reservoir pressure gradient of 0.435 psi/ft,
- Initial reservoir temperature of 145°F,
- Reservoir water salinity of 12,000 parts per million (ppm), and
- Rock compressibility of 2.9e-6 psi^{-1}.

The sector model was designed to inject a maximum of 50 million cubic feet of CO_2 per day per injection well with a maximum bottom-hole pressure limit in the model of 3,900 psi. The sector model assumed 30 years of continuous CO_2 injection.

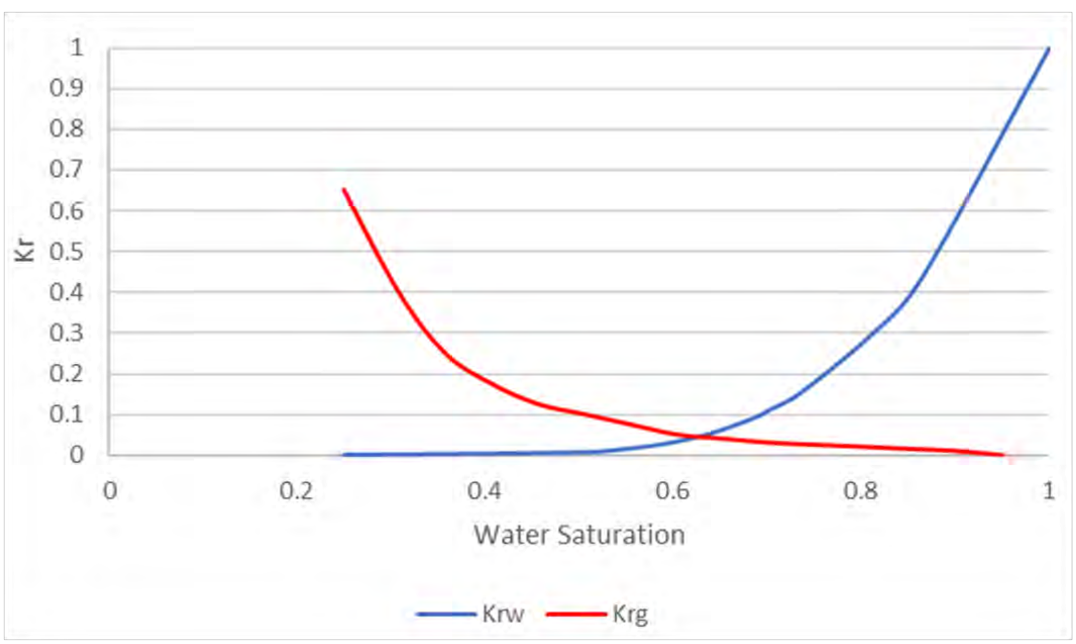
The sector model represented an interior type-pattern of the Staines Tongue CO_2 storage field at the PBU. Pressure boundaries were established on the northern and southern portions of the type-pattern to represent pressure confinement barriers from the adjoining patterns. The eastern and western boundaries of the sector model were open to allow the injection pressure and the CO_2 plume in the sector model to be unconfined in these two directions.

8.4.1 GEM Model Relative Permeability

The relative permeability curves used for the GEM model were based on history-matched CO_2 injection pressure and breakthrough response data for the Paluxy saline formation in Alabama. These curves were then adjusted for the higher porosity values seen in Staines Tongue formation.

Based on literature research regarding drainage and imbibition CO_2/brine relative permeability curves, the maximum relative permeability to gas was set to 0.65. Sequestration through relative permeability hysteresis was modeled with a maximum residual gas saturation of 0.3. The irreducible water saturation in the reservoir was set to 0.25, a typical value for sandstone (Exhibit 8-4).

Exhibit 8-4: GEM model relative permeability curves



9 STAINES TONGUE GEM MODEL RESULTS

9.1 CO_2 INJECTION PROFILE

The results of incorporating the Staines Tongue CO_2 storage sector model into the GEM reservoir simulator showed that the CO_2 injection well in the Staines Tongue saline formation is able to inject 50 MMcfd for 30 years without reaching the 3,900-psi bottom-hole pressure limitation.

The Gem reservoir simulation also showed that a single interior pattern in the sector model is able to accommodate cumulative CO_2 injection over 30 years of 548 billion cubic feet (Bcf) (29 MMmt).

9.2 AREAL EXTENT OF THE CO_2 PLUME

The results of the GEM sector model show that CO_2 concentration is highest near the injection well for each of the five net-pay intervals after 30 years of injection. CO_2 saturation approaches 70 percent at the center of the CO_2 plume and decreases to between 10 percent and 40 percent around the edges of the CO_2 plume.

After 30 years of injection, the CO_2 plume covers an area of 1.8 square miles in the top layer of the Staines Tongue formation (Exhibit 9-1). This is the maximum areal extent of the CO_2 plume after 30 years of injection.

The sector model also shows that at the end of CO_2 injection, about 14 percent of the injected CO_2 is dissolved in the formation water and about 11 percent of the injected CO_2 is trapped in the pore space. The remainder of the injected CO_2 is trapped by buoyancy in five distinct reservoir layers (Exhibit 9-2).

Exhibit 9-1: GEM model 30-Year CO_2 plume extent

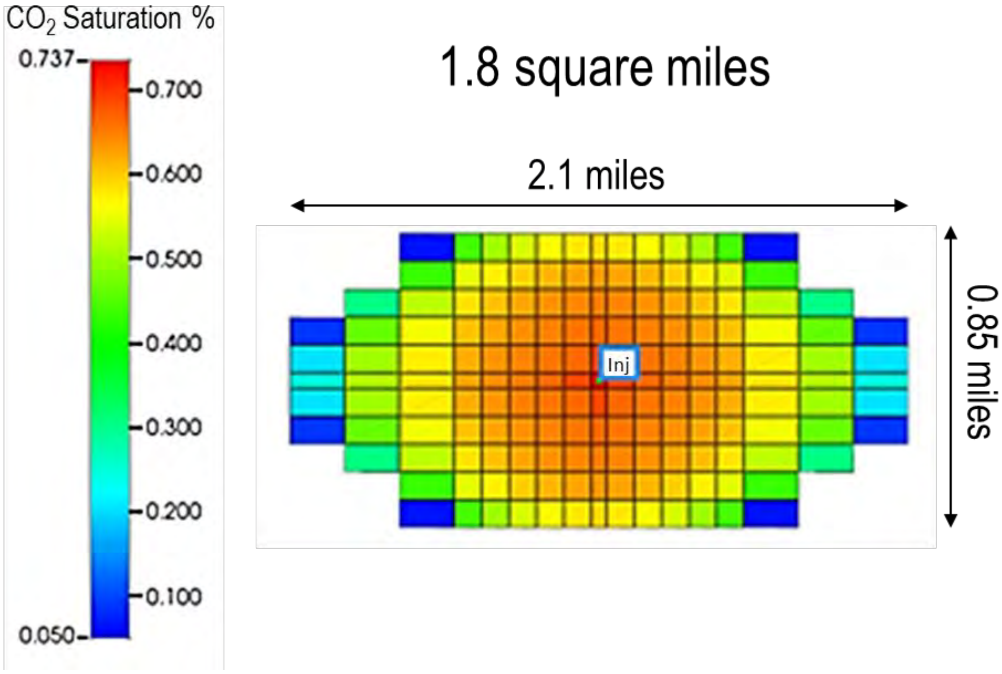
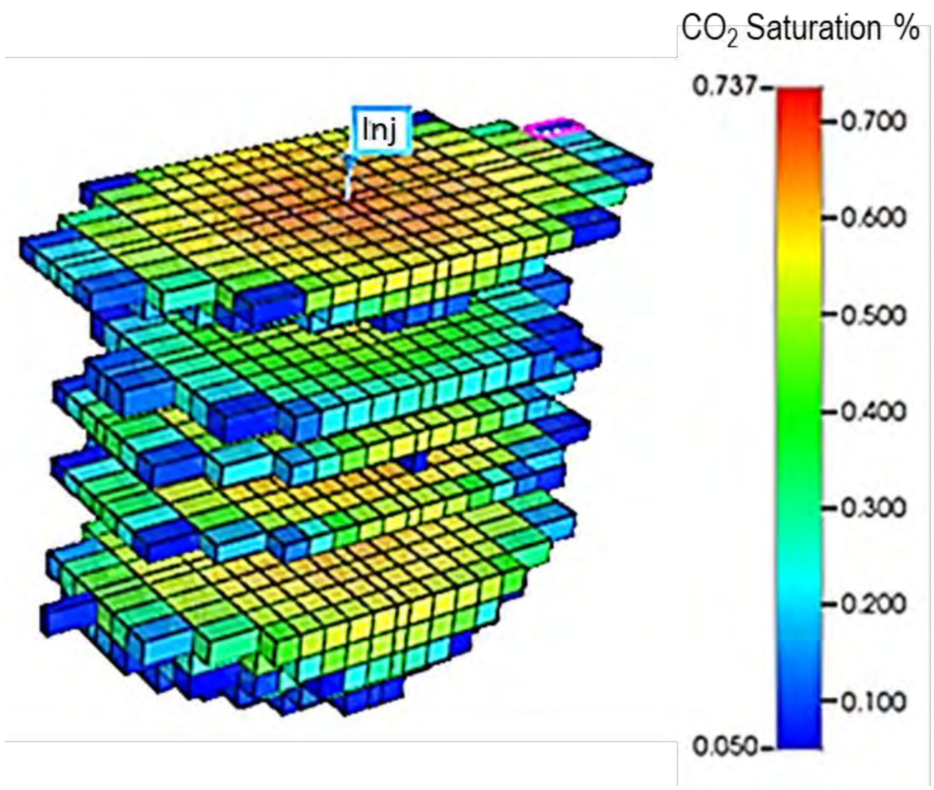


Exhibit 9-2: GEM model 30-Year CO_2 plume extent by reservoir layer



10 CO_2 STORAGE STUDY CONCLUSIONS

10.1 VIABILITY OF STAINES TONGUE FORMATION CO_2 STORAGE

The export of natural gas for the Alaska LNG project will generate a considerable volume of byproduct CO_2 that must be managed effectively over the 30-year life of the project. This report addresses the option of using a deep saline reservoir at the PBU for storing the byproduct CO_2 from the GTP Facility associated with the Alaska LNG Project.

Evaluation of well logs by this study identified the Staines Tongue reservoir at the PBU as a viable option for CO_2 storage. The reservoir has significant pay zones for CO_2 injection with favorable porosity and permeability characteristics. Log analysis for this study also showed that the Mikkelson Tongue overlying the Staines Tongue reservoir would provide a favorable seal for the CO_2 injected into the Staines Tongue saline reservoir.

A geologic model was built and populated using detailed well log analysis and reservoir characterization of the Staines Tongue formation at the PBU. The geologic model was then placed into the GEM reservoir simulator to establish the "dynamic storage capacity" of the Staines Tongue saline formation. This work showed that it is technically viable to store 350 MMcfd of byproduct CO_2 from the GTP Facility within the Staines Tongue CO_2 storage site at the PBU.

The results of the GEM model showed the CO_2 plume is well contained within the 42 square mile project area after 30 years of injection. Once the injection wells are shut-in the pressure in the saline formation would decline and the CO_2 concentration within the CO_2 plume would reach equilibrium.

Importantly, the study shows that the storage of byproduct CO_2 from the Alaska LNG Project in the saline formations below the PBU is technically feasible.

This option of storing CO_2 within the Staines Tongue saline formation underlying the PBU is one of several options for managing the byproduct CO_2 that would result from the sale of natural gas from PBU and PTU for the Alaska LNG Project. The final selection of CO_2 storage and management options will be made by the operators of the PBU and PTU and the Alaska LNG Project.

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U.S. Department of Energy

DOE/EIS-0512-S1

Alaska LNG Project

Final
Supplemental Environmental Impact Statement

APPENDIX C
LIFE CYCLE ANALYSIS STUDY

Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project

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APPENDIX C LIFE CYCLE GREENHOUSE GAS EMISSIONS FROM THE ALASKA LNG PROJECT (DECEMBER 21, 2022)

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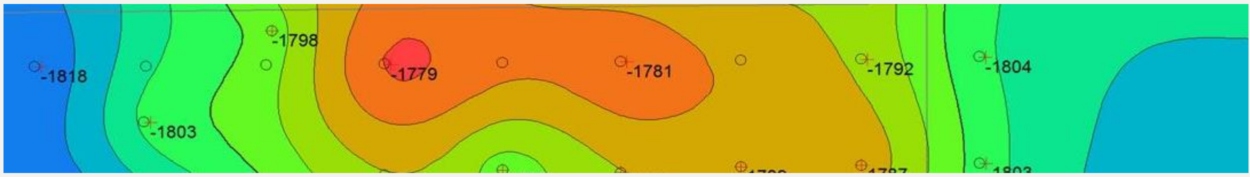
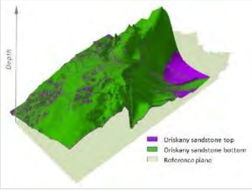
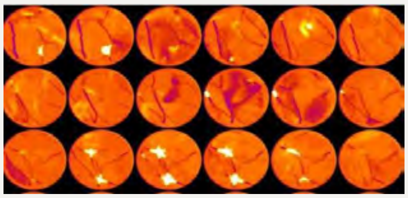
NATIONAL ENERGY TECHNOLOGY LABORATORY







Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project

December 21, 2022

DOE/NETL-2022/3791

Disclaimer

Timothy J. Skone, P.E.[1]: Conceptualization, Methodology, Writing – Review & Editing, Supervision, Project Administration, Funding Acquisition; Harshvardhan Khutal[1,2]: Methodology, Formal Analysis, Investigation, Writing – Original Draft, Visualization, Data Curation; Mackenzie R. Pias[1,2]: Methodology, Formal Analysis, Investigation, Writing – Original Draft, Visualization; Matthew B. Jamieson[2]: Supervision, Validation, Writing – Review & Editing, Data Curation; Srijana Rai[1,2]: Methodology, Formal Analysis, Investigation, Writing – Original Draft, Visualization; Krista Kirchner-Ortiz[1,2]: Investigation; H. Scott Matthews[1,2]: Investigation, Writing – Review & Editing; Gabrielle Yanai[1,2]: Investigation; Katherine Mumm[1,2]: Investigation; and Donald Remson[2]: Supervision.

[1] National Energy Technology Laboratory (NETL)
[2] NETL support contractor
*Corresponding contact: Timothy.Skone@netl.doe.gov, 412.386.4495

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LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
BAU	Business-as-usual
Bbl	Barrel
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
CELiC	Carbon Dioxide Enhance Oil Recovery Life Cycle
cf	Cubic feet
cfd	Cubic feet per day
CCS	Carbon capture and sequestration
CCUS	Carbon Capture, Utilization, and Storage
CH_4	Methane
CO_2	Carbon dioxide
d, D	Day
DAC	Direct air capture
EIA	Energy Information Administration
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
ft	Foot
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Reporting Program
GOR	Gas-to-Oil Ratio
GTP	Gas Treatment Plant
GWP	Global Warming Potential
H_2S	Hydrogen sulfide
hp	Horsepower
IPCC	Intergovernmental Panel on Climate Change
LCA	Life cycle analysis
LNG	Liquefied Natural Gas
m	Meter
M	Thousand
Mbbl	Thousand barrels
MMbbl	Million barrels
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
MM	Million
Mmt	Million metric tons
MMcfd	Million Cubic Feet per Day
MW, MWe	Megawatt electric
N_2O	Nitrous Oxide (Dinitrogen Monoxide)
n/a	Not available/applicable
NETL	National Energy Technology Laboratory
NG	Natural Gas
NGCC	Natural gas combined cycle
OPGEE 2.0	Oil Production Greenhouse gas Emissions Estimator 2.0
PBTL	Prudhoe Bay Transmission Line
PBU	Prudhoe Bay Unit
POP	Prudhoe Oil Pool
ppm	Parts per million
psi	Pounds per square inch
psig	Pound per square inch gauge
PTTL	Point Thomson Transmission Line
PTU	Point Thomson Unit
scf	Standard cubic feet
SF_6	Sulfur Hexafluoride
TAPS	Trans Alaska Pipeline System
Tcf	Trillion cubic feet
TPES	Total primary energy supply
tonne	Metric ton (1,000 kg)
US	United States

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1 INTRODUCTION

The goal of the Alaska Liquefied Natural Gas (LNG) project is to export up to 2.55 billion cubic feet per day (Bcfd) of LNG over a period of more than 30 years from the North Slope of Alaska. The majority of this gas (75%) is expected to be sourced from the Prudhoe Bay Unit (PBU), which consists of the Prudhoe Bay Oil Pool (POP) and its satellite fields. The remaining 25% of gas is expected to come from the Point Thomson Unit (PTU).

Current operations in the PBU have primarily been focused on oil production. The associated natural gas produced from this region has been reinjected to maintain reservoir pressure to increase oil productivity. With the proposed LNG project this associated gas will be diverted for sales in international markets (modeled as Asian markets within this report) rather than reinjected on site, thus decreasing the oil production over time.

To produce 2.55 Bcfd of gas, the Alaska LNG project requires the construction of a gas treatment plant (GTP) near PBU. The GTP is projected to produce a by-product of approximately 350 million cubic feet of carbon dioxide (CO_2) per day. An approximately 800-mile-long pipeline is also necessary to transport the processed gas from the GTP to a liquefaction facility.

The Alaska LNG Upstream Study is a series of three reports (Kuuskraa, et al., 2022a) (Wallace, et al., 2022) (Kuuskraa, et al., 2022b) that defines a business-as-usual (BAU) scenario of no action and two proposed scenarios for LNG export. In this document this series of reports will be referred to as the Upstream Study. The purpose of this life cycle assessment (LCA) is to quantify the life cycle greenhouse gas (GHG) emissions associated with the Alaska LNG project across the BAU and two proposed scenarios. The first of the two proposed scenarios sequesters CO_2 from the GTP in a reservoir, and the other uses it for enhanced oil recovery (EOR) in the Kuparuk River Unit (KRU) oil field on the North Slope of Alaska. This report provides an attributional life cycle analysis that is not linked to analysis of potential energy market changes in alternate scenarios. The analysis in the LCA holds total oil and natural gas demand constant across scenarios -- if oil or natural gas is not produced in one area, it will be produced in another.

For each of the proposed scenarios in the Upstream Study, this study evaluates the life cycle global warming potential (GWP) of delivering LNG from Alaska to four destination countries: Japan, South Korea, China, and India. Results from this study are presented on both a multiproduct and single-product functional unit basis. The functional unit for the multiproduct basis is 1 MWh of electricity generated at a power plant in the respective LNG receiving country plus a standard amount of crude oil delivered and consumed in the Lower 48 United States. This amount of crude oil is set by the amount that is produced in Scenario 3 for each country and matched by the first two scenarios using an LCA technique known as system expansion which seeks to create equivalent analysis scenarios. The functional unit for the single-product system is 1 MWh of electricity generated at the power plant in the respective LNG receiving country. This study also considers GWP effects of generating the electricity with and without use of carbon capture and sequestration. This study did not evaluate alternative uses of imported LNG for non-power applications. It is likely that imported LNG could be used for industrial, commercial, and/or residential use to meet energy needs. Non-power use would generally result in higher methane emissions due to use of the destination country natural gas distribution system to deliver to non-power and non-industrial customers. Alternative use of LNG would result in approximately the same end use emissions across each scenario and therefore would not change the comparative results of the study but may result in minor differences in the total cumulative GHG results. The technical viability of sequestering carbon from power generation in each importing country was not evaluated as part of this study. The study brackets the range of GHG effects both with and without carbon capture and sequestration. It is worth noting that commercial deployment of carbon capture technology is new, with demonstration projects currently being supported by the U.S. Government. Therefore, end use results without carbon capture and sequestration are more likely for existing electricity generating plants today and the results with carbon capture and sequestration are more representative of future GHG performance to reduce emissions. Similarly, this study assumes LNG will be provided either by the Alaska LNG project or an alternative global source of LNG for each destination country. The analysis presented holds basic macroeconomic and industrial structures static and does not attempt to account for future energy market changes and non-LNG or oil market substitution energy effects. The actual market substitution effects are unknown and could be met by non-LNG sources. Global energy systems are dynamic and are currently in transition, with carbon reduction policies in place or under consideration in many countries, including the destination markets analyzed, creating uncertainty. Different energy source substitutions could either increase or decrease GHG emissions to provide the same service to society. For example, renewable power, low GHG hydrogen or ammonia can lead to further reductions in GHG emissions. Chapter 2 provides a qualitative assessment of alternative energy supplies.

Additionally, this study produces speciated results that break down the life cycle GHG emissions for Scenario 3 into individual emission sources. Supplementary results estimate a time series GHG emissions inventory from the implementation of this project in the year 2029 to the end of this project in 2061. The inventory is based on the production flow volumes for all co-products (Kuuskraa, et al., 2022a). A final set of results included in this study contain cumulative emission profiles that estimate emissions for each scenario over the entire timespan of the project. The Alaska LNG project is expected to produce the equivalent of 30 years of gas at 2.55 Bcfd. This study analyzes a 33-year timespan of the project in which it produces this 30-year equivalent amount of gas. For the purpose of the cumulative emissions profile, construction-related emissions are spread across the 9-year construction schedule from 2024 to 2032. GWP values from the IPCC’s Fourth Assessment Report (AR4) are used in the report to maintain consistency with the original FERC Environmental Impact Statement’s estimates. Results using GWP values from AR5 and AR6 (100- and 20-yr basis) are available in the Appendix.

In the following sections, this report defines the scenarios, data sources, and modeling approach for the LCA, and discusses results and findings from the study.

2 Scenario Descriptions and Qualitative Discussion

The Upstream Study considers three scenarios including BAU (1) and the two proposed scenarios (2 and 3), which are evaluated by this LCA to quantify their respective life cycle GHG emissions. **Sections 2.1**, **2.2**, and **2.1** describe the three scenarios in more detail. Given that both oil and gas are produced, the life cycle analysis of these scenarios represents a multiproduct system boundary. **Sections 2.3** and **2.5** contain oil and gas production data, as well as the functional equivalency method used throughout this study (Kuuskraa, et al., 2022a), and **Section 2.6** describes sub-scenarios within Scenarios 2 and 3. **Section 2.7** provides a qualitative discussion related to the study.

2.1 Scenario 1: "Business as Usual"

Scenario 1 represents the current operations of oil production with no major gas sales. All associated gas produced during oil production, 6.98 Bcfd, is assumed to be reinjected. Therefore, the major flows for this scenario are the production of oil and associated gas and the reinjection of that gas. This scenario is used to explain the expected BAU operations in Alaska, involving oil production from PBU over the 33-year timeframe of this analysis. **Exhibit 2-1** shows the process flow diagram for the BAU scenario. For the multiproduct system boundary analysis, US average crude oil and US average natural gas, shown in **Exhibit 2-2** and **Exhibit 2-3** respectively are added to Scenario 1 to compensate for the difference in oil and natural gas production between Scenarios 1 and 3, ensuring their functional equivalence.

Exhibit 2-1. Process Flow Diagram for Scenario 1 – Business as Usual (BAU)

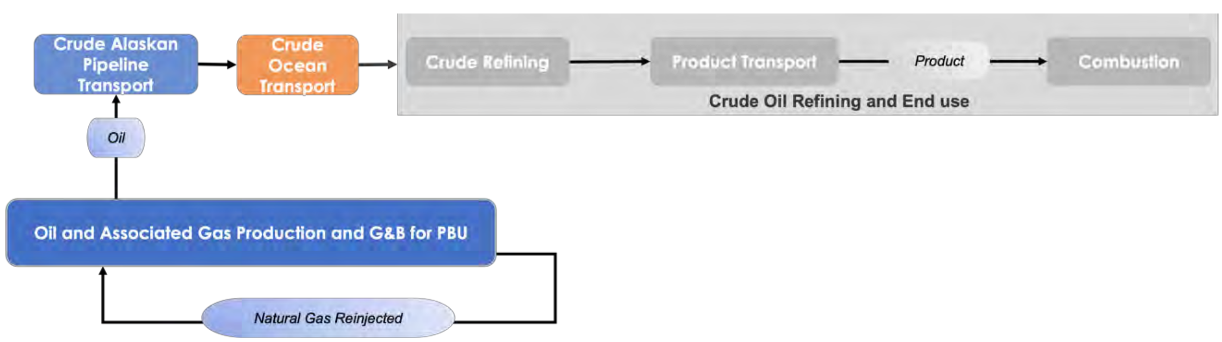


Exhibit 2-2. Process Flow Diagram - US Average Lower 48 Natural Gas

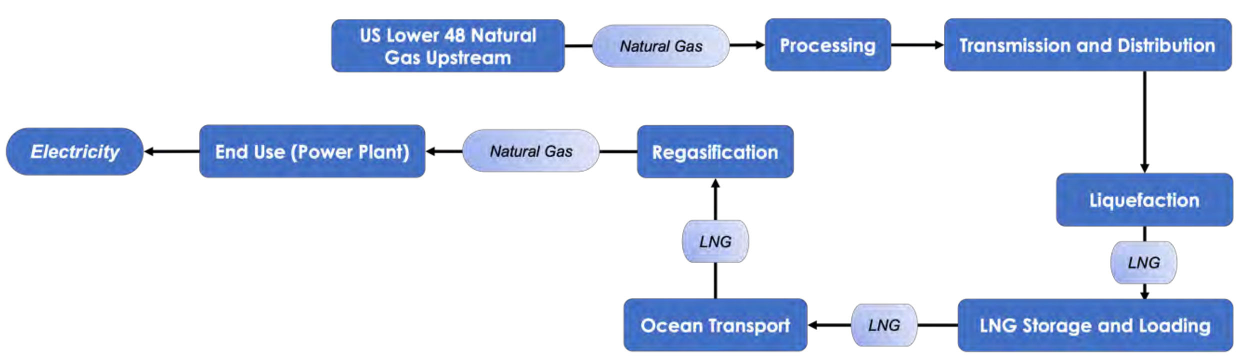
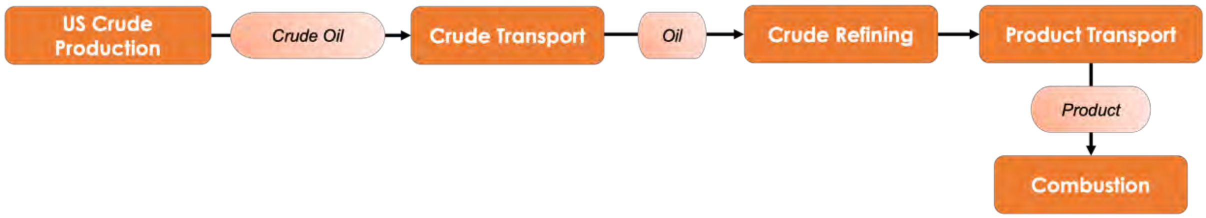


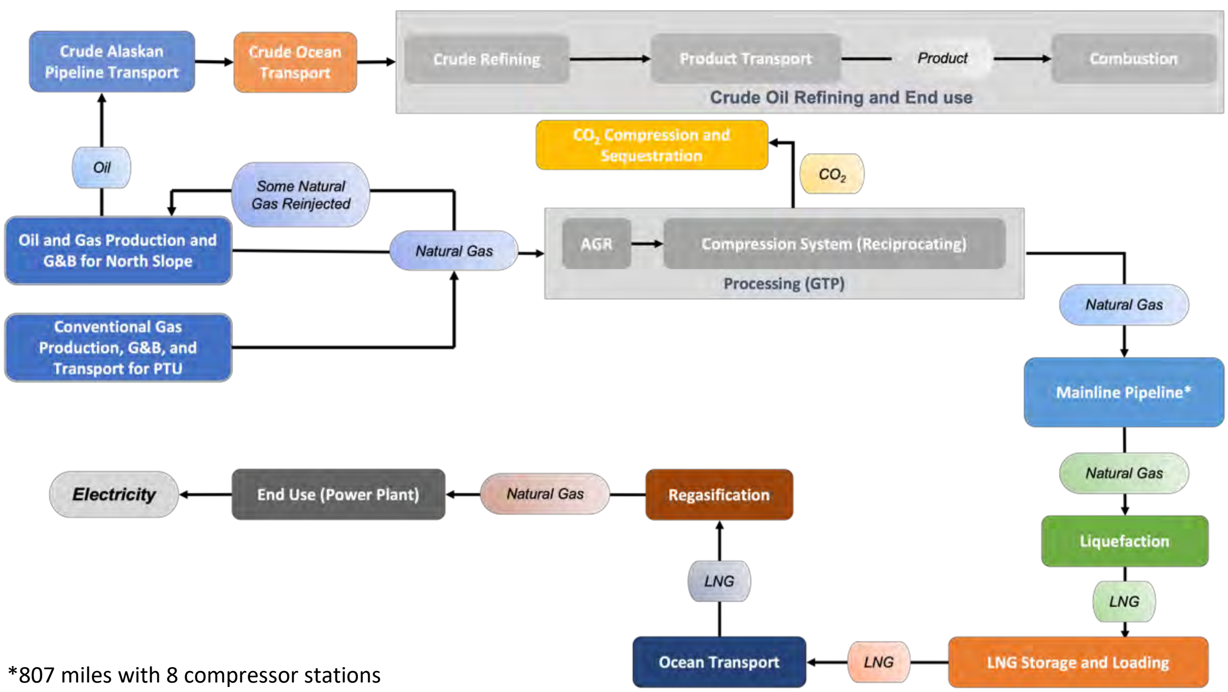
Exhibit 2-3. Process Flow Diagram – US Average Crude Oil



2.2 Scenario 2: Reduced Gas Injection

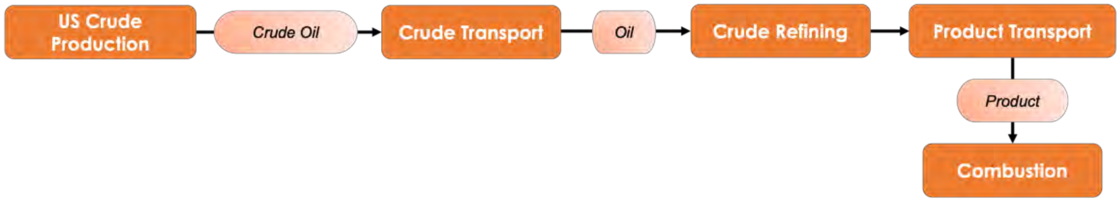
Scenarios 2 and 3 are modeled similarly with respect to associated gas production with some gas still being reinjected in this scenario for enhanced oil production, however in Scenario 2, the CO_2 removed from the natural gas stream at the GTP is captured and travels about 3 miles to where it is sequestered in saline aquifers. **Exhibit 2-4** shows the process flow diagram of this scenario. For the multiproduct system boundary analysis, US average crude oil is added to Scenario 2 to compensate for the difference in oil production between Scenarios 2 and 3, ensuring their functional equivalence. **Exhibit 2-5** displays the process flow diagram of US average crude oil production and end use. The oil produced in Scenario 2 is modeled to be transported, refined, and used at its final destination in the multiproduct system.

Exhibit 2-4. Process Flow Diagram, Scenario 2 – Reduced Gas Injection



*807 miles with 8 compressor stations

Exhibit 2-5. Process Flow Diagram – US Average Crude Oil



2.3 Scenario 3: Use and Storage of By-Product CO_2

Scenario 3 serves as the foundation for this LCA study. It assesses the changes that occur when associated gas from oil production is used for sales. Although some gas is still reinjected in this scenario for the first 20 years of the project, most gas is produced and sold, leading to a decline in reservoir pressure and oil production over the 33 years of the Alaska LNG project. Gas volumes available for reinjection are projected to decline from 7.2 Bcf per day (see **Exhibit 2-11**) to near zero after approximately 20 years of production, further reducing annual oil production from the PBU. However, this scenario does generate additional oil from the EOR process.

The upstream processes include oil and associated gas production and gathering and boosting. Some gas is reinjected, while the rest continues downstream to processing, mainline pipeline, liquefaction, storage and loading, ocean transport, regasification, and end use at a power plant in the destination country. Gas processing will take place at the new GTP where both acid gas removal and compression will occur. The CO_2 removed from the natural gas stream at the GTP is captured and used for EOR Injection. Approximately 350 million cubic feet per day of CO_2 injection is expected to occur in the Kuparuk River oil field to produce additional oil. As a result, Scenario 3 exhibits the highest 33-year average oil production volume as compared to the other two scenarios. In the multiproduct system boundary results, all oil produced in Scenario 3 is modeled to be transported, refined, and used at its destination.

Exhibit 2-6 shows the flow diagram for this scenario. **Exhibit 2-7** displays the process flow diagram of US average crude oil production and end use.

Exhibit 2-6. Process Flow Diagram, Scenario 3 – Use and Storage of By-Product CO_2

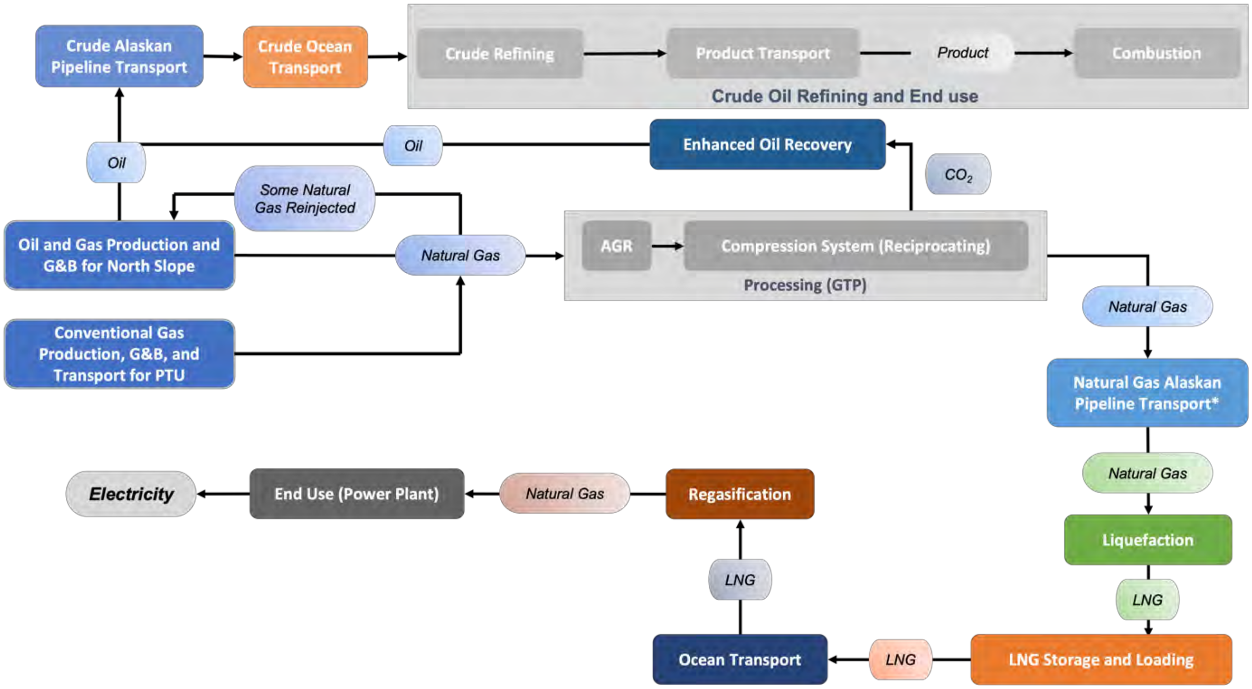
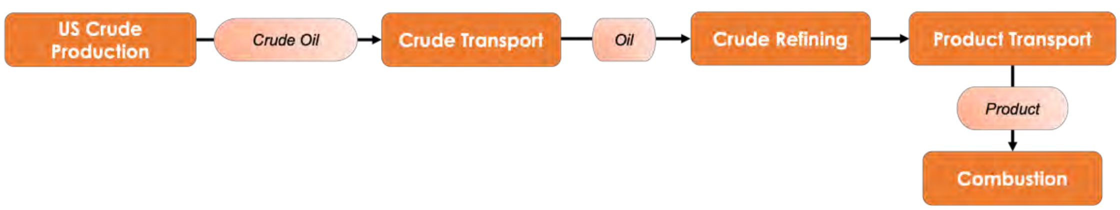


Exhibit 2-7. Process Flow Diagram – US Average Crude Oil



2.4 Annual Quantities of Crude Oil and Natural Gas

Exhibit 2-8 displays the annual quantities of crude oil that are produced and delivered over the timespan of the project. **Exhibit 2-9**, **Exhibit 2-10**, and **Exhibit 2-11** display the annual quantities of natural gas that are delivered to the GTP, exported for sales, and reinjected for oil production, respectively, over the same time period. The periods seen in these tables are determined by changes in natural gas production for sales in Scenarios 2 and 3. In the first four years of the project, natural gas production for sales steadily rises. By the year 2033, natural gas exports in these two scenarios will peak, as all three trains at the liquefaction facility are fully functional. In the final four years, natural gas production for sales is expected to slightly decrease.

Besides being exported for sales and reinjected to maintain reservoir pressure, small quantities of natural gas are also used as fuel during operations and for local in state use along the main pipeline between the North Slope and Nikiski, Alaska. In-state gas sales were modeled as 100% combusted without explicitly stating where and how the natural gas would be used. Emissions are assigned to the pipeline fuel use within this study.

***Exhibit 2-8. Annual Quantities of Crude Oil Produced and Exported (MMBbl/year) from North Slope for Each Scenario** (Wallace, Kuuskraa, & Remson, 2022)*

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	61.96	60.21	58.51	56.87	40.42 (average)	26.85 (average)
2	60.58	56.94	53.25	49.98	23.81 (average)	8.22 (average)
3	61.11	60.02	60.67	61.84	41.18 (average)	21.79 (average)

Exhibit 2-9. Annual Quantities of Natural Gas Delivered to GTP (Bcfd) from North Slope for Each Scenario (Wallace, Kuuskraa, & Remson, 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	0	0	0	0	0	0
2	0.56	1.40	2.52	3.08	3.36	2.22 (average)
3	0.56	1.40	2.52	3.08	3.36	2.22 (average)

Exhibit 2-10. Annual Quantities of Natural Gas Exported for Sales (Bcfd) from North Slope for Each Scenario (Wallace, Kuuskraa, & Remson, 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	-	-	-	-	-	-
2	0.43	1.06	1.91	2.34	2.55	1.69 (average)
3	0.43	1.06	1.91	2.34	2.55	1.69 (average)

Exhibit 2-11. Annual Quantities of Natural Gas Reinjected (Bcfd) from North Slope for Each Scenario (Wallace, Kuuskraa, & Remson, 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5- Scenario 1 (2033-2057)	Period 5 – Scenarios 2 and 3		Period 5 (2058-2061)
						2033-2048	2049-2057	
1	7.3	7.2	7.2	7.1	6.4 (average)	-	-	5.7 (average)
2	7.2	6.4	5.5	4.9	-	2.3 (average)	0	0
3	7.2	6.4	5.5	4.9	-	2.3 (average)	0	0

2.5 MAINTAINING FUNCTIONAL EQUIVALENCE

For the multiproduct system analysis, all three scenarios analyzed in this study were made functionally equivalent to generate 1 MWh of electricity at the destination country and consume a standard amount of crude oil (53 kg).

As observed in **Exhibit 2-8** the average oil production declines over the 33-year duration of the project for all scenarios, however, it is the highest for Scenario 3, followed by Scenario 1 and Scenario 2. Therefore, Scenario 3, modeled with a natural gas combined cycle (NGCC) power plant using CCS, served as the foundational case for this analysis. All other scenarios with or without CCS are adjusted to produce 1 MWh of electricity in the destination country using regasified natural gas and the same quantity of oil (53 kg) as this foundational case. The quantity of crude oil produced and consumed for Scenarios 1 and 2 is matched to Scenario 3 by expanding the life cycle system boundary to include the US average for crude oil production, refining, and consumption.

In addition, the volume of natural gas produced and exported for sale is zero for Scenario 1. The life cycle analysis system boundary is expanded to include the life cycle emissions profile of LNG shipped from the United States Lower 48 region, for generating 1 MWh of electricity in the destination country. This was done to ensure Scenario 1 provides an equivalent service to society as Scenario 3.

Exhibit 2-12 explains these adjustments in more detail. For each scenario modeled with and without CCS, the amount of US average crude that was added from system expansion to match the foundational case production of 53 kg can be seen in the third column (referred to as “makeup” crude). Ranges exist within this column as the four destination countries require slightly varying quantities of crude oil to be added through system expansion in order to match 53 kg of crude oil consumption.

Exhibit 2-12. Modeling Functional Equivalence for Scenarios, using NGCC Power Plant with or without CCS

Scenario	Case	US Avg Crude Makeup	US Avg Lower 48 LNG Export and End Use Makeup	Final Multi-Product Functional Unit
3	NGCC With CCS	+ 0.00 - 0.64 kg crude oil	-	1 MWh electricity using regasified LNG + 53 kg of crude oil
	NGCC without CCS	+ 5.86 – 6.43 kg crude oil	-	1 MWh electricity using regasified LNG + 53 kg of crude oil
2	NGCC with CCS	+ 19.79 – 20.19 kg crude oil	-	1 MWh electricity using regasified LNG + 53 kg of crude oil
	NGCC without CCS	+ 23.45 – 23.80 kg crude oil	-	1 MWh electricity using regasified LNG + 53 kg of crude oil
1	NGCC with CCS	+ 0.19 – 0.82 kg crude oil	+1 MWh electricity generated in power plant at destination country using LNG shipped from US Lower 48	1 MWh electricity using regasified LNG + 53 kg of crude oil
	NGCC without CCS	+ 6.03 – 6.59 kg crude oil	+1 MWh electricity generated in power plant at destination country using LNG shipped from US Lower 48	1 MWh electricity using regasified LNG + 53 kg of crude oil

2.6 Sub-Scenarios

Within each proposed scenario of LNG export from Alaska, four Asian countries are considered as destinations: Japan, China, South Korea, and India. The only difference in the parameters within these sub-scenarios is the ocean transport distance, which affects the life cycle of fuel consumed to transport the shipment. These four countries were chosen to represent geographically proximate delivery destinations from Alaska that at the time of study initiation were known or expected to be significant LNG importers. Note that the range of shipping distances to these specific countries (about 5,000 to 10,000 miles from Alaska) closely approximate those to other emerging LNG importers such as in Europe (about 10,000 miles away via the Panama Canal).

In Scenarios 2 and 3, results are shown with and without use of carbon capture and sequestration technologies at a power plant in each of the destination countries.

Finally, in the main report, global warming potential (GWP) results are estimated via the use of the IPCC Fourth Assessment Report (AR4) characterization factors over both 20 and 100-year time horizons (IPCC, 2007). The Appendix shows GWP results using both AR5 and AR6 methods.

2.7 Qualitative Discussion

Uncertainty about future technological and market developments limits DOE's ability to analyze LCA GHG emissions profiles for competing sources of energy for power generation in the selected destination countries (Japan, South Korea, China, and India) at the same level of detail as LNG delivered from the Alaska LNG Project. Sources of uncertainty include competing energy alternatives for power production (current and future technologies) and the role of energy services provided by imported natural gas as a result of changing emissions reduction strategies and targets.

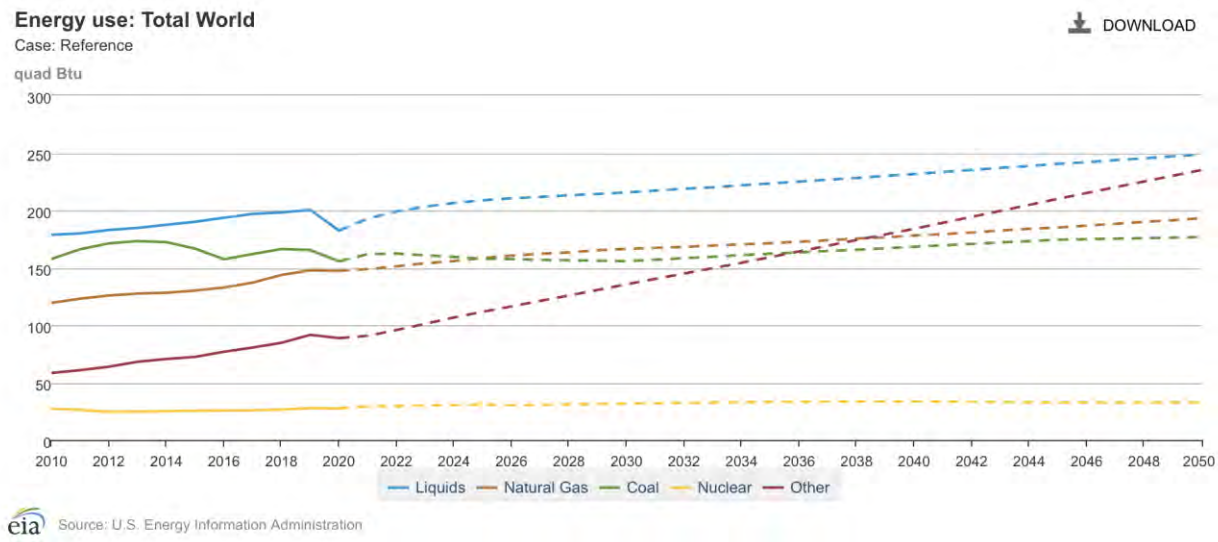
Nevertheless, DOE believes it is important to evaluate potential sources of energy that might be able to provide similar energy services in the destination countries in the future. The quantitative GHG emission impacts compared within this study assume LNG will be provided either by the Alaska LNG project or an alternative global source of LNG for each destination country. The actual market substitution effects are unknown and could be met by non-LNG sources. Different energy source substitutions could either increase or decrease GHG emissions to provide the same service to society. For example, renewable power, low GHG hydrogen or ammonia can lead to further reductions in GHG emissions. Accordingly, DOE is providing a qualitative assessment of alternative energy supplies.

All four destination countries are Asian economies with profiles that could be impacted as a result of additional supply from the Alaska North Slope. These countries also have different national energy and decarbonization goals. In this section, we seek to summarize the factors that may affect, or be affected by, the life cycle GWP profiles estimated in the quantitative section of this report.

2.7.1 Expected Trends in Global Energy Supply

The Energy Information Administration (EIA) International Energy Outlook 2021 modeled and graphically summarized its estimates of total energy supply through 2050 (US EIA, 2021). **Exhibit 2-13** shows that in its Reference Case, EIA expects global supply of renewables (most of the 'Other' category in the graph) to increase by a factor of five in the next 30 years. The energy supplied by renewables is expected to be comparable to that of liquid fuels by 2050. The increased use of renewables will lead to reduction in the carbon intensity of the global energy supply.

Exhibit 2-13. Estimated Total World Energy Supply Through 2050



Note: quad = quadrillion Btu

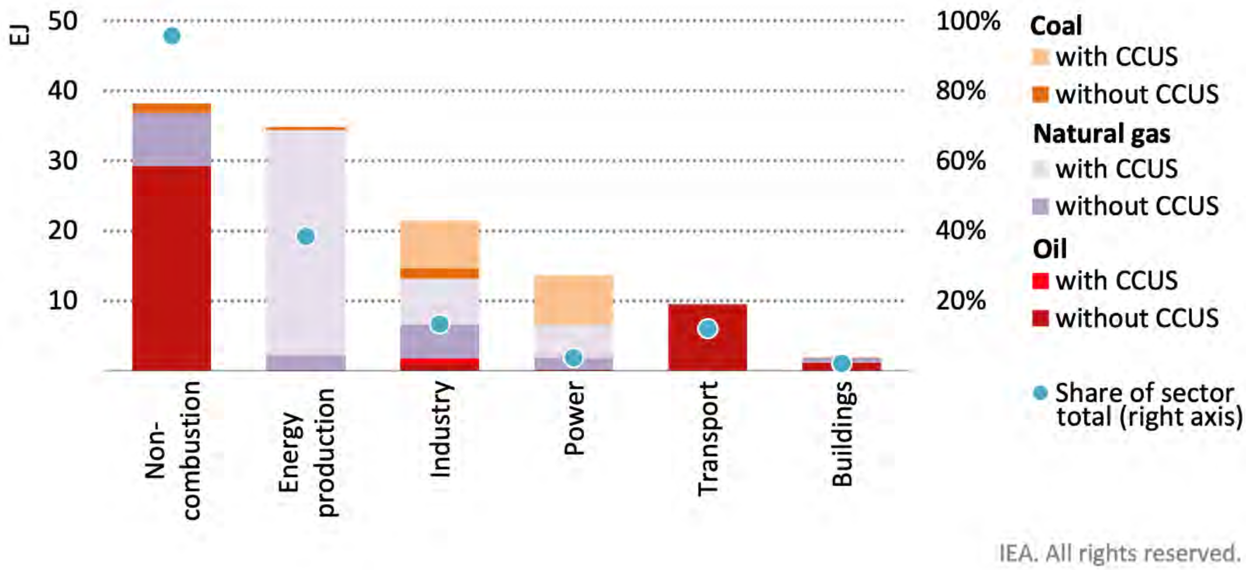
Source: EIA (US EIA, 2021)

While renewables receive much of the attention in discussions of future global energy and decarbonization policy, other sources are projected to continue to play a key role as well. With respect to baseload electricity generation specifically, various fuels and technologies are expected to compete in the global market. Use of coal and nuclear are expected to be relatively flat, while liquid fuels (mostly oil) and natural gas are expected to increase, with gas supply expected to nearly double by 2050. Coal has higher GWP impacts than natural gas, while nuclear and renewables have very low GWP impacts. Thus, there is significant uncertainty in what future global GHG emissions might be in the energy sector, and we have not tried to assess that in this report.

While it is acknowledged that there will be tremendous growth in renewables, even for baseload power, there is expected to be a continued role for natural gas, and thus from where it is sourced is of interest.

In terms of decarbonization, the International Energy Agency (IEA) report "Net Zero by 2050" (IEA, 2021b) estimates that in the energy production sector, almost all future fossil-based generation will come by pairing natural gas with carbon capture technologies and in power generation will be largely coal and natural gas plants with CCS (as shown in **Exhibit 2-14**).

Exhibit 2-14. Estimated Fossil Fuel Use and Share by Sector in 2050



Notes: Non-combustion includes use for non-emitting, non-energy purposes such as petrochemical feedstocks, lubricants, and asphalt. Energy production includes fuel use for direct air capture.

Source: IEA (IEA, 2021b)

Overall, natural gas is projected to continue to be a significant source of energy around the world, and for electricity generation, it is likely to be paired with carbon capture technology to help countries meet decarbonization goals across various future projections, including Net-Zero by 2050. LNG is a key part of a strategy to help to supply countries that do not have local or regional access to gas via pipelines.

2.7.2 Energy and Climate Transitions in the Export Countries

The four Asian countries modeled as LNG export markets in this study have varying energy mixes and decarbonization plans, as further described below. This subsection seeks to frame the general energy landscape in each country in support of further qualitative assessment.

2.7.2.1 Japan

In the last decade, Japan has reduced its reliance on nuclear energy from 15% in 2010 to 3% in 2020 and has also reduced its overall dependence on oil. This shift can be attributed to the 2011 earthquake and the subsequent nuclear accident at Fukushima. While much of the nuclear energy was replaced by fossil and renewable sources, nuclear generation is expected to increase again in the future as relicensing processes complete and decarbonization is re-prioritized. Such processes could be accelerated if costs of renewables or natural gas costs are higher. This is significant because Japan imports almost 90% of energy needed.

Japan was the world's largest importer of LNG in 2020, accounting for 21% of the global LNG market (International Trade Administration, 2022). With minimal in-country production, and no domestic or international gas pipelines, Japan relies entirely on LNG tanker shipments to meet their import demands. 24% of Japan's energy demands were met with natural gas, almost all of it from imported gas. In 2020, the majority of Japan's LNG imports came from Australia (39%), followed by Malaysia (14%), Qatar (12%), Russia (8%) and the United States (6%) (International Trade Administration, 2022). Between 2017 and 2020, Japan increased its import shares from the United States from 1% to 6%, all of it from the Gulf Coast projects following long-term contracts that entered service in 2018 and 2019.

In 2020, Japan declared that it would aim to achieve net-zero GHG emissions and realize a decarbonized society by 2050(IEA, 2021a). In 2019, 88% of Japan's total primary energy supply (TPES) was met by fossil fuels, so to achieve their 2050 vision the energy supply profile for Japan needs to change drastically. Japan has announced various strategies and policies to move onward with their ambitious goals. Japan also aims to increase its renewable shares from 8% in 2019 to 13% in 2030 and also restart its nuclear plants and increase their share from 4% in 2019 to 15% in 2030. As Japan shifts its energy profile, it is expected that the need for LNG will increase in the next decade because there is a lack of other viable energy sources.

2.7.2.2 South Korea

South Korea has insufficient domestic fossil fuel resources and relies almost entirely on imports to meet its energy demands (e.g., it produced 9 Bcf of natural gas and consumed 1.9 Tcf in 2019). South Korea relies largely on LNG imports for natural gas and does not have international pipeline infrastructure for importing gas. In 2019, South Korea received 27% of its LNG from Qatar, 19% from Australia, and 14% from the United States (IEA, 2020). However, over the last few years the trend has shifted to increased LNG imports from the United States and reduced imports from Qatar after multiple long-term contracts were signed with U.S. exporters. South Korea was the number one importer of U.S. LNG in 2021 (IEA, 2020). In addition, a long-term contract will come into effect in 2025 to purchase LNG from the US Freeport LNG terminal. Therefore, LNG imports from the US gulf coast region to South Korea are expected to increase in the near-term due to existing contracts.

The South Korean government aims to increase the share of renewable electricity to 20% by 2030 and 30-35% by 2040 (IEA, 2020). To meet ambitious climate goals as a part of the Paris Agreement, South Korea committed to phase-out coal. Natural gas will play an important role as a bridge fuel. South Korea also has ambitious goals of creating a strong hydrogen economy, especially in the transportation sector, and LNG is a potential source to enable that transition.

2.7.2.3 China

In 2019, the largest share of China's total energy demands was met by coal (58%), followed by petroleum and other liquids (20%). Only 8% of its demands were met by natural gas. However, the EIA anticipates that China's natural gas share will increase to about 14% by 2030, making it one of the fastest growing markets for natural gas in the world. Over the last decade, China's natural gas consumption has increased by about 13% every year (U.S. EIA, 2020a).

Domestic production of gas in China is modest but increasing. As a result, China relies heavily on imported gas to satisfy the widening gap between domestic production and demand. Since

2021, China has become the largest importer of LNG in the world. Sixty percent of the imports were from LNG and 40% were from pipeline imports, mostly from Turkmenistan (about 1 Tcf), but starting in 2020, China also began importing natural gas from Russia via the Power of Siberia pipeline, which will eventually grow to deliver 1 Tcf to eastern China. Australia has historically been the largest supplier of LNG to China accounting for 29% of the total supply followed by Qatar (9%). Disagreement on foreign policy led China to decrease Australian imports. China's LNG imports from the United States fluctuated in 2019 declined overall due to increased LNG tariffs. However, in early 2020 China offered tariff exemptions on LNG imports from the United States which is expected to boost the LNG supply from the United States, and several subsequent long-term contracts with U.S. LNG exports have since been signed. Turkmenistan is the second largest gas supplier for China but in the form of long-distance pipeline imports, it contributes 25% of total gas imports (LNG and pipeline). China plans to further increase natural gas pipeline capacity from Turkmenistan and is discussing a new pipeline from Western Siberia. While detailed demand and import projections were not available, pipeline gas supplies will compete with LNG supplies from other countries.

China expects to account for 40% of the global growth of renewable capacity between 2019 and 2024. However, China's high dependence on coal and future commitments to increase gas imports will mean that LNG and pipeline gas imports will also continue to rise in the near-term.

2.7.2.4 India

In 2020, 6% of India's energy demand was met with natural gas, 45% with coal, 25% with oil, and 20% with biofuels and waste (IEA, 2021c). However, India plans to increase the share of natural gas to 15% by 2030 (International Trade Association, 2018). India's natural gas demand exceeds its domestic production, and the country is expected to increase its LNG imports to meet the growing demand. In 2019, Qatar was the primary source of LNG imports for India with a 41% share. However, this share has decreased from 83% in 2014 as India diversifies its sources. The United States provides 8% of the LNG imports (U.S. EIA, 2020b). The regasification capacity for the country has increased over the years as more investments are made in natural gas infrastructure.

India is also investing heavily in pipeline infrastructure, having more than doubled its onshore gas pipeline network since 2008, and continues to construct pipelines in remote corners of the country. There are no plans for pipelines from other countries.

India plans to reach net zero emissions by 2070 and to meet 50% of its electricity requirements from renewable energy sources by 2030. This is occurring in the backdrop of a country with rapidly growing energy use, adding electricity access to about 50 million people per year. India has recently set a target of installing 500 gigawatts of renewable energy capacity by 2030, reducing the emissions intensity of its economy by 45%, and reducing emissions by a billion tonnes of CO_2.

2.7.3 Role of Carbon Capture and Storage in a Decarbonized Energy Sector

The four export destination country markets above have a diverse set of carbon management strategies in place for the future. Globally, one strategy with significant attention has been carbon capture and storage (CCS). While this study did not evaluate destination country geologic storage potential, CCS is a potentially pivotal technology that a country can take to start its march towards carbon-neutrality in support of large-scale power generation projects. There are movements within each of the countries to pursue the technology, including in offshore locations. CCS can reduce the impacts from existing infrastructure by retrofitting the existing fossil based power and industrial plants, or in the integrated design of new fossil plants, to capture the CO_2 emissions from these large point source emitters.

Carbon emissions from fossil power plant operations dominate the life cycle GHG profile of electricity. Capturing power plant emissions will drastically reduce the life cycle GHG impacts from power generation using fossil fuels. As this happens, demand for LNG stands to further increase for the changing energy economies of the destinations being considered in this work due to parasitic loads associated with the carbon capture units at facilities to produce the same amount of power.

2.7.4 Alternative Technologies for Fossil Fuel Based Electricity Generation

2.7.4.1 Other sources of LNG

As the United States has been the world's largest natural gas producer since 2009 (EIA 2018), the increased production of natural gas has created the opportunity for exports, leading to growing investments in new LNG facilities. The United States has keen competition in the global LNG export market from other suppliers, including Australia, Qatar, and Russia. Projections show the United States will have the largest LNG export capacity in the world by the end of 2022 (U.S. EIA, 2021), but the other main exporters are also planning capacity increases. Moreover, the Asian countries evaluated as the destinations for this work have diversified their LNG sources to increase energy supply reliability. This transition has worked in favor of US LNG, as its share in all the destination countries has seen growth in the last few years and is expected to increase in the future as all the countries aim to achieve ambitious decarbonization goals while maintaining energy reliability of service. The GHG impacts from any source depend on varied factors, but the biggest differentiators are the impacts of upstream natural gas and ocean transport of the LNG. While the United States is centrally located between potential demands around the world, there are various potential LNG importers that would have shorter ocean transport distance from LNG suppliers in other countries, making them potentially preferable on a life cycle GHG emissions basis.

2.7.4.1.1 US Gulf Coast

LNG from the US Gulf Coast to Asian markets is expected to have a larger GHG emissions impact as compared to LNG imported from Alaska because of two major reasons:

1. The ocean transport route from the Gulf Coast to Asia is longer compared to the route from Alaska to the Asian markets. The shortest distance between the Gulf Coast and China is 140% longer than the route from Alaska to China, so the impact of transporting LNG by ocean tanker is expected to be greater when moving from the Gulf Coast to Asia. In addition to the longer distances, the vessel will also need to pass through either the Panama or Suez Canals, but this comes with restrictions on vessel size, delays, and additional costs to pass thorough the canals.
2. Associated gas is produced alongside oil production. Other natural gas production is not co-produced with oil. For associated gas (and in our study), the GHG emissions from the production wells and initial oil and gas separation activities are shared across products on an energy basis, resulting in relatively lower GHG emissions on a per unit of natural gas product produced basis (compared to non-associated production). About 75% of the proposed Alaskan North Slope gas for LNG export is associated gas (Kuuskraa, Wallace, & Remson, 2022a). However, in the five major onshore oil production regions, including the Gulf Coast, only about 40% of gas produced is associated gas (U.S. EIA, 2021). Thus, the GHG intensity of natural gas from the Gulf Coast region would be expected to be higher.

2.7.4.1.2 Qatar

Qatar is the largest supplier of LNG for South Korea and India, and the second largest supplier for Japan and China. Qatar supplying LNG for India is ideal based on geographical proximity. However, for the other countries, the ocean transport distance from Alaska is shorter than the distance from Qatar, which implies lower GHG emissions in the ocean transport stage but as noted above, we have not attempted to quantify the GHG impacts of any of the foreign sources of natural gas.

2.7.4.1.3 Australia

Australia is the largest supplier of LNG for Japan and China and the second largest supplier for South Korea and India. Depending on which coast the LNG supplier is located on, Australia has the advantage of being geographically closer to all the Asian countries compared to Alaska, which would reduce the ocean shipping component of the life cycle emissions. However, as noted above, we have not attempted to quantify the GHG impacts of any of the foreign sources of natural gas.

2.7.4.2 Non-LNG sources of natural gas (e.g., regional and domestic pipeline gas supply)

Transporting natural gas via pipeline is a simpler and less GHG-intensive process than LNG. However, many Asian countries do not have existing pipeline infrastructure to receive international gas and to distribute it within the country; therefore, they would have to invest heavily into infrastructure expansion. That said, constructing pipelines results in GHG emissions, so power plants co-located to coastal LNG terminals could result in electricity with lower life cycle emissions than if significant domestic pipeline distribution was needed. Similarly, long cross-continental pipeline transport distance can result in higher GHG emissions that equal or exceed liquefaction, transportation and regasification operations. Existing active or planned regional pipelines, such as those delivering gas westward into Europe, or planned from Turkmenistan through Afghanistan and Pakistan to India, may be at risk of disruption due to conflict or policy changes, and could eventually lead to further demand for LNG to maintain energy security.

2.7.4.3 Domestic or regional coal

In general, coal as an energy source emits more GHGs than natural gas or LNG due to differences in the carbon ratio of the fuels, and in the relative efficiency of combustion and generation. NETL's 2019 LNG report (Roman-White, Rai, Littlefield, Cooney, & Skone, 2019) estimated that importing LNG from the US gulf coast to China emits 37% and 28% less carbon dioxide equivalents than regional coal on a 100-yr and 20-yr timeline, respectively. And while coal is currently the largest source of energy for many Asian countries, these countries are trying to move away from coal to be able to meet their climate goals.

2.7.5 Nuclear energy

While nuclear energy is a low GHG source of energy, with zero GHG emissions during operations and very low life cycle emissions, it has seen a lot of social challenges resulting from major nuclear power plant incidents over the past several decades. For example, Japan relied heavily on nuclear energy but quickly moved away following the Fukushima nuclear incident. Nuclear energy has been ramping back up in Japan as plants have been re-starting. South Korea has the highest density of nuclear plants in the world and had previously intended a decrease in nuclear energy after Fukushima but continues to have plants under construction and may be renewing nuclear targets. China continues to refine nuclear technology and hopes to export technology in the future. India is also demonstrating plants fully designed and developed using its own technologies and continues to build and announce new plants. Overall, IEA expects nuclear electricity production to double by 2050 in support of decarbonization goals (IEA, 2021b).

2.7.6 Other Relevant Technologies for Electricity Generation

2.7.6.1 Renewable energy

Hydro, wind, and solar are main sources of renewable electricity. These sources have lower GHG impacts when compared to fossil sources. Limitations include the intermittency of generation when the resource is available and misalignment of when renewable electricity is able to be supplied versus when it is in demand - which then requires energy to be stored. Use of traditional batteries on the grid currently is limited to about 6-8 hours of storage which limits its utility, but the storage technology field is rapidly growing. All countries that have signed the Paris Agreement have ambitious goals to transform their electricity grids to rely heavily on these renewable sources. However, most Asian economies have political, social, and technological hurdles that will make the goal of carbon neutrality challenging to achieve solely based on supplying electricity demand with renewable sources. Most countries will require bridge fuels before they become 100% renewable over the coming decades.

2.7.6.2 Hydrogen

Hydrogen has gained a lot of attention as an alternative fuel to meet energy demands. However, most hydrogen that is being produced in the market today is sourced from steam methane reforming of natural gas or coal gasification which does not necessarily make it a low-carbon alternative without capturing and permanently storing the carbon dioxide produced during the hydrogen production process. Hydrogen can also be produced from electrolysis of water using renewable electricity, but the technology is not utilized at a large enough scale yet to meet energy demand. Electrolysis of hydrogen with renewable electricity has significantly lower carbon footprint than that of existing fossil-based technologies (but will consume significant volumes of water).

2.7.6.3 Ammonia

The world is already producing large quantities of ammonia to be used as fertilizers, and the advent of technology to produce ammonia and combust it directly as fuel in power plants and engines or as a hydrogen carrier for applications like transportation make it a very attractive option. However, this technology is very new, and it will take a long time to scale up making ammonia a reliable energy source capable of replacing other existing options. There are thus substantial uncertainties and unknowns about its role in the future. So, although ammonia might become a competitor for other fuels in the future, studies on this topic are relatively recent and there is not enough research to predict its growth in the energy sector.

3 Modeling Approach and Key Parameters

This section describes the approach taken when modeling each stage in Scenarios 1, 2 and 3, as well as the key parameters used. This LCA utilized existing models (described in Sections 3.1 through 3.9) to inform the creation of a model to represent the Alaska LNG supply chain. This LCA follows ISO 14040 and ISO 14044 international standards (ISO, 2006a) (ISO, 2006b).

3.1 Production

This analysis combines two different processes to model the production stage in order to represent production from both PBU and PTU. It is important to note that approximately 75% of gas for the Alaska LNG Project is expected to be sourced from the PBU, while the remaining 25% is expected to come from the PTU. Together, these fields are expected to have about 41.1 Tcf of natural gas reserves, which is a sufficient volume for the needs of the project (Kuuskraa, et al., 2022a). All oil production for the project is expected to come from the PBU (with the exception of Scenario 3, which produces additional oil from CO_2-EOR in the Kuparuk River Unit (KRU) oil field on the North Slope of Alaska).

To model the production stage in PBU, the Oil Production Greenhouse gas Emissions Estimator (OPGEE) 2.0 model (El-Houjeiri, et al., 2018) was used to estimate the GHG emissions. The parameters in the model were updated based on technical performance data sourced from the ARI Upstream Study (Kuuskraa, et al., 2022a). This data includes the estimated oil and gas production from the North Slope over the 33-year timespan of the project. From this data, gas-to-oil ratios (GOR) were calculated based on an average over the 33 years of gas production as well as the 33 years of gas delivered to the processing plant. The producing well count and API Gravity was sourced from the Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP). These parameters (number of wells and API gravity) were taken from 2020 production facility data in the North Slope and assumed to be consistent throughout the duration of the project unless noted otherwise in the report (U.S. EPA, 2020).

The OPGEE 2.0 model provides life cycle GHG emissions in terms of CO_2e. These emissions are speciated into CO_2, CH_4, and N_2O, and incorporated into the total life cycle analysis to model the production stage. This stage includes emissions from drilling and development of wells, production and extraction, and surface processing of oil and associated gas. The production stage also includes the transportation of oil produced from the wells through a crude oil pipeline, which was modeled based on the oil pipeline unit process from NETL's Carbon Dioxide Enhance Oil Recovery Life Cycle (CELiC) model . The length of the Trans-Alaska Pipeline System (TAPS), the main pipeline network for oil transport in Alaska, is 800 miles. This pipeline is used to transport oil from PBU as well as oil produced via CO_2-EOR operations on the North Slope. Within OPGEE, the natural gas reinjection ratios were changed to reflect a 33-year average for each of the three scenarios (Wallace, et al., 2022). These ratios determine the volume of natural gas that is compressed for reinjection. On account of the lower fraction of reinjected natural gas in Scenarios 2 and 3, the reinjection energy requirements are lower than those of Scenario 1.

To model the production stage in PTU, parameters from the 2020 NETL One Future report (Rai, et al., 2020) were used. These parameters represent the US average of CO_2, CH_4, and N_2O

emission factors in the production stage of natural gas. The OPGEE 2.0 model was not used in modeling PTU because of the lack of oil production occurring at this site. Therefore, PTU production is only modeled for Scenarios 2 and 3, given that Scenario 1 only produces oil and not natural gas. Gas coming from PBU and PTU was modeled to be mixed in a ratio of 75:25 to represent the combination of the two gas streams.

For Scenario 1, there is no natural gas production for export from the North Slope. In order to compare Scenario 1 to Scenarios 2 and 3, it must provide the equivalent service or function to society with respect to the amount of crude oil derived services and natural gas derived services to society. The system boundary for Scenario 1 is expanded to include the production and delivery of natural gas from the Lower 48 United States to each of the receiving countries. Production and delivery of natural gas exports from the Lower 48 was modeled based on US average data from the 2020 NETL One Future report (Rai, et al., 2020). Additionally, the transport distance was adjusted to represent the distance to each receiving country in this study and the GWP values were changed from IPCC AR5 to IPCC AR4 values, the default GWP for this report. This was done in order to ensure that each of the three scenarios are functionally equivalent with respect to the amount of services provided by the crude oil derived products and the use of the imported natural gas for power generation (Wallace, et al., 2022).

While the Scenarios discuss 'lower 48', this categorization is creating a benchmark representation of alternative natural gas sources. However, by using high-resolution data available from the US lower 48 (e.g., from the US EPA GHGRP), our analysis offers a higher level of data quality and helps to stay consistent with the level of modeling accuracy. It also avoids using far more aggregated data from other regions that would lead to additional uncertainty.

Exhibit 3-1 summarizes the key parameters for the production stage in PBU. **Exhibit 3-2** summarizes the key parameters for the production stage in PTU.

Exhibit 3-1. Key Parameters for Production Stage of LCA - PBU

Parameter	Units	Value		Source
		Scenario 1	Scenarios 2 and 3	
Oil Production Volume, 33-year average	Mbbl/d	113	70	(Wallace, et al., 2022)
Gas Production Volume, 33-year average	Bcf/d	6.98	4.33	
Number of Gas Producing Wells	count	1,734		(U.S. EPA, 2020)
API Gravity	deg. API	26		
Gas-to-Oil Ratio (GOR), 33-yr average	scf/bbl	61,996	61,476	(Wallace, et al., 2022)
Gas Delivered to GTP and Oil Ratio (GTP GOR), 33-yr average	scf/bbl	-	31,150	
Natural Gas Reinjection Fraction, 33-year average	scf reinjected/scf	0.92	0.43	

Exhibit 3-2. Key Parameters for Production Stage of LCA - PTU

Parameter	Units	Value	Source
CO_2 Emission Factor	kg/kg gas	1.98E-01	(Rai, et al., 2020)
CH_4 Emission Factor	kg/kg gas	1.08E-06	
N_2O Emission Factor	kg/kg gas	6.13E-03	

3.2 Prudhoe Bay Transport Line (PBTL) and Point Thomson Transport Line (PTTL)

The gas from PBU and PTU travel through small sections of pipeline to reach the GTP. These transmission pipelines are small enough to not require compression stations, so they were modeled using the NETL baseline natural gas model's (Littlefield et al., 2019) pipeline stage unit processes with updated distance parameters. This stage includes emissions from emergency shutdowns, fugitives, integrity and maintenance work, repairs, cautionary work, venting, and other sources.

Exhibit 3-3 summarizes the key parameters for the transmission line stage.

Exhibit 3-3. Key Parameters for Transmission Life Stage of LCA

Parameter		Units	Value	Source
Pipeline Length	PBTL	miles	1	(FERC, 2020)
	PTTL		62.5	
Pipeline Fugitive Emission Factor		kg CH_4/mile	1,120	(Littlefield, et al., 2019)
Pipeline Venting Emissions	Cautionary Work Emissions	tonnes CH_4	Min: 2.53E+01 Exp: 9.02E+01 Max: 1.81E+02	(U.S. EPA, 2020)
	New Pipeline Construction or Modification Emissions	tonnes CH_4	Min: 4.29E+02 Exp: 9.66E+02 Max: 1.73E+03	(U.S. EPA, 2020)
	Emergency Shutdown Emissions	tonnes CH_4	Min: 1.52E-02 Exp: 4.95E+01 Max: 1.71E+02	(U.S. EPA, 2020)
	Pipeline Integrity Work Emissions	tonnes CH_4	Min: 2.89E+01 Exp: 5.46E+01 Max: 9.28E+01	(U.S. EPA, 2020)
	Maintenance Work Emissions	tonnes CH_4	Min: 5.32E+02 Exp: 1.46E+03 Max: 4.56E+03	(U.S. EPA, 2020)
	Repair Work Emissions	tonnes CH_4	Min: 3.14E+02 Exp: 1.43E+03 Max: 3.28E+03	(U.S. EPA, 2020)

Parameter		Units	Value	Source
	All Other Emissions	tonnes CH_4	Min: 1.84E+02 Exp: 3.31E+02 Max: 5.09E+02	(U.S. EPA, 2020)

3.3 Processing or Gas Treatment Plant (GTP)

The Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (FEIS) (FERC, 2020) on this LNG project and EPA's GHGRP data were the primary data sources for the parameters in the processing stage for Scenarios 2 and 3. The FEIS provided specification of the new GTP that will be constructed as a part of this project. These specifications were used to model the processing stage. This stage includes emissions from acid gas removal unit, reciprocating compressors, blowdowns, dehydrators, equipment leaks, pneumatic devices, flaring, venting, and combustion operations.

The reciprocating compression energy was modeled using the methodology followed by (Roman-White, et al., 2021) , which involves developing a US average HPh per Mcf factor. The transmission compression HPh per Mcf factor was used as a proxy for estimating reciprocating compression energy for the processing stage. **Section 3.7** provides the detailed methodology for developing the US average HPh per Mcf factor. The factor is multiplied with the processing facility throughput to obtain the required reciprocating compression energy output.

Scenario 1 gas processing was modeled based on the 2020 NETL One Future report (Rai, et al., 2020).

Exhibit 3-4 summarizes the key parameters for the GTP stage for Scenarios 2 and 3.

Exhibit 3-4. Key Parameters for GTP Stage of LCA

Parameter	Units	Value	Source
Natural Gas Throughput	Mcf/yr	1.02E+09	(Kuuskraa, et al., 2022a)
Avg Volume of CO_2 Reinjected/Removed	Mmcf	1.17E+05	(Kuuskraa, et al., 2022a)
Dehydrator Venting	tonnes CH_4/facility-yr	6.47E+00	(US EPA GHGRP, 2020)
Reciprocating Compressor Energy	HPh per Mcf factor	Min: 2.04E-01 Exp: 2.96E-01 Max: 4.66E-01	(Roman-White, et al., 2021)
	Reciprocating engine thermal efficiency	44%	(Littlefield, et al., 2019)
Reciprocating Compressor Venting	tonnes CH_4/facility-yr	Min: 7.36E+01 Exp: 9.69E+01 Max: 1.26E+02	(U.S. EPA, 2020)
Blowdowns	tonnes CH_4/facility-yr	6.23E+01	(U.S. EPA, 2020)

Parameter	Units	Value	Source
Equipment Leaks	tonnes CH_4/facility-yr	Min: 7.16E+01 Exp: 8.73E+01 Max: 1.06E+02	(U.S. EPA, 2020)
Flared Volume	scf	1.41E+08	(U.S. EPA, 2020)
Pneumatic Device Venting	kg CH_4/facility-yr	3.17E+03	(U.S. EPA, 2020)

3.4 Management of CO_2 from GTP

The CO_2 that is captured from the natural gas stream at the GTP has been modeled in two different ways in this study, as described in the following subsections.

3.5 CO_2 Sequestration in Saline Aquifer (only in Scenario 2)

Scenario 2 in this LCA study evaluated the emissions from sequestration of the CO_2 captured from the natural gas stream at the GTP in saline aquifers. This stage includes the transport of CO_2 from the GTP to saline aquifers 3 miles away. The sequestration emissions were estimated based on the NETL gate-to-grave life cycle analysis model of saline aquifer sequestration of CO_2 (Littlefield et al. 2019). The CO_2 pipeline transport was modeled based on the unit process from NETL's CELiC model. **Exhibit 3-5** below summarizes the key parameters for the CO_2 sequestration stage.

Exhibit 3-5. Key Parameters for CO_2 Sequestration of LCA

Parameter	Units	Value	Source
CO_2 Sequestration (Scenario 2 only)			
CO_2 Pipeline Distance	miles	3	(Kuuskraa, et al., 2022b)
Average CO_2 Injected (33-year average)	MMcf/year	117,237	
CO_2 Pipeline - CH_4	kg/kg CO_2 injected	1.54E-08	(Jamieson & Skone, 2019)
CO_2 Pipeline - CO_2	kg/kg CO_2 injected	5.14E-05	
CO_2 Pipeline – N_2O	kg/kg CO_2 injected	8.06E-10	
Sequestration CH_4 Emissions	kg CH_4/ton of CO_2 sequestered	3.15E-02	(Littlefield, et al., 2019)
Sequestration CO_2 Emissions	kg CO_2/ton of CO_2 sequestered	1.39E+01	
Sequestration N_2O Emissions	kg N_2O/ton of CO_2 sequestered	1.10E-04	
Sequestration SF_6 Emissions	kg SF_6/ton of CO_2 sequestered	1.93E-06	

3.6 Transport and Use for EOR (only in Scenario 3)

Scenario 3 in this LCA evaluated the emissions from enhanced oil recovery (EOR) using the CO_2 captured from the natural gas stream from the GTP. This stage includes the transport of CO_2 from the GTP to Kuparuk reservoir for EOR. The CO_2 pipeline transport and EOR emissions were estimated based on NETL's CELiC model (Jamieson & Skone, 2019). This stage also includes the transportation of the oil produced from EOR practices through the 800-mile TAPS.

A model process was constructed to model the CO_2 profile for the 33-year average of the results from CELiC. The CELiC model was run for parameters from each year as reported by the ARI upstream study. The CELiC model outputs are averaged over the 33 years to provide the CO_2 injected, average crude produced, and emissions from EOR.

Exhibit 3-6 summarizes the key parameters for the CO_2 transport and use stage. The leakage parameters provided result in an EOR sequestration efficiency of 99.9%.

Exhibit 3-6. Key Parameters for CO_2 EOR Stage of LCA

Parameter	Units	Value	Source
CO_2 EOR (Scenario 3 only)			
CO_2 Pipeline Distance	miles	50	(Kuuskraa, et al., 2022b)
Average New CO_2 Injected	MMcf/year	117,237	
Formation Leakage Rate	kg CO_2/kg CO_2 injected	5.00E-04	(Jamieson & Skone, 2019)
CO_2 Compressor Leakage	kg CO_2/kg CO_2 injected	2.85E-04	
CO_2 Pipeline - CH_4	kg/kg CO_2 injected	2.56E-07	
CO_2 Pipeline - CO_2	kg/kg CO_2 injected	8.57E-04	
CO_2 Pipeline – N_2O	kg/kg CO_2 injected	1.34E-08	
Average Oil Production	kg oil produced/kg new CO_2 injected	3.76E-01	
EOR CH_4 Emissions	kg/kg new CO_2 injected	2.84E-04	
EOR CO_2 Emissions	kg/kg new CO_2 injected	1.17E-01	
EOR N_2O Emissions	kg/kg new CO_2 injected	1.37E-06	
EOR SF_6 Emissions	kg/kg new CO_2 injected	2.49E-08	

3.7 Natural Gas - Transmission Compression and Mainline Pipeline

The Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (FEIS) (FERC 2020) on this LNG project, EPA's GHGRP data, and Roman-White et al, 2021 were the primary data sources for the parameters in the transmission compression stage for Scenarios 2 and 3. This stage includes emissions from reciprocating compressors, blowdowns, dehydrators, equipment leaks, pneumatic devices, flaring, venting, and combustion operations.

The reciprocating compression energy was modeled using the methodology followed by (Roman-White, et al., 2021), which involves developing a US average HPh per Mcf factor. The developed factor is multiplied with the facility throughput to obtain the required reciprocating compression energy output.

In 2019, total natural gas delivered in the United States to consumers = 28,291,006 MMcf (U.S. EIA, 2022).

Total HPh of transmission compression = 76,893 million HPh (U.S. EPA, 2021).

Using an average total transmission pipeline distance of 600 miles, and an average distance of 59 miles between transmission stations (Littlefield, et al., 2019), results in 9.2 compressor stations traveled by a unit of gas.

$$HPh\ per\ Mcf\ factor = \frac{76{,}893 \times 10^6\ HPh}{28{,}291{,}006\ \times 10^3\ Mcf} \times \frac{1}{9.2\ comp.stations}$$

$$HPh\ per\ Mcf\ factor = 0.296$$

The factor is multiplied with the ARI reported mainline pipeline throughput to obtain the required reciprocating compression energy output.

In addition, similar to the PBTL and PTTL, the mainline pipeline was also modeled for Scenarios 2 and 3 using NETL's baseline natural gas model's (Littlefield et al. 2019) pipeline stage unit processes with an updated distance parameter to represent the 806.9 miles of new pipeline that will be constructed for this project. This stage includes emissions from, emergency shutdowns, fugitives, integrity and maintenance work, repairs, cautionary work, venting and other sources.

Scenario 1 transmission compression and pipeline transport were modeled based on the 2020 NETL One Future report (Rai, et al., 2020).

Exhibit 3-7 summarizes the key parameters for the transmission compression and mainline pipeline stages for Scenarios 2 and 3.

Exhibit 3-7. Key Parameters for Transmission Compression Stage of LCA

Parameter		Units	Value	Source
Transmission Compression				
Number of Compression Stations		count	8	(FERC, 2020), (Roman-White, et al., 2021)
HPh per Mcf factor		HPh per Mcf	2.96E-01	
Natural Gas Throughput		Mcf/facility-yr	1.00E+09	(Kuuskraa, et al., 2022a)
Blowdowns		tonnes CH_4/yr	1.29E+02	(U.S. EPA, 2020)
Dehydrators	Emission factor	kg CH_4/Mmcf	1.80E+00	(U.S. EPA, 2020)
	Throughput volume for dehydrator vents	Mmcf/yr	1.19E+06	(U.S. EPA, 2020)

Parameter		Units	Value	Source
Equipment Leaks		tonnes CH_4/yr	2.39E+01	(U.S. EPA, 2020)
Flaring		tonnes CH_4/yr	1.10E-01	(U.S. EPA, 2020)
Pneumatic Devices	High bleed	count	1.53E+00	(U.S. EPA, 2020)
		kg/controller-yr	8.41E+02	(Littlefield, et al., 2019)
	Intermittent bleed	count	2.48E+01	(U.S. EPA, 2020)
		kg/controller-yr	2.27E+02	(Littlefield, et al., 2019)
	Low bleed	count	1.75E+00	(U.S. EPA, 2020)
		kg/controller-yr	6.60E+01	(Littlefield, et al., 2019)
Mainline Pipeline				
Pipeline Length		miles	806.9	(FERC, 2020)
Pipeline Fugitive Emission Factor		kg CH_4/mile	1,120	(Littlefield, et al., 2019)
Pipeline Venting Emissions	Cautionary work emissions	tonnes CH_4	Min: 2.53E+01; Exp: 9.02E+01; Max: 1.81E+02	(U.S. EPA, 2020)
	New pipeline construction emissions	tonnes CH_4	Min: 4.29E+02; Exp: 9.66E+02; Max: 1.73E+03	(U.S. EPA, 2020)
	Emergency Shutdown emissions	tonnes CH_4	Min: 1.52E-02; Exp: 4.95E+01; Max: 1.71E+02	(U.S. EPA, 2020)
	Pipeline Integrity work emissions	tonnes CH_4	Min: 2.89E+01; Exp: 5.46E+01; Max: 9.28E+01	(U.S. EPA, 2020)
	Maintenance work emissions	tonnes CH_4	Min: 5.32E+02; Exp: 1.46E+03; Max: 4.56E+03	(U.S. EPA, 2020)
	Repair work emissions	tonnes CH_4	Min: 3.14E+02; Exp: 1.43E+03; Max: 3.28E+03	(U.S. EPA, 2020)
	All other emissions	tonnes CH_4	Min: 1.84E+02; Exp: 3.31E+02; Max: 5.09E+02	(U.S. EPA, 2020)

3.8 LIQUEFACTION AND LOADING/UNLOADING

Liquefaction and loading/unloading were modeled for all three scenarios as per the 2019 NETL LNG report (Roman-White, et al., 2019). The liquefaction stage was updated in Scenarios 2 and 3 to only represent the Propane Precooled Mixed Refrigerant (AP-C3MR™) process with cryogenic distillation and heat recovery steam generator (HRSG). All of the liquefaction processes include emissions from construction, energy consumption and fuel combustion for operation, venting, flaring, and fugitives.

Exhibit 3-8 and **Exhibit 3-9** show the key parameters used for liquefaction and loading/unloading stages, respectively.

Exhibit 3-8. Key Parameters for Liquefaction Stage of LCA

Model Parameter		Low	Expected	High	Distribution	Units	Source
Energy Requirement	Adsorption Based HHC* Removal, with HRSG*	-	2.86	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
Energy Requirement	Adsorption Based HHC, without HRSG	-	3.08	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
Energy Requirement	Cryogenic Distillation Based HHC removal, with HRSG	-	2.78	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
Energy Requirement	Cryogenic Distillation Based HHC removal, without HRSG	-	3.35	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
Boil-off Rate (temporary storage)		0.02%	-	0.1%	Uniform	percent volume/day	(Dobrota, et al., 2013)
Storage Time		1.33	-	1.60	Uniform	days	(U.S. Energy Information Administration, 2017) (International Gas Union, 2017)
Power Consumption for BOG Recondenser		-	4,450	-	Point Estimate	kW/kg BOG condensed	(Li & Wen, 2016)
Handling Capacity of BOG Recondenser		-	13.38	-	Point Estimate	tonnes/hour	(Kinder Morgan, n.d.) (Li & Wen, 2016)

* HHC stands for heavy hydrocarbon removal and HRSG stands for heat recovery steam generator.

Exhibit 3-9. Key Parameters for Loading/Unloading Stages of LCA

Model Parameter	Low	Expected	High	Distribution	Units	References
Standard Loading/Unloading Rate	10,000		12,000	Uniform	m^3/hour	(Dobrota, et al., 2013)
Boil-off Rate		20,000		Point Estimate	kg/hour	(Dobrota, et al., 2013)

3.9 Ocean Transport and Crude Ocean Transport

Emissions associated with both transporting LNG to foreign markets and crude oil to the US west coast were included in this study. The model includes ocean transport of LNG from the liquefaction facility to four different overseas destinations: Japan, South Korea, China, and India. Scenario 1 natural gas was modeled as departing from the US Lower 48 and being delivered to the same four destinations. Ocean transport of crude oil was modeled from the southern coast of Alaska to a port in Washington state. **Exhibit 3-10** and **Exhibit 3-11** summarize the key parameters for the LNG ocean transport and crude ocean transport stages, respectively.

Exhibit 3-10. Key Parameters for LNG Ocean Transport Stage of LCA

Parameter	Units	Value				Source
Ocean Transport						
Vessel Capacity	m^3	176,000; Ranging from (150,000 to 180,000)				(FERC, 2020)
Distance [Source (Port) ↓; Destination (Port) →]	-	**Japan (Futtsu)**	**South Korea (Incheon)**	**China (Shanghai)**	**India (Mumbai)**	
Alaska, US (Nikiski)*	miles	4,456	5,443	5,489	10,614	(Searoutes, 2022)
US Lower 48 (Corpus Christi)	miles	10,575	11,625	11,671	11,266	
Parameter	**Units**	**Value**			**Distribution Type**	**Source**
Ship Speed, Laden	knots	-	19.5	-	Point Estimate	(Pace Global, 2015)
Ship Speed, Ballast	knots	-	20.9	-	Point Estimate	(Pace Global, 2015)
Ship Capacity	m^3	150,000	-	180,000	Uniform	(International Gas Union, 2017)
Available Volume	percent	-	98%	-	Point Estimate	(Hasan, 2009)
Percent Heel	percent	-	2.5%	-	Point Estimate	(Roman-White, et al., 2019))
Boil-Off Rate	percent volume/ day*	-	0.1%	-	Point Estimate	(International Gas Union, 2017)
Engine Power	kW	-	31,400	-	Point Estimate	(MAN Diesel and Turbo, 2013)
Gas Consumption, 100% Load	kJ/kWh	-	7,318	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 50% Load	kg/kWh	-	0.1904	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 75% Load	kg/kWh	-	0.1844	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 100% Load	kg/kWh	-	0.1896	-	Point Estimate	(Wärtsilä Corporation, 2018)

*Note that Anchorage was selected in the Searoutes calculator, because an option to select Nikiski was not available at the time in the Searoutes calculator. There is a negligible difference of about 60 miles between Nikiski and Anchorage.

Exhibit 3-11. Key Parameters for Crude Ocean Transport Stage of LCA

Parameter		Units	Value	Source
Crude Ocean Transport				
Vessel Capacity		m^3	176,000; Ranging from (150,000 to 180,000)	(FERC, 2020)
Distance [Alaska, US (Petersburgh) to Washington State, US]		miles	1,675	(Searoutes, 2022)
Fuel use proportions	Diesel	dimensionless	0.32	(NETL, 2010)
	Fuel oil	dimensionless	0.68	
Energy intensity of crude oil transportation		MJ/kg-km	1.00E-04	(NETL, 2010)

3.10 Regasification

Once the gas is delivered to the importing country, it is regasified in order to use it to produce electricity, a process that produces GHG emissions. **Exhibit 3-12** summarizes the key parameters for the gasification stage.

Exhibit 3-12. Key Parameters for Gasification Stage of LCA

Parameter	Units	Value	Source
Energy Requirement	MJ/kg LNG regasified	2.14E-01	(Pace Global, 2015)
Electricity Consumption	MWh/kg LNG regasified	1.21E-05	(Papadopoulo, et al., 2011)
Boil-Off Rate	Percent volume/day	0.06%	(Dobrota, et al., 2013)
Storage Time	days	1.46E+00	(EIA, 2017)
Fugitive Emission Rate	kg/kg LNG regasified	0.009%	(Papadopoulo, et al., 2011)

3.11 Power Generation

Two possible end uses of the delivered natural gas were modeled at the destination facility- power generation from a natural gas combined cycle (NGCC) power plant with and without carbon capture and sequestration (CCS). The power generation stage is modeled using the NETL baseline fossil energy plant report (James, 2019), and the modeling parameters do not vary across the four LNG receiving countries analyzed in this study.

Exhibit 3-13. summarizes the key parameters for the Power Generation stage.

Exhibit 3-13. Key Parameters for Power Generation Stage of LCA

Parameter	Units	Value	Source
NGCC without CCS			(James, 2019)
NOx Emissions, without CCS	kg/MWh_{net}	0.012	
CO_2 Emissions, without CCS	kg/MWh_{net}	342.46	
Natural Gas Flowrate, without CCS	kg/MWh_{net}	128.30	
NGCC with CCS			
NOx Emissions, with CCS	kg/MWh_{net}	0.010	
CO_2 Emissions, with CCS	kg/MWh_{net}	38.56	
Natural Gas Flowrate, with CCS	kg/MWh_{net}	144.38	
Carbon Capture Efficiency	%	90	

The life cycle abatement of CO_2e emissions resulting from the 90% carbon capture efficiency (reduction in power plant CO_2 emissions by 90%) modeled for NGCC plants with CCS is detailed in **Exhibit 3-14**.

Exhibit 3-14. Life Cycle Abatement of CO_2e Emissions Resulting from Carbon Capture

Country	Life Cycle Abatement Value		
	Scenario 1	Scenario 2	Scenario 3
China	-43%	-47%	-47%
Japan	-43%	-47%	-47%
South Korea	-43%	-47%	-47%
India	-43%	-46%	-46%

3.12 Construction

The impacts of constructing new facilities for the Alaska LNG project have been modeled based on estimated materials and data from the Alaska LNG Resource Report (Alaska LNG Project, 2017). Emissions from the construction of new wells were also estimated based on information provided by the ARI report on gas supply (Kuuskraa, et al., 2022a). The new facilities considered in construction emissions include the GTP, mainline pipeline, PBTL and PTTL, eleven new wells, and the liquefaction facility.

The Alaska LNG Resource Report (Alaska LNG Project, 2017) provides estimated annual emissions of construction-related operations for the GTP, mainline pipeline, PBTL and PTTL, and the liquefaction facility. This includes the emissions from onroad vehicles, nonroad equipment, generators, marine and rail logistics, and fugitives. These annual emissions were combined and added to estimates of material emissions for each new facility. Emissions from materials were estimated based on steel and concrete makeup. Components of the GTP that were included in these estimates include six natural gas compressor turbines, six CO_2 compressor turbines, six power generation turbines, two building heaters, three emergency generators, four CO_2 flares, and two gas bath heaters. Materials for the mainline pipeline and the PBTL and PTTL pipelines were estimated based on pipeline lengths (see **Exhibit 3-7** and **Exhibit 3-3**, respectively) and diameters. Furthermore, materials for the PBU Miscible Gas Sales Project and the PTU Expansion Project, two development projects required in order to meet gas demand, were also estimated. These emissions are based on data provided by (Kuuskraa, et al., 2022a). These projects would include the construction of four new pipelines that are 25, 3, 8, and 8 miles in length. Emissions from the dredging of 5,000 yd^3 of materials that is required for the PTU Expansion Project are also included, using data from (Bianchini, et al., 2019). Furthermore, given the possible addition of eleven new well drilling sites, material emissions were estimated based on (Prusinski, et al., 2004) and (World Steel, 2011). Material emissions from the liquefaction facility were estimated based on the NETL 2019 LNG LCA report (Roman-White, et al., 2019). **Exhibit 3-15** displays the total emissions estimated for each new construction required for the project. These values combine the emissions associated with construction operations and materials. **Exhibit 3-16** displays these parameters on a normalized basis of per kilogram of natural gas produced for sales over the entire 33-year timespan of the project. Please refer to the addendum for more information regarding updates made to construction phase parameters.

Exhibit 3-15. Summary of Parameters Used for Construction Stage of LCA

Parameter	Units	Value	Source
GTP Construction	kg CO_2e*	4.92E6	(Alaska LNG Project, 2017)
Mainline Pipeline and PTTL Construction	kg CO_2e*	1.55E9	
PBTL Construction	kg CO_2e*	1.47E6	
Liquefaction Facility Construction	kg CO_2e*	6.22E8	
Well Sites Construction	kg CO_2e*	4.25E5	(Kuuskraa, et al., 2022a)
PBU Miscible Gas Sales Project	kg CO_2e*	1.86E7	
PTU Expansion Project	kg CO_2e*	5.00E4	

*Reported in AR4 100-year values

Exhibit 3-16. Summary of Normalized Parameters Used for Construction Stage of LCA

Parameter	Units	Value	Source
GTP Construction	kg CO_2e/kg gas*	8.05E-06	(Alaska LNG Project, 2017)
Mainline Pipeline and PTTL Construction	kg CO_2e/kg gas*	2.74E-03	
PBTL Construction	kg CO_2e/kg gas*	2.59E-06	
Liquefaction Facility Construction	kg CO_2e/kg gas*	1.10E-03	
Well Sites Construction	kg CO_2e/kg gas*	7.52E-07	(Bianchini, et al., 2019)
PBU Miscible Gas Sales Project	kg CO_2e/kg gas*	3.28E-05	
PTU Expansion Project	kg CO_2e/kg gas*	8.84E-08	

*Reported in AR4 100-year values

3.13 US Average Crude Oil

In order to keep all three scenarios functionally equivalent for the multiproduct functional unit, US average crude oil data was used from the Crude Oil Baseline Report (Cooney et al., 2016). For all three scenarios, US average data for refinery and end use was added to oil produced in Alaska to cover the entire life cycle of crude oil. The entire life cycle includes production, transportation, refining, and end use. For Scenarios 1 and 2, US average crude oil data for all stages of the life cycle were used to match the production values in Scenario 3. **Exhibit 3-17** shows the key parameters used in this stage.

Exhibit 3-17. Summary of Parameters Used for US Average Stage of LCA

Parameter	Units	Value	Source
US Average Crude Refinery and End Use	kg CO_2e/kg crude*	3.30	(Cooney, et al., 2017)
US Average Crude Entire Life Cycle	kg CO_2e/kg crude*	3.70	

*Reported in AR4 100-year values

3.14 US Lower 48 Average Natural Gas

In order to make Scenario 1 functionally equivalent to Scenarios 2 and 3, US Lower 48 average natural gas supply data was used to model natural gas delivery to the four destination countries. Recall that while we use data from the US Lower 48 states, the goal of these analyses is to create globally representative benchmarks from other gas producing areas. Parameters from the NETL 2020 One Future report (Rai, et al., 2020) were used to model this data. The only processes that changed from this report were the processes related to power generation and ocean transport. The same power generation parameters that are seen in **Exhibit 3-13.** were used to model power generation for the US Lower 48 average natural gas. The ocean transport process was only varied to represent the distances between Corpus Christi, Texas and each of the four destination countries, as shown in **Exhibit 3-18.**

Exhibit 3-19 and **Exhibit 3-20** show the cradle-to-gate and cradle-to-grave emission factors used for the US Lower 48 LNG process of the model.

Exhibit 3-18. Summary of Parameters Used for Ocean Distances in US Lower 48 Average Gas Model

Parameter	Units	Japan (Futtsu)	South Korea (Incheon)	China (Shanghai)	India (Mumbai)	Source
Distance from Corpus Christi, US	miles	10,575	11,625	11,671	11,266	(Cooney, et al., 2017)

Exhibit 3-19. Summary of Parameters Used for US Lower 48 LNG Export and End Use Stage of LCA – Without CCS*

Parameter	Units	Country	Value	Source
Cradle to Liquefaction				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg LNG liquefied	Japan	8.99E-01	(Littlefield, et al., 2019)
		South Korea	8.99E-01	
		China	8.99E-01	
		India	9.00E-01	
Cradle to Delivered				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg NG regasified	Japan	1.28E+00	(Littlefield, et al., 2019)
		South Korea	1.31E+00	
		China	1.31E+00	
		India	1.31E+00	
Cradle to Grave				
US Lower 48 LNG Export and End Use	kg CO_2e/ MWh	Japan	5.07E+02	(Littlefield, et al., 2019)
		South Korea	5.10E+02	
		China	5.10E+02	
		India	5.10E+02	

*Reported in AR4 100-year values

Exhibit 3-20. Summary of Parameters Used for US Lower 48 LNG Export and End Use Stage of LCA – With CCS*

Parameter	Units	Country	Value	Source
Cradle to Liquefaction				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg LNG liquefied	Japan	5.10E-01	(Littlefield, et al., 2019)
		South Korea	5.35E-01	
		China	5.36E-01	
		India	5.26E-01	
Cradle to Delivered				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg NG regasified	Japan	8.27E-01	(Littlefield, et al., 2019)
		South Korea	8.55E-01	
		China	8.56E-01	
		India	8.45E-01	
Cradle to Grave				
US Lower 48 LNG Export and End Use	kg CO_2e/ MWh	Japan	2.23E+02	(Littlefield, et al., 2019)
		South Korea	2.27E+02	
		China	2.28E+02	
		India	2.26E+02	

*Reported in AR4 100-year values

3.15 Reporting Units

Consistent with the original FERC EIS study, the main report of this LCA presents the GWP results using the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC 2013a) 100-yr impact factors for CO_2, CH_4, N_2O, and SF_6. The appendix of this report also presents the results using the Fifth and Sixth Assessment Report (AR5) (IPCC 2013b) and AR6 (IPCC 2021)) 100-yr impact factors. **Exhibit 3-21** shows the GWP factors for the GHGs based on the three IPCC reports.

Exhibit 3-21. GWP Factors from AR4, AR5, and AR6 (kg CO_2-equivalent per kg of GHG emitted)

GHG	AR4 (20-yr)	AR4 (100-yr)	AR5 (20-yr)	AR5 (100-yr)	AR6 (20-yr)	AR6 (100 yr)
CO_2	1	1	1	1	1	1
CH_4	72	25	86	36	82.5	30
N_2O	289	298	268	298	273	273
SF_6	16,300	22,800	17,783	26,087	18,300	25,200

4 RESULTS

When comparing the GHG emissions results of Alaskan LNG production across the three scenarios, it is important to recognize that extracting the natural gas for export instead of using it for reservoir pressure management to produce oil (BAU, Scenario 1) has a direct effect on the quantity of oil produced in the North Slope. Therefore, to assess and compare how GHG emissions may change if natural gas is diverted to LNG exports, the change in the GHG emissions from oil production must also be considered. The multiproduct functional unit results provide the total GHG emissions per unit of service provided to society. As noted in **Section 2.5** above, the multiproduct functional unit is 1 MWh of electricity production from natural gas and 53 kg of crude oil-derived products consumed. Multiproduct functional results are provided in **Section 4.1** below.

Alternatively, results are presented in this study on a single product functional unit basis in **Section 4.2** to achieve comparability on a per unit of electricity production from use of imported natural gas in each receiving country. These results are comparatively the same as the multiproduct functional unit results, but only show the GHG contributions related to the natural gas product.

LCA results for all scenarios modeled from Alaska to the four destination countries (Japan, India, Korea, and China) are shown in this section. The main report shows results using the AR4 GWP values. Multiproduct and single-product functional unit results are shown over 20 and 100-year time horizons for each of the three scenarios with and without CCS for power generation at a NGCC power plant. Sensitivity analysis results are also shown over 20 and 100-year time horizons for Scenario 3 without CCS for power generation at a NGCC power plant. Speciated emissions results, as well as annual and lifetime profile results, are shown over 100-year time horizons. Additional results using AR5 and AR6 GWP values are located within the Appendix.

4.1 MULTIPRODUCT FUNCTIONAL UNIT RESULTS

The following section discusses multiproduct functional unit results. The results are available on a per 1 MWh of electricity generated and consumed in the destination country, and production and consumption of 53 kg of crude oil-derived products consumed, basis across all three scenarios. Transmission of electricity was not considered due to the highly variable and unknown transmission and distribution losses that occur within each destination country.

Scenario 3 serves as the foundation for generating multiproduct system boundary results. The other two scenarios are made functionally equivalent to Scenario 3 by compensating for the difference in oil and gas production through the addition of US average crude and natural gas. In addition, US average emissions from crude refining and end use have been added to all three scenarios to ensure both the natural gas and oil supply chain life cycle GHG emissions from extraction to end use are accounted for in the study.

While the LCA results generated presume combustion of the natural gas in an NGCC plant in the destination country, combustion of the natural gas in other ways would have GWP profiles similar to that of NGCC without CCS. Non-power use would generally result in higher methane emissions due to use of destination country natural gas distribution system to deliver to non-power and non-industrial customers. While there could be slight variations in end use efficiency and thus the quantitative results, we would expect directionally comparable differences between the three Scenarios.

4.1.1 Multiproduct Functional Unit Results (AR4 – 100-year)

Results in this section are shown using AR4 GWP values on a 100-year time scale. **Exhibit 4-1** shows Scenarios 1, 2, and 3 with delivery to Japan. An NGCC power plant both with and without CCS is considered. **Exhibit 4-2**, **Exhibit 4-3,** and **Exhibit 4-4** display the same results, but with LNG delivery to South Korea, China, and India, respectively.

Exhibit 4-1. Multiproduct Functional Unit – Japan (AR4 – 100-yr)

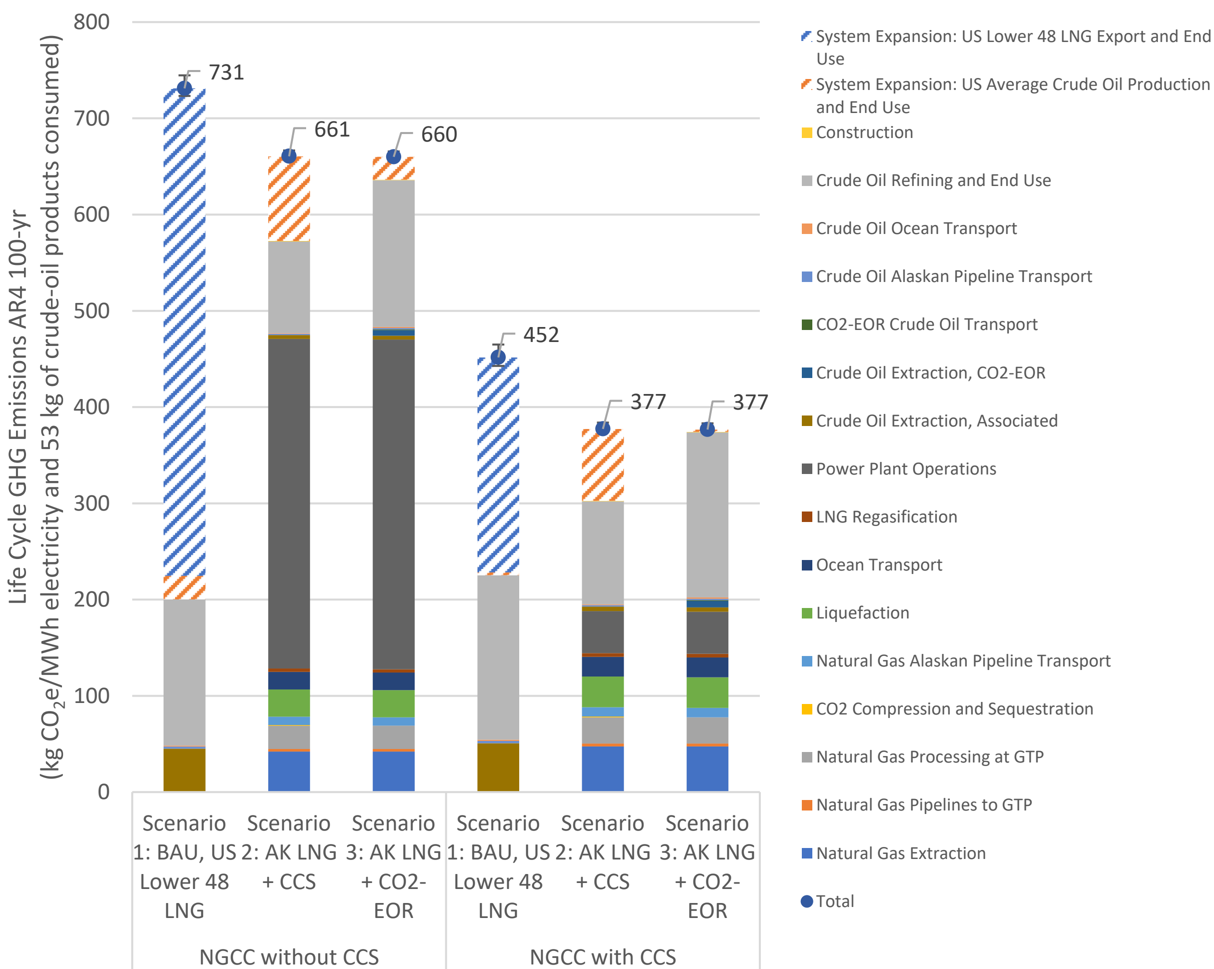


Exhibit 4-2. Multiproduct Functional Unit – South Korea (AR4 – 100-yr)

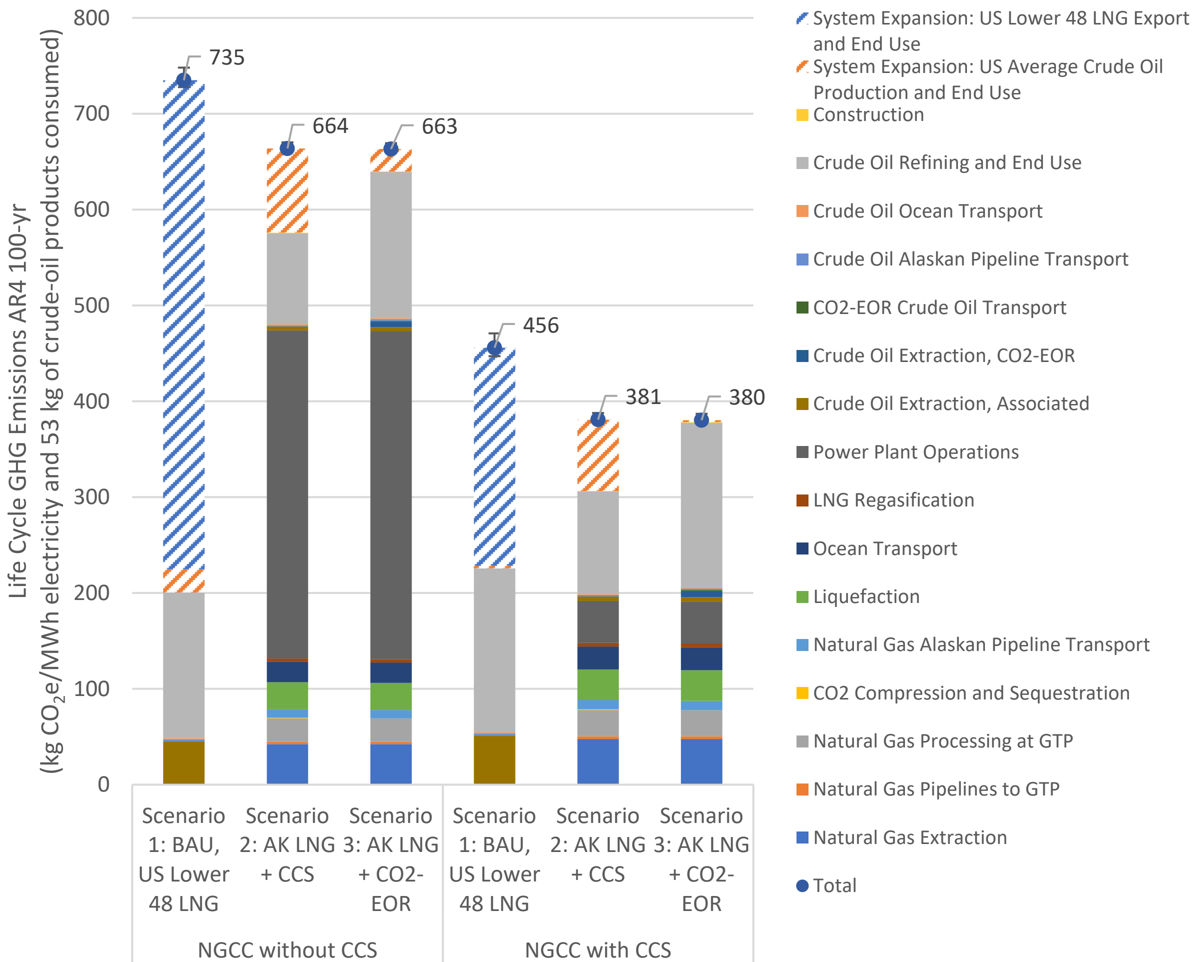


Exhibit 4-3. Multiproduct Functional Unit – China (AR4 – 100-yr)

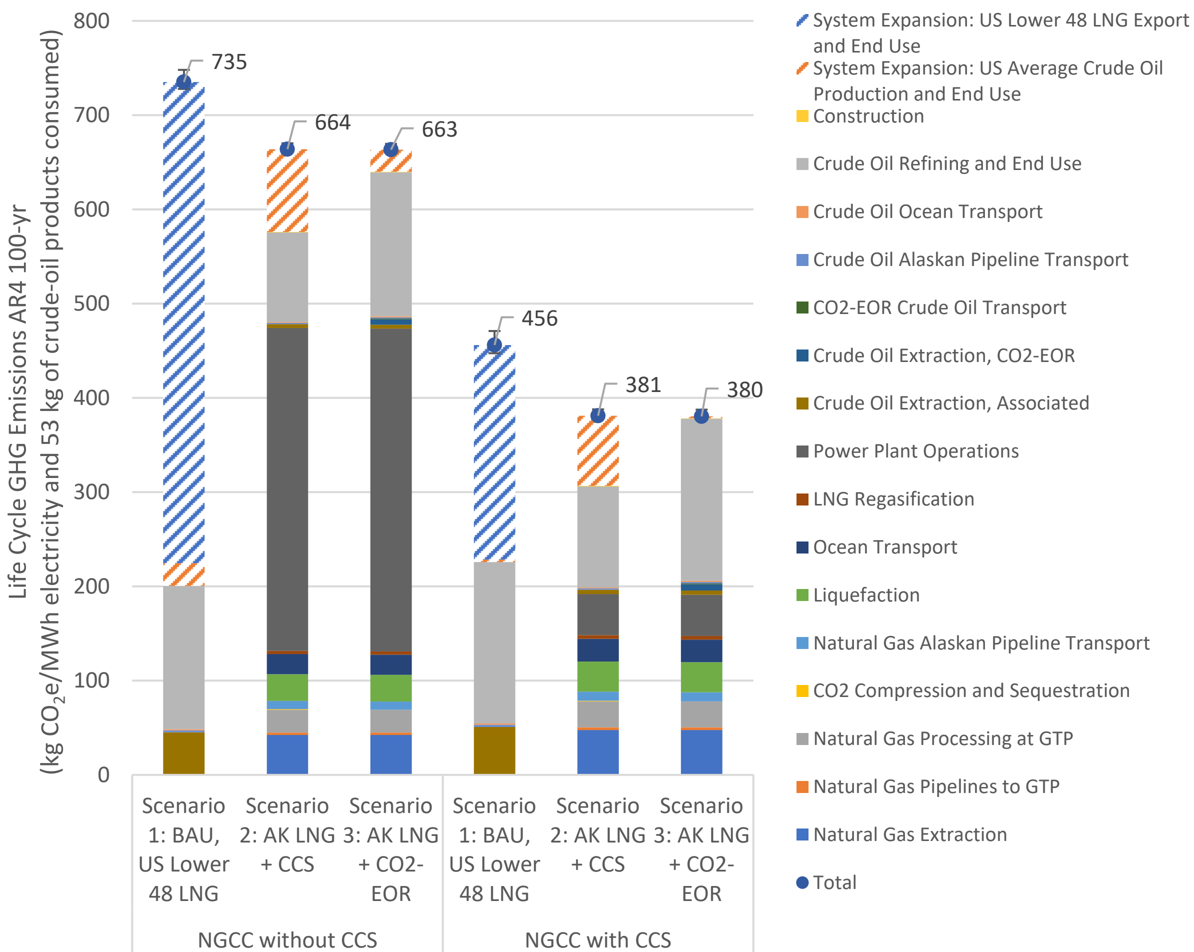
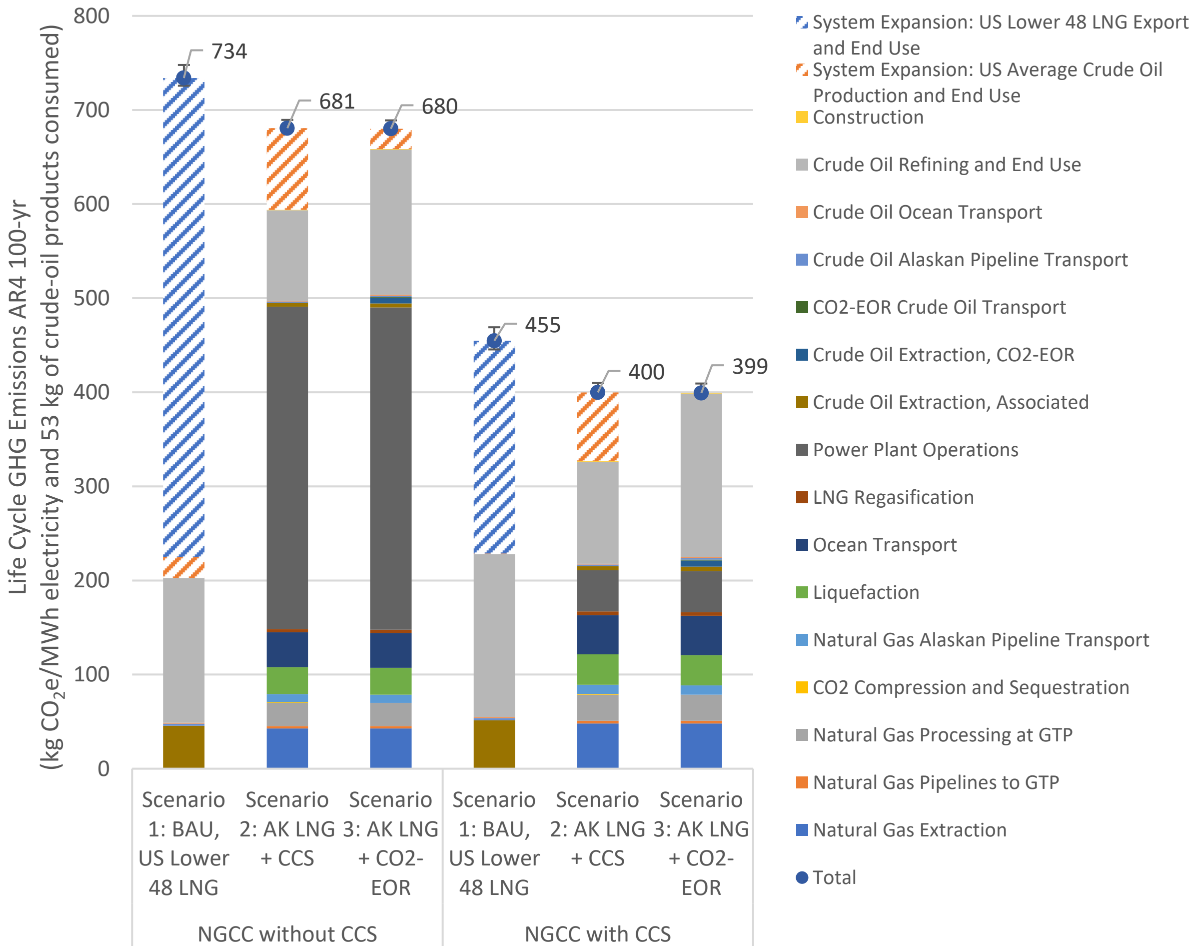


Exhibit 4-4. Multiproduct Functional Unit – India (AR4 – 100-yr)



The results show that for each of the four destination countries, expected life cycle emissions from Scenarios 2 and 3 are not higher than those from Scenario 1 when considering an NGCC power plant both with and without CCS and commensurate crude oil derived products consumption. The mean expected emissions from Scenarios 2 and 3 are lower than the mean expected emissions from Scenario 1. Please refer to the addendum for more information regarding updates made to modeling uncertainty.

The mean expected Scenario 1 BAU results are higher on a per unit of service provided basis over the life cycle because oil production in the PBU currently produces, separates, and compresses the associated gas produced and then reinjects it into the oil reservoir to assist in oil production. All GHG burdens are assigned to the only current product – crude oil. In Scenarios 2 and 3, where the gas is now a product, the GHG burdens associated with oil extraction and initial separation of liquid and gaseous products output from the production wells are allocated on an energy basis to both products – crude oil and exported natural gas. Natural gas liquids are separated at the GTP and then combined with the oil product for export. A small portion is used to support local operations, although no adjustment has been made in this study for local natural gas liquids use; the consumption is minor compared to total energy export volumes and do not impact the results interpretation. Natural gas liquids production is assigned to the oil product consistent with current operations.

In Scenario 2, the carbon dioxide separation, compression, and sequestration are shared by the oil and natural gas products on a product energy ratio. CO_2 under Scenario 3 used for CO_2-EOR production is assigned only to the oil product. In both Scenarios 2 and 3, a portion of the natural gas produced is still used to support oil production across the study period. The proportion varies across the 33-year study period, with nearly 90% in the initial years and then a steady decline to 0% by year 22 of the project. GHG emissions associated with the natural gas that is separated and compressed to a high pressure for reinjection into the oil field is assigned to the oil product. Oil production declines because of the reduction in natural gas availability for reservoir pressure management, in comparison to Scenario 1 BAU. The natural gas supply portion of the Upstream Study (Kuuskraa, Wallace, & Remson, 2022a) finds that for optimum long-term production of the natural gas reserves of the Prudhoe Bay Unit (PBU), the CO_2 from the Gas Treatment Plant needs to be reinjected into a geologic setting other than the oil and natural gas reservoir at the PBU. Avoiding reinjection of CO_2 into the PBU will enable the reservoir pressure in the PBU to be reduced, helping increase the ultimate recovery of natural gas reserves from the PBU. Similarly, this will preclude increasing the CO_2 concentration of the natural gas produced from the PBU, thus avoiding the steadily higher energy requirements for gas treatment and compression at the Gas Treatment Plant.

These are the primary reasons why CO_2 produced with the crude oil and associated natural gas must be managed through geologic sequestration (Scenario 2) or used for CO_2-EOR in the Kuparuk Oil Field (Scenario 3).

The power plant operation and system expansion addition of US average crude refining and end use dominate the life cycle results for Scenarios 2 and 3. Scenario 1 emissions are largely from the system expansion addition of US Lower 48 natural gas. Other notable sources of emissions for all scenarios are natural gas extraction, liquefaction, and ocean transport.

On comparing results for Scenarios 2 and 3, we estimate slightly lower mean GWP values for Scenario 3 on account of the higher emissions intensity of US average crude used for system expansion of Scenario 2, to ensure its functional equivalence to Scenario 3. However, the significant overlap between uncertainty ranges for the two scenarios makes it difficult to suggest one option over the other from a life cycle GHG emissions perspective. Over the four destination countries, the relative differences among the scenarios are small. This is because most of the stagewise emissions throughout the life cycle are similar for the four countries, except for ocean transport distances. The ocean distances for Japan, Korea, and China are very similar, but India is much further away, leading to distinctly larger GWP effects.

4.1.2 Multiproduct Functional Unit Results (AR4 – 20-year)

Results in this section are shown using AR4 20-year GWP factors. These results follow the same format as those in Section 4.1.1, using a multiproduct functional unit for each of the three scenarios to the four destination countries. Again, an NGCC power plant in the receiving country both with and without CCS is considered.

Similar to the AR4 100-year results, Scenarios 2 and 3 do not show an increase in expected emissions over Scenario 1. Again, the mean expected emissions for Scenario 1 is higher than those of Scenarios 2 and 3. These results also display the same dominating life cycle stages, with the system expansion of US Lower 48 natural gas being the largest emitter in Scenario 1, and power plant operations being the largest emitter in Scenarios 2 and 3. The results for the AR4 20-year scenarios (shown in **Exhibit 4-5**, **Exhibit 4-6**, **Exhibit 4-7**, and **Exhibit 4-8**) are consistently higher due to the higher GWP values used in the shorter time horizon, most notably for methane which has a GWP roughly three times higher than in the AR4 100-year method.

Exhibit 4-5. Multiproduct Functional Unit – Japan (AR4 – 20-yr)

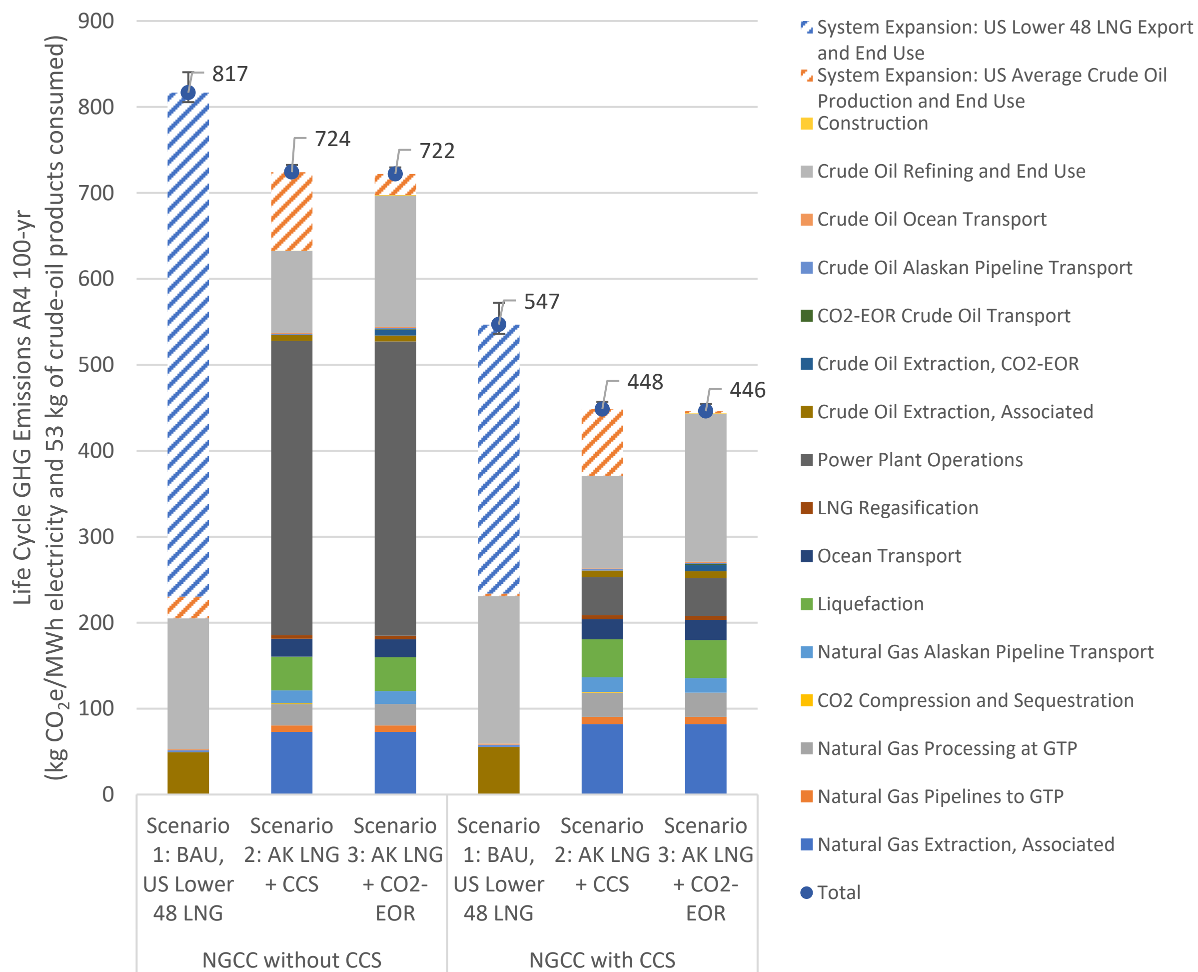


Exhibit 4-6. Multiproduct Functional Unit – South Korea (AR4 – 20-yr)

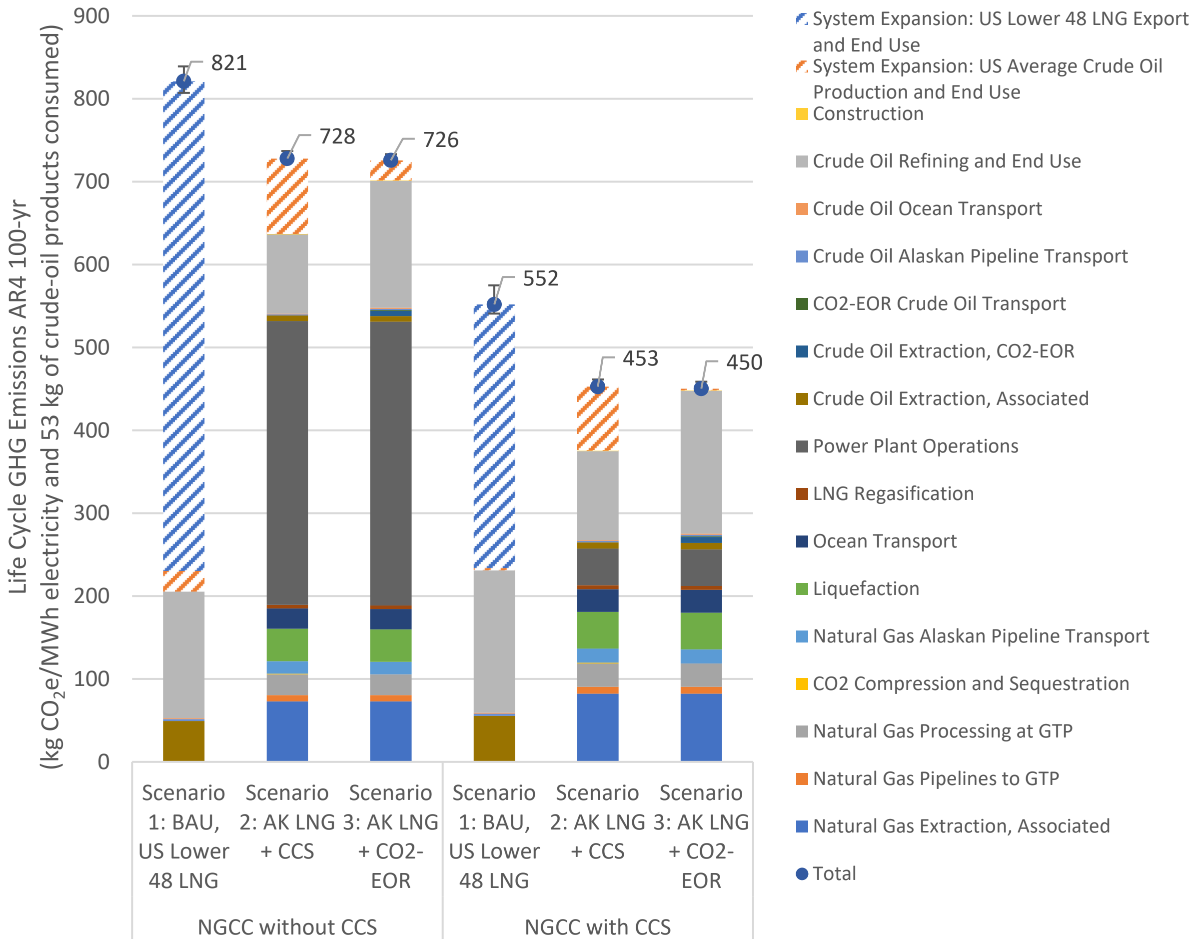


Exhibit 4-7. Multiproduct Functional Unit – China (AR4 – 20-yr)

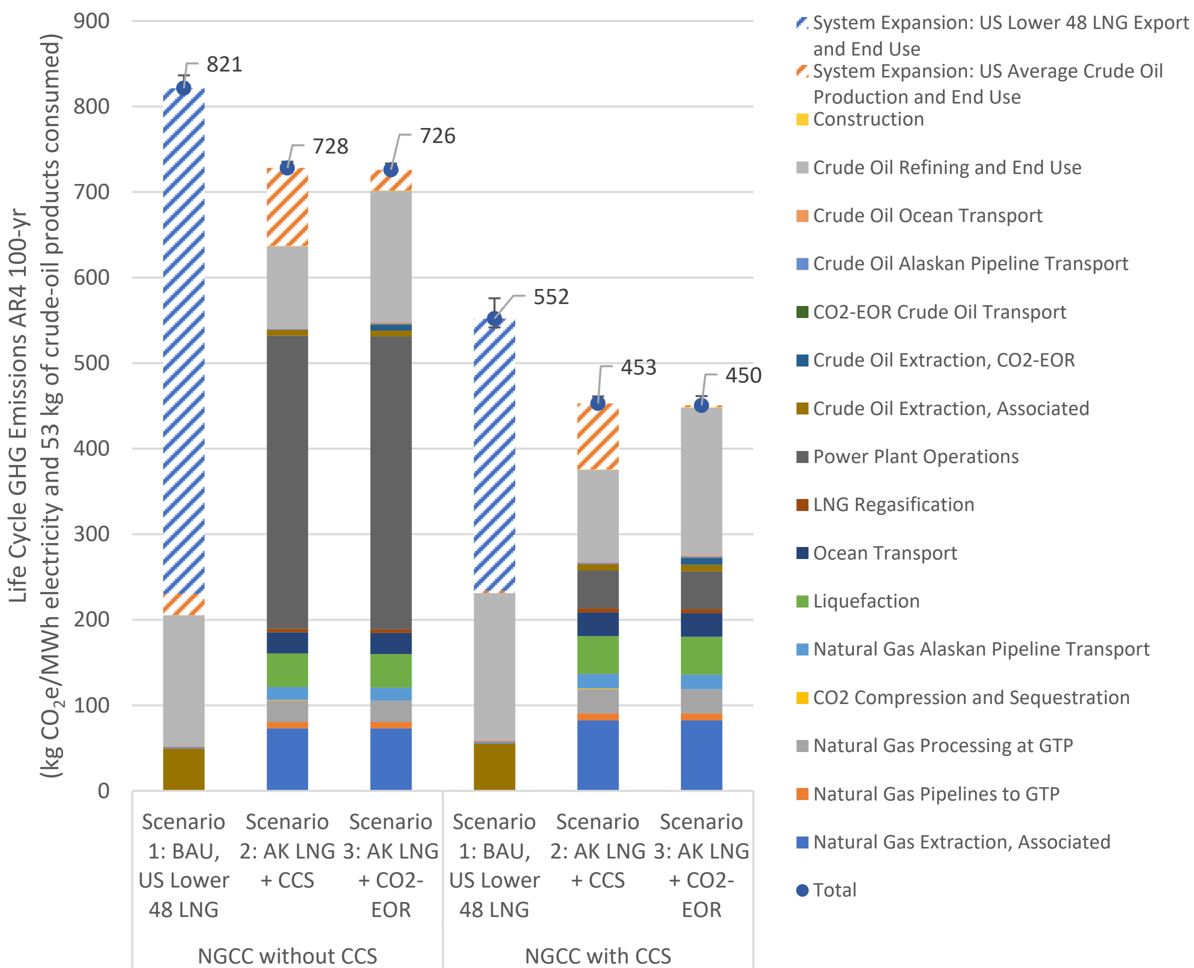
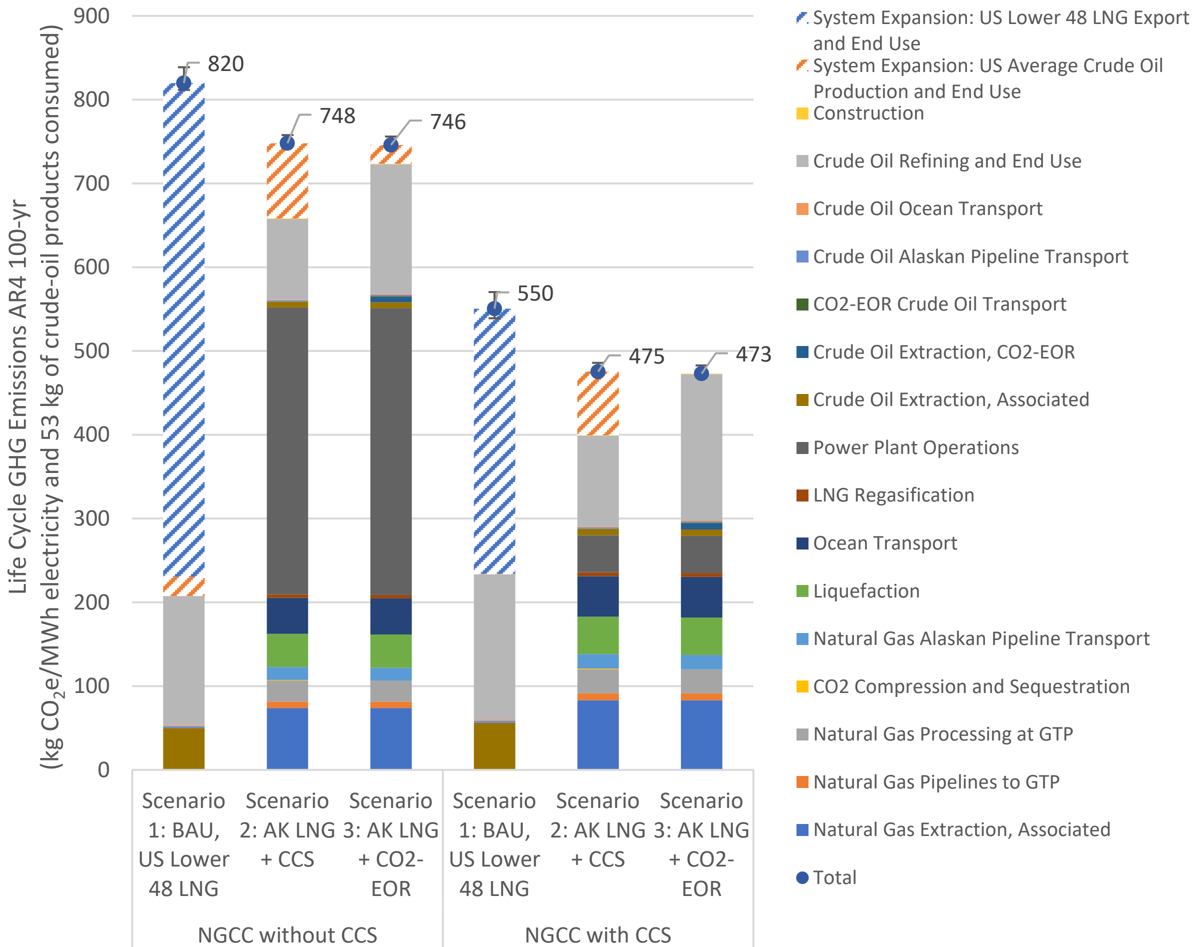


Exhibit 4-8. Multiproduct Functional Unit – India (AR4 – 20-yr)



4.2 Single Product Functional Unit Results

This section shows results using a single functional unit of 1 MWh of electricity generated in the destination countries (by combusting natural gas sourced from Alaska). These results differ from the multiproduct functional unit results as they do not include crude oil produced on the Alaskan North Slope, refining and end use of the crude oil over its life cycle, or the expanded system boundary contributions for US average crude oil production and end use. In short, these results are the same as the multiproduct functional unit results with the oil related product systems removed. These results are useful when comparing results on a natural gas power generation basis only but *should not be used to assess the comparative GHG difference between the three Scenarios as they do not represent an equivalent service to society*. These results are shown using 20 and 100-year time horizons and the IPCC AR4 GWP values, with and without CCS.

4.2.1 Single Product Functional Unit Results (AR4 – 100-yr)

These results are shown using AR4 100-year GWP factors. **Exhibit 4-9** displays results for Scenarios 1, 2, and 3 delivering to Japan, using an NGCC power plant both with and without CCS. **Exhibit 4-10**, **Exhibit 4-11**, and **Exhibit 4-12** show the same results, except for delivery to South Korea, China, and India, respectively.

Exhibit 4-9. Single Product Functional Unit – Japan (AR4 – 100-yr)

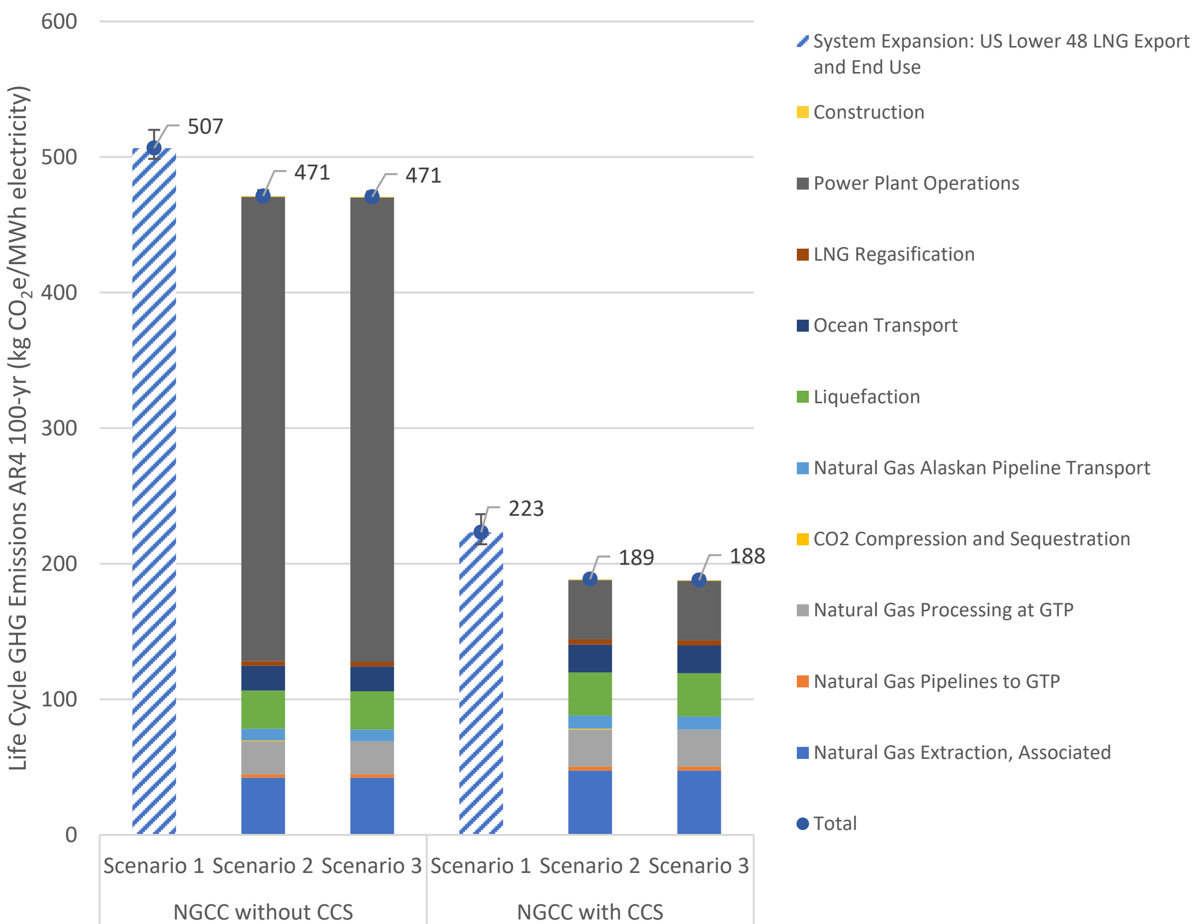


Exhibit 4-10. Single Product Functional Unit – South Korea (AR4 – 100-yr)

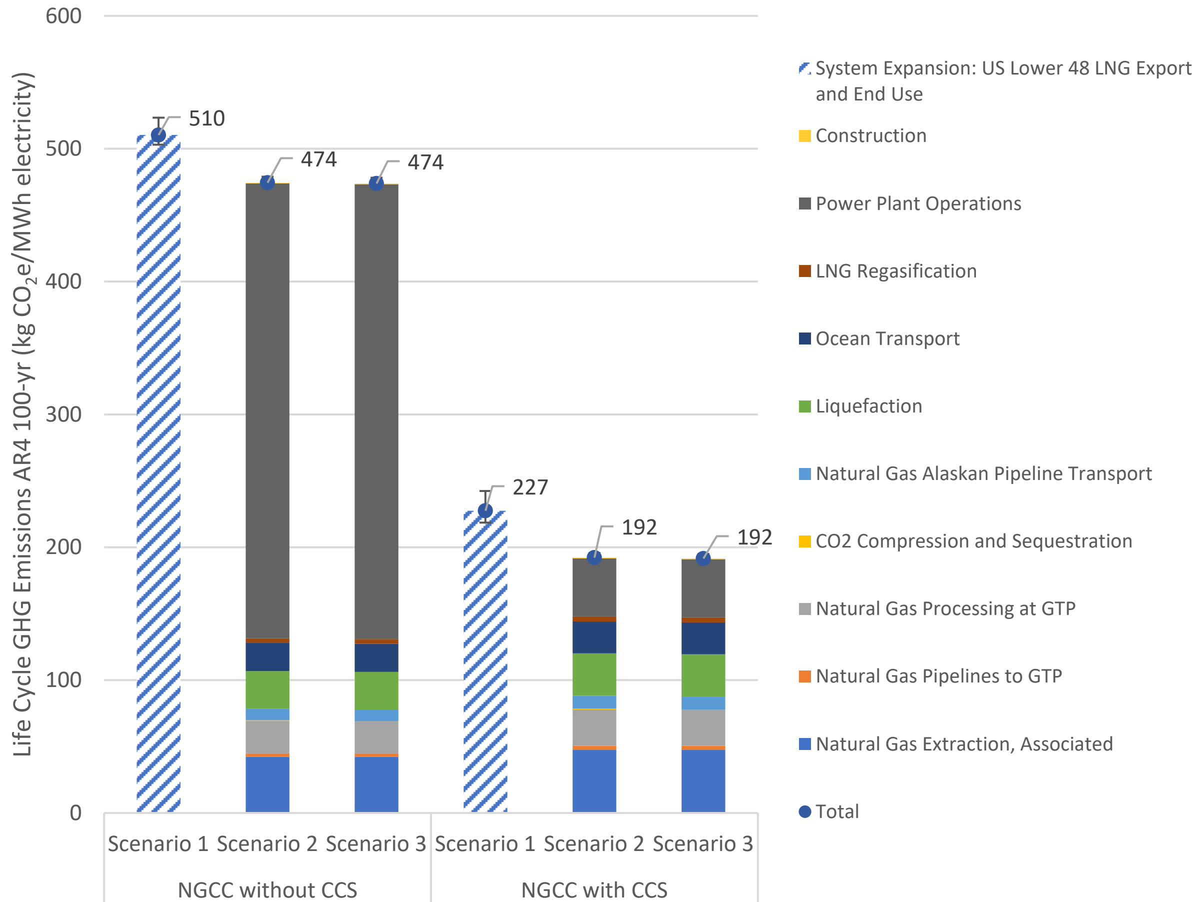


Exhibit 4-11. Single Product Functional Unit – China (AR4 – 100-yr)

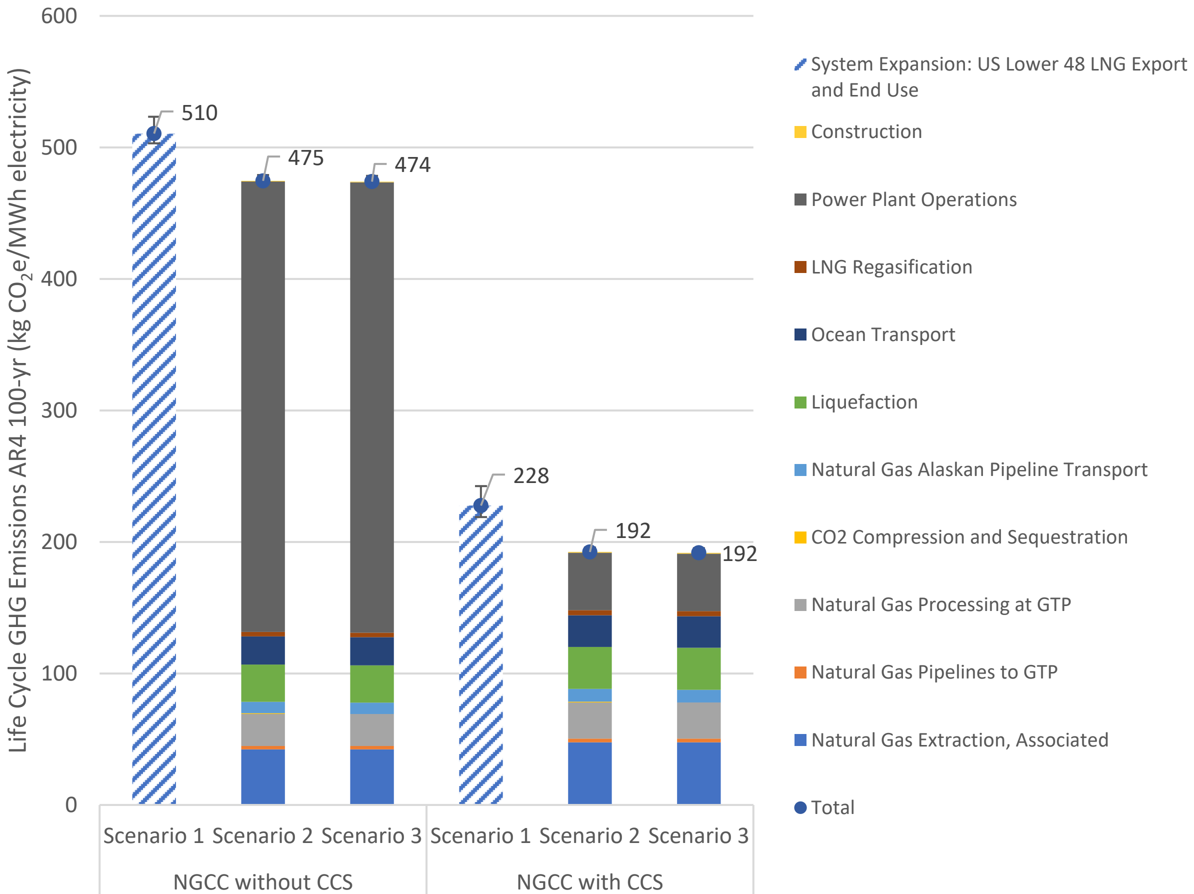
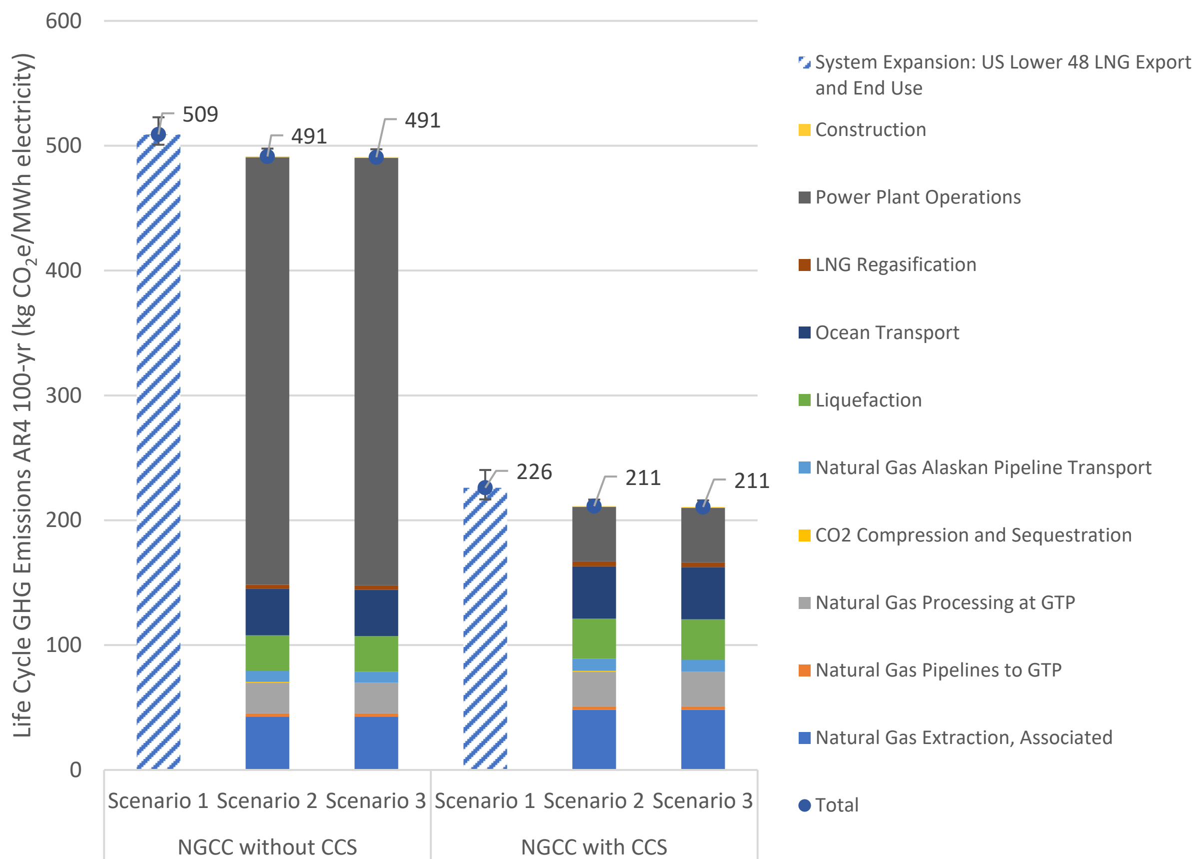


Exhibit 4-12. Single Product Functional Unit – India (AR4 – 100-yr)



These results show that both Scenarios 2 and 3 are not expected to produce an increase in emissions over Scenario 1. Like the multiproduct functional unit results, the mean expected emissions for Scenario 1 is higher than the other two scenarios. It is important to note that, for both multiproduct and single product results, the difference in mean expected emissions between scenarios shrinks as the ocean transport distance between Alaska and the destination country grows due to an increase in emissions in the ocean transport stage in Scenarios 2 and 3. Therefore, the difference in expected emissions between Scenarios 2 and 3 and Scenario 1 for India is less than that for Japan.

Scenario 2 and Scenario 3 have very similar results because while sequestration offers some emission savings, it does not make a notable difference when compared to Scenario 3. Furthermore, because the system expansion of crude oil has been taken out of the single functional unit results, there is less variability in the sources of emissions between Scenario 2 and Scenario 3, leading to more similar total emissions between them. In addition, the most variable component across countries is the ocean transport distance.

System expansion of US Lower 48 LNG Export and End Use is the only stage in Scenario 1 across each of the four destination countries. Power plant operations is by far the largest contributor to emissions in Scenarios 2 and 3. Other significant contributions come from ocean transport, natural gas extraction, and liquefaction.

4.2.2 Single Product Functional Unit Results (AR4 – 20-year)

Results were generated using AR4 20-year GWP factors (shown in **Exhibit 4-13**, **Exhibit 4-14**, **Exhibit 4-15**, and **Exhibit 4-16**). Similar to the results shown in Section 4.2.1, results are based on a single product functional unit for each of the three scenarios to each of the four destination countries. An NGCC power plant, both with and without CCS, is considered.

This section produces very similar results to those of the previous section. Once again, Scenario 1 is observed to generate higher mean emissions than both Scenarios 2 and 3 for all destination countries. The dominant life cycle stages also remain the same from the previous section, with system expansion of US Lower 48 LNG Export and End Use contributing the most to Scenario 1, and power plant operations contributing the most to Scenarios 2 and 3.

The main reason for the difference in results for this section are again the significantly higher GWP values for methane in the shorter 20-year time horizon.

Exhibit 4-13. Single Product Functional Unit – Japan (AR4 – 20-yr)

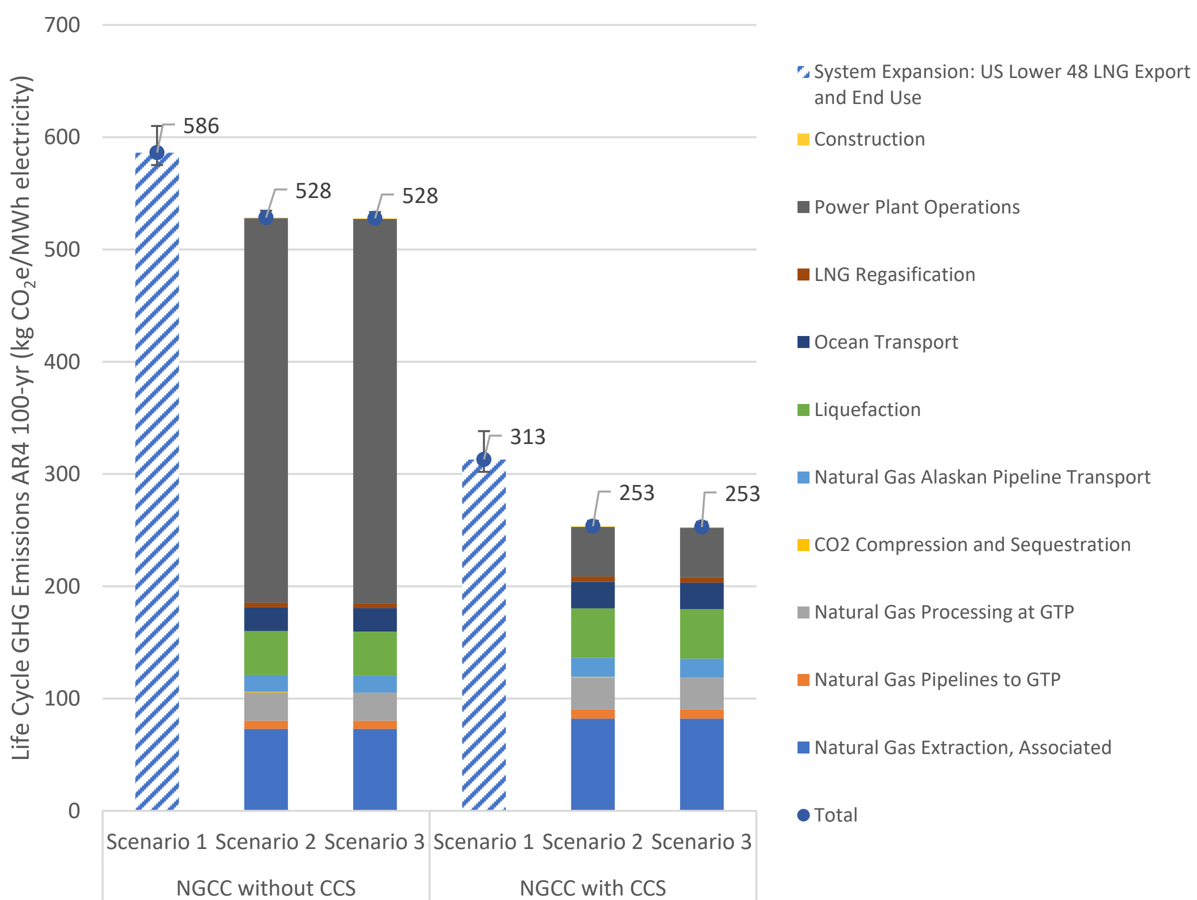


Exhibit 4-14. Single Product Functional Unit – South Korea (AR4 – 20-yr)

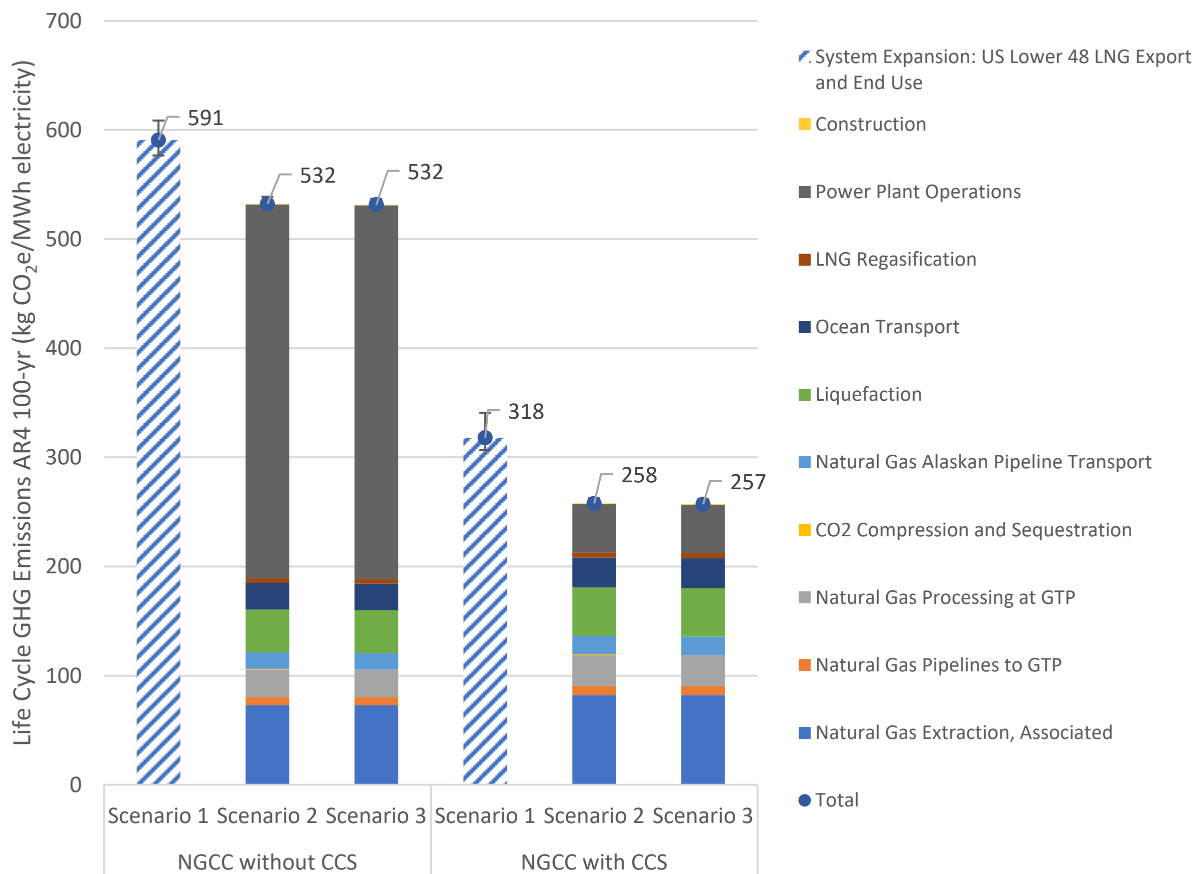


Exhibit 4-15. Single Product Functional Unit – China (AR4 – 20-yr)

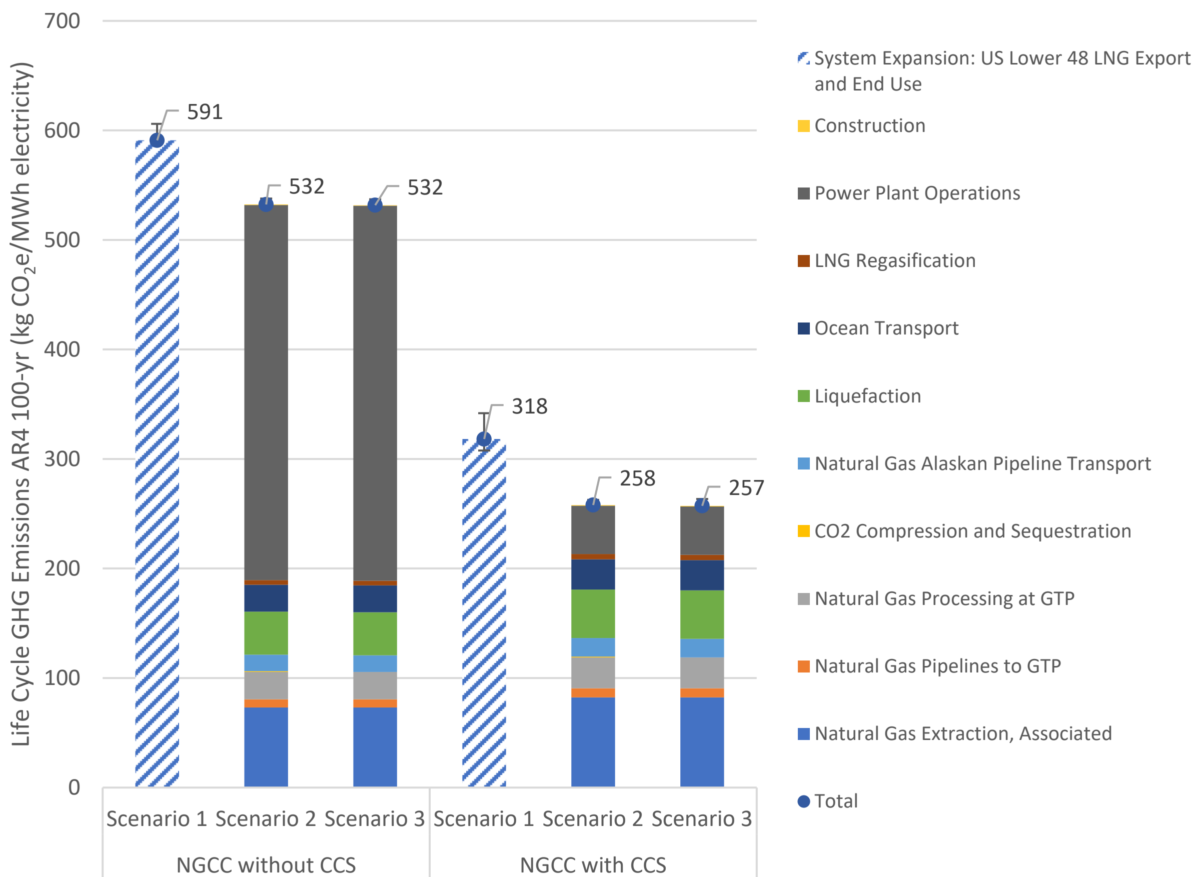
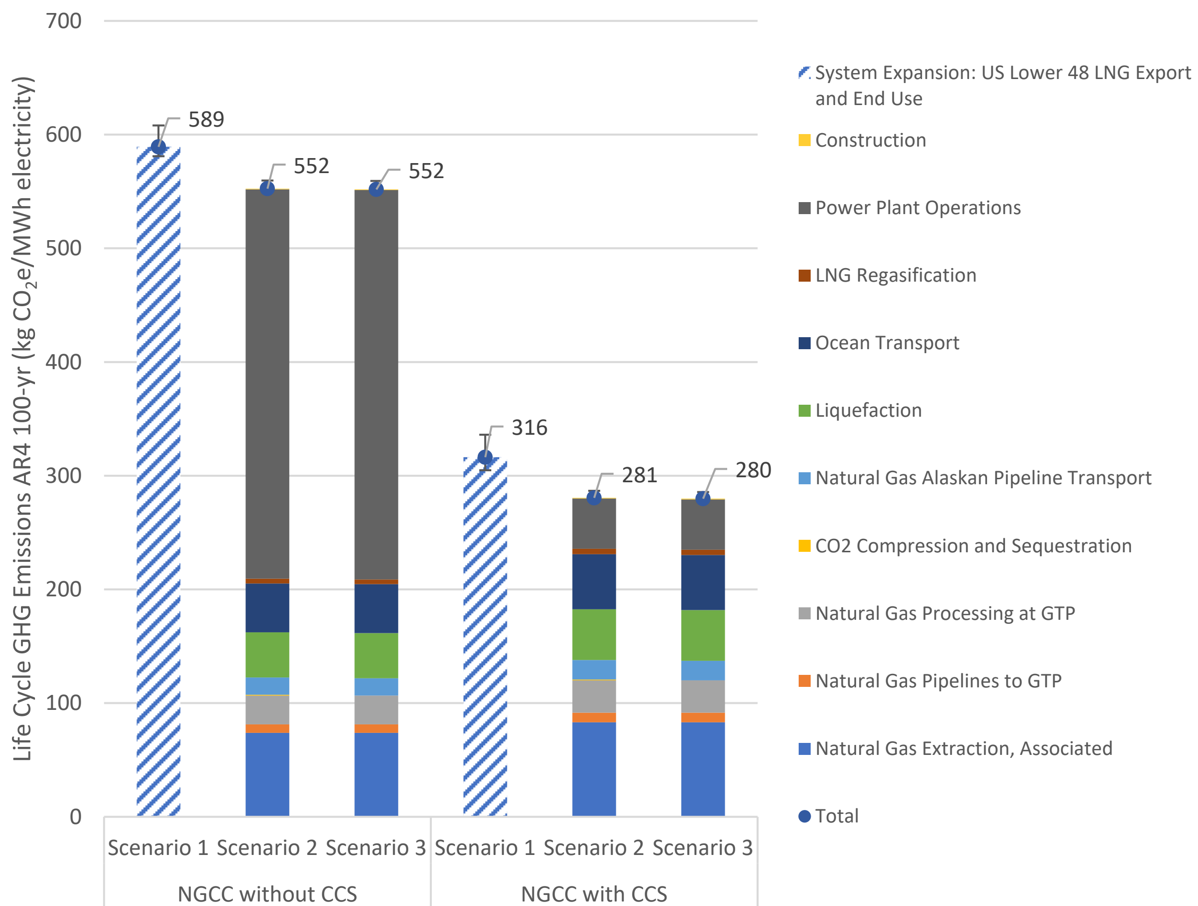


Exhibit 4-16. Single Product Functional Unit – India (AR4 – 20-yr)

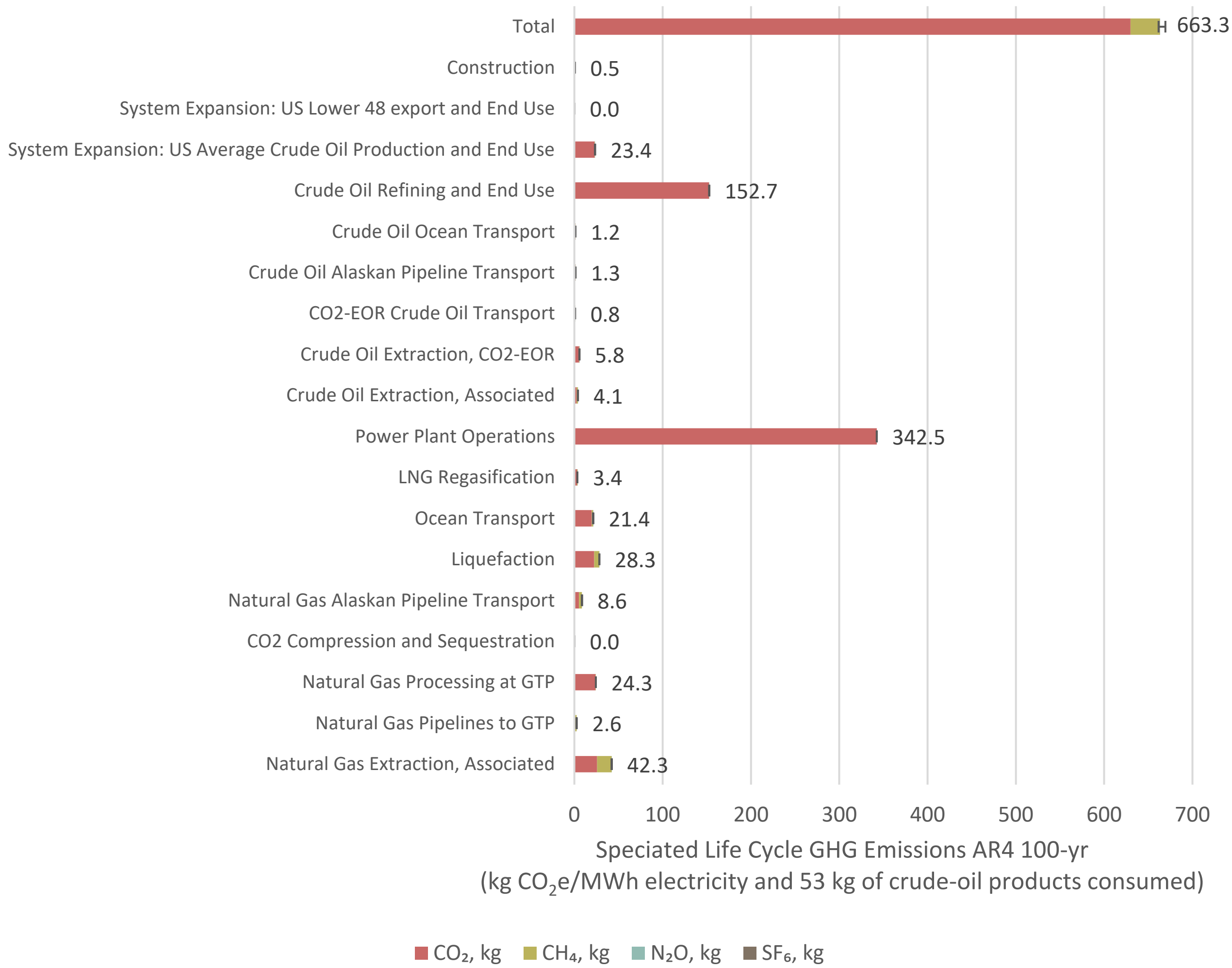


4.3 Speciated GHG Emissions (AR4 100-yr)

The following section shows speciated results (i.e., broken out by greenhouse gas) of Scenario 3 to China, on a AR4 100-year GWP basis. The results are shown on the same multiproduct functional unit basis used in **Section 4.1**. These results assume that natural gas is delivered to an NGCC power plant without CCS in China. The speciated results data tables for all destination countries are provided in the Appendix.

The resulting emissions are grouped into categories similar to those presented on the multiproduct functional unit basis above. **Exhibit 4-17** displays speciated results for LNG delivery to China, using NGCC plant without CCS.

Exhibit 4-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)



The results above show that similar to the single product and multiproduct functional unit results shown in prior sections, the Power Plant stage contributes most to overall emissions. The next largest stage contributor is crude oil refining and end use. These results also show that CO_2 emissions contribute the most to the GHG emissions in each category. Some of the stages, such as "Natural Gas Pipelines to GTP", "Natural Gas Alaskan Pipeline Transport", "Natural Gas Extraction, Associated", "Crude Oil Extraction, Associated", and "Natural Gas Processing at GTP", have high shares of CH_4 emissions for each of the four destination countries. Emissions of N_2O and SF_6 can be considered negligible in this study.

In addition, **Exhibit 4-18** compares the methane emission rates between Alaskan natural gas production (Scenarios 2 and 3) and US Lower 48 average natural gas production (used to represent global natural gas export production for Scenario 1) across the various life cycle stages for LNG delivery to China, using NGCC plant without CCS. The provided methane emission rates stay consistent across destination countries, except for slight variations observed in the ocean transport stage.

Exhibit 4-18. Comparison of CH_4 Emission Rates across Scenarios - NGCC without CCS to China

Stage	CH_4 emission rate (kg/kg NG delivered)	
	Scenario 1	Scenarios 2 and 3
Production and Gathering	0.71%	0.64%
Processing	0.10%	0.01%
Transmission Network	0.22%	0.11%
Liquefaction	0.18%	0.18%
Ocean Transport	0.11%	0.05%
Regasification	0.01%	0.01%
Power Plant	0.00%	0.00%
Total	**1.34%**	**1.00%**

4.4 Cumulative Emissions Profiles

The following section provides the cumulative emissions totals for the three scenarios over the 33-year lifetime of the project. **Exhibit 4-19** reports ARI provided data on annual quantities of crude and gas production for the three scenarios from the Alaskan North Slope. The exhibit also reports the quantities of makeup crude oil required to ensure that an equal amount of crude oil is delivered to consumers under each scenario for each year. In addition, the exhibit reports the quantity of makeup natural gas required by Scenario 1 in order to be functionally equivalent to Scenarios 2 and 3. These data are represented in the exhibit as system expansion values. The yearly data are provided on both a primary and alternative unit basis (kg and Tcf for natural gas; kg and MMbbl for oil).

The fuel quantities provided in **Exhibit 4-19** are multiplied with the corresponding emission factors estimated by this analysis to obtain the annual GHG emission totals over the project lifetime, as reported in **Exhibit 4-21.** As an example, the estimated emission factors and emissions totals for the case of China without CCS are depicted in this section. **Exhibit 4-20** displays the emission factors used to calculate cumulative emissions for each country, both without and with CCS.

Exhibit 4-19. Annual Quantities of Oil and Gas Produced in Each Scenario (Wallace, Kuuskraa, & Remson, 2022)*

Year	Scenario 1			Scenario 2			Scenario 3		
	Oil Production, kg (MMbbl)	System Expansion: Gas Production, kg (Tcf)	System Expansion: Oil Production, kg (MMbbl)	Gas Production, kg (Tcf)	Oil Production, kg (MMbbl)	System Expansion: Oil Production, kg (MMbbl)	Gas Production, kg (Tcf)	Oil Production, kg (MMbbl)	System Expansion: Oil Production, kg (MMbbl)
2029	8.96E+09 (6.20E+01)	3.15E+09 (1.55E-01)	0.00E+00 (0.00E+00)	3.15E+09 (1.55E-01)	8.76E+09 (6.06E+01)	2.00E+08 (1.38E+00)	3.15E+09 (1.55E-01)	8.84E+09 (6.11E+01)	1.23E+08 (8.48E-01)
2030	8.71E+09 (6.02E+01)	7.88E+09 (3.88E-01)	0.00E+00 (0.00E+00)	7.88E+09 (3.88E-01)	8.24E+09 (5.69E+01)	4.73E+08 (3.27E+00)	7.88E+09 (3.88E-01)	8.68E+09 (6.00E+01)	2.69E+07 (1.86E-01)
2031	8.46E+09 (5.85E+01)	1.42E+10 (6.98E-01)	3.12E+08 (2.16E+00)	1.42E+10 (6.98E-01)	7.70E+09 (5.33E+01)	1.07E+09 (7.42E+00)	1.42E+10 (6.98E-01)	8.78E+09 (6.07E+01)	0.00E+00 (0.00E+00)
2032	8.23E+09 (5.69E+01)	1.73E+10 (8.53E-01)	7.19E+08 (4.97E+00)	1.73E+10 (8.53E-01)	7.23E+09 (5.00E+01)	1.72E+09 (1.19E+01)	1.73E+10 (8.53E-01)	8.95E+09 (6.18E+01)	0.00E+00 (0.00E+00)
2033	8.00E+09 (5.53E+01)	1.89E+10 (9.31E-01)	9.63E+08 (6.66E+00)	1.89E+10 (9.31E-01)	6.79E+09 (4.69E+01)	2.17E+09 (1.50E+01)	1.89E+10 (9.31E-01)	8.96E+09 (6.19E+01)	0.00E+00 (0.00E+00)
2034	7.77E+09 (5.37E+01)	1.89E+10 (9.31E-01)	9.63E+08 (6.65E+00)	1.89E+10 (9.31E-01)	6.37E+09 (4.41E+01)	2.36E+09 (1.63E+01)	1.89E+10 (9.31E-01)	8.74E+09 (6.04E+01)	0.00E+00 (0.00E+00)
2035	7.56E+09 (5.22E+01)	1.89E+10 (9.31E-01)	8.56E+08 (5.91E+00)	1.89E+10 (9.31E-01)	5.96E+09 (4.12E+01)	2.45E+09 (1.69E+01)	1.89E+10 (9.31E-01)	8.41E+09 (5.82E+01)	0.00E+00 (0.00E+00)
2036	7.35E+09 (5.08E+01)	1.89E+10 (9.31E-01)	7.19E+08 (4.97E+00)	1.89E+10 (9.31E-01)	5.58E+09 (3.86E+01)	2.49E+09 (1.72E+01)	1.89E+10 (9.31E-01)	8.07E+09 (5.58E+01)	0.00E+00 (0.00E+00)
2037	7.15E+09 (4.94E+01)	1.89E+10 (9.31E-01)	6.07E+08 (4.20E+00)	1.89E+10 (9.31E-01)	5.22E+09 (3.61E+01)	2.53E+09 (1.75E+01)	1.89E+10 (9.31E-01)	7.75E+09 (5.36E+01)	0.00E+00 (0.00E+00)
2038	6.95E+09 (4.80E+01)	1.89E+10 (9.31E-01)	5.20E+08 (3.60E+00)	1.89E+10 (9.31E-01)	4.88E+09 (3.38E+01)	2.58E+09 (1.79E+01)	1.89E+10 (9.31E-01)	7.47E+09 (5.16E+01)	0.00E+00 (0.00E+00)
2039	6.75E+09 (4.67E+01)	1.89E+10 (9.31E-01)	4.21E+08 (2.91E+00)	1.89E+10 (9.31E-01)	4.57E+09 (3.16E+01)	2.61E+09 (1.80E+01)	1.89E+10 (9.31E-01)	7.17E+09 (4.96E+01)	0.00E+00 (0.00E+00)
2040	6.57E+09 (4.54E+01)	1.89E+10 (9.31E-01)	3.21E+08 (2.22E+00)	1.89E+10 (9.31E-01)	4.28E+09 (2.96E+01)	2.61E+09 (1.81E+01)	1.89E+10 (9.31E-01)	6.89E+09 (4.76E+01)	0.00E+00 (0.00E+00)
2041	6.39E+09 (4.42E+01)	1.89E+10 (9.31E-01)	2.14E+08 (1.48E+00)	1.89E+10 (9.31E-01)	4.00E+09 (2.77E+01)	2.60E+09 (1.80E+01)	1.89E+10 (9.31E-01)	6.60E+09 (4.56E+01)	0.00E+00 (0.00E+00)
2042	6.22E+09 (4.30E+01)	1.89E+10 (9.31E-01)	1.22E+08 (8.46E-01)	1.89E+10 (9.31E-01)	3.75E+09 (2.59E+01)	2.59E+09 (1.79E+01)	1.89E+10 (9.31E-01)	6.34E+09 (4.38E+01)	0.00E+00 (0.00E+00)
2043	6.05E+09 (4.18E+01)	1.89E+10 (9.31E-01)	4.86E+07 (3.36E-01)	1.89E+10 (9.31E-01)	3.51E+09 (2.43E+01)	2.58E+09 (1.79E+01)	1.89E+10 (9.31E-01)	6.09E+09 (4.21E+01)	0.00E+00 (0.00E+00)
2044	5.88E+09 (4.07E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	3.29E+09 (2.27E+01)	2.60E+09 (1.80E+01)	1.89E+10 (9.31E-01)	5.87E+09 (4.06E+01)	1.02E+07 (7.05E-01)
2045	5.72E+09 (3.96E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	3.08E+09 (2.13E+01)	2.65E+09 (1.83E+01)	1.89E+10 (9.31E-01)	5.67E+09 (3.92E+01)	5.11E+07 (3.53E-01)
2046	5.57E+09 (3.85E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.88E+09 (1.99E+01)	2.69E+09 (1.86E+01)	1.89E+10 (9.31E-01)	5.48E+09 (3.79E+01)	8.56E+07 (5.91E-01)

Year	Scenario 1			Scenario 2			Scenario 3		
	Oil Production, kg (MMbbl)	System Expansion: Gas Production, kg (Tcf)	System Expansion: Oil Production, kg (MMbbl)	Gas Production, kg (Tcf)	Oil Production, kg (MMbbl)	System Expansion: Oil Production, kg (MMbbl)	Gas Production, kg (Tcf)	Oil Production, kg (MMbbl)	System Expansion: Oil Production, kg (MMbbl)
2047	5.42E+09 (3.75E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.70E+09 (1.87E+01)	2.72E+09 (1.88E+01)	1.89E+10 (9.31E-01)	5.30E+09 (3.67E+01)	1.17E+08 (8.07E-01)
2048	5.27E+09 (3.65E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.53E+09 (1.75E+01)	2.74E+09 (1.90E+01)	1.89E+10 (9.31E-01)	5.12E+09 (3.54E+01)	1.57E+08 (1.08E+00)
2049	5.13E+09 (3.55E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.37E+09 (1.64E+01)	2.76E+09 (1.91E+01)	1.89E+10 (9.31E-01)	4.94E+09 (3.42E+01)	1.88E+08 (1.30E+00)
2050	5.00E+09 (3.45E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.22E+09 (1.54E+01)	2.77E+09 (1.92E+01)	1.89E+10 (9.31E-01)	4.79E+09 (3.31E+01)	2.09E+08 (1.44E+00)
2051	4.86E+09 (3.36E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	2.08E+09 (1.44E+01)	2.78E+09 (1.92E+01)	1.89E+10 (9.31E-01)	4.64E+09 (3.21E+01)	2.21E+08 (1.53E+00)
2052	4.73E+09 (3.27E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.95E+09 (1.35E+01)	2.78E+09 (1.92E+01)	1.89E+10 (9.31E-01)	4.47E+09 (3.09E+01)	2.63E+08 (1.82E+00)
2053	4.61E+09 (3.19E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.83E+09 (1.27E+01)	2.78E+09 (1.92E+01)	1.89E+10 (9.31E-01)	4.30E+09 (2.97E+01)	3.13E+08 (2.16E+00)
2054	4.49E+09 (3.10E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.72E+09 (1.19E+01)	2.77E+09 (1.91E+01)	1.89E+10 (9.31E-01)	4.14E+09 (2.86E+01)	3.42E+08 (2.36E+01)
2055	4.37E+09 (3.02E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.61E+09 (1.11E+01)	2.76E+09 (1.91E+01)	1.89E+10 (9.31E-01)	4.01E+09 (2.77E+01)	3.55E+08 (2.45E+00)
2056	4.25E+09 (2.94E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.51E+09 (1.04E+01)	2.75E+09 (1.90E+01)	1.89E+10 (9.31E-01)	3.91E+09 (2.71E+01)	3.41E+08 (2.36E+00)
2057	4.14E+09 (2.87E+01)	1.89E+10 (9.31E-01)	0.00E+00 (0.00E+00)	1.89E+10 (9.31E-01)	1.42E+09 (9.79E+00)	2.73E+09 (1.89E+01)	1.89E+10 (9.31E-01)	3.80E+09 (2.63E+01)	3.47E+08 (2.40E+00)
2058	4.04E+09 (2.79E+01)	1.69E+10 (8.34E-01)	0.00E+00 (0.00E+00)	1.69E+10 (8.34E-01)	1.33E+09 (9.18E+00)	2.71E+09 (1.87E+01)	1.69E+10 (8.34E-01)	3.62E+09 (2.50E+01)	4.13E+08 (2.86E+00)
2059	3.94E+09 (2.72E+01)	1.36E+10 (6.68E-01)	0.00E+00 (0.00E+00)	1.36E+10 (6.68E-01)	1.23E+09 (8.53E+00)	2.70E+09 (1.87E+01)	1.36E+10 (6.68E-01)	3.29E+09 (2.27E+01)	6.46E+08 (4.47E+00)
2060	3.83E+09 (2.65E+01)	1.09E+10 (5.35E-01)	0.00E+00 (0.00E+00)	1.09E+10 (5.35E-01)	1.14E+09 (7.90E+00)	2.69E+09 (1.86E+01)	1.09E+10 (5.35E-01)	2.99E+09 (2.07E+01)	8.39E+08 (5.80E+00)
2061	3.73E+09 (2.58E+01)	8.67E+09 (4.27E-01)	0.00E+00 (0.00E+00)	8.67E+09 (4.27E-01)	1.05E+09 (7.27E+00)	2.68E+09 (1.85E+01)	8.67E+09 (4.27E-01)	2.70E+09 (1.87E+01)	1.03E+09 (7.13E+00)
Total (kg)	**1.96E+11**	**5.65E+11**	**6.79E+09**	**5.65E+11**	**1.23E+11**	**8.01E+10**	**5.65E+11**	**1.97E+11**	**6.08E+09**
Total (MMbbl)	**1.36E+03**	**n/a**	**4.69E+01**	**n/a**	**8.49E+02**	**5.54E+02**	**n/a**	**1.36E+03**	**4.20E+01**
Total (Tcf)	**n/a**	**2.78E+01**	**n/a**	**2.78E+01**	**n/a**	**n/a**	**2.78E+01**	**n/a**	**n/a**

*Note: A conversion factor of 0.020 kg/scf was used for natural gas, and 144.7 kg/bbl for crude oil

Exhibit 4-20. Estimated Emission Factors for Scenarios 1, 2, and 3 by Category for Each Country (AR4 – 100-yr)

Country	With/Without CCS	Scenario	Emissions Category							
			Natural Gas Production, Transport and Liquefaction (kg CO_2e/kg NG liquefied)	Natural Gas Ocean Transport, Regasification, and Power Plant (kg CO_2e /kg NG liquefied)	Crude Oil Production and Transport to Lower 48 (kg CO_2e/kg crude oil)	Crude Oil CO_2-EOR Production and Transport to Lower 48 (kg CO_2e/kg crude oil)	Crude Oil Refining and End use (kg CO_2e/kg crude oil)	System Expansion: US Lower 48 LNG Export and End Use (kg CO_2e/kg NG liquefied)	System Expansion: US Average Crude Oil Production and End Use (kg CO_2e/kg crude oil)	Construction (kg CO_2e/kg NG liquefied)
Japan Emission Factors	Without CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	3.77E+00	3.70E+00	-
		Scen. 2	8.04E-01	2.75E+00	2.12E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	2.75E+00	2.12E-01	4.05E-01	3.30E+00	-	-	4.97E-03
	With CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	1.48E+00	3.70E+00	-
		Scen. 2	8.04E-01	4.56E-01	2.13E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	4.56E-01	2.13E-01	4.05E-01	3.30E+00	-	-	4.97E-03
South Korea Emission Factors	Without CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	3.79E+00	3.70E+00	-
		Scen. 2	8.04E-01	2.76E+00	2.12E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	2.76E+00	2.12E-01	4.05E-01	3.30E+00	-	-	4.87E-03
	With CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	1.50E+00	3.70E+00	-
		Scen. 2	8.04E-01	4.78E-01	2.13E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	4.78E-01	2.13E-01	4.05E-01	3.30E+00	-	-	4.97E-03
China Emission Factors	Without CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	3.79E+00	3.70E+00	-
		Scen. 2	8.04E-01	2.76E+00	2.12E-01	-	3.30E+00	-	3.70E+00	4.55E-03
		Scen. 3	7.99E-01	2.76E+00	2.12E-01	4.05E-01	3.30E+00	-	-	4.97E-03
	With CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	1.50E+00	3.70E+00	-
		Scen. 2	8.04E-01	4.79E-01	2.13E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	4.79E-01	2.13E-01	4.05E-01	3.30E+00	-	-	4.97E-03
India Emission Factors	Without CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	3.79E+00	3.70E+00	-
		Scen. 2	8.04E-01	2.85E+00	2.12E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	2.85E+00	2.12E-01	4.05E-01	3.30E+00	-	-	4.97E-03
	With CCS	Scen. 1	-	-	1.05E+00	-	3.30E+00	1.49E+00	3.70E+00	-
		Scen. 2	8.04E-01	5.91E-01	2.13E-01	-	3.30E+00	-	3.70E+00	4.53E-03
		Scen. 3	7.99E-01	5.91E-01	2.13E-01	4.05E-01	3.30E+00	-	-	4.97E-03

Exhibit 4-21. Estimated Cumulative Emissions Totals for Scenarios 1, 2, and 3 by Category, China without CCS case (MMT CO_2e)

	Scenario 1					Scenario 2							Scenario 3						
Year	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	1.20E+01	0.00E+00	5.10E+01	2.53E+00	8.71E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	4.50E+01	2.52E+00	8.71E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	4.53E+01
2030	1.86E+01	5.83E+01	4.18E+01	0.00E+00	1.19E+02	8.87E+00	3.05E+01	3.61E+00	5.61E+01	2.49E+00	2.46E+00	1.04E+02	8.81E+00	3.05E+01	3.88E+00	5.78E+01	5.53E-01	2.70E+00	1.04E+02
2031	2.74E+01	8.63E+01	9.57E+01	1.16E+00	2.11E+02	2.03E+01	6.97E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.86E+02	2.01E+01	6.97E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.86E+02
2032	3.61E+01	1.13E+02	1.61E+02	3.82E+00	3.15E+02	3.42E+01	1.18E+02	6.79E+00	1.05E+02	1.28E+01	2.57E+00	2.79E+02	3.40E+01	1.18E+02	8.18E+00	1.16E+02	5.53E-01	2.81E+00	2.79E+02
2033	4.45E+01	1.40E+02	2.33E+02	7.38E+00	4.25E+02	4.94E+01	1.70E+02	8.23E+00	1.28E+02	2.08E+01	2.57E+00	3.79E+02	4.91E+01	1.70E+02	1.05E+01	1.46E+02	5.53E-01	2.81E+00	3.79E+02
2034	5.26E+01	1.65E+02	3.05E+02	1.09E+01	5.34E+02	6.46E+01	2.22E+02	9.58E+00	1.49E+02	2.96E+01	2.57E+00	4.77E+02	6.42E+01	2.22E+02	1.28E+01	1.75E+02	5.53E-01	2.81E+00	4.77E+02
2035	6.06E+01	1.90E+02	3.77E+02	1.41E+01	6.42E+02	7.98E+01	2.74E+02	1.08E+01	1.69E+02	3.87E+01	2.57E+00	5.75E+02	7.93E+01	2.74E+02	1.50E+01	2.03E+02	5.53E-01	2.81E+00	5.75E+02
2036	6.83E+01	2.15E+02	4.48E+02	1.68E+01	7.48E+02	9.50E+01	3.27E+02	1.20E+01	1.87E+02	4.79E+01	2.57E+00	6.71E+02	9.44E+01	3.27E+02	1.72E+01	2.29E+02	5.53E-01	2.81E+00	6.71E+02
2037	7.58E+01	2.38E+02	5.20E+02	1.90E+01	8.53E+02	1.10E+02	3.79E+02	1.31E+01	2.04E+02	5.72E+01	2.57E+00	7.66E+02	1.09E+02	3.79E+02	1.94E+01	2.55E+02	5.53E-01	2.81E+00	7.66E+02
2038	8.31E+01	2.61E+02	5.92E+02	2.09E+01	9.57E+02	1.25E+02	4.31E+02	1.42E+01	2.20E+02	6.68E+01	2.57E+00	8.60E+02	1.25E+02	4.31E+02	2.14E+01	2.79E+02	5.53E-01	2.81E+00	8.60E+02
2039	9.02E+01	2.84E+02	6.64E+02	2.25E+01	1.06E+03	1.41E+02	4.83E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	9.53E+02	1.40E+02	4.83E+02	2.34E+01	3.03E+02	5.53E-01	2.81E+00	9.53E+02
2040	9.71E+01	3.05E+02	7.35E+02	2.37E+01	1.16E+03	1.56E+02	5.36E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	1.05E+03	1.55E+02	5.36E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	1.04E+03
2041	1.04E+02	3.26E+02	8.07E+02	2.45E+01	1.26E+03	1.71E+02	5.88E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	1.14E+03	1.70E+02	5.88E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	1.14E+03
2042	1.10E+02	3.47E+02	8.79E+02	2.49E+01	1.36E+03	1.86E+02	6.40E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	1.23E+03	1.85E+02	6.40E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	1.23E+03
2043	1.17E+02	3.67E+02	9.51E+02	2.51E+01	1.46E+03	2.01E+02	6.92E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	1.32E+03	2.00E+02	6.92E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	1.32E+03
2044	1.23E+02	3.86E+02	1.02E+03	2.51E+01	1.56E+03	2.17E+02	7.45E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	1.40E+03	2.15E+02	7.45E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	1.40E+03
2045	1.29E+02	4.05E+02	1.09E+03	2.51E+01	1.65E+03	2.32E+02	7.97E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	1.49E+03	2.30E+02	7.97E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	1.49E+03
2046	1.35E+02	4.23E+02	1.17E+03	2.51E+01	1.75E+03	2.47E+02	8.49E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	1.58E+03	2.45E+02	8.49E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	1.58E+03
2047	1.40E+02	4.41E+02	1.24E+03	2.51E+01	1.84E+03	2.62E+02	9.01E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	1.67E+03	2.60E+02	9.01E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	1.67E+03
2048	1.46E+02	4.59E+02	1.31E+03	2.51E+01	1.94E+03	2.77E+02	9.54E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.75E+03	2.76E+02	9.54E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.75E+03
2049	1.51E+02	4.76E+02	1.38E+03	2.51E+01	2.03E+03	2.93E+02	1.01E+03	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.84E+03	2.91E+02	1.01E+03	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.84E+03
2050	1.57E+02	4.92E+02	1.45E+03	2.51E+01	2.13E+03	3.08E+02	1.06E+03	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.93E+03	3.06E+02	1.06E+03	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.92E+03

	Scenario 1					Scenario 2							Scenario 3						
Year	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2051	1.62E+02	5.08E+02	1.52E+03	2.51E+01	2.22E+03	3.23E+02	1.11E+03	2.29E+01	3.56E+02	1.95E+02	2.57E+00	2.01E+03	3.21E+02	1.11E+03	4.41E+01	5.27E+02	4.39E+00	2.81E+00	2.01E+03
2052	1.67E+02	5.24E+02	1.60E+03	2.51E+01	2.31E+03	3.38E+02	1.16E+03	2.34E+01	3.63E+02	2.05E+02	2.57E+00	2.10E+03	3.36E+02	1.16E+03	4.57E+01	5.41E+02	5.37E+00	2.81E+00	2.09E+03
2053	1.71E+02	5.39E+02	1.67E+03	2.51E+01	2.40E+03	3.53E+02	1.21E+03	2.38E+01	3.69E+02	2.16E+02	2.57E+00	2.18E+03	3.51E+02	1.21E+03	4.72E+01	5.56E+02	6.53E+00	2.81E+00	2.18E+03
2054	1.76E+02	5.54E+02	1.74E+03	2.51E+01	2.49E+03	3.69E+02	1.27E+03	2.41E+01	3.75E+02	2.26E+02	2.57E+00	2.26E+03	3.66E+02	1.27E+03	4.86E+01	5.69E+02	7.79E+00	2.81E+00	2.26E+03
2055	1.81E+02	5.68E+02	1.81E+03	2.51E+01	2.59E+03	3.84E+02	1.32E+03	2.45E+01	3.80E+02	2.36E+02	2.57E+00	2.35E+03	3.81E+02	1.32E+03	5.01E+01	5.83E+02	9.11E+00	2.81E+00	2.35E+03
2056	1.85E+02	5.82E+02	1.88E+03	2.51E+01	2.68E+03	3.99E+02	1.37E+03	2.48E+01	3.85E+02	2.46E+02	2.57E+00	2.43E+03	3.96E+02	1.37E+03	5.15E+01	5.95E+02	1.04E+01	2.81E+00	2.43E+03
2057	1.90E+02	5.96E+02	1.95E+03	2.51E+01	2.77E+03	4.14E+02	1.42E+03	2.51E+01	3.90E+02	2.56E+02	2.57E+00	2.51E+03	4.12E+02	1.42E+03	5.29E+01	6.08E+02	1.17E+01	2.81E+00	2.51E+03
2058	1.94E+02	6.09E+02	2.02E+03	2.51E+01	2.85E+03	4.28E+02	1.47E+03	2.54E+01	3.94E+02	2.66E+02	2.57E+00	2.59E+03	4.25E+02	1.47E+03	5.43E+01	6.20E+02	1.32E+01	2.81E+00	2.59E+03
2059	1.98E+02	6.22E+02	2.07E+03	2.51E+01	2.92E+03	4.39E+02	1.51E+03	2.56E+01	3.98E+02	2.76E+02	2.57E+00	2.65E+03	4.36E+02	1.51E+03	5.56E+01	6.31E+02	1.56E+01	2.81E+00	2.65E+03
2060	2.02E+02	6.35E+02	2.11E+03	2.51E+01	2.97E+03	4.47E+02	1.54E+03	2.59E+01	4.02E+02	2.86E+02	2.57E+00	2.70E+03	4.45E+02	1.54E+03	5.70E+01	6.41E+02	1.87E+01	2.81E+00	2.70E+03
2061	2.06E+02	6.47E+02	2.14E+03	2.51E+01	3.02E+03	4.54E+02	1.56E+03	2.61E+01	4.05E+02	2.96E+02	2.57E+00	2.75E+03	4.51E+02	1.56E+03	5.83E+01	6.50E+02	2.25E+01	2.81E+00	2.75E+03

Exhibit 4-22. Total Electricity Generated in Each Destination Country

Country	With/Without CCS	Electricity (MWh)		
		Scenario 1	Scenario 2	Scenario 3
Japan	Without CCS	4.21E+09	4.26E+09	4.26E+09
	With CCS	3.74E+09	3.79E+09	3.79E+09
South Korea	Without CCS	4.20E+09	4.25E+09	4.25E+09
	With CCS	3.73E+09	3.78E+09	3.78E+09
China	Without CCS	4.20E+09	4.25E+09	4.25E+09
	With CCS	3.73E+09	3.78E+09	3.78E+09
India	Without CCS	4.20E+09	4.21E+09	4.21E+09
	With CCS	3.74E+09	3.74E+09	3.74E+09

The estimated results (see **Exhibit 4-21**) depict that the BAU scenario (Scenario 1) would have the highest cumulative emissions over the 33-year project lifetime, followed by Scenario 2 and Scenario 3, respectively. The cumulative emissions for Scenarios 2 and 3 include the 9-year construction schedule between the years 2024 to 2032. The high cumulative emissions for Scenario 1 are due to the high carbon intensity of US Lower 48 LNG export and end use as compared to PBU associated gas production. In addition to this, lower quantities of LNG need to be shipped from Alaska to the destination countries to generate a MWh of electricity (as compared to LNG shipped from US Lower 48), due to the shorter shipping distances. As a result, for the same quantity of LNG shipped from Alaska (for Scenarios 2 and 3) and US Lower 48 (for Scenario 1), the total amount of electricity generated in the destination countries for Scenario 1 is lower (see **Exhibit 4-22**). Recall that while we use data from the US Lower 48 states, the goal of these analyses is to create globally representative benchmarks from other gas producing areas. In summary, the total quantity of service (in this case, electricity generated) is not consistent because these results reflect a GHG inventory approach representative of the quantity of natural gas exported from the Alaskan liquefaction facility and the quantity of crude oil produced from Scenario 3 over the 33-year LNG authorization time period. The quantity of crude oil exported was aligned using system expansion for Scenarios 1 and 2 to match Scenario 3. Scenario 1 was also expanded to include natural gas production to match the quantity of natural gas exported in Scenario 3. These results are consistent in the quantity of natural gas and crude oil exported from Alaska to each receiving country.

The cumulative emissions for Scenarios 2 and 3 are close, however on account of the higher carbon intensity of US average crude oil (used for system expansion of Scenario 2 to be functionally equivalent to Scenario 3) as compared to PBU associated crude oil production, lifetime emissions for Scenario 2 are slightly higher. **Exhibit 4-23**, **Exhibit 4-24**, and **Exhibit 4-25** depict the cumulative emissions profile for the China without CCS case, across Scenarios 1, 2, and 3, respectively.

Exhibit 4-23. Cumulative Emissions Profile for Scenario 1 – NGCC without CCS to China

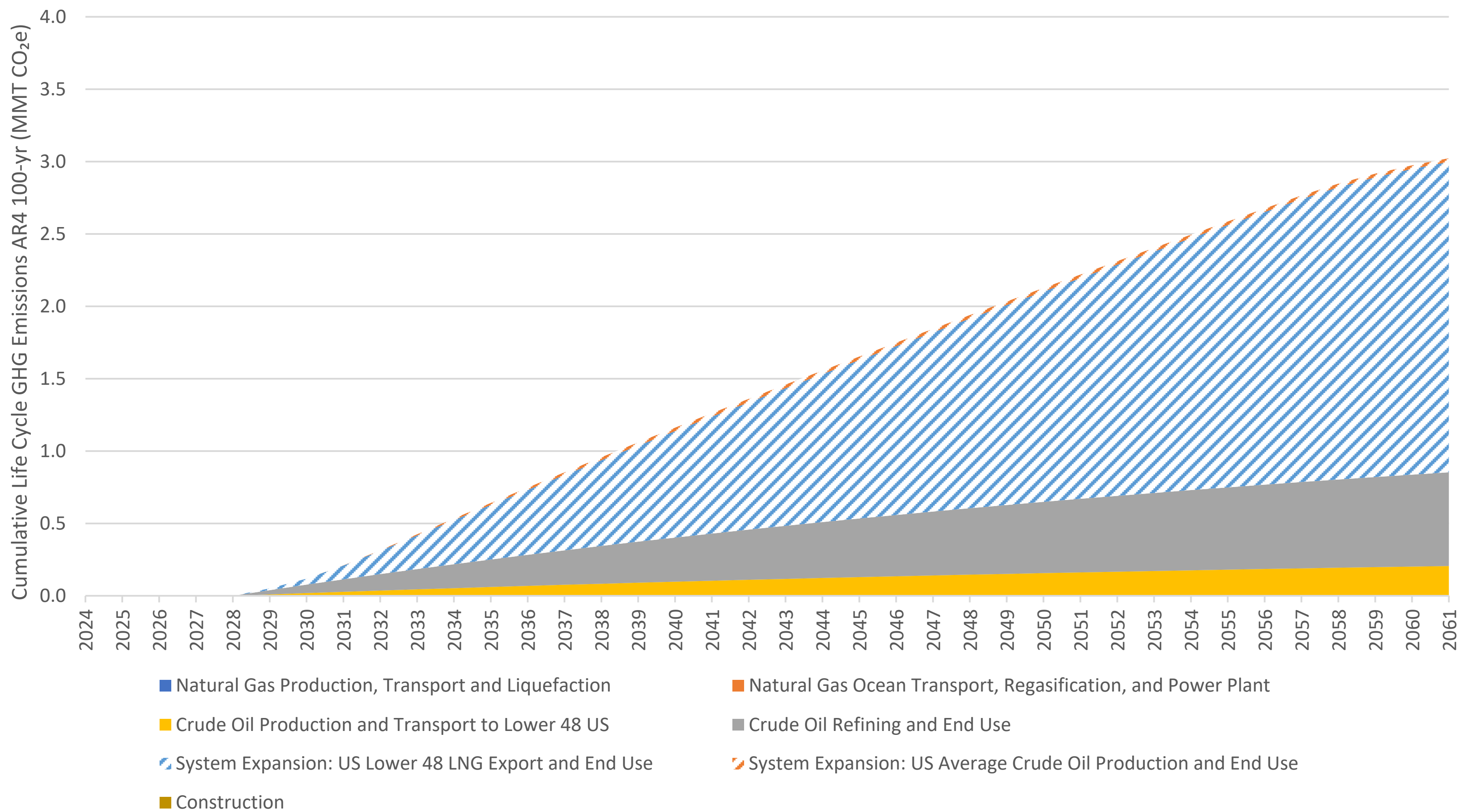


Exhibit 4-24. Cumulative Emissions Profile for Scenario 2 – NGCC without CCS to China

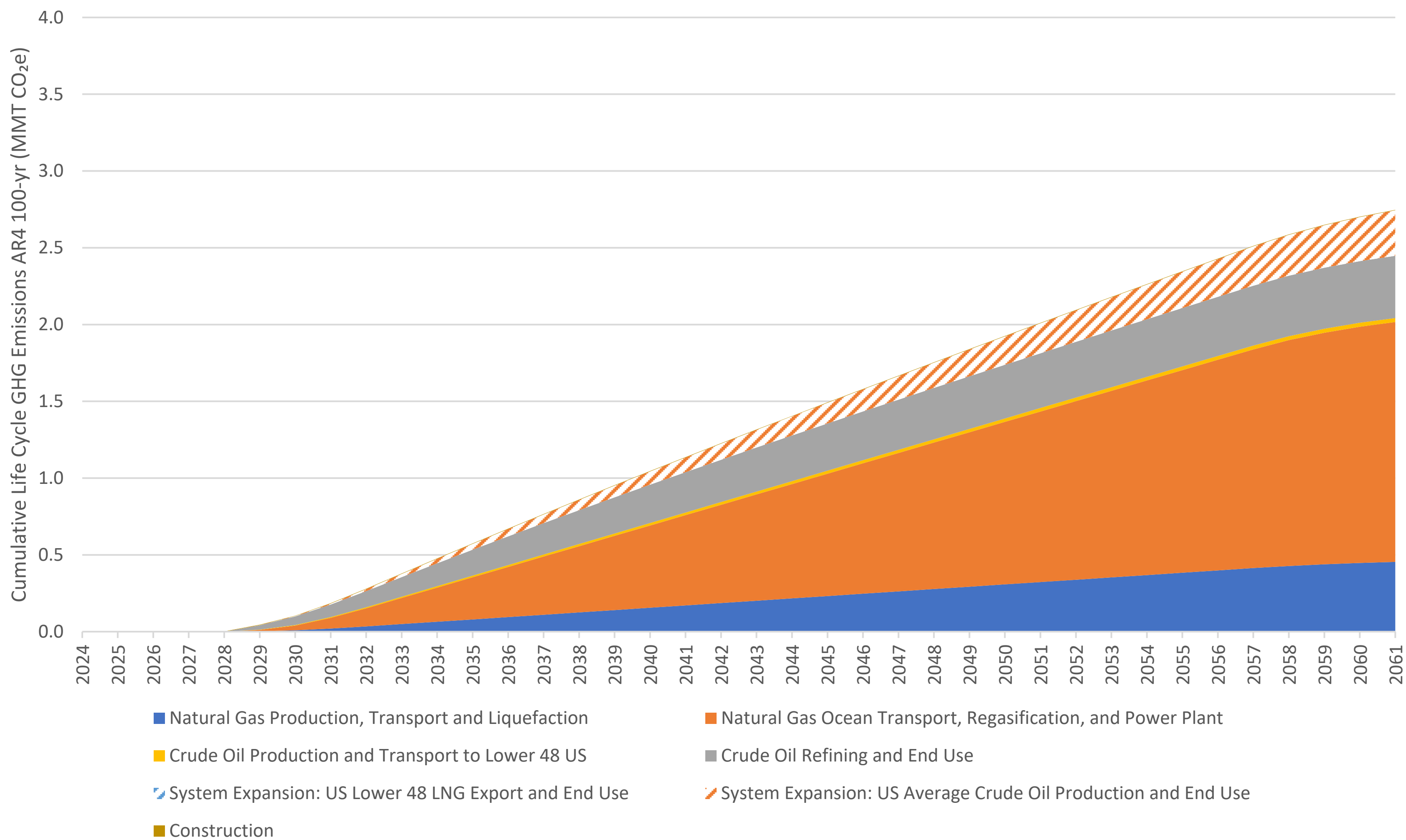
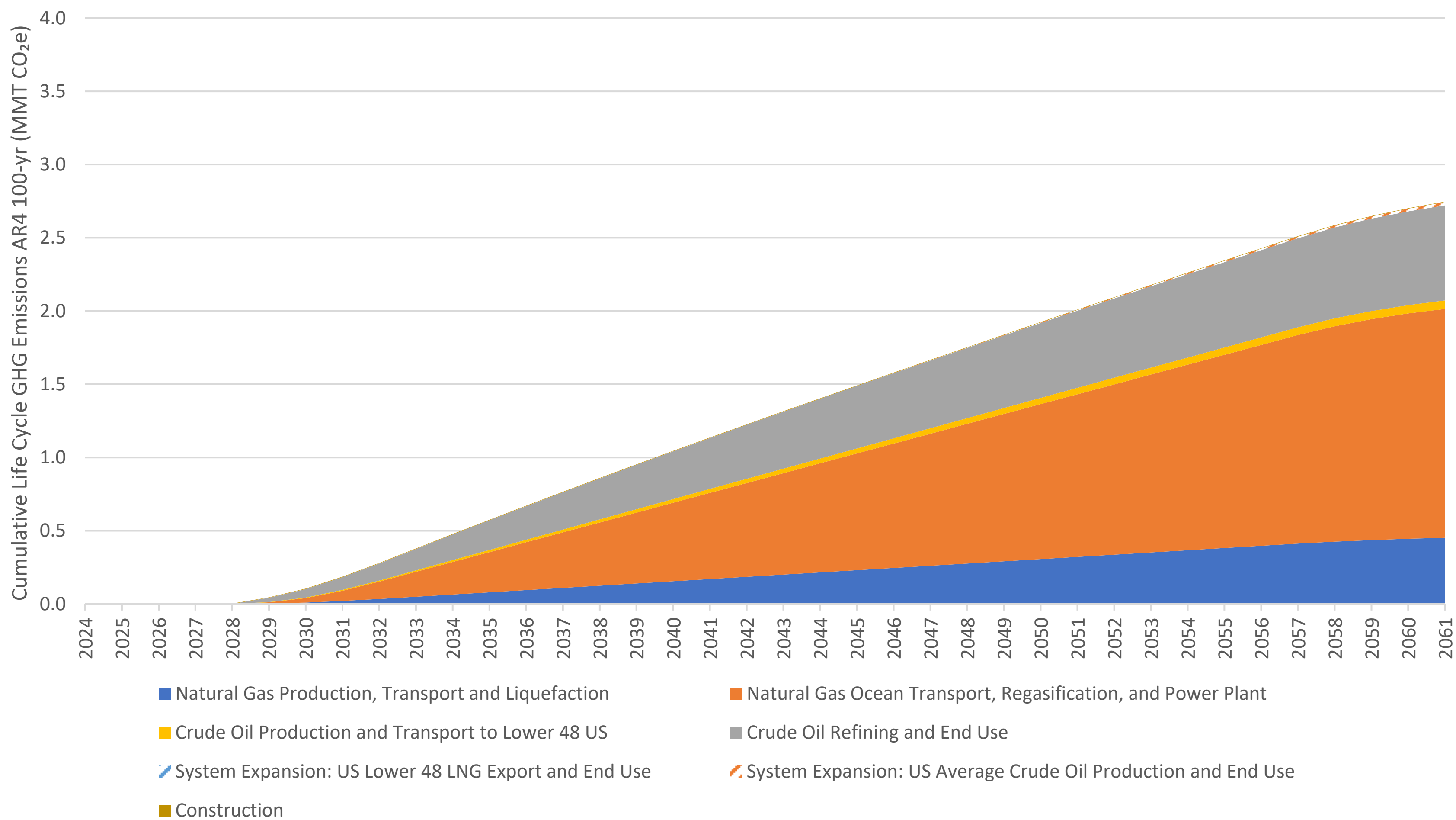


Exhibit 4-25. Cumulative Emissions Profile for Scenario 3 – NGCC without CCS to China



4.5 SENSITIVITY ANALYSIS

Various sensitivity analyses were performed on Scenario 3 using a multiproduct functional unit with delivery to a NGCC power plant without CCS in each of the four destination countries.

4.5.1 Gas Delivered to GTP and Oil Ratio Sensitivity

The first sensitivity analysis was based on changing a key parameter, the gas delivered to GTP and oil ratio (GTP GOR), within the model to produce different results. Because prior results utilize a 33-yr average for the GTP GOR in the project timespan, varying this ratio in a sensitivity analysis provides clarity into how it affects overall emissions. For this analysis, the GTP GOR was varied and run at 5% higher (32,708 scf/bbl) and 5% lower (29,592 scf/bbl) than its original value (31,150 scf/bbl). Scenario 3 without CCS was selected as the base case for understanding the effect of GTP GOR on the overall results.

Exhibit 4-26 displays the sensitivity analysis results using AR4 100-yr GWP factors and **Exhibit 4-27** displays them using AR4 20-yr GWP factors. The main blue bars for each country in these exhibits show the multiproduct functional unit results previously seen in **Section 4.1.1** and **Section 4.1.2**, whereas the orange points represent the quantity of Alaskan crude oil transported for consumption per MWh of electricity generated in the destination country. The ranges for the bars represent the total life cycle GHG emissions produced using the higher and lower GTP GOR values, and the ranges for the points represent the total Alaskan crude transported for consumption using the higher and lower GTP GOR values. A higher GTP gas-to-oil ratio leads to a lower quantity of Alaskan crude oil transported for consumption, resulting in a lower GHG emissions intensity as a greater portion of the oil demand is now met by U.S. average crude to ensure functional equivalence, and vice-versa.

This sensitivity analysis shows that varying the GTP GOR by ± 5% has a modest impact on life cycle GHG emissions. For each of the countries in both exhibits, the total GHG emissions varies about 1-2 kg CO_2e/MWh electricity produced and a specific quantity (X, depending on GTP GOR value) of crude-oil products consumed in either direction. This difference is relatively small, only about 0.1 - 0.3% of total life cycle GHG emissions.

Exhibit 4-26. GTP GOR Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 – 100-yr)

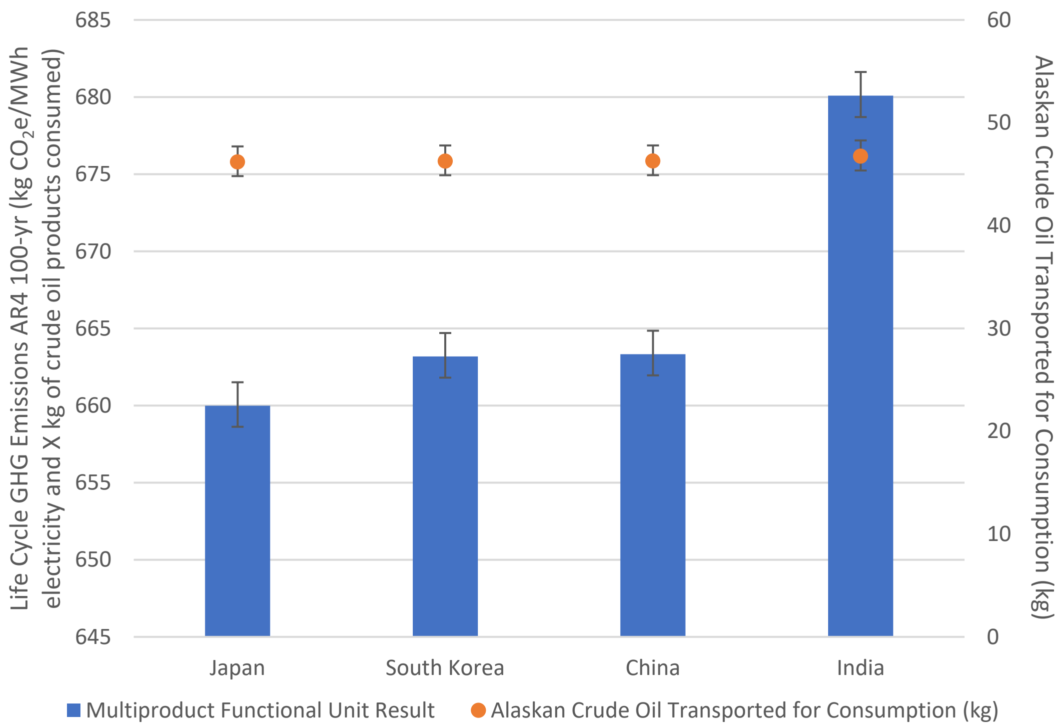
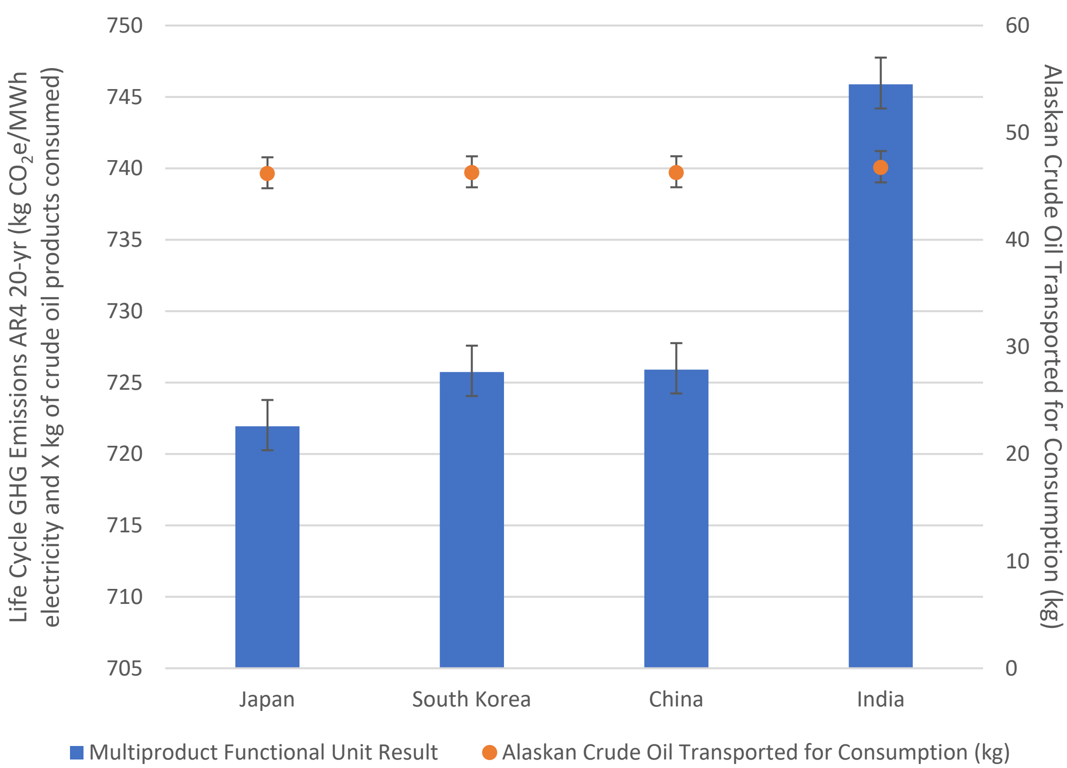


Exhibit 4-27. GTP GOR Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 - 20-yr)



4.5.2 Methane Emissions Sensitivity

The second sensitivity analysis was based on estimating the effects of variation in CH_4 emissions. For this analysis, ± 5% variation in CH_4 emissions was modeled, while taking CH_4 emissions from all life cycle stages into account. The purpose is to understand the effect of a change in methane emissions on the results, and the choice of ± 5% change in methane emissions is an arbitrary unit of change and not intended to imply a known range of direct methane emissions uncertainty within the study.

Exhibit 4-28 displays the sensitivity analysis results using AR4 100-yr GWP factors and **Exhibit 4-29** displays results using AR4 20-yr GWP factors.

As expected, the sensitivity is higher for the AR4 20-yr values because of the higher GWP values of CH_4 in the shorter time horizon.

As above, the main bars for each country in these exhibits show the multiproduct functional unit results previously seen in **Sections 4.1.1** and **4.1.2**. Error bars represent the total life cycle GHG emissions on account of a ± 5% variation in CH_4 emissions.

This sensitivity analysis shows that varying the CH_4 leakage has a modest impact on life cycle GHG emissions. For each of the countries in both exhibits, the total GHG emissions vary about 1.5 to 5 kg CO_2e/MWh electricity produced and 53 kg of crude-oil products consumed in either direction. This difference is representative of about 0.2 – 0.7% of total life cycle GHG emissions.

Exhibit 4-28. Methane Emissions Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 100-yr)

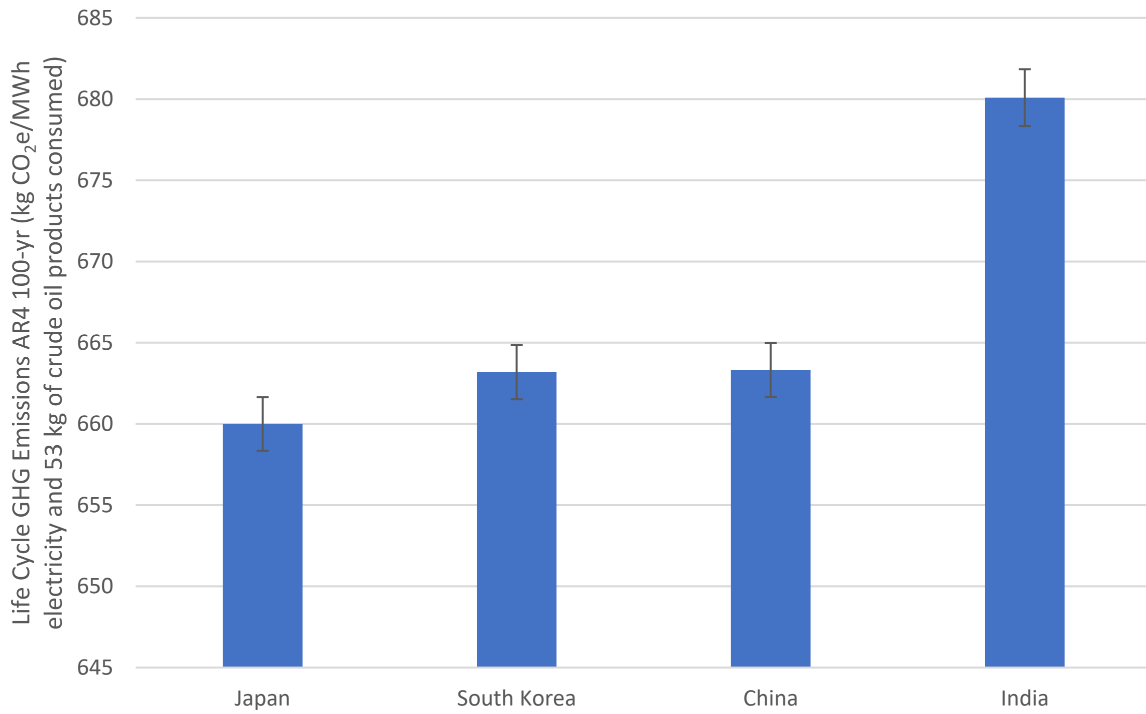
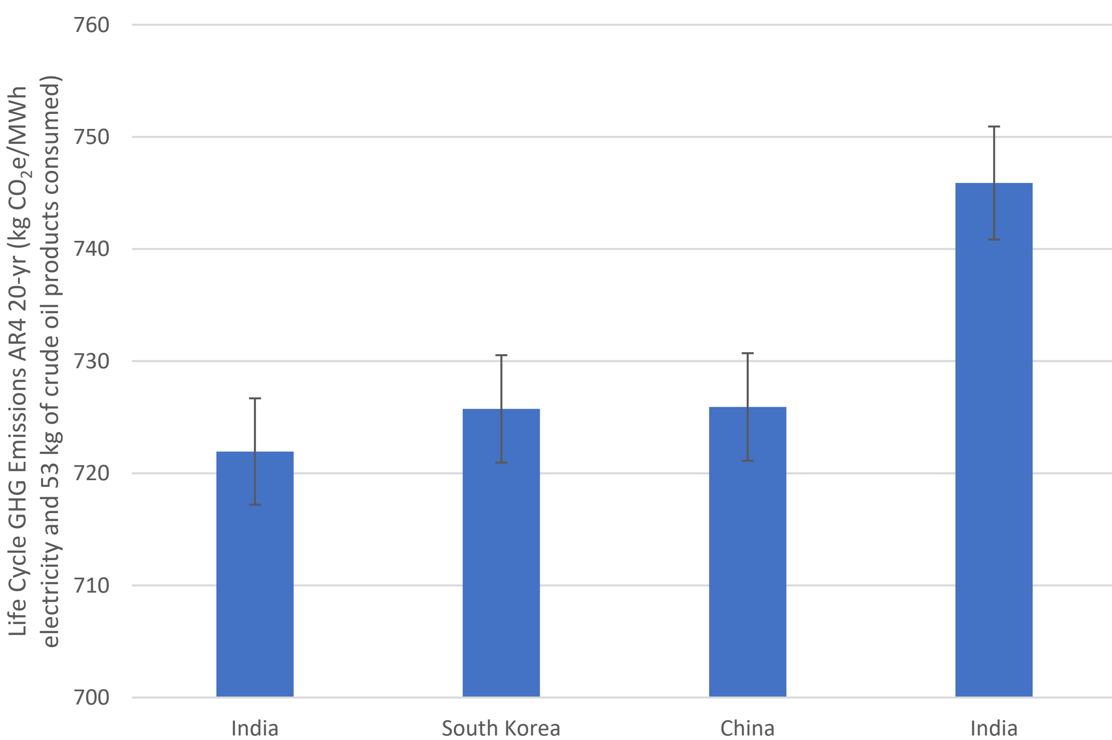


Exhibit 4-29. Methane Emissions Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 - 20-yr)



5 CONCLUSIONS

This analysis has determined that expected life cycle emissions for the two proposed Scenarios 2 and 3 of the Alaska LNG Project are lower than the BAU Scenario 1. Additionally, this study has found that there is not a substantial difference between the life cycle GHG emissions of Scenarios 2 and 3.

For both proposed scenarios, life cycle GHG emissions are very similar for each stage except ocean transport, which varies due to different distances between ports. The ocean transport stage results in very similar emissions for Japan, Korea and China since they are in relatively close proximity of each other. As India is slightly further away, it has distinctly higher emissions from the ocean transport stage and thus, overall. When CCS is not used, power generation consistently produces the most emissions of any life cycle stage. When CCS is utilized, the largest emissions contributing stage varies among scenarios.

The AR4 100-yr GWP expected emissions of exporting LNG from Alaska to Asia for Scenario 3's multiproduct functional unit varies from 660 to 680 kg CO_2e/ MWh electricity generated from a NGCC power plant without CCS and 53 kg of crude oil consumed, and 377 to 399 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 53 kg of crude oil consumed. For Scenario 2, the GWP ranges from 661 to 681 kg CO_2e/MWh electricity generated from NGCC power plant without CCS and 53 kg of crude oil consumed, and 377 to 400 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 53 kg of crude oil consumed. Both of these scenarios produce lower emissions than Scenario 1, which varies from 731 to 735 kg CO_2e/MWh electricity generated from NGCC power plant without CCS and 53 kg of crude oil consumed, and 452 to 456 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 53 kg of crude oil consumed. The results for AR4 20-year GWP, as well as AR5 and AR6 (for 100- and 20-year GWP) show the same qualitative results as mentioned for AR4 100-yr GWP in terms of the relative differences in Scenarios as well as comparable uncertainty. However, it is worth noting that current understanding of GWP-100 for methane (AR6) is about 20% higher than the value used in this study (AR4). Please refer to the addendum for more information regarding updates made to modeling uncertainty.

The LCA study concludes that life cycle GHG emissions from production of natural gas on the North Slope of Alaska and subsequent liquefaction and export of LNG from Alaska, along with related oil production changes, would not increase GHG emissions on a life cycle basis for both carbon management scenarios considered in the study when compared to providing an equivalent service to society from existing Alaska North Slope oil production and global natural gas export production represented by US Lower 48 natural gas production. The total expected (mean) life cycle GHG results show a small reduction (10 to 17 percent) compared with the no action alternative (Scenario 1: Business as Usual). In conclusion, exporting LNG from the North Slope of Alaska would not increase GHG emissions when providing the same services to society (through production of natural gas and oil) as the no action alternative.

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APPENDIX A: AR4 100-YR RESULTS

Six appendices have been prepared to supplement the main body of the report to show tabular results for alternative GWP methods and time horizons.

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR4 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR4 – 100-yr)
- Multiproduct Functional Unit – China (AR4 – 100-yr)
- Multiproduct Functional Unit – India (AR4 – 100-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 100-yr)
- Single Product Functional Unit in kg CO_2e – China (AR4 – 100-yr)
- Single Product Functional Unit in kg CO_2e – India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR4 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit A-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.22E+01	4.22E+01	-	4.75E+01	4.75E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.73E+01	2.73E+01
CO2 Compression and Sequestration	-	6.84E-01	-	-	7.70E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.61E+00	8.61E+00	-	9.69E+00	9.69E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.18E+01	3.18E+01
Ocean Transport	-	1.83E+01	1.83E+01	-	2.05E+01	2.05E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.51E+01	4.06E+00	4.06E+00	5.07E+01	4.58E+00	4.58E+00
Crude Oil Extraction, CO2-EOR	-	-	5.82E+00	-	-	6.54E+00
CO2-EOR Crude Oil Transport	-	-	7.94E-01	-	-	8.94E-01
Crude Oil Alaskan Pipeline Transport	2.10E+00	1.32E+00	1.32E+00	2.37E+00	1.48E+00	1.48E+00
Crude Oil Ocean Transport	1.12E+00	7.40E-01	1.19E+00	1.26E+00	8.33E-01	1.34E+00
Crude Oil Refining and End Use	1.52E+02	9.51E+01	1.52E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.15E-01	5.15E-01	-	5.80E-01	5.80E-01
System Expansion: US Average Crude Oil Production and End Use	2.44E+01	8.80E+01	2.38E+01	3.04E+00	7.47E+01	2.35E+00
System Expansion: US Lower 48 LNG Export and End Use	5.07E+02	-	-	2.23E+02	-	-
Total	7.31E+02	6.61E+02	6.60E+02	4.52E+02	3.77E+02	3.77E+02
Upper	1.35E+01	6.11E+00	5.63E+00	1.34E+01	6.63E+00	6.51E+00
Lower	7.87E+00	1.38E+00	1.38E+00	8.81E+00	1.42E+00	1.72E+00

Exhibit A-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.23E+01	4.23E+01	-	4.76E+01	4.76E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	6.86E-01	-	-	7.71E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.13E+01	2.13E+01	-	2.39E+01	2.39E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.52E+01	4.07E+00	4.07E+00	5.08E+01	4.59E+00	4.59E+00
Crude Oil Extraction, CO2-EOR	-	-	5.83E+00	-	-	6.56E+00
CO2-EOR Crude Oil Transport	-	-	7.96E-01	-	-	8.96E-01
Crude Oil Alaskan Pipeline Transport	2.11E+00	1.32E+00	1.32E+00	2.37E+00	1.49E+00	1.49E+00
Crude Oil Ocean Transport	1.13E+00	7.42E-01	1.19E+00	1.27E+00	8.35E-01	1.34E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	2.41E+01	8.78E+01	2.34E+01	2.67E+00	7.45E+01	1.98E+00
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.27E+02	-	-
Total	7.35E+02	6.64E+02	6.63E+02	4.56E+02	3.81E+02	3.80E+02
Upper	1.31E+01	6.39E+00	6.13E+00	1.50E+01	6.95E+00	6.72E+00
Lower	7.23E+00	1.38E+00	1.23E+00	8.84E+00	1.42E+00	1.60E+00

Exhibit A-3. Multiproduct Functional Unit in kg CO_2e – China (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.23E+01	4.23E+01	-	4.76E+01	4.76E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	6.86E-01	-	-	7.72E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.14E+01	2.14E+01	-	2.41E+01	2.41E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.52E+01	4.07E+00	4.07E+00	5.08E+01	4.59E+00	4.59E+00
Crude Oil Extraction, CO2-EOR	-	-	5.83E+00	-	-	6.56E+00
CO2-EOR Crude Oil Transport	-	-	7.96E-01	-	-	8.96E-01
Crude Oil Alaskan Pipeline Transport	2.11E+00	1.32E+00	1.32E+00	2.37E+00	1.49E+00	1.49E+00
Crude Oil Ocean Transport	1.13E+00	7.42E-01	1.19E+00	1.27E+00	8.35E-01	1.34E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	2.40E+01	8.78E+01	2.34E+01	2.65E+00	7.44E+01	1.96E+00
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.28E+02	-	-
Total	7.35E+02	6.64E+02	6.63E+02	4.56E+02	3.81E+02	3.80E+02
Upper	1.29E+01	6.24E+00	6.20E+00	1.49E+01	6.81E+00	7.12E+00
Lower	7.34E+00	1.41E+00	1.50E+00	8.70E+00	1.70E+00	1.68E+00

Exhibit A-4. Multiproduct Functional Unit in kg CO_2e – India (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.27E+01	4.27E+01	-	4.81E+01	4.81E+01
Natural Gas Pipelines to GTP	-	2.60E+00	2.60E+00	-	2.92E+00	2.92E+00
Natural Gas Processing at GTP	-	2.46E+01	2.46E+01	-	2.77E+01	2.77E+01
CO2 Compression and Sequestration	-	6.93E-01	-	-	7.79E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.72E+00	8.72E+00	-	9.81E+00	9.81E+00
Liquefaction	-	2.86E+01	2.86E+01	-	3.22E+01	3.22E+01
Ocean Transport	-	3.71E+01	3.71E+01	-	4.18E+01	4.18E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.56E+01	4.11E+00	4.11E+00	5.14E+01	4.63E+00	4.63E+00
Crude Oil Extraction, CO2-EOR	-	-	5.89E+00	-	-	6.62E+00
CO2-EOR Crude Oil Transport	-	-	8.04E-01	-	-	9.05E-01
Crude Oil Alaskan Pipeline Transport	2.13E+00	1.33E+00	1.33E+00	2.40E+00	1.50E+00	1.50E+00
Crude Oil Ocean Transport	1.14E+00	7.49E-01	1.20E+00	1.28E+00	8.43E-01	1.35E+00
Crude Oil Refining and End Use	1.54E+02	9.63E+01	1.54E+02	1.73E+02	1.08E+02	1.74E+02
Construction	-	5.21E-01	5.21E-01	-	5.87E-01	5.87E-01
System Expansion: US Average Crude Oil Production and End Use	2.23E+01	8.67E+01	2.17E+01	7.01E-01	7.32E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.09E+02	-	-	2.26E+02	-	-
Total	7.34E+02	6.81E+02	6.80E+02	4.55E+02	4.00E+02	3.99E+02
Upper	1.38E+01	8.77E+00	8.90E+00	1.43E+01	9.97E+00	1.01E+01
Lower	8.20E+00	1.03E+00	1.27E+00	9.24E+00	1.42E+00	1.45E+00

Exhibit A-5. Single Product Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.22E+01	4.22E+01	-	4.75E+01	4.75E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.73E+01	2.73E+01
CO2 Compression and Sequestration	-	5.88E-01	-	-	6.62E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.61E+00	8.61E+00	-	9.69E+00	9.69E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.18E+01	3.18E+01
Ocean Transport	-	1.83E+01	1.83E+01	-	2.05E+01	2.05E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.15E-01	5.15E-01	-	5.80E-01	5.80E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
DonesSystem Expansion: US Lower 48 LNG Export and End Use	5.07E+02	-	-	2.23E+02	-	-
Total	5.07E+02	4.71E+02	4.71E+02	2.23E+02	1.89E+02	1.88E+02
Upper	1.35E+01	4.36E+00	4.02E+00	1.33E+01	3.31E+00	3.25E+00
Lower	7.93E+00	9.87E-01	9.87E-01	8.88E+00	7.12E-01	8.56E-01

Exhibit A-6. Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.23E+01	4.23E+01	-	4.76E+01	4.76E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	5.90E-01	-	-	6.63E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.13E+01	2.13E+01	-	2.39E+01	2.39E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.27E+02	-	-
Total	5.10E+02	4.74E+02	4.74E+02	2.27E+02	1.92E+02	1.92E+02
Upper	1.31E+01	4.57E+00	4.38E+00	1.49E+01	3.50E+00	3.39E+00
Lower	7.28E+00	9.89E-01	8.76E-01	8.91E+00	7.15E-01	8.06E-01

Exhibit A-7. Single Product Functional Unit in kg CO_2e – China (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.23E+01	4.23E+01	-	4.76E+01	4.76E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.43E+01	2.43E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	5.90E-01	-	-	6.64E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.14E+01	2.14E+01	-	2.41E+01	2.41E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.28E+02	-	-
Total	5.10E+02	4.75E+02	4.74E+02	2.28E+02	1.92E+02	1.92E+02
Upper	1.28E+01	4.46E+00	4.43E+00	1.48E+01	3.44E+00	3.59E+00
Lower	7.40E+00	1.01E+00	1.07E+00	8.77E+00	8.56E-01	8.46E-01

Exhibit A-8. Single Product Functional Unit in kg CO_2e – India (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.27E+01	4.27E+01	-	4.81E+01	4.81E+01
Natural Gas Pipelines to GTP	-	2.60E+00	2.60E+00	-	2.92E+00	2.92E+00
Natural Gas Processing at GTP	-	2.46E+01	2.46E+01	-	2.77E+01	2.77E+01
CO2 Compression and Sequestration	-	5.96E-01	-	-	6.70E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.72E+00	8.72E+00	-	9.81E+00	9.81E+00
Liquefaction	-	2.86E+01	2.86E+01	-	3.22E+01	3.22E+01
Ocean Transport	-	3.71E+01	3.71E+01	-	4.18E+01	4.18E+01
LNG Regasification	-	3.43E+00	3.43E+00	-	3.86E+00	3.86E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.21E-01	5.21E-01	-	5.87E-01	5.87E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.09E+02	-	-	2.26E+02	-	-
Total	5.09E+02	4.91E+02	4.91E+02	2.26E+02	2.11E+02	2.11E+02
Upper	1.38E+01	6.33E+00	6.42E+00	1.43E+01	5.27E+00	5.30E+00
Lower	8.26E+00	7.43E-01	9.14E-01	9.30E+00	7.51E-01	7.63E-01

Exhibit A-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.29E+01	2.21E+00	6.09E-05	-	4.51E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	7.66E-02	1.08E-02	7.44E-09	2.10E+00
Crude Oil Ocean Transport	1.09E+00	2.67E-02	2.95E-03	1.11E-06	1.12E+00
Crude Oil Refining and End Use	1.52E+02	2.15E-01	7.58E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	4.67E-01	1.56E-02	-	2.44E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	4.24E+01	3.37E-01	1.84E-07	5.07E+02
Construction	-	-	-	-	-
Total	6.85E+02	4.54E+01	3.74E-01	1.30E-06	7.31E+02

Exhibit A-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	2.22E+00	6.10E-05	-	4.52E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	7.67E-02	1.08E-02	7.46E-09	2.11E+00
Crude Oil Ocean Transport	1.10E+00	2.67E-02	2.95E-03	1.11E-06	1.13E+00
Crude Oil Refining and End Use	1.52E+02	2.15E-01	7.59E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	4.61E-01	1.54E-02	-	2.41E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	4.28E+01	3.47E-01	1.84E-07	5.10E+02
Construction	-	-	-	-	-
Total	6.89E+02	4.58E+01	3.84E-01	1.30E-06	7.35E+02

Exhibit A-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	2.22E+00	6.10E-05	-	4.52E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	7.67E-02	1.08E-02	7.46E-09	2.11E+00
Crude Oil Ocean Transport	1.10E+00	2.67E-02	2.95E-03	1.11E-06	1.13E+00
Crude Oil Refining and End Use	1.52E+02	2.15E-01	7.59E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	4.60E-01	1.54E-02	-	2.40E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	4.28E+01	3.48E-01	1.84E-07	5.10E+02
Construction	-	-	-	-	-
Total	6.89E+02	4.58E+01	3.85E-01	1.30E-06	7.35E+02

Exhibit A-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.34E+01	2.24E+00	6.17E-05	-	4.56E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.04E+00	7.75E-02	1.09E-02	7.54E-09	2.13E+00
Crude Oil Ocean Transport	1.11E+00	2.70E-02	2.98E-03	1.12E-06	1.14E+00
Crude Oil Refining and End Use	1.54E+02	2.18E-01	7.67E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	4.27E-01	1.42E-02	-	2.23E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	4.27E+01	3.44E-01	1.84E-07	5.09E+02
Construction	-	-	-	-	-
Total	6.88E+02	4.57E+01	3.80E-01	1.31E-06	7.34E+02

Exhibit A-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	1.64E+01	1.58E-02	-	4.22E+01
Natural Gas Pipelines to GTP	2.14E-03	2.56E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.39E+01	3.90E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	6.44E-01	3.64E-02	1.52E-03	2.03E-03	6.84E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	3.44E+00	5.65E-07	-	8.61E+00
Liquefaction	2.25E+01	5.81E+00	4.19E-03	1.33E-07	2.83E+01
Ocean Transport	1.68E+01	1.42E+00	5.95E-02	-	1.83E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	1.44E+00	6.10E-06	-	4.06E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	4.79E-02	6.76E-03	4.66E-09	1.32E+00
Crude Oil Ocean Transport	7.14E-01	2.37E-02	2.31E-03	9.90E-07	7.40E-01
Crude Oil Refining and End Use	9.50E+01	1.35E-01	4.75E-03	-	9.51E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	1.69E+00	5.62E-02	-	8.80E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	6.63E-03	3.30E-03	-	5.15E-01
Total	6.27E+02	3.38E+01	1.65E-01	2.12E-03	6.61E+02

Exhibit A-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.64E+01	1.58E-02	-	4.23E+01
Natural Gas Pipelines to GTP	2.14E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.40E+01	3.91E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	6.45E-01	3.65E-02	1.53E-03	2.04E-03	6.86E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	4.20E-03	1.33E-07	2.83E+01
Ocean Transport	1.95E+01	1.69E+00	6.78E-02	-	2.13E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.45E+00	6.12E-06	-	4.07E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	4.80E-02	6.77E-03	4.67E-09	1.32E+00
Crude Oil Ocean Transport	7.16E-01	2.37E-02	2.32E-03	9.92E-07	7.42E-01
Crude Oil Refining and End Use	9.51E+01	1.35E-01	4.75E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	1.68E+00	5.61E-02	-	8.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	6.64E-03	3.31E-03	-	5.16E-01
Total	6.29E+02	3.41E+01	1.73E-01	2.13E-03	6.64E+02

Exhibit A-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.64E+01	1.58E-02	-	4.23E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.40E+01	3.91E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	6.46E-01	3.65E-02	1.53E-03	2.04E-03	6.86E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	4.20E-03	1.33E-07	2.83E+01
Ocean Transport	1.96E+01	1.71E+00	6.82E-02	-	2.14E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.45E+00	6.12E-06	-	4.07E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.27E+00	4.80E-02	6.77E-03	4.67E-09	1.32E+00
Crude Oil Ocean Transport	7.16E-01	2.37E-02	2.32E-03	9.92E-07	7.42E-01
Crude Oil Refining and End Use	9.51E+01	1.35E-01	4.75E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	1.68E+00	5.61E-02	-	8.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	6.64E-03	3.31E-03	-	5.16E-01
Total	6.30E+02	3.41E+01	1.73E-01	2.13E-03	6.64E+02

Exhibit A-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	1.66E+01	1.60E-02	-	4.27E+01
Natural Gas Pipelines to GTP	2.17E-03	2.59E+00	-	-	2.60E+00
Natural Gas Processing at GTP	2.42E+01	3.95E-01	2.74E-05	-	2.46E+01
CO2 Compression and Sequestration	6.52E-01	3.68E-02	1.54E-03	2.06E-03	6.93E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	3.48E+00	5.72E-07	-	8.72E+00
Liquefaction	2.27E+01	5.88E+00	4.24E-03	1.35E-07	2.86E+01
Ocean Transport	3.39E+01	3.14E+00	1.12E-01	-	3.71E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	1.46E+00	6.18E-06	-	4.11E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.28E+00	4.85E-02	6.84E-03	4.72E-09	1.33E+00
Crude Oil Ocean Transport	7.23E-01	2.40E-02	2.34E-03	1.00E-06	7.49E-01
Crude Oil Refining and End Use	9.61E+01	1.36E-01	4.80E-03	-	9.63E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	1.66E+00	5.54E-02	-	8.67E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	6.71E-03	3.34E-03	-	5.21E-01
Total	6.45E+02	3.58E+01	2.16E-01	2.15E-03	6.81E+02

Exhibit A-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	1.64E+01	1.58E-02	-	4.22E+01
Natural Gas Pipelines to GTP	2.14E-03	2.56E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.39E+01	3.90E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	3.44E+00	5.65E-07	-	8.61E+00
Liquefaction	2.25E+01	5.81E+00	4.19E-03	1.33E-07	2.83E+01
Ocean Transport	1.68E+01	1.42E+00	5.95E-02	-	1.83E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	1.44E+00	6.10E-06	-	4.06E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	3.28E-01	1.90E-02	2.62E-02	5.82E+00
CO2-EOR Crude Oil Transport	7.61E-01	2.89E-02	4.08E-03	2.81E-09	7.94E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	4.79E-02	6.76E-03	4.66E-09	1.32E+00
Crude Oil Ocean Transport	1.14E+00	3.80E-02	3.71E-03	1.59E-06	1.19E+00
Crude Oil Refining and End Use	1.52E+02	2.16E-01	7.61E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	4.55E-01	1.52E-02	-	2.38E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	6.63E-03	3.30E-03	-	5.15E-01
Total	6.27E+02	3.30E+01	1.49E-01	2.63E-02	6.60E+02

Exhibit A-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.64E+01	1.58E-02	-	4.23E+01
Natural Gas Pipelines to GTP	2.14E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.40E+01	3.91E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	4.20E-03	1.33E-07	2.83E+01
Ocean Transport	1.95E+01	1.69E+00	6.78E-02	-	2.13E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.45E+00	6.12E-06	-	4.07E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	3.29E-01	1.90E-02	2.63E-02	5.83E+00
CO2-EOR Crude Oil Transport	7.63E-01	2.90E-02	4.08E-03	2.82E-09	7.96E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	4.80E-02	6.77E-03	4.67E-09	1.32E+00
Crude Oil Ocean Transport	1.15E+00	3.80E-02	3.71E-03	1.59E-06	1.19E+00
Crude Oil Refining and End Use	1.53E+02	2.16E-01	7.62E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	4.49E-01	1.50E-02	-	2.34E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	6.64E-03	3.31E-03	-	5.16E-01
Total	6.30E+02	3.33E+01	1.58E-01	2.63E-02	6.63E+02

Exhibit A-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.64E+01	1.58E-02	-	4.23E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.40E+01	3.91E-01	2.71E-05	-	2.43E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	4.20E-03	1.33E-07	2.83E+01
Ocean Transport	1.96E+01	1.71E+00	6.82E-02	-	2.14E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.45E+00	6.12E-06	-	4.07E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	3.29E-01	1.90E-02	2.63E-02	5.83E+00
CO2-EOR Crude Oil Transport	7.63E-01	2.90E-02	4.08E-03	2.82E-09	7.96E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	4.80E-02	6.77E-03	4.67E-09	1.32E+00
Crude Oil Ocean Transport	1.15E+00	3.80E-02	3.71E-03	1.59E-06	1.19E+00
Crude Oil Refining and End Use	1.53E+02	2.16E-01	7.62E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	4.48E-01	1.50E-02	-	2.34E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	6.64E-03	3.31E-03	-	5.16E-01
Total	6.30E+02	3.33E+01	1.58E-01	2.63E-02	6.63E+02

Exhibit A-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	1.66E+01	1.60E-02	-	4.27E+01
Natural Gas Pipelines to GTP	2.17E-03	2.59E+00	-	-	2.60E+00
Natural Gas Processing at GTP	2.42E+01	3.95E-01	2.74E-05	-	2.46E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	3.48E+00	5.72E-07	-	8.72E+00
Liquefaction	2.27E+01	5.88E+00	4.24E-03	1.35E-07	2.86E+01
Ocean Transport	3.39E+01	3.14E+00	1.12E-01	-	3.71E+01
LNG Regasification	3.02E+00	4.00E-01	1.02E-02	8.93E-05	3.43E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	1.46E+00	6.18E-06	-	4.11E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	3.32E-01	1.92E-02	2.65E-02	5.89E+00
CO2-EOR Crude Oil Transport	7.71E-01	2.93E-02	4.13E-03	2.84E-09	8.04E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	4.85E-02	6.84E-03	4.72E-09	1.33E+00
Crude Oil Ocean Transport	1.16E+00	3.84E-02	3.75E-03	1.61E-06	1.20E+00
Crude Oil Refining and End Use	1.54E+02	2.18E-01	7.70E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	4.15E-01	1.38E-02	-	2.17E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	6.71E-03	3.34E-03	-	5.21E-01
Total	6.45E+02	3.50E+01	2.01E-01	2.66E-02	6.80E+02

Exhibit A-21. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	1.19E+01	0.00E+00	5.09E+01	2.53E+00	8.65E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	4.50E+01	2.52E+00	8.65E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	4.52E+01
2030	1.86E+01	5.83E+01	4.16E+01	0.00E+00	1.19E+02	8.87E+00	3.03E+01	3.61E+00	5.61E+01	2.49E+00	2.46E+00	1.04E+02	8.81E+00	3.03E+01	3.88E+00	5.78E+01	5.53E-01	2.70E+00	1.04E+02
2031	2.74E+01	8.63E+01	9.51E+01	1.16E+00	2.10E+02	2.03E+01	6.92E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.85E+02	2.01E+01	6.92E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.85E+02
2032	3.61E+01	1.13E+02	1.61E+02	3.82E+00	3.14E+02	3.42E+01	1.17E+02	6.79E+00	1.05E+02	1.28E+01	2.57E+00	2.79E+02	3.40E+01	1.17E+02	8.18E+00	1.16E+02	5.53E-01	2.81E+00	2.79E+02
2033	4.45E+01	1.40E+02	2.32E+02	7.38E+00	4.24E+02	4.94E+01	1.69E+02	8.23E+00	1.28E+02	2.08E+01	2.57E+00	3.78E+02	4.91E+01	1.69E+02	1.05E+01	1.46E+02	5.53E-01	2.81E+00	3.78E+02
2034	5.26E+01	1.65E+02	3.03E+02	1.09E+01	5.32E+02	6.46E+01	2.21E+02	9.58E+00	1.49E+02	2.96E+01	2.57E+00	4.76E+02	6.42E+01	2.21E+02	1.28E+01	1.75E+02	5.53E-01	2.81E+00	4.76E+02
2035	6.06E+01	1.90E+02	3.75E+02	1.41E+01	6.40E+02	7.98E+01	2.73E+02	1.08E+01	1.69E+02	3.87E+01	2.57E+00	5.73E+02	7.93E+01	2.73E+02	1.50E+01	2.03E+02	5.53E-01	2.81E+00	5.73E+02
2036	6.83E+01	2.15E+02	4.46E+02	1.68E+01	7.46E+02	9.50E+01	3.24E+02	1.20E+01	1.87E+02	4.79E+01	2.57E+00	6.69E+02	9.44E+01	3.24E+02	1.72E+01	2.29E+02	5.53E-01	2.81E+00	6.69E+02
2037	7.58E+01	2.38E+02	5.17E+02	1.90E+01	8.50E+02	1.10E+02	3.76E+02	1.31E+01	2.04E+02	5.72E+01	2.57E+00	7.64E+02	1.09E+02	3.76E+02	1.94E+01	2.55E+02	5.53E-01	2.81E+00	7.63E+02
2038	8.31E+01	2.61E+02	5.89E+02	2.09E+01	9.54E+02	1.25E+02	4.28E+02	1.42E+01	2.20E+02	6.68E+01	2.57E+00	8.57E+02	1.25E+02	4.28E+02	2.14E+01	2.79E+02	5.53E-01	2.81E+00	8.57E+02
2039	9.02E+01	2.84E+02	6.60E+02	2.25E+01	1.06E+03	1.41E+02	4.80E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	9.50E+02	1.40E+02	4.80E+02	2.34E+01	3.03E+02	5.53E-01	2.81E+00	9.50E+02
2040	9.71E+01	3.05E+02	7.31E+02	2.37E+01	1.16E+03	1.56E+02	5.32E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	1.04E+03	1.55E+02	5.32E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	1.04E+03
2041	1.04E+02	3.26E+02	8.03E+02	2.45E+01	1.26E+03	1.71E+02	5.84E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	1.13E+03	1.70E+02	5.84E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	1.13E+03
2042	1.10E+02	3.47E+02	8.74E+02	2.49E+01	1.36E+03	1.86E+02	6.36E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	1.22E+03	1.85E+02	6.36E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	1.22E+03
2043	1.17E+02	3.67E+02	9.45E+02	2.51E+01	1.45E+03	2.01E+02	6.88E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	1.31E+03	2.00E+02	6.88E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	1.31E+03
2044	1.23E+02	3.86E+02	1.02E+03	2.51E+01	1.55E+03	2.17E+02	7.40E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	1.40E+03	2.15E+02	7.40E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	1.40E+03
2045	1.29E+02	4.05E+02	1.09E+03	2.51E+01	1.65E+03	2.32E+02	7.92E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	1.49E+03	2.30E+02	7.92E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	1.49E+03
2046	1.35E+02	4.23E+02	1.16E+03	2.51E+01	1.74E+03	2.47E+02	8.44E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	1.57E+03	2.45E+02	8.44E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	1.57E+03
2047	1.40E+02	4.41E+02	1.23E+03	2.51E+01	1.84E+03	2.62E+02	8.95E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	1.66E+03	2.60E+02	8.95E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	1.66E+03
2048	1.46E+02	4.59E+02	1.30E+03	2.51E+01	1.93E+03	2.77E+02	9.47E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.75E+03	2.76E+02	9.47E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.75E+03
2049	1.51E+02	4.76E+02	1.37E+03	2.51E+01	2.03E+03	2.93E+02	9.99E+02	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.83E+03	2.91E+02	9.99E+02	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.83E+03
2050	1.57E+02	4.92E+02	1.44E+03	2.51E+01	2.12E+03	3.08E+02	1.05E+03	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.92E+03	3.06E+02	1.05E+03	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.92E+03
2051	1.62E+02	5.08E+02	1.52E+03	2.51E+01	2.21E+03	3.23E+02	1.10E+03	2.29E+01	3.56E+02	1.95E+02	2.57E+00	2.00E+03	3.21E+02	1.10E+03	4.41E+01	5.27E+02	4.39E+00	2.81E+00	2.00E+03
2052	1.67E+02	5.24E+02	1.59E+03	2.51E+01	2.30E+03	3.38E+02	1.16E+03	2.34E+01	3.63E+02	2.05E+02	2.57E+00	2.09E+03	3.36E+02	1.16E+03	4.57E+01	5.41E+02	5.37E+00	2.81E+00	2.09E+03
2053	1.71E+02	5.39E+02	1.66E+03	2.51E+01	2.39E+03	3.53E+02	1.21E+03	2.38E+01	3.69E+02	2.16E+02	2.57E+00	2.17E+03	3.51E+02	1.21E+03	4.72E+01	5.56E+02	6.53E+00	2.81E+00	2.17E+03
2054	1.76E+02	5.54E+02	1.73E+03	2.51E+01	2.49E+03	3.69E+02	1.26E+03	2.41E+01	3.75E+02	2.26E+02	2.57E+00	2.25E+03	3.66E+02	1.26E+03	4.86E+01	5.69E+02	7.79E+00	2.81E+00	2.25E+03
2055	1.81E+02	5.68E+02	1.80E+03	2.51E+01	2.58E+03	3.84E+02	1.31E+03	2.45E+01	3.80E+02	2.36E+02	2.57E+00	2.34E+03	3.81E+02	1.31E+03	5.01E+01	5.83E+02	9.11E+00	2.81E+00	2.34E+03
2056	1.85E+02	5.82E+02	1.87E+03	2.51E+01	2.67E+03	3.99E+02	1.36E+03	2.48E+01	3.85E+02	2.46E+02	2.57E+00	2.42E+03	3.96E+02	1.36E+03	5.15E+01	5.95E+02	1.04E+01	2.81E+00	2.42E+03
2057	1.90E+02	5.96E+02	1.94E+03	2.51E+01	2.75E+03	4.14E+02	1.41E+03	2.51E+01	3.90E+02	2.56E+02	2.57E+00	2.50E+03	4.12E+02	1.41E+03	5.29E+01	6.08E+02	1.17E+01	2.81E+00	2.50E+03
2058	1.94E+02	6.09E+02	2.01E+03	2.51E+01	2.84E+03	4.28E+02	1.46E+03	2.54E+01	3.94E+02	2.66E+02	2.57E+00	2.58E+03	4.25E+02	1.46E+03	5.43E+01	6.20E+02	1.32E+01	2.81E+00	2.58E+03
2059	1.98E+02	6.22E+02	2.06E+03	2.51E+01	2.90E+03	4.39E+02	1.50E+03	2.56E+01	3.98E+02	2.76E+02	2.57E+00	2.64E+03	4.36E+02	1.50E+03	5.56E+01	6.31E+02	1.56E+01	2.81E+00	2.64E+03
2060	2.02E+02	6.35E+02	2.10E+03	2.51E+01	2.96E+03	4.47E+02	1.53E+03	2.59E+01	4.02E+02	2.86E+02	2.57E+00	2.69E+03	4.45E+02	1.53E+03	5.70E+01	6.41E+02	1.87E+01	2.81E+00	2.69E+03
2061	2.06E+02	6.47E+02	2.13E+03	2.51E+01	3.01E+03	4.54E+02	1.55E+03	2.61E+01	4.05E+02	2.96E+02	2.57E+00	2.74E+03	4.51E+02	1.55E+03	5.83E+01	6.50E+02	2.25E+01	2.81E+00	2.74E+03

Exhibit A-22. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	1.20E+01	0.00E+00	5.10E+01	2.53E+00	8.71E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	4.50E+01	2.52E+00	8.71E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	4.53E+01
2030	1.86E+01	5.83E+01	4.18E+01	0.00E+00	1.19E+02	8.87E+00	3.05E+01	3.61E+00	5.61E+01	2.49E+00	2.46E+00	1.04E+02	8.81E+00	3.05E+01	3.88E+00	5.78E+01	5.53E-01	2.70E+00	1.04E+02
2031	2.74E+01	8.63E+01	9.56E+01	1.16E+00	2.11E+02	2.03E+01	6.96E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.86E+02	2.01E+01	6.96E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.86E+02
2032	3.61E+01	1.13E+02	1.61E+02	3.82E+00	3.15E+02	3.42E+01	1.18E+02	6.79E+00	1.05E+02	1.28E+01	2.57E+00	2.79E+02	3.40E+01	1.18E+02	8.18E+00	1.16E+02	5.53E-01	2.81E+00	2.79E+02
2033	4.45E+01	1.40E+02	2.33E+02	7.38E+00	4.25E+02	4.94E+01	1.70E+02	8.23E+00	1.28E+02	2.08E+01	2.57E+00	3.79E+02	4.91E+01	1.70E+02	1.05E+01	1.46E+02	5.53E-01	2.81E+00	3.79E+02
2034	5.26E+01	1.65E+02	3.05E+02	1.09E+01	5.34E+02	6.46E+01	2.22E+02	9.58E+00	1.49E+02	2.96E+01	2.57E+00	4.77E+02	6.42E+01	2.22E+02	1.28E+01	1.75E+02	5.53E-01	2.81E+00	4.77E+02
2035	6.06E+01	1.90E+02	3.77E+02	1.41E+01	6.42E+02	7.98E+01	2.74E+02	1.08E+01	1.69E+02	3.87E+01	2.57E+00	5.75E+02	7.93E+01	2.74E+02	1.50E+01	2.03E+02	5.53E-01	2.81E+00	5.74E+02
2036	6.83E+01	2.15E+02	4.48E+02	1.68E+01	7.48E+02	9.50E+01	3.26E+02	1.20E+01	1.87E+02	4.79E+01	2.57E+00	6.71E+02	9.44E+01	3.26E+02	1.72E+01	2.29E+02	5.53E-01	2.81E+00	6.71E+02
2037	7.58E+01	2.38E+02	5.20E+02	1.90E+01	8.53E+02	1.10E+02	3.79E+02	1.31E+01	2.04E+02	5.72E+01	2.57E+00	7.66E+02	1.09E+02	3.79E+02	1.94E+01	2.55E+02	5.53E-01	2.81E+00	7.66E+02
2038	8.31E+01	2.61E+02	5.92E+02	2.09E+01	9.57E+02	1.25E+02	4.31E+02	1.42E+01	2.20E+02	6.68E+01	2.57E+00	8.60E+02	1.25E+02	4.31E+02	2.14E+01	2.79E+02	5.53E-01	2.81E+00	8.60E+02
2039	9.02E+01	2.84E+02	6.63E+02	2.25E+01	1.06E+03	1.41E+02	4.83E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	9.53E+02	1.40E+02	4.83E+02	2.34E+01	3.03E+02	5.53E-01	2.81E+00	9.53E+02
2040	9.71E+01	3.05E+02	7.35E+02	2.37E+01	1.16E+03	1.56E+02	5.35E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	1.05E+03	1.55E+02	5.35E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	1.04E+03
2041	1.04E+02	3.26E+02	8.07E+02	2.45E+01	1.26E+03	1.71E+02	5.88E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	1.14E+03	1.70E+02	5.88E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	1.14E+03
2042	1.10E+02	3.47E+02	8.79E+02	2.49E+01	1.36E+03	1.86E+02	6.40E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	1.23E+03	1.85E+02	6.40E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	1.23E+03
2043	1.17E+02	3.67E+02	9.50E+02	2.51E+01	1.46E+03	2.01E+02	6.92E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	1.32E+03	2.00E+02	6.92E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	1.32E+03
2044	1.23E+02	3.86E+02	1.02E+03	2.51E+01	1.56E+03	2.17E+02	7.44E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	1.40E+03	2.15E+02	7.44E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	1.40E+03
2045	1.29E+02	4.05E+02	1.09E+03	2.51E+01	1.65E+03	2.32E+02	7.97E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	1.49E+03	2.30E+02	7.97E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	1.49E+03
2046	1.35E+02	4.23E+02	1.17E+03	2.51E+01	1.75E+03	2.47E+02	8.49E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	1.58E+03	2.45E+02	8.49E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	1.58E+03
2047	1.40E+02	4.41E+02	1.24E+03	2.51E+01	1.84E+03	2.62E+02	9.01E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	1.67E+03	2.60E+02	9.01E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	1.67E+03
2048	1.46E+02	4.59E+02	1.31E+03	2.51E+01	1.94E+03	2.77E+02	9.53E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.75E+03	2.76E+02	9.53E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.75E+03
2049	1.51E+02	4.76E+02	1.38E+03	2.51E+01	2.03E+03	2.93E+02	1.01E+03	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.84E+03	2.91E+02	1.01E+03	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.84E+03
2050	1.57E+02	4.92E+02	1.45E+03	2.51E+01	2.13E+03	3.08E+02	1.06E+03	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.93E+03	3.06E+02	1.06E+03	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.92E+03
2051	1.62E+02	5.08E+02	1.52E+03	2.51E+01	2.22E+03	3.23E+02	1.11E+03	2.29E+01	3.56E+02	1.95E+02	2.57E+00	2.01E+03	3.21E+02	1.11E+03	4.41E+01	5.27E+02	4.39E+00	2.81E+00	2.01E+03
2052	1.67E+02	5.24E+02	1.60E+03	2.51E+01	2.31E+03	3.38E+02	1.16E+03	2.34E+01	3.63E+02	2.05E+02	2.57E+00	2.09E+03	3.36E+02	1.16E+03	4.57E+01	5.41E+02	5.37E+00	2.81E+00	2.09E+03
2053	1.71E+02	5.39E+02	1.67E+03	2.51E+01	2.40E+03	3.53E+02	1.21E+03	2.38E+01	3.69E+02	2.16E+02	2.57E+00	2.18E+03	3.51E+02	1.21E+03	4.72E+01	5.56E+02	6.53E+00	2.81E+00	2.18E+03
2054	1.76E+02	5.54E+02	1.74E+03	2.51E+01	2.49E+03	3.69E+02	1.27E+03	2.41E+01	3.75E+02	2.26E+02	2.57E+00	2.26E+03	3.66E+02	1.27E+03	4.86E+01	5.69E+02	7.79E+00	2.81E+00	2.26E+03
2055	1.81E+02	5.68E+02	1.81E+03	2.51E+01	2.59E+03	3.84E+02	1.32E+03	2.45E+01	3.80E+02	2.36E+02	2.57E+00	2.35E+03	3.81E+02	1.32E+03	5.01E+01	5.83E+02	9.11E+00	2.81E+00	2.34E+03
2056	1.85E+02	5.82E+02	1.88E+03	2.51E+01	2.68E+03	3.99E+02	1.37E+03	2.48E+01	3.85E+02	2.46E+02	2.57E+00	2.43E+03	3.96E+02	1.37E+03	5.15E+01	5.95E+02	1.04E+01	2.81E+00	2.43E+03
2057	1.90E+02	5.96E+02	1.95E+03	2.51E+01	2.77E+03	4.14E+02	1.42E+03	2.51E+01	3.90E+02	2.56E+02	2.57E+00	2.51E+03	4.12E+02	1.42E+03	5.29E+01	6.08E+02	1.17E+01	2.81E+00	2.51E+03
2058	1.94E+02	6.09E+02	2.02E+03	2.51E+01	2.85E+03	4.28E+02	1.47E+03	2.54E+01	3.94E+02	2.66E+02	2.57E+00	2.59E+03	4.25E+02	1.47E+03	5.43E+01	6.20E+02	1.32E+01	2.81E+00	2.59E+03
2059	1.98E+02	6.22E+02	2.07E+03	2.51E+01	2.92E+03	4.39E+02	1.51E+03	2.56E+01	3.98E+02	2.76E+02	2.57E+00	2.65E+03	4.36E+02	1.51E+03	5.56E+01	6.31E+02	1.56E+01	2.81E+00	2.65E+03
2060	2.02E+02	6.35E+02	2.11E+03	2.51E+01	2.97E+03	4.47E+02	1.54E+03	2.59E+01	4.02E+02	2.86E+02	2.57E+00	2.70E+03	4.45E+02	1.54E+03	5.70E+01	6.41E+02	1.87E+01	2.81E+00	2.70E+03
2061	2.06E+02	6.47E+02	2.14E+03	2.51E+01	3.02E+03	4.54E+02	1.56E+03	2.61E+01	4.05E+02	2.96E+02	2.57E+00	2.75E+03	4.51E+02	1.56E+03	5.83E+01	6.50E+02	2.25E+01	2.81E+00	2.75E+03

Exhibit A-23. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	1.20E+01	0.00E+00	5.10E+01	2.53E+00	8.71E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	4.50E+01	2.52E+00	8.71E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	4.53E+01
2030	1.86E+01	5.83E+01	4.18E+01	0.00E+00	1.19E+02	8.87E+00	3.05E+01	3.61E+00	5.61E+01	2.49E+00	2.46E+00	1.04E+02	8.81E+00	3.05E+01	3.88E+00	5.78E+01	5.53E-01	2.70E+00	1.04E+02
2031	2.74E+01	8.63E+01	9.57E+01	1.16E+00	2.11E+02	2.03E+01	6.97E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.86E+02	2.01E+01	6.97E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.86E+02
2032	3.61E+01	1.13E+02	1.61E+02	3.82E+00	3.15E+02	3.42E+01	1.18E+02	6.79E+00	1.05E+02	1.28E+01	2.57E+00	2.79E+02	3.40E+01	1.18E+02	8.18E+00	1.16E+02	5.53E-01	2.81E+00	2.79E+02
2033	4.45E+01	1.40E+02	2.33E+02	7.38E+00	4.25E+02	4.94E+01	1.70E+02	8.23E+00	1.28E+02	2.08E+01	2.57E+00	3.79E+02	4.91E+01	1.70E+02	1.05E+01	1.46E+02	5.53E-01	2.81E+00	3.79E+02
2034	5.26E+01	1.65E+02	3.05E+02	1.09E+01	5.34E+02	6.46E+01	2.22E+02	9.58E+00	1.49E+02	2.96E+01	2.57E+00	4.77E+02	6.42E+01	2.22E+02	1.28E+01	1.75E+02	5.53E-01	2.81E+00	4.77E+02
2035	6.06E+01	1.90E+02	3.77E+02	1.41E+01	6.42E+02	7.98E+01	2.74E+02	1.08E+01	1.69E+02	3.87E+01	2.57E+00	5.75E+02	7.93E+01	2.74E+02	1.50E+01	2.03E+02	5.53E-01	2.81E+00	5.75E+02
2036	6.83E+01	2.15E+02	4.48E+02	1.68E+01	7.48E+02	9.50E+01	3.27E+02	1.20E+01	1.87E+02	4.79E+01	2.57E+00	6.71E+02	9.44E+01	3.27E+02	1.72E+01	2.29E+02	5.53E-01	2.81E+00	6.71E+02
2037	7.58E+01	2.38E+02	5.20E+02	1.90E+01	8.53E+02	1.10E+02	3.79E+02	1.31E+01	2.04E+02	5.72E+01	2.57E+00	7.66E+02	1.09E+02	3.79E+02	1.94E+01	2.55E+02	5.53E-01	2.81E+00	7.66E+02
2038	8.31E+01	2.61E+02	5.92E+02	2.09E+01	9.57E+02	1.25E+02	4.31E+02	1.42E+01	2.20E+02	6.68E+01	2.57E+00	8.60E+02	1.25E+02	4.31E+02	2.14E+01	2.79E+02	5.53E-01	2.81E+00	8.60E+02
2039	9.02E+01	2.84E+02	6.64E+02	2.25E+01	1.06E+03	1.41E+02	4.83E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	9.53E+02	1.40E+02	4.83E+02	2.34E+01	3.03E+02	5.53E-01	2.81E+00	9.53E+02
2040	9.71E+01	3.05E+02	7.35E+02	2.37E+01	1.16E+03	1.56E+02	5.36E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	1.05E+03	1.55E+02	5.36E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	1.04E+03
2041	1.04E+02	3.26E+02	8.07E+02	2.45E+01	1.26E+03	1.71E+02	5.88E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	1.14E+03	1.70E+02	5.88E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	1.14E+03
2042	1.10E+02	3.47E+02	8.79E+02	2.49E+01	1.36E+03	1.86E+02	6.40E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	1.23E+03	1.85E+02	6.40E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	1.23E+03
2043	1.17E+02	3.67E+02	9.51E+02	2.51E+01	1.46E+03	2.01E+02	6.92E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	1.32E+03	2.00E+02	6.92E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	1.32E+03
2044	1.23E+02	3.86E+02	1.02E+03	2.51E+01	1.56E+03	2.17E+02	7.45E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	1.40E+03	2.15E+02	7.45E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	1.40E+03
2045	1.29E+02	4.05E+02	1.09E+03	2.51E+01	1.65E+03	2.32E+02	7.97E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	1.49E+03	2.30E+02	7.97E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	1.49E+03
2046	1.35E+02	4.23E+02	1.17E+03	2.51E+01	1.75E+03	2.47E+02	8.49E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	1.58E+03	2.45E+02	8.49E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	1.58E+03
2047	1.40E+02	4.41E+02	1.24E+03	2.51E+01	1.84E+03	2.62E+02	9.01E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	1.67E+03	2.60E+02	9.01E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	1.67E+03
2048	1.46E+02	4.59E+02	1.31E+03	2.51E+01	1.94E+03	2.77E+02	9.54E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.75E+03	2.76E+02	9.54E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.75E+03
2049	1.51E+02	4.76E+02	1.38E+03	2.51E+01	2.03E+03	2.93E+02	1.01E+03	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.84E+03	2.91E+02	1.01E+03	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.84E+03
2050	1.57E+02	4.92E+02	1.45E+03	2.51E+01	2.13E+03	3.08E+02	1.06E+03	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.93E+03	3.06E+02	1.06E+03	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.92E+03
2051	1.62E+02	5.08E+02	1.52E+03	2.51E+01	2.22E+03	3.23E+02	1.11E+03	2.29E+01	3.56E+02	1.95E+02	2.57E+00	2.01E+03	3.21E+02	1.11E+03	4.41E+01	5.27E+02	4.39E+00	2.81E+00	2.01E+03
2052	1.67E+02	5.24E+02	1.60E+03	2.51E+01	2.31E+03	3.38E+02	1.16E+03	2.34E+01	3.63E+02	2.05E+02	2.57E+00	2.10E+03	3.36E+02	1.16E+03	4.57E+01	5.41E+02	5.37E+00	2.81E+00	2.09E+03
2053	1.71E+02	5.39E+02	1.67E+03	2.51E+01	2.40E+03	3.53E+02	1.21E+03	2.38E+01	3.69E+02	2.16E+02	2.57E+00	2.18E+03	3.51E+02	1.21E+03	4.72E+01	5.56E+02	6.53E+00	2.81E+00	2.18E+03
2054	1.76E+02	5.54E+02	1.74E+03	2.51E+01	2.49E+03	3.69E+02	1.27E+03	2.41E+01	3.75E+02	2.26E+02	2.57E+00	2.26E+03	3.66E+02	1.27E+03	4.86E+01	5.69E+02	7.79E+00	2.81E+00	2.26E+03
2055	1.81E+02	5.68E+02	1.81E+03	2.51E+01	2.59E+03	3.84E+02	1.32E+03	2.45E+01	3.80E+02	2.36E+02	2.57E+00	2.35E+03	3.81E+02	1.32E+03	5.01E+01	5.83E+02	9.11E+00	2.81E+00	2.35E+03
2056	1.85E+02	5.82E+02	1.88E+03	2.51E+01	2.68E+03	3.99E+02	1.37E+03	2.48E+01	3.85E+02	2.46E+02	2.57E+00	2.43E+03	3.96E+02	1.37E+03	5.15E+01	5.95E+02	1.04E+01	2.81E+00	2.43E+03
2057	1.90E+02	5.96E+02	1.95E+03	2.51E+01	2.77E+03	4.14E+02	1.42E+03	2.51E+01	3.90E+02	2.56E+02	2.57E+00	2.51E+03	4.12E+02	1.42E+03	5.29E+01	6.08E+02	1.17E+01	2.81E+00	2.51E+03
2058	1.94E+02	6.09E+02	2.02E+03	2.51E+01	2.85E+03	4.28E+02	1.47E+03	2.54E+01	3.94E+02	2.66E+02	2.57E+00	2.59E+03	4.25E+02	1.47E+03	5.43E+01	6.20E+02	1.32E+01	2.81E+00	2.59E+03
2059	1.98E+02	6.22E+02	2.07E+03	2.51E+01	2.92E+03	4.39E+02	1.51E+03	2.56E+01	3.98E+02	2.76E+02	2.57E+00	2.65E+03	4.36E+02	1.51E+03	5.56E+01	6.31E+02	1.56E+01	2.81E+00	2.65E+03
2060	2.02E+02	6.35E+02	2.11E+03	2.51E+01	2.97E+03	4.47E+02	1.54E+03	2.59E+01	4.02E+02	2.86E+02	2.57E+00	2.70E+03	4.45E+02	1.54E+03	5.70E+01	6.41E+02	1.87E+01	2.81E+00	2.70E+03
2061	2.06E+02	6.47E+02	2.14E+03	2.51E+01	3.02E+03	4.54E+02	1.56E+03	2.61E+01	4.05E+02	2.96E+02	2.57E+00	2.75E+03	4.51E+02	1.56E+03	5.83E+01	6.50E+02	2.25E+01	2.81E+00	2.75E+03

Exhibit A-24. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	1.19E+01	0.00E+00	5.09E+01	2.53E+00	8.99E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	4.53E+01	2.52E+00	8.99E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	4.56E+01
2030	1.86E+01	5.83E+01	4.18E+01	0.00E+00	1.19E+02	8.87E+00	3.15E+01	3.61E+00	5.61E+01	2.49E+00	2.46E+00	1.05E+02	8.81E+00	3.15E+01	3.88E+00	5.78E+01	5.53E-01	2.70E+00	1.05E+02
2031	2.74E+01	8.63E+01	9.55E+01	1.16E+00	2.10E+02	2.03E+01	7.19E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.88E+02	2.01E+01	7.19E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.88E+02
2032	3.61E+01	1.13E+02	1.61E+02	3.82E+00	3.14E+02	3.42E+01	1.21E+02	6.79E+00	1.05E+02	1.28E+01	2.57E+00	2.83E+02	3.40E+01	1.21E+02	8.18E+00	1.16E+02	5.53E-01	2.81E+00	2.83E+02
2033	4.45E+01	1.40E+02	2.33E+02	7.38E+00	4.24E+02	4.94E+01	1.75E+02	8.23E+00	1.28E+02	2.08E+01	2.57E+00	3.84E+02	4.91E+01	1.75E+02	1.05E+01	1.46E+02	5.53E-01	2.81E+00	3.84E+02
2034	5.26E+01	1.65E+02	3.04E+02	1.09E+01	5.33E+02	6.46E+01	2.29E+02	9.58E+00	1.49E+02	2.96E+01	2.57E+00	4.84E+02	6.42E+01	2.29E+02	1.28E+01	1.75E+02	5.53E-01	2.81E+00	4.84E+02
2035	6.06E+01	1.90E+02	3.76E+02	1.41E+01	6.41E+02	7.98E+01	2.83E+02	1.08E+01	1.69E+02	3.87E+01	2.57E+00	5.84E+02	7.93E+01	2.83E+02	1.50E+01	2.03E+02	5.53E-01	2.81E+00	5.83E+02
2036	6.83E+01	2.15E+02	4.47E+02	1.68E+01	7.47E+02	9.50E+01	3.37E+02	1.20E+01	1.87E+02	4.79E+01	2.57E+00	6.82E+02	9.44E+01	3.37E+02	1.72E+01	2.29E+02	5.53E-01	2.81E+00	6.81E+02
2037	7.58E+01	2.38E+02	5.19E+02	1.90E+01	8.52E+02	1.10E+02	3.91E+02	1.31E+01	2.04E+02	5.72E+01	2.57E+00	7.78E+02	1.09E+02	3.91E+02	1.94E+01	2.55E+02	5.53E-01	2.81E+00	7.78E+02
2038	8.31E+01	2.61E+02	5.91E+02	2.09E+01	9.56E+02	1.25E+02	4.45E+02	1.42E+01	2.20E+02	6.68E+01	2.57E+00	8.74E+02	1.25E+02	4.45E+02	2.14E+01	2.79E+02	5.53E-01	2.81E+00	8.74E+02
2039	9.02E+01	2.84E+02	6.62E+02	2.25E+01	1.06E+03	1.41E+02	4.99E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	9.69E+02	1.40E+02	4.99E+02	2.34E+01	3.03E+02	5.53E-01	2.81E+00	9.69E+02
2040	9.71E+01	3.05E+02	7.34E+02	2.37E+01	1.16E+03	1.56E+02	5.53E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	1.06E+03	1.55E+02	5.53E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	1.06E+03
2041	1.04E+02	3.26E+02	8.05E+02	2.45E+01	1.26E+03	1.71E+02	6.07E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	1.16E+03	1.70E+02	6.07E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	1.15E+03
2042	1.10E+02	3.47E+02	8.77E+02	2.49E+01	1.36E+03	1.86E+02	6.61E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	1.25E+03	1.85E+02	6.61E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	1.25E+03
2043	1.17E+02	3.67E+02	9.49E+02	2.51E+01	1.46E+03	2.01E+02	7.15E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	1.34E+03	2.00E+02	7.15E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	1.34E+03
2044	1.23E+02	3.86E+02	1.02E+03	2.51E+01	1.55E+03	2.17E+02	7.69E+02	1.91E+01	2.98E+02	1.24E+02	2.57E+00	1.43E+03	2.15E+02	7.69E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	1.43E+03
2045	1.29E+02	4.05E+02	1.09E+03	2.51E+01	1.65E+03	2.32E+02	8.23E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	1.52E+03	2.30E+02	8.23E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	1.52E+03
2046	1.35E+02	4.23E+02	1.16E+03	2.51E+01	1.75E+03	2.47E+02	8.77E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	1.61E+03	2.45E+02	8.77E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	1.61E+03
2047	1.40E+02	4.41E+02	1.24E+03	2.51E+01	1.84E+03	2.62E+02	9.30E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	1.70E+03	2.60E+02	9.30E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	1.70E+03
2048	1.46E+02	4.59E+02	1.31E+03	2.51E+01	1.94E+03	2.77E+02	9.84E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.78E+03	2.76E+02	9.84E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.78E+03
2049	1.51E+02	4.76E+02	1.38E+03	2.51E+01	2.03E+03	2.93E+02	1.04E+03	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.87E+03	2.91E+02	1.04E+03	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.87E+03
2050	1.57E+02	4.92E+02	1.45E+03	2.51E+01	2.12E+03	3.08E+02	1.09E+03	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.96E+03	3.06E+02	1.09E+03	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.96E+03
2051	1.62E+02	5.08E+02	1.52E+03	2.51E+01	2.22E+03	3.23E+02	1.15E+03	2.29E+01	3.56E+02	1.95E+02	2.57E+00	2.05E+03	3.21E+02	1.15E+03	4.41E+01	5.27E+02	4.39E+00	2.81E+00	2.05E+03
2052	1.67E+02	5.24E+02	1.59E+03	2.51E+01	2.31E+03	3.38E+02	1.20E+03	2.34E+01	3.63E+02	2.05E+02	2.57E+00	2.13E+03	3.36E+02	1.20E+03	4.57E+01	5.41E+02	5.37E+00	2.81E+00	2.13E+03
2053	1.71E+02	5.39E+02	1.66E+03	2.51E+01	2.40E+03	3.53E+02	1.25E+03	2.37E+01	3.69E+02	2.16E+02	2.57E+00	2.22E+03	3.51E+02	1.25E+03	4.72E+01	5.56E+02	6.53E+00	2.81E+00	2.22E+03
2054	1.76E+02	5.54E+02	1.74E+03	2.51E+01	2.49E+03	3.69E+02	1.31E+03	2.41E+01	3.75E+02	2.26E+02	2.57E+00	2.30E+03	3.66E+02	1.31E+03	4.86E+01	5.69E+02	7.79E+00	2.81E+00	2.30E+03
2055	1.81E+02	5.68E+02	1.81E+03	2.51E+01	2.58E+03	3.84E+02	1.36E+03	2.45E+01	3.80E+02	2.36E+02	2.57E+00	2.39E+03	3.81E+02	1.36E+03	5.01E+01	5.83E+02	9.11E+00	2.81E+00	2.39E+03
2056	1.85E+02	5.82E+02	1.88E+03	2.51E+01	2.67E+03	3.99E+02	1.42E+03	2.48E+01	3.85E+02	2.46E+02	2.57E+00	2.47E+03	3.96E+02	1.42E+03	5.15E+01	5.95E+02	1.04E+01	2.81E+00	2.47E+03
2057	1.90E+02	5.96E+02	1.95E+03	2.51E+01	2.76E+03	4.14E+02	1.47E+03	2.51E+01	3.90E+02	2.56E+02	2.57E+00	2.56E+03	4.11E+02	1.47E+03	5.29E+01	6.08E+02	1.17E+01	2.81E+00	2.56E+03
2058	1.94E+02	6.09E+02	2.02E+03	2.51E+01	2.84E+03	4.28E+02	1.52E+03	2.54E+01	3.94E+02	2.66E+02	2.57E+00	2.63E+03	4.25E+02	1.52E+03	5.43E+01	6.20E+02	1.32E+01	2.81E+00	2.63E+03
2059	1.98E+02	6.22E+02	2.07E+03	2.51E+01	2.91E+03	4.39E+02	1.56E+03	2.56E+01	3.98E+02	2.76E+02	2.57E+00	2.70E+03	4.36E+02	1.56E+03	5.56E+01	6.31E+02	1.56E+01	2.81E+00	2.70E+03
2060	2.02E+02	6.35E+02	2.11E+03	2.51E+01	2.97E+03	4.47E+02	1.59E+03	2.59E+01	4.02E+02	2.86E+02	2.57E+00	2.75E+03	4.45E+02	1.59E+03	5.70E+01	6.41E+02	1.87E+01	2.81E+00	2.75E+03
2061	2.06E+02	6.47E+02	2.14E+03	2.51E+01	3.02E+03	4.54E+02	1.61E+03	2.61E+01	4.05E+02	2.96E+02	2.57E+00	2.80E+03	4.51E+02	1.61E+03	5.83E+01	6.50E+02	2.25E+01	2.81E+00	2.80E+03

Exhibit A-25. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	4.66E+00	0.00E+00	4.37E+01	2.53E+00	1.44E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	3.77E+01	2.52E+00	1.44E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	3.80E+01
2030	1.86E+01	5.83E+01	1.63E+01	0.00E+00	9.32E+01	8.87E+00	5.03E+00	3.61E+00	5.61E+01	2.49E+00	2.46E+00	7.86E+01	8.81E+00	5.03E+00	3.88E+00	5.78E+01	5.53E-01	2.70E+00	7.88E+01
2031	2.74E+01	8.63E+01	3.72E+01	1.16E+00	1.52E+02	2.03E+01	1.15E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.28E+02	2.01E+01	1.15E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.28E+02
2032	3.61E+01	1.13E+02	6.29E+01	3.82E+00	2.16E+02	3.42E+01	1.94E+01	6.79E+00	1.05E+02	1.28E+01	2.57E+00	1.81E+02	3.40E+01	1.94E+01	8.18E+00	1.16E+02	5.53E-01	2.81E+00	1.81E+02
2033	4.45E+01	1.40E+02	9.08E+01	7.38E+00	2.82E+02	4.94E+01	2.80E+01	8.23E+00	1.28E+02	2.08E+01	2.57E+00	2.37E+02	4.91E+01	2.80E+01	1.05E+01	1.46E+02	5.53E-01	2.81E+00	2.37E+02
2034	5.26E+01	1.65E+02	1.19E+02	1.09E+01	3.48E+02	6.46E+01	3.67E+01	9.59E+00	1.49E+02	2.96E+01	2.57E+00	2.92E+02	6.42E+01	3.67E+01	1.28E+01	1.75E+02	5.53E-01	2.81E+00	2.92E+02
2035	6.06E+01	1.90E+02	1.47E+02	1.41E+01	4.12E+02	7.98E+01	4.53E+01	1.09E+01	1.69E+02	3.87E+01	2.57E+00	3.46E+02	7.93E+01	4.53E+01	1.50E+01	2.03E+02	5.53E-01	2.81E+00	3.46E+02
2036	6.83E+01	2.15E+02	1.75E+02	1.68E+01	4.74E+02	9.50E+01	5.39E+01	1.20E+01	1.87E+02	4.79E+01	2.57E+00	3.98E+02	9.44E+01	5.39E+01	1.72E+01	2.29E+02	5.53E-01	2.81E+00	3.98E+02
2037	7.58E+01	2.38E+02	2.03E+02	1.90E+01	5.36E+02	1.10E+02	6.25E+01	1.31E+01	2.04E+02	5.72E+01	2.57E+00	4.50E+02	1.10E+02	6.25E+01	1.94E+01	2.55E+02	5.53E-01	2.81E+00	4.50E+02
2038	8.31E+01	2.61E+02	2.30E+02	2.09E+01	5.96E+02	1.25E+02	7.12E+01	1.42E+01	2.20E+02	6.68E+01	2.57E+00	5.00E+02	1.25E+02	7.12E+01	2.14E+01	2.79E+02	5.53E-01	2.81E+00	5.00E+02
2039	9.02E+01	2.84E+02	2.58E+02	2.25E+01	6.55E+02	1.41E+02	7.98E+01	1.52E+01	2.35E+02	7.64E+01	2.57E+00	5.50E+02	1.40E+02	7.98E+01	2.35E+01	3.03E+02	5.53E-01	2.81E+00	5.49E+02
2040	9.71E+01	3.05E+02	2.86E+02	2.37E+01	7.12E+02	1.56E+02	8.84E+01	1.61E+01	2.49E+02	8.61E+01	2.57E+00	5.98E+02	1.55E+02	8.84E+01	2.54E+01	3.26E+02	5.53E-01	2.81E+00	5.98E+02
2041	1.04E+02	3.26E+02	3.14E+02	2.45E+01	7.69E+02	1.71E+02	9.70E+01	1.69E+01	2.63E+02	9.57E+01	2.57E+00	6.46E+02	1.70E+02	9.70E+01	2.73E+01	3.48E+02	5.53E-01	2.81E+00	6.45E+02
2042	1.10E+02	3.47E+02	3.42E+02	2.49E+01	8.24E+02	1.86E+02	1.06E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	6.93E+02	1.85E+02	1.06E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	6.92E+02
2043	1.17E+02	3.67E+02	3.70E+02	2.51E+01	8.79E+02	2.01E+02	1.14E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	7.38E+02	2.00E+02	1.14E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	7.37E+02
2044	1.23E+02	3.86E+02	3.98E+02	2.51E+01	9.32E+02	2.17E+02	1.23E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	7.83E+02	2.15E+02	1.23E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	7.82E+02
2045	1.29E+02	4.05E+02	4.26E+02	2.51E+01	9.85E+02	2.32E+02	1.32E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	8.28E+02	2.30E+02	1.32E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	8.27E+02
2046	1.35E+02	4.23E+02	4.54E+02	2.51E+01	1.04E+03	2.47E+02	1.40E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	8.72E+02	2.45E+02	1.40E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	8.70E+02
2047	1.40E+02	4.41E+02	4.82E+02	2.51E+01	1.09E+03	2.62E+02	1.49E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	9.15E+02	2.61E+02	1.49E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	9.14E+02
2048	1.46E+02	4.59E+02	5.10E+02	2.51E+01	1.14E+03	2.77E+02	1.57E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	9.58E+02	2.76E+02	1.57E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	9.57E+02
2049	1.51E+02	4.76E+02	5.38E+02	2.51E+01	1.19E+03	2.93E+02	1.66E+02	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.00E+03	2.91E+02	1.66E+02	4.10E+01	4.96E+02	2.80E+00	2.81E+00	9.99E+02
2050	1.57E+02	4.92E+02	5.66E+02	2.51E+01	1.24E+03	3.08E+02	1.75E+02	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.04E+03	3.06E+02	1.75E+02	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.04E+03
2051	1.62E+02	5.08E+02	5.94E+02	2.51E+01	1.29E+03	3.23E+02	1.83E+02	2.30E+01	3.56E+02	1.95E+02	2.57E+00	1.08E+03	3.21E+02	1.83E+02	4.41E+01	5.27E+02	4.39E+00	2.81E+00	1.08E+03
2052	1.67E+02	5.24E+02	6.22E+02	2.51E+01	1.34E+03	3.38E+02	1.92E+02	2.34E+01	3.63E+02	2.05E+02	2.57E+00	1.12E+03	3.36E+02	1.92E+02	4.57E+01	5.41E+02	5.37E+00	2.81E+00	1.12E+03
2053	1.71E+02	5.39E+02	6.50E+02	2.51E+01	1.39E+03	3.53E+02	2.01E+02	2.38E+01	3.69E+02	2.16E+02	2.57E+00	1.17E+03	3.51E+02	2.01E+02	4.72E+01	5.56E+02	6.53E+00	2.81E+00	1.16E+03
2054	1.76E+02	5.54E+02	6.77E+02	2.51E+01	1.43E+03	3.69E+02	2.09E+02	2.41E+01	3.75E+02	2.26E+02	2.57E+00	1.21E+03	3.66E+02	2.09E+02	4.87E+01	5.69E+02	7.79E+00	2.81E+00	1.20E+03
2055	1.81E+02	5.68E+02	7.05E+02	2.51E+01	1.48E+03	3.84E+02	2.18E+02	2.45E+01	3.80E+02	2.36E+02	2.57E+00	1.24E+03	3.81E+02	2.18E+02	5.01E+01	5.83E+02	9.11E+00	2.81E+00	1.24E+03
2056	1.85E+02	5.82E+02	7.33E+02	2.51E+01	1.53E+03	3.99E+02	2.26E+02	2.48E+01	3.85E+02	2.46E+02	2.57E+00	1.28E+03	3.96E+02	2.26E+02	5.15E+01	5.95E+02	1.04E+01	2.81E+00	1.28E+03
2057	1.90E+02	5.96E+02	7.61E+02	2.51E+01	1.57E+03	4.14E+02	2.35E+02	2.51E+01	3.90E+02	2.56E+02	2.57E+00	1.32E+03	4.12E+02	2.35E+02	5.29E+01	6.08E+02	1.17E+01	2.81E+00	1.32E+03
2058	1.94E+02	6.09E+02	7.86E+02	2.51E+01	1.61E+03	4.28E+02	2.43E+02	2.54E+01	3.94E+02	2.66E+02	2.57E+00	1.36E+03	4.25E+02	2.43E+02	5.43E+01	6.20E+02	1.32E+01	2.81E+00	1.36E+03
2059	1.98E+02	6.22E+02	8.06E+02	2.51E+01	1.65E+03	4.39E+02	2.49E+02	2.56E+01	3.98E+02	2.76E+02	2.57E+00	1.39E+03	4.36E+02	2.49E+02	5.56E+01	6.31E+02	1.56E+01	2.81E+00	1.39E+03
2060	2.02E+02	6.35E+02	8.22E+02	2.51E+01	1.68E+03	4.47E+02	2.54E+02	2.59E+01	4.02E+02	2.86E+02	2.57E+00	1.42E+03	4.45E+02	2.54E+02	5.70E+01	6.41E+02	1.87E+01	2.81E+00	1.42E+03
2061	2.06E+02	6.47E+02	8.35E+02	2.51E+01	1.71E+03	4.54E+02	2.58E+02	2.61E+01	4.05E+02	2.96E+02	2.57E+00	1.44E+03	4.52E+02	2.58E+02	5.83E+01	6.50E+02	2.25E+01	2.81E+00	1.44E+03

Exhibit A-26. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	4.73E+00	0.00E+00	4.37E+01	2.53E+00	1.51E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	3.78E+01	2.52E+00	1.51E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	3.81E+01
2030	1.86E+01	5.83E+01	1.66E+01	0.00E+00	9.35E+01	8.87E+00	5.27E+00	3.61E+00	5.61E+01	2.49E+00	2.46E+00	7.88E+01	8.81E+00	5.27E+00	3.88E+00	5.78E+01	5.53E-01	2.70E+00	7.91E+01
2031	2.74E+01	8.63E+01	3.79E+01	1.16E+00	1.53E+02	2.03E+01	1.20E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.28E+02	2.01E+01	1.20E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.28E+02
2032	3.61E+01	1.13E+02	6.39E+01	3.82E+00	2.17E+02	3.42E+01	2.03E+01	6.79E+00	1.05E+02	1.28E+01	2.57E+00	1.82E+02	3.40E+01	2.03E+01	8.18E+00	1.16E+02	5.53E-01	2.81E+00	1.82E+02
2033	4.45E+01	1.40E+02	9.23E+01	7.38E+00	2.84E+02	4.94E+01	2.94E+01	8.23E+00	1.28E+02	2.08E+01	2.57E+00	2.38E+02	4.91E+01	2.94E+01	1.05E+01	1.46E+02	5.53E-01	2.81E+00	2.38E+02
2034	5.26E+01	1.65E+02	1.21E+02	1.09E+01	3.50E+02	6.46E+01	3.84E+01	9.59E+00	1.49E+02	2.96E+01	2.57E+00	2.94E+02	6.42E+01	3.84E+01	1.28E+01	1.75E+02	5.53E-01	2.81E+00	2.94E+02
2035	6.06E+01	1.90E+02	1.49E+02	1.41E+01	4.14E+02	7.98E+01	4.74E+01	1.09E+01	1.69E+02	3.87E+01	2.57E+00	3.48E+02	7.93E+01	4.74E+01	1.50E+01	2.03E+02	5.53E-01	2.81E+00	3.48E+02
2036	6.83E+01	2.15E+02	1.78E+02	1.68E+01	4.77E+02	9.50E+01	5.65E+01	1.20E+01	1.87E+02	4.79E+01	2.57E+00	4.01E+02	9.44E+01	5.65E+01	1.72E+01	2.29E+02	5.53E-01	2.81E+00	4.01E+02
2037	7.58E+01	2.38E+02	2.06E+02	1.90E+01	5.39E+02	1.10E+02	6.55E+01	1.31E+01	2.04E+02	5.72E+01	2.57E+00	4.53E+02	1.09E+02	6.55E+01	1.94E+01	2.55E+02	5.53E-01	2.81E+00	4.52E+02
2038	8.31E+01	2.61E+02	2.34E+02	2.09E+01	6.00E+02	1.25E+02	7.45E+01	1.42E+01	2.20E+02	6.68E+01	2.57E+00	5.04E+02	1.25E+02	7.45E+01	2.14E+01	2.79E+02	5.53E-01	2.81E+00	5.03E+02
2039	9.02E+01	2.84E+02	2.63E+02	2.25E+01	6.59E+02	1.41E+02	8.36E+01	1.52E+01	2.35E+02	7.64E+01	2.57E+00	5.54E+02	1.40E+02	8.36E+01	2.35E+01	3.03E+02	5.53E-01	2.81E+00	5.53E+02
2040	9.71E+01	3.05E+02	2.91E+02	2.37E+01	7.17E+02	1.56E+02	9.26E+01	1.61E+01	2.49E+02	8.61E+01	2.57E+00	6.03E+02	1.55E+02	9.26E+01	2.54E+01	3.26E+02	5.53E-01	2.81E+00	6.02E+02
2041	1.04E+02	3.26E+02	3.20E+02	2.45E+01	7.74E+02	1.71E+02	1.02E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	6.51E+02	1.70E+02	1.02E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	6.50E+02
2042	1.10E+02	3.47E+02	3.48E+02	2.49E+01	8.30E+02	1.86E+02	1.11E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	6.98E+02	1.85E+02	1.11E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	6.97E+02
2043	1.17E+02	3.67E+02	3.76E+02	2.51E+01	8.85E+02	2.01E+02	1.20E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	7.44E+02	2.00E+02	1.20E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	7.43E+02
2044	1.23E+02	3.86E+02	4.05E+02	2.51E+01	9.39E+02	2.17E+02	1.29E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	7.89E+02	2.15E+02	1.29E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	7.88E+02
2045	1.29E+02	4.05E+02	4.33E+02	2.51E+01	9.92E+02	2.32E+02	1.38E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	8.34E+02	2.30E+02	1.38E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	8.33E+02
2046	1.35E+02	4.23E+02	4.62E+02	2.51E+01	1.04E+03	2.47E+02	1.47E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	8.78E+02	2.45E+02	1.47E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	8.77E+02
2047	1.40E+02	4.41E+02	4.90E+02	2.51E+01	1.10E+03	2.62E+02	1.56E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	9.22E+02	2.61E+02	1.56E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	9.21E+02
2048	1.46E+02	4.59E+02	5.18E+02	2.51E+01	1.15E+03	2.77E+02	1.65E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	9.65E+02	2.76E+02	1.65E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	9.64E+02
2049	1.51E+02	4.76E+02	5.47E+02	2.51E+01	1.20E+03	2.93E+02	1.74E+02	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.01E+03	2.91E+02	1.74E+02	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.01E+03
2050	1.57E+02	4.92E+02	5.75E+02	2.51E+01	1.25E+03	3.08E+02	1.83E+02	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.05E+03	3.06E+02	1.83E+02	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.05E+03
2051	1.62E+02	5.08E+02	6.04E+02	2.51E+01	1.30E+03	3.23E+02	1.92E+02	2.30E+01	3.56E+02	1.95E+02	2.57E+00	1.09E+03	3.21E+02	1.92E+02	4.41E+01	5.27E+02	4.39E+00	2.81E+00	1.09E+03
2052	1.67E+02	5.24E+02	6.32E+02	2.51E+01	1.35E+03	3.38E+02	2.01E+02	2.34E+01	3.63E+02	2.05E+02	2.57E+00	1.13E+03	3.36E+02	2.01E+02	4.57E+01	5.41E+02	5.37E+00	2.81E+00	1.13E+03
2053	1.71E+02	5.39E+02	6.60E+02	2.51E+01	1.40E+03	3.53E+02	2.10E+02	2.38E+01	3.69E+02	2.16E+02	2.57E+00	1.17E+03	3.51E+02	2.10E+02	4.72E+01	5.56E+02	6.53E+00	2.81E+00	1.17E+03
2054	1.76E+02	5.54E+02	6.89E+02	2.51E+01	1.44E+03	3.69E+02	2.19E+02	2.41E+01	3.75E+02	2.26E+02	2.57E+00	1.22E+03	3.66E+02	2.19E+02	4.87E+01	5.69E+02	7.79E+00	2.81E+00	1.21E+03
2055	1.81E+02	5.68E+02	7.17E+02	2.51E+01	1.49E+03	3.84E+02	2.28E+02	2.45E+01	3.80E+02	2.36E+02	2.57E+00	1.26E+03	3.81E+02	2.28E+02	5.01E+01	5.83E+02	9.11E+00	2.81E+00	1.25E+03
2056	1.85E+02	5.82E+02	7.46E+02	2.51E+01	1.54E+03	3.99E+02	2.37E+02	2.48E+01	3.85E+02	2.46E+02	2.57E+00	1.29E+03	3.96E+02	2.37E+02	5.15E+01	5.95E+02	1.04E+01	2.81E+00	1.29E+03
2057	1.90E+02	5.96E+02	7.74E+02	2.51E+01	1.58E+03	4.14E+02	2.46E+02	2.51E+01	3.90E+02	2.56E+02	2.57E+00	1.33E+03	4.12E+02	2.46E+02	5.29E+01	6.08E+02	1.17E+01	2.81E+00	1.33E+03
2058	1.94E+02	6.09E+02	8.00E+02	2.51E+01	1.63E+03	4.28E+02	2.54E+02	2.54E+01	3.94E+02	2.66E+02	2.57E+00	1.37E+03	4.25E+02	2.54E+02	5.43E+01	6.20E+02	1.32E+01	2.81E+00	1.37E+03
2059	1.98E+02	6.22E+02	8.20E+02	2.51E+01	1.67E+03	4.39E+02	2.61E+02	2.56E+01	3.98E+02	2.76E+02	2.57E+00	1.40E+03	4.36E+02	2.61E+02	5.56E+01	6.31E+02	1.56E+01	2.81E+00	1.40E+03
2060	2.02E+02	6.35E+02	8.36E+02	2.51E+01	1.70E+03	4.47E+02	2.66E+02	2.59E+01	4.02E+02	2.86E+02	2.57E+00	1.43E+03	4.45E+02	2.66E+02	5.70E+01	6.41E+02	1.87E+01	2.81E+00	1.43E+03
2061	2.06E+02	6.47E+02	8.49E+02	2.51E+01	1.73E+03	4.54E+02	2.70E+02	2.61E+01	4.05E+02	2.96E+02	2.57E+00	1.45E+03	4.52E+02	2.70E+02	5.83E+01	6.50E+02	2.25E+01	2.81E+00	1.45E+03

Exhibit A-27. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	4.74E+00	0.00E+00	4.37E+01	2.53E+00	1.51E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	3.78E+01	2.52E+00	1.51E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	3.81E+01
2030	1.86E+01	5.83E+01	1.66E+01	0.00E+00	9.35E+01	8.87E+00	5.28E+00	3.61E+00	5.61E+01	2.49E+00	2.46E+00	7.88E+01	8.81E+00	5.28E+00	3.88E+00	5.78E+01	5.53E-01	2.70E+00	7.91E+01
2031	2.74E+01	8.63E+01	3.79E+01	1.16E+00	1.53E+02	2.03E+01	1.21E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.28E+02	2.01E+01	1.21E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.28E+02
2032	3.61E+01	1.13E+02	6.40E+01	3.82E+00	2.17E+02	3.42E+01	2.04E+01	6.79E+00	1.05E+02	1.28E+01	2.57E+00	1.82E+02	3.40E+01	2.04E+01	8.18E+00	1.16E+02	5.53E-01	2.81E+00	1.82E+02
2033	4.45E+01	1.40E+02	9.24E+01	7.38E+00	2.84E+02	4.94E+01	2.94E+01	8.23E+00	1.28E+02	2.08E+01	2.57E+00	2.38E+02	4.91E+01	2.94E+01	1.05E+01	1.46E+02	5.53E-01	2.81E+00	2.38E+02
2034	5.26E+01	1.65E+02	1.21E+02	1.09E+01	3.50E+02	6.46E+01	3.85E+01	9.59E+00	1.49E+02	2.96E+01	2.57E+00	2.94E+02	6.42E+01	3.85E+01	1.28E+01	1.75E+02	5.53E-01	2.81E+00	2.94E+02
2035	6.06E+01	1.90E+02	1.49E+02	1.41E+01	4.14E+02	7.98E+01	4.75E+01	1.09E+01	1.69E+02	3.87E+01	2.57E+00	3.48E+02	7.93E+01	4.75E+01	1.50E+01	2.03E+02	5.53E-01	2.81E+00	3.48E+02
2036	6.83E+01	2.15E+02	1.78E+02	1.68E+01	4.77E+02	9.50E+01	5.66E+01	1.20E+01	1.87E+02	4.79E+01	2.57E+00	4.01E+02	9.44E+01	5.66E+01	1.72E+01	2.29E+02	5.53E-01	2.81E+00	4.01E+02
2037	7.58E+01	2.38E+02	2.06E+02	1.90E+01	5.39E+02	1.10E+02	6.56E+01	1.31E+01	2.04E+02	5.72E+01	2.57E+00	4.53E+02	1.09E+02	6.56E+01	1.94E+01	2.55E+02	5.53E-01	2.81E+00	4.53E+02
2038	8.31E+01	2.61E+02	2.35E+02	2.09E+01	6.00E+02	1.25E+02	7.47E+01	1.42E+01	2.20E+02	6.68E+01	2.57E+00	5.04E+02	1.25E+02	7.47E+01	2.14E+01	2.79E+02	5.53E-01	2.81E+00	5.03E+02
2039	9.02E+01	2.84E+02	2.63E+02	2.25E+01	6.59E+02	1.41E+02	8.37E+01	1.52E+01	2.35E+02	7.64E+01	2.57E+00	5.54E+02	1.40E+02	8.37E+01	2.35E+01	3.03E+02	5.53E-01	2.81E+00	5.53E+02
2040	9.71E+01	3.05E+02	2.91E+02	2.37E+01	7.17E+02	1.56E+02	9.28E+01	1.61E+01	2.49E+02	8.61E+01	2.57E+00	6.03E+02	1.55E+02	9.28E+01	2.54E+01	3.26E+02	5.53E-01	2.81E+00	6.02E+02
2041	1.04E+02	3.26E+02	3.20E+02	2.45E+01	7.74E+02	1.71E+02	1.02E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	6.51E+02	1.70E+02	1.02E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	6.50E+02
2042	1.10E+02	3.47E+02	3.48E+02	2.49E+01	8.30E+02	1.86E+02	1.11E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	6.98E+02	1.85E+02	1.11E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	6.97E+02
2043	1.17E+02	3.67E+02	3.77E+02	2.51E+01	8.85E+02	2.01E+02	1.20E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	7.44E+02	2.00E+02	1.20E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	7.43E+02
2044	1.23E+02	3.86E+02	4.05E+02	2.51E+01	9.39E+02	2.17E+02	1.29E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	7.89E+02	2.15E+02	1.29E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	7.88E+02
2045	1.29E+02	4.05E+02	4.34E+02	2.51E+01	9.93E+02	2.32E+02	1.38E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	8.34E+02	2.30E+02	1.38E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	8.33E+02
2046	1.35E+02	4.23E+02	4.62E+02	2.51E+01	1.05E+03	2.47E+02	1.47E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	8.79E+02	2.45E+02	1.47E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	8.77E+02
2047	1.40E+02	4.41E+02	4.90E+02	2.51E+01	1.10E+03	2.62E+02	1.56E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	9.22E+02	2.61E+02	1.56E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	9.21E+02
2048	1.46E+02	4.59E+02	5.19E+02	2.51E+01	1.15E+03	2.77E+02	1.65E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	9.66E+02	2.76E+02	1.65E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	9.64E+02
2049	1.51E+02	4.76E+02	5.47E+02	2.51E+01	1.20E+03	2.93E+02	1.74E+02	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.01E+03	2.91E+02	1.74E+02	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.01E+03
2050	1.57E+02	4.92E+02	5.76E+02	2.51E+01	1.25E+03	3.08E+02	1.83E+02	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.05E+03	3.06E+02	1.83E+02	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.05E+03
2051	1.62E+02	5.08E+02	6.04E+02	2.51E+01	1.30E+03	3.23E+02	1.92E+02	2.30E+01	3.56E+02	1.95E+02	2.57E+00	1.09E+03	3.21E+02	1.92E+02	4.41E+01	5.27E+02	4.39E+00	2.81E+00	1.09E+03
2052	1.67E+02	5.24E+02	6.33E+02	2.51E+01	1.35E+03	3.38E+02	2.01E+02	2.34E+01	3.63E+02	2.05E+02	2.57E+00	1.13E+03	3.36E+02	2.01E+02	4.57E+01	5.41E+02	5.37E+00	2.81E+00	1.13E+03
2053	1.71E+02	5.39E+02	6.61E+02	2.51E+01	1.40E+03	3.53E+02	2.10E+02	2.38E+01	3.69E+02	2.16E+02	2.57E+00	1.17E+03	3.51E+02	2.10E+02	4.72E+01	5.56E+02	6.53E+00	2.81E+00	1.17E+03
2054	1.76E+02	5.54E+02	6.89E+02	2.51E+01	1.44E+03	3.69E+02	2.20E+02	2.41E+01	3.75E+02	2.26E+02	2.57E+00	1.22E+03	3.66E+02	2.20E+02	4.87E+01	5.69E+02	7.79E+00	2.81E+00	1.21E+03
2055	1.81E+02	5.68E+02	7.18E+02	2.51E+01	1.49E+03	3.84E+02	2.29E+02	2.45E+01	3.80E+02	2.36E+02	2.57E+00	1.26E+03	3.81E+02	2.29E+02	5.01E+01	5.83E+02	9.11E+00	2.81E+00	1.25E+03
2056	1.85E+02	5.82E+02	7.46E+02	2.51E+01	1.54E+03	3.99E+02	2.38E+02	2.48E+01	3.85E+02	2.46E+02	2.57E+00	1.30E+03	3.96E+02	2.38E+02	5.15E+01	5.95E+02	1.04E+01	2.81E+00	1.29E+03
2057	1.90E+02	5.96E+02	7.75E+02	2.51E+01	1.59E+03	4.14E+02	2.47E+02	2.51E+01	3.90E+02	2.56E+02	2.57E+00	1.33E+03	4.12E+02	2.47E+02	5.29E+01	6.08E+02	1.17E+01	2.81E+00	1.33E+03
2058	1.94E+02	6.09E+02	8.00E+02	2.51E+01	1.63E+03	4.28E+02	2.55E+02	2.54E+01	3.94E+02	2.66E+02	2.57E+00	1.37E+03	4.25E+02	2.55E+02	5.43E+01	6.20E+02	1.32E+01	2.81E+00	1.37E+03
2059	1.98E+02	6.22E+02	8.21E+02	2.51E+01	1.67E+03	4.39E+02	2.61E+02	2.56E+01	3.98E+02	2.76E+02	2.57E+00	1.40E+03	4.36E+02	2.61E+02	5.56E+01	6.31E+02	1.56E+01	2.81E+00	1.40E+03
2060	2.02E+02	6.35E+02	8.37E+02	2.51E+01	1.70E+03	4.47E+02	2.66E+02	2.59E+01	4.02E+02	2.86E+02	2.57E+00	1.43E+03	4.45E+02	2.66E+02	5.70E+01	6.41E+02	1.87E+01	2.81E+00	1.43E+03
2061	2.06E+02	6.47E+02	8.50E+02	2.51E+01	1.73E+03	4.54E+02	2.71E+02	2.61E+01	4.05E+02	2.96E+02	2.57E+00	1.46E+03	4.52E+02	2.71E+02	5.83E+01	6.50E+02	2.25E+01	2.81E+00	1.46E+03

Exhibit A-28. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-02	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-01	5.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	7.37E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.41E+00	2.96E+01	4.71E+00	0.00E+00	4.37E+01	2.53E+00	1.86E+00	1.86E+00	2.89E+01	7.39E-01	2.24E+00	3.82E+01	2.52E+00	1.86E+00	1.94E+00	2.92E+01	4.54E-01	2.48E+00	3.84E+01
2030	1.86E+01	5.83E+01	1.65E+01	0.00E+00	9.34E+01	8.87E+00	6.52E+00	3.61E+00	5.61E+01	2.49E+00	2.46E+00	8.01E+01	8.81E+00	6.52E+00	3.88E+00	5.78E+01	5.53E-01	2.70E+00	8.03E+01
2031	2.74E+01	8.63E+01	3.77E+01	1.16E+00	1.53E+02	2.03E+01	1.49E+01	5.25E+00	8.15E+01	6.46E+00	2.54E+00	1.31E+02	2.01E+01	1.49E+01	5.95E+00	8.68E+01	5.53E-01	2.77E+00	1.31E+02
2032	3.61E+01	1.13E+02	6.36E+01	3.82E+00	2.17E+02	3.42E+01	2.51E+01	6.79E+00	1.05E+02	1.28E+01	2.57E+00	1.87E+02	3.40E+01	2.51E+01	8.18E+00	1.16E+02	5.53E-01	2.81E+00	1.87E+02
2033	4.45E+01	1.40E+02	9.18E+01	7.38E+00	2.84E+02	4.94E+01	3.63E+01	8.23E+00	1.28E+02	2.08E+01	2.57E+00	2.45E+02	4.91E+01	3.63E+01	1.05E+01	1.46E+02	5.53E-01	2.81E+00	2.45E+02
2034	5.26E+01	1.65E+02	1.20E+02	1.09E+01	3.49E+02	6.46E+01	4.75E+01	9.59E+00	1.49E+02	2.96E+01	2.57E+00	3.03E+02	6.42E+01	4.75E+01	1.28E+01	1.75E+02	5.53E-01	2.81E+00	3.03E+02
2035	6.06E+01	1.90E+02	1.48E+02	1.41E+01	4.13E+02	7.98E+01	5.87E+01	1.09E+01	1.69E+02	3.87E+01	2.57E+00	3.59E+02	7.93E+01	5.87E+01	1.50E+01	2.03E+02	5.53E-01	2.81E+00	3.59E+02
2036	6.83E+01	2.15E+02	1.77E+02	1.68E+01	4.76E+02	9.50E+01	6.99E+01	1.20E+01	1.87E+02	4.79E+01	2.57E+00	4.14E+02	9.44E+01	6.99E+01	1.72E+01	2.29E+02	5.53E-01	2.81E+00	4.14E+02
2037	7.58E+01	2.38E+02	2.05E+02	1.90E+01	5.38E+02	1.10E+02	8.10E+01	1.31E+01	2.04E+02	5.72E+01	2.57E+00	4.68E+02	1.09E+02	8.10E+01	1.94E+01	2.55E+02	5.53E-01	2.81E+00	4.68E+02
2038	8.31E+01	2.61E+02	2.33E+02	2.09E+01	5.98E+02	1.25E+02	9.22E+01	1.42E+01	2.20E+02	6.68E+01	2.57E+00	5.21E+02	1.25E+02	9.22E+01	2.14E+01	2.79E+02	5.53E-01	2.81E+00	5.21E+02
2039	9.02E+01	2.84E+02	2.61E+02	2.25E+01	6.57E+02	1.41E+02	1.03E+02	1.52E+01	2.35E+02	7.64E+01	2.57E+00	5.74E+02	1.40E+02	1.03E+02	2.35E+01	3.03E+02	5.53E-01	2.81E+00	5.73E+02
2040	9.71E+01	3.05E+02	2.90E+02	2.37E+01	7.15E+02	1.56E+02	1.15E+02	1.61E+01	2.49E+02	8.61E+01	2.57E+00	6.25E+02	1.55E+02	1.15E+02	2.54E+01	3.26E+02	5.53E-01	2.81E+00	6.24E+02
2041	1.04E+02	3.26E+02	3.18E+02	2.45E+01	7.72E+02	1.71E+02	1.26E+02	1.69E+01	2.63E+02	9.57E+01	2.57E+00	6.75E+02	1.70E+02	1.26E+02	2.73E+01	3.48E+02	5.53E-01	2.81E+00	6.74E+02
2042	1.10E+02	3.47E+02	3.46E+02	2.49E+01	8.28E+02	1.86E+02	1.37E+02	1.77E+01	2.75E+02	1.05E+02	2.57E+00	7.24E+02	1.85E+02	1.37E+02	2.91E+01	3.69E+02	5.53E-01	2.81E+00	7.23E+02
2043	1.17E+02	3.67E+02	3.74E+02	2.51E+01	8.83E+02	2.01E+02	1.48E+02	1.85E+01	2.87E+02	1.15E+02	2.57E+00	7.72E+02	2.00E+02	1.48E+02	3.09E+01	3.89E+02	5.53E-01	2.81E+00	7.71E+02
2044	1.23E+02	3.86E+02	4.03E+02	2.51E+01	9.37E+02	2.17E+02	1.59E+02	1.92E+01	2.98E+02	1.24E+02	2.57E+00	8.20E+02	2.15E+02	1.59E+02	3.27E+01	4.08E+02	5.91E-01	2.81E+00	8.19E+02
2045	1.29E+02	4.05E+02	4.31E+02	2.51E+01	9.90E+02	2.32E+02	1.70E+02	1.98E+01	3.08E+02	1.34E+02	2.57E+00	8.67E+02	2.30E+02	1.70E+02	3.44E+01	4.27E+02	7.80E-01	2.81E+00	8.66E+02
2046	1.35E+02	4.23E+02	4.59E+02	2.51E+01	1.04E+03	2.47E+02	1.82E+02	2.04E+01	3.17E+02	1.44E+02	2.57E+00	9.13E+02	2.45E+02	1.82E+02	3.61E+01	4.45E+02	1.10E+00	2.81E+00	9.12E+02
2047	1.40E+02	4.41E+02	4.87E+02	2.51E+01	1.09E+03	2.62E+02	1.93E+02	2.10E+01	3.26E+02	1.54E+02	2.57E+00	9.59E+02	2.61E+02	1.93E+02	3.77E+01	4.62E+02	1.53E+00	2.81E+00	9.58E+02
2048	1.46E+02	4.59E+02	5.16E+02	2.51E+01	1.15E+03	2.77E+02	2.04E+02	2.15E+01	3.34E+02	1.64E+02	2.57E+00	1.00E+03	2.76E+02	2.04E+02	3.94E+01	4.79E+02	2.11E+00	2.81E+00	1.00E+03
2049	1.51E+02	4.76E+02	5.44E+02	2.51E+01	1.20E+03	2.93E+02	2.15E+02	2.20E+01	3.42E+02	1.75E+02	2.57E+00	1.05E+03	2.91E+02	2.15E+02	4.10E+01	4.96E+02	2.80E+00	2.81E+00	1.05E+03
2050	1.57E+02	4.92E+02	5.72E+02	2.51E+01	1.25E+03	3.08E+02	2.26E+02	2.25E+01	3.50E+02	1.85E+02	2.57E+00	1.09E+03	3.06E+02	2.26E+02	4.26E+01	5.11E+02	3.58E+00	2.81E+00	1.09E+03
2051	1.62E+02	5.08E+02	6.00E+02	2.51E+01	1.30E+03	3.23E+02	2.38E+02	2.30E+01	3.56E+02	1.95E+02	2.57E+00	1.14E+03	3.21E+02	2.38E+02	4.41E+01	5.27E+02	4.39E+00	2.81E+00	1.14E+03
2052	1.67E+02	5.24E+02	6.28E+02	2.51E+01	1.34E+03	3.38E+02	2.49E+02	2.34E+01	3.63E+02	2.05E+02	2.57E+00	1.18E+03	3.36E+02	2.49E+02	4.57E+01	5.41E+02	5.37E+00	2.81E+00	1.18E+03
2053	1.71E+02	5.39E+02	6.57E+02	2.51E+01	1.39E+03	3.53E+02	2.60E+02	2.38E+01	3.69E+02	2.16E+02	2.57E+00	1.22E+03	3.51E+02	2.60E+02	4.72E+01	5.56E+02	6.53E+00	2.81E+00	1.22E+03
2054	1.76E+02	5.54E+02	6.85E+02	2.51E+01	1.44E+03	3.69E+02	2.71E+02	2.41E+01	3.75E+02	2.26E+02	2.57E+00	1.27E+03	3.66E+02	2.71E+02	4.87E+01	5.69E+02	7.79E+00	2.81E+00	1.27E+03
2055	1.81E+02	5.68E+02	7.13E+02	2.51E+01	1.49E+03	3.84E+02	2.82E+02	2.45E+01	3.80E+02	2.36E+02	2.57E+00	1.31E+03	3.81E+02	2.82E+02	5.01E+01	5.83E+02	9.11E+00	2.81E+00	1.31E+03
2056	1.85E+02	5.82E+02	7.41E+02	2.51E+01	1.53E+03	3.99E+02	2.93E+02	2.48E+01	3.85E+02	2.46E+02	2.57E+00	1.35E+03	3.96E+02	2.93E+02	5.15E+01	5.95E+02	1.04E+01	2.81E+00	1.35E+03
2057	1.90E+02	5.96E+02	7.70E+02	2.51E+01	1.58E+03	4.14E+02	3.05E+02	2.51E+01	3.90E+02	2.56E+02	2.57E+00	1.39E+03	4.12E+02	3.05E+02	5.29E+01	6.08E+02	1.17E+01	2.81E+00	1.39E+03
2058	1.94E+02	6.09E+02	7.95E+02	2.51E+01	1.62E+03	4.28E+02	3.15E+02	2.54E+01	3.94E+02	2.66E+02	2.57E+00	1.43E+03	4.25E+02	3.15E+02	5.43E+01	6.20E+02	1.32E+01	2.81E+00	1.43E+03
2059	1.98E+02	6.22E+02	8.15E+02	2.51E+01	1.66E+03	4.39E+02	3.23E+02	2.56E+01	3.98E+02	2.76E+02	2.57E+00	1.46E+03	4.36E+02	3.23E+02	5.56E+01	6.31E+02	1.56E+01	2.81E+00	1.46E+03
2060	2.02E+02	6.35E+02	8.32E+02	2.51E+01	1.69E+03	4.47E+02	3.29E+02	2.59E+01	4.02E+02	2.86E+02	2.57E+00	1.49E+03	4.45E+02	3.29E+02	5.70E+01	6.41E+02	1.87E+01	2.81E+00	1.49E+03
2061	2.06E+02	6.47E+02	8.44E+02	2.51E+01	1.72E+03	4.54E+02	3.34E+02	2.61E+01	4.05E+02	2.96E+02	2.57E+00	1.52E+03	4.52E+02	3.34E+02	5.83E+01	6.50E+02	2.25E+01	2.81E+00	1.52E+03

Exhibit A-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.60E+02	6.63E+02	6.63E+02	6.80E+02
Lower GOR	6.61E+02	6.64E+02	6.64E+02	6.81E+02
Higher GOR	6.59E+02	6.62E+02	6.62E+02	6.79E+02

Exhibit A-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.60E+02	6.63E+02	6.63E+02	6.80E+02
Decrease in Methane Emissions	6.58E+02	6.62E+02	6.62E+02	6.78E+02
Increase in Methane Emissions	6.62E+02	6.65E+02	6.65E+02	6.82E+02

APPENDIX B: AR4 20-YR RESULTS

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR4 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR4 – 20-yr)
- Multiproduct Functional Unit – China (AR4 – 20-yr)
- Multiproduct Functional Unit – India (AR4 – 20-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR4 – 20-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 20-yr)
- Single Product Functional Unit in kg CO_2e – China (AR4 – 20-yr)
- Single Product Functional Unit in kg CO_2e – India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR4 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit B-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.30E+01	7.30E+01	-	8.21E+01	8.21E+01
Natural Gas Pipelines to GTP	-	7.38E+00	7.38E+00	-	8.31E+00	8.31E+00
Natural Gas Processing at GTP	-	2.50E+01	2.50E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	7.52E-01	-	-	8.46E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.92E+01	3.92E+01	-	4.41E+01	4.41E+01
Ocean Transport	-	2.09E+01	2.09E+01	-	2.36E+01	2.36E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	4.92E+01	6.78E+00	6.78E+00	5.54E+01	7.63E+00	7.63E+00
Crude Oil Extraction, CO2-EOR	-	-	6.42E+00	-	-	7.23E+00
CO2-EOR Crude Oil Transport	-	-	8.48E-01	-	-	9.55E-01
Crude Oil Alaskan Pipeline Transport	2.25E+00	1.41E+00	1.41E+00	2.53E+00	1.58E+00	1.58E+00
Crude Oil Ocean Transport	1.17E+00	7.85E-01	1.26E+00	1.32E+00	8.83E-01	1.42E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.27E-01	5.27E-01	-	5.93E-01	5.93E-01
System Expansion: US Average Crude Oil Production and End Use	2.53E+01	9.12E+01	2.46E+01	3.15E+00	7.74E+01	2.44E+00
System Expansion: US Lower 48 LNG Export and End Use	5.86E+02	-	-	3.13E+02	-	-
Total	8.17E+02	7.24E+02	7.22E+02	5.47E+02	4.48E+02	4.46E+02
Upper	2.38E+01	8.42E+00	7.68E+00	2.53E+01	8.68E+00	8.38E+00
Lower	1.10E+01	3.86E+00	3.42E+00	1.09E+01	2.83E+00	3.95E+00

Exhibit B-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.31E+01	7.31E+01	-	8.23E+01	8.23E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	7.53E-01	-	-	8.48E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	4.93E+01	6.79E+00	6.79E+00	5.55E+01	7.65E+00	7.65E+00
Crude Oil Extraction, CO2-EOR	-	-	6.44E+00	-	-	7.24E+00
CO2-EOR Crude Oil Transport	-	-	8.50E-01	-	-	9.56E-01
Crude Oil Alaskan Pipeline Transport	2.25E+00	1.41E+00	1.41E+00	2.53E+00	1.59E+00	1.59E+00
Crude Oil Ocean Transport	1.18E+00	7.86E-01	1.26E+00	1.32E+00	8.85E-01	1.42E+00
Crude Oil Refining and End Use	1.53E+02	9.55E+01	1.53E+02	1.72E+02	1.08E+02	1.72E+02
Construction	-	5.28E-01	5.28E-01	-	5.95E-01	5.95E-01
System Expansion: US Average Crude Oil Production and End Use	2.49E+01	9.10E+01	2.43E+01	2.77E+00	7.71E+01	2.05E+00
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	8.21E+02	7.28E+02	7.26E+02	5.52E+02	4.53E+02	4.50E+02
Upper	1.80E+01	9.12E+00	7.45E+00	2.30E+01	8.74E+00	8.38E+00
Lower	1.40E+01	3.93E+00	2.89E+00	1.10E+01	2.49E+00	3.42E+00

Exhibit B-3. Multiproduct Functional Unit in kg CO_2e – China (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.31E+01	7.31E+01	-	8.23E+01	8.23E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	7.53E-01	-	-	8.48E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.46E+01	2.46E+01	-	2.77E+01	2.77E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	4.93E+01	6.79E+00	6.79E+00	5.55E+01	7.65E+00	7.65E+00
Crude Oil Extraction, CO2-EOR	-	-	6.44E+00	-	-	7.24E+00
CO2-EOR Crude Oil Transport	-	-	8.50E-01	-	-	9.57E-01
Crude Oil Alaskan Pipeline Transport	2.25E+00	1.41E+00	1.41E+00	2.53E+00	1.59E+00	1.59E+00
Crude Oil Ocean Transport	1.18E+00	7.86E-01	1.26E+00	1.32E+00	8.85E-01	1.42E+00
Crude Oil Refining and End Use	1.53E+02	9.55E+01	1.53E+02	1.72E+02	1.08E+02	1.72E+02
Construction	-	5.28E-01	5.28E-01	-	5.95E-01	5.95E-01
System Expansion: US Average Crude Oil Production and End Use	2.49E+01	9.10E+01	2.43E+01	2.75E+00	7.71E+01	2.03E+00
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	8.21E+02	7.28E+02	7.26E+02	5.52E+02	4.53E+02	4.50E+02
Upper	1.51E+01	7.40E+00	7.36E+00	2.37E+01	8.24E+00	1.10E+01
Lower	2.00E+00	3.01E+00	3.58E+00	1.04E+01	3.24E+00	3.99E+00

Exhibit B-4. Multiproduct Functional Unit in kg CO_2e – India (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.39E+01	7.39E+01	-	8.31E+01	8.31E+01
Natural Gas Pipelines to GTP	-	7.47E+00	7.47E+00	-	8.41E+00	8.41E+00
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	7.61E-01	-	-	8.57E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.53E+01	1.53E+01	-	1.72E+01	1.72E+01
Liquefaction	-	3.97E+01	3.97E+01	-	4.47E+01	4.47E+01
Ocean Transport	-	4.30E+01	4.30E+01	-	4.84E+01	4.84E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	4.99E+01	6.86E+00	6.86E+00	5.61E+01	7.72E+00	7.72E+00
Crude Oil Extraction, CO2-EOR	-	-	6.50E+00	-	-	7.32E+00
CO2-EOR Crude Oil Transport	-	-	8.59E-01	-	-	9.66E-01
Crude Oil Alaskan Pipeline Transport	2.27E+00	1.42E+00	1.42E+00	2.56E+00	1.60E+00	1.60E+00
Crude Oil Ocean Transport	1.19E+00	7.94E-01	1.27E+00	1.34E+00	8.94E-01	1.43E+00
Crude Oil Refining and End Use	1.54E+02	9.65E+01	1.55E+02	1.73E+02	1.09E+02	1.74E+02
Construction	-	5.34E-01	5.34E-01	-	6.01E-01	6.01E-01
System Expansion: US Average Crude Oil Production and End Use	2.31E+01	8.99E+01	2.25E+01	7.26E-01	7.58E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.89E+02	-	-	3.16E+02	-	-
Total	8.20E+02	7.48E+02	7.46E+02	5.50E+02	4.75E+02	4.73E+02
Upper	1.89E+01	9.71E+00	1.01E+01	1.99E+01	1.05E+01	9.85E+00
Lower	8.19E+00	3.22E+00	3.33E+00	1.14E+01	3.43E+00	2.94E+00

Exhibit B-5. Single Product Functional Unit in kg CO_2e – Japan (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.30E+01	7.30E+01	-	8.21E+01	8.21E+01
Natural Gas Pipelines to GTP	-	7.38E+00	7.38E+00	-	8.31E+00	8.31E+00
Natural Gas Processing at GTP	-	2.50E+01	2.50E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	6.47E-01	-	-	7.28E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.92E+01	3.92E+01	-	4.41E+01	4.41E+01
Ocean Transport	-	2.09E+01	2.09E+01	-	2.36E+01	2.36E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.27E-01	5.27E-01	-	5.93E-01	5.93E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.86E+02	-	-	3.13E+02	-	-
Total	5.86E+02	5.28E+02	5.28E+02	3.13E+02	2.53E+02	2.53E+02
Upper	2.37E+01	6.14E+00	5.61E+00	2.52E+01	4.91E+00	4.75E+00
Lower	1.11E+01	2.82E+00	2.50E+00	1.10E+01	1.60E+00	2.24E+00

Exhibit B-6. Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.31E+01	7.31E+01	-	8.23E+01	8.23E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	6.48E-01	-	-	7.29E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.28E-01	5.28E-01	-	5.95E-01	5.95E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	5.91E+02	5.32E+02	5.32E+02	3.18E+02	2.58E+02	2.57E+02
Upper	1.80E+01	6.67E+00	5.46E+00	2.30E+01	4.98E+00	4.78E+00
Lower	1.40E+01	2.87E+00	2.12E+00	1.11E+01	1.42E+00	1.95E+00

Exhibit B-7. Single Product Functional Unit in kg CO_2e – China (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.31E+01	7.31E+01	-	8.23E+01	8.23E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
CO2 Compression and Sequestration	-	6.48E-01	-	-	7.29E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.46E+01	2.46E+01	-	2.77E+01	2.77E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.28E-01	5.28E-01	-	5.95E-01	5.95E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	5.91E+02	5.32E+02	5.32E+02	3.18E+02	2.58E+02	2.57E+02
Upper	1.50E+01	5.41E+00	5.39E+00	2.36E+01	4.70E+00	6.26E+00
Lower	2.08E+00	2.20E+00	2.63E+00	1.05E+01	1.85E+00	2.28E+00

Exhibit B-8. Single Product Functional Unit in kg CO_2e – India (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.39E+01	7.39E+01	-	8.31E+01	8.31E+01
Natural Gas Pipelines to GTP	-	7.47E+00	7.47E+00	-	8.41E+00	8.41E+00
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	6.55E-01	-	-	7.37E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.53E+01	1.53E+01	-	1.72E+01	1.72E+01
Liquefaction	-	3.97E+01	3.97E+01	-	4.47E+01	4.47E+01
Ocean Transport	-	4.30E+01	4.30E+01	-	4.84E+01	4.84E+01
LNG Regasification	-	4.18E+00	4.18E+00	-	4.70E+00	4.70E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.34E-01	5.34E-01	-	6.01E-01	6.01E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.89E+02	-	-	3.16E+02	-	-
Total	5.89E+02	5.52E+02	5.52E+02	3.16E+02	2.81E+02	2.80E+02
Upper	1.88E+01	7.17E+00	7.45E+00	1.98E+01	6.21E+00	5.83E+00
Lower	8.27E+00	2.38E+00	2.46E+00	1.15E+01	2.02E+00	1.74E+00

Exhibit B-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.29E+01	6.37E+00	5.62E-05	-	4.92E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.21E-01	9.96E-03	5.32E-09	2.25E+00
Crude Oil Ocean Transport	1.09E+00	7.68E-02	2.72E-03	7.91E-07	1.17E+00
Crude Oil Refining and End Use	1.52E+02	6.19E-01	6.99E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	1.34E+00	1.44E-02	-	2.53E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.22E+02	3.11E-01	1.31E-07	5.86E+02
Construction	-	-	-	-	-
Total	6.85E+02	1.31E+02	3.45E-01	9.27E-07	8.17E+02

Exhibit B-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	6.38E+00	5.63E-05	-	4.93E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.21E-01	9.98E-03	5.33E-09	2.25E+00
Crude Oil Ocean Transport	1.10E+00	7.70E-02	2.72E-03	7.92E-07	1.18E+00
Crude Oil Refining and End Use	1.52E+02	6.20E-01	7.01E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.33E+00	1.42E-02	-	2.49E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.23E+02	3.21E-01	1.32E-07	5.91E+02
Construction	-	-	-	-	-
Total	6.89E+02	1.32E+02	3.55E-01	9.29E-07	8.21E+02

Exhibit B-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	6.38E+00	5.63E-05	-	4.93E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.21E-01	9.98E-03	5.33E-09	2.25E+00
Crude Oil Ocean Transport	1.10E+00	7.70E-02	2.72E-03	7.92E-07	1.18E+00
Crude Oil Refining and End Use	1.52E+02	6.20E-01	7.01E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.33E+00	1.42E-02	-	2.49E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.23E+02	3.21E-01	1.32E-07	5.91E+02
Construction	-	-	-	-	-
Total	6.89E+02	1.32E+02	3.55E-01	9.29E-07	8.21E+02

Exhibit B-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.34E+01	6.45E+00	5.69E-05	-	4.99E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.04E+00	2.23E-01	1.01E-02	5.39E-09	2.27E+00
Crude Oil Ocean Transport	1.11E+00	7.78E-02	2.75E-03	8.00E-07	1.19E+00
Crude Oil Refining and End Use	1.54E+02	6.26E-01	7.08E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	1.23E+00	1.31E-02	-	2.31E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.23E+02	3.17E-01	1.31E-07	5.89E+02
Construction	-	-	-	-	-
Total	6.88E+02	1.32E+02	3.50E-01	9.37E-07	8.20E+02

Exhibit B-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	4.72E+01	1.46E-02	-	7.30E+01
Natural Gas Pipelines to GTP	2.14E-03	7.38E+00	-	-	7.38E+00
Natural Gas Processing at GTP	2.39E+01	1.12E+00	2.50E-05	-	2.50E+01
CO2 Compression and Sequestration	6.44E-01	1.05E-01	1.41E-03	1.45E-03	7.52E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	9.90E+00	5.21E-07	-	1.51E+01
Liquefaction	2.25E+01	1.67E+01	3.87E-03	9.52E-08	3.92E+01
Ocean Transport	1.68E+01	4.10E+00	5.49E-02	-	2.09E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	4.16E+00	5.63E-06	-	6.78E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.38E-01	6.24E-03	3.33E-09	1.41E+00
Crude Oil Ocean Transport	7.14E-01	6.82E-02	2.13E-03	7.08E-07	7.85E-01
Crude Oil Refining and End Use	9.50E+01	3.87E-01	4.38E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	4.85E+00	5.19E-02	-	9.12E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	1.91E-02	3.05E-03	-	5.27E-01
Total	6.27E+02	9.73E+01	1.52E-01	1.52E-03	7.24E+02

Exhibit B-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	4.72E+01	1.46E-02	-	7.31E+01
Natural Gas Pipelines to GTP	2.14E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.40E+01	1.13E+00	2.50E-05	-	2.51E+01
CO2 Compression and Sequestration	6.45E-01	1.05E-01	1.41E-03	1.46E-03	7.53E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	9.91E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	3.87E-03	9.54E-08	3.93E+01
Ocean Transport	1.95E+01	4.88E+00	6.26E-02	-	2.44E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.17E+00	5.64E-06	-	6.79E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.38E-01	6.25E-03	3.34E-09	1.41E+00
Crude Oil Ocean Transport	7.16E-01	6.83E-02	2.14E-03	7.09E-07	7.86E-01
Crude Oil Refining and End Use	9.51E+01	3.88E-01	4.39E-03	-	9.55E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	4.84E+00	5.18E-02	-	9.10E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	1.91E-02	3.05E-03	-	5.28E-01
Total	6.29E+02	9.82E+01	1.60E-01	1.52E-03	7.28E+02

Exhibit B-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	4.72E+01	1.46E-02	-	7.31E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.40E+01	1.13E+00	2.51E-05	-	2.51E+01
CO2 Compression and Sequestration	6.46E-01	1.05E-01	1.41E-03	1.46E-03	7.53E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	9.92E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	3.87E-03	9.54E-08	3.93E+01
Ocean Transport	1.96E+01	4.92E+00	6.29E-02	-	2.46E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.17E+00	5.64E-06	-	6.79E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.38E-01	6.25E-03	3.34E-09	1.41E+00
Crude Oil Ocean Transport	7.16E-01	6.83E-02	2.14E-03	7.09E-07	7.86E-01
Crude Oil Refining and End Use	9.51E+01	3.88E-01	4.39E-03	-	9.55E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	4.84E+00	5.17E-02	-	9.10E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	1.91E-02	3.05E-03	-	5.28E-01
Total	6.30E+02	9.83E+01	1.60E-01	1.52E-03	7.28E+02

Exhibit B-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	4.77E+01	1.48E-02	-	7.39E+01
Natural Gas Pipelines to GTP	2.17E-03	7.47E+00	-	-	7.47E+00
Natural Gas Processing at GTP	2.42E+01	1.14E+00	2.53E-05	-	2.53E+01
CO2 Compression and Sequestration	6.52E-01	1.06E-01	1.42E-03	1.47E-03	7.61E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.00E+01	5.28E-07	-	1.53E+01
Liquefaction	2.27E+01	1.69E+01	3.91E-03	9.64E-08	3.97E+01
Ocean Transport	3.39E+01	9.04E+00	1.03E-01	-	4.30E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	4.21E+00	5.70E-06	-	6.86E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.40E-01	6.31E-03	3.37E-09	1.42E+00
Crude Oil Ocean Transport	7.23E-01	6.90E-02	2.16E-03	7.17E-07	7.94E-01
Crude Oil Refining and End Use	9.61E+01	3.92E-01	4.43E-03	-	9.65E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	4.78E+00	5.11E-02	-	8.99E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	1.93E-02	3.08E-03	-	5.34E-01
Total	6.45E+02	1.03E+02	2.00E-01	1.54E-03	7.48E+02

Exhibit B-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	4.72E+01	1.46E-02	-	7.30E+01
Natural Gas Pipelines to GTP	2.14E-03	7.38E+00	-	-	7.38E+00
Natural Gas Processing at GTP	2.39E+01	1.12E+00	2.50E-05	-	2.50E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	9.90E+00	5.21E-07	-	1.51E+01
Liquefaction	2.25E+01	1.67E+01	3.87E-03	9.52E-08	3.92E+01
Ocean Transport	1.68E+01	4.10E+00	5.49E-02	-	2.09E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	4.16E+00	5.63E-06	-	6.78E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	9.45E-01	1.75E-02	1.87E-02	6.42E+00
CO2-EOR Crude Oil Transport	7.61E-01	8.33E-02	3.76E-03	2.01E-09	8.48E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.38E-01	6.24E-03	3.33E-09	1.41E+00
Crude Oil Ocean Transport	1.14E+00	1.09E-01	3.42E-03	1.13E-06	1.26E+00
Crude Oil Refining and End Use	1.52E+02	6.21E-01	7.02E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	1.31E+00	1.40E-02	-	2.46E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	1.91E-02	3.05E-03	-	5.27E-01
Total	6.27E+02	9.49E+01	1.38E-01	1.88E-02	7.22E+02

Exhibit B-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	4.72E+01	1.46E-02	-	7.31E+01
Natural Gas Pipelines to GTP	2.14E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.40E+01	1.13E+00	2.50E-05	-	2.51E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	9.91E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	3.87E-03	9.54E-08	3.93E+01
Ocean Transport	1.95E+01	4.88E+00	6.26E-02	-	2.44E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.17E+00	5.64E-06	-	6.79E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	9.47E-01	1.76E-02	1.88E-02	6.44E+00
CO2-EOR Crude Oil Transport	7.63E-01	8.34E-02	3.77E-03	2.01E-09	8.50E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.38E-01	6.25E-03	3.34E-09	1.41E+00
Crude Oil Ocean Transport	1.15E+00	1.10E-01	3.43E-03	1.14E-06	1.26E+00
Crude Oil Refining and End Use	1.53E+02	6.22E-01	7.03E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.29E+00	1.38E-02	-	2.43E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	1.91E-02	3.05E-03	-	5.28E-01
Total	6.30E+02	9.59E+01	1.45E-01	1.88E-02	7.26E+02

Exhibit B-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	4.72E+01	1.46E-02	-	7.31E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.40E+01	1.13E+00	2.51E-05	-	2.51E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	9.92E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	3.87E-03	9.54E-08	3.93E+01
Ocean Transport	1.96E+01	4.92E+00	6.29E-02	-	2.46E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.17E+00	5.64E-06	-	6.79E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	9.47E-01	1.76E-02	1.88E-02	6.44E+00
CO2-EOR Crude Oil Transport	7.63E-01	8.34E-02	3.77E-03	2.01E-09	8.50E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.38E-01	6.25E-03	3.34E-09	1.41E+00
Crude Oil Ocean Transport	1.15E+00	1.10E-01	3.43E-03	1.14E-06	1.26E+00
Crude Oil Refining and End Use	1.53E+02	6.22E-01	7.03E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.29E+00	1.38E-02	-	2.43E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	1.91E-02	3.05E-03	-	5.28E-01
Total	6.30E+02	9.59E+01	1.46E-01	1.88E-02	7.26E+02

Exhibit B-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	4.77E+01	1.48E-02	-	7.39E+01
Natural Gas Pipelines to GTP	2.17E-03	7.47E+00	-	-	7.47E+00
Natural Gas Processing at GTP	2.42E+01	1.14E+00	2.53E-05	-	2.53E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.00E+01	5.28E-07	-	1.53E+01
Liquefaction	2.27E+01	1.69E+01	3.91E-03	9.64E-08	3.97E+01
Ocean Transport	3.39E+01	9.04E+00	1.03E-01	-	4.30E+01
LNG Regasification	3.02E+00	1.15E+00	9.43E-03	6.38E-05	4.18E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	4.21E+00	5.70E-06	-	6.86E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	9.56E-01	1.77E-02	1.90E-02	6.50E+00
CO2-EOR Crude Oil Transport	7.71E-01	8.43E-02	3.81E-03	2.03E-09	8.59E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.40E-01	6.31E-03	3.37E-09	1.42E+00
Crude Oil Ocean Transport	1.16E+00	1.11E-01	3.46E-03	1.15E-06	1.27E+00
Crude Oil Refining and End Use	1.54E+02	6.29E-01	7.11E-03	-	1.55E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	1.20E+00	1.28E-02	-	2.25E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	1.93E-02	3.08E-03	-	5.34E-01
Total	6.45E+02	1.01E+02	1.86E-01	1.90E-02	7.46E+02

Exhibit B-21. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	1.38E+01	0.00E+00	5.37E+01	3.81E+00	8.73E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.73E+01	3.79E+00	8.73E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.76E+01
2030	2.02E+01	5.85E+01	4.82E+01	0.00E+00	1.27E+02	1.33E+01	3.06E+01	5.29E+00	5.63E+01	2.58E+00	2.51E+00	1.11E+02	1.33E+01	3.06E+01	5.59E+00	5.80E+01	5.73E-01	2.75E+00	1.11E+02
2031	2.99E+01	8.65E+01	1.10E+02	1.20E+00	2.28E+02	3.05E+01	6.99E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	1.99E+02	3.03E+01	6.99E+01	8.46E+00	8.70E+01	5.73E-01	2.83E+00	1.99E+02
2032	3.93E+01	1.14E+02	1.86E+02	3.95E+00	3.43E+02	5.14E+01	1.18E+02	9.94E+00	1.06E+02	1.33E+01	2.63E+00	3.01E+02	5.12E+01	1.18E+02	1.15E+01	1.17E+02	5.73E-01	2.87E+00	3.01E+02
2033	4.85E+01	1.40E+02	2.68E+02	7.64E+00	4.65E+02	7.43E+01	1.70E+02	1.21E+01	1.28E+02	2.16E+01	2.63E+00	4.09E+02	7.40E+01	1.70E+02	1.45E+01	1.46E+02	5.73E-01	2.87E+00	4.09E+02
2034	5.74E+01	1.66E+02	3.51E+02	1.13E+01	5.86E+02	9.72E+01	2.23E+02	1.40E+01	1.49E+02	3.06E+01	2.63E+00	5.16E+02	9.67E+01	2.23E+02	1.76E+01	1.75E+02	5.73E-01	2.87E+00	5.16E+02
2035	6.60E+01	1.91E+02	4.34E+02	1.46E+01	7.05E+02	1.20E+02	2.75E+02	1.59E+01	1.69E+02	4.00E+01	2.63E+00	6.23E+02	1.19E+02	2.75E+02	2.05E+01	2.03E+02	5.73E-01	2.87E+00	6.22E+02
2036	7.44E+01	2.15E+02	5.16E+02	1.74E+01	8.23E+02	1.43E+02	3.27E+02	1.76E+01	1.87E+02	4.96E+01	2.63E+00	7.28E+02	1.42E+02	3.27E+02	2.33E+01	2.30E+02	5.73E-01	2.87E+00	7.26E+02
2037	8.26E+01	2.39E+02	5.99E+02	1.97E+01	9.40E+02	1.66E+02	3.80E+02	1.93E+01	2.05E+02	5.93E+01	2.63E+00	8.32E+02	1.65E+02	3.80E+02	2.61E+01	2.55E+02	5.73E-01	2.87E+00	8.30E+02
2038	9.06E+01	2.62E+02	6.81E+02	2.17E+01	1.06E+03	1.89E+02	4.32E+02	2.08E+01	2.21E+02	6.92E+01	2.63E+00	9.34E+02	1.88E+02	4.32E+02	2.88E+01	2.80E+02	5.73E-01	2.87E+00	9.32E+02
2039	9.83E+01	2.84E+02	7.64E+02	2.33E+01	1.17E+03	2.12E+02	4.85E+02	2.22E+01	2.36E+02	7.92E+01	2.63E+00	1.04E+03	2.11E+02	4.85E+02	3.13E+01	3.04E+02	5.73E-01	2.87E+00	1.03E+03
2040	1.06E+02	3.06E+02	8.46E+02	2.45E+01	1.28E+03	2.34E+02	5.37E+02	2.35E+01	2.50E+02	8.92E+01	2.63E+00	1.14E+03	2.33E+02	5.37E+02	3.38E+01	3.27E+02	5.73E-01	2.87E+00	1.13E+03
2041	1.13E+02	3.27E+02	9.29E+02	2.54E+01	1.39E+03	2.57E+02	5.89E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	1.24E+03	2.56E+02	5.89E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	1.23E+03
2042	1.20E+02	3.48E+02	1.01E+03	2.58E+01	1.51E+03	2.80E+02	6.42E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	1.34E+03	2.79E+02	6.42E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	1.33E+03
2043	1.27E+02	3.68E+02	1.09E+03	2.60E+01	1.62E+03	3.03E+02	6.94E+02	2.70E+01	2.87E+02	1.19E+02	2.63E+00	1.43E+03	3.02E+02	6.94E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	1.43E+03
2044	1.34E+02	3.87E+02	1.18E+03	2.60E+01	1.72E+03	3.26E+02	7.47E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	1.53E+03	3.24E+02	7.47E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	1.53E+03
2045	1.40E+02	4.06E+02	1.26E+03	2.60E+01	1.83E+03	3.49E+02	7.99E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	1.63E+03	3.47E+02	7.99E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	1.62E+03
2046	1.47E+02	4.25E+02	1.34E+03	2.60E+01	1.94E+03	3.72E+02	8.51E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.72E+03	3.70E+02	8.51E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.72E+03
2047	1.53E+02	4.43E+02	1.42E+03	2.60E+01	2.05E+03	3.94E+02	9.04E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.82E+03	3.93E+02	9.04E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.81E+03
2048	1.59E+02	4.60E+02	1.51E+03	2.60E+01	2.15E+03	4.17E+02	9.56E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.91E+03	4.15E+02	9.56E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.91E+03
2049	1.65E+02	4.77E+02	1.59E+03	2.60E+01	2.26E+03	4.40E+02	1.01E+03	3.23E+01	3.43E+02	1.81E+02	2.63E+00	2.01E+03	4.38E+02	1.01E+03	5.31E+01	4.97E+02	2.90E+00	2.87E+00	2.00E+03
2050	1.71E+02	4.93E+02	1.67E+03	2.60E+01	2.36E+03	4.63E+02	1.06E+03	3.30E+01	3.51E+02	1.92E+02	2.63E+00	2.10E+03	4.61E+02	1.06E+03	5.51E+01	5.13E+02	3.70E+00	2.87E+00	2.10E+03
2051	1.76E+02	5.10E+02	1.75E+03	2.60E+01	2.47E+03	4.86E+02	1.11E+03	3.36E+01	3.57E+02	2.02E+02	2.63E+00	2.20E+03	4.84E+02	1.11E+03	5.69E+01	5.28E+02	4.55E+00	2.87E+00	2.19E+03
2052	1.82E+02	5.25E+02	1.84E+03	2.60E+01	2.57E+03	5.09E+02	1.17E+03	3.42E+01	3.64E+02	2.13E+02	2.63E+00	2.29E+03	5.06E+02	1.17E+03	5.88E+01	5.43E+02	5.56E+00	2.87E+00	2.28E+03
2053	1.87E+02	5.40E+02	1.92E+03	2.60E+01	2.67E+03	5.32E+02	1.22E+03	3.48E+01	3.70E+02	2.24E+02	2.63E+00	2.38E+03	5.29E+02	1.22E+03	6.06E+01	5.57E+02	6.76E+00	2.87E+00	2.37E+03
2054	1.92E+02	5.55E+02	2.00E+03	2.60E+01	2.78E+03	5.54E+02	1.27E+03	3.53E+01	3.76E+02	2.34E+02	2.63E+00	2.47E+03	5.52E+02	1.27E+03	6.23E+01	5.71E+02	8.07E+00	2.87E+00	2.47E+03
2055	1.97E+02	5.70E+02	2.09E+03	2.60E+01	2.88E+03	5.77E+02	1.32E+03	3.58E+01	3.81E+02	2.45E+02	2.63E+00	2.56E+03	5.75E+02	1.32E+03	6.40E+01	5.84E+02	9.43E+00	2.87E+00	2.56E+03
2056	2.02E+02	5.84E+02	2.17E+03	2.60E+01	2.98E+03	6.00E+02	1.38E+03	3.63E+01	3.86E+02	2.55E+02	2.63E+00	2.66E+03	5.97E+02	1.38E+03	6.57E+01	5.97E+02	1.07E+01	2.87E+00	2.65E+03
2057	2.07E+02	5.98E+02	2.25E+03	2.60E+01	3.08E+03	6.23E+02	1.43E+03	3.68E+01	3.91E+02	2.66E+02	2.63E+00	2.75E+03	6.20E+02	1.43E+03	6.74E+01	6.10E+02	1.21E+01	2.87E+00	2.74E+03
2058	2.11E+02	6.11E+02	2.32E+03	2.60E+01	3.17E+03	6.44E+02	1.47E+03	3.72E+01	3.95E+02	2.76E+02	2.63E+00	2.83E+03	6.41E+02	1.47E+03	6.90E+01	6.22E+02	1.37E+01	2.87E+00	2.82E+03
2059	2.16E+02	6.24E+02	2.38E+03	2.60E+01	3.25E+03	6.60E+02	1.51E+03	3.76E+01	3.99E+02	2.86E+02	2.63E+00	2.90E+03	6.57E+02	1.51E+03	7.06E+01	6.33E+02	1.61E+01	2.87E+00	2.89E+03
2060	2.20E+02	6.37E+02	2.43E+03	2.60E+01	3.31E+03	6.73E+02	1.54E+03	3.79E+01	4.03E+02	2.97E+02	2.63E+00	2.96E+03	6.70E+02	1.54E+03	7.21E+01	6.42E+02	1.93E+01	2.87E+00	2.95E+03
2061	2.24E+02	6.49E+02	2.47E+03	2.60E+01	3.37E+03	6.84E+02	1.57E+03	3.82E+01	4.06E+02	3.07E+02	2.63E+00	3.00E+03	6.80E+02	1.57E+03	7.36E+01	6.51E+02	2.33E+01	2.87E+00	3.00E+03

Exhibit B-22. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	1.38E+01	0.00E+00	5.38E+01	3.81E+00	8.80E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.74E+01	3.79E+00	8.80E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.77E+01
2030	2.02E+01	5.85E+01	4.84E+01	0.00E+00	1.27E+02	1.33E+01	3.08E+01	5.29E+00	5.63E+01	2.58E+00	2.51E+00	1.11E+02	1.33E+01	3.08E+01	5.59E+00	5.80E+01	5.73E-01	2.75E+00	1.11E+02
2031	2.99E+01	8.65E+01	1.11E+02	1.20E+00	2.28E+02	3.05E+01	7.04E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	2.00E+02	3.03E+01	7.04E+01	8.46E+00	8.70E+01	5.73E-01	2.83E+00	2.00E+02
2032	3.93E+01	1.14E+02	1.87E+02	3.95E+00	3.44E+02	5.14E+01	1.19E+02	9.94E+00	1.06E+02	1.33E+01	2.63E+00	3.02E+02	5.12E+01	1.19E+02	1.15E+01	1.17E+02	5.73E-01	2.87E+00	3.02E+02
2033	4.85E+01	1.40E+02	2.70E+02	7.64E+00	4.66E+02	7.43E+01	1.72E+02	1.21E+01	1.28E+02	2.16E+01	2.63E+00	4.10E+02	7.40E+01	1.72E+02	1.45E+01	1.46E+02	5.73E-01	2.87E+00	4.10E+02
2034	5.74E+01	1.66E+02	3.53E+02	1.13E+01	5.88E+02	9.72E+01	2.24E+02	1.40E+01	1.49E+02	3.06E+01	2.63E+00	5.18E+02	9.67E+01	2.24E+02	1.76E+01	1.75E+02	5.73E-01	2.87E+00	5.17E+02
2035	6.60E+01	1.91E+02	4.36E+02	1.46E+01	7.08E+02	1.20E+02	2.77E+02	1.59E+01	1.69E+02	4.00E+01	2.63E+00	6.25E+02	1.19E+02	2.77E+02	2.05E+01	2.03E+02	5.73E-01	2.87E+00	6.24E+02
2036	7.44E+01	2.15E+02	5.19E+02	1.74E+01	8.26E+02	1.43E+02	3.30E+02	1.76E+01	1.87E+02	4.96E+01	2.63E+00	7.30E+02	1.42E+02	3.30E+02	2.33E+01	2.30E+02	5.73E-01	2.87E+00	7.29E+02
2037	8.26E+01	2.39E+02	6.02E+02	1.97E+01	9.43E+02	1.66E+02	3.83E+02	1.93E+01	2.05E+02	5.93E+01	2.63E+00	8.34E+02	1.65E+02	3.83E+02	2.61E+01	2.55E+02	5.73E-01	2.87E+00	8.33E+02
2038	9.06E+01	2.62E+02	6.85E+02	2.17E+01	1.06E+03	1.89E+02	4.36E+02	2.08E+01	2.21E+02	6.92E+01	2.63E+00	9.38E+02	1.88E+02	4.36E+02	2.88E+01	2.80E+02	5.73E-01	2.87E+00	9.36E+02
2039	9.83E+01	2.84E+02	7.68E+02	2.33E+01	1.17E+03	2.12E+02	4.88E+02	2.22E+01	2.36E+02	7.92E+01	2.63E+00	1.04E+03	2.11E+02	4.88E+02	3.13E+01	3.04E+02	5.73E-01	2.87E+00	1.04E+03
2040	1.06E+02	3.06E+02	8.51E+02	2.45E+01	1.29E+03	2.34E+02	5.41E+02	2.35E+01	2.50E+02	8.92E+01	2.63E+00	1.14E+03	2.33E+02	5.41E+02	3.38E+01	3.27E+02	5.73E-01	2.87E+00	1.14E+03
2041	1.13E+02	3.27E+02	9.34E+02	2.54E+01	1.40E+03	2.57E+02	5.94E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	1.24E+03	2.56E+02	5.94E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	1.24E+03
2042	1.20E+02	3.48E+02	1.02E+03	2.58E+01	1.51E+03	2.80E+02	6.47E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	1.34E+03	2.79E+02	6.47E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	1.34E+03
2043	1.27E+02	3.68E+02	1.10E+03	2.60E+01	1.62E+03	3.03E+02	7.00E+02	2.70E+01	2.87E+02	1.19E+02	2.63E+00	1.44E+03	3.02E+02	7.00E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	1.43E+03
2044	1.34E+02	3.87E+02	1.18E+03	2.60E+01	1.73E+03	3.26E+02	7.52E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	1.54E+03	3.24E+02	7.52E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	1.53E+03
2045	1.40E+02	4.06E+02	1.27E+03	2.60E+01	1.84E+03	3.49E+02	8.05E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	1.63E+03	3.47E+02	8.05E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	1.63E+03
2046	1.47E+02	4.25E+02	1.35E+03	2.60E+01	1.95E+03	3.72E+02	8.58E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.73E+03	3.70E+02	8.58E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.72E+03
2047	1.53E+02	4.43E+02	1.43E+03	2.60E+01	2.05E+03	3.94E+02	9.11E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.83E+03	3.93E+02	9.11E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.82E+03
2048	1.59E+02	4.60E+02	1.52E+03	2.60E+01	2.16E+03	4.17E+02	9.64E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.92E+03	4.15E+02	9.64E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.92E+03
2049	1.65E+02	4.77E+02	1.60E+03	2.60E+01	2.27E+03	4.40E+02	1.02E+03	3.23E+01	3.43E+02	1.81E+02	2.63E+00	2.02E+03	4.38E+02	1.02E+03	5.31E+01	4.97E+02	2.90E+00	2.87E+00	2.01E+03
2050	1.71E+02	4.93E+02	1.68E+03	2.60E+01	2.37E+03	4.63E+02	1.07E+03	3.30E+01	3.51E+02	1.92E+02	2.63E+00	2.11E+03	4.61E+02	1.07E+03	5.51E+01	5.13E+02	3.70E+00	2.87E+00	2.10E+03
2051	1.76E+02	5.10E+02	1.76E+03	2.60E+01	2.48E+03	4.86E+02	1.12E+03	3.36E+01	3.57E+02	2.02E+02	2.63E+00	2.20E+03	4.84E+02	1.12E+03	5.69E+01	5.28E+02	4.55E+00	2.87E+00	2.20E+03
2052	1.82E+02	5.25E+02	1.85E+03	2.60E+01	2.58E+03	5.09E+02	1.17E+03	3.42E+01	3.64E+02	2.13E+02	2.63E+00	2.30E+03	5.06E+02	1.17E+03	5.88E+01	5.43E+02	5.56E+00	2.87E+00	2.29E+03
2053	1.87E+02	5.40E+02	1.93E+03	2.60E+01	2.68E+03	5.32E+02	1.23E+03	3.48E+01	3.70E+02	2.24E+02	2.63E+00	2.39E+03	5.29E+02	1.23E+03	6.06E+01	5.57E+02	6.76E+00	2.87E+00	2.38E+03
2054	1.92E+02	5.55E+02	2.01E+03	2.60E+01	2.79E+03	5.54E+02	1.28E+03	3.53E+01	3.76E+02	2.34E+02	2.63E+00	2.48E+03	5.52E+02	1.28E+03	6.23E+01	5.71E+02	8.07E+00	2.87E+00	2.48E+03
2055	1.97E+02	5.70E+02	2.10E+03	2.60E+01	2.89E+03	5.77E+02	1.33E+03	3.58E+01	3.81E+02	2.45E+02	2.63E+00	2.57E+03	5.75E+02	1.33E+03	6.40E+01	5.84E+02	9.43E+00	2.87E+00	2.57E+03
2056	2.02E+02	5.84E+02	2.18E+03	2.60E+01	2.99E+03	6.00E+02	1.39E+03	3.63E+01	3.86E+02	2.55E+02	2.63E+00	2.67E+03	5.97E+02	1.39E+03	6.57E+01	5.97E+02	1.07E+01	2.87E+00	2.66E+03
2057	2.07E+02	5.98E+02	2.26E+03	2.60E+01	3.09E+03	6.23E+02	1.44E+03	3.68E+01	3.91E+02	2.66E+02	2.63E+00	2.76E+03	6.20E+02	1.44E+03	6.74E+01	6.10E+02	1.21E+01	2.87E+00	2.75E+03
2058	2.11E+02	6.11E+02	2.34E+03	2.60E+01	3.19E+03	6.44E+02	1.49E+03	3.72E+01	3.95E+02	2.76E+02	2.63E+00	2.84E+03	6.41E+02	1.49E+03	6.90E+01	6.22E+02	1.37E+01	2.87E+00	2.83E+03
2059	2.16E+02	6.24E+02	2.40E+03	2.60E+01	3.26E+03	6.60E+02	1.52E+03	3.76E+01	3.99E+02	2.86E+02	2.63E+00	2.91E+03	6.57E+02	1.52E+03	7.06E+01	6.33E+02	1.61E+01	2.87E+00	2.90E+03
2060	2.20E+02	6.37E+02	2.44E+03	2.60E+01	3.33E+03	6.73E+02	1.55E+03	3.79E+01	4.03E+02	2.97E+02	2.63E+00	2.97E+03	6.70E+02	1.55E+03	7.21E+01	6.42E+02	1.93E+01	2.87E+00	2.96E+03
2061	2.24E+02	6.49E+02	2.48E+03	2.60E+01	3.38E+03	6.84E+02	1.58E+03	3.82E+01	4.06E+02	3.07E+02	2.63E+00	3.02E+03	6.80E+02	1.58E+03	7.36E+01	6.51E+02	2.33E+01	2.87E+00	3.01E+03

Exhibit B-23. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	1.38E+01	0.00E+00	5.38E+01	3.81E+00	8.80E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.74E+01	3.79E+00	8.80E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.77E+01
2030	2.02E+01	5.85E+01	4.84E+01	0.00E+00	1.27E+02	1.33E+01	3.08E+01	5.29E+00	5.63E+01	2.58E+00	2.51E+00	1.11E+02	1.33E+01	3.08E+01	5.59E+00	5.80E+01	5.73E-01	2.75E+00	1.11E+02
2031	2.99E+01	8.65E+01	1.11E+02	1.20E+00	2.28E+02	3.05E+01	7.04E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	2.00E+02	3.03E+01	7.04E+01	8.46E+00	8.70E+01	5.73E-01	2.83E+00	2.00E+02
2032	3.93E+01	1.14E+02	1.87E+02	3.95E+00	3.44E+02	5.14E+01	1.19E+02	9.94E+00	1.06E+02	1.33E+01	2.63E+00	3.02E+02	5.12E+01	1.19E+02	1.15E+01	1.17E+02	5.73E-01	2.87E+00	3.02E+02
2033	4.85E+01	1.40E+02	2.70E+02	7.64E+00	4.66E+02	7.43E+01	1.72E+02	1.21E+01	1.28E+02	2.16E+01	2.63E+00	4.10E+02	7.40E+01	1.72E+02	1.45E+01	1.46E+02	5.73E-01	2.87E+00	4.10E+02
2034	5.74E+01	1.66E+02	3.53E+02	1.13E+01	5.88E+02	9.72E+01	2.24E+02	1.40E+01	1.49E+02	3.06E+01	2.63E+00	5.18E+02	9.67E+01	2.24E+02	1.76E+01	1.75E+02	5.73E-01	2.87E+00	5.17E+02
2035	6.60E+01	1.91E+02	4.36E+02	1.46E+01	7.08E+02	1.20E+02	2.77E+02	1.59E+01	1.69E+02	4.00E+01	2.63E+00	6.25E+02	1.19E+02	2.77E+02	2.05E+01	2.03E+02	5.73E-01	2.87E+00	6.24E+02
2036	7.44E+01	2.15E+02	5.19E+02	1.74E+01	8.26E+02	1.43E+02	3.30E+02	1.76E+01	1.87E+02	4.96E+01	2.63E+00	7.30E+02	1.42E+02	3.30E+02	2.33E+01	2.30E+02	5.73E-01	2.87E+00	7.29E+02
2037	8.26E+01	2.39E+02	6.02E+02	1.97E+01	9.43E+02	1.66E+02	3.83E+02	1.93E+01	2.05E+02	5.93E+01	2.63E+00	8.35E+02	1.65E+02	3.83E+02	2.61E+01	2.55E+02	5.73E-01	2.87E+00	8.33E+02
2038	9.06E+01	2.62E+02	6.85E+02	2.17E+01	1.06E+03	1.89E+02	4.36E+02	2.08E+01	2.21E+02	6.92E+01	2.63E+00	9.38E+02	1.88E+02	4.36E+02	2.88E+01	2.80E+02	5.73E-01	2.87E+00	9.36E+02
2039	9.83E+01	2.84E+02	7.68E+02	2.33E+01	1.17E+03	2.12E+02	4.89E+02	2.22E+01	2.36E+02	7.92E+01	2.63E+00	1.04E+03	2.11E+02	4.89E+02	3.13E+01	3.04E+02	5.73E-01	2.87E+00	1.04E+03
2040	1.06E+02	3.06E+02	8.51E+02	2.45E+01	1.29E+03	2.34E+02	5.41E+02	2.35E+01	2.50E+02	8.92E+01	2.63E+00	1.14E+03	2.33E+02	5.41E+02	3.38E+01	3.27E+02	5.73E-01	2.87E+00	1.14E+03
2041	1.13E+02	3.27E+02	9.34E+02	2.54E+01	1.40E+03	2.57E+02	5.94E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	1.24E+03	2.56E+02	5.94E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	1.24E+03
2042	1.20E+02	3.48E+02	1.02E+03	2.58E+01	1.51E+03	2.80E+02	6.47E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	1.34E+03	2.79E+02	6.47E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	1.34E+03
2043	1.27E+02	3.68E+02	1.10E+03	2.60E+01	1.62E+03	3.03E+02	7.00E+02	2.70E+01	2.87E+02	1.19E+02	2.63E+00	1.44E+03	3.02E+02	7.00E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	1.44E+03
2044	1.34E+02	3.87E+02	1.18E+03	2.60E+01	1.73E+03	3.26E+02	7.53E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	1.54E+03	3.24E+02	7.53E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	1.53E+03
2045	1.40E+02	4.06E+02	1.27E+03	2.60E+01	1.84E+03	3.49E+02	8.05E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	1.63E+03	3.47E+02	8.05E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	1.63E+03
2046	1.47E+02	4.25E+02	1.35E+03	2.60E+01	1.95E+03	3.72E+02	8.58E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.73E+03	3.70E+02	8.58E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.73E+03
2047	1.53E+02	4.43E+02	1.43E+03	2.60E+01	2.05E+03	3.94E+02	9.11E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.83E+03	3.93E+02	9.11E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.82E+03
2048	1.59E+02	4.60E+02	1.52E+03	2.60E+01	2.16E+03	4.17E+02	9.64E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.92E+03	4.15E+02	9.64E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.92E+03
2049	1.65E+02	4.77E+02	1.60E+03	2.60E+01	2.27E+03	4.40E+02	1.02E+03	3.23E+01	3.43E+02	1.81E+02	2.63E+00	2.02E+03	4.38E+02	1.02E+03	5.31E+01	4.97E+02	2.90E+00	2.87E+00	2.01E+03
2050	1.71E+02	4.93E+02	1.68E+03	2.60E+01	2.37E+03	4.63E+02	1.07E+03	3.30E+01	3.51E+02	1.92E+02	2.63E+00	2.11E+03	4.61E+02	1.07E+03	5.51E+01	5.13E+02	3.70E+00	2.87E+00	2.10E+03
2051	1.76E+02	5.10E+02	1.76E+03	2.60E+01	2.48E+03	4.86E+02	1.12E+03	3.36E+01	3.57E+02	2.02E+02	2.63E+00	2.20E+03	4.84E+02	1.12E+03	5.69E+01	5.28E+02	4.55E+00	2.87E+00	2.20E+03
2052	1.82E+02	5.25E+02	1.85E+03	2.60E+01	2.58E+03	5.09E+02	1.18E+03	3.42E+01	3.64E+02	2.13E+02	2.63E+00	2.30E+03	5.06E+02	1.18E+03	5.88E+01	5.43E+02	5.56E+00	2.87E+00	2.29E+03
2053	1.87E+02	5.40E+02	1.93E+03	2.60E+01	2.68E+03	5.32E+02	1.23E+03	3.48E+01	3.70E+02	2.24E+02	2.63E+00	2.39E+03	5.29E+02	1.23E+03	6.06E+01	5.57E+02	6.76E+00	2.87E+00	2.38E+03
2054	1.92E+02	5.55E+02	2.01E+03	2.60E+01	2.79E+03	5.54E+02	1.28E+03	3.53E+01	3.76E+02	2.34E+02	2.63E+00	2.48E+03	5.52E+02	1.28E+03	6.23E+01	5.71E+02	8.07E+00	2.87E+00	2.48E+03
2055	1.97E+02	5.70E+02	2.10E+03	2.60E+01	2.89E+03	5.77E+02	1.33E+03	3.58E+01	3.81E+02	2.45E+02	2.63E+00	2.58E+03	5.75E+02	1.33E+03	6.40E+01	5.84E+02	9.43E+00	2.87E+00	2.57E+03
2056	2.02E+02	5.84E+02	2.18E+03	2.60E+01	2.99E+03	6.00E+02	1.39E+03	3.63E+01	3.86E+02	2.55E+02	2.63E+00	2.67E+03	5.97E+02	1.39E+03	6.57E+01	5.97E+02	1.07E+01	2.87E+00	2.66E+03
2057	2.07E+02	5.98E+02	2.26E+03	2.60E+01	3.09E+03	6.23E+02	1.44E+03	3.68E+01	3.91E+02	2.66E+02	2.63E+00	2.76E+03	6.20E+02	1.44E+03	6.74E+01	6.10E+02	1.21E+01	2.87E+00	2.75E+03
2058	2.11E+02	6.11E+02	2.34E+03	2.60E+01	3.19E+03	6.44E+02	1.49E+03	3.72E+01	3.95E+02	2.76E+02	2.63E+00	2.84E+03	6.41E+02	1.49E+03	6.90E+01	6.22E+02	1.37E+01	2.87E+00	2.83E+03
2059	2.16E+02	6.24E+02	2.40E+03	2.60E+01	3.26E+03	6.60E+02	1.52E+03	3.76E+01	3.99E+02	2.86E+02	2.63E+00	2.91E+03	6.57E+02	1.52E+03	7.06E+01	6.33E+02	1.61E+01	2.87E+00	2.90E+03
2060	2.20E+02	6.37E+02	2.44E+03	2.60E+01	3.33E+03	6.73E+02	1.55E+03	3.79E+01	4.03E+02	2.97E+02	2.63E+00	2.97E+03	6.70E+02	1.55E+03	7.21E+01	6.42E+02	1.93E+01	2.87E+00	2.96E+03
2061	2.24E+02	6.49E+02	2.48E+03	2.60E+01	3.38E+03	6.84E+02	1.58E+03	3.82E+01	4.06E+02	3.07E+02	2.63E+00	3.02E+03	6.80E+02	1.58E+03	7.36E+01	6.51E+02	2.33E+01	2.87E+00	3.01E+03

Exhibit B-24. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	1.38E+01	0.00E+00	5.37E+01	3.81E+00	9.15E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.77E+01	3.79E+00	9.15E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.80E+01
2030	2.02E+01	5.85E+01	4.83E+01	0.00E+00	1.27E+02	1.33E+01	3.20E+01	5.29E+00	5.63E+01	2.58E+00	2.51E+00	1.12E+02	1.33E+01	3.20E+01	5.59E+00	5.80E+01	5.73E-01	2.75E+00	1.12E+02
2031	2.99E+01	8.65E+01	1.11E+02	1.20E+00	2.28E+02	3.05E+01	7.32E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	2.02E+02	3.03E+01	7.32E+01	8.46E+00	8.70E+01	5.73E-01	2.83E+00	2.02E+02
2032	3.93E+01	1.14E+02	1.86E+02	3.95E+00	3.44E+02	5.14E+01	1.23E+02	9.94E+00	1.06E+02	1.33E+01	2.63E+00	3.06E+02	5.12E+01	1.23E+02	1.15E+01	1.17E+02	5.73E-01	2.87E+00	3.06E+02
2033	4.85E+01	1.40E+02	2.69E+02	7.64E+00	4.66E+02	7.43E+01	1.78E+02	1.21E+01	1.28E+02	2.16E+01	2.63E+00	4.17E+02	7.40E+01	1.78E+02	1.45E+01	1.46E+02	5.73E-01	2.87E+00	4.17E+02
2034	5.74E+01	1.66E+02	3.52E+02	1.13E+01	5.87E+02	9.72E+01	2.33E+02	1.40E+01	1.49E+02	3.06E+01	2.63E+00	5.27E+02	9.67E+01	2.33E+02	1.76E+01	1.75E+02	5.73E-01	2.87E+00	5.26E+02
2035	6.60E+01	1.91E+02	4.35E+02	1.46E+01	7.07E+02	1.20E+02	2.88E+02	1.59E+01	1.69E+02	4.00E+01	2.63E+00	6.36E+02	1.19E+02	2.88E+02	2.05E+01	2.03E+02	5.73E-01	2.87E+00	6.35E+02
2036	7.44E+01	2.15E+02	5.18E+02	1.74E+01	8.25E+02	1.43E+02	3.43E+02	1.76E+01	1.87E+02	4.96E+01	2.63E+00	7.43E+02	1.42E+02	3.43E+02	2.33E+01	2.30E+02	5.73E-01	2.87E+00	7.42E+02
2037	8.26E+01	2.39E+02	6.01E+02	1.97E+01	9.42E+02	1.66E+02	3.98E+02	1.93E+01	2.05E+02	5.93E+01	2.63E+00	8.50E+02	1.65E+02	3.98E+02	2.61E+01	2.55E+02	5.73E-01	2.87E+00	8.48E+02
2038	9.06E+01	2.62E+02	6.84E+02	2.17E+01	1.06E+03	1.89E+02	4.53E+02	2.08E+01	2.21E+02	6.92E+01	2.63E+00	9.55E+02	1.88E+02	4.53E+02	2.88E+01	2.80E+02	5.73E-01	2.87E+00	9.53E+02
2039	9.83E+01	2.84E+02	7.67E+02	2.33E+01	1.17E+03	2.11E+02	5.08E+02	2.22E+01	2.36E+02	7.92E+01	2.63E+00	1.06E+03	2.11E+02	5.08E+02	3.13E+01	3.04E+02	5.73E-01	2.87E+00	1.06E+03
2040	1.06E+02	3.06E+02	8.49E+02	2.45E+01	1.29E+03	2.34E+02	5.62E+02	2.35E+01	2.50E+02	8.92E+01	2.63E+00	1.16E+03	2.33E+02	5.62E+02	3.38E+01	3.27E+02	5.73E-01	2.87E+00	1.16E+03
2041	1.13E+02	3.27E+02	9.32E+02	2.54E+01	1.40E+03	2.57E+02	6.17E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	1.26E+03	2.56E+02	6.17E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	1.26E+03
2042	1.20E+02	3.48E+02	1.02E+03	2.58E+01	1.51E+03	2.80E+02	6.72E+02	2.59E+01	2.76E+02	1.09E+02	2.63E+00	1.37E+03	2.79E+02	6.72E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	1.36E+03
2043	1.27E+02	3.68E+02	1.10E+03	2.60E+01	1.62E+03	3.03E+02	7.27E+02	2.70E+01	2.87E+02	1.19E+02	2.63E+00	1.47E+03	3.02E+02	7.27E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	1.46E+03
2044	1.34E+02	3.87E+02	1.18E+03	2.60E+01	1.73E+03	3.26E+02	7.82E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	1.57E+03	3.24E+02	7.82E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	1.56E+03
2045	1.40E+02	4.06E+02	1.26E+03	2.60E+01	1.84E+03	3.49E+02	8.37E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	1.66E+03	3.47E+02	8.37E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	1.66E+03
2046	1.47E+02	4.25E+02	1.35E+03	2.60E+01	1.94E+03	3.72E+02	8.92E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.76E+03	3.70E+02	8.92E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.76E+03
2047	1.53E+02	4.43E+02	1.43E+03	2.60E+01	2.05E+03	3.94E+02	9.47E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.86E+03	3.93E+02	9.47E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.86E+03
2048	1.59E+02	4.60E+02	1.51E+03	2.60E+01	2.16E+03	4.17E+02	1.00E+03	3.15E+01	3.35E+02	1.70E+02	2.63E+00	1.96E+03	4.15E+02	1.00E+03	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.95E+03
2049	1.65E+02	4.77E+02	1.60E+03	2.60E+01	2.26E+03	4.40E+02	1.06E+03	3.23E+01	3.43E+02	1.81E+02	2.63E+00	2.06E+03	4.38E+02	1.06E+03	5.31E+01	4.97E+02	2.90E+00	2.87E+00	2.05E+03
2050	1.71E+02	4.93E+02	1.68E+03	2.60E+01	2.37E+03	4.63E+02	1.11E+03	3.30E+01	3.51E+02	1.92E+02	2.63E+00	2.15E+03	4.61E+02	1.11E+03	5.51E+01	5.13E+02	3.70E+00	2.87E+00	2.15E+03
2051	1.76E+02	5.10E+02	1.76E+03	2.60E+01	2.47E+03	4.86E+02	1.17E+03	3.36E+01	3.57E+02	2.02E+02	2.63E+00	2.25E+03	4.84E+02	1.17E+03	5.69E+01	5.28E+02	4.55E+00	2.87E+00	2.24E+03
2052	1.82E+02	5.25E+02	1.84E+03	2.60E+01	2.58E+03	5.09E+02	1.22E+03	3.42E+01	3.64E+02	2.13E+02	2.63E+00	2.34E+03	5.06E+02	1.22E+03	5.88E+01	5.43E+02	5.56E+00	2.87E+00	2.34E+03
2053	1.87E+02	5.40E+02	1.93E+03	2.60E+01	2.68E+03	5.32E+02	1.28E+03	3.48E+01	3.70E+02	2.24E+02	2.63E+00	2.44E+03	5.29E+02	1.28E+03	6.06E+01	5.57E+02	6.76E+00	2.87E+00	2.43E+03
2054	1.92E+02	5.55E+02	2.01E+03	2.60E+01	2.78E+03	5.54E+02	1.33E+03	3.53E+01	3.76E+02	2.34E+02	2.63E+00	2.53E+03	5.52E+02	1.33E+03	6.23E+01	5.71E+02	8.07E+00	2.87E+00	2.53E+03
2055	1.97E+02	5.70E+02	2.09E+03	2.60E+01	2.89E+03	5.77E+02	1.39E+03	3.58E+01	3.81E+02	2.45E+02	2.63E+00	2.63E+03	5.75E+02	1.39E+03	6.40E+01	5.84E+02	9.43E+00	2.87E+00	2.62E+03
2056	2.02E+02	5.84E+02	2.18E+03	2.60E+01	2.99E+03	6.00E+02	1.44E+03	3.63E+01	3.86E+02	2.55E+02	2.63E+00	2.72E+03	5.97E+02	1.44E+03	6.57E+01	5.97E+02	1.07E+01	2.87E+00	2.71E+03
2057	2.07E+02	5.98E+02	2.26E+03	2.60E+01	3.09E+03	6.23E+02	1.50E+03	3.68E+01	3.91E+02	2.66E+02	2.63E+00	2.81E+03	6.20E+02	1.50E+03	6.74E+01	6.10E+02	1.21E+01	2.87E+00	2.81E+03
2058	2.11E+02	6.11E+02	2.33E+03	2.60E+01	3.18E+03	6.44E+02	1.54E+03	3.72E+01	3.95E+02	2.76E+02	2.63E+00	2.90E+03	6.41E+02	1.54E+03	6.90E+01	6.22E+02	1.37E+01	2.87E+00	2.89E+03
2059	2.16E+02	6.24E+02	2.39E+03	2.60E+01	3.26E+03	6.60E+02	1.58E+03	3.75E+01	3.99E+02	2.86E+02	2.63E+00	2.97E+03	6.57E+02	1.58E+03	7.06E+01	6.33E+02	1.61E+01	2.87E+00	2.96E+03
2060	2.20E+02	6.37E+02	2.44E+03	2.60E+01	3.32E+03	6.73E+02	1.62E+03	3.79E+01	4.03E+02	2.97E+02	2.63E+00	3.03E+03	6.70E+02	1.62E+03	7.21E+01	6.42E+02	1.93E+01	2.87E+00	3.02E+03
2061	2.24E+02	6.49E+02	2.48E+03	2.60E+01	3.38E+03	6.84E+02	1.64E+03	3.82E+01	4.06E+02	3.07E+02	2.63E+00	3.08E+03	6.80E+02	1.64E+03	7.36E+01	6.51E+02	2.33E+01	2.87E+00	3.07E+03

Exhibit B-25. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	6.53E+00	0.00E+00	4.65E+01	3.81E+00	1.53E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.01E+01	3.79E+00	1.53E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.04E+01
2030	2.02E+01	5.85E+01	2.28E+01	0.00E+00	1.02E+02	1.33E+01	5.35E+00	5.30E+00	5.63E+01	2.58E+00	2.51E+00	8.54E+01	1.33E+01	5.35E+00	5.59E+00	5.80E+01	5.73E-01	2.75E+00	8.55E+01
2031	2.99E+01	8.65E+01	5.22E+01	1.20E+00	1.70E+02	3.05E+01	1.22E+01	7.70E+00	8.18E+01	6.69E+00	2.59E+00	1.41E+02	3.03E+01	1.22E+01	8.47E+00	8.70E+01	5.73E-01	2.83E+00	1.42E+02
2032	3.93E+01	1.14E+02	8.81E+01	3.95E+00	2.45E+02	5.15E+01	2.07E+01	9.95E+00	1.06E+02	1.33E+01	2.63E+00	2.04E+02	5.12E+01	2.07E+01	1.15E+01	1.17E+02	5.73E-01	2.87E+00	2.03E+02
2033	4.85E+01	1.40E+02	1.27E+02	7.64E+00	3.24E+02	7.43E+01	2.98E+01	1.21E+01	1.28E+02	2.16E+01	2.63E+00	2.69E+02	7.40E+01	2.98E+01	1.46E+01	1.46E+02	5.73E-01	2.87E+00	2.68E+02
2034	5.74E+01	1.66E+02	1.66E+02	1.13E+01	4.01E+02	9.72E+01	3.90E+01	1.40E+01	1.49E+02	3.06E+01	2.63E+00	3.33E+02	9.67E+01	3.90E+01	1.76E+01	1.75E+02	5.73E-01	2.87E+00	3.32E+02
2035	6.60E+01	1.91E+02	2.06E+02	1.46E+01	4.77E+02	1.20E+02	4.82E+01	1.59E+01	1.69E+02	4.00E+01	2.63E+00	3.96E+02	1.19E+02	4.82E+01	2.05E+01	2.03E+02	5.73E-01	2.87E+00	3.95E+02
2036	7.44E+01	2.15E+02	2.45E+02	1.74E+01	5.52E+02	1.43E+02	5.74E+01	1.76E+01	1.87E+02	4.96E+01	2.63E+00	4.58E+02	1.42E+02	5.74E+01	2.34E+01	2.30E+02	5.73E-01	2.87E+00	4.56E+02
2037	8.26E+01	2.39E+02	2.84E+02	1.97E+01	6.25E+02	1.66E+02	6.65E+01	1.93E+01	2.05E+02	5.93E+01	2.63E+00	5.18E+02	1.65E+02	6.65E+01	2.61E+01	2.55E+02	5.73E-01	2.87E+00	5.17E+02
2038	9.06E+01	2.62E+02	3.23E+02	2.17E+01	6.97E+02	1.89E+02	7.57E+01	2.08E+01	2.21E+02	6.92E+01	2.63E+00	5.78E+02	1.88E+02	7.57E+01	2.88E+01	2.80E+02	5.73E-01	2.87E+00	5.76E+02
2039	9.83E+01	2.84E+02	3.62E+02	2.33E+01	7.68E+02	2.12E+02	8.49E+01	2.22E+01	2.36E+02	7.92E+01	2.63E+00	6.36E+02	2.11E+02	8.49E+01	3.13E+01	3.04E+02	5.73E-01	2.87E+00	6.34E+02
2040	1.06E+02	3.06E+02	4.01E+02	2.45E+01	8.38E+02	2.34E+02	9.41E+01	2.35E+01	2.50E+02	8.92E+01	2.63E+00	6.94E+02	2.33E+02	9.41E+01	3.38E+01	3.27E+02	5.73E-01	2.87E+00	6.91E+02
2041	1.13E+02	3.27E+02	4.41E+02	2.54E+01	9.06E+02	2.57E+02	1.03E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	7.51E+02	2.56E+02	1.03E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	7.48E+02
2042	1.20E+02	3.48E+02	4.80E+02	2.58E+01	9.74E+02	2.80E+02	1.12E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	8.06E+02	2.79E+02	1.12E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	8.03E+02
2043	1.27E+02	3.68E+02	5.19E+02	2.60E+01	1.04E+03	3.03E+02	1.22E+02	2.71E+01	2.87E+02	1.19E+02	2.63E+00	8.61E+02	3.02E+02	1.22E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	8.57E+02
2044	1.34E+02	3.87E+02	5.58E+02	2.60E+01	1.11E+03	3.26E+02	1.31E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	9.15E+02	3.24E+02	1.31E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	9.11E+02
2045	1.40E+02	4.06E+02	5.97E+02	2.60E+01	1.17E+03	3.49E+02	1.40E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	9.68E+02	3.47E+02	1.40E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	9.64E+02
2046	1.47E+02	4.25E+02	6.36E+02	2.60E+01	1.23E+03	3.72E+02	1.49E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.02E+03	3.70E+02	1.49E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.02E+03
2047	1.53E+02	4.43E+02	6.76E+02	2.60E+01	1.30E+03	3.94E+02	1.58E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.07E+03	3.93E+02	1.58E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.07E+03
2048	1.59E+02	4.60E+02	7.15E+02	2.60E+01	1.36E+03	4.17E+02	1.67E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.12E+03	4.15E+02	1.67E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.12E+03
2049	1.65E+02	4.77E+02	7.54E+02	2.60E+01	1.42E+03	4.40E+02	1.77E+02	3.23E+01	3.43E+02	1.81E+02	2.63E+00	1.18E+03	4.38E+02	1.77E+02	5.31E+01	4.97E+02	2.90E+00	2.87E+00	1.17E+03
2050	1.71E+02	4.93E+02	7.93E+02	2.60E+01	1.48E+03	4.63E+02	1.86E+02	3.30E+01	3.51E+02	1.92E+02	2.63E+00	1.23E+03	4.61E+02	1.86E+02	5.51E+01	5.13E+02	3.70E+00	2.87E+00	1.22E+03
2051	1.76E+02	5.10E+02	8.32E+02	2.60E+01	1.54E+03	4.86E+02	1.95E+02	3.36E+01	3.57E+02	2.02E+02	2.63E+00	1.28E+03	4.84E+02	1.95E+02	5.69E+01	5.28E+02	4.55E+00	2.87E+00	1.27E+03
2052	1.82E+02	5.25E+02	8.71E+02	2.60E+01	1.60E+03	5.09E+02	2.04E+02	3.42E+01	3.64E+02	2.13E+02	2.63E+00	1.33E+03	5.06E+02	2.04E+02	5.88E+01	5.43E+02	5.56E+00	2.87E+00	1.32E+03
2053	1.87E+02	5.40E+02	9.11E+02	2.60E+01	1.66E+03	5.32E+02	2.13E+02	3.48E+01	3.70E+02	2.24E+02	2.63E+00	1.38E+03	5.29E+02	2.13E+02	6.06E+01	5.57E+02	6.76E+00	2.87E+00	1.37E+03
2054	1.92E+02	5.55E+02	9.50E+02	2.60E+01	1.72E+03	5.55E+02	2.23E+02	3.54E+01	3.76E+02	2.34E+02	2.63E+00	1.42E+03	5.52E+02	2.23E+02	6.23E+01	5.71E+02	8.07E+00	2.87E+00	1.42E+03
2055	1.97E+02	5.70E+02	9.89E+02	2.60E+01	1.78E+03	5.77E+02	2.32E+02	3.59E+01	3.81E+02	2.45E+02	2.63E+00	1.47E+03	5.75E+02	2.32E+02	6.41E+01	5.84E+02	9.43E+00	2.87E+00	1.47E+03
2056	2.02E+02	5.84E+02	1.03E+03	2.60E+01	1.84E+03	6.00E+02	2.41E+02	3.63E+01	3.86E+02	2.55E+02	2.63E+00	1.52E+03	5.97E+02	2.41E+02	6.57E+01	5.97E+02	1.07E+01	2.87E+00	1.51E+03
2057	2.07E+02	5.98E+02	1.07E+03	2.60E+01	1.90E+03	6.23E+02	2.50E+02	3.68E+01	3.91E+02	2.66E+02	2.63E+00	1.57E+03	6.20E+02	2.50E+02	6.74E+01	6.10E+02	1.21E+01	2.87E+00	1.56E+03
2058	2.11E+02	6.11E+02	1.10E+03	2.60E+01	1.95E+03	6.44E+02	2.58E+02	3.72E+01	3.95E+02	2.76E+02	2.63E+00	1.61E+03	6.41E+02	2.58E+02	6.90E+01	6.22E+02	1.37E+01	2.87E+00	1.61E+03
2059	2.16E+02	6.24E+02	1.13E+03	2.60E+01	2.00E+03	6.60E+02	2.65E+02	3.76E+01	3.99E+02	2.86E+02	2.63E+00	1.65E+03	6.57E+02	2.65E+02	7.06E+01	6.33E+02	1.61E+01	2.87E+00	1.64E+03
2060	2.20E+02	6.37E+02	1.15E+03	2.60E+01	2.04E+03	6.73E+02	2.70E+02	3.79E+01	4.03E+02	2.97E+02	2.63E+00	1.68E+03	6.70E+02	2.70E+02	7.21E+01	6.42E+02	1.93E+01	2.87E+00	1.68E+03
2061	2.24E+02	6.49E+02	1.17E+03	2.60E+01	2.07E+03	6.84E+02	2.74E+02	3.82E+01	4.06E+02	3.07E+02	2.63E+00	1.71E+03	6.80E+02	2.74E+02	7.36E+01	6.51E+02	2.33E+01	2.87E+00	1.71E+03

Exhibit B-26. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	6.62E+00	0.00E+00	4.65E+01	3.81E+00	1.61E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.02E+01	3.79E+00	1.61E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.05E+01
2030	2.02E+01	5.85E+01	2.32E+01	0.00E+00	1.02E+02	1.33E+01	5.63E+00	5.30E+00	5.63E+01	2.58E+00	2.51E+00	8.56E+01	1.33E+01	5.63E+00	5.59E+00	5.80E+01	5.73E-01	2.75E+00	8.58E+01
2031	2.99E+01	8.65E+01	5.30E+01	1.20E+00	1.71E+02	3.05E+01	1.29E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	1.42E+02	3.03E+01	1.29E+01	8.47E+00	8.70E+01	5.73E-01	2.83E+00	1.42E+02
2032	3.93E+01	1.14E+02	8.94E+01	3.95E+00	2.46E+02	5.15E+01	2.17E+01	9.95E+00	1.06E+02	1.33E+01	2.63E+00	2.05E+02	5.12E+01	2.17E+01	1.15E+01	1.17E+02	5.73E-01	2.87E+00	2.05E+02
2033	4.85E+01	1.40E+02	1.29E+02	7.64E+00	3.25E+02	7.43E+01	3.14E+01	1.21E+01	1.28E+02	2.16E+01	2.63E+00	2.70E+02	7.40E+01	3.14E+01	1.45E+01	1.46E+02	5.73E-01	2.87E+00	2.70E+02
2034	5.74E+01	1.66E+02	1.69E+02	1.13E+01	4.03E+02	9.72E+01	4.11E+01	1.40E+01	1.49E+02	3.06E+01	2.63E+00	3.35E+02	9.67E+01	4.11E+01	1.76E+01	1.75E+02	5.73E-01	2.87E+00	3.34E+02
2035	6.60E+01	1.91E+02	2.09E+02	1.46E+01	4.80E+02	1.20E+02	5.07E+01	1.59E+01	1.69E+02	4.00E+01	2.63E+00	3.98E+02	1.19E+02	5.07E+01	2.05E+01	2.03E+02	5.73E-01	2.87E+00	3.97E+02
2036	7.44E+01	2.15E+02	2.48E+02	1.74E+01	5.55E+02	1.43E+02	6.04E+01	1.76E+01	1.87E+02	4.96E+01	2.63E+00	4.61E+02	1.42E+02	6.04E+01	2.34E+01	2.30E+02	5.73E-01	2.87E+00	4.59E+02
2037	8.26E+01	2.39E+02	2.88E+02	1.97E+01	6.29E+02	1.66E+02	7.00E+01	1.93E+01	2.05E+02	5.93E+01	2.63E+00	5.22E+02	1.65E+02	7.00E+01	2.61E+01	2.55E+02	5.73E-01	2.87E+00	5.20E+02
2038	9.06E+01	2.62E+02	3.28E+02	2.17E+01	7.02E+02	1.89E+02	7.97E+01	2.08E+01	2.21E+02	6.92E+01	2.63E+00	5.82E+02	1.88E+02	7.97E+01	2.88E+01	2.80E+02	5.73E-01	2.87E+00	5.80E+02
2039	9.83E+01	2.84E+02	3.67E+02	2.33E+01	7.73E+02	2.12E+02	8.93E+01	2.22E+01	2.36E+02	7.92E+01	2.63E+00	6.41E+02	2.11E+02	8.93E+01	3.13E+01	3.04E+02	5.73E-01	2.87E+00	6.39E+02
2040	1.06E+02	3.06E+02	4.07E+02	2.45E+01	8.43E+02	2.34E+02	9.90E+01	2.35E+01	2.50E+02	8.92E+01	2.63E+00	6.99E+02	2.33E+02	9.90E+01	3.38E+01	3.27E+02	5.73E-01	2.87E+00	6.96E+02
2041	1.13E+02	3.27E+02	4.47E+02	2.54E+01	9.12E+02	2.57E+02	1.09E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	7.56E+02	2.56E+02	1.09E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	7.53E+02
2042	1.20E+02	3.48E+02	4.87E+02	2.58E+01	9.80E+02	2.80E+02	1.18E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	8.12E+02	2.79E+02	1.18E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	8.09E+02
2043	1.27E+02	3.68E+02	5.26E+02	2.60E+01	1.05E+03	3.03E+02	1.28E+02	2.71E+01	2.87E+02	1.19E+02	2.63E+00	8.67E+02	3.02E+02	1.28E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	8.63E+02
2044	1.34E+02	3.87E+02	5.66E+02	2.60E+01	1.11E+03	3.26E+02	1.38E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	9.21E+02	3.24E+02	1.38E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	9.18E+02
2045	1.40E+02	4.06E+02	6.06E+02	2.60E+01	1.18E+03	3.49E+02	1.47E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	9.75E+02	3.47E+02	1.47E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	9.71E+02
2046	1.47E+02	4.25E+02	6.45E+02	2.60E+01	1.24E+03	3.72E+02	1.57E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.03E+03	3.70E+02	1.57E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.02E+03
2047	1.53E+02	4.43E+02	6.85E+02	2.60E+01	1.31E+03	3.94E+02	1.67E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.08E+03	3.93E+02	1.67E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.08E+03
2048	1.59E+02	4.60E+02	7.25E+02	2.60E+01	1.37E+03	4.17E+02	1.76E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.13E+03	4.15E+02	1.76E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.13E+03
2049	1.65E+02	4.77E+02	7.65E+02	2.60E+01	1.43E+03	4.40E+02	1.86E+02	3.23E+01	3.43E+02	1.81E+02	2.63E+00	1.19E+03	4.38E+02	1.86E+02	5.31E+01	4.97E+02	2.90E+00	2.87E+00	1.18E+03
2050	1.71E+02	4.93E+02	8.04E+02	2.60E+01	1.49E+03	4.63E+02	1.96E+02	3.30E+01	3.51E+02	1.92E+02	2.63E+00	1.24E+03	4.61E+02	1.96E+02	5.51E+01	5.13E+02	3.70E+00	2.87E+00	1.23E+03
2051	1.76E+02	5.10E+02	8.44E+02	2.60E+01	1.56E+03	4.86E+02	2.05E+02	3.36E+01	3.57E+02	2.02E+02	2.63E+00	1.29E+03	4.84E+02	2.05E+02	5.69E+01	5.28E+02	4.55E+00	2.87E+00	1.28E+03
2052	1.82E+02	5.25E+02	8.84E+02	2.60E+01	1.62E+03	5.09E+02	2.15E+02	3.42E+01	3.64E+02	2.13E+02	2.63E+00	1.34E+03	5.06E+02	2.15E+02	5.88E+01	5.43E+02	5.56E+00	2.87E+00	1.33E+03
2053	1.87E+02	5.40E+02	9.23E+02	2.60E+01	1.68E+03	5.32E+02	2.25E+02	3.48E+01	3.70E+02	2.24E+02	2.63E+00	1.39E+03	5.29E+02	2.25E+02	6.06E+01	5.57E+02	6.76E+00	2.87E+00	1.38E+03
2054	1.92E+02	5.55E+02	9.63E+02	2.60E+01	1.74E+03	5.55E+02	2.34E+02	3.54E+01	3.76E+02	2.34E+02	2.63E+00	1.44E+03	5.52E+02	2.34E+02	6.23E+01	5.71E+02	8.07E+00	2.87E+00	1.43E+03
2055	1.97E+02	5.70E+02	1.00E+03	2.60E+01	1.80E+03	5.77E+02	2.44E+02	3.59E+01	3.81E+02	2.45E+02	2.63E+00	1.49E+03	5.75E+02	2.44E+02	6.41E+01	5.84E+02	9.43E+00	2.87E+00	1.48E+03
2056	2.02E+02	5.84E+02	1.04E+03	2.60E+01	1.85E+03	6.00E+02	2.54E+02	3.63E+01	3.86E+02	2.55E+02	2.63E+00	1.53E+03	5.97E+02	2.54E+02	6.57E+01	5.97E+02	1.07E+01	2.87E+00	1.53E+03
2057	2.07E+02	5.98E+02	1.08E+03	2.60E+01	1.91E+03	6.23E+02	2.63E+02	3.68E+01	3.91E+02	2.66E+02	2.63E+00	1.58E+03	6.20E+02	2.63E+02	6.74E+01	6.10E+02	1.21E+01	2.87E+00	1.58E+03
2058	2.11E+02	6.11E+02	1.12E+03	2.60E+01	1.97E+03	6.44E+02	2.72E+02	3.72E+01	3.95E+02	2.76E+02	2.63E+00	1.63E+03	6.41E+02	2.72E+02	6.90E+01	6.22E+02	1.37E+01	2.87E+00	1.62E+03
2059	2.16E+02	6.24E+02	1.15E+03	2.60E+01	2.01E+03	6.60E+02	2.79E+02	3.76E+01	3.99E+02	2.86E+02	2.63E+00	1.66E+03	6.57E+02	2.79E+02	7.06E+01	6.33E+02	1.61E+01	2.87E+00	1.66E+03
2060	2.20E+02	6.37E+02	1.17E+03	2.60E+01	2.05E+03	6.73E+02	2.84E+02	3.79E+01	4.03E+02	2.97E+02	2.63E+00	1.70E+03	6.70E+02	2.84E+02	7.21E+01	6.42E+02	1.93E+01	2.87E+00	1.69E+03
2061	2.24E+02	6.49E+02	1.19E+03	2.60E+01	2.09E+03	6.84E+02	2.89E+02	3.82E+01	4.06E+02	3.07E+02	2.63E+00	1.73E+03	6.80E+02	2.89E+02	7.36E+01	6.51E+02	2.33E+01	2.87E+00	1.72E+03

Exhibit B-27. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	6.62E+00	0.00E+00	4.66E+01	3.81E+00	1.61E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.02E+01	3.79E+00	1.61E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.05E+01
2030	2.02E+01	5.85E+01	2.32E+01	0.00E+00	1.02E+02	1.33E+01	5.65E+00	5.30E+00	5.63E+01	2.58E+00	2.51E+00	8.56E+01	1.33E+01	5.65E+00	5.59E+00	5.80E+01	5.73E-01	2.75E+00	8.58E+01
2031	2.99E+01	8.65E+01	5.30E+01	1.20E+00	1.71E+02	3.05E+01	1.29E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	1.42E+02	3.03E+01	1.29E+01	8.47E+00	8.70E+01	5.73E-01	2.83E+00	1.42E+02
2032	3.93E+01	1.14E+02	8.94E+01	3.95E+00	2.46E+02	5.15E+01	2.18E+01	9.95E+00	1.06E+02	1.33E+01	2.63E+00	2.05E+02	5.12E+01	2.18E+01	1.15E+01	1.17E+02	5.73E-01	2.87E+00	2.05E+02
2033	4.85E+01	1.40E+02	1.29E+02	7.64E+00	3.26E+02	7.43E+01	3.15E+01	1.21E+01	1.28E+02	2.16E+01	2.63E+00	2.70E+02	7.40E+01	3.15E+01	1.45E+01	1.46E+02	5.73E-01	2.87E+00	2.70E+02
2034	5.74E+01	1.66E+02	1.69E+02	1.13E+01	4.04E+02	9.72E+01	4.11E+01	1.40E+01	1.49E+02	3.06E+01	2.63E+00	3.35E+02	9.67E+01	4.11E+01	1.76E+01	1.75E+02	5.73E-01	2.87E+00	3.34E+02
2035	6.60E+01	1.91E+02	2.09E+02	1.46E+01	4.80E+02	1.20E+02	5.08E+01	1.59E+01	1.69E+02	4.00E+01	2.63E+00	3.98E+02	1.19E+02	5.08E+01	2.05E+01	2.03E+02	5.73E-01	2.87E+00	3.97E+02
2036	7.44E+01	2.15E+02	2.48E+02	1.74E+01	5.55E+02	1.43E+02	6.05E+01	1.76E+01	1.87E+02	4.96E+01	2.63E+00	4.61E+02	1.42E+02	6.05E+01	2.34E+01	2.30E+02	5.73E-01	2.87E+00	4.59E+02
2037	8.26E+01	2.39E+02	2.88E+02	1.97E+01	6.29E+02	1.66E+02	7.02E+01	1.93E+01	2.05E+02	5.93E+01	2.63E+00	5.22E+02	1.65E+02	7.02E+01	2.61E+01	2.55E+02	5.73E-01	2.87E+00	5.20E+02
2038	9.06E+01	2.62E+02	3.28E+02	2.17E+01	7.02E+02	1.89E+02	7.99E+01	2.08E+01	2.21E+02	6.92E+01	2.63E+00	5.82E+02	1.88E+02	7.99E+01	2.88E+01	2.80E+02	5.73E-01	2.87E+00	5.80E+02
2039	9.83E+01	2.84E+02	3.68E+02	2.33E+01	7.73E+02	2.12E+02	8.96E+01	2.22E+01	2.36E+02	7.92E+01	2.63E+00	6.41E+02	2.11E+02	8.96E+01	3.13E+01	3.04E+02	5.73E-01	2.87E+00	6.39E+02
2040	1.06E+02	3.06E+02	4.07E+02	2.45E+01	8.44E+02	2.34E+02	9.92E+01	2.35E+01	2.50E+02	8.92E+01	2.63E+00	6.99E+02	2.33E+02	9.92E+01	3.38E+01	3.27E+02	5.73E-01	2.87E+00	6.96E+02
2041	1.13E+02	3.27E+02	4.47E+02	2.54E+01	9.13E+02	2.57E+02	1.09E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	7.56E+02	2.56E+02	1.09E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	7.53E+02
2042	1.20E+02	3.48E+02	4.87E+02	2.58E+01	9.81E+02	2.80E+02	1.19E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	8.12E+02	2.79E+02	1.19E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	8.09E+02
2043	1.27E+02	3.68E+02	5.27E+02	2.60E+01	1.05E+03	3.03E+02	1.28E+02	2.71E+01	2.87E+02	1.19E+02	2.63E+00	8.67E+02	3.02E+02	1.28E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	8.64E+02
2044	1.34E+02	3.87E+02	5.66E+02	2.60E+01	1.11E+03	3.26E+02	1.38E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	9.22E+02	3.24E+02	1.38E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	9.18E+02
2045	1.40E+02	4.06E+02	6.06E+02	2.60E+01	1.18E+03	3.49E+02	1.48E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	9.76E+02	3.47E+02	1.48E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	9.71E+02
2046	1.47E+02	4.25E+02	6.46E+02	2.60E+01	1.24E+03	3.72E+02	1.57E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.03E+03	3.70E+02	1.57E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.02E+03
2047	1.53E+02	4.43E+02	6.86E+02	2.60E+01	1.31E+03	3.94E+02	1.67E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.08E+03	3.93E+02	1.67E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.08E+03
2048	1.59E+02	4.60E+02	7.25E+02	2.60E+01	1.37E+03	4.17E+02	1.77E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.13E+03	4.15E+02	1.77E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.13E+03
2049	1.65E+02	4.77E+02	7.65E+02	2.60E+01	1.43E+03	4.40E+02	1.86E+02	3.23E+01	3.43E+02	1.81E+02	2.63E+00	1.19E+03	4.38E+02	1.86E+02	5.31E+01	4.97E+02	2.90E+00	2.87E+00	1.18E+03
2050	1.71E+02	4.93E+02	8.05E+02	2.60E+01	1.49E+03	4.63E+02	1.96E+02	3.30E+01	3.51E+02	1.92E+02	2.63E+00	1.24E+03	4.61E+02	1.96E+02	5.51E+01	5.13E+02	3.70E+00	2.87E+00	1.23E+03
2051	1.76E+02	5.10E+02	8.45E+02	2.60E+01	1.56E+03	4.86E+02	2.06E+02	3.36E+01	3.57E+02	2.02E+02	2.63E+00	1.29E+03	4.84E+02	2.06E+02	5.69E+01	5.28E+02	4.55E+00	2.87E+00	1.28E+03
2052	1.82E+02	5.25E+02	8.84E+02	2.60E+01	1.62E+03	5.09E+02	2.15E+02	3.42E+01	3.64E+02	2.13E+02	2.63E+00	1.34E+03	5.06E+02	2.15E+02	5.88E+01	5.43E+02	5.56E+00	2.87E+00	1.33E+03
2053	1.87E+02	5.40E+02	9.24E+02	2.60E+01	1.68E+03	5.32E+02	2.25E+02	3.48E+01	3.70E+02	2.24E+02	2.63E+00	1.39E+03	5.29E+02	2.25E+02	6.06E+01	5.57E+02	6.76E+00	2.87E+00	1.38E+03
2054	1.92E+02	5.55E+02	9.64E+02	2.60E+01	1.74E+03	5.55E+02	2.35E+02	3.54E+01	3.76E+02	2.34E+02	2.63E+00	1.44E+03	5.52E+02	2.35E+02	6.23E+01	5.71E+02	8.07E+00	2.87E+00	1.43E+03
2055	1.97E+02	5.70E+02	1.00E+03	2.60E+01	1.80E+03	5.77E+02	2.44E+02	3.59E+01	3.81E+02	2.45E+02	2.63E+00	1.49E+03	5.75E+02	2.44E+02	6.41E+01	5.84E+02	9.43E+00	2.87E+00	1.48E+03
2056	2.02E+02	5.84E+02	1.04E+03	2.60E+01	1.86E+03	6.00E+02	2.54E+02	3.63E+01	3.86E+02	2.55E+02	2.63E+00	1.53E+03	5.97E+02	2.54E+02	6.57E+01	5.97E+02	1.07E+01	2.87E+00	1.53E+03
2057	2.07E+02	5.98E+02	1.08E+03	2.60E+01	1.91E+03	6.23E+02	2.64E+02	3.68E+01	3.91E+02	2.66E+02	2.63E+00	1.58E+03	6.20E+02	2.64E+02	6.74E+01	6.10E+02	1.21E+01	2.87E+00	1.58E+03
2058	2.11E+02	6.11E+02	1.12E+03	2.60E+01	1.97E+03	6.44E+02	2.72E+02	3.72E+01	3.95E+02	2.76E+02	2.63E+00	1.63E+03	6.41E+02	2.72E+02	6.90E+01	6.22E+02	1.37E+01	2.87E+00	1.62E+03
2059	2.16E+02	6.24E+02	1.15E+03	2.60E+01	2.01E+03	6.60E+02	2.79E+02	3.76E+01	3.99E+02	2.86E+02	2.63E+00	1.67E+03	6.57E+02	2.79E+02	7.06E+01	6.33E+02	1.61E+01	2.87E+00	1.66E+03
2060	2.20E+02	6.37E+02	1.17E+03	2.60E+01	2.05E+03	6.73E+02	2.85E+02	3.79E+01	4.03E+02	2.97E+02	2.63E+00	1.70E+03	6.70E+02	2.85E+02	7.21E+01	6.42E+02	1.93E+01	2.87E+00	1.69E+03
2061	2.24E+02	6.49E+02	1.19E+03	2.60E+01	2.09E+03	6.84E+02	2.89E+02	3.82E+01	4.06E+02	3.07E+02	2.63E+00	1.73E+03	6.80E+02	2.89E+02	7.36E+01	6.51E+02	2.33E+01	2.87E+00	1.72E+03

Exhibit B-28. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-02	1.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-02	5.97E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-01	3.51E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.12E-01	6.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-01	7.55E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+00	2.12E+00
2029	1.03E+01	2.97E+01	6.59E+00	0.00E+00	4.65E+01	3.81E+00	2.03E+00	2.73E+00	2.90E+01	7.65E-01	2.29E+00	4.06E+01	3.79E+00	2.03E+00	2.82E+00	2.93E+01	4.70E-01	2.53E+00	4.09E+01
2030	2.02E+01	5.85E+01	2.31E+01	0.00E+00	1.02E+02	1.33E+01	7.10E+00	5.30E+00	5.63E+01	2.58E+00	2.51E+00	8.71E+01	1.33E+01	7.10E+00	5.59E+00	5.80E+01	5.73E-01	2.75E+00	8.73E+01
2031	2.99E+01	8.65E+01	5.27E+01	1.20E+00	1.70E+02	3.05E+01	1.62E+01	7.69E+00	8.18E+01	6.69E+00	2.59E+00	1.45E+02	3.03E+01	1.62E+01	8.47E+00	8.70E+01	5.73E-01	2.83E+00	1.45E+02
2032	3.93E+01	1.14E+02	8.89E+01	3.95E+00	2.46E+02	5.15E+01	2.74E+01	9.95E+00	1.06E+02	1.33E+01	2.63E+00	2.10E+02	5.12E+01	2.74E+01	1.15E+01	1.17E+02	5.73E-01	2.87E+00	2.10E+02
2033	4.85E+01	1.40E+02	1.28E+02	7.64E+00	3.25E+02	7.43E+01	3.96E+01	1.21E+01	1.28E+02	2.16E+01	2.63E+00	2.78E+02	7.40E+01	3.96E+01	1.45E+01	1.46E+02	5.73E-01	2.87E+00	2.78E+02
2034	5.74E+01	1.66E+02	1.68E+02	1.13E+01	4.03E+02	9.72E+01	5.18E+01	1.40E+01	1.49E+02	3.06E+01	2.63E+00	3.46E+02	9.67E+01	5.18E+01	1.76E+01	1.75E+02	5.73E-01	2.87E+00	3.45E+02
2035	6.60E+01	1.91E+02	2.08E+02	1.46E+01	4.79E+02	1.20E+02	6.39E+01	1.59E+01	1.69E+02	4.00E+01	2.63E+00	4.12E+02	1.19E+02	6.39E+01	2.05E+01	2.03E+02	5.73E-01	2.87E+00	4.10E+02
2036	7.44E+01	2.15E+02	2.47E+02	1.74E+01	5.54E+02	1.43E+02	7.61E+01	1.76E+01	1.87E+02	4.96E+01	2.63E+00	4.76E+02	1.42E+02	7.61E+01	2.34E+01	2.30E+02	5.73E-01	2.87E+00	4.75E+02
2037	8.26E+01	2.39E+02	2.87E+02	1.97E+01	6.28E+02	1.66E+02	8.83E+01	1.93E+01	2.05E+02	5.93E+01	2.63E+00	5.40E+02	1.65E+02	8.83E+01	2.61E+01	2.55E+02	5.73E-01	2.87E+00	5.38E+02
2038	9.06E+01	2.62E+02	3.26E+02	2.17E+01	7.00E+02	1.89E+02	1.00E+02	2.08E+01	2.21E+02	6.92E+01	2.63E+00	6.03E+02	1.88E+02	1.00E+02	2.88E+01	2.80E+02	5.73E-01	2.87E+00	6.01E+02
2039	9.83E+01	2.84E+02	3.66E+02	2.33E+01	7.72E+02	2.12E+02	1.13E+02	2.22E+01	2.36E+02	7.92E+01	2.63E+00	6.64E+02	2.11E+02	1.13E+02	3.13E+01	3.04E+02	5.73E-01	2.87E+00	6.62E+02
2040	1.06E+02	3.06E+02	4.05E+02	2.45E+01	8.42E+02	2.34E+02	1.25E+02	2.35E+01	2.50E+02	8.92E+01	2.63E+00	7.25E+02	2.33E+02	1.25E+02	3.38E+01	3.27E+02	5.73E-01	2.87E+00	7.22E+02
2041	1.13E+02	3.27E+02	4.45E+02	2.54E+01	9.10E+02	2.57E+02	1.37E+02	2.48E+01	2.63E+02	9.92E+01	2.63E+00	7.84E+02	2.56E+02	1.37E+02	3.62E+01	3.49E+02	5.73E-01	2.87E+00	7.81E+02
2042	1.20E+02	3.48E+02	4.84E+02	2.58E+01	9.78E+02	2.80E+02	1.49E+02	2.60E+01	2.76E+02	1.09E+02	2.63E+00	8.43E+02	2.79E+02	1.49E+02	3.85E+01	3.70E+02	5.73E-01	2.87E+00	8.39E+02
2043	1.27E+02	3.68E+02	5.24E+02	2.60E+01	1.04E+03	3.03E+02	1.61E+02	2.70E+01	2.87E+02	1.19E+02	2.63E+00	9.00E+02	3.02E+02	1.61E+02	4.08E+01	3.90E+02	5.73E-01	2.87E+00	8.97E+02
2044	1.34E+02	3.87E+02	5.63E+02	2.60E+01	1.11E+03	3.26E+02	1.74E+02	2.81E+01	2.98E+02	1.29E+02	2.63E+00	9.57E+02	3.24E+02	1.74E+02	4.29E+01	4.09E+02	6.12E-01	2.87E+00	9.53E+02
2045	1.40E+02	4.06E+02	6.03E+02	2.60E+01	1.18E+03	3.49E+02	1.86E+02	2.90E+01	3.08E+02	1.39E+02	2.63E+00	1.01E+03	3.47E+02	1.86E+02	4.51E+01	4.28E+02	8.08E-01	2.87E+00	1.01E+03
2046	1.47E+02	4.25E+02	6.42E+02	2.60E+01	1.24E+03	3.72E+02	1.98E+02	2.99E+01	3.18E+02	1.49E+02	2.63E+00	1.07E+03	3.70E+02	1.98E+02	4.71E+01	4.46E+02	1.14E+00	2.87E+00	1.06E+03
2047	1.53E+02	4.43E+02	6.82E+02	2.60E+01	1.30E+03	3.94E+02	2.10E+02	3.08E+01	3.27E+02	1.60E+02	2.63E+00	1.12E+03	3.93E+02	2.10E+02	4.92E+01	4.64E+02	1.58E+00	2.87E+00	1.12E+03
2048	1.59E+02	4.60E+02	7.21E+02	2.60E+01	1.37E+03	4.17E+02	2.22E+02	3.16E+01	3.35E+02	1.70E+02	2.63E+00	1.18E+03	4.15E+02	2.22E+02	5.12E+01	4.81E+02	2.18E+00	2.87E+00	1.17E+03
2049	1.65E+02	4.77E+02	7.61E+02	2.60E+01	1.43E+03	4.40E+02	2.34E+02	3.23E+01	3.43E+02	1.81E+02	2.63E+00	1.23E+03	4.38E+02	2.34E+02	5.31E+01	4.97E+02	2.90E+00	2.87E+00	1.23E+03
2050	1.71E+02	4.93E+02	8.00E+02	2.60E+01	1.49E+03	4.63E+02	2.47E+02	3.30E+01	3.51E+02	1.92E+02	2.63E+00	1.29E+03	4.61E+02	2.47E+02	5.51E+01	5.13E+02	3.70E+00	2.87E+00	1.28E+03
2051	1.76E+02	5.10E+02	8.40E+02	2.60E+01	1.55E+03	4.86E+02	2.59E+02	3.36E+01	3.57E+02	2.02E+02	2.63E+00	1.34E+03	4.84E+02	2.59E+02	5.69E+01	5.28E+02	4.55E+00	2.87E+00	1.33E+03
2052	1.82E+02	5.25E+02	8.80E+02	2.60E+01	1.61E+03	5.09E+02	2.71E+02	3.42E+01	3.64E+02	2.13E+02	2.63E+00	1.39E+03	5.06E+02	2.71E+02	5.88E+01	5.43E+02	5.56E+00	2.87E+00	1.39E+03
2053	1.87E+02	5.40E+02	9.19E+02	2.60E+01	1.67E+03	5.32E+02	2.83E+02	3.48E+01	3.70E+02	2.24E+02	2.63E+00	1.45E+03	5.29E+02	2.83E+02	6.06E+01	5.57E+02	6.76E+00	2.87E+00	1.44E+03
2054	1.92E+02	5.55E+02	9.59E+02	2.60E+01	1.73E+03	5.55E+02	2.95E+02	3.53E+01	3.76E+02	2.34E+02	2.63E+00	1.50E+03	5.52E+02	2.95E+02	6.23E+01	5.71E+02	8.07E+00	2.87E+00	1.49E+03
2055	1.97E+02	5.70E+02	9.98E+02	2.60E+01	1.79E+03	5.77E+02	3.07E+02	3.59E+01	3.81E+02	2.45E+02	2.63E+00	1.55E+03	5.75E+02	3.07E+02	6.40E+01	5.84E+02	9.43E+00	2.87E+00	1.54E+03
2056	2.02E+02	5.84E+02	1.04E+03	2.60E+01	1.85E+03	6.00E+02	3.20E+02	3.63E+01	3.86E+02	2.55E+02	2.63E+00	1.60E+03	5.97E+02	3.20E+02	6.57E+01	5.97E+02	1.07E+01	2.87E+00	1.59E+03
2057	2.07E+02	5.98E+02	1.08E+03	2.60E+01	1.91E+03	6.23E+02	3.32E+02	3.68E+01	3.91E+02	2.66E+02	2.63E+00	1.65E+03	6.20E+02	3.32E+02	6.74E+01	6.10E+02	1.21E+01	2.87E+00	1.64E+03
2058	2.11E+02	6.11E+02	1.11E+03	2.60E+01	1.96E+03	6.44E+02	3.43E+02	3.72E+01	3.95E+02	2.76E+02	2.63E+00	1.70E+03	6.41E+02	3.43E+02	6.90E+01	6.22E+02	1.37E+01	2.87E+00	1.69E+03
2059	2.16E+02	6.24E+02	1.14E+03	2.60E+01	2.01E+03	6.60E+02	3.51E+02	3.76E+01	3.99E+02	2.86E+02	2.63E+00	1.74E+03	6.57E+02	3.51E+02	7.06E+01	6.33E+02	1.61E+01	2.87E+00	1.73E+03
2060	2.20E+02	6.37E+02	1.16E+03	2.60E+01	2.05E+03	6.73E+02	3.58E+02	3.79E+01	4.03E+02	2.97E+02	2.63E+00	1.77E+03	6.70E+02	3.58E+02	7.21E+01	6.42E+02	1.93E+01	2.87E+00	1.77E+03
2061	2.24E+02	6.49E+02	1.18E+03	2.60E+01	2.08E+03	6.84E+02	3.64E+02	3.82E+01	4.06E+02	3.07E+02	2.63E+00	1.80E+03	6.80E+02	3.64E+02	7.36E+01	6.51E+02	2.33E+01	2.87E+00	1.80E+03

Exhibit B-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.22E+02	7.26E+02	7.26E+02	7.46E+02
Lower GOR	7.24E+02	7.28E+02	7.28E+02	7.48E+02
Higher GOR	7.20E+02	7.24E+02	7.24E+02	7.44E+02

Exhibit B-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.22E+02	7.26E+02	7.26E+02	7.46E+02
Decrease in Methane Emissions	7.17E+02	7.21E+02	7.21E+02	7.41E+02
Increase in Methane Emissions	7.27E+02	7.31E+02	7.31E+02	7.51E+02

APPENDIX C: AR5 100-YR RESULTS

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR5 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR5 – 100-yr)
- Multiproduct Functional Unit – China (AR5 – 100-yr)
- Multiproduct Functional Unit – India (AR5 – 100-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 100-yr)
- Single Product Functional Unit in kg CO_2e – China (AR5 – 100-yr)
- Single Product Functional Unit in kg CO_2e – India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR5 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit C-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.94E+01	4.94E+01	-	5.56E+01	5.56E+01
Natural Gas Pipelines to GTP	-	3.69E+00	3.69E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	7.00E-01	-	-	7.88E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.08E+01	3.08E+01	-	3.47E+01	3.47E+01
Ocean Transport	-	1.89E+01	1.89E+01	-	2.13E+01	2.13E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	4.61E+01	4.70E+00	4.70E+00	5.18E+01	5.29E+00	5.29E+00
Crude Oil Extraction, CO2-EOR	-	-	5.96E+00	-	-	6.71E+00
CO2-EOR Crude Oil Transport	-	-	8.07E-01	-	-	9.08E-01
Crude Oil Alaskan Pipeline Transport	2.14E+00	1.34E+00	1.34E+00	2.41E+00	1.51E+00	1.51E+00
Crude Oil Ocean Transport	1.14E+00	7.51E-01	1.20E+00	1.28E+00	8.45E-01	1.35E+00
Crude Oil Refining and End Use	1.52E+02	9.52E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.18E-01	5.18E-01	-	5.83E-01	5.83E-01
System Expansion: US Average Crude Oil Production and End Use	2.46E+01	8.88E+01	2.40E+01	3.07E+00	7.53E+01	2.37E+00
System Expansion: US Lower 48 LNG Export and End Use	5.25E+02	-	-	2.44E+02	-	-
Total	7.51E+02	6.75E+02	6.74E+02	4.74E+02	3.94E+02	3.93E+02
Upper	1.59E+01	6.26E+00	5.72E+00	1.62E+01	6.66E+00	6.51E+00
Lower	8.60E+00	2.36E+00	2.26E+00	9.30E+00	2.20E+00	2.68E+00

Exhibit C-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.95E+01	4.95E+01	-	5.57E+01	5.57E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
CO2 Compression and Sequestration	-	7.02E-01	-	-	7.90E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.20E+01	2.20E+01	-	2.48E+01	2.48E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	4.62E+01	4.71E+00	4.71E+00	5.19E+01	5.30E+00	5.30E+00
Crude Oil Extraction, CO2-EOR	-	-	5.97E+00	-	-	6.72E+00
CO2-EOR Crude Oil Transport	-	-	8.09E-01	-	-	9.10E-01
Crude Oil Alaskan Pipeline Transport	2.14E+00	1.34E+00	1.34E+00	2.41E+00	1.51E+00	1.51E+00
Crude Oil Ocean Transport	1.14E+00	7.52E-01	1.21E+00	1.28E+00	8.46E-01	1.36E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.19E-01	5.19E-01	-	5.84E-01	5.84E-01
System Expansion: US Average Crude Oil Production and End Use	2.43E+01	8.86E+01	2.36E+01	2.69E+00	7.51E+01	1.99E+00
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	7.55E+02	6.79E+02	6.78E+02	4.78E+02	3.98E+02	3.97E+02
Upper	1.43E+01	6.64E+00	6.04E+00	1.69E+01	6.92E+00	6.66E+00
Lower	8.80E+00	2.37E+00	2.01E+00	9.35E+00	2.11E+00	2.47E+00

Exhibit C-3. Multiproduct Functional Unit in kg CO_2e – China (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.95E+01	4.95E+01	-	5.57E+01	5.57E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
CO2 Compression and Sequestration	-	7.02E-01	-	-	7.90E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.21E+01	2.21E+01	-	2.49E+01	2.49E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	4.62E+01	4.71E+00	4.71E+00	5.19E+01	5.30E+00	5.30E+00
Crude Oil Extraction, CO2-EOR	-	-	5.97E+00	-	-	6.72E+00
CO2-EOR Crude Oil Transport	-	-	8.09E-01	-	-	9.10E-01
Crude Oil Alaskan Pipeline Transport	2.14E+00	1.34E+00	1.34E+00	2.41E+00	1.51E+00	1.51E+00
Crude Oil Ocean Transport	1.14E+00	7.52E-01	1.21E+00	1.28E+00	8.47E-01	1.36E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.19E-01	5.19E-01	-	5.84E-01	5.84E-01
System Expansion: US Average Crude Oil Production and End Use	2.42E+01	8.86E+01	2.36E+01	2.68E+00	7.51E+01	1.98E+00
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	7.55E+02	6.79E+02	6.78E+02	4.79E+02	3.98E+02	3.97E+02
Upper	1.34E+01	6.12E+00	6.08E+00	1.69E+01	6.70E+00	7.57E+00
Lower	6.09E+00	2.18E+00	2.38E+00	9.10E+00	2.50E+00	2.67E+00

Exhibit C-4. Multiproduct Functional Unit in kg CO_2e – India (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.00E+01	5.00E+01	-	5.63E+01	5.63E+01
Natural Gas Pipelines to GTP	-	3.74E+00	3.74E+00	-	4.21E+00	4.21E+00
Natural Gas Processing at GTP	-	2.48E+01	2.48E+01	-	2.79E+01	2.79E+01
CO2 Compression and Sequestration	-	7.09E-01	-	-	7.98E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.02E+01	1.02E+01	-	1.15E+01	1.15E+01
Liquefaction	-	3.12E+01	3.12E+01	-	3.51E+01	3.51E+01
Ocean Transport	-	3.85E+01	3.85E+01	-	4.33E+01	4.33E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	4.66E+01	4.76E+00	4.76E+00	5.25E+01	5.36E+00	5.36E+00
Crude Oil Extraction, CO2-EOR	-	-	6.03E+00	-	-	6.79E+00
CO2-EOR Crude Oil Transport	-	-	8.17E-01	-	-	9.19E-01
Crude Oil Alaskan Pipeline Transport	2.16E+00	1.35E+00	1.35E+00	2.43E+00	1.52E+00	1.52E+00
Crude Oil Ocean Transport	1.15E+00	7.60E-01	1.22E+00	1.29E+00	8.55E-01	1.37E+00
Crude Oil Refining and End Use	1.54E+02	9.63E+01	1.54E+02	1.73E+02	1.08E+02	1.74E+02
Construction	-	5.24E-01	5.24E-01	-	5.90E-01	5.90E-01
System Expansion: US Average Crude Oil Production and End Use	2.25E+01	8.75E+01	2.19E+01	7.07E-01	7.38E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.28E+02	-	-	2.47E+02	-	-
Total	7.54E+02	6.96E+02	6.95E+02	4.77E+02	4.18E+02	4.17E+02
Upper	1.50E+01	8.59E+00	8.78E+00	1.56E+01	9.65E+00	9.56E+00
Lower	8.20E+00	1.94E+00	2.15E+00	9.75E+00	2.34E+00	2.25E+00

Exhibit C-5. Single Product Functional Unit in kg CO_2e – Japan (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.94E+01	4.94E+01	-	5.56E+01	5.56E+01
Natural Gas Pipelines to GTP	-	3.69E+00	3.69E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	6.02E-01	-	-	6.78E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.08E+01	3.08E+01	-	3.47E+01	3.47E+01
Ocean Transport	-	1.89E+01	1.89E+01	-	2.13E+01	2.13E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.18E-01	5.18E-01	-	5.83E-01	5.83E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.25E+02	-	-	2.44E+02	-	-
Total	5.25E+02	4.85E+02	4.84E+02	2.44E+02	2.04E+02	2.03E+02
Upper	1.59E+01	4.49E+00	4.10E+00	1.61E+01	3.45E+00	3.36E+00
Lower	8.66E+00	1.69E+00	1.62E+00	9.37E+00	1.14E+00	1.39E+00

Exhibit C-6. Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.95E+01	4.95E+01	-	5.57E+01	5.57E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
CO2 Compression and Sequestration	-	6.03E-01	-	-	6.79E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.20E+01	2.20E+01	-	2.48E+01	2.48E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.19E-01	5.19E-01	-	5.84E-01	5.84E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	5.29E+02	4.88E+02	4.87E+02	2.49E+02	2.08E+02	2.07E+02
Upper	1.42E+01	4.77E+00	4.34E+00	1.68E+01	3.61E+00	3.48E+00
Lower	8.87E+00	1.71E+00	1.45E+00	9.42E+00	1.10E+00	1.29E+00

Exhibit C-7. Single Product Functional Unit in kg CO_2e – China (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.95E+01	4.95E+01	-	5.57E+01	5.57E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
CO2 Compression and Sequestration	-	6.03E-01	-	-	6.79E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.21E+01	2.21E+01	-	2.49E+01	2.49E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.19E-01	5.19E-01	-	5.84E-01	5.84E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	5.29E+02	4.88E+02	4.87E+02	2.49E+02	2.08E+02	2.07E+02
Upper	1.33E+01	4.40E+00	4.37E+00	1.69E+01	3.50E+00	3.95E+00
Lower	6.16E+00	1.57E+00	1.71E+00	9.17E+00	1.31E+00	1.39E+00

Exhibit C-8. Single Product Functional Unit in kg CO_2e – India (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.00E+01	5.00E+01	-	5.63E+01	5.63E+01
Natural Gas Pipelines to GTP	-	3.74E+00	3.74E+00	-	4.21E+00	4.21E+00
Natural Gas Processing at GTP	-	2.48E+01	2.48E+01	-	2.79E+01	2.79E+01
CO2 Compression and Sequestration	-	6.10E-01	-	-	6.86E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.02E+01	1.02E+01	-	1.15E+01	1.15E+01
Liquefaction	-	3.12E+01	3.12E+01	-	3.51E+01	3.51E+01
Ocean Transport	-	3.85E+01	3.85E+01	-	4.33E+01	4.33E+01
LNG Regasification	-	3.61E+00	3.61E+00	-	4.06E+00	4.06E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.24E-01	5.24E-01	-	5.90E-01	5.90E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.28E+02	-	-	2.47E+02	-	-
Total	5.28E+02	5.06E+02	5.05E+02	2.47E+02	2.27E+02	2.27E+02
Upper	1.49E+01	6.24E+00	6.37E+00	1.56E+01	5.26E+00	5.21E+00
Lower	8.27E+00	1.41E+00	1.56E+00	9.82E+00	1.28E+00	1.22E+00

Exhibit C-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.29E+01	3.19E+00	6.09E-05	-	4.61E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	1.10E-01	1.08E-02	7.67E-09	2.14E+00
Crude Oil Ocean Transport	1.09E+00	3.84E-02	2.95E-03	1.14E-06	1.14E+00
Crude Oil Refining and End Use	1.52E+02	3.09E-01	7.58E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	6.72E-01	1.56E-02	-	2.46E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	6.11E+01	3.37E-01	1.89E-07	5.25E+02
Construction	-	-	-	-	-
Total	6.85E+02	6.54E+01	3.74E-01	1.34E-06	7.51E+02

Exhibit C-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	3.19E+00	6.10E-05	-	4.62E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	1.10E-01	1.08E-02	7.69E-09	2.14E+00
Crude Oil Ocean Transport	1.10E+00	3.85E-02	2.95E-03	1.14E-06	1.14E+00
Crude Oil Refining and End Use	1.52E+02	3.10E-01	7.59E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	6.63E-01	1.54E-02	-	2.43E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	6.16E+01	3.47E-01	1.90E-07	5.29E+02
Construction	-	-	-	-	-
Total	6.89E+02	6.60E+01	3.84E-01	1.34E-06	7.55E+02

Exhibit C-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	3.19E+00	6.10E-05	-	4.62E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	1.10E-01	1.08E-02	7.69E-09	2.14E+00
Crude Oil Ocean Transport	1.10E+00	3.85E-02	2.95E-03	1.14E-06	1.14E+00
Crude Oil Refining and End Use	1.52E+02	3.10E-01	7.59E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	6.63E-01	1.54E-02	-	2.42E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	6.17E+01	3.48E-01	1.90E-07	5.29E+02
Construction	-	-	-	-	-
Total	6.89E+02	6.60E+01	3.85E-01	1.34E-06	7.55E+02

Exhibit C-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.34E+01	3.22E+00	6.17E-05	-	4.66E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.04E+00	1.12E-01	1.09E-02	7.77E-09	2.16E+00
Crude Oil Ocean Transport	1.11E+00	3.89E-02	2.98E-03	1.15E-06	1.15E+00
Crude Oil Refining and End Use	1.54E+02	3.13E-01	7.67E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	6.15E-01	1.42E-02	-	2.25E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	6.15E+01	3.44E-01	1.90E-07	5.28E+02
Construction	-	-	-	-	-
Total	6.88E+02	6.58E+01	3.80E-01	1.35E-06	7.54E+02

Exhibit C-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	2.36E+01	1.58E-02	-	4.94E+01
Natural Gas Pipelines to GTP	2.14E-03	3.69E+00	-	-	3.69E+00
Natural Gas Processing at GTP	2.39E+01	5.62E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	6.44E-01	5.24E-02	1.52E-03	2.09E-03	7.00E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.95E+00	5.65E-07	-	1.01E+01
Liquefaction	2.25E+01	8.37E+00	4.19E-03	1.37E-07	3.08E+01
Ocean Transport	1.68E+01	2.05E+00	5.95E-02	-	1.89E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	2.08E+00	6.10E-06	-	4.70E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	6.90E-02	6.76E-03	4.80E-09	1.34E+00
Crude Oil Ocean Transport	7.14E-01	3.41E-02	2.31E-03	1.02E-06	7.51E-01
Crude Oil Refining and End Use	9.50E+01	1.94E-01	4.75E-03	-	9.52E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	2.43E+00	5.62E-02	-	8.88E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	9.55E-03	3.30E-03	-	5.18E-01
Total	6.27E+02	4.86E+01	1.65E-01	2.19E-03	6.75E+02

Exhibit C-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	2.36E+01	1.58E-02	-	4.95E+01
Natural Gas Pipelines to GTP	2.14E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.40E+01	5.63E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	6.45E-01	5.25E-02	1.53E-03	2.10E-03	7.02E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	4.20E-03	1.38E-07	3.09E+01
Ocean Transport	1.95E+01	2.44E+00	6.78E-02	-	2.20E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	2.08E+00	6.12E-06	-	4.71E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	6.92E-02	6.77E-03	4.81E-09	1.34E+00
Crude Oil Ocean Transport	7.16E-01	3.42E-02	2.32E-03	1.02E-06	7.52E-01
Crude Oil Refining and End Use	9.51E+01	1.94E-01	4.75E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	2.42E+00	5.61E-02	-	8.86E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	9.56E-03	3.31E-03	-	5.19E-01
Total	6.29E+02	4.91E+01	1.73E-01	2.19E-03	6.79E+02

Exhibit C-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	2.36E+01	1.58E-02	-	4.95E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.40E+01	5.63E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	6.46E-01	5.25E-02	1.53E-03	2.10E-03	7.02E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	4.20E-03	1.38E-07	3.09E+01
Ocean Transport	1.96E+01	2.46E+00	6.82E-02	-	2.21E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	2.08E+00	6.12E-06	-	4.71E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.27E+00	6.92E-02	6.77E-03	4.81E-09	1.34E+00
Crude Oil Ocean Transport	7.16E-01	3.42E-02	2.32E-03	1.02E-06	7.52E-01
Crude Oil Refining and End Use	9.51E+01	1.94E-01	4.75E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	2.42E+00	5.61E-02	-	8.86E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	9.56E-03	3.31E-03	-	5.19E-01
Total	6.30E+02	4.91E+01	1.73E-01	2.19E-03	6.79E+02

Exhibit C-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	2.39E+01	1.60E-02	-	5.00E+01
Natural Gas Pipelines to GTP	2.17E-03	3.74E+00	-	-	3.74E+00
Natural Gas Processing at GTP	2.42E+01	5.68E-01	2.74E-05	-	2.48E+01
CO2 Compression and Sequestration	6.52E-01	5.30E-02	1.54E-03	2.12E-03	7.09E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	5.01E+00	5.72E-07	-	1.02E+01
Liquefaction	2.27E+01	8.47E+00	4.24E-03	1.39E-07	3.12E+01
Ocean Transport	3.39E+01	4.52E+00	1.12E-01	-	3.85E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	2.10E+00	6.18E-06	-	4.76E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.28E+00	6.99E-02	6.84E-03	4.86E-09	1.35E+00
Crude Oil Ocean Transport	7.23E-01	3.45E-02	2.34E-03	1.03E-06	7.60E-01
Crude Oil Refining and End Use	9.61E+01	1.96E-01	4.80E-03	-	9.63E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	2.39E+00	5.54E-02	-	8.75E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	9.66E-03	3.34E-03	-	5.24E-01
Total	6.45E+02	5.16E+01	2.16E-01	2.21E-03	6.96E+02

Exhibit C-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	2.36E+01	1.58E-02	-	4.94E+01
Natural Gas Pipelines to GTP	2.14E-03	3.69E+00	-	-	3.69E+00
Natural Gas Processing at GTP	2.39E+01	5.62E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.95E+00	5.65E-07	-	1.01E+01
Liquefaction	2.25E+01	8.37E+00	4.19E-03	1.37E-07	3.08E+01
Ocean Transport	1.68E+01	2.05E+00	5.95E-02	-	1.89E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	2.08E+00	6.10E-06	-	4.70E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	4.72E-01	1.90E-02	2.70E-02	5.96E+00
CO2-EOR Crude Oil Transport	7.61E-01	4.16E-02	4.08E-03	2.90E-09	8.07E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	6.90E-02	6.76E-03	4.80E-09	1.34E+00
Crude Oil Ocean Transport	1.14E+00	5.47E-02	3.71E-03	1.64E-06	1.20E+00
Crude Oil Refining and End Use	1.52E+02	3.11E-01	7.61E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	6.55E-01	1.52E-02	-	2.40E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	9.55E-03	3.30E-03	-	5.18E-01
Total	6.27E+02	4.75E+01	1.49E-01	2.71E-02	6.74E+02

Exhibit C-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	2.36E+01	1.58E-02	-	4.95E+01
Natural Gas Pipelines to GTP	2.14E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.40E+01	5.63E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	4.20E-03	1.38E-07	3.09E+01
Ocean Transport	1.95E+01	2.44E+00	6.78E-02	-	2.20E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	2.08E+00	6.12E-06	-	4.71E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	4.73E-01	1.90E-02	2.71E-02	5.97E+00
CO2-EOR Crude Oil Transport	7.63E-01	4.17E-02	4.08E-03	2.90E-09	8.09E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	6.92E-02	6.77E-03	4.81E-09	1.34E+00
Crude Oil Ocean Transport	1.15E+00	5.48E-02	3.71E-03	1.64E-06	1.21E+00
Crude Oil Refining and End Use	1.53E+02	3.11E-01	7.62E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	6.46E-01	1.50E-02	-	2.36E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	9.56E-03	3.31E-03	-	5.19E-01
Total	6.30E+02	4.79E+01	1.58E-01	2.72E-02	6.78E+02

Exhibit C-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	2.36E+01	1.58E-02	-	4.95E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.40E+01	5.63E-01	2.71E-05	-	2.45E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	4.20E-03	1.38E-07	3.09E+01
Ocean Transport	1.96E+01	2.46E+00	6.82E-02	-	2.21E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	2.08E+00	6.12E-06	-	4.71E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	4.73E-01	1.90E-02	2.71E-02	5.97E+00
CO2-EOR Crude Oil Transport	7.63E-01	4.17E-02	4.08E-03	2.90E-09	8.09E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	6.92E-02	6.77E-03	4.81E-09	1.34E+00
Crude Oil Ocean Transport	1.15E+00	5.48E-02	3.71E-03	1.64E-06	1.21E+00
Crude Oil Refining and End Use	1.53E+02	3.11E-01	7.62E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	6.46E-01	1.50E-02	-	2.36E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	9.56E-03	3.31E-03	-	5.19E-01
Total	6.30E+02	4.80E+01	1.58E-01	2.72E-02	6.78E+02

Exhibit C-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	2.39E+01	1.60E-02	-	5.00E+01
Natural Gas Pipelines to GTP	2.17E-03	3.74E+00	-	-	3.74E+00
Natural Gas Processing at GTP	2.42E+01	5.68E-01	2.74E-05	-	2.48E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	5.01E+00	5.72E-07	-	1.02E+01
Liquefaction	2.27E+01	8.47E+00	4.24E-03	1.39E-07	3.12E+01
Ocean Transport	3.39E+01	4.52E+00	1.12E-01	-	3.85E+01
LNG Regasification	3.02E+00	5.76E-01	1.02E-02	9.20E-05	3.61E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	2.10E+00	6.18E-06	-	4.76E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	4.78E-01	1.92E-02	2.73E-02	6.03E+00
CO2-EOR Crude Oil Transport	7.71E-01	4.21E-02	4.13E-03	2.93E-09	8.17E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	6.99E-02	6.84E-03	4.86E-09	1.35E+00
Crude Oil Ocean Transport	1.16E+00	5.53E-02	3.75E-03	1.66E-06	1.22E+00
Crude Oil Refining and End Use	1.54E+02	3.14E-01	7.70E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	5.98E-01	1.38E-02	-	2.19E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	9.66E-03	3.34E-03	-	5.24E-01
Total	6.45E+02	5.04E+01	2.01E-01	2.74E-02	6.95E+02

Exhibit C-21. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	1.23E+01	0.00E+00	5.15E+01	2.83E+00	8.67E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	4.55E+01	2.82E+00	8.67E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	4.58E+01
2030	1.90E+01	5.84E+01	4.32E+01	0.00E+00	1.20E+02	9.91E+00	3.03E+01	4.01E+00	5.62E+01	2.51E+00	2.47E+00	1.05E+02	9.85E+00	3.03E+01	4.28E+00	5.79E+01	5.58E-01	2.71E+00	1.06E+02
2031	2.80E+01	8.63E+01	9.86E+01	1.17E+00	2.14E+02	2.27E+01	6.94E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.89E+02	2.25E+01	6.94E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.89E+02
2032	3.68E+01	1.14E+02	1.66E+02	3.85E+00	3.21E+02	3.82E+01	1.17E+02	7.53E+00	1.05E+02	1.29E+01	2.59E+00	2.84E+02	3.80E+01	1.17E+02	8.95E+00	1.16E+02	5.58E-01	2.82E+00	2.84E+02
2033	4.54E+01	1.40E+02	2.40E+02	7.44E+00	4.33E+02	5.52E+01	1.69E+02	9.12E+00	1.28E+02	2.10E+01	2.59E+00	3.85E+02	5.49E+01	1.69E+02	1.14E+01	1.46E+02	5.58E-01	2.82E+00	3.85E+02
2034	5.38E+01	1.66E+02	3.14E+02	1.10E+01	5.45E+02	7.22E+01	2.21E+02	1.06E+01	1.49E+02	2.98E+01	2.59E+00	4.85E+02	7.18E+01	2.21E+02	1.39E+01	1.75E+02	5.58E-01	2.82E+00	4.85E+02
2035	6.19E+01	1.91E+02	3.88E+02	1.42E+01	6.55E+02	8.92E+01	2.73E+02	1.20E+01	1.69E+02	3.90E+01	2.59E+00	5.85E+02	8.87E+01	2.73E+02	1.63E+01	2.03E+02	5.58E-01	2.82E+00	5.84E+02
2036	6.97E+01	2.15E+02	4.62E+02	1.69E+01	7.64E+02	1.06E+02	3.25E+02	1.33E+01	1.87E+02	4.83E+01	2.59E+00	6.83E+02	1.06E+02	3.25E+02	1.87E+01	2.29E+02	5.58E-01	2.82E+00	6.82E+02
2037	7.74E+01	2.38E+02	5.36E+02	1.92E+01	8.71E+02	1.23E+02	3.77E+02	1.46E+01	2.04E+02	5.77E+01	2.59E+00	7.80E+02	1.22E+02	3.77E+02	2.09E+01	2.55E+02	5.58E-01	2.82E+00	7.79E+02
2038	8.48E+01	2.61E+02	6.10E+02	2.11E+01	9.78E+02	1.40E+02	4.29E+02	1.57E+01	2.20E+02	6.74E+01	2.59E+00	8.76E+02	1.39E+02	4.29E+02	2.31E+01	2.80E+02	5.58E-01	2.82E+00	8.75E+02
2039	9.21E+01	2.84E+02	6.84E+02	2.27E+01	1.08E+03	1.57E+02	4.81E+02	1.68E+01	2.36E+02	7.71E+01	2.59E+00	9.70E+02	1.56E+02	4.81E+02	2.53E+01	3.03E+02	5.58E-01	2.82E+00	9.69E+02
2040	9.91E+01	3.05E+02	7.58E+02	2.39E+01	1.19E+03	1.74E+02	5.33E+02	1.78E+01	2.50E+02	8.68E+01	2.59E+00	1.06E+03	1.73E+02	5.33E+02	2.74E+01	3.26E+02	5.58E-01	2.82E+00	1.06E+03
2041	1.06E+02	3.26E+02	8.32E+02	2.47E+01	1.29E+03	1.91E+02	5.85E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	1.16E+03	1.90E+02	5.85E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	1.16E+03
2042	1.13E+02	3.47E+02	9.06E+02	2.51E+01	1.39E+03	2.08E+02	6.37E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	1.25E+03	2.07E+02	6.37E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	1.25E+03
2043	1.19E+02	3.67E+02	9.80E+02	2.53E+01	1.49E+03	2.25E+02	6.89E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	1.34E+03	2.24E+02	6.89E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	1.34E+03
2044	1.25E+02	3.86E+02	1.05E+03	2.53E+01	1.59E+03	2.42E+02	7.41E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	1.43E+03	2.41E+02	7.41E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	1.43E+03
2045	1.32E+02	4.05E+02	1.13E+03	2.53E+01	1.69E+03	2.59E+02	7.93E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	1.52E+03	2.58E+02	7.93E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	1.52E+03
2046	1.38E+02	4.24E+02	1.20E+03	2.53E+01	1.79E+03	2.76E+02	8.45E+02	2.26E+01	3.17E+02	1.45E+02	2.59E+00	1.61E+03	2.75E+02	8.45E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	1.61E+03
2047	1.43E+02	4.42E+02	1.28E+03	2.53E+01	1.89E+03	2.93E+02	8.97E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	1.70E+03	2.91E+02	8.97E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	1.70E+03
2048	1.49E+02	4.59E+02	1.35E+03	2.53E+01	1.98E+03	3.10E+02	9.49E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.79E+03	3.08E+02	9.49E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.78E+03
2049	1.55E+02	4.76E+02	1.42E+03	2.53E+01	2.08E+03	3.27E+02	1.00E+03	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.87E+03	3.25E+02	1.00E+03	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.87E+03
2050	1.60E+02	4.92E+02	1.50E+03	2.53E+01	2.18E+03	3.44E+02	1.05E+03	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.96E+03	3.42E+02	1.05E+03	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.96E+03
2051	1.65E+02	5.09E+02	1.57E+03	2.53E+01	2.27E+03	3.61E+02	1.11E+03	2.54E+01	3.57E+02	1.97E+02	2.59E+00	2.05E+03	3.59E+02	1.11E+03	4.71E+01	5.27E+02	4.43E+00	2.82E+00	2.05E+03
2052	1.70E+02	5.24E+02	1.65E+03	2.53E+01	2.37E+03	3.78E+02	1.16E+03	2.59E+01	3.63E+02	2.07E+02	2.59E+00	2.13E+03	3.76E+02	1.16E+03	4.87E+01	5.42E+02	5.41E+00	2.82E+00	2.13E+03
2053	1.75E+02	5.39E+02	1.72E+03	2.53E+01	2.46E+03	3.95E+02	1.21E+03	2.63E+01	3.69E+02	2.18E+02	2.59E+00	2.22E+03	3.93E+02	1.21E+03	5.03E+01	5.56E+02	6.58E+00	2.82E+00	2.22E+03
2054	1.80E+02	5.54E+02	1.79E+03	2.53E+01	2.55E+03	4.12E+02	1.26E+03	2.67E+01	3.75E+02	2.28E+02	2.59E+00	2.31E+03	4.10E+02	1.26E+03	5.18E+01	5.70E+02	7.86E+00	2.82E+00	2.30E+03
2055	1.85E+02	5.69E+02	1.87E+03	2.53E+01	2.65E+03	4.29E+02	1.31E+03	2.71E+01	3.80E+02	2.38E+02	2.59E+00	2.39E+03	4.27E+02	1.31E+03	5.34E+01	5.83E+02	9.18E+00	2.82E+00	2.39E+03
2056	1.89E+02	5.83E+02	1.94E+03	2.53E+01	2.74E+03	4.46E+02	1.37E+03	2.75E+01	3.85E+02	2.48E+02	2.59E+00	2.48E+03	4.43E+02	1.37E+03	5.48E+01	5.96E+02	1.05E+01	2.82E+00	2.47E+03
2057	1.94E+02	5.96E+02	2.02E+03	2.53E+01	2.83E+03	4.63E+02	1.42E+03	2.78E+01	3.90E+02	2.59E+02	2.59E+00	2.56E+03	4.60E+02	1.42E+03	5.63E+01	6.08E+02	1.17E+01	2.82E+00	2.56E+03
2058	1.98E+02	6.10E+02	2.08E+03	2.53E+01	2.92E+03	4.78E+02	1.46E+03	2.81E+01	3.94E+02	2.69E+02	2.59E+00	2.64E+03	4.75E+02	1.46E+03	5.77E+01	6.20E+02	1.33E+01	2.82E+00	2.63E+03
2059	2.02E+02	6.23E+02	2.14E+03	2.53E+01	2.99E+03	4.90E+02	1.50E+03	2.84E+01	3.98E+02	2.79E+02	2.59E+00	2.70E+03	4.88E+02	1.50E+03	5.91E+01	6.31E+02	1.57E+01	2.82E+00	2.70E+03
2060	2.06E+02	6.35E+02	2.18E+03	2.53E+01	3.04E+03	5.00E+02	1.53E+03	2.87E+01	4.02E+02	2.89E+02	2.59E+00	2.75E+03	4.97E+02	1.53E+03	6.05E+01	6.41E+02	1.88E+01	2.82E+00	2.75E+03
2061	2.10E+02	6.48E+02	2.21E+03	2.53E+01	3.09E+03	5.08E+02	1.56E+03	2.89E+01	4.06E+02	2.99E+02	2.59E+00	2.80E+03	5.05E+02	1.56E+03	6.19E+01	6.50E+02	2.27E+01	2.82E+00	2.80E+03

Exhibit C-22. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	1.24E+01	0.00E+00	5.16E+01	2.83E+00	8.73E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	4.56E+01	2.82E+00	8.73E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	4.58E+01
2030	1.89E+01	5.84E+01	4.34E+01	0.00E+00	1.21E+02	9.91E+00	3.05E+01	4.01E+00	5.62E+01	2.51E+00	2.47E+00	1.06E+02	9.85E+00	3.05E+01	4.28E+00	5.79E+01	5.58E-01	2.71E+00	1.06E+02
2031	2.80E+01	8.63E+01	9.92E+01	1.17E+00	2.15E+02	2.27E+01	6.98E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.89E+02	2.25E+01	6.98E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.89E+02
2032	3.68E+01	1.14E+02	1.67E+02	3.85E+00	3.22E+02	3.82E+01	1.18E+02	7.53E+00	1.05E+02	1.29E+01	2.59E+00	2.85E+02	3.80E+01	1.18E+02	8.95E+00	1.16E+02	5.58E-01	2.82E+00	2.85E+02
2033	4.54E+01	1.40E+02	2.42E+02	7.44E+00	4.34E+02	5.52E+01	1.70E+02	9.12E+00	1.28E+02	2.10E+01	2.59E+00	3.86E+02	5.49E+01	1.70E+02	1.14E+01	1.46E+02	5.58E-01	2.82E+00	3.86E+02
2034	5.38E+01	1.66E+02	3.16E+02	1.10E+01	5.46E+02	7.22E+01	2.23E+02	1.06E+01	1.49E+02	2.98E+01	2.59E+00	4.87E+02	7.18E+01	2.23E+02	1.39E+01	1.75E+02	5.58E-01	2.82E+00	4.87E+02
2035	6.19E+01	1.91E+02	3.90E+02	1.42E+01	6.57E+02	8.92E+01	2.75E+02	1.20E+01	1.69E+02	3.90E+01	2.59E+00	5.86E+02	8.87E+01	2.75E+02	1.63E+01	2.03E+02	5.58E-01	2.82E+00	5.86E+02
2036	6.97E+01	2.15E+02	4.65E+02	1.69E+01	7.66E+02	1.06E+02	3.27E+02	1.33E+01	1.87E+02	4.83E+01	2.59E+00	6.85E+02	1.06E+02	3.27E+02	1.87E+01	2.29E+02	5.58E-01	2.82E+00	6.84E+02
2037	7.74E+01	2.38E+02	5.39E+02	1.92E+01	8.74E+02	1.23E+02	3.80E+02	1.46E+01	2.04E+02	5.77E+01	2.59E+00	7.82E+02	1.22E+02	3.80E+02	2.09E+01	2.55E+02	5.58E-01	2.82E+00	7.81E+02
2038	8.48E+01	2.61E+02	6.14E+02	2.11E+01	9.81E+02	1.40E+02	4.32E+02	1.57E+01	2.20E+02	6.74E+01	2.59E+00	8.78E+02	1.39E+02	4.32E+02	2.31E+01	2.80E+02	5.58E-01	2.82E+00	8.77E+02
2039	9.21E+01	2.84E+02	6.88E+02	2.27E+01	1.09E+03	1.57E+02	4.84E+02	1.68E+01	2.36E+02	7.71E+01	2.59E+00	9.74E+02	1.56E+02	4.84E+02	2.53E+01	3.03E+02	5.58E-01	2.82E+00	9.73E+02
2040	9.91E+01	3.05E+02	7.62E+02	2.39E+01	1.19E+03	1.74E+02	5.37E+02	1.78E+01	2.50E+02	8.68E+01	2.59E+00	1.07E+03	1.73E+02	5.37E+02	2.74E+01	3.26E+02	5.58E-01	2.82E+00	1.07E+03
2041	1.06E+02	3.26E+02	8.37E+02	2.47E+01	1.29E+03	1.91E+02	5.89E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	1.16E+03	1.90E+02	5.89E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	1.16E+03
2042	1.13E+02	3.47E+02	9.11E+02	2.51E+01	1.40E+03	2.08E+02	6.41E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	1.25E+03	2.07E+02	6.41E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	1.25E+03
2043	1.19E+02	3.67E+02	9.85E+02	2.53E+01	1.50E+03	2.25E+02	6.94E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	1.34E+03	2.24E+02	6.94E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	1.34E+03
2044	1.25E+02	3.86E+02	1.06E+03	2.53E+01	1.60E+03	2.42E+02	7.46E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	1.44E+03	2.41E+02	7.46E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	1.43E+03
2045	1.32E+02	4.05E+02	1.13E+03	2.53E+01	1.70E+03	2.59E+02	7.99E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	1.53E+03	2.58E+02	7.99E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	1.52E+03
2046	1.38E+02	4.24E+02	1.21E+03	2.53E+01	1.80E+03	2.76E+02	8.51E+02	2.26E+01	3.17E+02	1.45E+02	2.59E+00	1.62E+03	2.75E+02	8.51E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	1.61E+03
2047	1.43E+02	4.42E+02	1.28E+03	2.53E+01	1.89E+03	2.93E+02	9.03E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	1.70E+03	2.91E+02	9.03E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	1.70E+03
2048	1.49E+02	4.59E+02	1.36E+03	2.53E+01	1.99E+03	3.10E+02	9.56E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.79E+03	3.08E+02	9.56E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.79E+03
2049	1.55E+02	4.76E+02	1.43E+03	2.53E+01	2.09E+03	3.27E+02	1.01E+03	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.88E+03	3.25E+02	1.01E+03	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.88E+03
2050	1.60E+02	4.92E+02	1.51E+03	2.53E+01	2.18E+03	3.44E+02	1.06E+03	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.97E+03	3.42E+02	1.06E+03	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.97E+03
2051	1.65E+02	5.09E+02	1.58E+03	2.53E+01	2.28E+03	3.61E+02	1.11E+03	2.54E+01	3.57E+02	1.97E+02	2.59E+00	2.06E+03	3.59E+02	1.11E+03	4.71E+01	5.27E+02	4.43E+00	2.82E+00	2.05E+03
2052	1.70E+02	5.24E+02	1.65E+03	2.53E+01	2.37E+03	3.78E+02	1.17E+03	2.59E+01	3.63E+02	2.07E+02	2.59E+00	2.14E+03	3.76E+02	1.17E+03	4.87E+01	5.42E+02	5.41E+00	2.82E+00	2.14E+03
2053	1.75E+02	5.39E+02	1.73E+03	2.53E+01	2.47E+03	3.95E+02	1.22E+03	2.63E+01	3.69E+02	2.18E+02	2.59E+00	2.23E+03	3.93E+02	1.22E+03	5.03E+01	5.56E+02	6.58E+00	2.82E+00	2.23E+03
2054	1.80E+02	5.54E+02	1.80E+03	2.53E+01	2.56E+03	4.12E+02	1.27E+03	2.67E+01	3.75E+02	2.28E+02	2.59E+00	2.31E+03	4.10E+02	1.27E+03	5.18E+01	5.70E+02	7.86E+00	2.82E+00	2.31E+03
2055	1.85E+02	5.69E+02	1.88E+03	2.53E+01	2.66E+03	4.29E+02	1.32E+03	2.71E+01	3.80E+02	2.38E+02	2.59E+00	2.40E+03	4.27E+02	1.32E+03	5.34E+01	5.83E+02	9.18E+00	2.82E+00	2.40E+03
2056	1.89E+02	5.83E+02	1.95E+03	2.53E+01	2.75E+03	4.46E+02	1.37E+03	2.75E+01	3.85E+02	2.48E+02	2.59E+00	2.48E+03	4.43E+02	1.37E+03	5.48E+01	5.96E+02	1.05E+01	2.82E+00	2.48E+03
2057	1.94E+02	5.96E+02	2.03E+03	2.53E+01	2.84E+03	4.63E+02	1.43E+03	2.78E+01	3.90E+02	2.59E+02	2.59E+00	2.57E+03	4.60E+02	1.43E+03	5.63E+01	6.08E+02	1.17E+01	2.82E+00	2.57E+03
2058	1.98E+02	6.10E+02	2.09E+03	2.53E+01	2.93E+03	4.78E+02	1.47E+03	2.81E+01	3.94E+02	2.69E+02	2.59E+00	2.65E+03	4.75E+02	1.47E+03	5.77E+01	6.20E+02	1.33E+01	2.82E+00	2.64E+03
2059	2.02E+02	6.23E+02	2.15E+03	2.53E+01	3.00E+03	4.90E+02	1.51E+03	2.84E+01	3.98E+02	2.79E+02	2.59E+00	2.71E+03	4.88E+02	1.51E+03	5.91E+01	6.31E+02	1.57E+01	2.82E+00	2.71E+03
2060	2.06E+02	6.35E+02	2.19E+03	2.53E+01	3.06E+03	5.00E+02	1.54E+03	2.87E+01	4.02E+02	2.89E+02	2.59E+00	2.76E+03	4.97E+02	1.54E+03	6.05E+01	6.41E+02	1.88E+01	2.82E+00	2.76E+03
2061	2.10E+02	6.48E+02	2.22E+03	2.53E+01	3.11E+03	5.08E+02	1.57E+03	2.89E+01	4.06E+02	2.99E+02	2.59E+00	2.81E+03	5.05E+02	1.57E+03	6.19E+01	6.50E+02	2.27E+01	2.82E+00	2.81E+03

Exhibit C-23. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	1.24E+01	0.00E+00	5.16E+01	2.83E+00	8.73E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	4.56E+01	2.82E+00	8.73E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	4.58E+01
2030	1.89E+01	5.84E+01	4.34E+01	0.00E+00	1.21E+02	9.91E+00	3.06E+01	4.01E+00	5.62E+01	2.51E+00	2.47E+00	1.06E+02	9.85E+00	3.06E+01	4.28E+00	5.79E+01	5.58E-01	2.71E+00	1.06E+02
2031	2.80E+01	8.63E+01	9.92E+01	1.17E+00	2.15E+02	2.27E+01	6.98E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.89E+02	2.25E+01	6.98E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.89E+02
2032	3.68E+01	1.14E+02	1.67E+02	3.85E+00	3.22E+02	3.82E+01	1.18E+02	7.53E+00	1.05E+02	1.29E+01	2.59E+00	2.85E+02	3.80E+01	1.18E+02	8.95E+00	1.16E+02	5.58E-01	2.82E+00	2.85E+02
2033	4.54E+01	1.40E+02	2.42E+02	7.44E+00	4.35E+02	5.52E+01	1.70E+02	9.12E+00	1.28E+02	2.10E+01	2.59E+00	3.86E+02	5.49E+01	1.70E+02	1.14E+01	1.46E+02	5.58E-01	2.82E+00	3.86E+02
2034	5.38E+01	1.66E+02	3.16E+02	1.10E+01	5.47E+02	7.22E+01	2.23E+02	1.06E+01	1.49E+02	2.98E+01	2.59E+00	4.87E+02	7.18E+01	2.23E+02	1.39E+01	1.75E+02	5.58E-01	2.82E+00	4.87E+02
2035	6.19E+01	1.91E+02	3.91E+02	1.42E+01	6.57E+02	8.92E+01	2.75E+02	1.20E+01	1.69E+02	3.90E+01	2.59E+00	5.86E+02	8.87E+01	2.75E+02	1.63E+01	2.03E+02	5.58E-01	2.82E+00	5.86E+02
2036	6.97E+01	2.15E+02	4.65E+02	1.69E+01	7.66E+02	1.06E+02	3.27E+02	1.33E+01	1.87E+02	4.83E+01	2.59E+00	6.85E+02	1.06E+02	3.27E+02	1.87E+01	2.29E+02	5.58E-01	2.82E+00	6.84E+02
2037	7.74E+01	2.38E+02	5.39E+02	1.92E+01	8.74E+02	1.23E+02	3.80E+02	1.46E+01	2.04E+02	5.77E+01	2.59E+00	7.82E+02	1.22E+02	3.80E+02	2.09E+01	2.55E+02	5.58E-01	2.82E+00	7.81E+02
2038	8.48E+01	2.61E+02	6.14E+02	2.11E+01	9.81E+02	1.40E+02	4.32E+02	1.57E+01	2.20E+02	6.74E+01	2.59E+00	8.78E+02	1.39E+02	4.32E+02	2.31E+01	2.80E+02	5.58E-01	2.82E+00	8.78E+02
2039	9.21E+01	2.84E+02	6.88E+02	2.27E+01	1.09E+03	1.57E+02	4.85E+02	1.68E+01	2.36E+02	7.71E+01	2.59E+00	9.74E+02	1.56E+02	4.85E+02	2.53E+01	3.03E+02	5.58E-01	2.82E+00	9.73E+02
2040	9.91E+01	3.05E+02	7.62E+02	2.39E+01	1.19E+03	1.74E+02	5.37E+02	1.78E+01	2.50E+02	8.68E+01	2.59E+00	1.07E+03	1.73E+02	5.37E+02	2.74E+01	3.26E+02	5.58E-01	2.82E+00	1.07E+03
2041	1.06E+02	3.26E+02	8.37E+02	2.47E+01	1.29E+03	1.91E+02	5.89E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	1.16E+03	1.90E+02	5.89E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	1.16E+03
2042	1.13E+02	3.47E+02	9.11E+02	2.51E+01	1.40E+03	2.08E+02	6.42E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	1.25E+03	2.07E+02	6.42E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	1.25E+03
2043	1.19E+02	3.67E+02	9.86E+02	2.53E+01	1.50E+03	2.25E+02	6.94E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	1.34E+03	2.24E+02	6.94E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	1.34E+03
2044	1.25E+02	3.86E+02	1.06E+03	2.53E+01	1.60E+03	2.42E+02	7.46E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	1.44E+03	2.41E+02	7.46E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	1.43E+03
2045	1.32E+02	4.05E+02	1.13E+03	2.53E+01	1.70E+03	2.59E+02	7.99E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	1.53E+03	2.58E+02	7.99E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	1.52E+03
2046	1.38E+02	4.24E+02	1.21E+03	2.53E+01	1.80E+03	2.76E+02	8.51E+02	2.26E+01	3.17E+02	1.45E+02	2.59E+00	1.62E+03	2.75E+02	8.51E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	1.61E+03
2047	1.43E+02	4.42E+02	1.28E+03	2.53E+01	1.89E+03	2.93E+02	9.04E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	1.70E+03	2.91E+02	9.04E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	1.70E+03
2048	1.49E+02	4.59E+02	1.36E+03	2.53E+01	1.99E+03	3.10E+02	9.56E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.79E+03	3.08E+02	9.56E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.79E+03
2049	1.55E+02	4.76E+02	1.43E+03	2.53E+01	2.09E+03	3.27E+02	1.01E+03	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.88E+03	3.25E+02	1.01E+03	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.88E+03
2050	1.60E+02	4.92E+02	1.51E+03	2.53E+01	2.18E+03	3.44E+02	1.06E+03	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.97E+03	3.42E+02	1.06E+03	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.97E+03
2051	1.65E+02	5.09E+02	1.58E+03	2.53E+01	2.28E+03	3.61E+02	1.11E+03	2.54E+01	3.57E+02	1.97E+02	2.59E+00	2.06E+03	3.59E+02	1.11E+03	4.71E+01	5.27E+02	4.43E+00	2.82E+00	2.05E+03
2052	1.70E+02	5.24E+02	1.66E+03	2.53E+01	2.37E+03	3.78E+02	1.17E+03	2.59E+01	3.63E+02	2.07E+02	2.59E+00	2.14E+03	3.76E+02	1.17E+03	4.87E+01	5.42E+02	5.41E+00	2.82E+00	2.14E+03
2053	1.75E+02	5.39E+02	1.73E+03	2.53E+01	2.47E+03	3.95E+02	1.22E+03	2.63E+01	3.69E+02	2.18E+02	2.59E+00	2.23E+03	3.93E+02	1.22E+03	5.03E+01	5.56E+02	6.58E+00	2.82E+00	2.23E+03
2054	1.80E+02	5.54E+02	1.80E+03	2.53E+01	2.56E+03	4.12E+02	1.27E+03	2.67E+01	3.75E+02	2.28E+02	2.59E+00	2.31E+03	4.10E+02	1.27E+03	5.18E+01	5.70E+02	7.86E+00	2.82E+00	2.31E+03
2055	1.85E+02	5.69E+02	1.88E+03	2.53E+01	2.66E+03	4.29E+02	1.32E+03	2.71E+01	3.80E+02	2.38E+02	2.59E+00	2.40E+03	4.27E+02	1.32E+03	5.34E+01	5.83E+02	9.18E+00	2.82E+00	2.40E+03
2056	1.89E+02	5.83E+02	1.95E+03	2.53E+01	2.75E+03	4.46E+02	1.38E+03	2.75E+01	3.85E+02	2.48E+02	2.59E+00	2.48E+03	4.43E+02	1.38E+03	5.48E+01	5.96E+02	1.05E+01	2.82E+00	2.48E+03
2057	1.94E+02	5.96E+02	2.03E+03	2.53E+01	2.84E+03	4.63E+02	1.43E+03	2.78E+01	3.90E+02	2.59E+02	2.59E+00	2.57E+03	4.60E+02	1.43E+03	5.63E+01	6.08E+02	1.17E+01	2.82E+00	2.57E+03
2058	1.98E+02	6.10E+02	2.09E+03	2.53E+01	2.93E+03	4.78E+02	1.47E+03	2.81E+01	3.94E+02	2.69E+02	2.59E+00	2.65E+03	4.75E+02	1.47E+03	5.77E+01	6.20E+02	1.33E+01	2.82E+00	2.64E+03
2059	2.02E+02	6.23E+02	2.15E+03	2.53E+01	3.00E+03	4.90E+02	1.51E+03	2.84E+01	3.98E+02	2.79E+02	2.59E+00	2.71E+03	4.88E+02	1.51E+03	5.91E+01	6.31E+02	1.57E+01	2.82E+00	2.71E+03
2060	2.06E+02	6.35E+02	2.19E+03	2.53E+01	3.06E+03	5.00E+02	1.54E+03	2.87E+01	4.02E+02	2.89E+02	2.59E+00	2.76E+03	4.97E+02	1.54E+03	6.05E+01	6.41E+02	1.88E+01	2.82E+00	2.76E+03
2061	2.10E+02	6.48E+02	2.22E+03	2.53E+01	3.11E+03	5.08E+02	1.57E+03	2.89E+01	4.06E+02	2.99E+02	2.59E+00	2.81E+03	5.05E+02	1.57E+03	6.19E+01	6.50E+02	2.27E+01	2.82E+00	2.81E+03

Exhibit C-24. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	1.24E+01	0.00E+00	5.16E+01	2.83E+00	9.03E+00	2.06E+00	2.89E+01	7.45E-01	2.26E+00	4.59E+01	2.82E+00	9.03E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	4.61E+01
2030	1.89E+01	5.84E+01	4.33E+01	0.00E+00	1.21E+02	9.91E+00	3.16E+01	4.01E+00	5.62E+01	2.51E+00	2.47E+00	1.07E+02	9.85E+00	3.16E+01	4.28E+00	5.79E+01	5.58E-01	2.71E+00	1.07E+02
2031	2.80E+01	8.63E+01	9.90E+01	1.17E+00	2.15E+02	2.27E+01	7.22E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.91E+02	2.25E+01	7.22E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.91E+02
2032	3.68E+01	1.14E+02	1.67E+02	3.85E+00	3.21E+02	3.82E+01	1.22E+02	7.52E+00	1.05E+02	1.29E+01	2.59E+00	2.89E+02	3.80E+01	1.22E+02	8.95E+00	1.16E+02	5.58E-01	2.82E+00	2.89E+02
2033	4.54E+01	1.40E+02	2.41E+02	7.44E+00	4.34E+02	5.52E+01	1.76E+02	9.12E+00	1.28E+02	2.10E+01	2.59E+00	3.92E+02	5.49E+01	1.76E+02	1.14E+01	1.46E+02	5.58E-01	2.82E+00	3.92E+02
2034	5.38E+01	1.66E+02	3.16E+02	1.10E+01	5.46E+02	7.22E+01	2.30E+02	1.06E+01	1.49E+02	2.98E+01	2.59E+00	4.94E+02	7.18E+01	2.30E+02	1.39E+01	1.75E+02	5.58E-01	2.82E+00	4.94E+02
2035	6.19E+01	1.91E+02	3.90E+02	1.42E+01	6.56E+02	8.92E+01	2.84E+02	1.20E+01	1.69E+02	3.90E+01	2.59E+00	5.96E+02	8.87E+01	2.84E+02	1.63E+01	2.03E+02	5.58E-01	2.82E+00	5.95E+02
2036	6.97E+01	2.15E+02	4.64E+02	1.69E+01	7.65E+02	1.06E+02	3.38E+02	1.33E+01	1.87E+02	4.83E+01	2.59E+00	6.96E+02	1.06E+02	3.38E+02	1.87E+01	2.29E+02	5.58E-01	2.82E+00	6.95E+02
2037	7.74E+01	2.38E+02	5.38E+02	1.92E+01	8.73E+02	1.23E+02	3.93E+02	1.46E+01	2.04E+02	5.77E+01	2.59E+00	7.95E+02	1.22E+02	3.93E+02	2.09E+01	2.55E+02	5.58E-01	2.82E+00	7.94E+02
2038	8.48E+01	2.61E+02	6.12E+02	2.11E+01	9.80E+02	1.40E+02	4.47E+02	1.57E+01	2.20E+02	6.74E+01	2.59E+00	8.93E+02	1.39E+02	4.47E+02	2.31E+01	2.80E+02	5.58E-01	2.82E+00	8.92E+02
2039	9.21E+01	2.84E+02	6.87E+02	2.27E+01	1.09E+03	1.57E+02	5.01E+02	1.68E+01	2.36E+02	7.71E+01	2.59E+00	9.90E+02	1.56E+02	5.01E+02	2.53E+01	3.03E+02	5.58E-01	2.82E+00	9.89E+02
2040	9.91E+01	3.05E+02	7.61E+02	2.39E+01	1.19E+03	1.74E+02	5.55E+02	1.78E+01	2.50E+02	8.68E+01	2.59E+00	1.09E+03	1.73E+02	5.55E+02	2.74E+01	3.26E+02	5.58E-01	2.82E+00	1.09E+03
2041	1.06E+02	3.26E+02	8.35E+02	2.47E+01	1.29E+03	1.91E+02	6.09E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	1.18E+03	1.90E+02	6.09E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	1.18E+03
2042	1.13E+02	3.47E+02	9.09E+02	2.51E+01	1.39E+03	2.08E+02	6.63E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	1.28E+03	2.07E+02	6.63E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	1.27E+03
2043	1.19E+02	3.67E+02	9.84E+02	2.53E+01	1.50E+03	2.25E+02	7.18E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	1.37E+03	2.24E+02	7.18E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	1.37E+03
2044	1.25E+02	3.86E+02	1.06E+03	2.53E+01	1.60E+03	2.42E+02	7.72E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	1.46E+03	2.41E+02	7.72E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	1.46E+03
2045	1.32E+02	4.05E+02	1.13E+03	2.53E+01	1.69E+03	2.59E+02	8.26E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	1.55E+03	2.58E+02	8.26E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	1.55E+03
2046	1.38E+02	4.24E+02	1.21E+03	2.53E+01	1.79E+03	2.76E+02	8.80E+02	2.26E+01	3.17E+02	1.45E+02	2.59E+00	1.64E+03	2.75E+02	8.80E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	1.64E+03
2047	1.43E+02	4.42E+02	1.28E+03	2.53E+01	1.89E+03	2.93E+02	9.34E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	1.74E+03	2.91E+02	9.34E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	1.73E+03
2048	1.49E+02	4.59E+02	1.35E+03	2.53E+01	1.99E+03	3.10E+02	9.88E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.83E+03	3.08E+02	9.88E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.82E+03
2049	1.55E+02	4.76E+02	1.43E+03	2.53E+01	2.08E+03	3.27E+02	1.04E+03	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.92E+03	3.25E+02	1.04E+03	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.91E+03
2050	1.60E+02	4.92E+02	1.50E+03	2.53E+01	2.18E+03	3.44E+02	1.10E+03	2.50E+01	3.50E+02	1.86E+02	2.59E+00	2.00E+03	3.42E+02	1.10E+03	4.55E+01	5.12E+02	3.61E+00	2.82E+00	2.00E+03
2051	1.65E+02	5.09E+02	1.58E+03	2.53E+01	2.28E+03	3.61E+02	1.15E+03	2.54E+01	3.57E+02	1.97E+02	2.59E+00	2.09E+03	3.59E+02	1.15E+03	4.71E+01	5.27E+02	4.43E+00	2.82E+00	2.09E+03
2052	1.70E+02	5.24E+02	1.65E+03	2.53E+01	2.37E+03	3.78E+02	1.21E+03	2.59E+01	3.63E+02	2.07E+02	2.59E+00	2.18E+03	3.76E+02	1.21E+03	4.87E+01	5.42E+02	5.41E+00	2.82E+00	2.18E+03
2053	1.75E+02	5.39E+02	1.73E+03	2.53E+01	2.47E+03	3.95E+02	1.26E+03	2.63E+01	3.69E+02	2.18E+02	2.59E+00	2.27E+03	3.93E+02	1.26E+03	5.03E+01	5.56E+02	6.58E+00	2.82E+00	2.27E+03
2054	1.80E+02	5.54E+02	1.80E+03	2.53E+01	2.56E+03	4.12E+02	1.31E+03	2.67E+01	3.75E+02	2.28E+02	2.59E+00	2.36E+03	4.10E+02	1.31E+03	5.18E+01	5.70E+02	7.86E+00	2.82E+00	2.36E+03
2055	1.85E+02	5.69E+02	1.87E+03	2.53E+01	2.65E+03	4.29E+02	1.37E+03	2.71E+01	3.80E+02	2.38E+02	2.59E+00	2.44E+03	4.27E+02	1.37E+03	5.34E+01	5.83E+02	9.18E+00	2.82E+00	2.44E+03
2056	1.89E+02	5.83E+02	1.95E+03	2.53E+01	2.75E+03	4.46E+02	1.42E+03	2.75E+01	3.85E+02	2.48E+02	2.59E+00	2.53E+03	4.43E+02	1.42E+03	5.48E+01	5.96E+02	1.05E+01	2.82E+00	2.53E+03
2057	1.94E+02	5.96E+02	2.02E+03	2.53E+01	2.84E+03	4.63E+02	1.48E+03	2.78E+01	3.90E+02	2.59E+02	2.59E+00	2.62E+03	4.60E+02	1.48E+03	5.63E+01	6.08E+02	1.17E+01	2.82E+00	2.62E+03
2058	1.98E+02	6.10E+02	2.09E+03	2.53E+01	2.92E+03	4.78E+02	1.52E+03	2.81E+01	3.94E+02	2.69E+02	2.59E+00	2.70E+03	4.75E+02	1.52E+03	5.77E+01	6.20E+02	1.33E+01	2.82E+00	2.69E+03
2059	2.02E+02	6.23E+02	2.14E+03	2.53E+01	2.99E+03	4.90E+02	1.56E+03	2.84E+01	3.98E+02	2.79E+02	2.59E+00	2.76E+03	4.88E+02	1.56E+03	5.91E+01	6.31E+02	1.57E+01	2.82E+00	2.76E+03
2060	2.06E+02	6.35E+02	2.19E+03	2.53E+01	3.05E+03	5.00E+02	1.59E+03	2.87E+01	4.02E+02	2.89E+02	2.59E+00	2.82E+03	4.97E+02	1.59E+03	6.05E+01	6.41E+02	1.88E+01	2.82E+00	2.81E+03
2061	2.10E+02	6.48E+02	2.22E+03	2.53E+01	3.10E+03	5.08E+02	1.62E+03	2.89E+01	4.06E+02	2.99E+02	2.59E+00	2.86E+03	5.05E+02	1.62E+03	6.18E+01	6.50E+02	2.27E+01	2.82E+00	2.86E+03

Exhibit C-25. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	5.09E+00	0.00E+00	4.43E+01	2.83E+00	1.46E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	3.83E+01	2.82E+00	1.46E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	3.86E+01
2030	1.90E+01	5.84E+01	1.78E+01	0.00E+00	9.52E+01	9.91E+00	5.11E+00	4.01E+00	5.62E+01	2.51E+00	2.47E+00	8.02E+01	9.86E+00	5.11E+00	4.28E+00	5.79E+01	5.58E-01	2.71E+00	8.04E+01
2031	2.80E+01	8.63E+01	4.08E+01	1.17E+00	1.56E+02	2.27E+01	1.17E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.31E+02	2.25E+01	1.17E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.31E+02
2032	3.68E+01	1.14E+02	6.88E+01	3.85E+00	2.23E+02	3.82E+01	1.97E+01	7.53E+00	1.05E+02	1.29E+01	2.59E+00	1.86E+02	3.80E+01	1.97E+01	8.95E+00	1.16E+02	5.58E-01	2.82E+00	1.86E+02
2033	4.54E+01	1.40E+02	9.93E+01	7.44E+00	2.92E+02	5.52E+01	2.85E+01	9.13E+00	1.28E+02	2.10E+01	2.59E+00	2.44E+02	5.49E+01	2.85E+01	1.14E+01	1.46E+02	5.58E-01	2.82E+00	2.44E+02
2034	5.38E+01	1.66E+02	1.30E+02	1.10E+01	3.60E+02	7.22E+01	3.72E+01	1.06E+01	1.49E+02	2.98E+01	2.59E+00	3.01E+02	7.18E+01	3.72E+01	1.39E+01	1.75E+02	5.58E-01	2.82E+00	3.01E+02
2035	6.19E+01	1.91E+02	1.60E+02	1.42E+01	4.27E+02	8.92E+01	4.60E+01	1.20E+01	1.69E+02	3.90E+01	2.59E+00	3.57E+02	8.87E+01	4.60E+01	1.63E+01	2.03E+02	5.58E-01	2.82E+00	3.57E+02
2036	6.97E+01	2.15E+02	1.91E+02	1.69E+01	4.93E+02	1.06E+02	5.47E+01	1.34E+01	1.87E+02	4.83E+01	2.59E+00	4.12E+02	1.06E+02	5.47E+01	1.87E+01	2.29E+02	5.58E-01	2.82E+00	4.12E+02
2037	7.74E+01	2.38E+02	2.22E+02	1.92E+01	5.57E+02	1.23E+02	6.35E+01	1.46E+01	2.04E+02	5.77E+01	2.59E+00	4.66E+02	1.22E+02	6.35E+01	2.09E+01	2.55E+02	5.58E-01	2.82E+00	4.65E+02
2038	8.48E+01	2.61E+02	2.52E+02	2.11E+01	6.20E+02	1.40E+02	7.22E+01	1.57E+01	2.20E+02	6.74E+01	2.59E+00	5.19E+02	1.39E+02	7.22E+01	2.32E+01	2.80E+02	5.58E-01	2.82E+00	5.18E+02
2039	9.21E+01	2.84E+02	2.83E+02	2.27E+01	6.81E+02	1.57E+02	8.10E+01	1.68E+01	2.36E+02	7.71E+01	2.59E+00	5.70E+02	1.56E+02	8.10E+01	2.53E+01	3.03E+02	5.58E-01	2.82E+00	5.69E+02
2040	9.91E+01	3.05E+02	3.13E+02	2.39E+01	7.42E+02	1.74E+02	8.97E+01	1.78E+01	2.50E+02	8.68E+01	2.59E+00	6.21E+02	1.73E+02	8.97E+01	2.74E+01	3.26E+02	5.58E-01	2.82E+00	6.20E+02
2041	1.06E+02	3.26E+02	3.44E+02	2.47E+01	8.01E+02	1.91E+02	9.85E+01	1.88E+01	2.63E+02	9.65E+01	2.59E+00	6.70E+02	1.90E+02	9.85E+01	2.94E+01	3.48E+02	5.58E-01	2.82E+00	6.69E+02
2042	1.13E+02	3.47E+02	3.74E+02	2.51E+01	8.59E+02	2.08E+02	1.07E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	7.19E+02	2.07E+02	1.07E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	7.18E+02
2043	1.19E+02	3.67E+02	4.05E+02	2.53E+01	9.16E+02	2.25E+02	1.16E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	7.67E+02	2.24E+02	1.16E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	7.65E+02
2044	1.25E+02	3.86E+02	4.36E+02	2.53E+01	9.73E+02	2.42E+02	1.25E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	8.14E+02	2.41E+02	1.25E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	8.12E+02
2045	1.32E+02	4.05E+02	4.66E+02	2.53E+01	1.03E+03	2.59E+02	1.34E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	8.60E+02	2.58E+02	1.34E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	8.59E+02
2046	1.38E+02	4.24E+02	4.97E+02	2.53E+01	1.08E+03	2.76E+02	1.42E+02	2.27E+01	3.17E+02	1.45E+02	2.59E+00	9.06E+02	2.75E+02	1.42E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	9.05E+02
2047	1.43E+02	4.42E+02	5.27E+02	2.53E+01	1.14E+03	2.93E+02	1.51E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	9.52E+02	2.91E+02	1.51E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	9.50E+02
2048	1.49E+02	4.59E+02	5.58E+02	2.53E+01	1.19E+03	3.10E+02	1.60E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	9.97E+02	3.08E+02	1.60E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	9.95E+02
2049	1.55E+02	4.76E+02	5.88E+02	2.53E+01	1.24E+03	3.27E+02	1.69E+02	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.04E+03	3.25E+02	1.69E+02	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.04E+03
2050	1.60E+02	4.92E+02	6.19E+02	2.53E+01	1.30E+03	3.44E+02	1.77E+02	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.09E+03	3.42E+02	1.77E+02	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.08E+03
2051	1.65E+02	5.09E+02	6.50E+02	2.53E+01	1.35E+03	3.61E+02	1.86E+02	2.55E+01	3.57E+02	1.97E+02	2.59E+00	1.13E+03	3.59E+02	1.86E+02	4.71E+01	5.27E+02	4.43E+00	2.82E+00	1.13E+03
2052	1.70E+02	5.24E+02	6.80E+02	2.53E+01	1.40E+03	3.78E+02	1.95E+02	2.59E+01	3.63E+02	2.07E+02	2.59E+00	1.17E+03	3.76E+02	1.95E+02	4.87E+01	5.42E+02	5.41E+00	2.82E+00	1.17E+03
2053	1.75E+02	5.39E+02	7.11E+02	2.53E+01	1.45E+03	3.95E+02	2.04E+02	2.63E+01	3.69E+02	2.18E+02	2.59E+00	1.21E+03	3.93E+02	2.04E+02	5.03E+01	5.56E+02	6.58E+00	2.82E+00	1.21E+03
2054	1.80E+02	5.54E+02	7.41E+02	2.53E+01	1.50E+03	4.12E+02	2.12E+02	2.68E+01	3.75E+02	2.28E+02	2.59E+00	1.26E+03	4.10E+02	2.12E+02	5.19E+01	5.70E+02	7.86E+00	2.82E+00	1.25E+03
2055	1.85E+02	5.69E+02	7.72E+02	2.53E+01	1.55E+03	4.29E+02	2.21E+02	2.71E+01	3.80E+02	2.38E+02	2.59E+00	1.30E+03	4.27E+02	2.21E+02	5.34E+01	5.83E+02	9.18E+00	2.82E+00	1.30E+03
2056	1.89E+02	5.83E+02	8.02E+02	2.53E+01	1.60E+03	4.46E+02	2.30E+02	2.75E+01	3.85E+02	2.48E+02	2.59E+00	1.34E+03	4.44E+02	2.30E+02	5.49E+01	5.96E+02	1.05E+01	2.82E+00	1.34E+03
2057	1.94E+02	5.96E+02	8.33E+02	2.53E+01	1.65E+03	4.63E+02	2.39E+02	2.78E+01	3.90E+02	2.59E+02	2.59E+00	1.38E+03	4.60E+02	2.39E+02	5.63E+01	6.08E+02	1.17E+01	2.82E+00	1.38E+03
2058	1.98E+02	6.10E+02	8.60E+02	2.53E+01	1.69E+03	4.78E+02	2.46E+02	2.81E+01	3.94E+02	2.69E+02	2.59E+00	1.42E+03	4.76E+02	2.46E+02	5.77E+01	6.20E+02	1.33E+01	2.82E+00	1.42E+03
2059	2.02E+02	6.23E+02	8.82E+02	2.53E+01	1.73E+03	4.91E+02	2.53E+02	2.84E+01	3.98E+02	2.79E+02	2.59E+00	1.45E+03	4.88E+02	2.53E+02	5.91E+01	6.31E+02	1.57E+01	2.82E+00	1.45E+03
2060	2.06E+02	6.35E+02	9.00E+02	2.53E+01	1.77E+03	5.00E+02	2.58E+02	2.87E+01	4.02E+02	2.89E+02	2.59E+00	1.48E+03	4.97E+02	2.58E+02	6.05E+01	6.41E+02	1.88E+01	2.82E+00	1.48E+03
2061	2.10E+02	6.48E+02	9.14E+02	2.53E+01	1.80E+03	5.08E+02	2.62E+02	2.89E+01	4.06E+02	2.99E+02	2.59E+00	1.51E+03	5.05E+02	2.62E+02	6.19E+01	6.50E+02	2.27E+01	2.82E+00	1.50E+03

Exhibit C-26. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	5.18E+00	0.00E+00	4.44E+01	2.83E+00	1.53E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	3.84E+01	2.82E+00	1.53E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	3.86E+01
2030	1.89E+01	5.84E+01	1.81E+01	0.00E+00	9.54E+01	9.91E+00	5.36E+00	4.01E+00	5.62E+01	2.51E+00	2.47E+00	8.04E+01	9.86E+00	5.36E+00	4.28E+00	5.79E+01	5.58E-01	2.71E+00	8.06E+01
2031	2.80E+01	8.63E+01	4.14E+01	1.17E+00	1.57E+02	2.27E+01	1.22E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.31E+02	2.25E+01	1.22E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.32E+02
2032	3.68E+01	1.14E+02	6.99E+01	3.85E+00	2.24E+02	3.82E+01	2.07E+01	7.53E+00	1.05E+02	1.29E+01	2.59E+00	1.87E+02	3.80E+01	2.07E+01	8.95E+00	1.16E+02	5.58E-01	2.82E+00	1.87E+02
2033	4.54E+01	1.40E+02	1.01E+02	7.44E+00	2.94E+02	5.52E+01	2.98E+01	9.13E+00	1.28E+02	2.10E+01	2.59E+00	2.46E+02	5.49E+01	2.98E+01	1.14E+01	1.46E+02	5.58E-01	2.82E+00	2.46E+02
2034	5.38E+01	1.66E+02	1.32E+02	1.10E+01	3.62E+02	7.22E+01	3.90E+01	1.06E+01	1.49E+02	2.98E+01	2.59E+00	3.03E+02	7.18E+01	3.90E+01	1.39E+01	1.75E+02	5.58E-01	2.82E+00	3.03E+02
2035	6.19E+01	1.91E+02	1.63E+02	1.42E+01	4.30E+02	8.92E+01	4.82E+01	1.20E+01	1.69E+02	3.90E+01	2.59E+00	3.60E+02	8.87E+01	4.82E+01	1.63E+01	2.03E+02	5.58E-01	2.82E+00	3.59E+02
2036	6.97E+01	2.15E+02	1.94E+02	1.69E+01	4.96E+02	1.06E+02	5.74E+01	1.34E+01	1.87E+02	4.83E+01	2.59E+00	4.15E+02	1.06E+02	5.74E+01	1.87E+01	2.29E+02	5.58E-01	2.82E+00	4.14E+02
2037	7.74E+01	2.38E+02	2.25E+02	1.92E+01	5.60E+02	1.23E+02	6.66E+01	1.46E+01	2.04E+02	5.77E+01	2.59E+00	4.69E+02	1.22E+02	6.66E+01	2.09E+01	2.55E+02	5.58E-01	2.82E+00	4.68E+02
2038	8.48E+01	2.61E+02	2.56E+02	2.11E+01	6.24E+02	1.40E+02	7.57E+01	1.57E+01	2.20E+02	6.74E+01	2.59E+00	5.22E+02	1.39E+02	7.57E+01	2.32E+01	2.80E+02	5.58E-01	2.82E+00	5.21E+02
2039	9.21E+01	2.84E+02	2.87E+02	2.27E+01	6.86E+02	1.57E+02	8.49E+01	1.68E+01	2.36E+02	7.71E+01	2.59E+00	5.74E+02	1.56E+02	8.49E+01	2.53E+01	3.03E+02	5.58E-01	2.82E+00	5.73E+02
2040	9.91E+01	3.05E+02	3.18E+02	2.39E+01	7.47E+02	1.74E+02	9.41E+01	1.78E+01	2.50E+02	8.68E+01	2.59E+00	6.25E+02	1.73E+02	9.41E+01	2.74E+01	3.26E+02	5.58E-01	2.82E+00	6.24E+02
2041	1.06E+02	3.26E+02	3.49E+02	2.47E+01	8.07E+02	1.91E+02	1.03E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	6.75E+02	1.90E+02	1.03E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	6.74E+02
2042	1.13E+02	3.47E+02	3.80E+02	2.51E+01	8.65E+02	2.08E+02	1.12E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	7.24E+02	2.07E+02	1.12E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	7.23E+02
2043	1.19E+02	3.67E+02	4.11E+02	2.53E+01	9.23E+02	2.25E+02	1.22E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	7.73E+02	2.24E+02	1.22E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	7.71E+02
2044	1.25E+02	3.86E+02	4.43E+02	2.53E+01	9.80E+02	2.42E+02	1.31E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	8.20E+02	2.41E+02	1.31E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	8.18E+02
2045	1.32E+02	4.05E+02	4.74E+02	2.53E+01	1.04E+03	2.59E+02	1.40E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	8.67E+02	2.58E+02	1.40E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	8.65E+02
2046	1.38E+02	4.24E+02	5.05E+02	2.53E+01	1.09E+03	2.76E+02	1.49E+02	2.27E+01	3.17E+02	1.45E+02	2.59E+00	9.13E+02	2.75E+02	1.49E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	9.11E+02
2047	1.43E+02	4.42E+02	5.36E+02	2.53E+01	1.15E+03	2.93E+02	1.58E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	9.59E+02	2.91E+02	1.58E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	9.57E+02
2048	1.49E+02	4.59E+02	5.67E+02	2.53E+01	1.20E+03	3.10E+02	1.68E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.00E+03	3.08E+02	1.68E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.00E+03
2049	1.55E+02	4.76E+02	5.98E+02	2.53E+01	1.25E+03	3.27E+02	1.77E+02	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.05E+03	3.25E+02	1.77E+02	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.05E+03
2050	1.60E+02	4.92E+02	6.29E+02	2.53E+01	1.31E+03	3.44E+02	1.86E+02	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.09E+03	3.42E+02	1.86E+02	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.09E+03
2051	1.65E+02	5.09E+02	6.60E+02	2.53E+01	1.36E+03	3.61E+02	1.95E+02	2.55E+01	3.57E+02	1.97E+02	2.59E+00	1.14E+03	3.59E+02	1.95E+02	4.71E+01	5.27E+02	4.43E+00	2.82E+00	1.14E+03
2052	1.70E+02	5.24E+02	6.91E+02	2.53E+01	1.41E+03	3.78E+02	2.04E+02	2.59E+01	3.63E+02	2.07E+02	2.59E+00	1.18E+03	3.76E+02	2.04E+02	4.87E+01	5.42E+02	5.41E+00	2.82E+00	1.18E+03
2053	1.75E+02	5.39E+02	7.22E+02	2.53E+01	1.46E+03	3.95E+02	2.13E+02	2.63E+01	3.69E+02	2.18E+02	2.59E+00	1.22E+03	3.93E+02	2.13E+02	5.03E+01	5.56E+02	6.58E+00	2.82E+00	1.22E+03
2054	1.80E+02	5.54E+02	7.53E+02	2.53E+01	1.51E+03	4.12E+02	2.23E+02	2.68E+01	3.75E+02	2.28E+02	2.59E+00	1.27E+03	4.10E+02	2.23E+02	5.19E+01	5.70E+02	7.86E+00	2.82E+00	1.26E+03
2055	1.85E+02	5.69E+02	7.84E+02	2.53E+01	1.56E+03	4.29E+02	2.32E+02	2.71E+01	3.80E+02	2.38E+02	2.59E+00	1.31E+03	4.27E+02	2.32E+02	5.34E+01	5.83E+02	9.18E+00	2.82E+00	1.31E+03
2056	1.89E+02	5.83E+02	8.15E+02	2.53E+01	1.61E+03	4.46E+02	2.41E+02	2.75E+01	3.85E+02	2.48E+02	2.59E+00	1.35E+03	4.44E+02	2.41E+02	5.49E+01	5.96E+02	1.05E+01	2.82E+00	1.35E+03
2057	1.94E+02	5.96E+02	8.46E+02	2.53E+01	1.66E+03	4.63E+02	2.50E+02	2.78E+01	3.90E+02	2.59E+02	2.59E+00	1.39E+03	4.60E+02	2.50E+02	5.63E+01	6.08E+02	1.17E+01	2.82E+00	1.39E+03
2058	1.98E+02	6.10E+02	8.74E+02	2.53E+01	1.71E+03	4.78E+02	2.58E+02	2.81E+01	3.94E+02	2.69E+02	2.59E+00	1.43E+03	4.76E+02	2.58E+02	5.77E+01	6.20E+02	1.33E+01	2.82E+00	1.43E+03
2059	2.02E+02	6.23E+02	8.96E+02	2.53E+01	1.75E+03	4.91E+02	2.65E+02	2.84E+01	3.98E+02	2.79E+02	2.59E+00	1.46E+03	4.88E+02	2.65E+02	5.91E+01	6.31E+02	1.57E+01	2.82E+00	1.46E+03
2060	2.06E+02	6.35E+02	9.14E+02	2.53E+01	1.78E+03	5.00E+02	2.70E+02	2.87E+01	4.02E+02	2.89E+02	2.59E+00	1.49E+03	4.97E+02	2.70E+02	6.05E+01	6.41E+02	1.88E+01	2.82E+00	1.49E+03
2061	2.10E+02	6.48E+02	9.28E+02	2.53E+01	1.81E+03	5.08E+02	2.74E+02	2.89E+01	4.06E+02	2.99E+02	2.59E+00	1.52E+03	5.05E+02	2.74E+02	6.19E+01	6.50E+02	2.27E+01	2.82E+00	1.52E+03

Exhibit C-27. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	5.18E+00	0.00E+00	4.44E+01	2.83E+00	1.53E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	3.84E+01	2.82E+00	1.53E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	3.86E+01
2030	1.90E+01	5.84E+01	1.81E+01	0.00E+00	9.55E+01	9.91E+00	5.37E+00	4.01E+00	5.62E+01	2.51E+00	2.47E+00	8.04E+01	9.86E+00	5.37E+00	4.28E+00	5.79E+01	5.58E-01	2.71E+00	8.07E+01
2031	2.80E+01	8.63E+01	4.14E+01	1.17E+00	1.57E+02	2.27E+01	1.23E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.31E+02	2.25E+01	1.23E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.32E+02
2032	3.68E+01	1.14E+02	6.99E+01	3.85E+00	2.24E+02	3.82E+01	2.07E+01	7.53E+00	1.05E+02	1.29E+01	2.59E+00	1.87E+02	3.80E+01	2.07E+01	8.95E+00	1.16E+02	5.58E-01	2.82E+00	1.87E+02
2033	4.54E+01	1.40E+02	1.01E+02	7.44E+00	2.94E+02	5.52E+01	2.99E+01	9.13E+00	1.28E+02	2.10E+01	2.59E+00	2.46E+02	5.49E+01	2.99E+01	1.14E+01	1.46E+02	5.58E-01	2.82E+00	2.46E+02
2034	5.38E+01	1.66E+02	1.32E+02	1.10E+01	3.62E+02	7.22E+01	3.91E+01	1.06E+01	1.49E+02	2.98E+01	2.59E+00	3.03E+02	7.18E+01	3.91E+01	1.39E+01	1.75E+02	5.58E-01	2.82E+00	3.03E+02
2035	6.19E+01	1.91E+02	1.63E+02	1.42E+01	4.30E+02	8.92E+01	4.83E+01	1.20E+01	1.69E+02	3.90E+01	2.59E+00	3.60E+02	8.87E+01	4.83E+01	1.63E+01	2.03E+02	5.58E-01	2.82E+00	3.59E+02
2036	6.97E+01	2.15E+02	1.94E+02	1.69E+01	4.96E+02	1.06E+02	5.75E+01	1.34E+01	1.87E+02	4.83E+01	2.59E+00	4.15E+02	1.06E+02	5.75E+01	1.87E+01	2.29E+02	5.58E-01	2.82E+00	4.14E+02
2037	7.74E+01	2.38E+02	2.25E+02	1.92E+01	5.60E+02	1.23E+02	6.67E+01	1.46E+01	2.04E+02	5.77E+01	2.59E+00	4.69E+02	1.22E+02	6.67E+01	2.09E+01	2.55E+02	5.58E-01	2.82E+00	4.68E+02
2038	8.48E+01	2.61E+02	2.56E+02	2.11E+01	6.24E+02	1.40E+02	7.59E+01	1.57E+01	2.20E+02	6.74E+01	2.59E+00	5.22E+02	1.39E+02	7.59E+01	2.32E+01	2.80E+02	5.58E-01	2.82E+00	5.21E+02
2039	9.21E+01	2.84E+02	2.87E+02	2.27E+01	6.86E+02	1.57E+02	8.51E+01	1.68E+01	2.36E+02	7.71E+01	2.59E+00	5.74E+02	1.56E+02	8.51E+01	2.53E+01	3.03E+02	5.58E-01	2.82E+00	5.73E+02
2040	9.91E+01	3.05E+02	3.19E+02	2.39E+01	7.47E+02	1.74E+02	9.43E+01	1.78E+01	2.50E+02	8.68E+01	2.59E+00	6.25E+02	1.73E+02	9.43E+01	2.74E+01	3.26E+02	5.58E-01	2.82E+00	6.24E+02
2041	1.06E+02	3.26E+02	3.50E+02	2.47E+01	8.07E+02	1.91E+02	1.04E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	6.75E+02	1.90E+02	1.04E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	6.74E+02
2042	1.13E+02	3.47E+02	3.81E+02	2.51E+01	8.65E+02	2.08E+02	1.13E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	7.25E+02	2.07E+02	1.13E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	7.23E+02
2043	1.19E+02	3.67E+02	4.12E+02	2.53E+01	9.23E+02	2.25E+02	1.22E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	7.73E+02	2.24E+02	1.22E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	7.71E+02
2044	1.25E+02	3.86E+02	4.43E+02	2.53E+01	9.80E+02	2.42E+02	1.31E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	8.20E+02	2.41E+02	1.31E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	8.19E+02
2045	1.32E+02	4.05E+02	4.74E+02	2.53E+01	1.04E+03	2.59E+02	1.40E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	8.67E+02	2.58E+02	1.40E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	8.65E+02
2046	1.38E+02	4.24E+02	5.05E+02	2.53E+01	1.09E+03	2.76E+02	1.50E+02	2.27E+01	3.17E+02	1.45E+02	2.59E+00	9.14E+02	2.75E+02	1.50E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	9.12E+02
2047	1.43E+02	4.42E+02	5.36E+02	2.53E+01	1.15E+03	2.93E+02	1.59E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	9.60E+02	2.91E+02	1.59E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	9.58E+02
2048	1.49E+02	4.59E+02	5.67E+02	2.53E+01	1.20E+03	3.10E+02	1.68E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.00E+03	3.08E+02	1.68E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.00E+03
2049	1.55E+02	4.76E+02	5.98E+02	2.53E+01	1.25E+03	3.27E+02	1.77E+02	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.05E+03	3.25E+02	1.77E+02	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.05E+03
2050	1.60E+02	4.92E+02	6.29E+02	2.53E+01	1.31E+03	3.44E+02	1.86E+02	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.09E+03	3.42E+02	1.86E+02	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.09E+03
2051	1.65E+02	5.09E+02	6.60E+02	2.53E+01	1.36E+03	3.61E+02	1.96E+02	2.55E+01	3.57E+02	1.97E+02	2.59E+00	1.14E+03	3.59E+02	1.96E+02	4.71E+01	5.27E+02	4.43E+00	2.82E+00	1.14E+03
2052	1.70E+02	5.24E+02	6.91E+02	2.53E+01	1.41E+03	3.78E+02	2.05E+02	2.59E+01	3.63E+02	2.07E+02	2.59E+00	1.18E+03	3.76E+02	2.05E+02	4.87E+01	5.42E+02	5.41E+00	2.82E+00	1.18E+03
2053	1.75E+02	5.39E+02	7.23E+02	2.53E+01	1.46E+03	3.95E+02	2.14E+02	2.63E+01	3.69E+02	2.18E+02	2.59E+00	1.22E+03	3.93E+02	2.14E+02	5.03E+01	5.56E+02	6.58E+00	2.82E+00	1.22E+03
2054	1.80E+02	5.54E+02	7.54E+02	2.53E+01	1.51E+03	4.12E+02	2.23E+02	2.68E+01	3.75E+02	2.28E+02	2.59E+00	1.27E+03	4.10E+02	2.23E+02	5.19E+01	5.70E+02	7.86E+00	2.82E+00	1.27E+03
2055	1.85E+02	5.69E+02	7.85E+02	2.53E+01	1.56E+03	4.29E+02	2.32E+02	2.71E+01	3.80E+02	2.38E+02	2.59E+00	1.31E+03	4.27E+02	2.32E+02	5.34E+01	5.83E+02	9.18E+00	2.82E+00	1.31E+03
2056	1.89E+02	5.83E+02	8.16E+02	2.53E+01	1.61E+03	4.46E+02	2.42E+02	2.75E+01	3.85E+02	2.48E+02	2.59E+00	1.35E+03	4.44E+02	2.42E+02	5.49E+01	5.96E+02	1.05E+01	2.82E+00	1.35E+03
2057	1.94E+02	5.96E+02	8.47E+02	2.53E+01	1.66E+03	4.63E+02	2.51E+02	2.78E+01	3.90E+02	2.59E+02	2.59E+00	1.39E+03	4.60E+02	2.51E+02	5.63E+01	6.08E+02	1.17E+01	2.82E+00	1.39E+03
2058	1.98E+02	6.10E+02	8.75E+02	2.53E+01	1.71E+03	4.78E+02	2.59E+02	2.81E+01	3.94E+02	2.69E+02	2.59E+00	1.43E+03	4.76E+02	2.59E+02	5.77E+01	6.20E+02	1.33E+01	2.82E+00	1.43E+03
2059	2.02E+02	6.23E+02	8.97E+02	2.53E+01	1.75E+03	4.91E+02	2.66E+02	2.84E+01	3.98E+02	2.79E+02	2.59E+00	1.46E+03	4.88E+02	2.66E+02	5.91E+01	6.31E+02	1.57E+01	2.82E+00	1.46E+03
2060	2.06E+02	6.35E+02	9.15E+02	2.53E+01	1.78E+03	5.00E+02	2.71E+02	2.87E+01	4.02E+02	2.89E+02	2.59E+00	1.49E+03	4.97E+02	2.71E+02	6.05E+01	6.41E+02	1.88E+01	2.82E+00	1.49E+03
2061	2.10E+02	6.48E+02	9.29E+02	2.53E+01	1.81E+03	5.08E+02	2.75E+02	2.89E+01	4.06E+02	2.99E+02	2.59E+00	1.52E+03	5.05E+02	2.75E+02	6.19E+01	6.50E+02	2.27E+01	2.82E+00	1.52E+03

Exhibit C-28. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-01	5.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	7.41E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+00	1.27E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E+00	1.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.61E+00	2.96E+01	5.15E+00	0.00E+00	4.44E+01	2.83E+00	1.90E+00	2.07E+00	2.89E+01	7.45E-01	2.26E+00	3.87E+01	2.82E+00	1.90E+00	2.15E+00	2.92E+01	4.57E-01	2.49E+00	3.90E+01
2030	1.90E+01	5.84E+01	1.80E+01	0.00E+00	9.53E+01	9.91E+00	6.66E+00	4.01E+00	5.62E+01	2.51E+00	2.47E+00	8.17E+01	9.86E+00	6.66E+00	4.28E+00	5.79E+01	5.58E-01	2.71E+00	8.19E+01
2031	2.80E+01	8.63E+01	4.12E+01	1.17E+00	1.57E+02	2.27E+01	1.52E+01	5.82E+00	8.16E+01	6.51E+00	2.55E+00	1.34E+02	2.25E+01	1.52E+01	6.54E+00	8.69E+01	5.58E-01	2.79E+00	1.34E+02
2032	3.68E+01	1.14E+02	6.95E+01	3.85E+00	2.24E+02	3.82E+01	2.57E+01	7.53E+00	1.05E+02	1.29E+01	2.59E+00	1.92E+02	3.80E+01	2.57E+01	8.95E+00	1.16E+02	5.58E-01	2.82E+00	1.92E+02
2033	4.54E+01	1.40E+02	1.00E+02	7.44E+00	2.93E+02	5.52E+01	3.71E+01	9.13E+00	1.28E+02	2.10E+01	2.59E+00	2.53E+02	5.49E+01	3.71E+01	1.14E+01	1.46E+02	5.58E-01	2.82E+00	2.53E+02
2034	5.38E+01	1.66E+02	1.31E+02	1.10E+01	3.62E+02	7.22E+01	4.85E+01	1.06E+01	1.49E+02	2.98E+01	2.59E+00	3.13E+02	7.18E+01	4.85E+01	1.39E+01	1.75E+02	5.58E-01	2.82E+00	3.12E+02
2035	6.19E+01	1.91E+02	1.62E+02	1.42E+01	4.29E+02	8.92E+01	5.99E+01	1.20E+01	1.69E+02	3.90E+01	2.59E+00	3.71E+02	8.87E+01	5.99E+01	1.63E+01	2.03E+02	5.58E-01	2.82E+00	3.71E+02
2036	6.97E+01	2.15E+02	1.93E+02	1.69E+01	4.95E+02	1.06E+02	7.13E+01	1.33E+01	1.87E+02	4.83E+01	2.59E+00	4.29E+02	1.06E+02	7.13E+01	1.87E+01	2.29E+02	5.58E-01	2.82E+00	4.28E+02
2037	7.74E+01	2.38E+02	2.24E+02	1.92E+01	5.59E+02	1.23E+02	8.27E+01	1.46E+01	2.04E+02	5.77E+01	2.59E+00	4.85E+02	1.22E+02	8.27E+01	2.09E+01	2.55E+02	5.58E-01	2.82E+00	4.84E+02
2038	8.48E+01	2.61E+02	2.55E+02	2.11E+01	6.22E+02	1.40E+02	9.41E+01	1.57E+01	2.20E+02	6.74E+01	2.59E+00	5.40E+02	1.39E+02	9.41E+01	2.31E+01	2.80E+02	5.58E-01	2.82E+00	5.40E+02
2039	9.21E+01	2.84E+02	2.86E+02	2.27E+01	6.84E+02	1.57E+02	1.06E+02	1.68E+01	2.36E+02	7.71E+01	2.59E+00	5.95E+02	1.56E+02	1.06E+02	2.53E+01	3.03E+02	5.58E-01	2.82E+00	5.94E+02
2040	9.91E+01	3.05E+02	3.17E+02	2.39E+01	7.45E+02	1.74E+02	1.17E+02	1.78E+01	2.50E+02	8.68E+01	2.59E+00	6.48E+02	1.73E+02	1.17E+02	2.74E+01	3.26E+02	5.58E-01	2.82E+00	6.47E+02
2041	1.06E+02	3.26E+02	3.47E+02	2.47E+01	8.05E+02	1.91E+02	1.28E+02	1.88E+01	2.63E+02	9.65E+01	2.59E+00	7.00E+02	1.90E+02	1.28E+02	2.94E+01	3.48E+02	5.58E-01	2.82E+00	6.99E+02
2042	1.13E+02	3.47E+02	3.78E+02	2.51E+01	8.63E+02	2.08E+02	1.40E+02	1.96E+01	2.75E+02	1.06E+02	2.59E+00	7.52E+02	2.07E+02	1.40E+02	3.13E+01	3.69E+02	5.58E-01	2.82E+00	7.50E+02
2043	1.19E+02	3.67E+02	4.09E+02	2.53E+01	9.21E+02	2.25E+02	1.51E+02	2.05E+01	2.87E+02	1.16E+02	2.59E+00	8.02E+02	2.24E+02	1.51E+02	3.32E+01	3.89E+02	5.58E-01	2.82E+00	8.01E+02
2044	1.25E+02	3.86E+02	4.40E+02	2.53E+01	9.77E+02	2.42E+02	1.63E+02	2.12E+01	2.98E+02	1.26E+02	2.59E+00	8.52E+02	2.41E+02	1.63E+02	3.51E+01	4.08E+02	5.96E-01	2.82E+00	8.50E+02
2045	1.32E+02	4.05E+02	4.71E+02	2.53E+01	1.03E+03	2.59E+02	1.74E+02	2.20E+01	3.08E+02	1.35E+02	2.59E+00	9.01E+02	2.58E+02	1.74E+02	3.69E+01	4.27E+02	7.86E-01	2.82E+00	8.99E+02
2046	1.38E+02	4.24E+02	5.02E+02	2.53E+01	1.09E+03	2.76E+02	1.85E+02	2.26E+01	3.17E+02	1.45E+02	2.59E+00	9.50E+02	2.75E+02	1.85E+02	3.87E+01	4.45E+02	1.11E+00	2.82E+00	9.48E+02
2047	1.43E+02	4.42E+02	5.33E+02	2.53E+01	1.14E+03	2.93E+02	1.97E+02	2.33E+01	3.26E+02	1.56E+02	2.59E+00	9.98E+02	2.91E+02	1.97E+02	4.04E+01	4.63E+02	1.54E+00	2.82E+00	9.96E+02
2048	1.49E+02	4.59E+02	5.64E+02	2.53E+01	1.20E+03	3.10E+02	2.08E+02	2.39E+01	3.35E+02	1.66E+02	2.59E+00	1.05E+03	3.08E+02	2.08E+02	4.21E+01	4.80E+02	2.13E+00	2.82E+00	1.04E+03
2049	1.55E+02	4.76E+02	5.95E+02	2.53E+01	1.25E+03	3.27E+02	2.20E+02	2.44E+01	3.43E+02	1.76E+02	2.59E+00	1.09E+03	3.25E+02	2.20E+02	4.38E+01	4.96E+02	2.83E+00	2.82E+00	1.09E+03
2050	1.60E+02	4.92E+02	6.25E+02	2.53E+01	1.30E+03	3.44E+02	2.31E+02	2.50E+01	3.50E+02	1.86E+02	2.59E+00	1.14E+03	3.42E+02	2.31E+02	4.55E+01	5.12E+02	3.61E+00	2.82E+00	1.14E+03
2051	1.65E+02	5.09E+02	6.56E+02	2.53E+01	1.36E+03	3.61E+02	2.43E+02	2.55E+01	3.57E+02	1.97E+02	2.59E+00	1.19E+03	3.59E+02	2.43E+02	4.71E+01	5.27E+02	4.43E+00	2.82E+00	1.18E+03
2052	1.70E+02	5.24E+02	6.87E+02	2.53E+01	1.41E+03	3.78E+02	2.54E+02	2.59E+01	3.63E+02	2.07E+02	2.59E+00	1.23E+03	3.76E+02	2.54E+02	4.87E+01	5.42E+02	5.41E+00	2.82E+00	1.23E+03
2053	1.75E+02	5.39E+02	7.18E+02	2.53E+01	1.46E+03	3.95E+02	2.65E+02	2.63E+01	3.69E+02	2.18E+02	2.59E+00	1.28E+03	3.93E+02	2.65E+02	5.03E+01	5.56E+02	6.58E+00	2.82E+00	1.27E+03
2054	1.80E+02	5.54E+02	7.49E+02	2.53E+01	1.51E+03	4.12E+02	2.77E+02	2.68E+01	3.75E+02	2.28E+02	2.59E+00	1.32E+03	4.10E+02	2.77E+02	5.19E+01	5.70E+02	7.86E+00	2.82E+00	1.32E+03
2055	1.85E+02	5.69E+02	7.80E+02	2.53E+01	1.56E+03	4.29E+02	2.88E+02	2.71E+01	3.80E+02	2.38E+02	2.59E+00	1.37E+03	4.27E+02	2.88E+02	5.34E+01	5.83E+02	9.18E+00	2.82E+00	1.36E+03
2056	1.89E+02	5.83E+02	8.11E+02	2.53E+01	1.61E+03	4.46E+02	3.00E+02	2.75E+01	3.85E+02	2.48E+02	2.59E+00	1.41E+03	4.43E+02	3.00E+02	5.49E+01	5.96E+02	1.05E+01	2.82E+00	1.41E+03
2057	1.94E+02	5.96E+02	8.42E+02	2.53E+01	1.66E+03	4.63E+02	3.11E+02	2.78E+01	3.90E+02	2.59E+02	2.59E+00	1.45E+03	4.60E+02	3.11E+02	5.63E+01	6.08E+02	1.17E+01	2.82E+00	1.45E+03
2058	1.98E+02	6.10E+02	8.69E+02	2.53E+01	1.70E+03	4.78E+02	3.21E+02	2.81E+01	3.94E+02	2.69E+02	2.59E+00	1.49E+03	4.76E+02	3.21E+02	5.77E+01	6.20E+02	1.33E+01	2.82E+00	1.49E+03
2059	2.02E+02	6.23E+02	8.92E+02	2.53E+01	1.74E+03	4.91E+02	3.29E+02	2.84E+01	3.98E+02	2.79E+02	2.59E+00	1.53E+03	4.88E+02	3.29E+02	5.91E+01	6.31E+02	1.57E+01	2.82E+00	1.53E+03
2060	2.06E+02	6.35E+02	9.09E+02	2.53E+01	1.78E+03	5.00E+02	3.36E+02	2.87E+01	4.02E+02	2.89E+02	2.59E+00	1.56E+03	4.97E+02	3.36E+02	6.05E+01	6.41E+02	1.88E+01	2.82E+00	1.56E+03
2061	2.10E+02	6.48E+02	9.23E+02	2.53E+01	1.81E+03	5.08E+02	3.41E+02	2.89E+01	4.06E+02	2.99E+02	2.59E+00	1.59E+03	5.05E+02	3.41E+02	6.19E+01	6.50E+02	2.27E+01	2.82E+00	1.58E+03

Exhibit C-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.74E+02	6.78E+02	6.78E+02	6.95E+02
Lower GOR	6.76E+02	6.79E+02	6.79E+02	6.97E+02
Higher GOR	6.73E+02	6.77E+02	6.77E+02	6.94E+02

Exhibit C-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.74E+02	6.78E+02	6.78E+02	6.95E+02
Decrease in Methane Emissions	6.72E+02	6.75E+02	6.76E+02	6.93E+02
Increase in Methane Emissions	6.77E+02	6.80E+02	6.80E+02	6.98E+02

APPENDIX D: AR5 20-YR RESULTS

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report:

- Multiproduct Functional Unit – Japan (AR5 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR5 – 20-yr)
- Multiproduct Functional Unit – China (AR5 – 20-yr)
- Multiproduct Functional Unit – India (AR5 – 20-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR5 – 20-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 20-yr)
- Single Product Functional Unit in kg CO_2e – China (AR5 – 20-yr)
- Single Product Functional Unit in kg CO_2e – India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR5 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit D-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.28E+01	8.28E+01	-	9.32E+01	9.32E+01
Natural Gas Pipelines to GTP	-	8.92E+00	8.92E+00	-	1.00E+01	1.00E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	7.74E-01	-	-	8.71E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.71E+01	1.71E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.27E+01	4.27E+01	-	4.80E+01	4.80E+01
Ocean Transport	-	2.18E+01	2.18E+01	-	2.45E+01	2.45E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	5.06E+01	7.65E+00	7.65E+00	5.69E+01	8.61E+00	8.61E+00
Crude Oil Extraction, CO2-EOR	-	-	6.62E+00	-	-	7.45E+00
CO2-EOR Crude Oil Transport	-	-	8.66E-01	-	-	9.74E-01
Crude Oil Alaskan Pipeline Transport	2.29E+00	1.44E+00	1.44E+00	2.58E+00	1.62E+00	1.62E+00
Crude Oil Ocean Transport	1.19E+00	7.99E-01	1.28E+00	1.34E+00	8.99E-01	1.44E+00
Crude Oil Refining and End Use	1.52E+02	9.54E+01	1.53E+02	1.72E+02	1.07E+02	1.72E+02
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	2.55E+01	9.22E+01	2.49E+01	3.19E+00	7.82E+01	2.46E+00
System Expansion: US Lower 48 LNG Export and End Use	6.12E+02	-	-	3.42E+02	-	-
Total	8.44E+02	7.44E+02	7.42E+02	5.77E+02	4.71E+02	4.68E+02
Upper	2.71E+01	9.32E+00	8.49E+00	2.91E+01	9.52E+00	9.17E+00
Lower	1.20E+01	4.49E+00	3.91E+00	1.16E+01	3.10E+00	4.48E+00

Exhibit D-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.30E+01	8.30E+01	-	9.34E+01	9.34E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	7.75E-01	-	-	8.73E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.54E+01	2.54E+01	-	2.86E+01	2.86E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	5.07E+01	7.66E+00	7.66E+00	5.70E+01	8.62E+00	8.62E+00
Crude Oil Extraction, CO2-EOR	-	-	6.63E+00	-	-	7.47E+00
CO2-EOR Crude Oil Transport	-	-	8.67E-01	-	-	9.76E-01
Crude Oil Alaskan Pipeline Transport	2.30E+00	1.44E+00	1.44E+00	2.59E+00	1.62E+00	1.62E+00
Crude Oil Ocean Transport	1.19E+00	8.00E-01	1.28E+00	1.34E+00	9.01E-01	1.44E+00
Crude Oil Refining and End Use	1.53E+02	9.56E+01	1.53E+02	1.72E+02	1.08E+02	1.72E+02
Construction	-	5.32E-01	5.32E-01	-	5.99E-01	5.99E-01
System Expansion: US Average Crude Oil Production and End Use	2.52E+01	9.20E+01	2.46E+01	2.80E+00	7.80E+01	2.07E+00
System Expansion: US Lower 48 LNG Export and End Use	6.16E+02	-	-	3.47E+02	-	-
Total	8.49E+02	7.48E+02	7.46E+02	5.83E+02	4.76E+02	4.73E+02
Upper	1.96E+01	1.02E+01	8.04E+00	2.56E+01	9.50E+00	9.09E+00
Lower	1.61E+01	4.58E+00	3.26E+00	1.17E+01	2.65E+00	3.82E+00

Exhibit D-3. Multiproduct Functional Unit in kg CO_2e – China (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.30E+01	8.30E+01	-	9.34E+01	9.34E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	7.75E-01	-	-	8.73E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	5.07E+01	7.66E+00	7.66E+00	5.70E+01	8.62E+00	8.62E+00
Crude Oil Extraction, CO2-EOR	-	-	6.63E+00	-	-	7.47E+00
CO2-EOR Crude Oil Transport	-	-	8.67E-01	-	-	9.76E-01
Crude Oil Alaskan Pipeline Transport	2.30E+00	1.44E+00	1.44E+00	2.59E+00	1.62E+00	1.62E+00
Crude Oil Ocean Transport	1.19E+00	8.00E-01	1.28E+00	1.34E+00	9.01E-01	1.44E+00
Crude Oil Refining and End Use	1.53E+02	9.56E+01	1.53E+02	1.72E+02	1.08E+02	1.73E+02
Construction	-	5.32E-01	5.32E-01	-	5.99E-01	5.99E-01
System Expansion: US Average Crude Oil Production and End Use	2.52E+01	9.20E+01	2.45E+01	2.78E+00	7.80E+01	2.05E+00
System Expansion: US Lower 48 LNG Export and End Use	6.17E+02	-	-	3.47E+02	-	-
Total	8.49E+02	7.48E+02	7.46E+02	5.83E+02	4.76E+02	4.73E+02
Upper	1.58E+01	7.94E+00	7.89E+00	2.65E+01	8.89E+00	1.24E+01
Lower	2.95E-01	3.36E+00	4.09E+00	1.09E+01	3.55E+00	4.54E+00

Exhibit D-4. Multiproduct Functional Unit in kg CO_2e – India (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.38E+01	8.38E+01	-	9.43E+01	9.43E+01
Natural Gas Pipelines to GTP	-	9.03E+00	9.03E+00	-	1.02E+01	1.02E+01
Natural Gas Processing at GTP	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
CO2 Compression and Sequestration	-	7.83E-01	-	-	8.81E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.73E+01	1.73E+01	-	1.95E+01	1.95E+01
Liquefaction	-	4.32E+01	4.32E+01	-	4.86E+01	4.86E+01
Ocean Transport	-	4.49E+01	4.49E+01	-	5.05E+01	5.05E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	5.12E+01	7.74E+00	7.74E+00	5.76E+01	8.71E+00	8.71E+00
Crude Oil Extraction, CO2-EOR	-	-	6.70E+00	-	-	7.54E+00
CO2-EOR Crude Oil Transport	-	-	8.76E-01	-	-	9.86E-01
Crude Oil Alaskan Pipeline Transport	2.32E+00	1.45E+00	1.45E+00	2.61E+00	1.64E+00	1.64E+00
Crude Oil Ocean Transport	1.20E+00	8.09E-01	1.30E+00	1.36E+00	9.10E-01	1.46E+00
Crude Oil Refining and End Use	1.54E+02	9.66E+01	1.55E+02	1.74E+02	1.09E+02	1.74E+02
Construction	-	5.38E-01	5.38E-01	-	6.05E-01	6.05E-01
System Expansion: US Average Crude Oil Production and End Use	2.34E+01	9.09E+01	2.27E+01	7.34E-01	7.67E+01	-
System Expansion: US Lower 48 LNG Export and End Use	6.15E+02	-	-	3.45E+02	-	-
Total	8.47E+02	7.70E+02	7.67E+02	5.81E+02	4.99E+02	4.96E+02
Upper	2.05E+01	1.02E+01	1.06E+01	2.16E+01	1.09E+01	9.97E+00
Lower	8.18E+00	3.76E+00	3.82E+00	1.21E+01	3.88E+00	3.23E+00

Exhibit D-5. Single Product Functional Unit in kg CO_2e – Japan (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.28E+01	8.28E+01	-	9.32E+01	9.32E+01
Natural Gas Pipelines to GTP	-	8.92E+00	8.92E+00	-	1.00E+01	1.00E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	6.65E-01	-	-	7.49E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.71E+01	1.71E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.27E+01	4.27E+01	-	4.80E+01	4.80E+01
Ocean Transport	-	2.18E+01	2.18E+01	-	2.45E+01	2.45E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.12E+02	-	-	3.42E+02	-	-
Total	6.12E+02	5.47E+02	5.46E+02	3.42E+02	2.74E+02	2.73E+02
Upper	2.70E+01	6.84E+00	6.25E+00	2.91E+01	5.54E+00	5.35E+00
Lower	1.21E+01	3.30E+00	2.88E+00	1.17E+01	1.80E+00	2.62E+00

Exhibit D-6. Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.30E+01	8.30E+01	-	9.34E+01	9.34E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	6.67E-01	-	-	7.50E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.54E+01	2.54E+01	-	2.86E+01	2.86E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.32E-01	5.32E-01	-	5.99E-01	5.99E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.16E+02	-	-	3.47E+02	-	-
Total	6.16E+02	5.51E+02	5.50E+02	3.47E+02	2.79E+02	2.78E+02
Upper	1.95E+01	7.47E+00	5.93E+00	2.55E+01	5.57E+00	5.35E+00
Lower	1.62E+01	3.37E+00	2.40E+00	1.18E+01	1.55E+00	2.25E+00

Exhibit D-7. Single Product Functional Unit in kg CO_2e – China (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.30E+01	8.30E+01	-	9.34E+01	9.34E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
CO2 Compression and Sequestration	-	6.67E-01	-	-	7.50E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.32E-01	5.32E-01	-	5.99E-01	5.99E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.17E+02	-	-	3.47E+02	-	-
Total	6.17E+02	5.51E+02	5.50E+02	3.47E+02	2.79E+02	2.78E+02
Upper	1.57E+01	5.84E+00	5.82E+00	2.64E+01	5.21E+00	7.28E+00
Lower	3.85E-01	2.47E+00	3.01E+00	1.10E+01	2.08E+00	2.67E+00

Exhibit D-8. Single Product Functional Unit in kg CO_2e – India (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.38E+01	8.38E+01	-	9.43E+01	9.43E+01
Natural Gas Pipelines to GTP	-	9.03E+00	9.03E+00	-	1.02E+01	1.02E+01
Natural Gas Processing at GTP	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
CO2 Compression and Sequestration	-	6.74E-01	-	-	7.58E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.73E+01	1.73E+01	-	1.95E+01	1.95E+01
Liquefaction	-	4.32E+01	4.32E+01	-	4.86E+01	4.86E+01
Ocean Transport	-	4.49E+01	4.49E+01	-	5.05E+01	5.05E+01
LNG Regasification	-	4.42E+00	4.42E+00	-	4.97E+00	4.97E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.38E-01	5.38E-01	-	6.05E-01	6.05E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.15E+02	-	-	3.45E+02	-	-
Total	6.15E+02	5.72E+02	5.71E+02	3.45E+02	3.03E+02	3.02E+02
Upper	2.04E+01	7.56E+00	7.91E+00	2.15E+01	6.59E+00	6.06E+00
Lower	8.27E+00	2.79E+00	2.84E+00	1.22E+01	2.35E+00	1.97E+00

Exhibit D-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Pipelines to GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Processing at GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liquefaction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ocean Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LNG Regasification	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Power Plant Operations	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Extraction, Associated	4.29E+01	7.70E+00	5.48E-05	0.00E+00	5.06E+01
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.66E-01	9.71E-03	5.71E-09	2.29E+00
Crude Oil Ocean Transport	1.09E+00	9.28E-02	2.65E-03	8.49E-07	1.19E+00
Crude Oil Refining and End Use	1.52E+02	7.48E-01	6.82E-03	0.00E+00	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	1.62E+00	1.40E-02	0.00E+00	2.55E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.48E+02	3.03E-01	1.41E-07	6.12E+02
Construction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.85E+02	1.58E+02	3.36E-01	9.95E-07	8.44E+02

Exhibit D-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Pipelines to GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Processing at GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liquefaction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ocean Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LNG Regasification	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Power Plant Operations	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Extraction, Associated	4.30E+01	7.71E+00	5.49E-05	0.00E+00	5.07E+01
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.67E-01	9.73E-03	5.73E-09	2.30E+00
Crude Oil Ocean Transport	1.10E+00	9.30E-02	2.65E-03	8.50E-07	1.19E+00
Crude Oil Refining and End Use	1.52E+02	7.49E-01	6.83E-03	0.00E+00	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.60E+00	1.38E-02	0.00E+00	2.52E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.49E+02	3.12E-01	1.41E-07	6.16E+02
Construction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.89E+02	1.59E+02	3.46E-01	9.97E-07	8.49E+02

Exhibit D-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Pipelines to GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Processing at GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liquefaction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ocean Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LNG Regasification	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Power Plant Operations	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Extraction, Associated	4.30E+01	7.71E+00	5.49E-05	0.00E+00	5.07E+01
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.67E-01	9.73E-03	5.73E-09	2.30E+00
Crude Oil Ocean Transport	1.10E+00	9.30E-02	2.65E-03	8.50E-07	1.19E+00
Crude Oil Refining and End Use	1.52E+02	7.49E-01	6.83E-03	0.00E+00	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.60E+00	1.38E-02	0.00E+00	2.52E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.49E+02	3.13E-01	1.41E-07	6.17E+02
Construction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.89E+02	1.59E+02	3.46E-01	9.97E-07	8.49E+02

Exhibit D-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Pipelines to GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Processing at GTP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liquefaction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ocean Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LNG Regasification	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Power Plant Operations	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Extraction, Associated	4.34E+01	7.79E+00	5.55E-05	0.00E+00	5.12E+01
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	2.04E+00	2.70E-01	9.83E-03	5.78E-09	2.32E+00
Crude Oil Ocean Transport	1.11E+00	9.40E-02	2.68E-03	8.59E-07	1.20E+00
Crude Oil Refining and End Use	1.54E+02	7.57E-01	6.90E-03	0.00E+00	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	1.49E+00	1.28E-02	0.00E+00	2.34E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.49E+02	3.09E-01	1.41E-07	6.15E+02
Construction	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.88E+02	1.59E+02	3.41E-01	1.01E-06	8.47E+02

Exhibit D-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	5.70E+01	1.42E-02	0.00E+00	8.28E+01
Natural Gas Pipelines to GTP	2.14E-03	8.92E+00	0.00E+00	0.00E+00	8.92E+00
Natural Gas Processing at GTP	2.39E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	6.44E-01	1.27E-01	1.37E-03	1.56E-03	7.74E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.20E+01	5.08E-07	0.00E+00	1.71E+01
Liquefaction	2.25E+01	2.02E+01	3.77E-03	1.02E-07	4.27E+01
Ocean Transport	1.68E+01	4.95E+00	5.35E-02	0.00E+00	2.18E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	5.03E+00	5.49E-06	0.00E+00	7.65E+00
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.67E-01	6.08E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	7.14E-01	8.24E-02	2.08E-03	7.60E-07	7.99E-01
Crude Oil Refining and End Use	9.50E+01	4.68E-01	4.27E-03	0.00E+00	9.54E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	5.86E+00	5.06E-02	0.00E+00	9.22E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.05E-01	2.31E-02	2.97E-03	0.00E+00	5.31E-01
Total	6.27E+02	1.18E+02	1.48E-01	1.63E-03	7.44E+02

Exhibit D-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.71E+01	1.43E-02	0.00E+00	8.30E+01
Natural Gas Pipelines to GTP	2.14E-03	8.94E+00	0.00E+00	0.00E+00	8.94E+00
Natural Gas Processing at GTP	2.40E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	6.45E-01	1.27E-01	1.37E-03	1.56E-03	7.75E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.20E+01	5.09E-07	0.00E+00	1.72E+01
Liquefaction	2.25E+01	2.03E+01	3.77E-03	1.02E-07	4.28E+01
Ocean Transport	1.95E+01	5.90E+00	6.10E-02	0.00E+00	2.54E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	5.04E+00	5.50E-06	0.00E+00	7.66E+00
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.67E-01	6.09E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	7.16E-01	8.26E-02	2.08E-03	7.62E-07	8.00E-01
Crude Oil Refining and End Use	9.51E+01	4.69E-01	4.28E-03	0.00E+00	9.56E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	5.85E+00	5.04E-02	0.00E+00	9.20E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.06E-01	2.31E-02	2.97E-03	0.00E+00	5.32E-01
Total	6.29E+02	1.19E+02	1.55E-01	1.63E-03	7.48E+02

Exhibit D-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.71E+01	1.43E-02	0.00E+00	8.30E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	0.00E+00	0.00E+00	8.94E+00
Natural Gas Processing at GTP	2.40E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	6.46E-01	1.27E-01	1.37E-03	1.56E-03	7.75E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.20E+01	5.09E-07	0.00E+00	1.72E+01
Liquefaction	2.25E+01	2.03E+01	3.78E-03	1.02E-07	4.28E+01
Ocean Transport	1.96E+01	5.94E+00	6.13E-02	0.00E+00	2.56E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	5.04E+00	5.50E-06	0.00E+00	7.66E+00
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.67E-01	6.09E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	7.16E-01	8.26E-02	2.08E-03	7.62E-07	8.00E-01
Crude Oil Refining and End Use	9.51E+01	4.69E-01	4.28E-03	0.00E+00	9.56E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	5.85E+00	5.04E-02	0.00E+00	9.20E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.06E-01	2.31E-02	2.97E-03	0.00E+00	5.32E-01
Total	6.30E+02	1.19E+02	1.56E-01	1.63E-03	7.48E+02

Exhibit D-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	5.77E+01	1.44E-02	0.00E+00	8.38E+01
Natural Gas Pipelines to GTP	2.17E-03	9.03E+00	0.00E+00	0.00E+00	9.03E+00
Natural Gas Processing at GTP	2.42E+01	1.37E+00	2.47E-05	0.00E+00	2.56E+01
CO2 Compression and Sequestration	6.52E-01	1.28E-01	1.39E-03	1.58E-03	7.83E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.21E+01	5.14E-07	0.00E+00	1.73E+01
Liquefaction	2.27E+01	2.05E+01	3.81E-03	1.03E-07	4.32E+01
Ocean Transport	3.39E+01	1.09E+01	1.00E-01	0.00E+00	4.49E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	5.09E+00	5.56E-06	0.00E+00	7.74E+00
Crude Oil Extraction, CO2-EOR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-EOR Crude Oil Transport	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.69E-01	6.15E-03	3.62E-09	1.45E+00
Crude Oil Ocean Transport	7.23E-01	8.34E-02	2.11E-03	7.69E-07	8.09E-01
Crude Oil Refining and End Use	9.61E+01	4.74E-01	4.32E-03	0.00E+00	9.66E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	5.78E+00	4.98E-02	0.00E+00	9.09E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.11E-01	2.33E-02	3.00E-03	0.00E+00	5.38E-01
Total	6.45E+02	1.25E+02	1.95E-01	1.65E-03	7.70E+02

Exhibit D-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	5.70E+01	1.42E-02	0.00E+00	8.28E+01
Natural Gas Pipelines to GTP	2.14E-03	8.92E+00	0.00E+00	0.00E+00	8.92E+00
Natural Gas Processing at GTP	2.39E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.20E+01	5.08E-07	0.00E+00	1.71E+01
Liquefaction	2.25E+01	2.02E+01	3.77E-03	1.02E-07	4.27E+01
Ocean Transport	1.68E+01	4.95E+00	5.35E-02	0.00E+00	2.18E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	5.03E+00	5.49E-06	0.00E+00	7.65E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	1.14E+00	1.71E-02	2.01E-02	6.62E+00
CO2-EOR Crude Oil Transport	7.61E-01	1.01E-01	3.66E-03	2.16E-09	8.66E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.67E-01	6.08E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	1.14E+00	1.32E-01	3.33E-03	1.22E-06	1.28E+00
Crude Oil Refining and End Use	1.52E+02	7.51E-01	6.84E-03	0.00E+00	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	1.58E+00	1.37E-02	0.00E+00	2.49E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.05E-01	2.31E-02	2.97E-03	0.00E+00	5.31E-01
Total	6.27E+02	1.15E+02	1.34E-01	2.02E-02	7.42E+02

Exhibit D-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.71E+01	1.43E-02	0.00E+00	8.30E+01
Natural Gas Pipelines to GTP	2.14E-03	8.94E+00	0.00E+00	0.00E+00	8.94E+00
Natural Gas Processing at GTP	2.40E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.20E+01	5.09E-07	0.00E+00	1.72E+01
Liquefaction	2.25E+01	2.03E+01	3.77E-03	1.02E-07	4.28E+01
Ocean Transport	1.95E+01	5.90E+00	6.10E-02	0.00E+00	2.54E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	5.04E+00	5.50E-06	0.00E+00	7.66E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	1.14E+00	1.71E-02	2.02E-02	6.63E+00
CO2-EOR Crude Oil Transport	7.63E-01	1.01E-01	3.67E-03	2.16E-09	8.67E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.67E-01	6.09E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	1.15E+00	1.32E-01	3.34E-03	1.22E-06	1.28E+00
Crude Oil Refining and End Use	1.53E+02	7.52E-01	6.85E-03	0.00E+00	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.56E+00	1.35E-02	0.00E+00	2.46E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.06E-01	2.31E-02	2.97E-03	0.00E+00	5.32E-01
Total	6.30E+02	1.16E+02	1.42E-01	2.02E-02	7.46E+02

Exhibit D-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 20-yr)D

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.71E+01	1.43E-02	0.00E+00	8.30E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	0.00E+00	0.00E+00	8.94E+00
Natural Gas Processing at GTP	2.40E+01	1.36E+00	2.44E-05	0.00E+00	2.53E+01
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.20E+01	5.09E-07	0.00E+00	1.72E+01
Liquefaction	2.25E+01	2.03E+01	3.78E-03	1.02E-07	4.28E+01
Ocean Transport	1.96E+01	5.94E+00	6.13E-02	0.00E+00	2.56E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	5.04E+00	5.50E-06	0.00E+00	7.66E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	1.14E+00	1.71E-02	2.02E-02	6.63E+00
CO2-EOR Crude Oil Transport	7.63E-01	1.01E-01	3.67E-03	2.16E-09	8.67E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.67E-01	6.09E-03	3.58E-09	1.44E+00
Crude Oil Ocean Transport	1.15E+00	1.32E-01	3.34E-03	1.22E-06	1.28E+00
Crude Oil Refining and End Use	1.53E+02	7.52E-01	6.85E-03	0.00E+00	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.56E+00	1.35E-02	0.00E+00	2.45E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.06E-01	2.31E-02	2.97E-03	0.00E+00	5.32E-01
Total	6.30E+02	1.16E+02	1.42E-01	2.02E-02	7.46E+02

Exhibit D-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	5.77E+01	1.44E-02	0.00E+00	8.38E+01
Natural Gas Pipelines to GTP	2.17E-03	9.03E+00	0.00E+00	0.00E+00	9.03E+00
Natural Gas Processing at GTP	2.42E+01	1.37E+00	2.47E-05	0.00E+00	2.56E+01
CO2 Compression and Sequestration	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.21E+01	5.14E-07	0.00E+00	1.73E+01
Liquefaction	2.27E+01	2.05E+01	3.81E-03	1.03E-07	4.32E+01
Ocean Transport	3.39E+01	1.09E+01	1.00E-01	0.00E+00	4.49E+01
LNG Regasification	3.02E+00	1.39E+00	9.19E-03	6.85E-05	4.42E+00
Power Plant Operations	3.42E+02	0.00E+00	0.00E+00	0.00E+00	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	5.09E+00	5.56E-06	0.00E+00	7.74E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	1.16E+00	1.73E-02	2.04E-02	6.70E+00
CO2-EOR Crude Oil Transport	7.71E-01	1.02E-01	3.71E-03	2.18E-09	8.76E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.69E-01	6.15E-03	3.62E-09	1.45E+00
Crude Oil Ocean Transport	1.16E+00	1.34E-01	3.37E-03	1.23E-06	1.30E+00
Crude Oil Refining and End Use	1.54E+02	7.60E-01	6.92E-03	0.00E+00	1.55E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	1.44E+00	1.25E-02	0.00E+00	2.27E+01
System Expansion: US Lower 48 export and End Use	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Construction	5.11E-01	2.33E-02	3.00E-03	0.00E+00	5.38E-01
Total	6.45E+02	1.22E+02	1.81E-01	2.04E-02	7.67E+02

Exhibit D-21. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	1.43E+01	0.00E+00	5.45E+01	4.19E+00	8.76E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.80E+01	4.17E+00	8.76E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.83E+01
2030	2.07E+01	5.85E+01	5.01E+01	0.00E+00	1.29E+02	1.47E+01	3.07E+01	5.79E+00	5.63E+01	2.61E+00	2.53E+00	1.13E+02	1.46E+01	3.07E+01	6.10E+00	5.80E+01	5.79E-01	2.77E+00	1.13E+02
2031	3.07E+01	8.66E+01	1.15E+02	1.21E+00	2.33E+02	3.35E+01	7.01E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	2.03E+02	3.34E+01	7.01E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	2.03E+02
2032	4.03E+01	1.14E+02	1.93E+02	3.99E+00	3.51E+02	5.66E+01	1.18E+02	1.09E+01	1.06E+02	1.34E+01	2.64E+00	3.08E+02	5.63E+01	1.18E+02	1.25E+01	1.17E+02	5.79E-01	2.88E+00	3.07E+02
2033	4.97E+01	1.40E+02	2.79E+02	7.72E+00	4.77E+02	8.17E+01	1.71E+02	1.32E+01	1.28E+02	2.18E+01	2.64E+00	4.18E+02	8.14E+01	1.71E+02	1.58E+01	1.46E+02	5.79E-01	2.88E+00	4.18E+02
2034	5.88E+01	1.66E+02	3.65E+02	1.15E+01	6.01E+02	1.07E+02	2.23E+02	1.54E+01	1.49E+02	3.10E+01	2.64E+00	5.29E+02	1.06E+02	2.23E+02	1.90E+01	1.75E+02	5.79E-01	2.88E+00	5.28E+02
2035	6.77E+01	1.91E+02	4.51E+02	1.48E+01	7.25E+02	1.32E+02	2.76E+02	1.74E+01	1.69E+02	4.05E+01	2.64E+00	6.38E+02	1.31E+02	2.76E+02	2.21E+01	2.03E+02	5.79E-01	2.88E+00	6.36E+02
2036	7.63E+01	2.15E+02	5.37E+02	1.75E+01	8.46E+02	1.57E+02	3.28E+02	1.93E+01	1.88E+02	5.01E+01	2.64E+00	7.45E+02	1.56E+02	3.28E+02	2.52E+01	2.30E+02	5.79E-01	2.88E+00	7.43E+02
2037	8.47E+01	2.39E+02	6.23E+02	1.99E+01	9.67E+02	1.82E+02	3.81E+02	2.11E+01	2.05E+02	5.99E+01	2.64E+00	8.52E+02	1.82E+02	3.81E+02	2.81E+01	2.56E+02	5.79E-01	2.88E+00	8.50E+02
2038	9.28E+01	2.62E+02	7.09E+02	2.19E+01	1.09E+03	2.07E+02	4.33E+02	2.27E+01	2.21E+02	6.99E+01	2.64E+00	9.57E+02	2.07E+02	4.33E+02	3.09E+01	2.80E+02	5.79E-01	2.88E+00	9.55E+02
2039	1.01E+02	2.84E+02	7.95E+02	2.35E+01	1.20E+03	2.33E+02	4.86E+02	2.43E+01	2.36E+02	8.00E+01	2.64E+00	1.06E+03	2.32E+02	4.86E+02	3.37E+01	3.04E+02	5.79E-01	2.88E+00	1.06E+03
2040	1.08E+02	3.06E+02	8.81E+02	2.48E+01	1.32E+03	2.58E+02	5.39E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	1.17E+03	2.57E+02	5.39E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	1.16E+03
2041	1.16E+02	3.27E+02	9.67E+02	2.56E+01	1.44E+03	2.83E+02	5.91E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	1.27E+03	2.82E+02	5.91E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	1.26E+03
2042	1.23E+02	3.48E+02	1.05E+03	2.61E+01	1.55E+03	3.08E+02	6.44E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	1.37E+03	3.07E+02	6.44E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	1.36E+03
2043	1.30E+02	3.68E+02	1.14E+03	2.63E+01	1.66E+03	3.33E+02	6.96E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	1.47E+03	3.32E+02	6.96E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	1.47E+03
2044	1.37E+02	3.87E+02	1.22E+03	2.63E+01	1.78E+03	3.58E+02	7.49E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	1.57E+03	3.57E+02	7.49E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	1.56E+03
2045	1.44E+02	4.06E+02	1.31E+03	2.63E+01	1.89E+03	3.84E+02	8.01E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.67E+03	3.82E+02	8.01E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.66E+03
2046	1.50E+02	4.25E+02	1.40E+03	2.63E+01	2.00E+03	4.09E+02	8.54E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.77E+03	4.07E+02	8.54E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.76E+03
2047	1.57E+02	4.43E+02	1.48E+03	2.63E+01	2.11E+03	4.34E+02	9.06E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.87E+03	4.32E+02	9.06E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.86E+03
2048	1.63E+02	4.60E+02	1.57E+03	2.63E+01	2.22E+03	4.59E+02	9.59E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.96E+03	4.57E+02	9.59E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.96E+03
2049	1.69E+02	4.77E+02	1.65E+03	2.63E+01	2.33E+03	4.84E+02	1.01E+03	3.53E+01	3.43E+02	1.83E+02	2.64E+00	2.06E+03	4.82E+02	1.01E+03	5.67E+01	4.97E+02	2.93E+00	2.88E+00	2.05E+03
2050	1.75E+02	4.94E+02	1.74E+03	2.63E+01	2.43E+03	5.09E+02	1.06E+03	3.61E+01	3.51E+02	1.94E+02	2.64E+00	2.16E+03	5.07E+02	1.06E+03	5.88E+01	5.13E+02	3.74E+00	2.88E+00	2.15E+03
2051	1.81E+02	5.10E+02	1.83E+03	2.63E+01	2.54E+03	5.34E+02	1.12E+03	3.68E+01	3.58E+02	2.04E+02	2.64E+00	2.25E+03	5.32E+02	1.12E+03	6.07E+01	5.29E+02	4.60E+00	2.88E+00	2.25E+03
2052	1.86E+02	5.26E+02	1.91E+03	2.63E+01	2.65E+03	5.60E+02	1.17E+03	3.75E+01	3.64E+02	2.15E+02	2.64E+00	2.35E+03	5.57E+02	1.17E+03	6.27E+01	5.43E+02	5.62E+00	2.88E+00	2.34E+03
2053	1.92E+02	5.41E+02	2.00E+03	2.63E+01	2.76E+03	5.85E+02	1.22E+03	3.81E+01	3.70E+02	2.26E+02	2.64E+00	2.44E+03	5.82E+02	1.22E+03	6.45E+01	5.58E+02	6.83E+00	2.88E+00	2.44E+03
2054	1.97E+02	5.56E+02	2.08E+03	2.63E+01	2.86E+03	6.10E+02	1.27E+03	3.87E+01	3.76E+02	2.37E+02	2.64E+00	2.54E+03	6.07E+02	1.27E+03	6.64E+01	5.71E+02	8.16E+00	2.88E+00	2.53E+03
2055	2.02E+02	5.70E+02	2.17E+03	2.63E+01	2.97E+03	6.35E+02	1.33E+03	3.92E+01	3.81E+02	2.47E+02	2.64E+00	2.63E+03	6.32E+02	1.33E+03	6.82E+01	5.85E+02	9.53E+00	2.88E+00	2.62E+03
2056	2.07E+02	5.84E+02	2.26E+03	2.63E+01	3.07E+03	6.60E+02	1.38E+03	3.97E+01	3.86E+02	2.58E+02	2.64E+00	2.73E+03	6.57E+02	1.38E+03	6.99E+01	5.98E+02	1.09E+01	2.88E+00	2.72E+03
2057	2.12E+02	5.98E+02	2.34E+03	2.63E+01	3.18E+03	6.85E+02	1.43E+03	4.02E+01	3.91E+02	2.68E+02	2.64E+00	2.82E+03	6.82E+02	1.43E+03	7.17E+01	6.10E+02	1.22E+01	2.88E+00	2.81E+03
2058	2.16E+02	6.11E+02	2.42E+03	2.63E+01	3.27E+03	7.08E+02	1.48E+03	4.07E+01	3.95E+02	2.79E+02	2.64E+00	2.90E+03	7.05E+02	1.48E+03	7.33E+01	6.22E+02	1.38E+01	2.88E+00	2.90E+03
2059	2.21E+02	6.24E+02	2.48E+03	2.63E+01	3.35E+03	7.26E+02	1.52E+03	4.11E+01	3.99E+02	2.89E+02	2.64E+00	2.98E+03	7.23E+02	1.52E+03	7.50E+01	6.33E+02	1.63E+01	2.88E+00	2.97E+03
2060	2.26E+02	6.37E+02	2.53E+03	2.63E+01	3.42E+03	7.40E+02	1.55E+03	4.15E+01	4.03E+02	3.00E+02	2.64E+00	3.03E+03	7.37E+02	1.55E+03	7.66E+01	6.43E+02	1.95E+01	2.88E+00	3.03E+03
2061	2.30E+02	6.50E+02	2.57E+03	2.63E+01	3.47E+03	7.52E+02	1.57E+03	4.19E+01	4.07E+02	3.10E+02	2.64E+00	3.08E+03	7.49E+02	1.57E+03	7.82E+01	6.52E+02	2.35E+01	2.88E+00	3.08E+03

Exhibit D-22. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	1.44E+01	0.00E+00	5.46E+01	4.19E+00	8.83E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.81E+01	4.17E+00	8.83E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.84E+01
2030	2.07E+01	5.85E+01	5.04E+01	0.00E+00	1.30E+02	1.47E+01	3.09E+01	5.79E+00	5.63E+01	2.61E+00	2.53E+00	1.13E+02	1.46E+01	3.09E+01	6.10E+00	5.80E+01	5.79E-01	2.77E+00	1.13E+02
2031	3.07E+01	8.66E+01	1.15E+02	1.21E+00	2.34E+02	3.35E+01	7.06E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	2.04E+02	3.34E+01	7.06E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	2.04E+02
2032	4.03E+01	1.14E+02	1.94E+02	3.99E+00	3.53E+02	5.66E+01	1.19E+02	1.09E+01	1.06E+02	1.34E+01	2.64E+00	3.08E+02	5.63E+01	1.19E+02	1.25E+01	1.17E+02	5.79E-01	2.88E+00	3.08E+02
2033	4.97E+01	1.40E+02	2.81E+02	7.72E+00	4.79E+02	8.17E+01	1.72E+02	1.32E+01	1.28E+02	2.18E+01	2.64E+00	4.20E+02	8.14E+01	1.72E+02	1.58E+01	1.46E+02	5.79E-01	2.88E+00	4.19E+02
2034	5.88E+01	1.66E+02	3.67E+02	1.15E+01	6.04E+02	1.07E+02	2.25E+02	1.54E+01	1.49E+02	3.10E+01	2.64E+00	5.30E+02	1.06E+02	2.25E+02	1.90E+01	1.75E+02	5.79E-01	2.88E+00	5.29E+02
2035	6.77E+01	1.91E+02	4.54E+02	1.48E+01	7.27E+02	1.32E+02	2.78E+02	1.74E+01	1.69E+02	4.05E+01	2.64E+00	6.40E+02	1.31E+02	2.78E+02	2.21E+01	2.03E+02	5.79E-01	2.88E+00	6.38E+02
2036	7.63E+01	2.15E+02	5.40E+02	1.75E+01	8.49E+02	1.57E+02	3.31E+02	1.93E+01	1.88E+02	5.01E+01	2.64E+00	7.48E+02	1.56E+02	3.31E+02	2.52E+01	2.30E+02	5.79E-01	2.88E+00	7.46E+02
2037	8.47E+01	2.39E+02	6.26E+02	1.99E+01	9.70E+02	1.82E+02	3.84E+02	2.11E+01	2.05E+02	5.99E+01	2.64E+00	8.55E+02	1.82E+02	3.84E+02	2.81E+01	2.56E+02	5.79E-01	2.88E+00	8.53E+02
2038	9.28E+01	2.62E+02	7.13E+02	2.19E+01	1.09E+03	2.07E+02	4.37E+02	2.27E+01	2.21E+02	6.99E+01	2.64E+00	9.61E+02	2.07E+02	4.37E+02	3.09E+01	2.80E+02	5.79E-01	2.88E+00	9.58E+02
2039	1.01E+02	2.84E+02	7.99E+02	2.35E+01	1.21E+03	2.33E+02	4.90E+02	2.43E+01	2.36E+02	8.00E+01	2.64E+00	1.07E+03	2.32E+02	4.90E+02	3.37E+01	3.04E+02	5.79E-01	2.88E+00	1.06E+03
2040	1.08E+02	3.06E+02	8.86E+02	2.48E+01	1.33E+03	2.58E+02	5.43E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	1.17E+03	2.57E+02	5.43E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	1.17E+03
2041	1.16E+02	3.27E+02	9.72E+02	2.56E+01	1.44E+03	2.83E+02	5.96E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	1.27E+03	2.82E+02	5.96E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	1.27E+03
2042	1.23E+02	3.48E+02	1.06E+03	2.61E+01	1.56E+03	3.08E+02	6.49E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	1.37E+03	3.07E+02	6.49E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	1.37E+03
2043	1.30E+02	3.68E+02	1.14E+03	2.63E+01	1.67E+03	3.33E+02	7.02E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	1.48E+03	3.32E+02	7.02E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	1.47E+03
2044	1.37E+02	3.87E+02	1.23E+03	2.63E+01	1.78E+03	3.58E+02	7.55E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	1.58E+03	3.57E+02	7.55E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	1.57E+03
2045	1.44E+02	4.06E+02	1.32E+03	2.63E+01	1.89E+03	3.84E+02	8.08E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.67E+03	3.82E+02	8.08E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.67E+03
2046	1.50E+02	4.25E+02	1.40E+03	2.63E+01	2.01E+03	4.09E+02	8.61E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.77E+03	4.07E+02	8.61E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.77E+03
2047	1.57E+02	4.43E+02	1.49E+03	2.63E+01	2.12E+03	4.34E+02	9.14E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.87E+03	4.32E+02	9.14E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.87E+03
2048	1.63E+02	4.60E+02	1.58E+03	2.63E+01	2.23E+03	4.59E+02	9.67E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.97E+03	4.57E+02	9.67E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.96E+03
2049	1.69E+02	4.77E+02	1.66E+03	2.63E+01	2.34E+03	4.84E+02	1.02E+03	3.53E+01	3.43E+02	1.83E+02	2.64E+00	2.07E+03	4.82E+02	1.02E+03	5.67E+01	4.97E+02	2.93E+00	2.88E+00	2.06E+03
2050	1.75E+02	4.94E+02	1.75E+03	2.63E+01	2.44E+03	5.09E+02	1.07E+03	3.61E+01	3.51E+02	1.94E+02	2.64E+00	2.16E+03	5.07E+02	1.07E+03	5.88E+01	5.13E+02	3.74E+00	2.88E+00	2.16E+03
2051	1.81E+02	5.10E+02	1.84E+03	2.63E+01	2.55E+03	5.34E+02	1.13E+03	3.68E+01	3.58E+02	2.04E+02	2.64E+00	2.26E+03	5.32E+02	1.13E+03	6.07E+01	5.29E+02	4.60E+00	2.88E+00	2.25E+03
2052	1.86E+02	5.26E+02	1.92E+03	2.63E+01	2.66E+03	5.60E+02	1.18E+03	3.75E+01	3.64E+02	2.15E+02	2.64E+00	2.36E+03	5.57E+02	1.18E+03	6.27E+01	5.43E+02	5.62E+00	2.88E+00	2.35E+03
2053	1.92E+02	5.41E+02	2.01E+03	2.63E+01	2.77E+03	5.85E+02	1.23E+03	3.81E+01	3.70E+02	2.26E+02	2.64E+00	2.45E+03	5.82E+02	1.23E+03	6.45E+01	5.58E+02	6.83E+00	2.88E+00	2.45E+03
2054	1.97E+02	5.56E+02	2.10E+03	2.63E+01	2.87E+03	6.10E+02	1.28E+03	3.87E+01	3.76E+02	2.37E+02	2.64E+00	2.55E+03	6.07E+02	1.28E+03	6.64E+01	5.71E+02	8.16E+00	2.88E+00	2.54E+03
2055	2.02E+02	5.70E+02	2.18E+03	2.63E+01	2.98E+03	6.35E+02	1.34E+03	3.92E+01	3.81E+02	2.47E+02	2.64E+00	2.64E+03	6.32E+02	1.34E+03	6.82E+01	5.85E+02	9.53E+00	2.88E+00	2.63E+03
2056	2.07E+02	5.84E+02	2.27E+03	2.63E+01	3.09E+03	6.60E+02	1.39E+03	3.97E+01	3.86E+02	2.58E+02	2.64E+00	2.74E+03	6.57E+02	1.39E+03	6.99E+01	5.98E+02	1.09E+01	2.88E+00	2.73E+03
2057	2.12E+02	5.98E+02	2.35E+03	2.63E+01	3.19E+03	6.85E+02	1.44E+03	4.02E+01	3.91E+02	2.68E+02	2.64E+00	2.83E+03	6.82E+02	1.44E+03	7.17E+01	6.10E+02	1.22E+01	2.88E+00	2.82E+03
2058	2.16E+02	6.11E+02	2.43E+03	2.63E+01	3.29E+03	7.08E+02	1.49E+03	4.07E+01	3.95E+02	2.79E+02	2.64E+00	2.92E+03	7.05E+02	1.49E+03	7.33E+01	6.22E+02	1.38E+01	2.88E+00	2.91E+03
2059	2.21E+02	6.24E+02	2.49E+03	2.63E+01	3.37E+03	7.26E+02	1.53E+03	4.11E+01	3.99E+02	2.89E+02	2.64E+00	2.99E+03	7.23E+02	1.53E+03	7.50E+01	6.33E+02	1.63E+01	2.88E+00	2.98E+03
2060	2.26E+02	6.37E+02	2.54E+03	2.63E+01	3.43E+03	7.40E+02	1.56E+03	4.15E+01	4.03E+02	3.00E+02	2.64E+00	3.05E+03	7.37E+02	1.56E+03	7.66E+01	6.43E+02	1.95E+01	2.88E+00	3.04E+03
2061	2.30E+02	6.50E+02	2.58E+03	2.63E+01	3.49E+03	7.52E+02	1.58E+03	4.19E+01	4.07E+02	3.10E+02	2.64E+00	3.10E+03	7.49E+02	1.58E+03	7.82E+01	6.52E+02	2.35E+01	2.88E+00	3.09E+03

Exhibit D-23. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	1.44E+01	0.00E+00	5.46E+01	4.19E+00	8.83E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.81E+01	4.17E+00	8.83E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.84E+01
2030	2.07E+01	5.85E+01	5.04E+01	0.00E+00	1.30E+02	1.47E+01	3.09E+01	5.79E+00	5.63E+01	2.61E+00	2.53E+00	1.13E+02	1.46E+01	3.09E+01	6.10E+00	5.80E+01	5.79E-01	2.77E+00	1.13E+02
2031	3.07E+01	8.66E+01	1.15E+02	1.21E+00	2.34E+02	3.35E+01	7.06E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	2.04E+02	3.34E+01	7.06E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	2.04E+02
2032	4.03E+01	1.14E+02	1.94E+02	3.99E+00	3.53E+02	5.66E+01	1.19E+02	1.09E+01	1.06E+02	1.34E+01	2.64E+00	3.09E+02	5.63E+01	1.19E+02	1.25E+01	1.17E+02	5.79E-01	2.88E+00	3.08E+02
2033	4.97E+01	1.40E+02	2.81E+02	7.72E+00	4.79E+02	8.17E+01	1.72E+02	1.32E+01	1.28E+02	2.18E+01	2.64E+00	4.20E+02	8.14E+01	1.72E+02	1.58E+01	1.46E+02	5.79E-01	2.88E+00	4.19E+02
2034	5.88E+01	1.66E+02	3.67E+02	1.15E+01	6.04E+02	1.07E+02	2.25E+02	1.54E+01	1.49E+02	3.10E+01	2.64E+00	5.30E+02	1.06E+02	2.25E+02	1.90E+01	1.75E+02	5.79E-01	2.88E+00	5.29E+02
2035	6.77E+01	1.91E+02	4.54E+02	1.48E+01	7.27E+02	1.32E+02	2.78E+02	1.74E+01	1.69E+02	4.05E+01	2.64E+00	6.40E+02	1.31E+02	2.78E+02	2.21E+01	2.03E+02	5.79E-01	2.88E+00	6.38E+02
2036	7.63E+01	2.15E+02	5.40E+02	1.75E+01	8.49E+02	1.57E+02	3.31E+02	1.93E+01	1.88E+02	5.01E+01	2.64E+00	7.48E+02	1.56E+02	3.31E+02	2.52E+01	2.30E+02	5.79E-01	2.88E+00	7.46E+02
2037	8.47E+01	2.39E+02	6.27E+02	1.99E+01	9.70E+02	1.82E+02	3.84E+02	2.11E+01	2.05E+02	5.99E+01	2.64E+00	8.55E+02	1.82E+02	3.84E+02	2.81E+01	2.56E+02	5.79E-01	2.88E+00	8.53E+02
2038	9.28E+01	2.62E+02	7.13E+02	2.19E+01	1.09E+03	2.07E+02	4.37E+02	2.27E+01	2.21E+02	6.99E+01	2.64E+00	9.61E+02	2.07E+02	4.37E+02	3.09E+01	2.80E+02	5.79E-01	2.88E+00	9.58E+02
2039	1.01E+02	2.84E+02	7.99E+02	2.35E+01	1.21E+03	2.33E+02	4.90E+02	2.43E+01	2.36E+02	8.00E+01	2.64E+00	1.07E+03	2.32E+02	4.90E+02	3.37E+01	3.04E+02	5.79E-01	2.88E+00	1.06E+03
2040	1.08E+02	3.06E+02	8.86E+02	2.48E+01	1.33E+03	2.58E+02	5.43E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	1.17E+03	2.57E+02	5.43E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	1.17E+03
2041	1.16E+02	3.27E+02	9.72E+02	2.56E+01	1.44E+03	2.83E+02	5.96E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	1.27E+03	2.82E+02	5.96E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	1.27E+03
2042	1.23E+02	3.48E+02	1.06E+03	2.61E+01	1.56E+03	3.08E+02	6.49E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	1.37E+03	3.07E+02	6.49E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	1.37E+03
2043	1.30E+02	3.68E+02	1.15E+03	2.63E+01	1.67E+03	3.33E+02	7.02E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	1.48E+03	3.32E+02	7.02E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	1.47E+03
2044	1.37E+02	3.87E+02	1.23E+03	2.63E+01	1.78E+03	3.58E+02	7.55E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	1.58E+03	3.57E+02	7.55E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	1.57E+03
2045	1.44E+02	4.06E+02	1.32E+03	2.63E+01	1.89E+03	3.84E+02	8.08E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.68E+03	3.82E+02	8.08E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.67E+03
2046	1.50E+02	4.25E+02	1.40E+03	2.63E+01	2.01E+03	4.09E+02	8.61E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.77E+03	4.07E+02	8.61E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.77E+03
2047	1.57E+02	4.43E+02	1.49E+03	2.63E+01	2.12E+03	4.34E+02	9.14E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.87E+03	4.32E+02	9.14E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.87E+03
2048	1.63E+02	4.60E+02	1.58E+03	2.63E+01	2.23E+03	4.59E+02	9.67E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.97E+03	4.57E+02	9.67E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.96E+03
2049	1.69E+02	4.77E+02	1.66E+03	2.63E+01	2.34E+03	4.84E+02	1.02E+03	3.53E+01	3.43E+02	1.83E+02	2.64E+00	2.07E+03	4.82E+02	1.02E+03	5.67E+01	4.97E+02	2.93E+00	2.88E+00	2.06E+03
2050	1.75E+02	4.94E+02	1.75E+03	2.63E+01	2.45E+03	5.09E+02	1.07E+03	3.61E+01	3.51E+02	1.94E+02	2.64E+00	2.17E+03	5.07E+02	1.07E+03	5.88E+01	5.13E+02	3.74E+00	2.88E+00	2.16E+03
2051	1.81E+02	5.10E+02	1.84E+03	2.63E+01	2.55E+03	5.34E+02	1.13E+03	3.68E+01	3.58E+02	2.04E+02	2.64E+00	2.26E+03	5.32E+02	1.13E+03	6.07E+01	5.29E+02	4.60E+00	2.88E+00	2.25E+03
2052	1.86E+02	5.26E+02	1.92E+03	2.63E+01	2.66E+03	5.60E+02	1.18E+03	3.75E+01	3.64E+02	2.15E+02	2.64E+00	2.36E+03	5.57E+02	1.18E+03	6.27E+01	5.43E+02	5.62E+00	2.88E+00	2.35E+03
2053	1.92E+02	5.41E+02	2.01E+03	2.63E+01	2.77E+03	5.85E+02	1.23E+03	3.81E+01	3.70E+02	2.26E+02	2.64E+00	2.45E+03	5.82E+02	1.23E+03	6.45E+01	5.58E+02	6.83E+00	2.88E+00	2.45E+03
2054	1.97E+02	5.56E+02	2.10E+03	2.63E+01	2.87E+03	6.10E+02	1.28E+03	3.87E+01	3.76E+02	2.37E+02	2.64E+00	2.55E+03	6.07E+02	1.28E+03	6.64E+01	5.71E+02	8.16E+00	2.88E+00	2.54E+03
2055	2.02E+02	5.70E+02	2.18E+03	2.63E+01	2.98E+03	6.35E+02	1.34E+03	3.92E+01	3.81E+02	2.47E+02	2.64E+00	2.64E+03	6.32E+02	1.34E+03	6.82E+01	5.85E+02	9.53E+00	2.88E+00	2.64E+03
2056	2.07E+02	5.84E+02	2.27E+03	2.63E+01	3.09E+03	6.60E+02	1.39E+03	3.97E+01	3.86E+02	2.58E+02	2.64E+00	2.74E+03	6.57E+02	1.39E+03	6.99E+01	5.98E+02	1.09E+01	2.88E+00	2.73E+03
2057	2.12E+02	5.98E+02	2.35E+03	2.63E+01	3.19E+03	6.85E+02	1.44E+03	4.02E+01	3.91E+02	2.68E+02	2.64E+00	2.83E+03	6.82E+02	1.44E+03	7.17E+01	6.10E+02	1.22E+01	2.88E+00	2.82E+03
2058	2.16E+02	6.11E+02	2.43E+03	2.63E+01	3.29E+03	7.08E+02	1.49E+03	4.07E+01	3.95E+02	2.79E+02	2.64E+00	2.92E+03	7.05E+02	1.49E+03	7.33E+01	6.22E+02	1.38E+01	2.88E+00	2.91E+03
2059	2.21E+02	6.24E+02	2.49E+03	2.63E+01	3.37E+03	7.26E+02	1.53E+03	4.11E+01	3.99E+02	2.89E+02	2.64E+00	2.99E+03	7.23E+02	1.53E+03	7.50E+01	6.33E+02	1.63E+01	2.88E+00	2.98E+03
2060	2.26E+02	6.37E+02	2.54E+03	2.63E+01	3.43E+03	7.40E+02	1.56E+03	4.15E+01	4.03E+02	3.00E+02	2.64E+00	3.05E+03	7.37E+02	1.56E+03	7.66E+01	6.43E+02	1.95E+01	2.88E+00	3.04E+03
2061	2.30E+02	6.50E+02	2.58E+03	2.63E+01	3.49E+03	7.52E+02	1.58E+03	4.19E+01	4.07E+02	3.10E+02	2.64E+00	3.10E+03	7.49E+02	1.58E+03	7.82E+01	6.52E+02	2.35E+01	2.88E+00	3.09E+03

Exhibit D-24. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	1.44E+01	0.00E+00	5.46E+01	4.19E+00	9.19E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.85E+01	4.17E+00	9.19E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.87E+01
2030	2.07E+01	5.85E+01	5.03E+01	0.00E+00	1.30E+02	1.47E+01	3.22E+01	5.79E+00	5.63E+01	2.61E+00	2.53E+00	1.14E+02	1.46E+01	3.22E+01	6.10E+00	5.80E+01	5.79E-01	2.77E+00	1.14E+02
2031	3.07E+01	8.66E+01	1.15E+02	1.21E+00	2.33E+02	3.35E+01	7.35E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	2.07E+02	3.34E+01	7.35E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	2.07E+02
2032	4.03E+01	1.14E+02	1.94E+02	3.99E+00	3.52E+02	5.66E+01	1.24E+02	1.09E+01	1.06E+02	1.34E+01	2.64E+00	3.13E+02	5.63E+01	1.24E+02	1.25E+01	1.17E+02	5.79E-01	2.88E+00	3.13E+02
2033	4.97E+01	1.40E+02	2.80E+02	7.72E+00	4.78E+02	8.17E+01	1.79E+02	1.32E+01	1.28E+02	2.18E+01	2.64E+00	4.27E+02	8.14E+01	1.79E+02	1.58E+01	1.46E+02	5.79E-01	2.88E+00	4.26E+02
2034	5.88E+01	1.66E+02	3.67E+02	1.15E+01	6.03E+02	1.07E+02	2.34E+02	1.54E+01	1.49E+02	3.10E+01	2.64E+00	5.40E+02	1.06E+02	2.34E+02	1.90E+01	1.75E+02	5.79E-01	2.88E+00	5.39E+02
2035	6.77E+01	1.91E+02	4.53E+02	1.48E+01	7.26E+02	1.32E+02	2.90E+02	1.74E+01	1.69E+02	4.05E+01	2.64E+00	6.51E+02	1.31E+02	2.90E+02	2.21E+01	2.03E+02	5.79E-01	2.88E+00	6.50E+02
2036	7.63E+01	2.15E+02	5.39E+02	1.75E+01	8.48E+02	1.57E+02	3.45E+02	1.93E+01	1.88E+02	5.01E+01	2.64E+00	7.62E+02	1.56E+02	3.45E+02	2.52E+01	2.30E+02	5.79E-01	2.88E+00	7.60E+02
2037	8.47E+01	2.39E+02	6.25E+02	1.99E+01	9.69E+02	1.82E+02	4.00E+02	2.11E+01	2.05E+02	5.99E+01	2.64E+00	8.71E+02	1.82E+02	4.00E+02	2.81E+01	2.56E+02	5.79E-01	2.88E+00	8.69E+02
2038	9.28E+01	2.62E+02	7.11E+02	2.19E+01	1.09E+03	2.07E+02	4.55E+02	2.27E+01	2.21E+02	6.99E+01	2.64E+00	9.79E+02	2.07E+02	4.55E+02	3.09E+01	2.80E+02	5.79E-01	2.88E+00	9.76E+02
2039	1.01E+02	2.84E+02	7.98E+02	2.35E+01	1.21E+03	2.33E+02	5.10E+02	2.43E+01	2.36E+02	8.00E+01	2.64E+00	1.09E+03	2.32E+02	5.10E+02	3.37E+01	3.04E+02	5.79E-01	2.88E+00	1.08E+03
2040	1.08E+02	3.06E+02	8.84E+02	2.48E+01	1.32E+03	2.58E+02	5.65E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	1.19E+03	2.57E+02	5.65E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	1.19E+03
2041	1.16E+02	3.27E+02	9.70E+02	2.56E+01	1.44E+03	2.83E+02	6.20E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	1.30E+03	2.82E+02	6.20E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	1.29E+03
2042	1.23E+02	3.48E+02	1.06E+03	2.61E+01	1.55E+03	3.08E+02	6.76E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	1.40E+03	3.07E+02	6.76E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	1.40E+03
2043	1.30E+02	3.68E+02	1.14E+03	2.63E+01	1.67E+03	3.33E+02	7.31E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	1.50E+03	3.32E+02	7.31E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	1.50E+03
2044	1.37E+02	3.87E+02	1.23E+03	2.63E+01	1.78E+03	3.58E+02	7.86E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	1.61E+03	3.57E+02	7.86E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	1.60E+03
2045	1.44E+02	4.06E+02	1.32E+03	2.63E+01	1.89E+03	3.84E+02	8.41E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.71E+03	3.82E+02	8.41E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.70E+03
2046	1.50E+02	4.25E+02	1.40E+03	2.63E+01	2.00E+03	4.09E+02	8.96E+02	3.27E+01	3.18E+02	1.51E+02	2.64E+00	1.81E+03	4.07E+02	8.96E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.80E+03
2047	1.57E+02	4.43E+02	1.49E+03	2.63E+01	2.11E+03	4.34E+02	9.51E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.91E+03	4.32E+02	9.51E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.90E+03
2048	1.63E+02	4.60E+02	1.57E+03	2.63E+01	2.22E+03	4.59E+02	1.01E+03	3.45E+01	3.36E+02	1.72E+02	2.64E+00	2.01E+03	4.57E+02	1.01E+03	5.47E+01	4.81E+02	2.21E+00	2.88E+00	2.00E+03
2049	1.69E+02	4.77E+02	1.66E+03	2.63E+01	2.33E+03	4.84E+02	1.06E+03	3.53E+01	3.43E+02	1.83E+02	2.64E+00	2.11E+03	4.82E+02	1.06E+03	5.67E+01	4.97E+02	2.93E+00	2.88E+00	2.10E+03
2050	1.75E+02	4.94E+02	1.75E+03	2.63E+01	2.44E+03	5.09E+02	1.12E+03	3.61E+01	3.51E+02	1.94E+02	2.64E+00	2.21E+03	5.07E+02	1.12E+03	5.88E+01	5.13E+02	3.74E+00	2.88E+00	2.20E+03
2051	1.81E+02	5.10E+02	1.83E+03	2.63E+01	2.55E+03	5.34E+02	1.17E+03	3.68E+01	3.58E+02	2.04E+02	2.64E+00	2.31E+03	5.32E+02	1.17E+03	6.07E+01	5.29E+02	4.60E+00	2.88E+00	2.30E+03
2052	1.86E+02	5.26E+02	1.92E+03	2.63E+01	2.66E+03	5.60E+02	1.23E+03	3.75E+01	3.64E+02	2.15E+02	2.64E+00	2.41E+03	5.57E+02	1.23E+03	6.27E+01	5.43E+02	5.62E+00	2.88E+00	2.40E+03
2053	1.92E+02	5.41E+02	2.00E+03	2.63E+01	2.76E+03	5.85E+02	1.28E+03	3.81E+01	3.70E+02	2.26E+02	2.64E+00	2.50E+03	5.82E+02	1.28E+03	6.45E+01	5.58E+02	6.83E+00	2.88E+00	2.50E+03
2054	1.97E+02	5.56E+02	2.09E+03	2.63E+01	2.87E+03	6.10E+02	1.34E+03	3.87E+01	3.76E+02	2.37E+02	2.64E+00	2.60E+03	6.07E+02	1.34E+03	6.64E+01	5.71E+02	8.16E+00	2.88E+00	2.59E+03
2055	2.02E+02	5.70E+02	2.18E+03	2.63E+01	2.98E+03	6.35E+02	1.39E+03	3.92E+01	3.81E+02	2.47E+02	2.64E+00	2.70E+03	6.32E+02	1.39E+03	6.82E+01	5.85E+02	9.53E+00	2.88E+00	2.69E+03
2056	2.07E+02	5.84E+02	2.26E+03	2.63E+01	3.08E+03	6.60E+02	1.45E+03	3.97E+01	3.86E+02	2.58E+02	2.64E+00	2.79E+03	6.57E+02	1.45E+03	6.99E+01	5.98E+02	1.09E+01	2.88E+00	2.79E+03
2057	2.12E+02	5.98E+02	2.35E+03	2.63E+01	3.19E+03	6.85E+02	1.50E+03	4.02E+01	3.91E+02	2.68E+02	2.64E+00	2.89E+03	6.82E+02	1.50E+03	7.17E+01	6.10E+02	1.22E+01	2.88E+00	2.88E+03
2058	2.16E+02	6.11E+02	2.43E+03	2.63E+01	3.28E+03	7.08E+02	1.55E+03	4.07E+01	3.95E+02	2.79E+02	2.64E+00	2.98E+03	7.05E+02	1.55E+03	7.33E+01	6.22E+02	1.38E+01	2.88E+00	2.97E+03
2059	2.21E+02	6.24E+02	2.49E+03	2.63E+01	3.36E+03	7.26E+02	1.59E+03	4.11E+01	3.99E+02	2.89E+02	2.64E+00	3.05E+03	7.23E+02	1.59E+03	7.50E+01	6.33E+02	1.63E+01	2.88E+00	3.04E+03
2060	2.26E+02	6.37E+02	2.54E+03	2.63E+01	3.43E+03	7.40E+02	1.62E+03	4.15E+01	4.03E+02	3.00E+02	2.64E+00	3.11E+03	7.37E+02	1.62E+03	7.66E+01	6.43E+02	1.95E+01	2.88E+00	3.10E+03
2061	2.30E+02	6.50E+02	2.58E+03	2.63E+01	3.48E+03	7.52E+02	1.65E+03	4.18E+01	4.07E+02	3.10E+02	2.64E+00	3.16E+03	7.49E+02	1.65E+03	7.82E+01	6.52E+02	2.35E+01	2.88E+00	3.15E+03

Exhibit D-25. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	7.09E+00	0.00E+00	4.73E+01	4.19E+00	1.56E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.08E+01	4.17E+00	1.56E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.11E+01
2030	2.07E+01	5.85E+01	2.48E+01	0.00E+00	1.04E+02	1.47E+01	5.45E+00	5.80E+00	5.63E+01	2.61E+00	2.53E+00	8.74E+01	1.46E+01	5.45E+00	6.10E+00	5.80E+01	5.79E-01	2.77E+00	8.76E+01
2031	3.07E+01	8.66E+01	5.67E+01	1.21E+00	1.75E+02	3.35E+01	1.25E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	1.46E+02	3.34E+01	1.25E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	1.46E+02
2032	4.03E+01	1.14E+02	9.56E+01	3.99E+00	2.54E+02	5.66E+01	2.10E+01	1.09E+01	1.06E+02	1.34E+01	2.64E+00	2.10E+02	5.63E+01	2.10E+01	1.25E+01	1.17E+02	5.79E-01	2.88E+00	2.10E+02
2033	4.97E+01	1.40E+02	1.38E+02	7.72E+00	3.36E+02	8.17E+01	3.04E+01	1.32E+01	1.28E+02	2.18E+01	2.64E+00	2.78E+02	8.14E+01	3.04E+01	1.58E+01	1.46E+02	5.79E-01	2.88E+00	2.77E+02
2034	5.88E+01	1.66E+02	1.81E+02	1.15E+01	4.17E+02	1.07E+02	3.97E+01	1.54E+01	1.49E+02	3.10E+01	2.64E+00	3.45E+02	1.06E+02	3.97E+01	1.90E+01	1.75E+02	5.79E-01	2.88E+00	3.44E+02
2035	6.77E+01	1.91E+02	2.23E+02	1.48E+01	4.97E+02	1.32E+02	4.90E+01	1.74E+01	1.69E+02	4.05E+01	2.64E+00	4.11E+02	1.31E+02	4.90E+01	2.21E+01	2.03E+02	5.79E-01	2.88E+00	4.09E+02
2036	7.63E+01	2.15E+02	2.66E+02	1.75E+01	5.75E+02	1.57E+02	5.84E+01	1.93E+01	1.88E+02	5.01E+01	2.64E+00	4.75E+02	1.57E+02	5.84E+01	2.52E+01	2.30E+02	5.79E-01	2.88E+00	4.73E+02
2037	8.47E+01	2.39E+02	3.08E+02	1.99E+01	6.52E+02	1.82E+02	6.77E+01	2.11E+01	2.05E+02	5.99E+01	2.64E+00	5.39E+02	1.82E+02	6.77E+01	2.81E+01	2.56E+02	5.79E-01	2.88E+00	5.36E+02
2038	9.28E+01	2.62E+02	3.51E+02	2.19E+01	7.28E+02	2.07E+02	7.71E+01	2.28E+01	2.21E+02	6.99E+01	2.64E+00	6.01E+02	2.07E+02	7.71E+01	3.09E+01	2.80E+02	5.79E-01	2.88E+00	5.98E+02
2039	1.01E+02	2.84E+02	3.93E+02	2.35E+01	8.02E+02	2.33E+02	8.64E+01	2.43E+01	2.36E+02	8.00E+01	2.64E+00	6.62E+02	2.32E+02	8.64E+01	3.37E+01	3.04E+02	5.79E-01	2.88E+00	6.59E+02
2040	1.08E+02	3.06E+02	4.36E+02	2.48E+01	8.75E+02	2.58E+02	9.58E+01	2.58E+01	2.50E+02	9.01E+01	2.64E+00	7.22E+02	2.57E+02	9.58E+01	3.63E+01	3.27E+02	5.79E-01	2.88E+00	7.19E+02
2041	1.16E+02	3.27E+02	4.78E+02	2.56E+01	9.47E+02	2.83E+02	1.05E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	7.82E+02	2.82E+02	1.05E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	7.78E+02
2042	1.23E+02	3.48E+02	5.21E+02	2.61E+01	1.02E+03	3.08E+02	1.14E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	8.40E+02	3.07E+02	1.14E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	8.36E+02
2043	1.30E+02	3.68E+02	5.63E+02	2.63E+01	1.09E+03	3.33E+02	1.24E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	8.97E+02	3.32E+02	1.24E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	8.93E+02
2044	1.37E+02	3.87E+02	6.06E+02	2.63E+01	1.16E+03	3.58E+02	1.33E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	9.54E+02	3.57E+02	1.33E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	9.49E+02
2045	1.44E+02	4.06E+02	6.48E+02	2.63E+01	1.22E+03	3.84E+02	1.42E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.01E+03	3.82E+02	1.42E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.00E+03
2046	1.50E+02	4.25E+02	6.91E+02	2.63E+01	1.29E+03	4.09E+02	1.52E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.07E+03	4.07E+02	1.52E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.06E+03
2047	1.57E+02	4.43E+02	7.33E+02	2.63E+01	1.36E+03	4.34E+02	1.61E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.12E+03	4.32E+02	1.61E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.11E+03
2048	1.63E+02	4.60E+02	7.76E+02	2.63E+01	1.43E+03	4.59E+02	1.70E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.17E+03	4.57E+02	1.70E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.17E+03
2049	1.69E+02	4.77E+02	8.18E+02	2.63E+01	1.49E+03	4.84E+02	1.80E+02	3.54E+01	3.43E+02	1.83E+02	2.64E+00	1.23E+03	4.82E+02	1.80E+02	5.68E+01	4.97E+02	2.93E+00	2.88E+00	1.22E+03
2050	1.75E+02	4.94E+02	8.61E+02	2.63E+01	1.56E+03	5.09E+02	1.89E+02	3.61E+01	3.51E+02	1.94E+02	2.64E+00	1.28E+03	5.07E+02	1.89E+02	5.88E+01	5.13E+02	3.74E+00	2.88E+00	1.27E+03
2051	1.81E+02	5.10E+02	9.03E+02	2.63E+01	1.62E+03	5.34E+02	1.99E+02	3.68E+01	3.58E+02	2.04E+02	2.64E+00	1.33E+03	5.32E+02	1.99E+02	6.07E+01	5.29E+02	4.60E+00	2.88E+00	1.33E+03
2052	1.86E+02	5.26E+02	9.46E+02	2.63E+01	1.68E+03	5.60E+02	2.08E+02	3.75E+01	3.64E+02	2.15E+02	2.64E+00	1.39E+03	5.57E+02	2.08E+02	6.27E+01	5.43E+02	5.62E+00	2.88E+00	1.38E+03
2053	1.92E+02	5.41E+02	9.88E+02	2.63E+01	1.75E+03	5.85E+02	2.17E+02	3.81E+01	3.70E+02	2.26E+02	2.64E+00	1.44E+03	5.82E+02	2.17E+02	6.46E+01	5.58E+02	6.83E+00	2.88E+00	1.43E+03
2054	1.97E+02	5.56E+02	1.03E+03	2.63E+01	1.81E+03	6.10E+02	2.27E+02	3.87E+01	3.76E+02	2.37E+02	2.64E+00	1.49E+03	6.07E+02	2.27E+02	6.64E+01	5.71E+02	8.16E+00	2.88E+00	1.48E+03
2055	2.02E+02	5.70E+02	1.07E+03	2.63E+01	1.87E+03	6.35E+02	2.36E+02	3.92E+01	3.81E+02	2.47E+02	2.64E+00	1.54E+03	6.32E+02	2.36E+02	6.82E+01	5.85E+02	9.53E+00	2.88E+00	1.53E+03
2056	2.07E+02	5.84E+02	1.12E+03	2.63E+01	1.93E+03	6.60E+02	2.45E+02	3.98E+01	3.86E+02	2.58E+02	2.64E+00	1.59E+03	6.57E+02	2.45E+02	7.00E+01	5.98E+02	1.09E+01	2.88E+00	1.58E+03
2057	2.12E+02	5.98E+02	1.16E+03	2.63E+01	1.99E+03	6.85E+02	2.55E+02	4.02E+01	3.91E+02	2.68E+02	2.64E+00	1.64E+03	6.82E+02	2.55E+02	7.17E+01	6.10E+02	1.22E+01	2.88E+00	1.63E+03
2058	2.16E+02	6.11E+02	1.20E+03	2.63E+01	2.05E+03	7.08E+02	2.63E+02	4.07E+01	3.95E+02	2.79E+02	2.64E+00	1.69E+03	7.05E+02	2.63E+02	7.34E+01	6.22E+02	1.38E+01	2.88E+00	1.68E+03
2059	2.21E+02	6.24E+02	1.23E+03	2.63E+01	2.10E+03	7.26E+02	2.70E+02	4.11E+01	3.99E+02	2.89E+02	2.64E+00	1.73E+03	7.23E+02	2.70E+02	7.50E+01	6.33E+02	1.63E+01	2.88E+00	1.72E+03
2060	2.26E+02	6.37E+02	1.25E+03	2.63E+01	2.14E+03	7.40E+02	2.75E+02	4.15E+01	4.03E+02	3.00E+02	2.64E+00	1.76E+03	7.37E+02	2.75E+02	7.66E+01	6.43E+02	1.95E+01	2.88E+00	1.75E+03
2061	2.30E+02	6.50E+02	1.27E+03	2.63E+01	2.18E+03	7.52E+02	2.79E+02	4.19E+01	4.07E+02	3.10E+02	2.64E+00	1.79E+03	7.49E+02	2.79E+02	7.82E+01	6.52E+02	2.35E+01	2.88E+00	1.78E+03

Exhibit D-26. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	7.18E+00	0.00E+00	4.74E+01	4.19E+00	1.64E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.09E+01	4.17E+00	1.64E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.12E+01
2030	2.07E+01	5.85E+01	2.51E+01	0.00E+00	1.04E+02	1.47E+01	5.74E+00	5.80E+00	5.63E+01	2.61E+00	2.53E+00	8.77E+01	1.46E+01	5.74E+00	6.10E+00	5.80E+01	5.79E-01	2.77E+00	8.78E+01
2031	3.07E+01	8.66E+01	5.74E+01	1.21E+00	1.76E+02	3.35E+01	1.31E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	1.46E+02	3.34E+01	1.31E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	1.46E+02
2032	4.03E+01	1.14E+02	9.69E+01	3.99E+00	2.55E+02	5.66E+01	2.21E+01	1.09E+01	1.06E+02	1.34E+01	2.64E+00	2.11E+02	5.63E+01	2.21E+01	1.25E+01	1.17E+02	5.79E-01	2.88E+00	2.11E+02
2033	4.97E+01	1.40E+02	1.40E+02	7.72E+00	3.38E+02	8.17E+01	3.20E+01	1.32E+01	1.28E+02	2.18E+01	2.64E+00	2.80E+02	8.14E+01	3.20E+01	1.58E+01	1.46E+02	5.79E-01	2.88E+00	2.79E+02
2034	5.88E+01	1.66E+02	1.83E+02	1.15E+01	4.19E+02	1.07E+02	4.18E+01	1.54E+01	1.49E+02	3.10E+01	2.64E+00	3.47E+02	1.06E+02	4.18E+01	1.90E+01	1.75E+02	5.79E-01	2.88E+00	3.46E+02
2035	6.77E+01	1.91E+02	2.26E+02	1.48E+01	5.00E+02	1.32E+02	5.17E+01	1.74E+01	1.69E+02	4.05E+01	2.64E+00	4.13E+02	1.31E+02	5.17E+01	2.21E+01	2.03E+02	5.79E-01	2.88E+00	4.12E+02
2036	7.63E+01	2.15E+02	2.69E+02	1.75E+01	5.79E+02	1.57E+02	6.15E+01	1.93E+01	1.88E+02	5.01E+01	2.64E+00	4.78E+02	1.57E+02	6.15E+01	2.52E+01	2.30E+02	5.79E-01	2.88E+00	4.77E+02
2037	8.47E+01	2.39E+02	3.12E+02	1.99E+01	6.56E+02	1.82E+02	7.14E+01	2.11E+01	2.05E+02	5.99E+01	2.64E+00	5.42E+02	1.82E+02	7.14E+01	2.81E+01	2.56E+02	5.79E-01	2.88E+00	5.40E+02
2038	9.28E+01	2.62E+02	3.55E+02	2.19E+01	7.32E+02	2.07E+02	8.12E+01	2.28E+01	2.21E+02	6.99E+01	2.64E+00	6.05E+02	2.07E+02	8.12E+01	3.09E+01	2.80E+02	5.79E-01	2.88E+00	6.03E+02
2039	1.01E+02	2.84E+02	3.99E+02	2.35E+01	8.07E+02	2.33E+02	9.11E+01	2.43E+01	2.36E+02	8.00E+01	2.64E+00	6.67E+02	2.32E+02	9.11E+01	3.37E+01	3.04E+02	5.79E-01	2.88E+00	6.64E+02
2040	1.08E+02	3.06E+02	4.42E+02	2.48E+01	8.81E+02	2.58E+02	1.01E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	7.28E+02	2.57E+02	1.01E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	7.24E+02
2041	1.16E+02	3.27E+02	4.85E+02	2.56E+01	9.54E+02	2.83E+02	1.11E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	7.87E+02	2.82E+02	1.11E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	7.84E+02
2042	1.23E+02	3.48E+02	5.28E+02	2.61E+01	1.03E+03	3.08E+02	1.21E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	8.46E+02	3.07E+02	1.21E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	8.42E+02
2043	1.30E+02	3.68E+02	5.71E+02	2.63E+01	1.10E+03	3.33E+02	1.30E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	9.04E+02	3.32E+02	1.30E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	8.99E+02
2044	1.37E+02	3.87E+02	6.14E+02	2.63E+01	1.16E+03	3.58E+02	1.40E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	9.61E+02	3.57E+02	1.40E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	9.56E+02
2045	1.44E+02	4.06E+02	6.57E+02	2.63E+01	1.23E+03	3.84E+02	1.50E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.02E+03	3.82E+02	1.50E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.01E+03
2046	1.50E+02	4.25E+02	7.00E+02	2.63E+01	1.30E+03	4.09E+02	1.60E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.07E+03	4.07E+02	1.60E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.07E+03
2047	1.57E+02	4.43E+02	7.43E+02	2.63E+01	1.37E+03	4.34E+02	1.70E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.13E+03	4.32E+02	1.70E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.12E+03
2048	1.63E+02	4.60E+02	7.86E+02	2.63E+01	1.44E+03	4.59E+02	1.80E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.18E+03	4.57E+02	1.80E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.18E+03
2049	1.69E+02	4.77E+02	8.29E+02	2.63E+01	1.50E+03	4.84E+02	1.90E+02	3.54E+01	3.43E+02	1.83E+02	2.64E+00	1.24E+03	4.82E+02	1.90E+02	5.68E+01	4.97E+02	2.93E+00	2.88E+00	1.23E+03
2050	1.75E+02	4.94E+02	8.72E+02	2.63E+01	1.57E+03	5.09E+02	1.99E+02	3.61E+01	3.51E+02	1.94E+02	2.64E+00	1.29E+03	5.07E+02	1.99E+02	5.88E+01	5.13E+02	3.74E+00	2.88E+00	1.28E+03
2051	1.81E+02	5.10E+02	9.16E+02	2.63E+01	1.63E+03	5.34E+02	2.09E+02	3.68E+01	3.58E+02	2.04E+02	2.64E+00	1.35E+03	5.32E+02	2.09E+02	6.07E+01	5.29E+02	4.60E+00	2.88E+00	1.34E+03
2052	1.86E+02	5.26E+02	9.59E+02	2.63E+01	1.70E+03	5.60E+02	2.19E+02	3.75E+01	3.64E+02	2.15E+02	2.64E+00	1.40E+03	5.57E+02	2.19E+02	6.27E+01	5.43E+02	5.62E+00	2.88E+00	1.39E+03
2053	1.92E+02	5.41E+02	1.00E+03	2.63E+01	1.76E+03	5.85E+02	2.29E+02	3.81E+01	3.70E+02	2.26E+02	2.64E+00	1.45E+03	5.82E+02	2.29E+02	6.46E+01	5.58E+02	6.83E+00	2.88E+00	1.44E+03
2054	1.97E+02	5.56E+02	1.04E+03	2.63E+01	1.82E+03	6.10E+02	2.39E+02	3.87E+01	3.76E+02	2.37E+02	2.64E+00	1.50E+03	6.07E+02	2.39E+02	6.64E+01	5.71E+02	8.16E+00	2.88E+00	1.49E+03
2055	2.02E+02	5.70E+02	1.09E+03	2.63E+01	1.89E+03	6.35E+02	2.49E+02	3.92E+01	3.81E+02	2.47E+02	2.64E+00	1.55E+03	6.32E+02	2.49E+02	6.82E+01	5.85E+02	9.53E+00	2.88E+00	1.55E+03
2056	2.07E+02	5.84E+02	1.13E+03	2.63E+01	1.95E+03	6.60E+02	2.58E+02	3.98E+01	3.86E+02	2.58E+02	2.64E+00	1.61E+03	6.57E+02	2.58E+02	7.00E+01	5.98E+02	1.09E+01	2.88E+00	1.60E+03
2057	2.12E+02	5.98E+02	1.17E+03	2.63E+01	2.01E+03	6.85E+02	2.68E+02	4.02E+01	3.91E+02	2.68E+02	2.64E+00	1.66E+03	6.82E+02	2.68E+02	7.17E+01	6.10E+02	1.22E+01	2.88E+00	1.65E+03
2058	2.16E+02	6.11E+02	1.21E+03	2.63E+01	2.07E+03	7.08E+02	2.77E+02	4.07E+01	3.95E+02	2.79E+02	2.64E+00	1.70E+03	7.05E+02	2.77E+02	7.34E+01	6.22E+02	1.38E+01	2.88E+00	1.69E+03
2059	2.21E+02	6.24E+02	1.24E+03	2.63E+01	2.12E+03	7.26E+02	2.84E+02	4.11E+01	3.99E+02	2.89E+02	2.64E+00	1.74E+03	7.23E+02	2.84E+02	7.50E+01	6.33E+02	1.63E+01	2.88E+00	1.73E+03
2060	2.26E+02	6.37E+02	1.27E+03	2.63E+01	2.16E+03	7.40E+02	2.90E+02	4.15E+01	4.03E+02	3.00E+02	2.64E+00	1.78E+03	7.37E+02	2.90E+02	7.66E+01	6.43E+02	1.95E+01	2.88E+00	1.77E+03
2061	2.30E+02	6.50E+02	1.29E+03	2.63E+01	2.19E+03	7.52E+02	2.94E+02	4.19E+01	4.07E+02	3.10E+02	2.64E+00	1.81E+03	7.49E+02	2.94E+02	7.82E+01	6.52E+02	2.35E+01	2.88E+00	1.80E+03

Exhibit D-27. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	7.18E+00	0.00E+00	4.74E+01	4.19E+00	1.64E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.09E+01	4.17E+00	1.64E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.12E+01
2030	2.07E+01	5.85E+01	2.51E+01	0.00E+00	1.04E+02	1.47E+01	5.76E+00	5.80E+00	5.63E+01	2.61E+00	2.53E+00	8.77E+01	1.46E+01	5.76E+00	6.10E+00	5.80E+01	5.79E-01	2.77E+00	8.79E+01
2031	3.07E+01	8.66E+01	5.75E+01	1.21E+00	1.76E+02	3.35E+01	1.32E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	1.46E+02	3.34E+01	1.32E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	1.46E+02
2032	4.03E+01	1.14E+02	9.70E+01	3.99E+00	2.55E+02	5.66E+01	2.22E+01	1.09E+01	1.06E+02	1.34E+01	2.64E+00	2.12E+02	5.63E+01	2.22E+01	1.25E+01	1.17E+02	5.79E-01	2.88E+00	2.11E+02
2033	4.97E+01	1.40E+02	1.40E+02	7.72E+00	3.38E+02	8.17E+01	3.21E+01	1.32E+01	1.28E+02	2.18E+01	2.64E+00	2.80E+02	8.14E+01	3.21E+01	1.58E+01	1.46E+02	5.79E-01	2.88E+00	2.79E+02
2034	5.88E+01	1.66E+02	1.83E+02	1.15E+01	4.20E+02	1.07E+02	4.19E+01	1.54E+01	1.49E+02	3.10E+01	2.64E+00	3.47E+02	1.06E+02	4.19E+01	1.90E+01	1.75E+02	5.79E-01	2.88E+00	3.46E+02
2035	6.77E+01	1.91E+02	2.26E+02	1.48E+01	5.00E+02	1.32E+02	5.18E+01	1.74E+01	1.69E+02	4.05E+01	2.64E+00	4.13E+02	1.31E+02	5.18E+01	2.21E+01	2.03E+02	5.79E-01	2.88E+00	4.12E+02
2036	7.63E+01	2.15E+02	2.69E+02	1.75E+01	5.79E+02	1.57E+02	6.17E+01	1.93E+01	1.88E+02	5.01E+01	2.64E+00	4.79E+02	1.57E+02	6.17E+01	2.52E+01	2.30E+02	5.79E-01	2.88E+00	4.77E+02
2037	8.47E+01	2.39E+02	3.13E+02	1.99E+01	6.56E+02	1.82E+02	7.15E+01	2.11E+01	2.05E+02	5.99E+01	2.64E+00	5.42E+02	1.82E+02	7.15E+01	2.81E+01	2.56E+02	5.79E-01	2.88E+00	5.40E+02
2038	9.28E+01	2.62E+02	3.56E+02	2.19E+01	7.32E+02	2.07E+02	8.14E+01	2.28E+01	2.21E+02	6.99E+01	2.64E+00	6.05E+02	2.07E+02	8.14E+01	3.09E+01	2.80E+02	5.79E-01	2.88E+00	6.03E+02
2039	1.01E+02	2.84E+02	3.99E+02	2.35E+01	8.08E+02	2.33E+02	9.13E+01	2.43E+01	2.36E+02	8.00E+01	2.64E+00	6.67E+02	2.32E+02	9.13E+01	3.37E+01	3.04E+02	5.79E-01	2.88E+00	6.64E+02
2040	1.08E+02	3.06E+02	4.42E+02	2.48E+01	8.81E+02	2.58E+02	1.01E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	7.28E+02	2.57E+02	1.01E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	7.25E+02
2041	1.16E+02	3.27E+02	4.85E+02	2.56E+01	9.54E+02	2.83E+02	1.11E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	7.88E+02	2.82E+02	1.11E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	7.84E+02
2042	1.23E+02	3.48E+02	5.28E+02	2.61E+01	1.03E+03	3.08E+02	1.21E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	8.46E+02	3.07E+02	1.21E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	8.42E+02
2043	1.30E+02	3.68E+02	5.71E+02	2.63E+01	1.10E+03	3.33E+02	1.31E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	9.04E+02	3.32E+02	1.31E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	9.00E+02
2044	1.37E+02	3.87E+02	6.14E+02	2.63E+01	1.17E+03	3.58E+02	1.41E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	9.61E+02	3.57E+02	1.41E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	9.56E+02
2045	1.44E+02	4.06E+02	6.57E+02	2.63E+01	1.23E+03	3.84E+02	1.50E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.02E+03	3.82E+02	1.50E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.01E+03
2046	1.50E+02	4.25E+02	7.01E+02	2.63E+01	1.30E+03	4.09E+02	1.60E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.07E+03	4.07E+02	1.60E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.07E+03
2047	1.57E+02	4.43E+02	7.44E+02	2.63E+01	1.37E+03	4.34E+02	1.70E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.13E+03	4.32E+02	1.70E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.12E+03
2048	1.63E+02	4.60E+02	7.87E+02	2.63E+01	1.44E+03	4.59E+02	1.80E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.18E+03	4.57E+02	1.80E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.18E+03
2049	1.69E+02	4.77E+02	8.30E+02	2.63E+01	1.50E+03	4.84E+02	1.90E+02	3.54E+01	3.43E+02	1.83E+02	2.64E+00	1.24E+03	4.82E+02	1.90E+02	5.68E+01	4.97E+02	2.93E+00	2.88E+00	1.23E+03
2050	1.75E+02	4.94E+02	8.73E+02	2.63E+01	1.57E+03	5.09E+02	2.00E+02	3.61E+01	3.51E+02	1.94E+02	2.64E+00	1.29E+03	5.07E+02	2.00E+02	5.88E+01	5.13E+02	3.74E+00	2.88E+00	1.29E+03
2051	1.81E+02	5.10E+02	9.16E+02	2.63E+01	1.63E+03	5.34E+02	2.10E+02	3.68E+01	3.58E+02	2.04E+02	2.64E+00	1.35E+03	5.32E+02	2.10E+02	6.07E+01	5.29E+02	4.60E+00	2.88E+00	1.34E+03
2052	1.86E+02	5.26E+02	9.59E+02	2.63E+01	1.70E+03	5.60E+02	2.20E+02	3.75E+01	3.64E+02	2.15E+02	2.64E+00	1.40E+03	5.57E+02	2.20E+02	6.27E+01	5.43E+02	5.62E+00	2.88E+00	1.39E+03
2053	1.92E+02	5.41E+02	1.00E+03	2.63E+01	1.76E+03	5.85E+02	2.29E+02	3.81E+01	3.70E+02	2.26E+02	2.64E+00	1.45E+03	5.82E+02	2.29E+02	6.46E+01	5.58E+02	6.83E+00	2.88E+00	1.44E+03
2054	1.97E+02	5.56E+02	1.05E+03	2.63E+01	1.82E+03	6.10E+02	2.39E+02	3.87E+01	3.76E+02	2.37E+02	2.64E+00	1.50E+03	6.07E+02	2.39E+02	6.64E+01	5.71E+02	8.16E+00	2.88E+00	1.50E+03
2055	2.02E+02	5.70E+02	1.09E+03	2.63E+01	1.89E+03	6.35E+02	2.49E+02	3.92E+01	3.81E+02	2.47E+02	2.64E+00	1.55E+03	6.32E+02	2.49E+02	6.82E+01	5.85E+02	9.53E+00	2.88E+00	1.55E+03
2056	2.07E+02	5.84E+02	1.13E+03	2.63E+01	1.95E+03	6.60E+02	2.59E+02	3.98E+01	3.86E+02	2.58E+02	2.64E+00	1.61E+03	6.57E+02	2.59E+02	7.00E+01	5.98E+02	1.09E+01	2.88E+00	1.60E+03
2057	2.12E+02	5.98E+02	1.17E+03	2.63E+01	2.01E+03	6.85E+02	2.69E+02	4.02E+01	3.91E+02	2.68E+02	2.64E+00	1.66E+03	6.82E+02	2.69E+02	7.17E+01	6.10E+02	1.22E+01	2.88E+00	1.65E+03
2058	2.16E+02	6.11E+02	1.21E+03	2.63E+01	2.07E+03	7.08E+02	2.78E+02	4.07E+01	3.95E+02	2.79E+02	2.64E+00	1.70E+03	7.05E+02	2.78E+02	7.34E+01	6.22E+02	1.38E+01	2.88E+00	1.69E+03
2059	2.21E+02	6.24E+02	1.24E+03	2.63E+01	2.12E+03	7.26E+02	2.85E+02	4.11E+01	3.99E+02	2.89E+02	2.64E+00	1.74E+03	7.23E+02	2.85E+02	7.50E+01	6.33E+02	1.63E+01	2.88E+00	1.73E+03
2060	2.26E+02	6.37E+02	1.27E+03	2.63E+01	2.16E+03	7.40E+02	2.90E+02	4.15E+01	4.03E+02	3.00E+02	2.64E+00	1.78E+03	7.37E+02	2.90E+02	7.66E+01	6.43E+02	1.95E+01	2.88E+00	1.77E+03
2061	2.30E+02	6.50E+02	1.29E+03	2.63E+01	2.19E+03	7.52E+02	2.95E+02	4.19E+01	4.07E+02	3.10E+02	2.64E+00	1.81E+03	7.49E+02	2.95E+02	7.82E+01	6.52E+02	2.35E+01	2.88E+00	1.80E+03

Exhibit D-28. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-01	6.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.60E-01	7.60E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.30E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.05E+01	2.97E+01	7.15E+00	0.00E+00	4.74E+01	4.19E+00	2.08E+00	2.99E+00	2.90E+01	7.73E-01	2.30E+00	4.14E+01	4.17E+00	2.08E+00	3.08E+00	2.93E+01	4.75E-01	2.54E+00	4.16E+01
2030	2.07E+01	5.85E+01	2.50E+01	0.00E+00	1.04E+02	1.47E+01	7.28E+00	5.80E+00	5.63E+01	2.61E+00	2.53E+00	8.92E+01	1.46E+01	7.28E+00	6.10E+00	5.80E+01	5.79E-01	2.77E+00	8.94E+01
2031	3.07E+01	8.66E+01	5.72E+01	1.21E+00	1.76E+02	3.35E+01	1.66E+01	8.42E+00	8.18E+01	6.76E+00	2.61E+00	1.50E+02	3.34E+01	1.66E+01	9.21E+00	8.71E+01	5.79E-01	2.84E+00	1.50E+02
2032	4.03E+01	1.14E+02	9.65E+01	3.99E+00	2.55E+02	5.66E+01	2.81E+01	1.09E+01	1.06E+02	1.34E+01	2.64E+00	2.17E+02	5.63E+01	2.81E+01	1.25E+01	1.17E+02	5.79E-01	2.88E+00	2.17E+02
2033	4.97E+01	1.40E+02	1.39E+02	7.72E+00	3.37E+02	8.17E+01	4.05E+01	1.32E+01	1.28E+02	2.18E+01	2.64E+00	2.88E+02	8.14E+01	4.05E+01	1.58E+01	1.46E+02	5.79E-01	2.88E+00	2.88E+02
2034	5.88E+01	1.66E+02	1.82E+02	1.15E+01	4.19E+02	1.07E+02	5.30E+01	1.54E+01	1.49E+02	3.10E+01	2.64E+00	3.58E+02	1.06E+02	5.30E+01	1.90E+01	1.75E+02	5.79E-01	2.88E+00	3.57E+02
2035	6.77E+01	1.91E+02	2.25E+02	1.48E+01	4.99E+02	1.32E+02	6.55E+01	1.74E+01	1.69E+02	4.05E+01	2.64E+00	4.27E+02	1.31E+02	6.55E+01	2.21E+01	2.03E+02	5.79E-01	2.88E+00	4.26E+02
2036	7.63E+01	2.15E+02	2.68E+02	1.75E+01	5.77E+02	1.57E+02	7.80E+01	1.93E+01	1.88E+02	5.01E+01	2.64E+00	4.95E+02	1.57E+02	7.80E+01	2.52E+01	2.30E+02	5.79E-01	2.88E+00	4.93E+02
2037	8.47E+01	2.39E+02	3.11E+02	1.99E+01	6.55E+02	1.82E+02	9.04E+01	2.11E+01	2.05E+02	5.99E+01	2.64E+00	5.61E+02	1.82E+02	9.04E+01	2.81E+01	2.56E+02	5.79E-01	2.88E+00	5.59E+02
2038	9.28E+01	2.62E+02	3.54E+02	2.19E+01	7.31E+02	2.07E+02	1.03E+02	2.28E+01	2.21E+02	6.99E+01	2.64E+00	6.27E+02	2.07E+02	1.03E+02	3.09E+01	2.80E+02	5.79E-01	2.88E+00	6.24E+02
2039	1.01E+02	2.84E+02	3.97E+02	2.35E+01	8.05E+02	2.33E+02	1.15E+02	2.43E+01	2.36E+02	8.00E+01	2.64E+00	6.91E+02	2.32E+02	1.15E+02	3.37E+01	3.04E+02	5.79E-01	2.88E+00	6.88E+02
2040	1.08E+02	3.06E+02	4.40E+02	2.48E+01	8.79E+02	2.58E+02	1.28E+02	2.58E+01	2.50E+02	9.01E+01	2.64E+00	7.55E+02	2.57E+02	1.28E+02	3.63E+01	3.27E+02	5.79E-01	2.88E+00	7.51E+02
2041	1.16E+02	3.27E+02	4.82E+02	2.56E+01	9.51E+02	2.83E+02	1.40E+02	2.71E+01	2.64E+02	1.00E+02	2.64E+00	8.17E+02	2.82E+02	1.40E+02	3.89E+01	3.49E+02	5.79E-01	2.88E+00	8.13E+02
2042	1.23E+02	3.48E+02	5.25E+02	2.61E+01	1.02E+03	3.08E+02	1.53E+02	2.84E+01	2.76E+02	1.10E+02	2.64E+00	8.78E+02	3.07E+02	1.53E+02	4.13E+01	3.70E+02	5.79E-01	2.88E+00	8.74E+02
2043	1.30E+02	3.68E+02	5.68E+02	2.63E+01	1.09E+03	3.33E+02	1.65E+02	2.96E+01	2.88E+02	1.20E+02	2.64E+00	9.39E+02	3.32E+02	1.65E+02	4.37E+01	3.90E+02	5.79E-01	2.88E+00	9.34E+02
2044	1.37E+02	3.87E+02	6.11E+02	2.63E+01	1.16E+03	3.58E+02	1.78E+02	3.07E+01	2.99E+02	1.30E+02	2.64E+00	9.98E+02	3.57E+02	1.78E+02	4.60E+01	4.09E+02	6.18E-01	2.88E+00	9.94E+02
2045	1.44E+02	4.06E+02	6.54E+02	2.63E+01	1.23E+03	3.84E+02	1.90E+02	3.18E+01	3.09E+02	1.41E+02	2.64E+00	1.06E+03	3.82E+02	1.90E+02	4.82E+01	4.28E+02	8.16E-01	2.88E+00	1.05E+03
2046	1.50E+02	4.25E+02	6.97E+02	2.63E+01	1.30E+03	4.09E+02	2.03E+02	3.28E+01	3.18E+02	1.51E+02	2.64E+00	1.12E+03	4.07E+02	2.03E+02	5.04E+01	4.46E+02	1.15E+00	2.88E+00	1.11E+03
2047	1.57E+02	4.43E+02	7.40E+02	2.63E+01	1.37E+03	4.34E+02	2.15E+02	3.37E+01	3.27E+02	1.61E+02	2.64E+00	1.17E+03	4.32E+02	2.15E+02	5.26E+01	4.64E+02	1.60E+00	2.88E+00	1.17E+03
2048	1.63E+02	4.60E+02	7.83E+02	2.63E+01	1.43E+03	4.59E+02	2.28E+02	3.45E+01	3.36E+02	1.72E+02	2.64E+00	1.23E+03	4.57E+02	2.28E+02	5.47E+01	4.81E+02	2.21E+00	2.88E+00	1.23E+03
2049	1.69E+02	4.77E+02	8.26E+02	2.63E+01	1.50E+03	4.84E+02	2.40E+02	3.53E+01	3.43E+02	1.83E+02	2.64E+00	1.29E+03	4.82E+02	2.40E+02	5.68E+01	4.97E+02	2.93E+00	2.88E+00	1.28E+03
2050	1.75E+02	4.94E+02	8.68E+02	2.63E+01	1.56E+03	5.09E+02	2.53E+02	3.61E+01	3.51E+02	1.94E+02	2.64E+00	1.35E+03	5.07E+02	2.53E+02	5.88E+01	5.13E+02	3.74E+00	2.88E+00	1.34E+03
2051	1.81E+02	5.10E+02	9.11E+02	2.63E+01	1.63E+03	5.34E+02	2.65E+02	3.68E+01	3.58E+02	2.04E+02	2.64E+00	1.40E+03	5.32E+02	2.65E+02	6.07E+01	5.29E+02	4.60E+00	2.88E+00	1.39E+03
2052	1.86E+02	5.26E+02	9.54E+02	2.63E+01	1.69E+03	5.60E+02	2.78E+02	3.75E+01	3.64E+02	2.15E+02	2.64E+00	1.46E+03	5.57E+02	2.78E+02	6.27E+01	5.43E+02	5.62E+00	2.88E+00	1.45E+03
2053	1.92E+02	5.41E+02	9.97E+02	2.63E+01	1.76E+03	5.85E+02	2.90E+02	3.81E+01	3.70E+02	2.26E+02	2.64E+00	1.51E+03	5.82E+02	2.90E+02	6.46E+01	5.58E+02	6.83E+00	2.88E+00	1.50E+03
2054	1.97E+02	5.56E+02	1.04E+03	2.63E+01	1.82E+03	6.10E+02	3.03E+02	3.87E+01	3.76E+02	2.37E+02	2.64E+00	1.57E+03	6.07E+02	3.03E+02	6.64E+01	5.71E+02	8.16E+00	2.88E+00	1.56E+03
2055	2.02E+02	5.70E+02	1.08E+03	2.63E+01	1.88E+03	6.35E+02	3.15E+02	3.92E+01	3.81E+02	2.47E+02	2.64E+00	1.62E+03	6.32E+02	3.15E+02	6.82E+01	5.85E+02	9.53E+00	2.88E+00	1.61E+03
2056	2.07E+02	5.84E+02	1.13E+03	2.63E+01	1.94E+03	6.60E+02	3.27E+02	3.98E+01	3.86E+02	2.58E+02	2.64E+00	1.67E+03	6.57E+02	3.27E+02	7.00E+01	5.98E+02	1.09E+01	2.88E+00	1.67E+03
2057	2.12E+02	5.98E+02	1.17E+03	2.63E+01	2.00E+03	6.85E+02	3.40E+02	4.02E+01	3.91E+02	2.68E+02	2.64E+00	1.73E+03	6.82E+02	3.40E+02	7.17E+01	6.10E+02	1.22E+01	2.88E+00	1.72E+03
2058	2.16E+02	6.11E+02	1.21E+03	2.63E+01	2.06E+03	7.08E+02	3.51E+02	4.07E+01	3.95E+02	2.79E+02	2.64E+00	1.78E+03	7.05E+02	3.51E+02	7.34E+01	6.22E+02	1.38E+01	2.88E+00	1.77E+03
2059	2.21E+02	6.24E+02	1.24E+03	2.63E+01	2.11E+03	7.26E+02	3.60E+02	4.11E+01	3.99E+02	2.89E+02	2.64E+00	1.82E+03	7.23E+02	3.60E+02	7.50E+01	6.33E+02	1.63E+01	2.88E+00	1.81E+03
2060	2.26E+02	6.37E+02	1.26E+03	2.63E+01	2.15E+03	7.40E+02	3.67E+02	4.15E+01	4.03E+02	3.00E+02	2.64E+00	1.85E+03	7.37E+02	3.67E+02	7.66E+01	6.43E+02	1.95E+01	2.88E+00	1.85E+03
2061	2.30E+02	6.50E+02	1.28E+03	2.63E+01	2.19E+03	7.52E+02	3.73E+02	4.19E+01	4.07E+02	3.10E+02	2.64E+00	1.89E+03	7.49E+02	3.73E+02	7.82E+01	6.52E+02	2.35E+01	2.88E+00	1.88E+03

Exhibit D-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.42E+02	7.46E+02	7.46E+02	7.67E+02
Lower GOR	7.44E+02	7.48E+02	7.48E+02	7.69E+02
Higher GOR	7.40E+02	7.44E+02	7.44E+02	7.65E+02

Exhibit D-30. CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.42E+02	7.46E+02	7.46E+02	7.67E+02
Decrease in Methane Emissions	7.36E+02	7.40E+02	7.40E+02	7.61E+02
Increase in Methane Emissions	7.47E+02	7.51E+02	7.52E+02	7.73E+02

APPENDIX E: AR6 100-YR RESULTS

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report:

- Multiproduct Functional Unit – Japan (AR6 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR6 – 100-yr)
- Multiproduct Functional Unit – China (AR6 – 100-yr)
- Multiproduct Functional Unit – India (AR6 – 100-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR6 – 100-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 100-yr)
- Single Product Functional Unit in kg CO_2e – China (AR6 – 100-yr)
- Single Product Functional Unit in kg CO_2e – India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR6 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit E-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.53E+01	4.53E+01	-	5.10E+01	5.10E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.44E+00	3.44E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	6.91E-01	-	-	7.78E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.27E+00	9.27E+00	-	1.04E+01	1.04E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	1.85E+01	1.85E+01	-	2.09E+01	2.09E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.55E+01	4.34E+00	4.34E+00	5.12E+01	4.89E+00	4.89E+00
Crude Oil Extraction, CO2-EOR	-	-	5.88E+00	-	-	6.61E+00
CO2-EOR Crude Oil Transport	-	-	7.99E-01	-	-	9.00E-01
Crude Oil Alaskan Pipeline Transport	2.12E+00	1.33E+00	1.33E+00	2.38E+00	1.49E+00	1.49E+00
Crude Oil Ocean Transport	1.13E+00	7.45E-01	1.19E+00	1.27E+00	8.38E-01	1.34E+00
Crude Oil Refining and End Use	1.52E+02	9.51E+01	1.52E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	2.45E+01	8.84E+01	2.39E+01	3.05E+00	7.50E+01	2.36E+00
System Expansion: US Lower 48 LNG Export and End Use	5.15E+02	-	-	2.32E+02	-	-
Total	7.40E+02	6.67E+02	6.66E+02	4.61E+02	3.85E+02	3.84E+02
Upper	1.46E+01	5.89E+00	5.38E+00	1.46E+01	6.32E+00	6.18E+00
Lower	8.19E+00	2.10E+00	2.06E+00	9.02E+00	2.09E+00	2.46E+00

Exhibit E-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.54E+01	4.54E+01	-	5.11E+01	5.11E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	6.92E-01	-	-	7.79E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.16E+01	2.16E+01	-	2.43E+01	2.43E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.56E+01	4.35E+00	4.35E+00	5.13E+01	4.90E+00	4.90E+00
Crude Oil Extraction, CO2-EOR	-	-	5.89E+00	-	-	6.63E+00
CO2-EOR Crude Oil Transport	-	-	8.01E-01	-	-	9.01E-01
Crude Oil Alaskan Pipeline Transport	2.12E+00	1.33E+00	1.33E+00	2.39E+00	1.49E+00	1.49E+00
Crude Oil Ocean Transport	1.13E+00	7.46E-01	1.20E+00	1.27E+00	8.40E-01	1.35E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.17E-01	5.17E-01	-	5.82E-01	5.82E-01
System Expansion: US Average Crude Oil Production and End Use	2.41E+01	8.82E+01	2.35E+01	2.68E+00	7.47E+01	1.98E+00
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	7.44E+02	6.70E+02	6.70E+02	4.66E+02	3.88E+02	3.87E+02
Upper	1.36E+01	6.21E+00	5.80E+00	1.58E+01	6.61E+00	6.37E+00
Lower	7.92E+00	2.11E+00	1.86E+00	9.06E+00	2.05E+00	2.31E+00

Exhibit E-3. Multiproduct Functional Unit in kg CO_2e – China (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.54E+01	4.54E+01	-	5.11E+01	5.11E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	6.93E-01	-	-	7.79E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.44E+01	2.44E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.56E+01	4.35E+00	4.35E+00	5.13E+01	4.90E+00	4.90E+00
Crude Oil Extraction, CO2-EOR	-	-	5.89E+00	-	-	6.63E+00
CO2-EOR Crude Oil Transport	-	-	8.01E-01	-	-	9.02E-01
Crude Oil Alaskan Pipeline Transport	2.12E+00	1.33E+00	1.33E+00	2.39E+00	1.50E+00	1.50E+00
Crude Oil Ocean Transport	1.13E+00	7.46E-01	1.20E+00	1.27E+00	8.40E-01	1.35E+00
Crude Oil Refining and End Use	1.52E+02	9.53E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.17E-01	5.17E-01	-	5.82E-01	5.82E-01
System Expansion: US Average Crude Oil Production and End Use	2.41E+01	8.82E+01	2.35E+01	2.66E+00	7.47E+01	1.97E+00
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	7.44E+02	6.70E+02	6.70E+02	4.66E+02	3.88E+02	3.88E+02
Upper	1.31E+01	5.89E+00	5.86E+00	1.58E+01	6.43E+00	6.99E+00
Lower	6.80E+00	2.03E+00	2.18E+00	8.88E+00	2.37E+00	2.44E+00

Exhibit E-4. Multiproduct Functional Unit in kg CO_2e – India (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	**Scenario 2: AK LNG + CCS**	**Scenario 3: AK LNG + CO2-EOR**	**Scenario 1: BAU, US Lower 48 LNG**	**Scenario 2: AK LNG + CCS**	**Scenario 3: AK LNG + CO2-EOR**
Natural Gas Extraction, Associated	-	4.59E+01	4.59E+01	-	5.17E+01	5.17E+01
Natural Gas Pipelines to GTP	-	3.09E+00	3.09E+00	-	3.48E+00	3.48E+00
Natural Gas Processing at GTP	-	2.47E+01	2.47E+01	-	2.78E+01	2.78E+01
CO2 Compression and Sequestration	-	7.00E-01	-	-	7.87E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.38E+00	9.38E+00	-	1.06E+01	1.06E+01
Liquefaction	-	2.97E+01	2.97E+01	-	3.35E+01	3.35E+01
Ocean Transport	-	3.77E+01	3.77E+01	-	4.24E+01	4.24E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	4.61E+01	4.39E+00	4.39E+00	5.18E+01	4.95E+00	4.95E+00
Crude Oil Extraction, CO2-EOR	-	-	5.95E+00	-	-	6.70E+00
CO2-EOR Crude Oil Transport	-	-	8.09E-01	-	-	9.11E-01
Crude Oil Alaskan Pipeline Transport	2.14E+00	1.34E+00	1.34E+00	2.41E+00	1.51E+00	1.51E+00
Crude Oil Ocean Transport	1.14E+00	7.54E-01	1.21E+00	1.29E+00	8.48E-01	1.36E+00
Crude Oil Refining and End Use	1.54E+02	9.63E+01	1.54E+02	1.73E+02	1.08E+02	1.74E+02
Construction	-	5.22E-01	5.22E-01	-	5.88E-01	5.88E-01
System Expansion: US Average Crude Oil Production and End Use	2.24E+01	8.71E+01	2.18E+01	7.03E-01	7.35E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.17E+02	-	-	2.35E+02	-	-
Total	7.43E+02	6.88E+02	6.87E+02	4.65E+02	4.08E+02	4.07E+02
Upper	1.43E+01	8.40E+00	8.55E+00	1.49E+01	9.50E+00	9.51E+00
Lower	8.20E+00	1.72E+00	1.94E+00	9.46E+00	2.15E+00	2.12E+00

Exhibit E-5. Single Product Functional Unit in kg CO_2e – Japan (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.53E+01	4.53E+01	-	5.10E+01	5.10E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.44E+00	3.44E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.74E+01	2.74E+01
CO2 Compression and Sequestration	-	5.94E-01	-	-	6.69E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.27E+00	9.27E+00	-	1.04E+01	1.04E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	1.85E+01	1.85E+01	-	2.09E+01	2.09E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.16E-01	5.16E-01	-	5.81E-01	5.81E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.15E+02	-	-	2.32E+02	-	-
Total	5.15E+02	4.77E+02	4.76E+02	2.32E+02	1.95E+02	1.95E+02
Upper	1.45E+01	4.21E+00	3.85E+00	1.46E+01	3.21E+00	3.13E+00
Lower	8.25E+00	1.50E+00	1.47E+00	9.09E+00	1.06E+00	1.25E+00

Exhibit E-6. Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.54E+01	4.54E+01	-	5.11E+01	5.11E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	5.96E-01	-	-	6.70E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.16E+01	2.16E+01	-	2.43E+01	2.43E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.17E-01	5.17E-01	-	5.82E-01	5.82E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	5.19E+02	4.80E+02	4.80E+02	2.37E+02	1.99E+02	1.98E+02
Upper	1.36E+01	4.45E+00	4.15E+00	1.57E+01	3.38E+00	3.26E+00
Lower	7.97E+00	1.51E+00	1.33E+00	9.13E+00	1.05E+00	1.18E+00

Exhibit E-7. Single Product Functional Unit in kg CO_2e – China (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.54E+01	4.54E+01	-	5.11E+01	5.11E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.44E+01	2.44E+01	-	2.75E+01	2.75E+01
CO2 Compression and Sequestration	-	5.96E-01	-	-	6.70E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.44E+01	2.44E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.17E-01	5.17E-01	-	5.82E-01	5.82E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	5.19E+02	4.80E+02	4.80E+02	2.37E+02	1.99E+02	1.98E+02
Upper	1.30E+01	4.22E+00	4.20E+00	1.57E+01	3.30E+00	3.58E+00
Lower	6.86E+00	1.46E+00	1.56E+00	8.95E+00	1.22E+00	1.25E+00

Exhibit E-8. Single Product Functional Unit in kg CO_2e – India (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	4.59E+01	4.59E+01	-	5.17E+01	5.17E+01
Natural Gas Pipelines to GTP	-	3.09E+00	3.09E+00	-	3.48E+00	3.48E+00
Natural Gas Processing at GTP	-	2.47E+01	2.47E+01	-	2.78E+01	2.78E+01
CO2 Compression and Sequestration	-	6.02E-01	-	-	6.77E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.38E+00	9.38E+00	-	1.06E+01	1.06E+01
Liquefaction	-	2.97E+01	2.97E+01	-	3.35E+01	3.35E+01
Ocean Transport	-	3.77E+01	3.77E+01	-	4.24E+01	4.24E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.94E+00	3.94E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.22E-01	5.22E-01	-	5.88E-01	5.88E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.17E+02	-	-	2.35E+02	-	-
Total	5.17E+02	4.98E+02	4.97E+02	2.35E+02	2.18E+02	2.18E+02
Upper	1.43E+01	6.08E+00	6.19E+00	1.48E+01	5.09E+00	5.09E+00
Lower	8.26E+00	1.25E+00	1.41E+00	9.53E+00	1.15E+00	1.14E+00

Exhibit E-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.29E+01	2.64E+00	5.58E-05	-	4.55E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	9.13E-02	9.89E-03	7.67E-09	2.12E+00
Crude Oil Ocean Transport	1.09E+00	3.18E-02	2.70E-03	1.14E-06	1.13E+00
Crude Oil Refining and End Use	1.52E+02	2.56E-01	6.94E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	5.56E-01	1.43E-02	-	2.45E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	5.06E+01	3.09E-01	1.89E-07	5.15E+02
Construction	-	-	-	-	-
Total	6.85E+02	5.41E+01	3.43E-01	1.34E-06	7.40E+02

Exhibit E-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	2.64E+00	5.59E-05	-	4.56E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	9.14E-02	9.91E-03	7.69E-09	2.12E+00
Crude Oil Ocean Transport	1.10E+00	3.19E-02	2.70E-03	1.14E-06	1.13E+00
Crude Oil Refining and End Use	1.52E+02	2.57E-01	6.96E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	5.49E-01	1.41E-02	-	2.41E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	5.10E+01	3.18E-01	1.90E-07	5.19E+02
Construction	-	-	-	-	-
Total	6.89E+02	5.46E+01	3.52E-01	1.34E-06	7.44E+02

Exhibit E-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	2.64E+00	5.59E-05	-	4.56E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	9.15E-02	9.91E-03	7.69E-09	2.12E+00
Crude Oil Ocean Transport	1.10E+00	3.19E-02	2.70E-03	1.14E-06	1.13E+00
Crude Oil Refining and End Use	1.52E+02	2.57E-01	6.96E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	5.49E-01	1.41E-02	-	2.41E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	5.10E+01	3.19E-01	1.90E-07	5.19E+02
Construction	-	-	-	-	-
Total	6.89E+02	5.46E+01	3.52E-01	1.34E-06	7.44E+02

Exhibit E-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.34E+01	2.67E+00	5.65E-05	-	4.61E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.04E+00	9.24E-02	1.00E-02	7.77E-09	2.14E+00
Crude Oil Ocean Transport	1.11E+00	3.22E-02	2.73E-03	1.15E-06	1.14E+00
Crude Oil Refining and End Use	1.54E+02	2.59E-01	7.03E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	5.09E-01	1.30E-02	-	2.24E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	5.09E+01	3.15E-01	1.90E-07	5.17E+02
Construction	-	-	-	-	-
Total	6.88E+02	5.44E+01	3.48E-01	1.35E-06	7.43E+02

Exhibit E-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	1.95E+01	1.45E-02	-	4.53E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.39E+01	4.65E-01	2.48E-05	-	2.44E+01
CO2 Compression and Sequestration	6.44E-01	4.34E-02	1.40E-03	2.09E-03	6.91E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.10E+00	5.17E-07	-	9.27E+00
Liquefaction	2.25E+01	6.93E+00	3.84E-03	1.37E-07	2.94E+01
Ocean Transport	1.68E+01	1.70E+00	5.45E-02	-	1.85E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	1.72E+00	5.59E-06	-	4.34E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	5.71E-02	6.19E-03	4.80E-09	1.33E+00
Crude Oil Ocean Transport	7.14E-01	2.82E-02	2.12E-03	1.02E-06	7.45E-01
Crude Oil Refining and End Use	9.50E+01	1.60E-01	4.35E-03	-	9.51E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	2.01E+00	5.15E-02	-	8.84E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	7.90E-03	3.02E-03	-	5.16E-01
Total	6.27E+02	4.03E+01	1.51E-01	2.19E-03	6.67E+02

Exhibit E-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.96E+01	1.45E-02	-	4.54E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.40E+01	4.66E-01	2.49E-05	-	2.44E+01
CO2 Compression and Sequestration	6.45E-01	4.35E-02	1.40E-03	2.10E-03	6.92E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	3.85E-03	1.38E-07	2.94E+01
Ocean Transport	1.95E+01	2.02E+00	6.21E-02	-	2.16E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.72E+00	5.60E-06	-	4.35E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	5.73E-02	6.20E-03	4.81E-09	1.33E+00
Crude Oil Ocean Transport	7.16E-01	2.83E-02	2.12E-03	1.02E-06	7.46E-01
Crude Oil Refining and End Use	9.51E+01	1.61E-01	4.36E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	2.00E+00	5.14E-02	-	8.82E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	7.92E-03	3.03E-03	-	5.17E-01
Total	6.29E+02	4.06E+01	1.58E-01	2.19E-03	6.70E+02

Exhibit E-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.96E+01	1.45E-02	-	4.54E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.40E+01	4.66E-01	2.49E-05	-	2.44E+01
CO2 Compression and Sequestration	6.46E-01	4.35E-02	1.40E-03	2.10E-03	6.93E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	3.85E-03	1.38E-07	2.94E+01
Ocean Transport	1.96E+01	2.03E+00	6.25E-02	-	2.17E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.72E+00	5.60E-06	-	4.35E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.27E+00	5.73E-02	6.20E-03	4.81E-09	1.33E+00
Crude Oil Ocean Transport	7.16E-01	2.83E-02	2.12E-03	1.02E-06	7.46E-01
Crude Oil Refining and End Use	9.51E+01	1.61E-01	4.36E-03	-	9.53E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	2.00E+00	5.14E-02	-	8.82E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	7.92E-03	3.03E-03	-	5.17E-01
Total	6.30E+02	4.07E+01	1.59E-01	2.19E-03	6.70E+02

Exhibit E-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	1.98E+01	1.47E-02	-	4.59E+01
Natural Gas Pipelines to GTP	2.17E-03	3.09E+00	-	-	3.09E+00
Natural Gas Processing at GTP	2.42E+01	4.71E-01	2.51E-05	-	2.47E+01
CO2 Compression and Sequestration	6.52E-01	4.39E-02	1.41E-03	2.12E-03	7.00E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	4.15E+00	5.24E-07	-	9.38E+00
Liquefaction	2.27E+01	7.01E+00	3.88E-03	1.39E-07	2.97E+01
Ocean Transport	3.39E+01	3.74E+00	1.02E-01	-	3.77E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	1.74E+00	5.66E-06	-	4.39E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.28E+00	5.78E-02	6.27E-03	4.86E-09	1.34E+00
Crude Oil Ocean Transport	7.23E-01	2.86E-02	2.14E-03	1.03E-06	7.54E-01
Crude Oil Refining and End Use	9.61E+01	1.62E-01	4.40E-03	-	9.63E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	1.98E+00	5.07E-02	-	8.71E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	8.00E-03	3.06E-03	-	5.22E-01
Total	6.45E+02	4.27E+01	1.98E-01	2.21E-03	6.88E+02

Exhibit E-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	1.95E+01	1.45E-02	-	4.53E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.39E+01	4.65E-01	2.48E-05	-	2.44E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.10E+00	5.17E-07	-	9.27E+00
Liquefaction	2.25E+01	6.93E+00	3.84E-03	1.37E-07	2.94E+01
Ocean Transport	1.68E+01	1.70E+00	5.45E-02	-	1.85E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	1.72E+00	5.59E-06	-	4.34E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	3.91E-01	1.74E-02	2.70E-02	5.88E+00
CO2-EOR Crude Oil Transport	7.61E-01	3.45E-02	3.73E-03	2.90E-09	7.99E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	5.71E-02	6.19E-03	4.80E-09	1.33E+00
Crude Oil Ocean Transport	1.14E+00	4.52E-02	3.40E-03	1.64E-06	1.19E+00
Crude Oil Refining and End Use	1.52E+02	2.57E-01	6.97E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	5.42E-01	1.39E-02	-	2.39E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	7.90E-03	3.02E-03	-	5.16E-01
Total	6.27E+02	3.93E+01	1.37E-01	2.71E-02	6.66E+02

Exhibit E-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.96E+01	1.45E-02	-	4.54E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.40E+01	4.66E-01	2.49E-05	-	2.44E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	3.85E-03	1.38E-07	2.94E+01
Ocean Transport	1.95E+01	2.02E+00	6.21E-02	-	2.16E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.72E+00	5.60E-06	-	4.35E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	3.92E-01	1.74E-02	2.71E-02	5.89E+00
CO2-EOR Crude Oil Transport	7.63E-01	3.45E-02	3.74E-03	2.90E-09	8.01E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	5.73E-02	6.20E-03	4.81E-09	1.33E+00
Crude Oil Ocean Transport	1.15E+00	4.53E-02	3.40E-03	1.64E-06	1.20E+00
Crude Oil Refining and End Use	1.53E+02	2.58E-01	6.98E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	5.35E-01	1.37E-02	-	2.35E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	7.92E-03	3.03E-03	-	5.17E-01
Total	6.30E+02	3.97E+01	1.44E-01	2.72E-02	6.70E+02

Exhibit E-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	1.96E+01	1.45E-02	-	4.54E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.40E+01	4.66E-01	2.49E-05	-	2.44E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	3.85E-03	1.38E-07	2.94E+01
Ocean Transport	1.96E+01	2.03E+00	6.25E-02	-	2.17E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	1.72E+00	5.60E-06	-	4.35E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	3.92E-01	1.74E-02	2.71E-02	5.89E+00
CO2-EOR Crude Oil Transport	7.63E-01	3.45E-02	3.74E-03	2.90E-09	8.01E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	5.73E-02	6.20E-03	4.81E-09	1.33E+00
Crude Oil Ocean Transport	1.15E+00	4.53E-02	3.40E-03	1.64E-06	1.20E+00
Crude Oil Refining and End Use	1.53E+02	2.58E-01	6.98E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	5.35E-01	1.37E-02	-	2.35E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	7.92E-03	3.03E-03	-	5.17E-01
Total	6.30E+02	3.97E+01	1.45E-01	2.72E-02	6.70E+02

Exhibit E-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	1.98E+01	1.47E-02	-	4.59E+01
Natural Gas Pipelines to GTP	2.17E-03	3.09E+00	-	-	3.09E+00
Natural Gas Processing at GTP	2.42E+01	4.71E-01	2.51E-05	-	2.47E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	4.15E+00	5.24E-07	-	9.38E+00
Liquefaction	2.27E+01	7.01E+00	3.88E-03	1.39E-07	2.97E+01
Ocean Transport	3.39E+01	3.74E+00	1.02E-01	-	3.77E+01
LNG Regasification	3.02E+00	4.77E-01	9.36E-03	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	1.74E+00	5.66E-06	-	4.39E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	3.96E-01	1.76E-02	2.73E-02	5.95E+00
CO2-EOR Crude Oil Transport	7.71E-01	3.49E-02	3.78E-03	2.93E-09	8.09E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	5.78E-02	6.27E-03	4.86E-09	1.34E+00
Crude Oil Ocean Transport	1.16E+00	4.58E-02	3.44E-03	1.66E-06	1.21E+00
Crude Oil Refining and End Use	1.54E+02	2.60E-01	7.05E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	4.95E-01	1.27E-02	-	2.18E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	8.00E-03	3.06E-03	-	5.22E-01
Total	6.45E+02	4.17E+01	1.84E-01	2.74E-02	6.87E+02

Exhibit E-21. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	1.21E+01	0.00E+00	5.12E+01	2.67E+00	8.66E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	4.52E+01	2.65E+00	8.66E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	4.55E+01
2030	1.87E+01	5.84E+01	4.23E+01	0.00E+00	1.19E+02	9.34E+00	3.03E+01	3.79E+00	5.61E+01	2.50E+00	2.46E+00	1.05E+02	9.28E+00	3.03E+01	4.06E+00	5.79E+01	5.55E-01	2.70E+00	1.05E+02
2031	2.77E+01	8.63E+01	9.67E+01	1.16E+00	2.12E+02	2.14E+01	6.93E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.87E+02	2.12E+01	6.93E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.87E+02
2032	3.64E+01	1.13E+02	1.63E+02	3.83E+00	3.17E+02	3.60E+01	1.17E+02	7.12E+00	1.05E+02	1.29E+01	2.58E+00	2.81E+02	3.58E+01	1.17E+02	8.53E+00	1.16E+02	5.55E-01	2.82E+00	2.81E+02
2033	4.49E+01	1.40E+02	2.36E+02	7.41E+00	4.28E+02	5.20E+01	1.69E+02	8.63E+00	1.28E+02	2.09E+01	2.58E+00	3.81E+02	5.17E+01	1.69E+02	1.09E+01	1.46E+02	5.55E-01	2.82E+00	3.81E+02
2034	5.31E+01	1.66E+02	3.08E+02	1.10E+01	5.38E+02	6.81E+01	2.21E+02	1.01E+01	1.49E+02	2.97E+01	2.58E+00	4.80E+02	6.76E+01	2.21E+02	1.33E+01	1.75E+02	5.55E-01	2.82E+00	4.80E+02
2035	6.12E+01	1.90E+02	3.81E+02	1.42E+01	6.47E+02	8.41E+01	2.73E+02	1.14E+01	1.69E+02	3.88E+01	2.58E+00	5.78E+02	8.36E+01	2.73E+02	1.56E+01	2.03E+02	5.55E-01	2.82E+00	5.78E+02
2036	6.89E+01	2.15E+02	4.53E+02	1.68E+01	7.54E+02	1.00E+02	3.25E+02	1.26E+01	1.87E+02	4.80E+01	2.58E+00	6.75E+02	9.95E+01	3.25E+02	1.79E+01	2.29E+02	5.55E-01	2.82E+00	6.75E+02
2037	7.65E+01	2.38E+02	5.26E+02	1.91E+01	8.60E+02	1.16E+02	3.77E+02	1.38E+01	2.04E+02	5.74E+01	2.58E+00	7.71E+02	1.15E+02	3.77E+02	2.01E+01	2.55E+02	5.55E-01	2.82E+00	7.70E+02
2038	8.39E+01	2.61E+02	5.98E+02	2.10E+01	9.65E+02	1.32E+02	4.29E+02	1.49E+01	2.20E+02	6.70E+01	2.58E+00	8.66E+02	1.31E+02	4.29E+02	2.22E+01	2.79E+02	5.55E-01	2.82E+00	8.65E+02
2039	9.10E+01	2.84E+02	6.71E+02	2.26E+01	1.07E+03	1.48E+02	4.81E+02	1.59E+01	2.35E+02	7.67E+01	2.58E+00	9.59E+02	1.47E+02	4.81E+02	2.43E+01	3.03E+02	5.55E-01	2.82E+00	9.59E+02
2040	9.80E+01	3.05E+02	7.43E+02	2.38E+01	1.17E+03	1.64E+02	5.33E+02	1.69E+01	2.50E+02	8.64E+01	2.58E+00	1.05E+03	1.63E+02	5.33E+02	2.63E+01	3.26E+02	5.55E-01	2.82E+00	1.05E+03
2041	1.05E+02	3.26E+02	8.16E+02	2.46E+01	1.27E+03	1.80E+02	5.85E+02	1.77E+01	2.63E+02	9.61E+01	2.58E+00	1.14E+03	1.79E+02	5.85E+02	2.82E+01	3.48E+02	5.55E-01	2.82E+00	1.14E+03
2042	1.11E+02	3.47E+02	8.89E+02	2.50E+01	1.37E+03	1.96E+02	6.37E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	1.23E+03	1.95E+02	6.37E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	1.23E+03
2043	1.18E+02	3.67E+02	9.61E+02	2.52E+01	1.47E+03	2.12E+02	6.88E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	1.32E+03	2.11E+02	6.88E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	1.32E+03
2044	1.24E+02	3.86E+02	1.03E+03	2.52E+01	1.57E+03	2.28E+02	7.40E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	1.41E+03	2.27E+02	7.40E+02	3.37E+01	4.08E+02	5.93E-01	2.82E+00	1.41E+03
2045	1.30E+02	4.05E+02	1.11E+03	2.52E+01	1.67E+03	2.44E+02	7.92E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	1.50E+03	2.43E+02	7.92E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	1.50E+03
2046	1.36E+02	4.24E+02	1.18E+03	2.52E+01	1.76E+03	2.60E+02	8.44E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	1.59E+03	2.59E+02	8.44E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	1.59E+03
2047	1.42E+02	4.41E+02	1.25E+03	2.52E+01	1.86E+03	2.76E+02	8.96E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	1.68E+03	2.75E+02	8.96E+02	3.89E+01	4.62E+02	1.53E+00	2.82E+00	1.68E+03
2048	1.47E+02	4.59E+02	1.32E+03	2.52E+01	1.96E+03	2.92E+02	9.48E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	1.77E+03	2.90E+02	9.48E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	1.76E+03
2049	1.53E+02	4.76E+02	1.40E+03	2.52E+01	2.05E+03	3.08E+02	1.00E+03	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.85E+03	3.06E+02	1.00E+03	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.85E+03
2050	1.58E+02	4.92E+02	1.47E+03	2.52E+01	2.14E+03	3.24E+02	1.05E+03	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.94E+03	3.22E+02	1.05E+03	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.94E+03
2051	1.63E+02	5.08E+02	1.54E+03	2.52E+01	2.24E+03	3.40E+02	1.10E+03	2.41E+01	3.57E+02	1.96E+02	2.58E+00	2.02E+03	3.38E+02	1.10E+03	4.55E+01	5.27E+02	4.41E+00	2.82E+00	2.02E+03
2052	1.68E+02	5.24E+02	1.61E+03	2.52E+01	2.33E+03	3.56E+02	1.16E+03	2.45E+01	3.63E+02	2.06E+02	2.58E+00	2.11E+03	3.54E+02	1.16E+03	4.70E+01	5.42E+02	5.39E+00	2.82E+00	2.11E+03
2053	1.73E+02	5.39E+02	1.69E+03	2.52E+01	2.42E+03	3.72E+02	1.21E+03	2.49E+01	3.69E+02	2.17E+02	2.58E+00	2.19E+03	3.70E+02	1.21E+03	4.86E+01	5.56E+02	6.55E+00	2.82E+00	2.19E+03
2054	1.78E+02	5.54E+02	1.76E+03	2.52E+01	2.52E+03	3.88E+02	1.26E+03	2.53E+01	3.75E+02	2.27E+02	2.58E+00	2.28E+03	3.86E+02	1.26E+03	5.01E+01	5.69E+02	7.82E+00	2.82E+00	2.28E+03
2055	1.83E+02	5.68E+02	1.83E+03	2.52E+01	2.61E+03	4.04E+02	1.31E+03	2.57E+01	3.80E+02	2.37E+02	2.58E+00	2.36E+03	4.02E+02	1.31E+03	5.16E+01	5.83E+02	9.14E+00	2.82E+00	2.36E+03
2056	1.87E+02	5.82E+02	1.90E+03	2.52E+01	2.70E+03	4.20E+02	1.36E+03	2.60E+01	3.85E+02	2.47E+02	2.58E+00	2.45E+03	4.18E+02	1.36E+03	5.30E+01	5.96E+02	1.04E+01	2.82E+00	2.44E+03
2057	1.91E+02	5.96E+02	1.98E+03	2.52E+01	2.79E+03	4.36E+02	1.42E+03	2.63E+01	3.90E+02	2.57E+02	2.58E+00	2.53E+03	4.34E+02	1.42E+03	5.44E+01	6.08E+02	1.17E+01	2.82E+00	2.53E+03
2058	1.96E+02	6.10E+02	2.04E+03	2.52E+01	2.87E+03	4.51E+02	1.46E+03	2.66E+01	3.94E+02	2.67E+02	2.58E+00	2.60E+03	4.48E+02	1.46E+03	5.58E+01	6.20E+02	1.32E+01	2.82E+00	2.60E+03
2059	2.00E+02	6.23E+02	2.09E+03	2.52E+01	2.94E+03	4.62E+02	1.50E+03	2.69E+01	3.98E+02	2.78E+02	2.58E+00	2.67E+03	4.59E+02	1.50E+03	5.72E+01	6.31E+02	1.56E+01	2.82E+00	2.67E+03
2060	2.04E+02	6.35E+02	2.14E+03	2.52E+01	3.00E+03	4.71E+02	1.53E+03	2.71E+01	4.02E+02	2.88E+02	2.58E+00	2.72E+03	4.69E+02	1.53E+03	5.86E+01	6.41E+02	1.87E+01	2.82E+00	2.72E+03
2061	2.08E+02	6.47E+02	2.17E+03	2.52E+01	3.05E+03	4.79E+02	1.55E+03	2.74E+01	4.05E+02	2.97E+02	2.58E+00	2.77E+03	4.76E+02	1.55E+03	5.99E+01	6.50E+02	2.26E+01	2.82E+00	2.76E+03

Exhibit E-22. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	1.22E+01	0.00E+00	5.13E+01	2.67E+00	8.72E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	4.53E+01	2.65E+00	8.72E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	4.55E+01
2030	1.87E+01	5.84E+01	4.25E+01	0.00E+00	1.20E+02	9.34E+00	3.05E+01	3.79E+00	5.61E+01	2.50E+00	2.46E+00	1.05E+02	9.28E+00	3.05E+01	4.06E+00	5.79E+01	5.55E-01	2.70E+00	1.05E+02
2031	2.77E+01	8.63E+01	9.72E+01	1.16E+00	2.12E+02	2.14E+01	6.97E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.87E+02	2.12E+01	6.97E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.87E+02
2032	3.64E+01	1.13E+02	1.64E+02	3.83E+00	3.18E+02	3.60E+01	1.18E+02	7.12E+00	1.05E+02	1.29E+01	2.58E+00	2.82E+02	3.58E+01	1.18E+02	8.53E+00	1.16E+02	5.55E-01	2.82E+00	2.82E+02
2033	4.49E+01	1.40E+02	2.37E+02	7.41E+00	4.29E+02	5.20E+01	1.70E+02	8.63E+00	1.28E+02	2.09E+01	2.58E+00	3.82E+02	5.17E+01	1.70E+02	1.09E+01	1.46E+02	5.55E-01	2.82E+00	3.82E+02
2034	5.31E+01	1.66E+02	3.10E+02	1.10E+01	5.40E+02	6.81E+01	2.22E+02	1.01E+01	1.49E+02	2.97E+01	2.58E+00	4.82E+02	6.76E+01	2.22E+02	1.33E+01	1.75E+02	5.55E-01	2.82E+00	4.81E+02
2035	6.12E+01	1.90E+02	3.83E+02	1.42E+01	6.49E+02	8.41E+01	2.75E+02	1.14E+01	1.69E+02	3.88E+01	2.58E+00	5.80E+02	8.36E+01	2.75E+02	1.56E+01	2.03E+02	5.55E-01	2.82E+00	5.80E+02
2036	6.89E+01	2.15E+02	4.56E+02	1.68E+01	7.56E+02	1.00E+02	3.27E+02	1.26E+01	1.87E+02	4.80E+01	2.58E+00	6.77E+02	9.95E+01	3.27E+02	1.79E+01	2.29E+02	5.55E-01	2.82E+00	6.77E+02
2037	7.65E+01	2.38E+02	5.29E+02	1.91E+01	8.63E+02	1.16E+02	3.79E+02	1.38E+01	2.04E+02	5.74E+01	2.58E+00	7.73E+02	1.15E+02	3.79E+02	2.01E+01	2.55E+02	5.55E-01	2.82E+00	7.73E+02
2038	8.39E+01	2.61E+02	6.02E+02	2.10E+01	9.68E+02	1.32E+02	4.31E+02	1.49E+01	2.20E+02	6.70E+01	2.58E+00	8.68E+02	1.31E+02	4.31E+02	2.22E+01	2.79E+02	5.55E-01	2.82E+00	8.68E+02
2039	9.10E+01	2.84E+02	6.75E+02	2.26E+01	1.07E+03	1.48E+02	4.84E+02	1.59E+01	2.35E+02	7.67E+01	2.58E+00	9.63E+02	1.47E+02	4.84E+02	2.43E+01	3.03E+02	5.55E-01	2.82E+00	9.62E+02
2040	9.80E+01	3.05E+02	7.47E+02	2.38E+01	1.17E+03	1.64E+02	5.36E+02	1.69E+01	2.50E+02	8.64E+01	2.58E+00	1.06E+03	1.63E+02	5.36E+02	2.63E+01	3.26E+02	5.55E-01	2.82E+00	1.05E+03
2041	1.05E+02	3.26E+02	8.20E+02	2.46E+01	1.28E+03	1.80E+02	5.88E+02	1.77E+01	2.63E+02	9.61E+01	2.58E+00	1.15E+03	1.79E+02	5.88E+02	2.82E+01	3.48E+02	5.55E-01	2.82E+00	1.15E+03
2042	1.11E+02	3.47E+02	8.93E+02	2.50E+01	1.38E+03	1.96E+02	6.41E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	1.24E+03	1.95E+02	6.41E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	1.24E+03
2043	1.18E+02	3.67E+02	9.66E+02	2.52E+01	1.48E+03	2.12E+02	6.93E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	1.33E+03	2.11E+02	6.93E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	1.33E+03
2044	1.24E+02	3.86E+02	1.04E+03	2.52E+01	1.57E+03	2.28E+02	7.45E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	1.42E+03	2.27E+02	7.45E+02	3.37E+01	4.08E+02	5.93E-01	2.82E+00	1.42E+03
2045	1.30E+02	4.05E+02	1.11E+03	2.52E+01	1.67E+03	2.44E+02	7.97E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	1.51E+03	2.43E+02	7.97E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	1.51E+03
2046	1.36E+02	4.24E+02	1.19E+03	2.52E+01	1.77E+03	2.60E+02	8.50E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	1.60E+03	2.59E+02	8.50E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	1.59E+03
2047	1.42E+02	4.41E+02	1.26E+03	2.52E+01	1.87E+03	2.76E+02	9.02E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	1.68E+03	2.75E+02	9.02E+02	3.89E+01	4.62E+02	1.53E+00	2.82E+00	1.68E+03
2048	1.47E+02	4.59E+02	1.33E+03	2.52E+01	1.96E+03	2.92E+02	9.54E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	1.77E+03	2.90E+02	9.54E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	1.77E+03
2049	1.53E+02	4.76E+02	1.40E+03	2.52E+01	2.06E+03	3.08E+02	1.01E+03	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.86E+03	3.06E+02	1.01E+03	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.86E+03
2050	1.58E+02	4.92E+02	1.48E+03	2.52E+01	2.15E+03	3.24E+02	1.06E+03	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.94E+03	3.22E+02	1.06E+03	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.94E+03
2051	1.63E+02	5.08E+02	1.55E+03	2.52E+01	2.25E+03	3.40E+02	1.11E+03	2.41E+01	3.57E+02	1.96E+02	2.58E+00	2.03E+03	3.38E+02	1.11E+03	4.55E+01	5.27E+02	4.41E+00	2.82E+00	2.03E+03
2052	1.68E+02	5.24E+02	1.62E+03	2.52E+01	2.34E+03	3.56E+02	1.16E+03	2.45E+01	3.63E+02	2.06E+02	2.58E+00	2.12E+03	3.54E+02	1.16E+03	4.70E+01	5.42E+02	5.39E+00	2.82E+00	2.11E+03
2053	1.73E+02	5.39E+02	1.70E+03	2.52E+01	2.43E+03	3.72E+02	1.22E+03	2.49E+01	3.69E+02	2.17E+02	2.58E+00	2.20E+03	3.70E+02	1.22E+03	4.86E+01	5.56E+02	6.55E+00	2.82E+00	2.20E+03
2054	1.78E+02	5.54E+02	1.77E+03	2.52E+01	2.53E+03	3.88E+02	1.27E+03	2.53E+01	3.75E+02	2.27E+02	2.58E+00	2.29E+03	3.86E+02	1.27E+03	5.01E+01	5.69E+02	7.82E+00	2.82E+00	2.28E+03
2055	1.83E+02	5.68E+02	1.84E+03	2.52E+01	2.62E+03	4.04E+02	1.32E+03	2.57E+01	3.80E+02	2.37E+02	2.58E+00	2.37E+03	4.02E+02	1.32E+03	5.16E+01	5.83E+02	9.14E+00	2.82E+00	2.37E+03
2056	1.87E+02	5.82E+02	1.91E+03	2.52E+01	2.71E+03	4.20E+02	1.37E+03	2.60E+01	3.85E+02	2.47E+02	2.58E+00	2.45E+03	4.18E+02	1.37E+03	5.30E+01	5.96E+02	1.04E+01	2.82E+00	2.45E+03
2057	1.91E+02	5.96E+02	1.99E+03	2.52E+01	2.80E+03	4.36E+02	1.43E+03	2.63E+01	3.90E+02	2.57E+02	2.58E+00	2.54E+03	4.34E+02	1.43E+03	5.44E+01	6.08E+02	1.17E+01	2.82E+00	2.54E+03
2058	1.96E+02	6.10E+02	2.05E+03	2.52E+01	2.88E+03	4.51E+02	1.47E+03	2.66E+01	3.94E+02	2.67E+02	2.58E+00	2.61E+03	4.48E+02	1.47E+03	5.58E+01	6.20E+02	1.32E+01	2.82E+00	2.61E+03
2059	2.00E+02	6.23E+02	2.10E+03	2.52E+01	2.95E+03	4.62E+02	1.51E+03	2.69E+01	3.98E+02	2.78E+02	2.58E+00	2.68E+03	4.59E+02	1.51E+03	5.72E+01	6.31E+02	1.56E+01	2.82E+00	2.68E+03
2060	2.04E+02	6.35E+02	2.15E+03	2.52E+01	3.01E+03	4.71E+02	1.54E+03	2.71E+01	4.02E+02	2.88E+02	2.58E+00	2.73E+03	4.69E+02	1.54E+03	5.86E+01	6.41E+02	1.87E+01	2.82E+00	2.73E+03
2061	2.08E+02	6.47E+02	2.18E+03	2.52E+01	3.06E+03	4.79E+02	1.56E+03	2.74E+01	4.05E+02	2.97E+02	2.58E+00	2.77E+03	4.76E+02	1.56E+03	5.99E+01	6.50E+02	2.26E+01	2.82E+00	2.77E+03

Exhibit E-23. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	1.22E+01	0.00E+00	5.13E+01	2.67E+00	8.72E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	4.53E+01	2.65E+00	8.72E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	4.55E+01
2030	1.87E+01	5.84E+01	4.25E+01	0.00E+00	1.20E+02	9.34E+00	3.05E+01	3.79E+00	5.61E+01	2.50E+00	2.46E+00	1.05E+02	9.28E+00	3.05E+01	4.06E+00	5.79E+01	5.55E-01	2.70E+00	1.05E+02
2031	2.77E+01	8.63E+01	9.73E+01	1.16E+00	2.12E+02	2.14E+01	6.97E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.87E+02	2.12E+01	6.97E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.87E+02
2032	3.64E+01	1.13E+02	1.64E+02	3.83E+00	3.18E+02	3.60E+01	1.18E+02	7.12E+00	1.05E+02	1.29E+01	2.58E+00	2.82E+02	3.58E+01	1.18E+02	8.53E+00	1.16E+02	5.55E-01	2.82E+00	2.82E+02
2033	4.49E+01	1.40E+02	2.37E+02	7.41E+00	4.29E+02	5.20E+01	1.70E+02	8.63E+00	1.28E+02	2.09E+01	2.58E+00	3.82E+02	5.17E+01	1.70E+02	1.09E+01	1.46E+02	5.55E-01	2.82E+00	3.82E+02
2034	5.31E+01	1.66E+02	3.10E+02	1.10E+01	5.40E+02	6.81E+01	2.22E+02	1.01E+01	1.49E+02	2.97E+01	2.58E+00	4.82E+02	6.76E+01	2.22E+02	1.33E+01	1.75E+02	5.55E-01	2.82E+00	4.81E+02
2035	6.12E+01	1.90E+02	3.83E+02	1.42E+01	6.49E+02	8.41E+01	2.75E+02	1.14E+01	1.69E+02	3.88E+01	2.58E+00	5.80E+02	8.36E+01	2.75E+02	1.56E+01	2.03E+02	5.55E-01	2.82E+00	5.80E+02
2036	6.89E+01	2.15E+02	4.56E+02	1.68E+01	7.56E+02	1.00E+02	3.27E+02	1.26E+01	1.87E+02	4.80E+01	2.58E+00	6.77E+02	9.95E+01	3.27E+02	1.79E+01	2.29E+02	5.55E-01	2.82E+00	6.77E+02
2037	7.65E+01	2.38E+02	5.29E+02	1.91E+01	8.63E+02	1.16E+02	3.79E+02	1.38E+01	2.04E+02	5.74E+01	2.58E+00	7.73E+02	1.15E+02	3.79E+02	2.01E+01	2.55E+02	5.55E-01	2.82E+00	7.73E+02
2038	8.39E+01	2.61E+02	6.02E+02	2.10E+01	9.68E+02	1.32E+02	4.32E+02	1.49E+01	2.20E+02	6.70E+01	2.58E+00	8.69E+02	1.31E+02	4.32E+02	2.22E+01	2.79E+02	5.55E-01	2.82E+00	8.68E+02
2039	9.10E+01	2.84E+02	6.75E+02	2.26E+01	1.07E+03	1.48E+02	4.84E+02	1.59E+01	2.35E+02	7.67E+01	2.58E+00	9.63E+02	1.47E+02	4.84E+02	2.43E+01	3.03E+02	5.55E-01	2.82E+00	9.62E+02
2040	9.80E+01	3.05E+02	7.48E+02	2.38E+01	1.17E+03	1.64E+02	5.36E+02	1.69E+01	2.50E+02	8.64E+01	2.58E+00	1.06E+03	1.63E+02	5.36E+02	2.63E+01	3.26E+02	5.55E-01	2.82E+00	1.05E+03
2041	1.05E+02	3.26E+02	8.21E+02	2.46E+01	1.28E+03	1.80E+02	5.88E+02	1.77E+01	2.63E+02	9.61E+01	2.58E+00	1.15E+03	1.79E+02	5.88E+02	2.82E+01	3.48E+02	5.55E-01	2.82E+00	1.15E+03
2042	1.11E+02	3.47E+02	8.94E+02	2.50E+01	1.38E+03	1.96E+02	6.41E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	1.24E+03	1.95E+02	6.41E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	1.24E+03
2043	1.18E+02	3.67E+02	9.66E+02	2.52E+01	1.48E+03	2.12E+02	6.93E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	1.33E+03	2.11E+02	6.93E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	1.33E+03
2044	1.24E+02	3.86E+02	1.04E+03	2.52E+01	1.57E+03	2.28E+02	7.45E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	1.42E+03	2.27E+02	7.45E+02	3.37E+01	4.08E+02	5.93E-01	2.82E+00	1.42E+03
2045	1.30E+02	4.05E+02	1.11E+03	2.52E+01	1.67E+03	2.44E+02	7.98E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	1.51E+03	2.43E+02	7.98E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	1.51E+03
2046	1.36E+02	4.24E+02	1.19E+03	2.52E+01	1.77E+03	2.60E+02	8.50E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	1.60E+03	2.59E+02	8.50E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	1.59E+03
2047	1.42E+02	4.41E+02	1.26E+03	2.52E+01	1.87E+03	2.76E+02	9.02E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	1.68E+03	2.75E+02	9.02E+02	3.89E+01	4.62E+02	1.53E+00	2.82E+00	1.68E+03
2048	1.47E+02	4.59E+02	1.33E+03	2.52E+01	1.96E+03	2.92E+02	9.55E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	1.77E+03	2.90E+02	9.55E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	1.77E+03
2049	1.53E+02	4.76E+02	1.40E+03	2.52E+01	2.06E+03	3.08E+02	1.01E+03	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.86E+03	3.06E+02	1.01E+03	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.86E+03
2050	1.58E+02	4.92E+02	1.48E+03	2.52E+01	2.15E+03	3.24E+02	1.06E+03	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.95E+03	3.22E+02	1.06E+03	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.94E+03
2051	1.63E+02	5.08E+02	1.55E+03	2.52E+01	2.25E+03	3.40E+02	1.11E+03	2.41E+01	3.57E+02	1.96E+02	2.58E+00	2.03E+03	3.38E+02	1.11E+03	4.55E+01	5.27E+02	4.41E+00	2.82E+00	2.03E+03
2052	1.68E+02	5.24E+02	1.62E+03	2.52E+01	2.34E+03	3.56E+02	1.16E+03	2.45E+01	3.63E+02	2.06E+02	2.58E+00	2.12E+03	3.54E+02	1.16E+03	4.70E+01	5.42E+02	5.39E+00	2.82E+00	2.11E+03
2053	1.73E+02	5.39E+02	1.70E+03	2.52E+01	2.43E+03	3.72E+02	1.22E+03	2.49E+01	3.69E+02	2.17E+02	2.58E+00	2.20E+03	3.70E+02	1.22E+03	4.86E+01	5.56E+02	6.55E+00	2.82E+00	2.20E+03
2054	1.78E+02	5.54E+02	1.77E+03	2.52E+01	2.53E+03	3.88E+02	1.27E+03	2.53E+01	3.75E+02	2.27E+02	2.58E+00	2.29E+03	3.86E+02	1.27E+03	5.01E+01	5.69E+02	7.82E+00	2.82E+00	2.28E+03
2055	1.83E+02	5.68E+02	1.84E+03	2.52E+01	2.62E+03	4.04E+02	1.32E+03	2.57E+01	3.80E+02	2.37E+02	2.58E+00	2.37E+03	4.02E+02	1.32E+03	5.16E+01	5.83E+02	9.14E+00	2.82E+00	2.37E+03
2056	1.87E+02	5.82E+02	1.91E+03	2.52E+01	2.71E+03	4.20E+02	1.37E+03	2.60E+01	3.85E+02	2.47E+02	2.58E+00	2.45E+03	4.18E+02	1.37E+03	5.30E+01	5.96E+02	1.04E+01	2.82E+00	2.45E+03
2057	1.91E+02	5.96E+02	1.99E+03	2.52E+01	2.80E+03	4.36E+02	1.43E+03	2.63E+01	3.90E+02	2.57E+02	2.58E+00	2.54E+03	4.34E+02	1.43E+03	5.44E+01	6.08E+02	1.17E+01	2.82E+00	2.54E+03
2058	1.96E+02	6.10E+02	2.05E+03	2.52E+01	2.88E+03	4.51E+02	1.47E+03	2.66E+01	3.94E+02	2.67E+02	2.58E+00	2.61E+03	4.48E+02	1.47E+03	5.58E+01	6.20E+02	1.32E+01	2.82E+00	2.61E+03
2059	2.00E+02	6.23E+02	2.11E+03	2.52E+01	2.95E+03	4.62E+02	1.51E+03	2.69E+01	3.98E+02	2.78E+02	2.58E+00	2.68E+03	4.59E+02	1.51E+03	5.72E+01	6.31E+02	1.56E+01	2.82E+00	2.68E+03
2060	2.04E+02	6.35E+02	2.15E+03	2.52E+01	3.01E+03	4.71E+02	1.54E+03	2.71E+01	4.02E+02	2.88E+02	2.58E+00	2.73E+03	4.69E+02	1.54E+03	5.86E+01	6.41E+02	1.87E+01	2.82E+00	2.73E+03
2061	2.08E+02	6.47E+02	2.18E+03	2.52E+01	3.06E+03	4.79E+02	1.56E+03	2.74E+01	4.05E+02	2.97E+02	2.58E+00	2.78E+03	4.76E+02	1.56E+03	5.99E+01	6.50E+02	2.26E+01	2.82E+00	2.77E+03

Exhibit E-24. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	1.21E+01	0.00E+00	5.12E+01	2.67E+00	9.01E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	4.56E+01	2.65E+00	9.01E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	4.58E+01
2030	1.87E+01	5.84E+01	4.25E+01	0.00E+00	1.20E+02	9.34E+00	3.15E+01	3.79E+00	5.61E+01	2.50E+00	2.46E+00	1.06E+02	9.28E+00	3.15E+01	4.06E+00	5.79E+01	5.55E-01	2.70E+00	1.06E+02
2031	2.77E+01	8.63E+01	9.71E+01	1.16E+00	2.12E+02	2.14E+01	7.21E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.90E+02	2.12E+01	7.21E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.90E+02
2032	3.64E+01	1.13E+02	1.64E+02	3.83E+00	3.18E+02	3.60E+01	1.22E+02	7.12E+00	1.05E+02	1.29E+01	2.58E+00	2.86E+02	3.58E+01	1.22E+02	8.52E+00	1.16E+02	5.55E-01	2.82E+00	2.86E+02
2033	4.49E+01	1.40E+02	2.37E+02	7.41E+00	4.29E+02	5.20E+01	1.76E+02	8.63E+00	1.28E+02	2.09E+01	2.58E+00	3.88E+02	5.17E+01	1.76E+02	1.09E+01	1.46E+02	5.55E-01	2.82E+00	3.88E+02
2034	5.31E+01	1.66E+02	3.09E+02	1.10E+01	5.39E+02	6.81E+01	2.30E+02	1.01E+01	1.49E+02	2.97E+01	2.58E+00	4.89E+02	6.76E+01	2.30E+02	1.33E+01	1.75E+02	5.55E-01	2.82E+00	4.89E+02
2035	6.12E+01	1.90E+02	3.82E+02	1.42E+01	6.48E+02	8.41E+01	2.84E+02	1.14E+01	1.69E+02	3.88E+01	2.58E+00	5.89E+02	8.36E+01	2.84E+02	1.56E+01	2.03E+02	5.55E-01	2.82E+00	5.89E+02
2036	6.89E+01	2.15E+02	4.55E+02	1.68E+01	7.55E+02	1.00E+02	3.38E+02	1.26E+01	1.87E+02	4.80E+01	2.58E+00	6.88E+02	9.95E+01	3.38E+02	1.79E+01	2.29E+02	5.55E-01	2.82E+00	6.88E+02
2037	7.65E+01	2.38E+02	5.28E+02	1.91E+01	8.62E+02	1.16E+02	3.92E+02	1.38E+01	2.04E+02	5.74E+01	2.58E+00	7.86E+02	1.15E+02	3.92E+02	2.01E+01	2.55E+02	5.55E-01	2.82E+00	7.85E+02
2038	8.39E+01	2.61E+02	6.01E+02	2.10E+01	9.67E+02	1.32E+02	4.46E+02	1.49E+01	2.20E+02	6.70E+01	2.58E+00	8.83E+02	1.31E+02	4.46E+02	2.22E+01	2.79E+02	5.55E-01	2.82E+00	8.82E+02
2039	9.10E+01	2.84E+02	6.73E+02	2.26E+01	1.07E+03	1.48E+02	5.00E+02	1.59E+01	2.35E+02	7.67E+01	2.58E+00	9.79E+02	1.47E+02	5.00E+02	2.43E+01	3.03E+02	5.55E-01	2.82E+00	9.78E+02
2040	9.80E+01	3.05E+02	7.46E+02	2.38E+01	1.17E+03	1.64E+02	5.54E+02	1.69E+01	2.50E+02	8.64E+01	2.58E+00	1.07E+03	1.63E+02	5.54E+02	2.63E+01	3.26E+02	5.55E-01	2.82E+00	1.07E+03
2041	1.05E+02	3.26E+02	8.19E+02	2.46E+01	1.27E+03	1.80E+02	6.08E+02	1.77E+01	2.63E+02	9.61E+01	2.58E+00	1.17E+03	1.79E+02	6.08E+02	2.82E+01	3.48E+02	5.55E-01	2.82E+00	1.17E+03
2042	1.11E+02	3.47E+02	8.92E+02	2.50E+01	1.37E+03	1.96E+02	6.62E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	1.26E+03	1.95E+02	6.62E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	1.26E+03
2043	1.18E+02	3.67E+02	9.64E+02	2.52E+01	1.47E+03	2.12E+02	7.16E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	1.35E+03	2.11E+02	7.16E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	1.35E+03
2044	1.24E+02	3.86E+02	1.04E+03	2.52E+01	1.57E+03	2.28E+02	7.70E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	1.44E+03	2.27E+02	7.70E+02	3.37E+01	4.08E+02	5.93E-01	2.82E+00	1.44E+03
2045	1.30E+02	4.05E+02	1.11E+03	2.52E+01	1.67E+03	2.44E+02	8.24E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	1.53E+03	2.43E+02	8.24E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	1.53E+03
2046	1.36E+02	4.24E+02	1.18E+03	2.52E+01	1.77E+03	2.60E+02	8.78E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	1.62E+03	2.59E+02	8.78E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	1.62E+03
2047	1.42E+02	4.41E+02	1.26E+03	2.52E+01	1.86E+03	2.76E+02	9.32E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	1.71E+03	2.75E+02	9.32E+02	3.89E+01	4.62E+02	1.53E+00	2.82E+00	1.71E+03
2048	1.47E+02	4.59E+02	1.33E+03	2.52E+01	1.96E+03	2.92E+02	9.86E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	1.80E+03	2.90E+02	9.86E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	1.80E+03
2049	1.53E+02	4.76E+02	1.40E+03	2.52E+01	2.06E+03	3.08E+02	1.04E+03	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.89E+03	3.06E+02	1.04E+03	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.89E+03
2050	1.58E+02	4.92E+02	1.47E+03	2.52E+01	2.15E+03	3.24E+02	1.09E+03	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.98E+03	3.22E+02	1.09E+03	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.98E+03
2051	1.63E+02	5.08E+02	1.55E+03	2.52E+01	2.24E+03	3.40E+02	1.15E+03	2.41E+01	3.57E+02	1.96E+02	2.58E+00	2.07E+03	3.38E+02	1.15E+03	4.55E+01	5.27E+02	4.41E+00	2.82E+00	2.07E+03
2052	1.68E+02	5.24E+02	1.62E+03	2.52E+01	2.34E+03	3.56E+02	1.20E+03	2.45E+01	3.63E+02	2.06E+02	2.58E+00	2.16E+03	3.54E+02	1.20E+03	4.70E+01	5.42E+02	5.39E+00	2.82E+00	2.15E+03
2053	1.73E+02	5.39E+02	1.69E+03	2.52E+01	2.43E+03	3.72E+02	1.26E+03	2.49E+01	3.69E+02	2.17E+02	2.58E+00	2.24E+03	3.70E+02	1.26E+03	4.86E+01	5.56E+02	6.55E+00	2.82E+00	2.24E+03
2054	1.78E+02	5.54E+02	1.77E+03	2.52E+01	2.52E+03	3.88E+02	1.31E+03	2.53E+01	3.75E+02	2.27E+02	2.58E+00	2.33E+03	3.86E+02	1.31E+03	5.01E+01	5.69E+02	7.82E+00	2.82E+00	2.33E+03
2055	1.83E+02	5.68E+02	1.84E+03	2.52E+01	2.61E+03	4.04E+02	1.36E+03	2.57E+01	3.80E+02	2.37E+02	2.58E+00	2.41E+03	4.02E+02	1.36E+03	5.16E+01	5.83E+02	9.14E+00	2.82E+00	2.41E+03
2056	1.87E+02	5.82E+02	1.91E+03	2.52E+01	2.71E+03	4.20E+02	1.42E+03	2.60E+01	3.85E+02	2.47E+02	2.58E+00	2.50E+03	4.18E+02	1.42E+03	5.30E+01	5.96E+02	1.04E+01	2.82E+00	2.50E+03
2057	1.91E+02	5.96E+02	1.98E+03	2.52E+01	2.80E+03	4.36E+02	1.47E+03	2.63E+01	3.90E+02	2.57E+02	2.58E+00	2.58E+03	4.34E+02	1.47E+03	5.44E+01	6.08E+02	1.17E+01	2.82E+00	2.58E+03
2058	1.96E+02	6.10E+02	2.05E+03	2.52E+01	2.88E+03	4.51E+02	1.52E+03	2.66E+01	3.94E+02	2.67E+02	2.58E+00	2.66E+03	4.48E+02	1.52E+03	5.58E+01	6.20E+02	1.32E+01	2.82E+00	2.66E+03
2059	2.00E+02	6.23E+02	2.10E+03	2.52E+01	2.95E+03	4.62E+02	1.56E+03	2.69E+01	3.98E+02	2.78E+02	2.58E+00	2.73E+03	4.59E+02	1.56E+03	5.72E+01	6.31E+02	1.56E+01	2.82E+00	2.73E+03
2060	2.04E+02	6.35E+02	2.14E+03	2.52E+01	3.01E+03	4.71E+02	1.59E+03	2.71E+01	4.02E+02	2.88E+02	2.58E+00	2.78E+03	4.69E+02	1.59E+03	5.86E+01	6.41E+02	1.87E+01	2.82E+00	2.78E+03
2061	2.08E+02	6.47E+02	2.18E+03	2.52E+01	3.06E+03	4.79E+02	1.62E+03	2.74E+01	4.05E+02	2.97E+02	2.58E+00	2.83E+03	4.76E+02	1.62E+03	5.99E+01	6.50E+02	2.26E+01	2.82E+00	2.83E+03

Exhibit E-25. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	4.85E+00	0.00E+00	4.40E+01	2.67E+00	1.45E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	3.80E+01	2.65E+00	1.45E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	3.83E+01
2030	1.87E+01	5.84E+01	1.70E+01	0.00E+00	9.41E+01	9.34E+00	5.06E+00	3.79E+00	5.61E+01	2.50E+00	2.46E+00	7.93E+01	9.29E+00	5.06E+00	4.07E+00	5.79E+01	5.55E-01	2.70E+00	7.95E+01
2031	2.77E+01	8.63E+01	3.88E+01	1.16E+00	1.54E+02	2.14E+01	1.16E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.29E+02	2.12E+01	1.16E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.29E+02
2032	3.64E+01	1.13E+02	6.55E+01	3.83E+00	2.19E+02	3.60E+01	1.95E+01	7.12E+00	1.05E+02	1.29E+01	2.58E+00	1.84E+02	3.58E+01	1.95E+01	8.53E+00	1.16E+02	5.55E-01	2.82E+00	1.84E+02
2033	4.49E+01	1.40E+02	9.47E+01	7.41E+00	2.87E+02	5.21E+01	2.82E+01	8.64E+00	1.28E+02	2.09E+01	2.58E+00	2.40E+02	5.17E+01	2.82E+01	1.09E+01	1.46E+02	5.55E-01	2.82E+00	2.40E+02
2034	5.31E+01	1.66E+02	1.24E+02	1.10E+01	3.53E+02	6.81E+01	3.69E+01	1.01E+01	1.49E+02	2.97E+01	2.58E+00	2.96E+02	6.77E+01	3.69E+01	1.33E+01	1.75E+02	5.55E-01	2.82E+00	2.96E+02
2035	6.12E+01	1.90E+02	1.53E+02	1.42E+01	4.19E+02	8.41E+01	4.56E+01	1.14E+01	1.69E+02	3.88E+01	2.58E+00	3.51E+02	8.36E+01	4.56E+01	1.56E+01	2.03E+02	5.55E-01	2.82E+00	3.51E+02
2036	6.90E+01	2.15E+02	1.82E+02	1.68E+01	4.83E+02	1.00E+02	5.43E+01	1.26E+01	1.87E+02	4.80E+01	2.58E+00	4.05E+02	9.95E+01	5.43E+01	1.79E+01	2.29E+02	5.55E-01	2.82E+00	4.04E+02
2037	7.65E+01	2.38E+02	2.11E+02	1.91E+01	5.45E+02	1.16E+02	6.30E+01	1.38E+01	2.04E+02	5.74E+01	2.58E+00	4.57E+02	1.15E+02	6.30E+01	2.01E+01	2.55E+02	5.55E-01	2.82E+00	4.57E+02
2038	8.39E+01	2.61E+02	2.40E+02	2.10E+01	6.06E+02	1.32E+02	7.16E+01	1.49E+01	2.20E+02	6.70E+01	2.58E+00	5.09E+02	1.31E+02	7.16E+01	2.22E+01	2.79E+02	5.55E-01	2.82E+00	5.08E+02
2039	9.10E+01	2.84E+02	2.69E+02	2.26E+01	6.67E+02	1.48E+02	8.03E+01	1.59E+01	2.35E+02	7.67E+01	2.58E+00	5.59E+02	1.47E+02	8.03E+01	2.43E+01	3.03E+02	5.55E-01	2.82E+00	5.58E+02
2040	9.80E+01	3.05E+02	2.99E+02	2.38E+01	7.26E+02	1.64E+02	8.90E+01	1.69E+01	2.50E+02	8.64E+01	2.58E+00	6.09E+02	1.63E+02	8.90E+01	2.63E+01	3.26E+02	5.55E-01	2.82E+00	6.08E+02
2041	1.05E+02	3.26E+02	3.28E+02	2.46E+01	7.83E+02	1.80E+02	9.77E+01	1.78E+01	2.63E+02	9.61E+01	2.58E+00	6.57E+02	1.79E+02	9.77E+01	2.83E+01	3.48E+02	5.55E-01	2.82E+00	6.56E+02
2042	1.11E+02	3.47E+02	3.57E+02	2.50E+01	8.40E+02	1.96E+02	1.06E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	7.05E+02	1.95E+02	1.06E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	7.04E+02
2043	1.18E+02	3.67E+02	3.86E+02	2.52E+01	8.96E+02	2.12E+02	1.15E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	7.51E+02	2.11E+02	1.15E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	7.50E+02
2044	1.24E+02	3.86E+02	4.15E+02	2.52E+01	9.51E+02	2.28E+02	1.24E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	7.97E+02	2.27E+02	1.24E+02	3.38E+01	4.08E+02	5.93E-01	2.82E+00	7.96E+02
2045	1.30E+02	4.05E+02	4.44E+02	2.52E+01	1.00E+03	2.44E+02	1.32E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	8.43E+02	2.43E+02	1.32E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	8.41E+02
2046	1.36E+02	4.24E+02	4.73E+02	2.52E+01	1.06E+03	2.60E+02	1.41E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	8.87E+02	2.59E+02	1.41E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	8.86E+02
2047	1.42E+02	4.41E+02	5.02E+02	2.52E+01	1.11E+03	2.76E+02	1.50E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	9.32E+02	2.75E+02	1.50E+02	3.90E+01	4.62E+02	1.53E+00	2.82E+00	9.30E+02
2048	1.47E+02	4.59E+02	5.32E+02	2.52E+01	1.16E+03	2.92E+02	1.58E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	9.76E+02	2.91E+02	1.58E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	9.74E+02
2049	1.53E+02	4.76E+02	5.61E+02	2.52E+01	1.21E+03	3.08E+02	1.67E+02	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.02E+03	3.06E+02	1.67E+02	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.02E+03
2050	1.58E+02	4.92E+02	5.90E+02	2.52E+01	1.27E+03	3.24E+02	1.76E+02	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.06E+03	3.22E+02	1.76E+02	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.06E+03
2051	1.63E+02	5.08E+02	6.19E+02	2.52E+01	1.32E+03	3.40E+02	1.85E+02	2.41E+01	3.57E+02	1.96E+02	2.58E+00	1.10E+03	3.38E+02	1.85E+02	4.55E+01	5.27E+02	4.41E+00	2.82E+00	1.10E+03
2052	1.68E+02	5.24E+02	6.48E+02	2.52E+01	1.37E+03	3.56E+02	1.93E+02	2.45E+01	3.63E+02	2.06E+02	2.58E+00	1.15E+03	3.54E+02	1.93E+02	4.71E+01	5.42E+02	5.39E+00	2.82E+00	1.14E+03
2053	1.73E+02	5.39E+02	6.77E+02	2.52E+01	1.41E+03	3.72E+02	2.02E+02	2.49E+01	3.69E+02	2.17E+02	2.58E+00	1.19E+03	3.70E+02	2.02E+02	4.86E+01	5.56E+02	6.55E+00	2.82E+00	1.19E+03
2054	1.78E+02	5.54E+02	7.06E+02	2.52E+01	1.46E+03	3.88E+02	2.11E+02	2.53E+01	3.75E+02	2.27E+02	2.58E+00	1.23E+03	3.86E+02	2.11E+02	5.01E+01	5.69E+02	7.82E+00	2.82E+00	1.23E+03
2055	1.83E+02	5.68E+02	7.35E+02	2.52E+01	1.51E+03	4.04E+02	2.19E+02	2.57E+01	3.80E+02	2.37E+02	2.58E+00	1.27E+03	4.02E+02	2.19E+02	5.16E+01	5.83E+02	9.14E+00	2.82E+00	1.27E+03
2056	1.87E+02	5.82E+02	7.65E+02	2.52E+01	1.56E+03	4.20E+02	2.28E+02	2.60E+01	3.85E+02	2.47E+02	2.58E+00	1.31E+03	4.18E+02	2.28E+02	5.30E+01	5.96E+02	1.04E+01	2.82E+00	1.31E+03
2057	1.91E+02	5.96E+02	7.94E+02	2.52E+01	1.61E+03	4.36E+02	2.37E+02	2.63E+01	3.90E+02	2.57E+02	2.58E+00	1.35E+03	4.34E+02	2.37E+02	5.45E+01	6.08E+02	1.17E+01	2.82E+00	1.35E+03
2058	1.96E+02	6.10E+02	8.20E+02	2.52E+01	1.65E+03	4.51E+02	2.44E+02	2.66E+01	3.94E+02	2.67E+02	2.58E+00	1.39E+03	4.48E+02	2.44E+02	5.58E+01	6.20E+02	1.32E+01	2.82E+00	1.38E+03
2059	2.00E+02	6.23E+02	8.41E+02	2.52E+01	1.69E+03	4.62E+02	2.51E+02	2.69E+01	3.98E+02	2.78E+02	2.58E+00	1.42E+03	4.59E+02	2.51E+02	5.72E+01	6.31E+02	1.56E+01	2.82E+00	1.42E+03
2060	2.04E+02	6.35E+02	8.57E+02	2.52E+01	1.72E+03	4.71E+02	2.56E+02	2.72E+01	4.02E+02	2.88E+02	2.58E+00	1.45E+03	4.69E+02	2.56E+02	5.86E+01	6.41E+02	1.87E+01	2.82E+00	1.45E+03
2061	2.08E+02	6.47E+02	8.71E+02	2.52E+01	1.75E+03	4.79E+02	2.60E+02	2.74E+01	4.05E+02	2.97E+02	2.58E+00	1.47E+03	4.76E+02	2.60E+02	5.99E+01	6.50E+02	2.26E+01	2.82E+00	1.47E+03

Exhibit E-26. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	4.93E+00	0.00E+00	4.40E+01	2.67E+00	1.52E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	3.81E+01	2.65E+00	1.52E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	3.83E+01
2030	1.87E+01	5.84E+01	1.73E+01	0.00E+00	9.44E+01	9.34E+00	5.31E+00	3.79E+00	5.61E+01	2.50E+00	2.46E+00	7.95E+01	9.29E+00	5.31E+00	4.07E+00	5.79E+01	5.55E-01	2.70E+00	7.98E+01
2031	2.77E+01	8.63E+01	3.95E+01	1.16E+00	1.55E+02	2.14E+01	1.21E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.30E+02	2.12E+01	1.21E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.30E+02
2032	3.64E+01	1.13E+02	6.66E+01	3.83E+00	2.20E+02	3.60E+01	2.05E+01	7.12E+00	1.05E+02	1.29E+01	2.58E+00	1.85E+02	3.58E+01	2.05E+01	8.53E+00	1.16E+02	5.55E-01	2.82E+00	1.85E+02
2033	4.49E+01	1.40E+02	9.62E+01	7.41E+00	2.88E+02	5.21E+01	2.96E+01	8.64E+00	1.28E+02	2.09E+01	2.58E+00	2.42E+02	5.17E+01	2.96E+01	1.09E+01	1.46E+02	5.55E-01	2.82E+00	2.42E+02
2034	5.31E+01	1.66E+02	1.26E+02	1.10E+01	3.56E+02	6.81E+01	3.87E+01	1.01E+01	1.49E+02	2.97E+01	2.58E+00	2.98E+02	6.77E+01	3.87E+01	1.33E+01	1.75E+02	5.55E-01	2.82E+00	2.98E+02
2035	6.12E+01	1.90E+02	1.55E+02	1.42E+01	4.21E+02	8.41E+01	4.78E+01	1.14E+01	1.69E+02	3.88E+01	2.58E+00	3.53E+02	8.36E+01	4.78E+01	1.56E+01	2.03E+02	5.55E-01	2.82E+00	3.53E+02
2036	6.89E+01	2.15E+02	1.85E+02	1.68E+01	4.86E+02	1.00E+02	5.69E+01	1.26E+01	1.87E+02	4.80E+01	2.58E+00	4.07E+02	9.95E+01	5.69E+01	1.79E+01	2.29E+02	5.55E-01	2.82E+00	4.07E+02
2037	7.65E+01	2.38E+02	2.15E+02	1.91E+01	5.49E+02	1.16E+02	6.60E+01	1.38E+01	2.04E+02	5.74E+01	2.58E+00	4.60E+02	1.15E+02	6.60E+01	2.01E+01	2.55E+02	5.55E-01	2.82E+00	4.60E+02
2038	8.39E+01	2.61E+02	2.44E+02	2.10E+01	6.10E+02	1.32E+02	7.51E+01	1.49E+01	2.20E+02	6.70E+01	2.58E+00	5.12E+02	1.31E+02	7.51E+01	2.22E+01	2.79E+02	5.55E-01	2.82E+00	5.11E+02
2039	9.10E+01	2.84E+02	2.74E+02	2.26E+01	6.71E+02	1.48E+02	8.42E+01	1.59E+01	2.35E+02	7.67E+01	2.58E+00	5.63E+02	1.47E+02	8.42E+01	2.43E+01	3.03E+02	5.55E-01	2.82E+00	5.62E+02
2040	9.80E+01	3.05E+02	3.03E+02	2.38E+01	7.31E+02	1.64E+02	9.33E+01	1.69E+01	2.50E+02	8.64E+01	2.58E+00	6.13E+02	1.63E+02	9.33E+01	2.63E+01	3.26E+02	5.55E-01	2.82E+00	6.12E+02
2041	1.05E+02	3.26E+02	3.33E+02	2.46E+01	7.89E+02	1.80E+02	1.02E+02	1.78E+01	2.63E+02	9.61E+01	2.58E+00	6.62E+02	1.79E+02	1.02E+02	2.83E+01	3.48E+02	5.55E-01	2.82E+00	6.61E+02
2042	1.11E+02	3.47E+02	3.63E+02	2.50E+01	8.46E+02	1.96E+02	1.11E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	7.10E+02	1.95E+02	1.11E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	7.09E+02
2043	1.18E+02	3.67E+02	3.92E+02	2.52E+01	9.02E+02	2.12E+02	1.21E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	7.57E+02	2.11E+02	1.21E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	7.56E+02
2044	1.24E+02	3.86E+02	4.22E+02	2.52E+01	9.57E+02	2.28E+02	1.30E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	8.03E+02	2.27E+02	1.30E+02	3.38E+01	4.08E+02	5.93E-01	2.82E+00	8.02E+02
2045	1.30E+02	4.05E+02	4.52E+02	2.52E+01	1.01E+03	2.44E+02	1.39E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	8.49E+02	2.43E+02	1.39E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	8.48E+02
2046	1.36E+02	4.24E+02	4.81E+02	2.52E+01	1.07E+03	2.60E+02	1.48E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	8.94E+02	2.59E+02	1.48E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	8.93E+02
2047	1.42E+02	4.41E+02	5.11E+02	2.52E+01	1.12E+03	2.76E+02	1.57E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	9.39E+02	2.75E+02	1.57E+02	3.90E+01	4.62E+02	1.53E+00	2.82E+00	9.37E+02
2048	1.47E+02	4.59E+02	5.40E+02	2.52E+01	1.17E+03	2.92E+02	1.66E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	9.83E+02	2.90E+02	1.66E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	9.82E+02
2049	1.53E+02	4.76E+02	5.70E+02	2.52E+01	1.22E+03	3.08E+02	1.75E+02	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.03E+03	3.06E+02	1.75E+02	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.03E+03
2050	1.58E+02	4.92E+02	6.00E+02	2.52E+01	1.28E+03	3.24E+02	1.84E+02	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.07E+03	3.22E+02	1.84E+02	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.07E+03
2051	1.63E+02	5.08E+02	6.29E+02	2.52E+01	1.33E+03	3.40E+02	1.93E+02	2.41E+01	3.57E+02	1.96E+02	2.58E+00	1.11E+03	3.38E+02	1.93E+02	4.55E+01	5.27E+02	4.41E+00	2.82E+00	1.11E+03
2052	1.68E+02	5.24E+02	6.59E+02	2.52E+01	1.38E+03	3.56E+02	2.02E+02	2.45E+01	3.63E+02	2.06E+02	2.58E+00	1.16E+03	3.54E+02	2.02E+02	4.71E+01	5.42E+02	5.39E+00	2.82E+00	1.15E+03
2053	1.73E+02	5.39E+02	6.88E+02	2.52E+01	1.43E+03	3.72E+02	2.12E+02	2.49E+01	3.69E+02	2.17E+02	2.58E+00	1.20E+03	3.70E+02	2.12E+02	4.86E+01	5.56E+02	6.55E+00	2.82E+00	1.20E+03
2054	1.78E+02	5.54E+02	7.18E+02	2.52E+01	1.48E+03	3.88E+02	2.21E+02	2.53E+01	3.75E+02	2.27E+02	2.58E+00	1.24E+03	3.86E+02	2.21E+02	5.01E+01	5.69E+02	7.82E+00	2.82E+00	1.24E+03
2055	1.83E+02	5.68E+02	7.48E+02	2.52E+01	1.52E+03	4.04E+02	2.30E+02	2.57E+01	3.80E+02	2.37E+02	2.58E+00	1.28E+03	4.02E+02	2.30E+02	5.16E+01	5.83E+02	9.14E+00	2.82E+00	1.28E+03
2056	1.87E+02	5.82E+02	7.77E+02	2.52E+01	1.57E+03	4.20E+02	2.39E+02	2.60E+01	3.85E+02	2.47E+02	2.58E+00	1.32E+03	4.18E+02	2.39E+02	5.30E+01	5.96E+02	1.04E+01	2.82E+00	1.32E+03
2057	1.91E+02	5.96E+02	8.07E+02	2.52E+01	1.62E+03	4.36E+02	2.48E+02	2.63E+01	3.90E+02	2.57E+02	2.58E+00	1.36E+03	4.34E+02	2.48E+02	5.45E+01	6.08E+02	1.17E+01	2.82E+00	1.36E+03
2058	1.96E+02	6.10E+02	8.33E+02	2.52E+01	1.66E+03	4.51E+02	2.56E+02	2.66E+01	3.94E+02	2.67E+02	2.58E+00	1.40E+03	4.48E+02	2.56E+02	5.58E+01	6.20E+02	1.32E+01	2.82E+00	1.40E+03
2059	2.00E+02	6.23E+02	8.55E+02	2.52E+01	1.70E+03	4.62E+02	2.63E+02	2.69E+01	3.98E+02	2.78E+02	2.58E+00	1.43E+03	4.59E+02	2.63E+02	5.72E+01	6.31E+02	1.56E+01	2.82E+00	1.43E+03
2060	2.04E+02	6.35E+02	8.72E+02	2.52E+01	1.74E+03	4.71E+02	2.68E+02	2.72E+01	4.02E+02	2.88E+02	2.58E+00	1.46E+03	4.69E+02	2.68E+02	5.86E+01	6.41E+02	1.87E+01	2.82E+00	1.46E+03
2061	2.08E+02	6.47E+02	8.85E+02	2.52E+01	1.77E+03	4.79E+02	2.72E+02	2.74E+01	4.05E+02	2.97E+02	2.58E+00	1.48E+03	4.76E+02	2.72E+02	5.99E+01	6.50E+02	2.26E+01	2.82E+00	1.48E+03

Exhibit E-27. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	4.94E+00	0.00E+00	4.40E+01	2.67E+00	1.52E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	3.81E+01	2.65E+00	1.52E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	3.83E+01
2030	1.87E+01	5.84E+01	1.73E+01	0.00E+00	9.44E+01	9.34E+00	5.32E+00	3.79E+00	5.61E+01	2.50E+00	2.46E+00	7.96E+01	9.29E+00	5.32E+00	4.07E+00	5.79E+01	5.55E-01	2.70E+00	7.98E+01
2031	2.77E+01	8.63E+01	3.95E+01	1.16E+00	1.55E+02	2.14E+01	1.22E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.30E+02	2.12E+01	1.22E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.30E+02
2032	3.64E+01	1.13E+02	6.67E+01	3.83E+00	2.20E+02	3.60E+01	2.05E+01	7.12E+00	1.05E+02	1.29E+01	2.58E+00	1.85E+02	3.58E+01	2.05E+01	8.53E+00	1.16E+02	5.55E-01	2.82E+00	1.85E+02
2033	4.49E+01	1.40E+02	9.63E+01	7.41E+00	2.88E+02	5.21E+01	2.96E+01	8.64E+00	1.28E+02	2.09E+01	2.58E+00	2.42E+02	5.17E+01	2.96E+01	1.09E+01	1.46E+02	5.55E-01	2.82E+00	2.42E+02
2034	5.31E+01	1.66E+02	1.26E+02	1.10E+01	3.56E+02	6.81E+01	3.88E+01	1.01E+01	1.49E+02	2.97E+01	2.58E+00	2.98E+02	6.77E+01	3.88E+01	1.33E+01	1.75E+02	5.55E-01	2.82E+00	2.98E+02
2035	6.12E+01	1.90E+02	1.56E+02	1.42E+01	4.21E+02	8.41E+01	4.79E+01	1.14E+01	1.69E+02	3.88E+01	2.58E+00	3.53E+02	8.36E+01	4.79E+01	1.56E+01	2.03E+02	5.55E-01	2.82E+00	3.53E+02
2036	6.89E+01	2.15E+02	1.85E+02	1.68E+01	4.86E+02	1.00E+02	5.70E+01	1.26E+01	1.87E+02	4.80E+01	2.58E+00	4.07E+02	9.95E+01	5.70E+01	1.79E+01	2.29E+02	5.55E-01	2.82E+00	4.07E+02
2037	7.65E+01	2.38E+02	2.15E+02	1.91E+01	5.49E+02	1.16E+02	6.61E+01	1.38E+01	2.04E+02	5.74E+01	2.58E+00	4.60E+02	1.15E+02	6.61E+01	2.01E+01	2.55E+02	5.55E-01	2.82E+00	4.60E+02
2038	8.39E+01	2.61E+02	2.44E+02	2.10E+01	6.11E+02	1.32E+02	7.52E+01	1.49E+01	2.20E+02	6.70E+01	2.58E+00	5.12E+02	1.31E+02	7.52E+01	2.22E+01	2.79E+02	5.55E-01	2.82E+00	5.12E+02
2039	9.10E+01	2.84E+02	2.74E+02	2.26E+01	6.71E+02	1.48E+02	8.43E+01	1.59E+01	2.35E+02	7.67E+01	2.58E+00	5.63E+02	1.47E+02	8.43E+01	2.43E+01	3.03E+02	5.55E-01	2.82E+00	5.62E+02
2040	9.80E+01	3.05E+02	3.04E+02	2.38E+01	7.31E+02	1.64E+02	9.35E+01	1.69E+01	2.50E+02	8.64E+01	2.58E+00	6.13E+02	1.63E+02	9.35E+01	2.63E+01	3.26E+02	5.55E-01	2.82E+00	6.12E+02
2041	1.05E+02	3.26E+02	3.33E+02	2.46E+01	7.89E+02	1.80E+02	1.03E+02	1.78E+01	2.63E+02	9.61E+01	2.58E+00	6.62E+02	1.79E+02	1.03E+02	2.83E+01	3.48E+02	5.55E-01	2.82E+00	6.61E+02
2042	1.11E+02	3.47E+02	3.63E+02	2.50E+01	8.46E+02	1.96E+02	1.12E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	7.10E+02	1.95E+02	1.12E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	7.09E+02
2043	1.18E+02	3.67E+02	3.93E+02	2.52E+01	9.02E+02	2.12E+02	1.21E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	7.57E+02	2.11E+02	1.21E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	7.56E+02
2044	1.24E+02	3.86E+02	4.22E+02	2.52E+01	9.58E+02	2.28E+02	1.30E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	8.03E+02	2.27E+02	1.30E+02	3.38E+01	4.08E+02	5.93E-01	2.82E+00	8.02E+02
2045	1.30E+02	4.05E+02	4.52E+02	2.52E+01	1.01E+03	2.44E+02	1.39E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	8.49E+02	2.43E+02	1.39E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	8.48E+02
2046	1.36E+02	4.24E+02	4.81E+02	2.52E+01	1.07E+03	2.60E+02	1.48E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	8.94E+02	2.59E+02	1.48E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	8.93E+02
2047	1.42E+02	4.41E+02	5.11E+02	2.52E+01	1.12E+03	2.76E+02	1.57E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	9.39E+02	2.75E+02	1.57E+02	3.90E+01	4.62E+02	1.53E+00	2.82E+00	9.38E+02
2048	1.47E+02	4.59E+02	5.41E+02	2.52E+01	1.17E+03	2.92E+02	1.66E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	9.83E+02	2.90E+02	1.66E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	9.82E+02
2049	1.53E+02	4.76E+02	5.70E+02	2.52E+01	1.22E+03	3.08E+02	1.76E+02	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.03E+03	3.06E+02	1.76E+02	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.03E+03
2050	1.58E+02	4.92E+02	6.00E+02	2.52E+01	1.28E+03	3.24E+02	1.85E+02	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.07E+03	3.22E+02	1.85E+02	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.07E+03
2051	1.63E+02	5.08E+02	6.30E+02	2.52E+01	1.33E+03	3.40E+02	1.94E+02	2.41E+01	3.57E+02	1.96E+02	2.58E+00	1.11E+03	3.38E+02	1.94E+02	4.55E+01	5.27E+02	4.41E+00	2.82E+00	1.11E+03
2052	1.68E+02	5.24E+02	6.59E+02	2.52E+01	1.38E+03	3.56E+02	2.03E+02	2.45E+01	3.63E+02	2.06E+02	2.58E+00	1.16E+03	3.54E+02	2.03E+02	4.71E+01	5.42E+02	5.39E+00	2.82E+00	1.15E+03
2053	1.73E+02	5.39E+02	6.89E+02	2.52E+01	1.43E+03	3.72E+02	2.12E+02	2.49E+01	3.69E+02	2.17E+02	2.58E+00	1.20E+03	3.70E+02	2.12E+02	4.86E+01	5.56E+02	6.55E+00	2.82E+00	1.20E+03
2054	1.78E+02	5.54E+02	7.18E+02	2.52E+01	1.48E+03	3.88E+02	2.21E+02	2.53E+01	3.75E+02	2.27E+02	2.58E+00	1.24E+03	3.86E+02	2.21E+02	5.01E+01	5.69E+02	7.82E+00	2.82E+00	1.24E+03
2055	1.83E+02	5.68E+02	7.48E+02	2.52E+01	1.52E+03	4.04E+02	2.30E+02	2.57E+01	3.80E+02	2.37E+02	2.58E+00	1.28E+03	4.02E+02	2.30E+02	5.16E+01	5.83E+02	9.14E+00	2.82E+00	1.28E+03
2056	1.87E+02	5.82E+02	7.78E+02	2.52E+01	1.57E+03	4.20E+02	2.39E+02	2.60E+01	3.85E+02	2.47E+02	2.58E+00	1.32E+03	4.18E+02	2.39E+02	5.30E+01	5.96E+02	1.04E+01	2.82E+00	1.32E+03
2057	1.91E+02	5.96E+02	8.07E+02	2.52E+01	1.62E+03	4.36E+02	2.48E+02	2.63E+01	3.90E+02	2.57E+02	2.58E+00	1.36E+03	4.34E+02	2.48E+02	5.45E+01	6.08E+02	1.17E+01	2.82E+00	1.36E+03
2058	1.96E+02	6.10E+02	8.34E+02	2.52E+01	1.66E+03	4.51E+02	2.57E+02	2.66E+01	3.94E+02	2.67E+02	2.58E+00	1.40E+03	4.48E+02	2.57E+02	5.58E+01	6.20E+02	1.32E+01	2.82E+00	1.40E+03
2059	2.00E+02	6.23E+02	8.55E+02	2.52E+01	1.70E+03	4.62E+02	2.63E+02	2.69E+01	3.98E+02	2.78E+02	2.58E+00	1.43E+03	4.59E+02	2.63E+02	5.72E+01	6.31E+02	1.56E+01	2.82E+00	1.43E+03
2060	2.04E+02	6.35E+02	8.72E+02	2.52E+01	1.74E+03	4.71E+02	2.68E+02	2.72E+01	4.02E+02	2.88E+02	2.58E+00	1.46E+03	4.69E+02	2.68E+02	5.86E+01	6.41E+02	1.87E+01	2.82E+00	1.46E+03
2061	2.08E+02	6.47E+02	8.86E+02	2.52E+01	1.77E+03	4.79E+02	2.73E+02	2.74E+01	4.05E+02	2.97E+02	2.58E+00	1.48E+03	4.76E+02	2.73E+02	5.99E+01	6.50E+02	2.26E+01	2.82E+00	1.48E+03

Exhibit E-28. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-02	1.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-02	5.94E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.42E-01	3.42E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-01	5.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.39E-01	7.39E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+00	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E+00	1.26E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+00	2.09E+00
2029	9.50E+00	2.96E+01	4.91E+00	0.00E+00	4.40E+01	2.67E+00	1.88E+00	1.95E+00	2.89E+01	7.41E-01	2.25E+00	3.84E+01	2.65E+00	1.88E+00	2.04E+00	2.92E+01	4.55E-01	2.49E+00	3.87E+01
2030	1.87E+01	5.84E+01	1.72E+01	0.00E+00	9.43E+01	9.34E+00	6.58E+00	3.79E+00	5.61E+01	2.50E+00	2.46E+00	8.08E+01	9.29E+00	6.58E+00	4.06E+00	5.79E+01	5.55E-01	2.70E+00	8.11E+01
2031	2.77E+01	8.63E+01	3.93E+01	1.16E+00	1.54E+02	2.14E+01	1.50E+01	5.51E+00	8.16E+01	6.48E+00	2.54E+00	1.33E+02	2.12E+01	1.50E+01	6.22E+00	8.68E+01	5.55E-01	2.78E+00	1.33E+02
2032	3.64E+01	1.13E+02	6.62E+01	3.83E+00	2.20E+02	3.60E+01	2.54E+01	7.12E+00	1.05E+02	1.29E+01	2.58E+00	1.89E+02	3.58E+01	2.54E+01	8.53E+00	1.16E+02	5.55E-01	2.82E+00	1.89E+02
2033	4.49E+01	1.40E+02	9.57E+01	7.41E+00	2.88E+02	5.20E+01	3.67E+01	8.64E+00	1.28E+02	2.09E+01	2.58E+00	2.49E+02	5.17E+01	3.67E+01	1.09E+01	1.46E+02	5.55E-01	2.82E+00	2.49E+02
2034	5.31E+01	1.66E+02	1.25E+02	1.10E+01	3.55E+02	6.81E+01	4.80E+01	1.01E+01	1.49E+02	2.97E+01	2.58E+00	3.07E+02	6.76E+01	4.80E+01	1.33E+01	1.75E+02	5.55E-01	2.82E+00	3.07E+02
2035	6.12E+01	1.90E+02	1.55E+02	1.42E+01	4.20E+02	8.41E+01	5.92E+01	1.14E+01	1.69E+02	3.88E+01	2.58E+00	3.65E+02	8.36E+01	5.92E+01	1.56E+01	2.03E+02	5.55E-01	2.82E+00	3.64E+02
2036	6.89E+01	2.15E+02	1.84E+02	1.68E+01	4.85E+02	1.00E+02	7.05E+01	1.26E+01	1.87E+02	4.80E+01	2.58E+00	4.21E+02	9.95E+01	7.05E+01	1.79E+01	2.29E+02	5.55E-01	2.82E+00	4.20E+02
2037	7.65E+01	2.38E+02	2.13E+02	1.91E+01	5.47E+02	1.16E+02	8.18E+01	1.38E+01	2.04E+02	5.74E+01	2.58E+00	4.76E+02	1.15E+02	8.18E+01	2.01E+01	2.55E+02	5.55E-01	2.82E+00	4.75E+02
2038	8.39E+01	2.61E+02	2.43E+02	2.10E+01	6.09E+02	1.32E+02	9.31E+01	1.49E+01	2.20E+02	6.70E+01	2.58E+00	5.30E+02	1.31E+02	9.31E+01	2.22E+01	2.79E+02	5.55E-01	2.82E+00	5.29E+02
2039	9.10E+01	2.84E+02	2.72E+02	2.26E+01	6.70E+02	1.48E+02	1.04E+02	1.59E+01	2.35E+02	7.67E+01	2.58E+00	5.83E+02	1.47E+02	1.04E+02	2.43E+01	3.03E+02	5.55E-01	2.82E+00	5.82E+02
2040	9.80E+01	3.05E+02	3.02E+02	2.38E+01	7.29E+02	1.64E+02	1.16E+02	1.69E+01	2.50E+02	8.64E+01	2.58E+00	6.35E+02	1.63E+02	1.16E+02	2.63E+01	3.26E+02	5.55E-01	2.82E+00	6.34E+02
2041	1.05E+02	3.26E+02	3.31E+02	2.46E+01	7.87E+02	1.80E+02	1.27E+02	1.78E+01	2.63E+02	9.61E+01	2.58E+00	6.86E+02	1.79E+02	1.27E+02	2.82E+01	3.48E+02	5.55E-01	2.82E+00	6.85E+02
2042	1.11E+02	3.47E+02	3.61E+02	2.50E+01	8.44E+02	1.96E+02	1.38E+02	1.86E+01	2.75E+02	1.06E+02	2.58E+00	7.36E+02	1.95E+02	1.38E+02	3.01E+01	3.69E+02	5.55E-01	2.82E+00	7.35E+02
2043	1.18E+02	3.67E+02	3.90E+02	2.52E+01	9.00E+02	2.12E+02	1.49E+02	1.94E+01	2.87E+02	1.15E+02	2.58E+00	7.86E+02	2.11E+02	1.49E+02	3.20E+01	3.89E+02	5.55E-01	2.82E+00	7.84E+02
2044	1.24E+02	3.86E+02	4.20E+02	2.52E+01	9.55E+02	2.28E+02	1.61E+02	2.01E+01	2.98E+02	1.25E+02	2.58E+00	8.34E+02	2.27E+02	1.61E+02	3.38E+01	4.08E+02	5.93E-01	2.82E+00	8.33E+02
2045	1.30E+02	4.05E+02	4.49E+02	2.52E+01	1.01E+03	2.44E+02	1.72E+02	2.08E+01	3.08E+02	1.35E+02	2.58E+00	8.82E+02	2.43E+02	1.72E+02	3.55E+01	4.27E+02	7.83E-01	2.82E+00	8.81E+02
2046	1.36E+02	4.24E+02	4.78E+02	2.52E+01	1.06E+03	2.60E+02	1.83E+02	2.14E+01	3.17E+02	1.45E+02	2.58E+00	9.30E+02	2.59E+02	1.83E+02	3.72E+01	4.45E+02	1.10E+00	2.82E+00	9.28E+02
2047	1.42E+02	4.41E+02	5.08E+02	2.52E+01	1.12E+03	2.76E+02	1.95E+02	2.20E+01	3.26E+02	1.55E+02	2.58E+00	9.77E+02	2.75E+02	1.95E+02	3.90E+01	4.62E+02	1.53E+00	2.82E+00	9.75E+02
2048	1.47E+02	4.59E+02	5.37E+02	2.52E+01	1.17E+03	2.92E+02	2.06E+02	2.26E+01	3.35E+02	1.65E+02	2.58E+00	1.02E+03	2.90E+02	2.06E+02	4.06E+01	4.79E+02	2.12E+00	2.82E+00	1.02E+03
2049	1.53E+02	4.76E+02	5.67E+02	2.52E+01	1.22E+03	3.08E+02	2.17E+02	2.31E+01	3.42E+02	1.75E+02	2.58E+00	1.07E+03	3.06E+02	2.17E+02	4.23E+01	4.96E+02	2.81E+00	2.82E+00	1.07E+03
2050	1.58E+02	4.92E+02	5.96E+02	2.52E+01	1.27E+03	3.24E+02	2.28E+02	2.36E+01	3.50E+02	1.86E+02	2.58E+00	1.11E+03	3.22E+02	2.28E+02	4.39E+01	5.12E+02	3.59E+00	2.82E+00	1.11E+03
2051	1.63E+02	5.08E+02	6.26E+02	2.52E+01	1.32E+03	3.40E+02	2.40E+02	2.41E+01	3.57E+02	1.96E+02	2.58E+00	1.16E+03	3.38E+02	2.40E+02	4.55E+01	5.27E+02	4.41E+00	2.82E+00	1.16E+03
2052	1.68E+02	5.24E+02	6.55E+02	2.52E+01	1.37E+03	3.56E+02	2.51E+02	2.45E+01	3.63E+02	2.06E+02	2.58E+00	1.20E+03	3.54E+02	2.51E+02	4.71E+01	5.42E+02	5.39E+00	2.82E+00	1.20E+03
2053	1.73E+02	5.39E+02	6.85E+02	2.52E+01	1.42E+03	3.72E+02	2.62E+02	2.49E+01	3.69E+02	2.17E+02	2.58E+00	1.25E+03	3.70E+02	2.62E+02	4.86E+01	5.56E+02	6.55E+00	2.82E+00	1.25E+03
2054	1.78E+02	5.54E+02	7.14E+02	2.52E+01	1.47E+03	3.88E+02	2.74E+02	2.53E+01	3.75E+02	2.27E+02	2.58E+00	1.29E+03	3.86E+02	2.74E+02	5.01E+01	5.69E+02	7.82E+00	2.82E+00	1.29E+03
2055	1.83E+02	5.68E+02	7.43E+02	2.52E+01	1.52E+03	4.04E+02	2.85E+02	2.57E+01	3.80E+02	2.37E+02	2.58E+00	1.33E+03	4.02E+02	2.85E+02	5.16E+01	5.83E+02	9.14E+00	2.82E+00	1.33E+03
2056	1.87E+02	5.82E+02	7.73E+02	2.52E+01	1.57E+03	4.20E+02	2.96E+02	2.60E+01	3.85E+02	2.47E+02	2.58E+00	1.38E+03	4.18E+02	2.96E+02	5.30E+01	5.96E+02	1.04E+01	2.82E+00	1.38E+03
2057	1.91E+02	5.96E+02	8.02E+02	2.52E+01	1.62E+03	4.36E+02	3.07E+02	2.63E+01	3.90E+02	2.57E+02	2.58E+00	1.42E+03	4.34E+02	3.07E+02	5.44E+01	6.08E+02	1.17E+01	2.82E+00	1.42E+03
2058	1.96E+02	6.10E+02	8.29E+02	2.52E+01	1.66E+03	4.51E+02	3.18E+02	2.66E+01	3.94E+02	2.67E+02	2.58E+00	1.46E+03	4.48E+02	3.18E+02	5.58E+01	6.20E+02	1.32E+01	2.82E+00	1.46E+03
2059	2.00E+02	6.23E+02	8.50E+02	2.52E+01	1.70E+03	4.62E+02	3.26E+02	2.69E+01	3.98E+02	2.78E+02	2.58E+00	1.49E+03	4.59E+02	3.26E+02	5.72E+01	6.31E+02	1.56E+01	2.82E+00	1.49E+03
2060	2.04E+02	6.35E+02	8.67E+02	2.52E+01	1.73E+03	4.71E+02	3.32E+02	2.72E+01	4.02E+02	2.88E+02	2.58E+00	1.52E+03	4.69E+02	3.32E+02	5.86E+01	6.41E+02	1.87E+01	2.82E+00	1.52E+03
2061	2.08E+02	6.47E+02	8.80E+02	2.52E+01	1.76E+03	4.79E+02	3.37E+02	2.74E+01	4.05E+02	2.97E+02	2.58E+00	1.55E+03	4.76E+02	3.37E+02	5.99E+01	6.50E+02	2.26E+01	2.82E+00	1.55E+03

Exhibit E-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.66E+02	6.70E+02	6.70E+02	6.87E+02
Lower GOR	6.67E+02	6.71E+02	6.71E+02	6.88E+02
Higher GOR	6.65E+02	6.69E+02	6.69E+02	6.86E+02

Exhibit E-30. CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.66E+02	6.70E+02	6.70E+02	6.87E+02
Decrease in Methane Emissions	6.64E+02	6.68E+02	6.68E+02	6.85E+02
Increase in Methane Emissions	6.68E+02	6.72E+02	6.72E+02	6.89E+02

APPENDIX F: AR6 20-YR RESULTS

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report:

- Multiproduct Functional Unit – Japan (AR6 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR6 – 20-yr)
- Multiproduct Functional Unit – China (AR6 – 20-yr)
- Multiproduct Functional Unit – India (AR6 – 20-yr)
- Single Product Functional Unit in kg CO_2e – Japan (AR6 – 20-yr)
- Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 20-yr)
- Single Product Functional Unit in kg CO_2e – China (AR6 – 20-yr)
- Single Product Functional Unit in kg CO_2e – India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR6 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)

Note: Upper and Lower values listed in the multiproduct and single product functional unit results tables refer to the positive and negative offsets from the Total (Expected) value.

Exhibit F-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.98E+01	7.98E+01	-	8.99E+01	8.99E+01
Natural Gas Pipelines to GTP	-	8.46E+00	8.46E+00	-	9.52E+00	9.52E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	7.67E-01	-	-	8.63E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.16E+01	4.16E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	5.02E+01	7.39E+00	7.39E+00	5.65E+01	8.31E+00	8.31E+00
Crude Oil Extraction, CO2-EOR	-	-	6.56E+00	-	-	7.38E+00
CO2-EOR Crude Oil Transport	-	-	8.60E-01	-	-	9.68E-01
Crude Oil Alaskan Pipeline Transport	2.28E+00	1.43E+00	1.43E+00	2.56E+00	1.61E+00	1.61E+00
Crude Oil Ocean Transport	1.18E+00	7.95E-01	1.27E+00	1.33E+00	8.94E-01	1.43E+00
Crude Oil Refining and End Use	1.52E+02	9.54E+01	1.53E+02	1.71E+02	1.07E+02	1.72E+02
Construction	-	5.30E-01	5.30E-01	-	5.97E-01	5.97E-01
System Expansion: US Average Crude Oil Production and End Use	2.55E+01	9.19E+01	2.48E+01	3.18E+00	7.80E+01	2.45E+00
System Expansion: US Lower 48 LNG Export and End Use	6.04E+02	-	-	3.33E+02	-	-
Total	8.36E+02	7.38E+02	7.36E+02	5.68E+02	4.64E+02	4.61E+02
Upper	2.61E+01	9.05E+00	8.25E+00	2.80E+01	9.27E+00	8.93E+00
Lower	1.17E+01	4.30E+00	3.76E+00	1.14E+01	3.02E+00	4.32E+00

Exhibit F-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.00E+01	8.00E+01	-	9.00E+01	9.00E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.54E+00	9.54E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	7.69E-01	-	-	8.65E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.51E+01	2.51E+01	-	2.83E+01	2.83E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	5.03E+01	7.40E+00	7.40E+00	5.66E+01	8.33E+00	8.33E+00
Crude Oil Extraction, CO2-EOR	-	-	6.57E+00	-	-	7.40E+00
CO2-EOR Crude Oil Transport	-	-	8.62E-01	-	-	9.70E-01
Crude Oil Alaskan Pipeline Transport	2.28E+00	1.43E+00	1.43E+00	2.57E+00	1.61E+00	1.61E+00
Crude Oil Ocean Transport	1.19E+00	7.96E-01	1.28E+00	1.34E+00	8.96E-01	1.44E+00
Crude Oil Refining and End Use	1.53E+02	9.56E+01	1.53E+02	1.72E+02	1.08E+02	1.72E+02
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	2.51E+01	9.17E+01	2.45E+01	2.79E+00	7.77E+01	2.06E+00
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	8.40E+02	7.42E+02	7.40E+02	5.73E+02	4.69E+02	4.66E+02
Upper	1.91E+01	9.85E+00	7.86E+00	2.49E+01	9.27E+00	8.88E+00
Lower	1.55E+01	4.38E+00	3.15E+00	1.15E+01	2.60E+00	3.70E+00

Exhibit F-3. Multiproduct Functional Unit in kg CO_2e – China (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.00E+01	8.00E+01	-	9.01E+01	9.01E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.54E+00	9.54E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	7.69E-01	-	-	8.65E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	5.03E+01	7.40E+00	7.40E+00	5.66E+01	8.33E+00	8.33E+00
Crude Oil Extraction, CO2-EOR	-	-	6.58E+00	-	-	7.40E+00
CO2-EOR Crude Oil Transport	-	-	8.62E-01	-	-	9.70E-01
Crude Oil Alaskan Pipeline Transport	2.28E+00	1.43E+00	1.43E+00	2.57E+00	1.61E+00	1.61E+00
Crude Oil Ocean Transport	1.19E+00	7.96E-01	1.28E+00	1.34E+00	8.96E-01	1.44E+00
Crude Oil Refining and End Use	1.53E+02	9.56E+01	1.53E+02	1.72E+02	1.08E+02	1.72E+02
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	2.51E+01	9.17E+01	2.45E+01	2.77E+00	7.77E+01	2.05E+00
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	8.41E+02	7.42E+02	7.40E+02	5.74E+02	4.69E+02	4.66E+02
Upper	1.56E+01	7.78E+00	7.73E+00	2.56E+01	8.70E+00	1.19E+01
Lower	8.06E-01	3.26E+00	3.94E+00	1.08E+01	3.46E+00	4.38E+00

Exhibit F-4. Multiproduct Functional Unit in kg CO_2e – India (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.08E+01	8.08E+01	-	9.10E+01	9.10E+01
Natural Gas Pipelines to GTP	-	8.56E+00	8.56E+00	-	9.64E+00	9.64E+00
Natural Gas Processing at GTP	-	2.55E+01	2.55E+01	-	2.87E+01	2.87E+01
CO2 Compression and Sequestration	-	7.77E-01	-	-	8.74E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.67E+01	1.67E+01	-	1.88E+01	1.88E+01
Liquefaction	-	4.21E+01	4.21E+01	-	4.74E+01	4.74E+01
Ocean Transport	-	4.43E+01	4.43E+01	-	4.99E+01	4.99E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	5.08E+01	7.48E+00	7.48E+00	5.72E+01	8.42E+00	8.42E+00
Crude Oil Extraction, CO2-EOR	-	-	6.64E+00	-	-	7.48E+00
CO2-EOR Crude Oil Transport	-	-	8.71E-01	-	-	9.80E-01
Crude Oil Alaskan Pipeline Transport	2.31E+00	1.44E+00	1.44E+00	2.60E+00	1.63E+00	1.63E+00
Crude Oil Ocean Transport	1.20E+00	8.04E-01	1.29E+00	1.35E+00	9.05E-01	1.45E+00
Crude Oil Refining and End Use	1.54E+02	9.66E+01	1.55E+02	1.74E+02	1.09E+02	1.74E+02
Construction	-	5.37E-01	5.37E-01	-	6.04E-01	6.04E-01
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	9.06E+01	2.26E+01	7.32E-01	7.64E+01	-
System Expansion: US Lower 48 LNG Export and End Use	6.07E+02	-	-	3.36E+02	-	-
Total	8.39E+02	7.63E+02	7.61E+02	5.72E+02	4.92E+02	4.89E+02
Upper	2.00E+01	1.00E+01	1.05E+01	2.11E+01	1.08E+01	9.93E+00
Lower	8.19E+00	3.60E+00	3.67E+00	1.19E+01	3.75E+00	3.15E+00

Exhibit F-5. Single Product Functional Unit in kg CO_2e – Japan (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	7.98E+01	7.98E+01	-	8.99E+01	8.99E+01
Natural Gas Pipelines to GTP	-	8.46E+00	8.46E+00	-	9.52E+00	9.52E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	6.60E-01	-	-	7.43E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.16E+01	4.16E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.30E-01	5.30E-01	-	5.97E-01	5.97E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.04E+02	-	-	3.33E+02	-	-
Total	6.04E+02	5.41E+02	5.41E+02	3.33E+02	2.68E+02	2.67E+02
Upper	2.60E+01	6.63E+00	6.06E+00	2.79E+01	5.35E+00	5.17E+00
Lower	1.18E+01	3.16E+00	2.77E+00	1.15E+01	1.74E+00	2.50E+00

Exhibit F-6. Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.00E+01	8.00E+01	-	9.00E+01	9.00E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.54E+00	9.54E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	6.61E-01	-	-	7.44E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.51E+01	2.51E+01	-	2.83E+01	2.83E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	6.09E+02	5.45E+02	5.44E+02	3.38E+02	2.72E+02	2.72E+02
Upper	1.90E+01	7.23E+00	5.78E+00	2.48E+01	5.39E+00	5.18E+00
Lower	1.56E+01	3.22E+00	2.32E+00	1.16E+01	1.51E+00	2.16E+00

Exhibit F-7. Single Product Functional Unit in kg CO_2e – China (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.00E+01	8.00E+01	-	9.01E+01	9.01E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.54E+00	9.54E+00
Natural Gas Processing at GTP	-	2.52E+01	2.52E+01	-	2.84E+01	2.84E+01
CO2 Compression and Sequestration	-	6.61E-01	-	-	7.44E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.53E+01	2.53E+01	-	2.85E+01	2.85E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.31E-01	5.31E-01	-	5.98E-01	5.98E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	6.09E+02	5.45E+02	5.45E+02	3.38E+02	2.73E+02	2.72E+02
Upper	1.55E+01	5.71E+00	5.69E+00	2.55E+01	5.06E+00	6.97E+00
Lower	8.94E-01	2.39E+00	2.90E+00	1.09E+01	2.01E+00	2.55E+00

Exhibit F-8. Single Product Functional Unit in kg CO_2e – India (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	8.08E+01	8.08E+01	-	9.10E+01	9.10E+01
Natural Gas Pipelines to GTP	-	8.56E+00	8.56E+00	-	9.64E+00	9.64E+00
Natural Gas Processing at GTP	-	2.55E+01	2.55E+01	-	2.87E+01	2.87E+01
CO2 Compression and Sequestration	-	6.68E-01	-	-	7.52E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.67E+01	1.67E+01	-	1.88E+01	1.88E+01
Liquefaction	-	4.21E+01	4.21E+01	-	4.74E+01	4.74E+01
Ocean Transport	-	4.43E+01	4.43E+01	-	4.99E+01	4.99E+01
LNG Regasification	-	4.35E+00	4.35E+00	-	4.89E+00	4.89E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.37E-01	5.37E-01	-	6.04E-01	6.04E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.07E+02	-	-	3.36E+02	-	-
Total	6.07E+02	5.66E+02	5.65E+02	3.36E+02	2.96E+02	2.95E+02
Upper	1.99E+01	7.44E+00	7.77E+00	2.10E+01	6.48E+00	5.99E+00
Lower	8.27E+00	2.67E+00	2.73E+00	1.20E+01	2.25E+00	1.90E+00

Exhibit F-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.29E+01	7.30E+00	5.58E-05	-	5.02E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.53E-01	9.89E-03	5.71E-09	2.28E+00
Crude Oil Ocean Transport	1.09E+00	8.80E-02	2.70E-03	8.49E-07	1.18E+00
Crude Oil Refining and End Use	1.52E+02	7.09E-01	6.94E-03	-	1.52E+02
System Expansion: US Average Crude Oil Production and End Use	2.39E+01	1.54E+00	1.43E-02	-	2.55E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.40E+02	3.09E-01	1.41E-07	6.04E+02
Construction	-	-	-	-	-
Total	6.85E+02	1.50E+02	3.43E-01	9.95E-07	8.36E+02

Exhibit F-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	7.31E+00	5.59E-05	-	5.03E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.53E-01	9.91E-03	5.73E-09	2.28E+00
Crude Oil Ocean Transport	1.10E+00	8.82E-02	2.70E-03	8.50E-07	1.19E+00
Crude Oil Refining and End Use	1.52E+02	7.11E-01	6.96E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.52E+00	1.41E-02	-	2.51E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.41E+02	3.18E-01	1.41E-07	6.09E+02
Construction	-	-	-	-	-
Total	6.89E+02	1.51E+02	3.52E-01	9.97E-07	8.40E+02

Exhibit F-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.30E+01	7.32E+00	5.59E-05	-	5.03E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.02E+00	2.53E-01	9.91E-03	5.73E-09	2.28E+00
Crude Oil Ocean Transport	1.10E+00	8.82E-02	2.70E-03	8.50E-07	1.19E+00
Crude Oil Refining and End Use	1.52E+02	7.11E-01	6.96E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.36E+01	1.52E+00	1.41E-02	-	2.51E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.41E+02	3.19E-01	1.41E-07	6.09E+02
Construction	-	-	-	-	-
Total	6.89E+02	1.51E+02	3.52E-01	9.97E-07	8.41E+02

Exhibit F-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	4.34E+01	7.39E+00	5.65E-05	-	5.08E+01
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	2.04E+00	2.56E-01	1.00E-02	5.78E-09	2.31E+00
Crude Oil Ocean Transport	1.11E+00	8.91E-02	2.73E-03	8.59E-07	1.20E+00
Crude Oil Refining and End Use	1.54E+02	7.18E-01	7.03E-03	-	1.54E+02
System Expansion: US Average Crude Oil Production and End Use	2.19E+01	1.41E+00	1.30E-02	-	2.33E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.41E+02	3.15E-01	1.41E-07	6.07E+02
Construction	-	-	-	-	-
Total	6.88E+02	1.51E+02	3.48E-01	1.01E-06	8.39E+02

Exhibit F-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	5.40E+01	1.45E-02	-	7.98E+01
Natural Gas Pipelines to GTP	2.14E-03	8.46E+00	-	-	8.46E+00
Natural Gas Processing at GTP	2.39E+01	1.29E+00	2.48E-05	-	2.52E+01
CO2 Compression and Sequestration	6.44E-01	1.20E-01	1.40E-03	1.56E-03	7.67E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.13E+01	5.17E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.84E-03	1.02E-07	4.16E+01
Ocean Transport	1.68E+01	4.69E+00	5.45E-02	-	2.15E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	4.77E+00	5.59E-06	-	7.39E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.58E-01	6.19E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	7.14E-01	7.81E-02	2.12E-03	7.60E-07	7.95E-01
Crude Oil Refining and End Use	9.50E+01	4.44E-01	4.35E-03	-	9.54E+01
System Expansion: US Average Crude Oil Production and End Use	8.63E+01	5.56E+00	5.15E-02	-	9.19E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	2.19E-02	3.02E-03	-	5.30E-01
Total	6.27E+02	1.11E+02	1.51E-01	1.63E-03	7.38E+02

Exhibit F-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.41E+01	1.45E-02	-	8.00E+01
Natural Gas Pipelines to GTP	2.14E-03	8.47E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.40E+01	1.29E+00	2.49E-05	-	2.52E+01
CO2 Compression and Sequestration	6.45E-01	1.20E-01	1.40E-03	1.56E-03	7.69E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.85E-03	1.02E-07	4.17E+01
Ocean Transport	1.95E+01	5.59E+00	6.21E-02	-	2.51E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.77E+00	5.60E-06	-	7.40E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.59E-01	6.20E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	7.16E-01	7.83E-02	2.12E-03	7.62E-07	7.96E-01
Crude Oil Refining and End Use	9.51E+01	4.45E-01	4.36E-03	-	9.56E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	5.55E+00	5.14E-02	-	9.17E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	2.19E-02	3.03E-03	-	5.31E-01
Total	6.29E+02	1.13E+02	1.58E-01	1.63E-03	7.42E+02

Exhibit F-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.41E+01	1.45E-02	-	8.00E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.40E+01	1.29E+00	2.49E-05	-	2.52E+01
CO2 Compression and Sequestration	6.46E-01	1.20E-01	1.40E-03	1.56E-03	7.69E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.85E-03	1.02E-07	4.17E+01
Ocean Transport	1.96E+01	5.63E+00	6.25E-02	-	2.53E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.78E+00	5.60E-06	-	7.40E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.59E-01	6.20E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	7.16E-01	7.83E-02	2.12E-03	7.62E-07	7.96E-01
Crude Oil Refining and End Use	9.51E+01	4.45E-01	4.36E-03	-	9.56E+01
System Expansion: US Average Crude Oil Production and End Use	8.61E+01	5.55E+00	5.14E-02	-	9.17E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	2.19E-02	3.03E-03	-	5.31E-01
Total	6.30E+02	1.13E+02	1.59E-01	1.63E-03	7.42E+02

Exhibit F-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	5.47E+01	1.47E-02	-	8.08E+01
Natural Gas Pipelines to GTP	2.17E-03	8.56E+00	-	-	8.56E+00
Natural Gas Processing at GTP	2.42E+01	1.30E+00	2.51E-05	-	2.55E+01
CO2 Compression and Sequestration	6.52E-01	1.22E-01	1.41E-03	1.58E-03	7.77E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.15E+01	5.24E-07	-	1.67E+01
Liquefaction	2.27E+01	1.94E+01	3.88E-03	1.03E-07	4.21E+01
Ocean Transport	3.39E+01	1.04E+01	1.02E-01	-	4.43E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	4.82E+00	5.66E-06	-	7.48E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.60E-01	6.27E-03	3.62E-09	1.44E+00
Crude Oil Ocean Transport	7.23E-01	7.91E-02	2.14E-03	7.69E-07	8.04E-01
Crude Oil Refining and End Use	9.61E+01	4.49E-01	4.40E-03	-	9.66E+01
System Expansion: US Average Crude Oil Production and End Use	8.50E+01	5.48E+00	5.07E-02	-	9.06E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	2.21E-02	3.06E-03	-	5.37E-01
Total	6.45E+02	1.18E+02	1.98E-01	1.65E-03	7.63E+02

Exhibit F-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.58E+01	5.40E+01	1.45E-02	-	7.98E+01
Natural Gas Pipelines to GTP	2.14E-03	8.46E+00	-	-	8.46E+00
Natural Gas Processing at GTP	2.39E+01	1.29E+00	2.48E-05	-	2.52E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.13E+01	5.17E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.84E-03	1.02E-07	4.16E+01
Ocean Transport	1.68E+01	4.69E+00	5.45E-02	-	2.15E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.62E+00	4.77E+00	5.59E-06	-	7.39E+00
Crude Oil Extraction, CO2-EOR	5.44E+00	1.08E+00	1.74E-02	2.01E-02	6.56E+00
CO2-EOR Crude Oil Transport	7.61E-01	9.54E-02	3.73E-03	2.16E-09	8.60E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.58E-01	6.19E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	1.14E+00	1.25E-01	3.40E-03	1.22E-06	1.27E+00
Crude Oil Refining and End Use	1.52E+02	7.12E-01	6.97E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.33E+01	1.50E+00	1.39E-02	-	2.48E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.05E-01	2.19E-02	3.02E-03	-	5.30E-01
Total	6.27E+02	1.09E+02	1.37E-01	2.02E-02	7.36E+02

Exhibit F-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.41E+01	1.45E-02	-	8.00E+01
Natural Gas Pipelines to GTP	2.14E-03	8.47E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.40E+01	1.29E+00	2.49E-05	-	2.52E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.85E-03	1.02E-07	4.17E+01
Ocean Transport	1.95E+01	5.59E+00	6.21E-02	-	2.51E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.77E+00	5.60E-06	-	7.40E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	1.08E+00	1.74E-02	2.02E-02	6.57E+00
CO2-EOR Crude Oil Transport	7.63E-01	9.56E-02	3.74E-03	2.16E-09	8.62E-01
Crude Oil Alaskan Pipeline Transport	1.26E+00	1.59E-01	6.20E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	1.15E+00	1.25E-01	3.40E-03	1.22E-06	1.28E+00
Crude Oil Refining and End Use	1.53E+02	7.13E-01	6.98E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.48E+00	1.37E-02	-	2.45E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	2.19E-02	3.03E-03	-	5.31E-01
Total	6.30E+02	1.10E+02	1.44E-01	2.02E-02	7.40E+02

Exhibit F-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.59E+01	5.41E+01	1.45E-02	-	8.00E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.40E+01	1.29E+00	2.49E-05	-	2.52E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	3.85E-03	1.02E-07	4.17E+01
Ocean Transport	1.96E+01	5.63E+00	6.25E-02	-	2.53E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.63E+00	4.78E+00	5.60E-06	-	7.40E+00
Crude Oil Extraction, CO2-EOR	5.45E+00	1.08E+00	1.74E-02	2.02E-02	6.58E+00
CO2-EOR Crude Oil Transport	7.63E-01	9.56E-02	3.74E-03	2.16E-09	8.62E-01
Crude Oil Alaskan Pipeline Transport	1.27E+00	1.59E-01	6.20E-03	3.58E-09	1.43E+00
Crude Oil Ocean Transport	1.15E+00	1.25E-01	3.40E-03	1.22E-06	1.28E+00
Crude Oil Refining and End Use	1.53E+02	7.13E-01	6.98E-03	-	1.53E+02
System Expansion: US Average Crude Oil Production and End Use	2.30E+01	1.48E+00	1.37E-02	-	2.45E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.06E-01	2.19E-02	3.03E-03	-	5.31E-01
Total	6.30E+02	1.10E+02	1.45E-01	2.02E-02	7.40E+02

Exhibit F-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	2.61E+01	5.47E+01	1.47E-02	-	8.08E+01
Natural Gas Pipelines to GTP	2.17E-03	8.56E+00	-	-	8.56E+00
Natural Gas Processing at GTP	2.42E+01	1.30E+00	2.51E-05	-	2.55E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.15E+01	5.24E-07	-	1.67E+01
Liquefaction	2.27E+01	1.94E+01	3.88E-03	1.03E-07	4.21E+01
Ocean Transport	3.39E+01	1.04E+01	1.02E-01	-	4.43E+01
LNG Regasification	3.02E+00	1.32E+00	9.36E-03	6.85E-05	4.35E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	2.65E+00	4.82E+00	5.66E-06	-	7.48E+00
Crude Oil Extraction, CO2-EOR	5.51E+00	1.10E+00	1.76E-02	2.04E-02	6.64E+00
CO2-EOR Crude Oil Transport	7.71E-01	9.66E-02	3.78E-03	2.18E-09	8.71E-01
Crude Oil Alaskan Pipeline Transport	1.28E+00	1.60E-01	6.27E-03	3.62E-09	1.44E+00
Crude Oil Ocean Transport	1.16E+00	1.27E-01	3.44E-03	1.23E-06	1.29E+00
Crude Oil Refining and End Use	1.54E+02	7.20E-01	7.05E-03	-	1.55E+02
System Expansion: US Average Crude Oil Production and End Use	2.13E+01	1.37E+00	1.27E-02	-	2.26E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	5.11E-01	2.21E-02	3.06E-03	-	5.37E-01
Total	6.45E+02	1.16E+02	1.84E-01	2.04E-02	7.61E+02

Exhibit F-21. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	1.42E+01	0.00E+00	5.43E+01	4.10E+00	8.75E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.79E+01	4.08E+00	8.75E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.81E+01
2030	2.06E+01	5.85E+01	4.96E+01	0.00E+00	1.29E+02	1.43E+01	3.06E+01	5.67E+00	5.63E+01	2.60E+00	2.53E+00	1.12E+02	1.43E+01	3.06E+01	5.97E+00	5.80E+01	5.78E-01	2.76E+00	1.12E+02
2031	3.05E+01	8.66E+01	1.13E+02	1.21E+00	2.32E+02	3.28E+01	7.00E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	2.02E+02	3.26E+01	7.00E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	2.02E+02
2032	4.01E+01	1.14E+02	1.91E+02	3.98E+00	3.49E+02	5.53E+01	1.18E+02	1.06E+01	1.06E+02	1.34E+01	2.64E+00	3.06E+02	5.51E+01	1.18E+02	1.22E+01	1.17E+02	5.78E-01	2.88E+00	3.06E+02
2033	4.94E+01	1.40E+02	2.77E+02	7.70E+00	4.74E+02	7.99E+01	1.71E+02	1.29E+01	1.28E+02	2.18E+01	2.64E+00	4.16E+02	7.95E+01	1.71E+02	1.55E+01	1.46E+02	5.78E-01	2.88E+00	4.15E+02
2034	5.84E+01	1.66E+02	3.62E+02	1.14E+01	5.98E+02	1.04E+02	2.23E+02	1.50E+01	1.49E+02	3.09E+01	2.64E+00	5.26E+02	1.04E+02	2.23E+02	1.86E+01	1.75E+02	5.78E-01	2.88E+00	5.25E+02
2035	6.73E+01	1.91E+02	4.47E+02	1.47E+01	7.20E+02	1.29E+02	2.76E+02	1.70E+01	1.69E+02	4.04E+01	2.64E+00	6.34E+02	1.28E+02	2.76E+02	2.17E+01	2.03E+02	5.78E-01	2.88E+00	6.33E+02
2036	7.58E+01	2.15E+02	5.32E+02	1.75E+01	8.40E+02	1.54E+02	3.28E+02	1.89E+01	1.88E+02	5.00E+01	2.64E+00	7.41E+02	1.53E+02	3.28E+02	2.47E+01	2.30E+02	5.78E-01	2.88E+00	7.39E+02
2037	8.42E+01	2.39E+02	6.17E+02	1.98E+01	9.60E+02	1.78E+02	3.81E+02	2.06E+01	2.05E+02	5.97E+01	2.64E+00	8.47E+02	1.77E+02	3.81E+02	2.76E+01	2.56E+02	5.78E-01	2.88E+00	8.45E+02
2038	9.23E+01	2.62E+02	7.02E+02	2.19E+01	1.08E+03	2.03E+02	4.33E+02	2.23E+01	2.21E+02	6.97E+01	2.64E+00	9.52E+02	2.02E+02	4.33E+02	3.04E+01	2.80E+02	5.78E-01	2.88E+00	9.49E+02
2039	1.00E+02	2.84E+02	7.87E+02	2.35E+01	1.20E+03	2.27E+02	4.86E+02	2.38E+01	2.36E+02	7.98E+01	2.64E+00	1.06E+03	2.26E+02	4.86E+02	3.31E+01	3.04E+02	5.78E-01	2.88E+00	1.05E+03
2040	1.08E+02	3.06E+02	8.72E+02	2.47E+01	1.31E+03	2.52E+02	5.38E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	1.16E+03	2.51E+02	5.38E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	1.16E+03
2041	1.15E+02	3.27E+02	9.57E+02	2.56E+01	1.43E+03	2.77E+02	5.91E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	1.26E+03	2.75E+02	5.91E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	1.26E+03
2042	1.22E+02	3.48E+02	1.04E+03	2.60E+01	1.54E+03	3.01E+02	6.43E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	1.36E+03	3.00E+02	6.43E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	1.36E+03
2043	1.30E+02	3.68E+02	1.13E+03	2.62E+01	1.65E+03	3.26E+02	6.96E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	1.46E+03	3.24E+02	6.96E+02	4.30E+01	3.90E+02	5.78E-01	2.88E+00	1.46E+03
2044	1.36E+02	3.87E+02	1.21E+03	2.62E+01	1.76E+03	3.50E+02	7.48E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	1.56E+03	3.49E+02	7.48E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	1.55E+03
2045	1.43E+02	4.06E+02	1.30E+03	2.62E+01	1.87E+03	3.75E+02	8.01E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.66E+03	3.73E+02	8.01E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.65E+03
2046	1.50E+02	4.25E+02	1.38E+03	2.62E+01	1.98E+03	3.99E+02	8.53E+02	3.20E+01	3.18E+02	1.51E+02	2.64E+00	1.76E+03	3.98E+02	8.53E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.75E+03
2047	1.56E+02	4.43E+02	1.47E+03	2.62E+01	2.09E+03	4.24E+02	9.06E+02	3.29E+01	3.27E+02	1.61E+02	2.64E+00	1.85E+03	4.22E+02	9.06E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.85E+03
2048	1.62E+02	4.60E+02	1.55E+03	2.62E+01	2.20E+03	4.49E+02	9.58E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.95E+03	4.47E+02	9.58E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.94E+03
2049	1.68E+02	4.77E+02	1.64E+03	2.62E+01	2.31E+03	4.73E+02	1.01E+03	3.46E+01	3.43E+02	1.82E+02	2.64E+00	2.05E+03	4.71E+02	1.01E+03	5.58E+01	4.97E+02	2.93E+00	2.88E+00	2.04E+03
2050	1.74E+02	4.94E+02	1.72E+03	2.62E+01	2.42E+03	4.98E+02	1.06E+03	3.53E+01	3.51E+02	1.93E+02	2.64E+00	2.14E+03	4.96E+02	1.06E+03	5.78E+01	5.13E+02	3.73E+00	2.88E+00	2.14E+03
2051	1.79E+02	5.10E+02	1.81E+03	2.62E+01	2.52E+03	5.22E+02	1.12E+03	3.60E+01	3.58E+02	2.04E+02	2.64E+00	2.24E+03	5.20E+02	1.12E+03	5.98E+01	5.28E+02	4.59E+00	2.88E+00	2.23E+03
2052	1.85E+02	5.26E+02	1.89E+03	2.62E+01	2.63E+03	5.47E+02	1.17E+03	3.67E+01	3.64E+02	2.15E+02	2.64E+00	2.33E+03	5.44E+02	1.17E+03	6.17E+01	5.43E+02	5.61E+00	2.88E+00	2.33E+03
2053	1.90E+02	5.41E+02	1.98E+03	2.62E+01	2.74E+03	5.71E+02	1.22E+03	3.73E+01	3.70E+02	2.25E+02	2.64E+00	2.43E+03	5.69E+02	1.22E+03	6.36E+01	5.57E+02	6.81E+00	2.88E+00	2.42E+03
2054	1.96E+02	5.56E+02	2.06E+03	2.62E+01	2.84E+03	5.96E+02	1.27E+03	3.78E+01	3.76E+02	2.36E+02	2.64E+00	2.52E+03	5.93E+02	1.27E+03	6.54E+01	5.71E+02	8.13E+00	2.88E+00	2.51E+03
2055	2.01E+02	5.70E+02	2.15E+03	2.62E+01	2.95E+03	6.21E+02	1.33E+03	3.84E+01	3.81E+02	2.47E+02	2.64E+00	2.62E+03	6.18E+02	1.33E+03	6.72E+01	5.84E+02	9.51E+00	2.88E+00	2.61E+03
2056	2.06E+02	5.84E+02	2.23E+03	2.62E+01	3.05E+03	6.45E+02	1.38E+03	3.89E+01	3.86E+02	2.57E+02	2.64E+00	2.71E+03	6.42E+02	1.38E+03	6.89E+01	5.97E+02	1.08E+01	2.88E+00	2.70E+03
2057	2.10E+02	5.98E+02	2.32E+03	2.62E+01	3.15E+03	6.70E+02	1.43E+03	3.94E+01	3.91E+02	2.68E+02	2.64E+00	2.80E+03	6.67E+02	1.43E+03	7.06E+01	6.10E+02	1.22E+01	2.88E+00	2.79E+03
2058	2.15E+02	6.11E+02	2.39E+03	2.62E+01	3.25E+03	6.92E+02	1.48E+03	3.98E+01	3.95E+02	2.78E+02	2.64E+00	2.89E+03	6.89E+02	1.48E+03	7.23E+01	6.22E+02	1.38E+01	2.88E+00	2.88E+03
2059	2.20E+02	6.24E+02	2.46E+03	2.62E+01	3.33E+03	7.09E+02	1.52E+03	4.02E+01	3.99E+02	2.89E+02	2.64E+00	2.96E+03	7.06E+02	1.52E+03	7.39E+01	6.33E+02	1.63E+01	2.88E+00	2.95E+03
2060	2.24E+02	6.37E+02	2.50E+03	2.62E+01	3.39E+03	7.24E+02	1.55E+03	4.06E+01	4.03E+02	2.99E+02	2.64E+00	3.01E+03	7.20E+02	1.55E+03	7.55E+01	6.43E+02	1.95E+01	2.88E+00	3.01E+03
2061	2.29E+02	6.49E+02	2.54E+03	2.62E+01	3.45E+03	7.35E+02	1.57E+03	4.09E+01	4.07E+02	3.09E+02	2.64E+00	3.06E+03	7.32E+02	1.57E+03	7.70E+01	6.52E+02	2.35E+01	2.88E+00	3.06E+03

Exhibit F-22. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	1.43E+01	0.00E+00	5.44E+01	4.10E+00	8.82E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.79E+01	4.08E+00	8.82E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.82E+01
2030	2.06E+01	5.85E+01	4.99E+01	0.00E+00	1.29E+02	1.43E+01	3.09E+01	5.67E+00	5.63E+01	2.60E+00	2.53E+00	1.12E+02	1.43E+01	3.09E+01	5.97E+00	5.80E+01	5.78E-01	2.76E+00	1.12E+02
2031	3.05E+01	8.66E+01	1.14E+02	1.21E+00	2.32E+02	3.28E+01	7.06E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	2.03E+02	3.26E+01	7.06E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	2.03E+02
2032	4.01E+01	1.14E+02	1.93E+02	3.98E+00	3.50E+02	5.53E+01	1.19E+02	1.06E+01	1.06E+02	1.34E+01	2.64E+00	3.07E+02	5.51E+01	1.19E+02	1.22E+01	1.17E+02	5.78E-01	2.88E+00	3.07E+02
2033	4.94E+01	1.40E+02	2.78E+02	7.70E+00	4.75E+02	7.99E+01	1.72E+02	1.29E+01	1.28E+02	2.18E+01	2.64E+00	4.17E+02	7.95E+01	1.72E+02	1.55E+01	1.46E+02	5.78E-01	2.88E+00	4.17E+02
2034	5.84E+01	1.66E+02	3.64E+02	1.14E+01	6.00E+02	1.04E+02	2.25E+02	1.50E+01	1.49E+02	3.09E+01	2.64E+00	5.27E+02	1.04E+02	2.25E+02	1.86E+01	1.75E+02	5.78E-01	2.88E+00	5.26E+02
2035	6.73E+01	1.91E+02	4.49E+02	1.47E+01	7.22E+02	1.29E+02	2.78E+02	1.70E+01	1.69E+02	4.04E+01	2.64E+00	6.36E+02	1.28E+02	2.78E+02	2.17E+01	2.03E+02	5.78E-01	2.88E+00	6.35E+02
2036	7.58E+01	2.15E+02	5.35E+02	1.75E+01	8.43E+02	1.54E+02	3.31E+02	1.89E+01	1.88E+02	5.00E+01	2.64E+00	7.43E+02	1.53E+02	3.31E+02	2.47E+01	2.30E+02	5.78E-01	2.88E+00	7.42E+02
2037	8.42E+01	2.39E+02	6.20E+02	1.98E+01	9.63E+02	1.78E+02	3.84E+02	2.06E+01	2.05E+02	5.97E+01	2.64E+00	8.50E+02	1.77E+02	3.84E+02	2.76E+01	2.56E+02	5.78E-01	2.88E+00	8.48E+02
2038	9.23E+01	2.62E+02	7.06E+02	2.19E+01	1.08E+03	2.03E+02	4.37E+02	2.23E+01	2.21E+02	6.97E+01	2.64E+00	9.55E+02	2.02E+02	4.37E+02	3.04E+01	2.80E+02	5.78E-01	2.88E+00	9.53E+02
2039	1.00E+02	2.84E+02	7.91E+02	2.35E+01	1.20E+03	2.27E+02	4.90E+02	2.38E+01	2.36E+02	7.98E+01	2.64E+00	1.06E+03	2.26E+02	4.90E+02	3.31E+01	3.04E+02	5.78E-01	2.88E+00	1.06E+03
2040	1.08E+02	3.06E+02	8.77E+02	2.47E+01	1.32E+03	2.52E+02	5.42E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	1.16E+03	2.51E+02	5.42E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	1.16E+03
2041	1.15E+02	3.27E+02	9.63E+02	2.56E+01	1.43E+03	2.77E+02	5.95E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	1.26E+03	2.75E+02	5.95E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	1.26E+03
2042	1.22E+02	3.48E+02	1.05E+03	2.60E+01	1.54E+03	3.01E+02	6.48E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	1.37E+03	3.00E+02	6.48E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	1.36E+03
2043	1.30E+02	3.68E+02	1.13E+03	2.62E+01	1.66E+03	3.26E+02	7.01E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	1.47E+03	3.24E+02	7.01E+02	4.29E+01	3.90E+02	5.78E-01	2.88E+00	1.46E+03
2044	1.36E+02	3.87E+02	1.22E+03	2.62E+01	1.77E+03	3.50E+02	7.54E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	1.57E+03	3.49E+02	7.54E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	1.56E+03
2045	1.43E+02	4.06E+02	1.30E+03	2.62E+01	1.88E+03	3.75E+02	8.07E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.66E+03	3.73E+02	8.07E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.66E+03
2046	1.50E+02	4.25E+02	1.39E+03	2.62E+01	1.99E+03	3.99E+02	8.60E+02	3.20E+01	3.18E+02	1.51E+02	2.64E+00	1.76E+03	3.98E+02	8.60E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.76E+03
2047	1.56E+02	4.43E+02	1.48E+03	2.62E+01	2.10E+03	4.24E+02	9.13E+02	3.29E+01	3.27E+02	1.61E+02	2.64E+00	1.86E+03	4.22E+02	9.13E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.86E+03
2048	1.62E+02	4.60E+02	1.56E+03	2.62E+01	2.21E+03	4.49E+02	9.66E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.96E+03	4.47E+02	9.66E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.95E+03
2049	1.68E+02	4.77E+02	1.65E+03	2.62E+01	2.32E+03	4.73E+02	1.02E+03	3.46E+01	3.43E+02	1.82E+02	2.64E+00	2.05E+03	4.71E+02	1.02E+03	5.58E+01	4.97E+02	2.93E+00	2.88E+00	2.05E+03
2050	1.74E+02	4.94E+02	1.73E+03	2.62E+01	2.43E+03	4.98E+02	1.07E+03	3.53E+01	3.51E+02	1.93E+02	2.64E+00	2.15E+03	4.95E+02	1.07E+03	5.78E+01	5.13E+02	3.73E+00	2.88E+00	2.14E+03
2051	1.79E+02	5.10E+02	1.82E+03	2.62E+01	2.53E+03	5.22E+02	1.12E+03	3.60E+01	3.58E+02	2.04E+02	2.64E+00	2.25E+03	5.20E+02	1.12E+03	5.98E+01	5.28E+02	4.59E+00	2.88E+00	2.24E+03
2052	1.85E+02	5.26E+02	1.90E+03	2.62E+01	2.64E+03	5.47E+02	1.18E+03	3.67E+01	3.64E+02	2.15E+02	2.64E+00	2.34E+03	5.44E+02	1.18E+03	6.17E+01	5.43E+02	5.61E+00	2.88E+00	2.34E+03
2053	1.90E+02	5.41E+02	1.99E+03	2.62E+01	2.75E+03	5.71E+02	1.23E+03	3.73E+01	3.70E+02	2.25E+02	2.64E+00	2.44E+03	5.69E+02	1.23E+03	6.36E+01	5.57E+02	6.81E+00	2.88E+00	2.43E+03
2054	1.96E+02	5.56E+02	2.07E+03	2.62E+01	2.85E+03	5.96E+02	1.28E+03	3.78E+01	3.76E+02	2.36E+02	2.64E+00	2.53E+03	5.93E+02	1.28E+03	6.54E+01	5.71E+02	8.13E+00	2.88E+00	2.52E+03
2055	2.01E+02	5.70E+02	2.16E+03	2.62E+01	2.96E+03	6.21E+02	1.34E+03	3.84E+01	3.81E+02	2.47E+02	2.64E+00	2.63E+03	6.18E+02	1.34E+03	6.72E+01	5.84E+02	9.51E+00	2.88E+00	2.62E+03
2056	2.06E+02	5.84E+02	2.25E+03	2.62E+01	3.06E+03	6.45E+02	1.39E+03	3.89E+01	3.86E+02	2.57E+02	2.64E+00	2.72E+03	6.42E+02	1.39E+03	6.89E+01	5.97E+02	1.08E+01	2.88E+00	2.71E+03
2057	2.10E+02	5.98E+02	2.33E+03	2.62E+01	3.17E+03	6.70E+02	1.44E+03	3.94E+01	3.91E+02	2.68E+02	2.64E+00	2.81E+03	6.67E+02	1.44E+03	7.06E+01	6.10E+02	1.22E+01	2.88E+00	2.80E+03
2058	2.15E+02	6.11E+02	2.41E+03	2.62E+01	3.26E+03	6.92E+02	1.49E+03	3.98E+01	3.95E+02	2.78E+02	2.64E+00	2.90E+03	6.89E+02	1.49E+03	7.23E+01	6.22E+02	1.38E+01	2.88E+00	2.89E+03
2059	2.20E+02	6.24E+02	2.47E+03	2.62E+01	3.34E+03	7.09E+02	1.53E+03	4.02E+01	3.99E+02	2.89E+02	2.64E+00	2.97E+03	7.06E+02	1.53E+03	7.39E+01	6.33E+02	1.63E+01	2.88E+00	2.96E+03
2060	2.24E+02	6.37E+02	2.52E+03	2.62E+01	3.41E+03	7.24E+02	1.56E+03	4.06E+01	4.03E+02	2.99E+02	2.64E+00	3.03E+03	7.20E+02	1.56E+03	7.55E+01	6.43E+02	1.95E+01	2.88E+00	3.02E+03
2061	2.29E+02	6.49E+02	2.56E+03	2.62E+01	3.46E+03	7.35E+02	1.58E+03	4.09E+01	4.07E+02	3.09E+02	2.64E+00	3.08E+03	7.32E+02	1.58E+03	7.70E+01	6.52E+02	2.35E+01	2.88E+00	3.07E+03

Exhibit F-23. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	1.43E+01	0.00E+00	5.44E+01	4.10E+00	8.82E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.79E+01	4.08E+00	8.82E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.82E+01
2030	2.06E+01	5.85E+01	4.99E+01	0.00E+00	1.29E+02	1.43E+01	3.09E+01	5.67E+00	5.63E+01	2.60E+00	2.53E+00	1.12E+02	1.43E+01	3.09E+01	5.97E+00	5.80E+01	5.78E-01	2.76E+00	1.13E+02
2031	3.05E+01	8.66E+01	1.14E+02	1.21E+00	2.32E+02	3.28E+01	7.06E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	2.03E+02	3.26E+01	7.06E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	2.03E+02
2032	4.01E+01	1.14E+02	1.93E+02	3.98E+00	3.50E+02	5.53E+01	1.19E+02	1.06E+01	1.06E+02	1.34E+01	2.64E+00	3.07E+02	5.51E+01	1.19E+02	1.22E+01	1.17E+02	5.78E-01	2.88E+00	3.07E+02
2033	4.94E+01	1.40E+02	2.78E+02	7.70E+00	4.76E+02	7.99E+01	1.72E+02	1.29E+01	1.28E+02	2.18E+01	2.64E+00	4.17E+02	7.95E+01	1.72E+02	1.55E+01	1.46E+02	5.78E-01	2.88E+00	4.17E+02
2034	5.84E+01	1.66E+02	3.64E+02	1.14E+01	6.00E+02	1.04E+02	2.25E+02	1.50E+01	1.49E+02	3.09E+01	2.64E+00	5.27E+02	1.04E+02	2.25E+02	1.86E+01	1.75E+02	5.78E-01	2.88E+00	5.26E+02
2035	6.73E+01	1.91E+02	4.49E+02	1.47E+01	7.22E+02	1.29E+02	2.78E+02	1.70E+01	1.69E+02	4.04E+01	2.64E+00	6.36E+02	1.28E+02	2.78E+02	2.17E+01	2.03E+02	5.78E-01	2.88E+00	6.35E+02
2036	7.58E+01	2.15E+02	5.35E+02	1.75E+01	8.44E+02	1.54E+02	3.31E+02	1.89E+01	1.88E+02	5.00E+01	2.64E+00	7.44E+02	1.53E+02	3.31E+02	2.47E+01	2.30E+02	5.78E-01	2.88E+00	7.42E+02
2037	8.42E+01	2.39E+02	6.20E+02	1.98E+01	9.64E+02	1.78E+02	3.84E+02	2.06E+01	2.05E+02	5.97E+01	2.64E+00	8.50E+02	1.77E+02	3.84E+02	2.76E+01	2.56E+02	5.78E-01	2.88E+00	8.48E+02
2038	9.23E+01	2.62E+02	7.06E+02	2.19E+01	1.08E+03	2.03E+02	4.37E+02	2.23E+01	2.21E+02	6.97E+01	2.64E+00	9.55E+02	2.02E+02	4.37E+02	3.04E+01	2.80E+02	5.78E-01	2.88E+00	9.53E+02
2039	1.00E+02	2.84E+02	7.92E+02	2.35E+01	1.20E+03	2.27E+02	4.90E+02	2.38E+01	2.36E+02	7.98E+01	2.64E+00	1.06E+03	2.26E+02	4.90E+02	3.31E+01	3.04E+02	5.78E-01	2.88E+00	1.06E+03
2040	1.08E+02	3.06E+02	8.77E+02	2.47E+01	1.32E+03	2.52E+02	5.43E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	1.16E+03	2.51E+02	5.43E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	1.16E+03
2041	1.15E+02	3.27E+02	9.63E+02	2.56E+01	1.43E+03	2.77E+02	5.96E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	1.26E+03	2.75E+02	5.96E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	1.26E+03
2042	1.22E+02	3.48E+02	1.05E+03	2.60E+01	1.54E+03	3.01E+02	6.49E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	1.37E+03	3.00E+02	6.49E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	1.36E+03
2043	1.30E+02	3.68E+02	1.13E+03	2.62E+01	1.66E+03	3.26E+02	7.01E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	1.47E+03	3.24E+02	7.01E+02	4.29E+01	3.90E+02	5.78E-01	2.88E+00	1.46E+03
2044	1.36E+02	3.87E+02	1.22E+03	2.62E+01	1.77E+03	3.50E+02	7.54E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	1.57E+03	3.49E+02	7.54E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	1.56E+03
2045	1.43E+02	4.06E+02	1.31E+03	2.62E+01	1.88E+03	3.75E+02	8.07E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.66E+03	3.73E+02	8.07E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.66E+03
2046	1.50E+02	4.25E+02	1.39E+03	2.62E+01	1.99E+03	3.99E+02	8.60E+02	3.20E+01	3.18E+02	1.51E+02	2.64E+00	1.76E+03	3.98E+02	8.60E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.76E+03
2047	1.56E+02	4.43E+02	1.48E+03	2.62E+01	2.10E+03	4.24E+02	9.13E+02	3.29E+01	3.27E+02	1.61E+02	2.64E+00	1.86E+03	4.22E+02	9.13E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.86E+03
2048	1.62E+02	4.60E+02	1.56E+03	2.62E+01	2.21E+03	4.49E+02	9.66E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.96E+03	4.47E+02	9.66E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.95E+03
2049	1.68E+02	4.77E+02	1.65E+03	2.62E+01	2.32E+03	4.73E+02	1.02E+03	3.46E+01	3.43E+02	1.82E+02	2.64E+00	2.06E+03	4.71E+02	1.02E+03	5.58E+01	4.97E+02	2.93E+00	2.88E+00	2.05E+03
2050	1.74E+02	4.94E+02	1.73E+03	2.62E+01	2.43E+03	4.98E+02	1.07E+03	3.53E+01	3.51E+02	1.93E+02	2.64E+00	2.15E+03	4.95E+02	1.07E+03	5.78E+01	5.13E+02	3.73E+00	2.88E+00	2.15E+03
2051	1.79E+02	5.10E+02	1.82E+03	2.62E+01	2.53E+03	5.22E+02	1.12E+03	3.60E+01	3.58E+02	2.04E+02	2.64E+00	2.25E+03	5.20E+02	1.12E+03	5.98E+01	5.28E+02	4.59E+00	2.88E+00	2.24E+03
2052	1.85E+02	5.26E+02	1.90E+03	2.62E+01	2.64E+03	5.47E+02	1.18E+03	3.67E+01	3.64E+02	2.15E+02	2.64E+00	2.34E+03	5.44E+02	1.18E+03	6.17E+01	5.43E+02	5.61E+00	2.88E+00	2.34E+03
2053	1.90E+02	5.41E+02	1.99E+03	2.62E+01	2.75E+03	5.71E+02	1.23E+03	3.73E+01	3.70E+02	2.25E+02	2.64E+00	2.44E+03	5.69E+02	1.23E+03	6.36E+01	5.57E+02	6.81E+00	2.88E+00	2.43E+03
2054	1.96E+02	5.56E+02	2.08E+03	2.62E+01	2.85E+03	5.96E+02	1.28E+03	3.78E+01	3.76E+02	2.36E+02	2.64E+00	2.53E+03	5.93E+02	1.28E+03	6.54E+01	5.71E+02	8.13E+00	2.88E+00	2.52E+03
2055	2.01E+02	5.70E+02	2.16E+03	2.62E+01	2.96E+03	6.21E+02	1.34E+03	3.84E+01	3.81E+02	2.47E+02	2.64E+00	2.63E+03	6.18E+02	1.34E+03	6.72E+01	5.84E+02	9.51E+00	2.88E+00	2.62E+03
2056	2.06E+02	5.84E+02	2.25E+03	2.62E+01	3.06E+03	6.45E+02	1.39E+03	3.89E+01	3.86E+02	2.57E+02	2.64E+00	2.72E+03	6.42E+02	1.39E+03	6.89E+01	5.97E+02	1.08E+01	2.88E+00	2.71E+03
2057	2.10E+02	5.98E+02	2.33E+03	2.62E+01	3.17E+03	6.70E+02	1.44E+03	3.94E+01	3.91E+02	2.68E+02	2.64E+00	2.81E+03	6.67E+02	1.44E+03	7.06E+01	6.10E+02	1.22E+01	2.88E+00	2.81E+03
2058	2.15E+02	6.11E+02	2.41E+03	2.62E+01	3.26E+03	6.92E+02	1.49E+03	3.98E+01	3.95E+02	2.78E+02	2.64E+00	2.90E+03	6.89E+02	1.49E+03	7.23E+01	6.22E+02	1.38E+01	2.88E+00	2.89E+03
2059	2.20E+02	6.24E+02	2.47E+03	2.62E+01	3.34E+03	7.09E+02	1.53E+03	4.02E+01	3.99E+02	2.89E+02	2.64E+00	2.97E+03	7.06E+02	1.53E+03	7.39E+01	6.33E+02	1.63E+01	2.88E+00	2.96E+03
2060	2.24E+02	6.37E+02	2.52E+03	2.62E+01	3.41E+03	7.24E+02	1.56E+03	4.06E+01	4.03E+02	2.99E+02	2.64E+00	3.03E+03	7.20E+02	1.56E+03	7.55E+01	6.43E+02	1.95E+01	2.88E+00	3.02E+03
2061	2.29E+02	6.49E+02	2.56E+03	2.62E+01	3.46E+03	7.35E+02	1.58E+03	4.09E+01	4.07E+02	3.09E+02	2.64E+00	3.08E+03	7.32E+02	1.58E+03	7.70E+01	6.52E+02	2.35E+01	2.88E+00	3.07E+03

Exhibit F-24. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	1.42E+01	0.00E+00	5.44E+01	4.10E+00	9.18E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.83E+01	4.08E+00	9.18E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.86E+01
2030	2.06E+01	5.85E+01	4.98E+01	0.00E+00	1.29E+02	1.43E+01	3.21E+01	5.67E+00	5.63E+01	2.60E+00	2.53E+00	1.14E+02	1.43E+01	3.21E+01	5.97E+00	5.80E+01	5.78E-01	2.76E+00	1.14E+02
2031	3.05E+01	8.66E+01	1.14E+02	1.21E+00	2.32E+02	3.28E+01	7.34E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	2.06E+02	3.26E+01	7.34E+01	9.02E+00	8.71E+01	5.78E-01	2.84E+00	2.06E+02
2032	4.01E+01	1.14E+02	1.92E+02	3.98E+00	3.50E+02	5.53E+01	1.24E+02	1.06E+01	1.06E+02	1.34E+01	2.64E+00	3.12E+02	5.51E+01	1.24E+02	1.22E+01	1.17E+02	5.78E-01	2.88E+00	3.11E+02
2033	4.94E+01	1.40E+02	2.78E+02	7.70E+00	4.75E+02	7.99E+01	1.79E+02	1.29E+01	1.28E+02	2.18E+01	2.64E+00	4.24E+02	7.95E+01	1.79E+02	1.55E+01	1.46E+02	5.78E-01	2.88E+00	4.24E+02
2034	5.84E+01	1.66E+02	3.63E+02	1.14E+01	5.99E+02	1.04E+02	2.34E+02	1.50E+01	1.49E+02	3.09E+01	2.64E+00	5.36E+02	1.04E+02	2.34E+02	1.86E+01	1.75E+02	5.78E-01	2.88E+00	5.36E+02
2035	6.73E+01	1.91E+02	4.48E+02	1.47E+01	7.21E+02	1.29E+02	2.89E+02	1.70E+01	1.69E+02	4.04E+01	2.64E+00	6.47E+02	1.28E+02	2.89E+02	2.17E+01	2.03E+02	5.78E-01	2.88E+00	6.46E+02
2036	7.58E+01	2.15E+02	5.34E+02	1.75E+01	8.42E+02	1.54E+02	3.44E+02	1.89E+01	1.88E+02	5.00E+01	2.64E+00	7.57E+02	1.53E+02	3.44E+02	2.47E+01	2.30E+02	5.78E-01	2.88E+00	7.55E+02
2037	8.42E+01	2.39E+02	6.19E+02	1.98E+01	9.62E+02	1.78E+02	3.99E+02	2.06E+01	2.05E+02	5.97E+01	2.64E+00	8.65E+02	1.77E+02	3.99E+02	2.76E+01	2.56E+02	5.78E-01	2.88E+00	8.63E+02
2038	9.23E+01	2.62E+02	7.05E+02	2.19E+01	1.08E+03	2.03E+02	4.54E+02	2.23E+01	2.21E+02	6.97E+01	2.64E+00	9.73E+02	2.02E+02	4.54E+02	3.04E+01	2.80E+02	5.78E-01	2.88E+00	9.70E+02
2039	1.00E+02	2.84E+02	7.90E+02	2.35E+01	1.20E+03	2.27E+02	5.10E+02	2.38E+01	2.36E+02	7.98E+01	2.64E+00	1.08E+03	2.26E+02	5.10E+02	3.31E+01	3.04E+02	5.78E-01	2.88E+00	1.08E+03
2040	1.08E+02	3.06E+02	8.75E+02	2.47E+01	1.31E+03	2.52E+02	5.65E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	1.18E+03	2.51E+02	5.65E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	1.18E+03
2041	1.15E+02	3.27E+02	9.61E+02	2.56E+01	1.43E+03	2.76E+02	6.20E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	1.29E+03	2.75E+02	6.20E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	1.29E+03
2042	1.22E+02	3.48E+02	1.05E+03	2.60E+01	1.54E+03	3.01E+02	6.75E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	1.39E+03	3.00E+02	6.75E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	1.39E+03
2043	1.30E+02	3.68E+02	1.13E+03	2.62E+01	1.66E+03	3.26E+02	7.30E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	1.49E+03	3.24E+02	7.30E+02	4.29E+01	3.90E+02	5.78E-01	2.88E+00	1.49E+03
2044	1.36E+02	3.87E+02	1.22E+03	2.62E+01	1.77E+03	3.50E+02	7.85E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	1.60E+03	3.49E+02	7.85E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	1.59E+03
2045	1.43E+02	4.06E+02	1.30E+03	2.62E+01	1.88E+03	3.75E+02	8.40E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.70E+03	3.73E+02	8.40E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.69E+03
2046	1.50E+02	4.25E+02	1.39E+03	2.62E+01	1.99E+03	3.99E+02	8.95E+02	3.20E+01	3.18E+02	1.51E+02	2.64E+00	1.80E+03	3.98E+02	8.95E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.79E+03
2047	1.56E+02	4.43E+02	1.47E+03	2.62E+01	2.10E+03	4.24E+02	9.50E+02	3.29E+01	3.27E+02	1.61E+02	2.64E+00	1.90E+03	4.22E+02	9.50E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.89E+03
2048	1.62E+02	4.60E+02	1.56E+03	2.62E+01	2.21E+03	4.49E+02	1.01E+03	3.38E+01	3.36E+02	1.72E+02	2.64E+00	2.00E+03	4.47E+02	1.01E+03	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.99E+03
2049	1.68E+02	4.77E+02	1.64E+03	2.62E+01	2.32E+03	4.73E+02	1.06E+03	3.46E+01	3.43E+02	1.82E+02	2.64E+00	2.10E+03	4.71E+02	1.06E+03	5.58E+01	4.97E+02	2.93E+00	2.88E+00	2.09E+03
2050	1.74E+02	4.94E+02	1.73E+03	2.62E+01	2.42E+03	4.98E+02	1.12E+03	3.53E+01	3.51E+02	1.93E+02	2.64E+00	2.19E+03	4.95E+02	1.12E+03	5.78E+01	5.13E+02	3.73E+00	2.88E+00	2.19E+03
2051	1.79E+02	5.10E+02	1.81E+03	2.62E+01	2.53E+03	5.22E+02	1.17E+03	3.60E+01	3.58E+02	2.04E+02	2.64E+00	2.29E+03	5.20E+02	1.17E+03	5.98E+01	5.28E+02	4.59E+00	2.88E+00	2.29E+03
2052	1.85E+02	5.26E+02	1.90E+03	2.62E+01	2.64E+03	5.47E+02	1.23E+03	3.67E+01	3.64E+02	2.15E+02	2.64E+00	2.39E+03	5.44E+02	1.23E+03	6.17E+01	5.43E+02	5.61E+00	2.88E+00	2.38E+03
2053	1.90E+02	5.41E+02	1.99E+03	2.62E+01	2.74E+03	5.71E+02	1.28E+03	3.73E+01	3.70E+02	2.25E+02	2.64E+00	2.49E+03	5.69E+02	1.28E+03	6.35E+01	5.57E+02	6.81E+00	2.88E+00	2.48E+03
2054	1.96E+02	5.56E+02	2.07E+03	2.62E+01	2.85E+03	5.96E+02	1.34E+03	3.78E+01	3.76E+02	2.36E+02	2.64E+00	2.58E+03	5.93E+02	1.34E+03	6.54E+01	5.71E+02	8.13E+00	2.88E+00	2.58E+03
2055	2.01E+02	5.70E+02	2.16E+03	2.62E+01	2.95E+03	6.21E+02	1.39E+03	3.84E+01	3.81E+02	2.47E+02	2.64E+00	2.68E+03	6.18E+02	1.39E+03	6.71E+01	5.84E+02	9.51E+00	2.88E+00	2.67E+03
2056	2.06E+02	5.84E+02	2.24E+03	2.62E+01	3.06E+03	6.45E+02	1.45E+03	3.89E+01	3.86E+02	2.57E+02	2.64E+00	2.78E+03	6.42E+02	1.45E+03	6.89E+01	5.97E+02	1.08E+01	2.88E+00	2.77E+03
2057	2.10E+02	5.98E+02	2.33E+03	2.62E+01	3.16E+03	6.70E+02	1.50E+03	3.94E+01	3.91E+02	2.68E+02	2.64E+00	2.87E+03	6.67E+02	1.50E+03	7.06E+01	6.10E+02	1.22E+01	2.88E+00	2.86E+03
2058	2.15E+02	6.11E+02	2.40E+03	2.62E+01	3.26E+03	6.92E+02	1.55E+03	3.98E+01	3.95E+02	2.78E+02	2.64E+00	2.96E+03	6.89E+02	1.55E+03	7.23E+01	6.22E+02	1.38E+01	2.88E+00	2.95E+03
2059	2.20E+02	6.24E+02	2.46E+03	2.62E+01	3.34E+03	7.09E+02	1.59E+03	4.02E+01	3.99E+02	2.89E+02	2.64E+00	3.03E+03	7.06E+02	1.59E+03	7.39E+01	6.33E+02	1.63E+01	2.88E+00	3.02E+03
2060	2.24E+02	6.37E+02	2.51E+03	2.62E+01	3.40E+03	7.23E+02	1.62E+03	4.06E+01	4.03E+02	2.99E+02	2.64E+00	3.09E+03	7.20E+02	1.62E+03	7.55E+01	6.43E+02	1.95E+01	2.88E+00	3.08E+03
2061	2.29E+02	6.49E+02	2.55E+03	2.62E+01	3.46E+03	7.35E+02	1.65E+03	4.09E+01	4.07E+02	3.09E+02	2.64E+00	3.14E+03	7.32E+02	1.65E+03	7.70E+01	6.52E+02	2.35E+01	2.88E+00	3.13E+03

Exhibit F-25. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to Japan (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	6.95E+00	0.00E+00	4.71E+01	4.10E+00	1.55E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.07E+01	4.08E+00	1.55E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.09E+01
2030	2.06E+01	5.85E+01	2.43E+01	0.00E+00	1.03E+02	1.43E+01	5.43E+00	5.67E+00	5.63E+01	2.60E+00	2.53E+00	8.69E+01	1.43E+01	5.43E+00	5.97E+00	5.80E+01	5.78E-01	2.76E+00	8.71E+01
2031	3.05E+01	8.66E+01	5.56E+01	1.21E+00	1.74E+02	3.28E+01	1.24E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	1.45E+02	3.26E+01	1.24E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	1.45E+02
2032	4.01E+01	1.14E+02	9.38E+01	3.98E+00	2.52E+02	5.53E+01	2.09E+01	1.07E+01	1.06E+02	1.34E+01	2.64E+00	2.09E+02	5.51E+01	2.09E+01	1.22E+01	1.17E+02	5.78E-01	2.88E+00	2.08E+02
2033	4.94E+01	1.40E+02	1.35E+02	7.70E+00	3.33E+02	7.99E+01	3.02E+01	1.29E+01	1.28E+02	2.18E+01	2.64E+00	2.76E+02	7.95E+01	3.02E+01	1.55E+01	1.46E+02	5.78E-01	2.88E+00	2.75E+02
2034	5.84E+01	1.66E+02	1.77E+02	1.14E+01	4.13E+02	1.04E+02	3.95E+01	1.50E+01	1.49E+02	3.09E+01	2.64E+00	3.42E+02	1.04E+02	3.95E+01	1.86E+01	1.75E+02	5.78E-01	2.88E+00	3.41E+02
2035	6.73E+01	1.91E+02	2.19E+02	1.47E+01	4.92E+02	1.29E+02	4.88E+01	1.70E+01	1.69E+02	4.04E+01	2.64E+00	4.07E+02	1.28E+02	4.88E+01	2.17E+01	2.03E+02	5.78E-01	2.88E+00	4.06E+02
2036	7.58E+01	2.15E+02	2.60E+02	1.75E+01	5.69E+02	1.54E+02	5.81E+01	1.89E+01	1.88E+02	5.00E+01	2.64E+00	4.71E+02	1.53E+02	5.81E+01	2.47E+01	2.30E+02	5.78E-01	2.88E+00	4.69E+02
2037	8.42E+01	2.39E+02	3.02E+02	1.98E+01	6.45E+02	1.78E+02	6.74E+01	2.06E+01	2.05E+02	5.97E+01	2.64E+00	5.34E+02	1.77E+02	6.74E+01	2.76E+01	2.56E+02	5.78E-01	2.88E+00	5.31E+02
2038	9.23E+01	2.62E+02	3.44E+02	2.19E+01	7.20E+02	2.03E+02	7.67E+01	2.23E+01	2.21E+02	6.97E+01	2.64E+00	5.95E+02	2.02E+02	7.67E+01	3.04E+01	2.80E+02	5.78E-01	2.88E+00	5.93E+02
2039	1.00E+02	2.84E+02	3.85E+02	2.35E+01	7.94E+02	2.27E+02	8.60E+01	2.38E+01	2.36E+02	7.98E+01	2.64E+00	6.56E+02	2.26E+02	8.60E+01	3.31E+01	3.04E+02	5.78E-01	2.88E+00	6.53E+02
2040	1.08E+02	3.06E+02	4.27E+02	2.47E+01	8.66E+02	2.52E+02	9.53E+01	2.52E+01	2.50E+02	8.99E+01	2.64E+00	7.15E+02	2.51E+02	9.53E+01	3.57E+01	3.27E+02	5.78E-01	2.88E+00	7.12E+02
2041	1.15E+02	3.27E+02	4.69E+02	2.56E+01	9.37E+02	2.77E+02	1.05E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	7.74E+02	2.75E+02	1.05E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	7.70E+02
2042	1.22E+02	3.48E+02	5.11E+02	2.60E+01	1.01E+03	3.01E+02	1.14E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	8.31E+02	3.00E+02	1.14E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	8.28E+02
2043	1.30E+02	3.68E+02	5.52E+02	2.62E+01	1.08E+03	3.26E+02	1.23E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	8.88E+02	3.24E+02	1.23E+02	4.30E+01	3.90E+02	5.78E-01	2.88E+00	8.84E+02
2044	1.36E+02	3.87E+02	5.94E+02	2.62E+01	1.14E+03	3.50E+02	1.33E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	9.44E+02	3.49E+02	1.33E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	9.39E+02
2045	1.43E+02	4.06E+02	6.36E+02	2.62E+01	1.21E+03	3.75E+02	1.42E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	9.99E+02	3.73E+02	1.42E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	9.94E+02
2046	1.50E+02	4.25E+02	6.77E+02	2.62E+01	1.28E+03	3.99E+02	1.51E+02	3.21E+01	3.18E+02	1.51E+02	2.64E+00	1.05E+03	3.98E+02	1.51E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.05E+03
2047	1.56E+02	4.43E+02	7.19E+02	2.62E+01	1.34E+03	4.24E+02	1.60E+02	3.30E+01	3.27E+02	1.61E+02	2.64E+00	1.11E+03	4.22E+02	1.60E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.10E+03
2048	1.62E+02	4.60E+02	7.61E+02	2.62E+01	1.41E+03	4.49E+02	1.70E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.16E+03	4.47E+02	1.70E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.16E+03
2049	1.68E+02	4.77E+02	8.02E+02	2.62E+01	1.47E+03	4.73E+02	1.79E+02	3.46E+01	3.43E+02	1.82E+02	2.64E+00	1.22E+03	4.71E+02	1.79E+02	5.59E+01	4.97E+02	2.93E+00	2.88E+00	1.21E+03
2050	1.74E+02	4.94E+02	8.44E+02	2.62E+01	1.54E+03	4.98E+02	1.88E+02	3.53E+01	3.51E+02	1.93E+02	2.64E+00	1.27E+03	4.96E+02	1.88E+02	5.78E+01	5.13E+02	3.73E+00	2.88E+00	1.26E+03
2051	1.79E+02	5.10E+02	8.86E+02	2.62E+01	1.60E+03	5.22E+02	1.98E+02	3.60E+01	3.58E+02	2.04E+02	2.64E+00	1.32E+03	5.20E+02	1.98E+02	5.98E+01	5.28E+02	4.59E+00	2.88E+00	1.31E+03
2052	1.85E+02	5.26E+02	9.27E+02	2.62E+01	1.66E+03	5.47E+02	2.07E+02	3.67E+01	3.64E+02	2.15E+02	2.64E+00	1.37E+03	5.44E+02	2.07E+02	6.17E+01	5.43E+02	5.61E+00	2.88E+00	1.36E+03
2053	1.90E+02	5.41E+02	9.69E+02	2.62E+01	1.73E+03	5.71E+02	2.16E+02	3.73E+01	3.70E+02	2.25E+02	2.64E+00	1.42E+03	5.69E+02	2.16E+02	6.36E+01	5.57E+02	6.81E+00	2.88E+00	1.42E+03
2054	1.96E+02	5.56E+02	1.01E+03	2.62E+01	1.79E+03	5.96E+02	2.26E+02	3.79E+01	3.76E+02	2.36E+02	2.64E+00	1.47E+03	5.93E+02	2.26E+02	6.54E+01	5.71E+02	8.13E+00	2.88E+00	1.47E+03
2055	2.01E+02	5.70E+02	1.05E+03	2.62E+01	1.85E+03	6.21E+02	2.35E+02	3.84E+01	3.81E+02	2.47E+02	2.64E+00	1.52E+03	6.18E+02	2.35E+02	6.72E+01	5.84E+02	9.51E+00	2.88E+00	1.52E+03
2056	2.06E+02	5.84E+02	1.09E+03	2.62E+01	1.91E+03	6.45E+02	2.44E+02	3.89E+01	3.86E+02	2.57E+02	2.64E+00	1.57E+03	6.42E+02	2.44E+02	6.89E+01	5.97E+02	1.08E+01	2.88E+00	1.57E+03
2057	2.10E+02	5.98E+02	1.14E+03	2.62E+01	1.97E+03	6.70E+02	2.53E+02	3.94E+01	3.91E+02	2.68E+02	2.64E+00	1.62E+03	6.67E+02	2.53E+02	7.06E+01	6.10E+02	1.22E+01	2.88E+00	1.62E+03
2058	2.15E+02	6.11E+02	1.17E+03	2.62E+01	2.03E+03	6.92E+02	2.62E+02	3.98E+01	3.95E+02	2.78E+02	2.64E+00	1.67E+03	6.89E+02	2.62E+02	7.23E+01	6.22E+02	1.38E+01	2.88E+00	1.66E+03
2059	2.20E+02	6.24E+02	1.20E+03	2.62E+01	2.07E+03	7.09E+02	2.68E+02	4.02E+01	3.99E+02	2.89E+02	2.64E+00	1.71E+03	7.06E+02	2.68E+02	7.39E+01	6.33E+02	1.63E+01	2.88E+00	1.70E+03
2060	2.24E+02	6.37E+02	1.23E+03	2.62E+01	2.11E+03	7.24E+02	2.74E+02	4.06E+01	4.03E+02	2.99E+02	2.64E+00	1.74E+03	7.20E+02	2.74E+02	7.55E+01	6.43E+02	1.95E+01	2.88E+00	1.73E+03
2061	2.29E+02	6.49E+02	1.25E+03	2.62E+01	2.15E+03	7.35E+02	2.78E+02	4.10E+01	4.07E+02	3.09E+02	2.64E+00	1.77E+03	7.32E+02	2.78E+02	7.70E+01	6.52E+02	2.35E+01	2.88E+00	1.76E+03

Exhibit F-26. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	7.04E+00	0.00E+00	4.72E+01	4.10E+00	1.63E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.07E+01	4.08E+00	1.63E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.10E+01
2030	2.06E+01	5.85E+01	2.46E+01	0.00E+00	1.04E+02	1.43E+01	5.72E+00	5.67E+00	5.63E+01	2.60E+00	2.53E+00	8.72E+01	1.43E+01	5.72E+00	5.97E+00	5.80E+01	5.78E-01	2.76E+00	8.73E+01
2031	3.05E+01	8.66E+01	5.63E+01	1.21E+00	1.75E+02	3.28E+01	1.31E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	1.45E+02	3.26E+01	1.31E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	1.45E+02
2032	4.01E+01	1.14E+02	9.50E+01	3.98E+00	2.53E+02	5.53E+01	2.20E+01	1.07E+01	1.06E+02	1.34E+01	2.64E+00	2.10E+02	5.51E+01	2.20E+01	1.22E+01	1.17E+02	5.78E-01	2.88E+00	2.10E+02
2033	4.94E+01	1.40E+02	1.37E+02	7.70E+00	3.35E+02	7.99E+01	3.18E+01	1.29E+01	1.28E+02	2.18E+01	2.64E+00	2.77E+02	7.95E+01	3.18E+01	1.55E+01	1.46E+02	5.78E-01	2.88E+00	2.77E+02
2034	5.84E+01	1.66E+02	1.80E+02	1.14E+01	4.15E+02	1.04E+02	4.16E+01	1.50E+01	1.49E+02	3.09E+01	2.64E+00	3.44E+02	1.04E+02	4.16E+01	1.86E+01	1.75E+02	5.78E-01	2.88E+00	3.43E+02
2035	6.73E+01	1.91E+02	2.22E+02	1.47E+01	4.95E+02	1.29E+02	5.14E+01	1.70E+01	1.69E+02	4.04E+01	2.64E+00	4.10E+02	1.28E+02	5.14E+01	2.17E+01	2.03E+02	5.78E-01	2.88E+00	4.08E+02
2036	7.58E+01	2.15E+02	2.64E+02	1.75E+01	5.73E+02	1.54E+02	6.12E+01	1.89E+01	1.88E+02	5.00E+01	2.64E+00	4.74E+02	1.53E+02	6.12E+01	2.47E+01	2.30E+02	5.78E-01	2.88E+00	4.72E+02
2037	8.42E+01	2.39E+02	3.06E+02	1.98E+01	6.49E+02	1.78E+02	7.10E+01	2.06E+01	2.05E+02	5.97E+01	2.64E+00	5.37E+02	1.77E+02	7.10E+01	2.76E+01	2.56E+02	5.78E-01	2.88E+00	5.35E+02
2038	9.23E+01	2.62E+02	3.48E+02	2.19E+01	7.25E+02	2.03E+02	8.08E+01	2.23E+01	2.21E+02	6.97E+01	2.64E+00	5.99E+02	2.02E+02	8.08E+01	3.04E+01	2.80E+02	5.78E-01	2.88E+00	5.97E+02
2039	1.00E+02	2.84E+02	3.91E+02	2.35E+01	7.99E+02	2.27E+02	9.06E+01	2.38E+01	2.36E+02	7.98E+01	2.64E+00	6.60E+02	2.26E+02	9.06E+01	3.31E+01	3.04E+02	5.78E-01	2.88E+00	6.58E+02
2040	1.08E+02	3.06E+02	4.33E+02	2.47E+01	8.72E+02	2.52E+02	1.00E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	7.20E+02	2.51E+02	1.00E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	7.17E+02
2041	1.15E+02	3.27E+02	4.75E+02	2.56E+01	9.43E+02	2.77E+02	1.10E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	7.79E+02	2.75E+02	1.10E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	7.76E+02
2042	1.22E+02	3.48E+02	5.17E+02	2.60E+01	1.01E+03	3.01E+02	1.20E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	8.37E+02	3.00E+02	1.20E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	8.34E+02
2043	1.30E+02	3.68E+02	5.60E+02	2.62E+01	1.08E+03	3.26E+02	1.30E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	8.95E+02	3.24E+02	1.30E+02	4.30E+01	3.90E+02	5.78E-01	2.88E+00	8.90E+02
2044	1.36E+02	3.87E+02	6.02E+02	2.62E+01	1.15E+03	3.50E+02	1.40E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	9.51E+02	3.49E+02	1.40E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	9.46E+02
2045	1.43E+02	4.06E+02	6.44E+02	2.62E+01	1.22E+03	3.75E+02	1.49E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.01E+03	3.73E+02	1.49E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.00E+03
2046	1.50E+02	4.25E+02	6.86E+02	2.62E+01	1.29E+03	3.99E+02	1.59E+02	3.21E+01	3.18E+02	1.51E+02	2.64E+00	1.06E+03	3.98E+02	1.59E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.06E+03
2047	1.56E+02	4.43E+02	7.29E+02	2.62E+01	1.35E+03	4.24E+02	1.69E+02	3.30E+01	3.27E+02	1.61E+02	2.64E+00	1.12E+03	4.22E+02	1.69E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.11E+03
2048	1.62E+02	4.60E+02	7.71E+02	2.62E+01	1.42E+03	4.49E+02	1.79E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.17E+03	4.47E+02	1.79E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.17E+03
2049	1.68E+02	4.77E+02	8.13E+02	2.62E+01	1.48E+03	4.73E+02	1.89E+02	3.46E+01	3.43E+02	1.82E+02	2.64E+00	1.22E+03	4.71E+02	1.89E+02	5.59E+01	4.97E+02	2.93E+00	2.88E+00	1.22E+03
2050	1.74E+02	4.94E+02	8.55E+02	2.62E+01	1.55E+03	4.98E+02	1.98E+02	3.53E+01	3.51E+02	1.93E+02	2.64E+00	1.28E+03	4.96E+02	1.98E+02	5.78E+01	5.13E+02	3.73E+00	2.88E+00	1.27E+03
2051	1.79E+02	5.10E+02	8.98E+02	2.62E+01	1.61E+03	5.22E+02	2.08E+02	3.60E+01	3.58E+02	2.04E+02	2.64E+00	1.33E+03	5.20E+02	2.08E+02	5.98E+01	5.28E+02	4.59E+00	2.88E+00	1.32E+03
2052	1.85E+02	5.26E+02	9.40E+02	2.62E+01	1.68E+03	5.47E+02	2.18E+02	3.67E+01	3.64E+02	2.15E+02	2.64E+00	1.38E+03	5.44E+02	2.18E+02	6.17E+01	5.43E+02	5.61E+00	2.88E+00	1.38E+03
2053	1.90E+02	5.41E+02	9.82E+02	2.62E+01	1.74E+03	5.71E+02	2.28E+02	3.73E+01	3.70E+02	2.25E+02	2.64E+00	1.43E+03	5.69E+02	2.28E+02	6.36E+01	5.57E+02	6.81E+00	2.88E+00	1.43E+03
2054	1.96E+02	5.56E+02	1.02E+03	2.62E+01	1.80E+03	5.96E+02	2.38E+02	3.79E+01	3.76E+02	2.36E+02	2.64E+00	1.49E+03	5.93E+02	2.38E+02	6.54E+01	5.71E+02	8.13E+00	2.88E+00	1.48E+03
2055	2.01E+02	5.70E+02	1.07E+03	2.62E+01	1.86E+03	6.21E+02	2.47E+02	3.84E+01	3.81E+02	2.47E+02	2.64E+00	1.54E+03	6.18E+02	2.47E+02	6.72E+01	5.84E+02	9.51E+00	2.88E+00	1.53E+03
2056	2.06E+02	5.84E+02	1.11E+03	2.62E+01	1.92E+03	6.45E+02	2.57E+02	3.89E+01	3.86E+02	2.57E+02	2.64E+00	1.59E+03	6.42E+02	2.57E+02	6.89E+01	5.97E+02	1.08E+01	2.88E+00	1.58E+03
2057	2.10E+02	5.98E+02	1.15E+03	2.62E+01	1.99E+03	6.70E+02	2.67E+02	3.94E+01	3.91E+02	2.68E+02	2.64E+00	1.64E+03	6.67E+02	2.67E+02	7.06E+01	6.10E+02	1.22E+01	2.88E+00	1.63E+03
2058	2.15E+02	6.11E+02	1.19E+03	2.62E+01	2.04E+03	6.92E+02	2.76E+02	3.98E+01	3.95E+02	2.78E+02	2.64E+00	1.68E+03	6.89E+02	2.76E+02	7.23E+01	6.22E+02	1.38E+01	2.88E+00	1.68E+03
2059	2.20E+02	6.24E+02	1.22E+03	2.62E+01	2.09E+03	7.09E+02	2.83E+02	4.02E+01	3.99E+02	2.89E+02	2.64E+00	1.72E+03	7.06E+02	2.83E+02	7.39E+01	6.33E+02	1.63E+01	2.88E+00	1.72E+03
2060	2.24E+02	6.37E+02	1.24E+03	2.62E+01	2.13E+03	7.24E+02	2.88E+02	4.06E+01	4.03E+02	2.99E+02	2.64E+00	1.76E+03	7.20E+02	2.88E+02	7.55E+01	6.43E+02	1.95E+01	2.88E+00	1.75E+03
2061	2.29E+02	6.49E+02	1.26E+03	2.62E+01	2.17E+03	7.35E+02	2.93E+02	4.10E+01	4.07E+02	3.09E+02	2.64E+00	1.79E+03	7.32E+02	2.93E+02	7.70E+01	6.52E+02	2.35E+01	2.88E+00	1.78E+03

Exhibit F-27. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to China (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	7.04E+00	0.00E+00	4.72E+01	4.10E+00	1.64E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.08E+01	4.08E+00	1.64E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.10E+01
2030	2.06E+01	5.85E+01	2.47E+01	0.00E+00	1.04E+02	1.43E+01	5.73E+00	5.67E+00	5.63E+01	2.60E+00	2.53E+00	8.72E+01	1.43E+01	5.73E+00	5.97E+00	5.80E+01	5.78E-01	2.76E+00	8.74E+01
2031	3.05E+01	8.66E+01	5.64E+01	1.21E+00	1.75E+02	3.28E+01	1.31E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	1.45E+02	3.26E+01	1.31E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	1.45E+02
2032	4.01E+01	1.14E+02	9.51E+01	3.98E+00	2.53E+02	5.53E+01	2.21E+01	1.07E+01	1.06E+02	1.34E+01	2.64E+00	2.10E+02	5.51E+01	2.21E+01	1.22E+01	1.17E+02	5.78E-01	2.88E+00	2.10E+02
2033	4.94E+01	1.40E+02	1.37E+02	7.70E+00	3.35E+02	7.99E+01	3.19E+01	1.29E+01	1.28E+02	2.18E+01	2.64E+00	2.77E+02	7.95E+01	3.19E+01	1.55E+01	1.46E+02	5.78E-01	2.88E+00	2.77E+02
2034	5.84E+01	1.66E+02	1.80E+02	1.14E+01	4.16E+02	1.04E+02	4.17E+01	1.50E+01	1.49E+02	3.09E+01	2.64E+00	3.44E+02	1.04E+02	4.17E+01	1.86E+01	1.75E+02	5.78E-01	2.88E+00	3.43E+02
2035	6.73E+01	1.91E+02	2.22E+02	1.47E+01	4.95E+02	1.29E+02	5.16E+01	1.70E+01	1.69E+02	4.04E+01	2.64E+00	4.10E+02	1.28E+02	5.16E+01	2.17E+01	2.03E+02	5.78E-01	2.88E+00	4.08E+02
2036	7.58E+01	2.15E+02	2.64E+02	1.75E+01	5.73E+02	1.54E+02	6.14E+01	1.89E+01	1.88E+02	5.00E+01	2.64E+00	4.74E+02	1.53E+02	6.14E+01	2.47E+01	2.30E+02	5.78E-01	2.88E+00	4.72E+02
2037	8.42E+01	2.39E+02	3.06E+02	1.98E+01	6.49E+02	1.78E+02	7.12E+01	2.06E+01	2.05E+02	5.97E+01	2.64E+00	5.37E+02	1.77E+02	7.12E+01	2.76E+01	2.56E+02	5.78E-01	2.88E+00	5.35E+02
2038	9.23E+01	2.62E+02	3.49E+02	2.19E+01	7.25E+02	2.03E+02	8.10E+01	2.23E+01	2.21E+02	6.97E+01	2.64E+00	5.99E+02	2.02E+02	8.10E+01	3.04E+01	2.80E+02	5.78E-01	2.88E+00	5.97E+02
2039	1.00E+02	2.84E+02	3.91E+02	2.35E+01	7.99E+02	2.27E+02	9.08E+01	2.38E+01	2.36E+02	7.98E+01	2.64E+00	6.61E+02	2.26E+02	9.08E+01	3.31E+01	3.04E+02	5.78E-01	2.88E+00	6.58E+02
2040	1.08E+02	3.06E+02	4.33E+02	2.47E+01	8.72E+02	2.52E+02	1.01E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	7.21E+02	2.51E+02	1.01E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	7.18E+02
2041	1.15E+02	3.27E+02	4.76E+02	2.56E+01	9.44E+02	2.77E+02	1.10E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	7.80E+02	2.75E+02	1.10E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	7.76E+02
2042	1.22E+02	3.48E+02	5.18E+02	2.60E+01	1.01E+03	3.01E+02	1.20E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	8.38E+02	3.00E+02	1.20E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	8.34E+02
2043	1.30E+02	3.68E+02	5.60E+02	2.62E+01	1.08E+03	3.26E+02	1.30E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	8.95E+02	3.24E+02	1.30E+02	4.30E+01	3.90E+02	5.78E-01	2.88E+00	8.91E+02
2044	1.36E+02	3.87E+02	6.02E+02	2.62E+01	1.15E+03	3.50E+02	1.40E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	9.51E+02	3.49E+02	1.40E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	9.47E+02
2045	1.43E+02	4.06E+02	6.45E+02	2.62E+01	1.22E+03	3.75E+02	1.50E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.01E+03	3.73E+02	1.50E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.00E+03
2046	1.50E+02	4.25E+02	6.87E+02	2.62E+01	1.29E+03	3.99E+02	1.60E+02	3.21E+01	3.18E+02	1.51E+02	2.64E+00	1.06E+03	3.98E+02	1.60E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.06E+03
2047	1.56E+02	4.43E+02	7.29E+02	2.62E+01	1.35E+03	4.24E+02	1.69E+02	3.30E+01	3.27E+02	1.61E+02	2.64E+00	1.12E+03	4.22E+02	1.69E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.11E+03
2048	1.62E+02	4.60E+02	7.71E+02	2.62E+01	1.42E+03	4.49E+02	1.79E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.17E+03	4.47E+02	1.79E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.17E+03
2049	1.68E+02	4.77E+02	8.14E+02	2.62E+01	1.49E+03	4.73E+02	1.89E+02	3.46E+01	3.43E+02	1.82E+02	2.64E+00	1.23E+03	4.71E+02	1.89E+02	5.59E+01	4.97E+02	2.93E+00	2.88E+00	1.22E+03
2050	1.74E+02	4.94E+02	8.56E+02	2.62E+01	1.55E+03	4.98E+02	1.99E+02	3.53E+01	3.51E+02	1.93E+02	2.64E+00	1.28E+03	4.96E+02	1.99E+02	5.78E+01	5.13E+02	3.73E+00	2.88E+00	1.27E+03
2051	1.79E+02	5.10E+02	8.98E+02	2.62E+01	1.61E+03	5.22E+02	2.09E+02	3.60E+01	3.58E+02	2.04E+02	2.64E+00	1.33E+03	5.20E+02	2.09E+02	5.98E+01	5.28E+02	4.59E+00	2.88E+00	1.32E+03
2052	1.85E+02	5.26E+02	9.40E+02	2.62E+01	1.68E+03	5.47E+02	2.19E+02	3.67E+01	3.64E+02	2.15E+02	2.64E+00	1.38E+03	5.44E+02	2.19E+02	6.17E+01	5.43E+02	5.61E+00	2.88E+00	1.38E+03
2053	1.90E+02	5.41E+02	9.83E+02	2.62E+01	1.74E+03	5.71E+02	2.28E+02	3.73E+01	3.70E+02	2.25E+02	2.64E+00	1.44E+03	5.69E+02	2.28E+02	6.36E+01	5.57E+02	6.81E+00	2.88E+00	1.43E+03
2054	1.96E+02	5.56E+02	1.02E+03	2.62E+01	1.80E+03	5.96E+02	2.38E+02	3.79E+01	3.76E+02	2.36E+02	2.64E+00	1.49E+03	5.93E+02	2.38E+02	6.54E+01	5.71E+02	8.13E+00	2.88E+00	1.48E+03
2055	2.01E+02	5.70E+02	1.07E+03	2.62E+01	1.86E+03	6.21E+02	2.48E+02	3.84E+01	3.81E+02	2.47E+02	2.64E+00	1.54E+03	6.18E+02	2.48E+02	6.72E+01	5.84E+02	9.51E+00	2.88E+00	1.53E+03
2056	2.06E+02	5.84E+02	1.11E+03	2.62E+01	1.93E+03	6.45E+02	2.58E+02	3.89E+01	3.86E+02	2.57E+02	2.64E+00	1.59E+03	6.42E+02	2.58E+02	6.89E+01	5.97E+02	1.08E+01	2.88E+00	1.58E+03
2057	2.10E+02	5.98E+02	1.15E+03	2.62E+01	1.99E+03	6.70E+02	2.68E+02	3.94E+01	3.91E+02	2.68E+02	2.64E+00	1.64E+03	6.67E+02	2.68E+02	7.06E+01	6.10E+02	1.22E+01	2.88E+00	1.63E+03
2058	2.15E+02	6.11E+02	1.19E+03	2.62E+01	2.04E+03	6.92E+02	2.76E+02	3.98E+01	3.95E+02	2.78E+02	2.64E+00	1.68E+03	6.89E+02	2.76E+02	7.23E+01	6.22E+02	1.38E+01	2.88E+00	1.68E+03
2059	2.20E+02	6.24E+02	1.22E+03	2.62E+01	2.09E+03	7.09E+02	2.83E+02	4.02E+01	3.99E+02	2.89E+02	2.64E+00	1.72E+03	7.06E+02	2.83E+02	7.39E+01	6.33E+02	1.63E+01	2.88E+00	1.72E+03
2060	2.24E+02	6.37E+02	1.24E+03	2.62E+01	2.13E+03	7.24E+02	2.89E+02	4.06E+01	4.03E+02	2.99E+02	2.64E+00	1.76E+03	7.20E+02	2.89E+02	7.55E+01	6.43E+02	1.95E+01	2.88E+00	1.75E+03
2061	2.29E+02	6.49E+02	1.26E+03	2.62E+01	2.17E+03	7.35E+02	2.94E+02	4.10E+01	4.07E+02	3.09E+02	2.64E+00	1.79E+03	7.32E+02	2.94E+02	7.70E+01	6.52E+02	2.35E+01	2.88E+00	1.78E+03

Exhibit F-28. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to India (MMT CO_2e)

Year	Scenario 1					Scenario 2							Scenario 3						
	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Average Crude Oil Production and End Use	Construction	Total
2024	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.98E-02	5.98E-02
2025	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.58E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	3.53E-01
2026	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-01	6.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-01	7.59E-01
2027	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+00	1.29E+00
2028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+00	2.13E+00
2029	1.04E+01	2.97E+01	7.01E+00	0.00E+00	4.71E+01	4.10E+00	2.07E+00	2.92E+00	2.90E+01	7.71E-01	2.30E+00	4.12E+01	4.08E+00	2.07E+00	3.01E+00	2.93E+01	4.74E-01	2.54E+00	4.14E+01
2030	2.06E+01	5.85E+01	2.45E+01	0.00E+00	1.04E+02	1.43E+01	7.23E+00	5.67E+00	5.63E+01	2.60E+00	2.53E+00	8.87E+01	1.43E+01	7.23E+00	5.97E+00	5.80E+01	5.78E-01	2.76E+00	8.89E+01
2031	3.05E+01	8.66E+01	5.61E+01	1.21E+00	1.74E+02	3.28E+01	1.65E+01	8.24E+00	8.18E+01	6.74E+00	2.60E+00	1.49E+02	3.26E+01	1.65E+01	9.03E+00	8.71E+01	5.78E-01	2.84E+00	1.49E+02
2032	4.01E+01	1.14E+02	9.46E+01	3.98E+00	2.52E+02	5.53E+01	2.79E+01	1.07E+01	1.06E+02	1.34E+01	2.64E+00	2.16E+02	5.51E+01	2.79E+01	1.22E+01	1.17E+02	5.78E-01	2.88E+00	2.15E+02
2033	4.94E+01	1.40E+02	1.37E+02	7.70E+00	3.34E+02	7.99E+01	4.03E+01	1.29E+01	1.28E+02	2.18E+01	2.64E+00	2.86E+02	7.95E+01	4.03E+01	1.55E+01	1.46E+02	5.78E-01	2.88E+00	2.85E+02
2034	5.84E+01	1.66E+02	1.79E+02	1.14E+01	4.15E+02	1.04E+02	5.27E+01	1.50E+01	1.49E+02	3.09E+01	2.64E+00	3.55E+02	1.04E+02	5.27E+01	1.86E+01	1.75E+02	5.78E-01	2.88E+00	3.54E+02
2035	6.73E+01	1.91E+02	2.21E+02	1.47E+01	4.94E+02	1.29E+02	6.51E+01	1.70E+01	1.69E+02	4.04E+01	2.64E+00	4.23E+02	1.28E+02	6.51E+01	2.17E+01	2.03E+02	5.78E-01	2.88E+00	4.22E+02
2036	7.58E+01	2.15E+02	2.63E+02	1.75E+01	5.72E+02	1.54E+02	7.75E+01	1.89E+01	1.88E+02	5.00E+01	2.64E+00	4.90E+02	1.53E+02	7.75E+01	2.47E+01	2.30E+02	5.78E-01	2.88E+00	4.89E+02
2037	8.42E+01	2.39E+02	3.05E+02	1.98E+01	6.48E+02	1.78E+02	8.99E+01	2.06E+01	2.05E+02	5.97E+01	2.64E+00	5.56E+02	1.77E+02	8.99E+01	2.76E+01	2.56E+02	5.78E-01	2.88E+00	5.54E+02
2038	9.23E+01	2.62E+02	3.47E+02	2.19E+01	7.23E+02	2.03E+02	1.02E+02	2.23E+01	2.21E+02	6.97E+01	2.64E+00	6.21E+02	2.02E+02	1.02E+02	3.04E+01	2.80E+02	5.78E-01	2.88E+00	6.18E+02
2039	1.00E+02	2.84E+02	3.89E+02	2.35E+01	7.97E+02	2.27E+02	1.15E+02	2.38E+01	2.36E+02	7.98E+01	2.64E+00	6.84E+02	2.26E+02	1.15E+02	3.31E+01	3.04E+02	5.78E-01	2.88E+00	6.82E+02
2040	1.08E+02	3.06E+02	4.31E+02	2.47E+01	8.70E+02	2.52E+02	1.27E+02	2.52E+01	2.50E+02	8.99E+01	2.64E+00	7.47E+02	2.51E+02	1.27E+02	3.57E+01	3.27E+02	5.78E-01	2.88E+00	7.44E+02
2041	1.15E+02	3.27E+02	4.73E+02	2.56E+01	9.41E+02	2.77E+02	1.40E+02	2.65E+01	2.64E+02	9.99E+01	2.64E+00	8.09E+02	2.75E+02	1.40E+02	3.82E+01	3.49E+02	5.78E-01	2.88E+00	8.05E+02
2042	1.22E+02	3.48E+02	5.15E+02	2.60E+01	1.01E+03	3.01E+02	1.52E+02	2.78E+01	2.76E+02	1.10E+02	2.64E+00	8.69E+02	3.00E+02	1.52E+02	4.06E+01	3.70E+02	5.78E-01	2.88E+00	8.65E+02
2043	1.30E+02	3.68E+02	5.57E+02	2.62E+01	1.08E+03	3.26E+02	1.64E+02	2.90E+01	2.88E+02	1.20E+02	2.64E+00	9.29E+02	3.24E+02	1.64E+02	4.30E+01	3.90E+02	5.78E-01	2.88E+00	9.25E+02
2044	1.36E+02	3.87E+02	5.99E+02	2.62E+01	1.15E+03	3.50E+02	1.77E+02	3.01E+01	2.98E+02	1.30E+02	2.64E+00	9.88E+02	3.49E+02	1.77E+02	4.52E+01	4.09E+02	6.17E-01	2.88E+00	9.83E+02
2045	1.43E+02	4.06E+02	6.41E+02	2.62E+01	1.22E+03	3.75E+02	1.89E+02	3.11E+01	3.09E+02	1.40E+02	2.64E+00	1.05E+03	3.73E+02	1.89E+02	4.74E+01	4.28E+02	8.14E-01	2.88E+00	1.04E+03
2046	1.50E+02	4.25E+02	6.83E+02	2.62E+01	1.28E+03	3.99E+02	2.02E+02	3.20E+01	3.18E+02	1.51E+02	2.64E+00	1.10E+03	3.98E+02	2.02E+02	4.96E+01	4.46E+02	1.14E+00	2.88E+00	1.10E+03
2047	1.56E+02	4.43E+02	7.25E+02	2.62E+01	1.35E+03	4.24E+02	2.14E+02	3.30E+01	3.27E+02	1.61E+02	2.64E+00	1.16E+03	4.22E+02	2.14E+02	5.17E+01	4.64E+02	1.60E+00	2.88E+00	1.16E+03
2048	1.62E+02	4.60E+02	7.67E+02	2.62E+01	1.42E+03	4.49E+02	2.26E+02	3.38E+01	3.36E+02	1.72E+02	2.64E+00	1.22E+03	4.47E+02	2.26E+02	5.38E+01	4.81E+02	2.20E+00	2.88E+00	1.21E+03
2049	1.68E+02	4.77E+02	8.09E+02	2.62E+01	1.48E+03	4.73E+02	2.39E+02	3.46E+01	3.43E+02	1.82E+02	2.64E+00	1.27E+03	4.71E+02	2.39E+02	5.59E+01	4.97E+02	2.93E+00	2.88E+00	1.27E+03
2050	1.74E+02	4.94E+02	8.51E+02	2.62E+01	1.55E+03	4.98E+02	2.51E+02	3.53E+01	3.51E+02	1.93E+02	2.64E+00	1.33E+03	4.96E+02	2.51E+02	5.78E+01	5.13E+02	3.73E+00	2.88E+00	1.32E+03
2051	1.79E+02	5.10E+02	8.94E+02	2.62E+01	1.61E+03	5.22E+02	2.64E+02	3.60E+01	3.58E+02	2.04E+02	2.64E+00	1.39E+03	5.20E+02	2.64E+02	5.98E+01	5.28E+02	4.59E+00	2.88E+00	1.38E+03
2052	1.85E+02	5.26E+02	9.36E+02	2.62E+01	1.67E+03	5.47E+02	2.76E+02	3.67E+01	3.64E+02	2.15E+02	2.64E+00	1.44E+03	5.44E+02	2.76E+02	6.17E+01	5.43E+02	5.61E+00	2.88E+00	1.43E+03
2053	1.90E+02	5.41E+02	9.78E+02	2.62E+01	1.74E+03	5.71E+02	2.88E+02	3.73E+01	3.70E+02	2.25E+02	2.64E+00	1.50E+03	5.69E+02	2.88E+02	6.36E+01	5.57E+02	6.81E+00	2.88E+00	1.49E+03
2054	1.96E+02	5.56E+02	1.02E+03	2.62E+01	1.80E+03	5.96E+02	3.01E+02	3.79E+01	3.76E+02	2.36E+02	2.64E+00	1.55E+03	5.93E+02	3.01E+02	6.54E+01	5.71E+02	8.13E+00	2.88E+00	1.54E+03
2055	2.01E+02	5.70E+02	1.06E+03	2.62E+01	1.86E+03	6.21E+02	3.13E+02	3.84E+01	3.81E+02	2.47E+02	2.64E+00	1.60E+03	6.18E+02	3.13E+02	6.72E+01	5.84E+02	9.51E+00	2.88E+00	1.59E+03
2056	2.06E+02	5.84E+02	1.10E+03	2.62E+01	1.92E+03	6.45E+02	3.26E+02	3.89E+01	3.86E+02	2.57E+02	2.64E+00	1.66E+03	6.42E+02	3.26E+02	6.89E+01	5.97E+02	1.08E+01	2.88E+00	1.65E+03
2057	2.10E+02	5.98E+02	1.15E+03	2.62E+01	1.98E+03	6.70E+02	3.38E+02	3.94E+01	3.91E+02	2.68E+02	2.64E+00	1.71E+03	6.67E+02	3.38E+02	7.06E+01	6.10E+02	1.22E+01	2.88E+00	1.70E+03
2058	2.15E+02	6.11E+02	1.18E+03	2.62E+01	2.04E+03	6.92E+02	3.49E+02	3.98E+01	3.95E+02	2.78E+02	2.64E+00	1.76E+03	6.89E+02	3.49E+02	7.23E+01	6.22E+02	1.38E+01	2.88E+00	1.75E+03
2059	2.20E+02	6.24E+02	1.21E+03	2.62E+01	2.08E+03	7.09E+02	3.58E+02	4.02E+01	3.99E+02	2.89E+02	2.64E+00	1.80E+03	7.06E+02	3.58E+02	7.39E+01	6.33E+02	1.63E+01	2.88E+00	1.79E+03
2060	2.24E+02	6.37E+02	1.24E+03	2.62E+01	2.13E+03	7.24E+02	3.65E+02	4.06E+01	4.03E+02	2.99E+02	2.64E+00	1.83E+03	7.20E+02	3.65E+02	7.55E+01	6.43E+02	1.95E+01	2.88E+00	1.83E+03
2061	2.29E+02	6.49E+02	1.26E+03	2.62E+01	2.16E+03	7.35E+02	3.71E+02	4.10E+01	4.07E+02	3.09E+02	2.64E+00	1.87E+03	7.32E+02	3.71E+02	7.70E+01	6.52E+02	2.35E+01	2.88E+00	1.86E+03

Exhibit F-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.36E+02	7.40E+02	7.40E+02	7.61E+02
Lower GOR	7.38E+02	7.42E+02	7.42E+02	7.63E+02
Higher GOR	7.34E+02	7.38E+02	7.38E+02	7.59E+02

Exhibit F-30. CH_4 Sensitivity – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	7.36E+02	7.40E+02	7.40E+02	7.61E+02
Decrease in Methane Emissions	7.30E+02	7.34E+02	7.34E+02	7.55E+02
Increase in Methane Emissions	7.41E+02	7.45E+02	7.45E+02	7.66E+02

ADDENDUM: MODELING CHANGES FROM DRAFT TO FINAL SEIS

CALCULATIONS OF THE SOCIAL COST OF CARBON (SCC) ADDED TO THE FINAL SEIS IN RESPONSE TO COMMENTS ON THE DRAFT SEIS

Estimates of the social cost of greenhouse gases associated with project alternatives analyzed using data from this study were not included in the Draft SEIS but are included in the Final SEIS. Preparing the life cycle data for calculating the SCC required that the speciated emissions (carbon dioxide, methane, and nitrous oxide) be specified on an annual basis and that construction emissions be broken out separately, beginning before the start of the first year of LNG operations. This yearly breakout of speciated emissions highlighted the fact that in some years, Scenario 1 had higher oil production than Scenario 3. From a life cycle accounting perspective, this had been handled through an emissions credit to match the lower annual production of Scenario 3 in those years, but these negative emissions credits - that enabled equitable comparability across the project study period for each Scenario in the draft SEIS - do not support SCC calculations.

Speciated emissions inventory data must be aligned to the specific years that emissions occur to correctly estimate the social cost of carbon dioxide, methane, and nitrous oxide emissions. The Life Cycle Analysis (LCA) model has been constructed by estimating the total emissions over the project life and then assigning average emissions based on the annual oil and gas production profile to determine the cumulative emissions. For specified annual emissions estimates, the LCA model was altered to calculate life cycle results directly for each individual year of construction and operation. This resulted in aligning the emissions across the 9-year construction period (5 years prior to start of year 1 operations, continuing for 4 additional years) and 33 years of operation, including ramp-up of production and reduced production in the last 3 years to allow the total quantity of gas exported to match the 30-year total authorized export gas volume (note that three additional years of production are authorized to allow the project to make-up for the reduced export capacity during the start-up of the liquefaction plant and therefore the total operating years is 33 for the project). Speciated emissions must therefore be assessed for each of 38 project years, from the beginning of construction through the end of the make-up period.

The 38 annual LCA model results are now summed to determine the cumulative life cycle emissions for the project over the entire 38-year period. This modeling change, required to enable the calculation of annual social costs, also revealed additional model adjustments to align the multiproduct functional unit results with the cumulative results to ensure agreement with total gas and oil production volumes. This resulted in changes to the model as further documented below. These adjustments changed the individual results for each Scenario, but did not change the comparative LCA results across Scenarios, or the study’s conclusions.

Adjustments to the LCA model to facilitate calculation of the social cost of greenhouse gases are described below.

CHANGE IN MULTI-FUNCTIONAL UNIT OF 1 MWH + 40 KG OIL TO 1 MWH + 53 KG OIL

The multiproduct functional unit results in the Draft SEIS were based on a representative gas and oil ratio that reflected the mid-point of the project's gas to oil ratio performance in the year 2052. The cumulative GHG emissions results reported in the draft SEIS were not based on the multiproduct functional unit ratio (in the Draft SEIS LCA Study, the volume of gas delivered to produce 1 MWh of electricity and 40 kg of crude oil delivered). The cumulative draft SEIS results were scaled based on the annual production schedules for amount of gas exported and amount of crude oil delivered to the Lower 48. Therefore, cumulative GHG emissions results are not affected by the change in the ratio of the multiproduct functional unit results.

In responding to comments on the Draft SEIS it was determined that the multiproduct functional unit results did not accurately represent the cumulative results if the multiproduct functional unit MWh to oil production (1 MWh and 40 kg of crude oil) ratio was used to scale to the cumulative results. This was corrected in the final SEIS to ensure the multiproduct functional unit ratio also matches the cumulative quantity of oil produced per unit of gas exported and its derivative quantity of electricity (MWh) produced in each receiving country. The average quantity of oil produced per MWh of electricity is now represented as 53 kg of crude oil per MWh. Consequently, the multiproduct functional unit results reported in the Final SEIS now also support scaling to the total quantity of gas exported and crude oil produced across the 33-year authorization volume for gas exports.

CHANGES IN ASSOCIATED AND POST-PROCESSING NATURAL GAS DENSITY

As modeled, the bulk of natural gas for LNG export is produced at the Prudhoe Bay Unit (PBU). The production amounts for oil and natural gas and oil are provided on a volumetric basis – oil in barrels and gas in standard cubic feet (scf). These quantities serve as inputs to the life cycle model, where lifetime oil production and the gas-oil ratio are both parameters. Within the life cycle process, the volume of gas is converted to a mass using the density of natural gas. In the draft SEIS, the value for natural gas density used was 0.019 kg/scf. For the final SEIS, this density parameter was changed to more accurately reflect the composition of the gas that is produced at the PBU before entering the gas treatment plant (assuming ~12% vol CO_2), thus 0.025 kg/scf, which also affects the ratio of MWh and oil produced as discussed above.

In addition, the post-processing gas composition was also updated to more accurately represent the composition of gas exiting the gas treatment plant. This change was implemented to ensure that the underlying gas density used for generating the multiproduct/single-product functional unit and cumulative emissions results in the LCA Study are properly aligned. In the Draft SEIS, the value for post-processing natural gas density was 0.025 kg/scf. For the Final SEIS, the density was revised to 0.020 kg/scf.

CHANGE IN PER KG GWP OF SCENARIO 1 PRUDHOE BAY UNIT OIL PRODUCTION

Scenario 1 multi-functional unit results show emissions contributions from Prudhoe Bay Unit (PBU) oil production. In the draft SEIS, the GWP per kg of oil was 0.0725 kg CO_2e/kg oil (AR4, 100-yr basis). Updated results show a higher GWP of 0.980 kg CO_2e (AR4, 100-yr). This increase in emissions intensity for PBU oil production resulted only from correcting an error in the life cycle model. Parameters that were used to define the performance and emissions at the PBU had been assigned to the wrong process within the model. This increase in intensity affects all multifunctional unit results, including cumulative emissions results.

As discussed in the LCA report, the emissions of PBU oil production are modeled separately in the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) and integrated within the life cycle model. For the final SEIS, the OPGEE modeling was updated to reflect the 33-year LNG authorization period.

CHANGE IN PER KG GWP OF SCENARIO 3 CO_2-EOR PRODUCTION

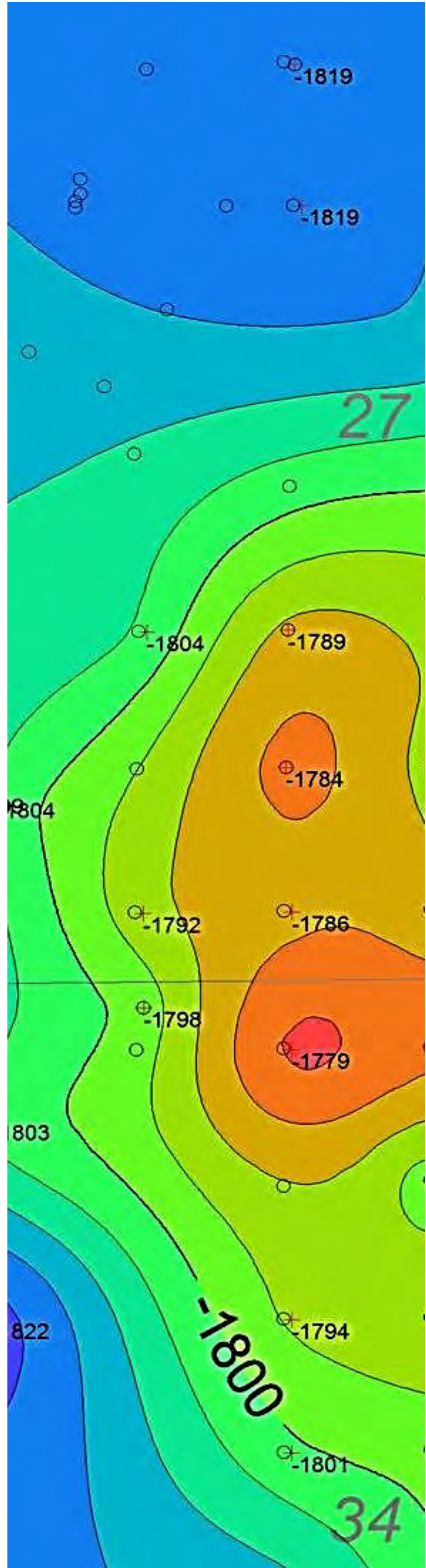
Emissions from CO_2-EOR operations for Scenario 3 are modeled using the CO_2-Enahnced Oil Recovery Life Cycle (CELiC) model. In the draft SEIS, the modeling in CELiC was based on a 30-year study period. For the final SEIS, the CELiC model parameters were updated to reflect the 33-year LNG authorization period. The total volume of LNG exported did not change between the Draft and Final SEIS. Additionally, emissions and performance are now based on the lifetime average CO_2-EOR production, whereas the previous emissions and performance were based on an oil-production weighted average, which was more reflective of mid-life performance. This change was necessary to improve the alignment of oil production volume as a result of the change to align the data for the calculation of social cost of carbon discussed above. The GWP per unit of CO_2-EOR oil has decreased from 0.347 kg CO_2e/kg oil (AR4, 100-yr) in the draft SEIS to 0.335 kg CO_2e/kg oil in the final SEIS.

CHANGES IN PRUDHOE BAY UNIT OIL PRODUCTION UNCERTAINTY

The draft SEIS multifunctional unit results (e.g., Exhibit 4-1 from *Life Cycle Greenhouse Gas Emissions from the Alaskan LNG Project*) include uncertainty that are the result of Monte Carlo simulation analysis of the life cycle model. This uncertainty includes contributions from “Crude Oil Extraction, Associated,” which represents production at the PBU. The uncertainty distributions defined in the process were informed by an assessment of emissions and performance of the PBU at a different gas-oil-ratio than the lifetime average. The results of that assessment were used to define uniform distributions of greenhouse gas emissions and natural gas combustion. These uncertainties have been removed from the final SEIS primarily because the intent of the study has been clarified to represent the average performance of the 33-year LNG authorization period. There was also a technical issue with the approach because uniform distributions were applied to individual greenhouse gas emissions (CO_2, CH_4, and N_2O), natural gas use, and the ratio of oil to gas production, incorrectly suggesting that there is no correlation between them (i.e., they are not independent and should not be modeled as such). This has resulted in a slight decrease in the upper range of uncertainties across all scenarios.

Changes in Construction Stage Emission Parameters

The draft SEIS construction phase emission parameters were updated in the final SEIS to ensure construction emissions properly aligned with estimates reported in the Alaska LNG Project Resource Report No. 9. The changes in natural gas density (as described above) and use of natural gas volumes over the entire 33-year timespan of the project for normalizing construction emissions are additional reasons for the observed variation in construction parameters between the draft SEIS and final SEIS.



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www.netl.doe.gov

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(800) 553-7681

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DOE/EIS-0512-S1

Alaska LNG Project

Final
Supplemental Environmental Impact Statement

APPENDIX D
COMMENT RESPONSE DOCUMENT

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ADNR	Alaska Department of Natural Resources
AGDC	Alaska Gasline Development Corporation
AOGCC	Alaska Oil and Gas Conservation Commission
BLM	Bureau of Land Management
CCUS	carbon capture, utilization, and sequestration
CDP	Census Designated Place
CEQ	Council on Environmental Quality
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
DOE	Department of Energy
E.O.	Executive Order
EIS	Environmental Impact Statement
EOR	enhanced oil recovery
FERC	Federal Energy Regulatory Commission
FID	Financial Investment Decision
FNSB	Fairbanks North Star Borough
FTA	Free Trade Agreement
GHG	greenhouse gas
GTP	Gas Treatment Plant
GWP	global warming potential
HIA	Health Impact Assessment
IPCC	International Panel on Climate Change
kg	kilogram
KRU	Kuparuk River Unit
LCA	Life-Cycle Analysis
LNG	liquefied natural gas
MMbbl	million barrels
MP	milepost
MWh	Megawatt-hour
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NGA	Natural Gas Act
NGCC	natural gas combined cycle
NGO	non-governmental organization
NMFS	National Marine Fisheries Service

Acronym	Definition
OPGEE	Oil Production Greenhouse Gas Emissions Estimator
OSHA	Occupational Safety and Health Administration
PBU	Prudhoe Bay Unit
PHMSA	Pipeline and Hazardous Materials Safety Administration
ppm	parts per million
PTU	Point Thomson Unit
RCM	replacement cost method
ROD	Record of Decision
ROI	Region of Influence
SEIS	Supplemental Environmental Impact Statement
TAPS	Trans-Alaska Pipeline System
U.S.	United States
UIC	Underground Injection Control
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VSM	vertical support member

APPENDIX D COMMENT RESPONSE DOCUMENT

D.1 INTRODUCTION

The U.S. Department of Energy (DOE) prepared the Alaska LNG Project Draft Supplemental Environmental Impact Statement (SEIS) to evaluate the potential environmental impacts associated with natural gas production on the North Slope of Alaska (North Slope) and life cycle greenhouse gas (GHG) emissions associated with authorizing Alaska LNG Project LLC (Alaska LNG) to export liquefied natural gas (LNG) to countries that do not have a free trade agreement (FTA) requiring national treatment for trade in natural gas, and with which trade is not prohibited by U.S. law or policy (non-FTA countries). Consistent with the National Environmental Policy Act (NEPA), the DOE released the Draft SEIS for a 45-day public comment period, which ran from July 1, 2022 to August 15, 2022.

This Appendix summarizes the Alaska LNG Project Draft SEIS public review process and provides information on and responses to the comments received during the 45-day public comment period. The Appendix is organized into the following sections:

- Section D.2 presents an overview of the agency and public review and comment process initiated by DOE. It also presents the number of comments submitted during the public comment period by entity and submission method, and describes the processing of comments received.
- Section D.3 outlines the major themes associated with comments received during the comment period.
- Section D.4 provides DOE responses to the major themes outlined in Section D.3.
- Section D.5 presents the comments of regulatory agencies (specifically the United States Environmental Protection Agency, the United States Department of Interior, and the Alaska Department of Environmental Conservation) requesting technical edits and clarifications to specific locations within the Draft SEIS, and provides DOE responses to each of the requested technical edits and clarifications.
- Section D.6 presents comments provided by other governmental agencies and Elected Officials.

D.2 AGENCY AND PUBLIC REVIEW AND COMMENT PROCESS

DOE published a Notice of Availability in the *Federal Register* (FR) on June 29, 2022, announcing availability of the Draft SEIS, a virtual public meeting to be held on July 20, 2022, and the 45-day comment period running from July 1, 2022 until August 15, 2022 (87 FR 38730). In addition, the U.S. Environmental Protection Agency (USEPA) published a Notice of Availability in the FR on July 1, 2022 announcing the availability of the Draft SEIS (87 FR 39517). DOE also placed notifications in seven newspapers, including local, regional and tribal publications. This included *Anchorage Daily News*, *Juneau Empire*, *Fairbanks Daily News-Miner*, *Mat-Su Valley Frontiersman*, *Seattle Times*, *Washington Post*, and *USA Today*. Along with the FR and newspaper notifications, DOE sent letters to notify stakeholders and potentially interested parties. The notifications contained a link to an electronic version of the Draft SEIS posted on the DOE's website and announced the availability of hard copies at eight libraries in Alaska. Chapter 8 of the SEIS, Distribution List, specifies the agencies, Alaska Native groups, and individuals to whom notifications were sent, and Section D.6 of this appendix contains sample notifications. Table D-1 summarizes the hard copies and notifications sent to stakeholders.

Table D-1. Draft SEIS Notification and Distribution

Group	Number of Hard Copies	Number of Notification Letters
Federal Elected Officials	0	5
State Elected Officials	0	60
Federal Agencies	0	127
State Agencies	0	40
City Agencies	0	37
Borough Agencies	0	24
Alaska Native	0	123
Non-Governmental Organizations	0	251
Libraries	8	1
Other	17	3

During the public comment period, federal agencies, state and local governmental entities, Alaska Native governments, and members of the public were invited to submit electronic comments via regulations.gov or email, written comments via the U.S. mail, or verbal comments at a virtual public meeting. Table D-2 summarizes the number of comments received by method of submission and entity type. Entities submitting comments included elected officials; federal, state, and local government agencies; Alaska Native governments; non-governmental organizations (NGOs); businesses; and the general public.

Table D-2. Numbers of Comment Documents Received by Entity and Method of Submission

Entity	Method of Submission				Total
	Regulations.gov	Email	Mail	Verbal	
Elected Official	6	1	2	0	9
Federal Agency	0	2	0	0	2
State Agency	2	0	0	0	2
Local Agency	4	0	0	0	4
Alaska Native Government	1	0	0	0	1
NGO/Advocacy Group	15	0	0	0	15
Business/Corporation	21	2	0	0	23
General Public	145	3	2	2	149

The virtual public meeting for the Draft SEIS was scheduled from 4:00 PM to 6:00 PM local Alaska time on Wednesday, July 20, 2022. The purpose of the meeting was to provide an opportunity for members of the public to learn about the Alaska LNG Project Draft SEIS, collect verbal comments from members of the public, and provide information regarding how to submit electronic comments via www.regulations.gov. All comments can be viewed on www.regulations.gov by entering "DOE-HQ-2022-0019-0001" in the search field. The virtual public meeting involved a formal presentation by DOE representatives and a comment period for attendees to provide verbal comments. Of the 33 attendees, 2 individuals provided verbal comments. DOE kept the meeting open for the full 2 hours. The meeting was recorded, and the transcript is available in Section D.5.

Upon receipt, all written comment documents were assigned a document number for tracking during the comment response process. Each commenter's name in the transcript from the public hearing also was assigned a document number. All comment documents were then reviewed for inclusion in this Appendix and development of major comment themes. In processing the comment documents, each document was analyzed to identify individual comments and DOE prepared responses to the applicable comment themes. Campaigns received from an NGO or advocacy group, identified by either a single submission backed by numerous signatories or multiple submissions of the same comment, only received a single response from DOE. The public comment period closed on August 15, 2022 but DOE considered late comments in preparation of the Final SEIS.

In preparing this Final SEIS, DOE reviewed all comments received as part of the public comment period ending on August 15, 2022. Comments that DOE determined to be outside the scope of the Alaska LNG Project SEIS are acknowledged as such in this Appendix. Policy experts, subject matter experts, and NEPA specialists then responded to the remaining substantive comments, as appropriate. This effort served to focus the revision process and ensure consistency throughout the final document. The comments assisted in determining whether the alternatives and analyses presented in the Draft SEIS should be modified or augmented, whether information presented in the Draft SEIS needed to be corrected or updated, and whether additional clarification was necessary to facilitate better understanding of certain issues. Areas where DOE made changes to the Final SEIS are noted in Section D.4, Thematic Comment Responses, and in Section D.5, Regulator Agency Technical Edits and Clarification Requests. Change bars in the margins of pages indicate where substantive changes were made and where text was added or deleted. Editorial changes are not marked. Notable changes made to the Final SEIS include clarifications to the LCA Study; No Action Alternative; EOR and seismic activity; floodplains; wetlands; subsistence; climate change impacts to protected species and EJ and subsistence populations; black carbon; and inclusion of the USEPA EJ Screen tool.

DOE will use the analysis presented in this Final SEIS, as well as other information, in preparing a Record of Decision (ROD). DOE will issue a ROD no sooner than 30 days after the USEPA publishes the Notice of Availability of this Final SEIS in the FR. The ROD will describe the alternative selected and explain how environmental impacts will be avoided, minimized, or mitigated, as appropriate.

D.3 MAJOR COMMENT THEMES

Upon review of the comments received on the Draft SEIS, DOE identified several topics of interest or "themes" to be addressed in this section of Appendix D. These include topics of broad interest or concern, as indicated by their recurrence in comments, or technical topics that warrant a more detailed discussion than might be afforded in responding to an individual comment. This section summarizes the comments received on a topic of interest, followed by DOE's response.

Table D-3 presents the major themes and sub-themes on which DOE received substantive comments. This table also provides the location(s) in the SEIS where the topic is discussed and lists comment sub-themes related to the central topic.

Table D-3. Major Comment Themes

Theme	SEIS Location	Sub-Theme Coding System[a]
Purpose and Need (P&N)	Chapter 1	General (1-1) Quality of the 2020 EIS and Request for a New Analysis (1-2) Quality of the Current SEIS Analysis (1-3) Market Conditions (1-4) Energy/Infrastructure (1-5) Climate Policy and Climate Goals (1-6)
Proposed Action (PRO)	Chapter 2	Construction (2-1)
Alternatives (ALT)	Chapter 2	Alternatives Considered (3-1) Alternatives Development (3-2)
Appendix A (APP A)	Appendix A	Consultation (A-1)
Appendix B (APP B)	Appendix B	Study Scenarios (B-1) Study Methodology and Assumptions (B-2) Study Conclusions (B-3)
Appendix C (APP C)	Appendix C	Study Scenarios (C-1) Study Methodology and Assumptions (C-2) Study Conclusions (C-3)
Impact Analysis (IMP)	Chapter 4	General (4-0) Geologic Resources and Geologic Hazards (4-1) Permafrost (4-2) Water Resources (4-3) Wetlands (4-4) Threatened, Endangered, and Other Special Status Species (4-8) Subsistence (4-14) Air Quality (4-15) Human Health (4-17) Reliability and Safety (4-18) Cumulative Impacts (4-20)
Socioeconomics and Environmental Justice (SOC)	Sections 3.11 and 4.11	General (4-11a) Economy and Jobs (4-11b) Environmental Justice (4-11c)
Greenhouse Gases & Climate Change (GHG)	Sections 3.19 and 4.19	General (4-19a) Impact Methodology and Assumptions (4-19b) Conclusions (4-19c) Life Cycle Emissions (4-19d) Climate Change Effects (4-19e)[b]
Mitigation (MIT)	Chapter 6	Mitigation Measures (6-1)

a. Coding System used in Section D.4 in identifying subthemes
b. The climate change effects theme includes comments related to the impact to species, vegetation, soils, permafrost, and subsistence.

D.4 THEMATIC COMMENT RESPONSES

This section provides a summary of each major comment theme identified in Table D-3 and a synopsis for the related sub-themes; refer to the table key for finding responses for a specific topic. Commenters can refer to the theme and sub-theme topics in this Appendix to view DOE responses. DOE provides a response to each sub-theme that includes references to relevant information presented in the SEIS and documents any changes incorporated into this Final SEIS as a result of the comments. All comments submitted online are available for viewing at www.regulations.gov by searching ID DOE-HQ-2022-0019-0001.

D.4.1 Purpose and Need (P&N)

DOE received comments related to the purpose of and need for the Project. This included comments regarding the NEPA process, general quality of the 2020 EIS and 2022 SEIS documents, and the need for a detailed market analysis. The majority of these comments involved general support for or opposition to the proposed Project.

Theme	SEIS Location	Sub-Themes
Purpose and Need (P&N)	Chapter 1	General (1-1) Quality of the 2020 EIS and Request for a New Analysis (1-2) Quality of the Current SEIS Analysis (1-3) Market Conditions (1-4) Energy/Infrastructure (1-5) Climate Policy and Climate Goals (1-6)

P&N Sub-Theme – General (1-1)

Synopsis:

These comments were general in nature and were related to opposition to or support of the Project. Opposing comments questioned the need for the Project, expressed concerns regarding the United States' dependence on oil and fossil fuels, expressed concerns about the studies prepared for the SEIS, and/or cited general environmental, cultural, and climate change concerns if the Project is approved. Those in favor of the Project cited local and regional socioeconomic benefits of the Project, including jobs and reduction in outward migration; interconnections to the main pipeline that could provide natural gas to Interior Alaska areas; the role of the Project in achieving national energy security; and the previous and current environmental reviews that have been conducted for the Alaska LNG Project by governmental agencies.

Response:

The NEPA process seeks to include environmental considerations into any federal agency planning, undertaking, or decision-making. The SEIS is prepared to objectively assess the potential environmental impacts associated with natural gas production on the North Slope of Alaska and life cycle GHG emissions associated with the proposed Project to provide decision-makers and other stakeholders with information needed to understand potentially significant environmental impacts resulting from an action, including mitigation and conservation measures warranted to protect a resource or minimize impact to a resource. Analyses are based on best available data, results of surveys, and academic and agency research and reports to characterize the resources present within the project area (region of influence) and the potential for adverse effects. Where possible, the Applicant would incorporate best management practices into the design of the Project and/or mitigation measures to reduce potential for adverse impacts.

Regarding comments in opposition to and in favor of the Project, DOE understands there are opposing viewpoints on whether this Project should proceed and appreciates the public input in the NEPA process. The SEIS builds upon the previously completed 2020 EIS by incorporating the best available data in documenting existing resources and to determine the potential adverse and beneficial effects on resources from the construction, operations, and maintenance of the Project. This includes an updated analysis of the potential for upstream development activities within the Point Thomson Unit (PTU), Prudhoe Bay Unit (PBU), Kuparuk River Unit (KRU), and the required pipeline infrastructure to transport natural gas and by-product carbon dioxide (CO_2) from the proposed Gas Treatment Plant (GTP) for storage or reuse within the North Slope of Alaska. The SEIS also presents a detailed life cycle analysis (LCA) for the proposed Alaska LNG Project, including additional considerations of the Project's contribution to greenhouse gas (GHG) emissions and effects of climate change and potential for cumulative effects on the North Slope.

The GHG, the North Slope Production Study (APP B), and the LCA Study (APP C) comment themes and responses presented in this Appendix have additional information regarding specific comments received on these topics. The SEIS discloses both the potential for adverse and beneficial effects from construction and operation of potential upstream development activities within the North Slope associated with the proposed Project along with life cycle GHG emissions generated by the proposed Project (Chapter 4). A primary benefit of the proposed Project is the potential for enhancing socioeconomic resources; Section 4.11 of the SEIS and Section 4.11 of the 2020 EIS contain discussions of socioeconomic effects, including tax benefits and creation of jobs. Chapter 6 of the SEIS contains a summary of mitigation measures to minimize the potential for adverse effects.

DOE considers comments regarding the proposed Alaska LNG Project analyzed in detail in the 2020 EIS and activities or resources outside of the North Slope of Alaska (aside from GHGs) to be out of scope for consideration in the SEIS.

See the Alternatives (ALT) theme for comments and responses related to consideration of renewable energy and additional alternatives proposed by commenters.

P&N Sub-Theme – Quality of the 2020 EIS and Request for a New Analysis (1-2)

Synopsis:

Comments both in opposition to and in support of the Project mentioned the quality of the previous 2020 EIS. Opposing comments expressed concerns about sufficiency of the 2020 EIS and agency decision documents, including the biological opinion associated with the 2020 EIS. Specifically, opposing comments cited an assertion that the 2020 EIS failed to take a "hard look" under NEPA including lack of consideration of development on the North Slope, lack of a comprehensive LCA for GHGs, and the Project's overall contribution to climate change. Some commenters claimed that the existing biological opinion was legally flawed as it did not rely on best available science, and that the biological opinion fails to conduct the proper jeopardy analysis. Due to these factors, commenters stated that DOE cannot rely on the existing 2020 EIS and supporting decision documents, such as the biological opinion, in its own decision-making process.

Comments supporting the Project stated that there has been extensive environmental impact assessment work by governmental agencies including years of analysis, multiple public meetings, numerous cooperating agencies, meaningful engagement with Alaska Natives, and thousands of pages of comprehensive impact assessment that provided the "hard look" at potential environmental impacts required by NEPA. Some comments stated that the sufficiency of the 2020 EIS is further supported by the number of regulatory agencies that adopted the 2020 EIS and issued applicable permits and right-of-way authorizations.

Response:

DOE, along with other Cooperating Agencies (U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, and National Marine Fisheries Service), contributed to the development of the 2020 EIS. Agencies contributed with respect to environmental resources and environmental impacts associated with the proposed Project where they had jurisdiction by law or special expertise. During the Summer of 2014, Alaska LNG submitted an Application for Long-Term Authorization to Export Liquefied Natural Gas to DOE (Docket No. 14-96-LNG) and began the Federal Energy Regulatory Commission (FERC) pre-filing process of reviewing the project, alternatives development, and mitigation (see Table 1.1-1 of the SEIS). FERC also conducted formal consultation under Section 7 of the Endangered Species Act with the National Marine Fisheries Service (NMFS), resulting in the issuance of a Section 7(a)(2) Biological Opinion by NMFS on June 3, 2020. The NEPA process continued for a period of six years leading up to FERC's issuance of the 2020 Final EIS. This process also involved a large public outreach effort, including consultation and engagement with Alaska Native communities as described in detail in the 2020 EIS and summarized in Section 1.4.4 and 1.4.5 of the SEIS.

As stated above, DOE participated as a Cooperating Agency in FERC's NEPA review of the proposed Alaska LNG Project. FERC issued the Final EIS for the Alaska LNG Project on March 6, 2020. In accordance with NEPA, DOE conducted an independent review of the Final EIS and determined that the Alaska LNG Project analyzed in the Final EIS is the same project for which DOE considered authorizing LNG exports. DOE found that its comments and suggestions were satisfied and adopted the Final EIS (DOE/EIS–0512) in accordance with the Council on Environmental Quality (CEQ) NEPA regulations (40 Code of Federal Regulations (CFR) 1506.3). After reviewing the extensive record examining both environmental and non-environmental factors, on August 20, 2020 DOE issued the Alaska LNG Order (DOE/FE Order No. 3643-A), under Section 3(a) of the Nature Gas Act (NGA), conditioning it on Alaska LNG's compliance with the 165 environmental conditions adopted in the FERC Order, among other requirements. DOE also issued the ROD under NEPA on August 20, 2020.

As described in Chapter 1 of the Draft SEIS, since the issuance of the Alaska LNG Order, President Biden has issued two Executive Orders (E.O.s) relevant to the Alaska LNG proceeding, including E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad* (see page 1-4 of the Draft SEIS). On April 15, 2021, DOE granted a Request for Rehearing of the Alaska LNG Order based on the Sierra Club's September 21, 2020 Request for Rehearing. As further explained in the Draft SEIS, consistent with E.O. 13990 and E.O. 14008, and considering the arguments on rehearing requesting Alaska-specific environmental studies, DOE stated that it was appropriate to further evaluate the environmental impacts of exporting LNG from the proposed Project to non-FTA countries. DOE's decision to further evaluate environmental impacts and supplement the 2020 EIS is consistent with the NEPA provisions for preparing supplements for addressing "*new circumstances or information*" or *"when the agency determines that the purposes of the Act will be furthered."*

DOE has prepared the SEIS to both (i) address new circumstances related to E.O. 13990's requirement to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change, as well as climate change aspects outlined under E.O. 14008, and (ii) evaluate arguments made by Sierra Club in its 2020 request for rehearing. The SEIS supplements the 2020 EIS by examining the environmental effects of natural gas production on the North Slope and GHG emissions associated with exports of LNG from Alaska from a life cycle perspective.

P&N Sub-Theme – Quality of the Current Draft SEIS (1-3)

Synopsis:

Comments both in opposition and in support of the Project mentioned the quality of the current Draft SEIS. Opposing comments stated that the SEIS does not speak clearly about errors or unsupported conclusions in the 2020 EIS. They assert that the SEIS Purpose and Need statement is overly narrow. Some commenters requested that the SEIS be re-circulated for an additional round of public review and comment based on deficiencies. A commenter also questioned whether the two Executive Orders referenced in the SEIS as part of DOE's rehearing on the Alaska LNG Order are implicit regulatory requirement drivers for a federal agency to revisit the original 2020 EIS.

Comments supporting the Project stated that DOE has completed a thorough assessment of the proposed Project that reinforces the extensive environmental review previously completed.

Response:

As stated in DOE's response in P&N Sub-Theme 1-2, Quality of the 2020 EIS, DOE, along with other Cooperating Agencies, contributed to the development of the 2020 EIS with respect to environmental resources and environmental impacts associated with the proposed Project where they had jurisdiction by law or special expertise. Specifically regarding DOE's Purpose and Need discussed in Section 1.2.1 of the SEIS, DOE's Purpose and Need is limited to its obligation under Section 3(a) of the NGA. By law, under Section 3(c) of the NGA, applications to export natural gas to countries with which the United States has FTAs that require national treatment for trade in natural gas are deemed to be consistent with the public interest, and DOE must grant authorizations without modification or delay. In the case of applications to export LNG to non-FTA countries, Section 3(a) of the NGA requires DOE to conduct a public interest review and grant authority to export unless DOE finds that the proposed exports would not be consistent with the public interest. Additionally, NEPA requires DOE to consider the environmental effects of its decisions regarding applications to export natural gas to non-FTA countries. As part of DOE's obligations under the NGA as well as NEPA, DOE has prepared the SEIS to gather additional information regarding the range of environmental effects for their decision of whether to reaffirm, modify, or set aside the Alaska LNG Order.

Chapter 1 of the SEIS provides background regarding the reasoning of DOE's decision to prepare a supplemental analysis to the 2020 EIS. Specifically, DOE prepared the SEIS to further evaluate the potential upstream environmental impacts and life cycle GHG emissions associated with authorizing Alaska LNG Project LLC to export LNG to non-FTA countries. As stated in Section 1.1 of the SEIS, preparation of a supplemental analysis was based on DOE's decision to grant a Request for Rehearing of the Alaska LNG Order based on the Sierra Club's September 21, 2020, Request for Rehearing filing. DOE's decision regarding rehearing allowed DOE to also consider the two new Executive Orders relevant to the Alaska LNG Rehearing Order proceeding directing agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change, as well as federal agencies to address climate change and assess, disclose, and mitigate for climate pollution and climate-related risks (see P&N Sub-Theme – Quality of the 2020 EIS and Request for a New Analysis (1-2) for additional information on the Executive Orders). Executive Orders are not laws enacted by Congress, rather they are used by the Executive Office of the President to provide direction to federal agencies and officials as they carry out operations within the executive branch and can have the force and effect of law.

Based on the Rehearing Order, DOE has prepared a focused supplement to the 2020 EIS, specifically evaluating in greater detail the potential for upstream development activities within the PTU, PBU, KRU, and the required pipeline infrastructure to transport natural gas along with by-product CO_2 from the proposed GTP for storage or reuse within the North Slope of Alaska. The SEIS also considers in greater detail the LCA for the proposed Alaska LNG Project, including additional considerations of the Project's contribution to GHG emissions and effects of climate change.

Regarding recirculation of the SEIS for public comment, DOE reviewed and considered all comments received during the public comment period. The Final SEIS has been edited to reflect new information presented during the public comment period, as summarized within this Appendix; however, DOE does not consider the additional information presented in the Final SEIS to warrant reissuance of the Draft SEIS and an additional public comment period.

P&N Sub-Theme – Market Conditions (1-4)

Synopsis:

Commenters discussed market conditions and various aspects of energy supply and demand. They claimed that nowhere in the Draft SEIS or prior analyses has DOE reached and supported a conclusion as to whether the Alaska LNG Project is likely to go forward or under what conditions the Project would not go forward. Commenters stated the analysis of overseas impact is inadequate and there would be no need for Alaska LNG, even without current global affairs (e.g., Russia's invasion of Ukraine), given the world is transitioning away from fossil fuels and any future demand for LNG would be sufficiently supplied from existing LNG sources in the U.S. and globally. Commenters also stated that as the Project is not needed, it is contrary to the public interest.

Commenters cited recent Annual Energy Outlook from the U.S. Energy Information Administration estimates of future LNG demands. Commenters stated that the Draft SEIS assumes a continued global demand for LNG but does not provide information about supply, demand, pricing, etc. They said it does not explain the demand of Alaska LNG compared to supply from existing U.S. or global sources of LNG. They also claimed if the Alaska LNG Project does enter operation, it will not simply substitute for other U.S. LNG exports, which undermines DOE's conclusion that the Alaska LNG Project provides public benefits.

Response:

The potential circumstances under which the Alaska LNG Project may or may not move forward are not within the scope of the SEIS. The ability and decision to move forward with the Project if export authorization is provided by DOE will be determined by AGDC, as an independent, public corporation of the State of Alaska, and its investors. AGDC's decisions and ability to move forward will likely include its assessment of project financial viability given the various aspects of regional and global energy supply and demand, anticipated natural gas market conditions, and other factors. As presented in the SEIS, the No Action Alternative would represent the Project not moving forward because DOE did not authorize exports to non-FTA countries or because of other factors. DOE has not undertaken an assessment of specific potential changes in global energy markets that could occur in the No Action Alternative. However, DOE is providing alternative perspectives on possible GHG emissions that could occur if the Project were not constructed.

P&N Sub-Theme – Energy/Infrastructure (1-5)

Synopsis:

Some commenters expressed concerns about current energy infrastructure and energy supply in Alaska. They said that the existing natural gas production rate in Alaska is not supplying enough natural gas to the most populous regions in the state to meet needs for heat and power, and that the Project would provide energy security for Alaskans. Commenters requested feeder lines from the main pipeline to supply their areas with natural gas to alleviate issues including increased cost of fuel oil and limited natural gas supply. They stated that Alaskans who currently pay some of the highest residential energy rates in the nation will benefit from low-cost gas from the large cross-state pipeline that would supply both in-state needs and large-scale production of LNG for export. Commenters stated that the Alaska LNG Project would provide the U.S. with long-term energy security and strengthen relationships with key international allies; that having a significant supply of natural gas would strengthen U.S. energy security and help de-weaponize energy on the global stage, and that natural gas would be available for U.S. military bases in Alaska, including Eielson Air Force Base and Fort Wainwright.

Response:

Section 4.19.2.5 of the 2020 EIS discusses in-state gas interconnections along the Mainline Pipeline to allow for future interconnects with lateral pipelines to provide in-state deliveries of natural gas to third-party utility or industrial customers. This includes identification of locations for the following three interconnections based on the execution of binding gas delivery agreements with end-use customers: Fairbanks/North Star Gas Interconnection near Milepost (MP) 441; Anchorage/Matanuska-Susitna Gas Interconnection near MP 764; and Kenai Peninsula Gas Interconnection near MP 806. Each of these locations is outside of the Region of Influence (ROI) for the SEIS, which focuses on the North Slope; however, as stated in the 2020 EIS, other future interconnections could be established during the life of the Alaska LNG Project to accommodate industrial or residential growth that could occur in communities. The 2020 EIS discusses the proposed Alaska LNG Project's potential benefits to energy infrastructure and supply in Alaska, along with benefits to the Alaska economy.

P&N Sub-Theme – Climate Policy and Climate Goals (1-6)

Synopsis:

Commenters stated that approval of the proposed Alaska LNG Project is contrary to the public interest as GHG emissions caused by the Project would further contribute to the catastrophic events being induced by climate change. They claimed any approvals of new fossil fuel extraction projects is incompatible with meeting global commitments to hold warming to 1.5 degrees Celsius. They also stated authorization of the Alaska LNG Project is contrary to U.S. climate goals, and the analysis in the SEIS, based upon the assumption that gas produced by the Alaska LNG Project would simply replace other U.S. natural gas production canceling out the Project's emissions, fails entirely to carry out the President's Executive Order directives.

Response:

NEPA is a procedural statute that requires federal agencies to assess the potential environmental effects (both adverse and beneficial) of proposed actions prior to making decisions. An EIS (or SEIS) document is meant to disclose relevant information on the potential environmental impacts of a proposed action and reasonable alternatives. NEPA does not mandate a particular decision, but it does ensure that the public is engaged in the assessment and that the agency's decisions are appropriately informed. As stated in Chapter 1 of the SEIS, DOE prepared the SEIS to further evaluate the potential upstream environmental impacts and life cycle GHG emissions associated with authorizing Alaska LNG Project LLC to export LNG pursuant to its decision to grant a Request for Rehearing of the Alaska LNG Order. DOE's decision in the Rehearing Order allowed DOE to also consider the two new Executive Orders relevant to the Alaska LNG Rehearing Order proceeding directing agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change, as well as directing federal agencies to address climate change and assess, disclose, and mitigate climate pollution and climate-related risks. DOE has also updated Section 4.19 of this SEIS to include an assessment of the social cost of GHGs from life cycle Project emissions. The SEIS will inform DOE's analysis of public interest considerations associated with Alaska LNG's exports to non-FTA countries. Following completion of the SEIS, DOE intends to issue an order under Section 3(a) of the NGA in which DOE may exercise its authority to reaffirm, modify, or set aside the Alaska LNG Order".

D.4.2 Proposed Action (PRO)

DOE received comments related to the Proposed Action. Comments relate to the proposed construction methods and assumptions about construction location(s).

Theme	SEIS Location	Sub-Themes
Proposed Action (PRO)	Chapter 2	Construction (2-1)

PRO Sub-Theme – Construction (2-1)

Synopsis:

Comments both in opposition and in support of the Project mentioned construction methods, authorization, and location. Opposing commenters expressed concerns about proposed methods increasing impacts. They stated that trenching in permafrost soils will have more adverse impacts than aboveground construction. They cited irreversible effects to wildlife and hydrology as reasons to prioritize maintenance of permafrost. Commenters also stated that the location of proposed construction activities is not clearly specified in the SEIS, and they said that the assumption that construction will take place in existing rights-of-way and follow mitigation from the 2020 EIS contributes to a minimized impact analysis. Commenters stated that open burning does not typically occur on the North Slope, and it could be helpful to know where it will take place. Comments supporting the Project described general confidence in the proposed construction procedures. They said that construction would not impact the land or their way of life.

Response:

Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of land disturbance for all activities and actual location for proposed infrastructure as discussed in Sections 2.3 and 4.21 of the SEIS as well as in the introduction to Chapter 4. The scope of the SEIS is focused on North Slope upstream development activities. Proposed pipeline infrastructure analyzed within the SEIS is assumed to be placed aboveground using existing vertical support member (VSM) networks or to be constructed aboveground on VSMs directly adjacent to existing networks to minimize effects to permafrost and the potential for thermokarst development and damage to pipelines. The 2020 EIS does describe areas where proposed infrastructure would be buried as part of the Alaska LNG Project. Regarding protection of permafrost, text was added to Section 4.2.5 of the Final SEIS to further describe the importance of avoiding impacts to permafrost along with measures to avoid permafrost impacts.

D.4.3 Alternatives (ALT)

DOE received comments related to the development of alternatives in the SEIS and consideration of other alternatives, specifically alternatives involving renewable energy.

Theme	SEIS Location	Sub-Themes
Alternatives (ALT)	Chapter 2	Alternatives Considered (3-1) Alternatives Development (3-2)

ALT Sub-Theme – Alternatives Considered (3-1)

Synopsis:

Comments stated that DOE should promote renewable energy alternatives and conservation efforts instead of encouraging development of fossil fuel infrastructure. Commenters stated that the global supply of renewables is expected to increase over the same period as the lifespan of the Alaska LNG Project, and that instead of using money to develop new fossil fuel infrastructure, the government should transition to renewable energy structures. Commenters emphasized that the costs of renewable energy have declined, and renewables are increasingly becoming a viable option for energy over fossil fuels. Additionally, commenters said DOE should not assume a fossil fuel-powered future, and alternative energy sources should be considered as viable alternatives. Other commenters stated that this project is a step toward cleaner energy sources since it uses existing resources while the engineering, development, and investment needed for cleaner energy sources is pursued.

Response:

DOE's authority under Section 3(a) of the NGA is to authorize the import and/or export of natural gas. DOE cannot direct an applicant to pursue alternatives such as renewable energy sources. The 2020 EIS provides extensive detail on the consideration of alternatives as part of the Alaska LNG Project, which are also summarized in Table 2.1.2 of the SEIS. In addition, the scope of this SEIS is focused on reasonably foreseeable North Slope production activities and GHG emissions as evaluated in the LCA Study and presented in this SEIS.

ALT Sub-Theme – Alternative Development (3-2)

Synopsis:

Commenters raised a range of topics related to alternative development, which included:

- The Draft SEIS identifies a No Action case, presented as Scenario 1, as a "business as usual" scenario that evaluates the remaining North Slope oil production at the PBU and PTU fields, without construction of the Alaska LNG Project. Under this scenario, there is no development of a pipeline or other means to export natural gas as LNG to foreign destinations. They requested the SEIS reevaluate the No Action Scenario 1 to represent a true NEPA "no action" alternative by eliminating the presumption that, if the Alaska LNG Project were not to proceed, LNG facilities located elsewhere would substitute the same volume of LNG exports to the Asian destination countries.

- The SEIS should include a complete comparison table of total GHG emissions associated with all scenarios, including the reevaluated No Action Scenario and LCA.
- The SEIS's scenario analysis is incomplete and implausible, and the analysis ignores the likelihood of the Trans-Alaska Pipeline System (TAPS) shutdown and the Project's potential to prolong TAPS operations and resulting emissions.
- DOE does not justify assuming that produced CO_2 will be stored rather than vented, and DOE must discuss costs and other factors that will determine which scenario actually occurs.
- The alternative scenario analysis should consider a fourth scenario or alternative to evaluate reinjection of the by-product CO_2 from the Liquefaction Facilities into saline formations of the Cook Inlet Basin for carbon capture, utilization, and sequestration (CCUS).

Response:

No Action Alternative: As stated in Section 2.4 of the SEIS, "The No Action Alternative considered in this Draft and Final SEIS assumes that the Alaska LNG Project would not be constructed and the associated environmental impacts from the proposed Project would not occur." While construction and operation impacts from the Project would not occur under the No Action, it is appropriate to recognize that energy production activities on the North Slope would continue and that there may still be foreign market demand for LNG that could be met by other sources of supply. Therefore, these anticipated ongoing conditions are accounted for and evaluated as part of DOE's LCA under the "Business as Usual" scenario. The "Business as Usual" scenario serves as the basis for the GHG analysis under the No Action Alternative as it accounts for emissions from these ongoing conditions. DOE uses the Lower 48 as a reasonable proxy to evaluate GHG emissions related to meeting foreign demand for the same volume of LNG exports to the Asian destination countries. Text in Sections 2.2.3, 2.3, and 2.4 has been edited to clarify the No Action Alternative.

- Additionally, DOE has presented GHG emissions for a second condition under the No Action that does not consider LNG produced from alternative sources located outside the North Slope. This second No Action Alternative (SEIS Non-equivalent Energy Baseline) only considers the projected continuation of oil production from the Project area in Alaska, and no assumption is made about providing the same energy services to society. This No Action analysis is separate from the LCA Study, as energy service provided to society through production of natural gas and oil would not be equivalent to the Proposed Action. Comparing Proposed Action GHG emissions against the No Action Alternative (SEIS Non-equivalent Energy Baseline) scenario results in a potential net increase in GHG emissions that could potentially occur if the Project were authorized, constructed, and operated. Table 2.3-1 and Section 4.19 of the Final SEIS have been updated accordingly.

Complete Comparison of Total GHG emissions by Scenario: Table 2.3-1 provides a comparison of oil and gas production and life cycle GHG emissions between the scenarios analyzed within the LCA Study (Appendix C of the SEIS). These total LCA emissions are used as the basis for analyzing GHG emissions in Section 4.19 of the SEIS. Note that Table 2.3-1 and Section 4.19 of the Final SEIS have been updated to include an additional No Action, "no equivalent energy" case as described above.

Scenario Analysis: DOE conducted studies to examine the energy and infrastructure resources available to support the Alaska LNG Project, impacts of PBU major gas sales on oil production, and the potential for management of project by-product CO_2. These studies are presented in Appendix B of the Draft SEIS and were developed to support the analysis of potential impacts related to potential new infrastructure that may be required and to provide information and bounding conditions to support the LCA. As part of these studies, DOE evaluated the remaining oil production potential out to the year 2058 from the PBU, in the case that the Alaska LNG Project does not go forward (see Case 1 in Appendix B.2). The three potential cases described in Production Report 2 (Appendix B.2) are herein referred to as "scenarios." The results of this study indicate that the PBU could produce approximately 1,277 million barrels (MMbbl) of oil over this period if the Alaska LNG Project does not occur. PBU production could decline to 825 MMbbl with the Alaska LNG Project over the same timeframe assuming by-product CO_2 is managed through sequestration and not utilized for oil production. DOE also considered a case in which by-product CO_2 would be used for enhanced oil recovery (EOR) at a nearby oil field (see Scenario 3 in Appendix B.2) which would slightly increase oil production to 1,298 MMbbl over projected PBU production in Scenario 1 (an increase of 21 MMbbl, or about 1.6 percent). Based on this analysis, oil production from the PBU, or otherwise related to the Project, would be similar (if EOR is employed) or lower than what could be produced without the development of the Project, if the Alaska LNG Project is approved. As described above, in Appendix B, DOE examined PBU oil production with and without the Alaska LNG project through 2058. DOE cannot predict changes in TAPS operations from continuation of ongoing activities on the North Slope without or during the life of the Alaska LNG project. DOE considers potential future operational changes to TAPS to be speculative and out of the scope of the SEIS analysis.

Justification of CO_2 Venting Assumptions: DOE considered the most likely scenarios for management of by-product CO_2 generated from the GTP on the North Slope based on the most recent information available from the Applicant and information related to Alaska Oil and Gas Conservation Commission Conservation (AOGCC) proceedings for major gas sales from the Prudhoe Oil Pool. The development of the Alaska LNG Project included detailed plans for management of the by-product CO_2 stream, both in the application approval process and in the design of the GTP that would be built at Prudhoe Bay. This information was described in the 2020 EIS. In addition, AOGCC Conservation Order 341 F (AOGCC 2015) includes a rule requiring a study to determine the possible applications and challenges of utilizing the by-product CO_2 stream for EOR operations on the North Slope. The rule includes the requirement for a utilization plan for the by-product CO_2 stream to be compressed and reinjected into North Slope oil fields. The "CO_2 Utilization Study" would be due after a Financial Investment Decision (FID) is made for the Alaska LNG Project, which DOE does not expect to occur until after completion of the NEPA process. Whether CO_2 produced along with natural gas is sequestered or used for EOR will be based on the outcome of the "CO_2 Utilization Study" and utilization plan. Based on this, and on the fact that separated CO_2 could have economic value to EOR operations, DOE considers the use of CO_2 for EOR to be the most likely scenario. The scope of the SEIS is bounded by the Project design proposed by the Applicants within the 2020 EIS, which does not include venting separated CO_2. If DOE exercises its authority to reaffirm the Alaska LNG Order, it is recommended that the following measure be included as an environmental condition of any such export authority: Alaska LNG shall submit to DOE, as part of its monthly report, a statement certifying that the natural gas produced for export in the form of LNG did not result in the venting of byproduct CO_2 into the atmosphere, unless required for emergency, maintenance, or operational exigencies and in compliance with the FERC Order. See additional detail in Section D.4.5 responses to APP B Sub-Theme – Study Methodology and Assumptions (B-2).

Fourth Scenario: The scope of the SEIS includes reasonably foreseeable North Slope production activities associated with the Project and GHG emissions as evaluated in the LCA and presented in the SEIS. The Applicant has not proposed CCUS outside of the North Slope. In addition, Project activities outside of the North Slope that were evaluated under the 2020 EIS are considered out of the scope of the SEIS. Similarly, evaluating the storage of by-product CO_2 in saline formations of the Cook Inlet Basin is considered out of scope. DOE has adequately evaluated the CO_2 emissions related to North Slope activities under Scenarios 2 and 3, and accounted for management of separated CO_2 through the LCA and presentation of LCA results in Section 4. However, if the Project were to receive DOE approval, the Applicant would have the option to pursue additional decarbonization activities to further reduce the Project GHG footprint. Any decision by the Applicant to implement additional strategies would likely be influenced by a number of factors including regulations and financial considerations.

D.4.4 Appendix A – Agency and Tribal Coordination (APP A)

DOE received comments related to the agency and Tribal coordination. Comments relate to compliance with the Endangered Species Act and adequacy of consultation with Alaska Native tribes.

Theme	SEIS Location	Sub-Themes
Appendix A (APP A)	Appendix A	Consultation (A-1)

APP A Sub-Theme – Consultation (A-1)

Synopsis:

Commenters stated that the potential for adverse effects to protected terrestrial and marine species resulting from the Project and the Project's contribution to climate change warrant additional consultations with the U.S. Fish and Wildlife Service (USFWS) and NMFS. They stated that as part of new consultations, DOE must consider any relevant new information and consult on GHG emissions caused by the Project, and that these agencies have the best scientific data available to determine the effects of a federal action on species or habitat.

They also claimed that additional consultations are required with Alaska Native tribes and minority/low-income populations, consistent with E.O. 13990. Commenters recommend DOE consult with federally recognized tribes and incorporate feedback from them when making decisions regarding the Project including Indigenous Traditional Ecological Knowledge, as appropriate, to address environmental justice and tribal concerns. They stated the SEIS should describe issues raised during the consultations and how those issues were addressed. They also recommend direct consultation and coordination with potentially affected subsistence communities, such as the Tribal Whaling Captains of the Alaska Eskimo Whaling Commission. However, the Alaska Eskimo Whaling Commission expressed support for the Project, saying that the pipeline would decrease potential impacts on marine waters and bowhead whales, and provide communities with affordable energy.

Response:

Consultation with USFWS and NMFS: These agencies served as Cooperating Agencies during the 2020 EIS and contributed to the EIS development, including USFWS issuance of a biological opinion. DOE contacted both the USFWS and NMFS and invited them to serve as Cooperating Agencies for the SEIS; neither agency chose to become a cooperating agency. These agencies were also provided a copy of the Draft SEIS for review and comment as part of the 45-day public comment period. With the exception of the Department of Interior, of which the USFWS is a part, these specific regulatory agencies did not provide additional comments on the Draft SEIS. The Department of Interior's comments focused on the importance of permafrost and recommended avoidance of permafrost features. Additional discussion has been included in Sections 3.19 and 4.19 regarding the impacts of climate change, including those to protected species.

Consultation with Federally Recognized Tribes: Section 1.4.5 of the SEIS describes the extensive tribal outreach done as part of the 2020 EIS. Additionally, DOE reached out to each of the 78 Alaska Native tribes involved in the 2020 EIS process (124 hard-copy coordination letters were mailed on

December 9, 2021). The coordination letters notified these tribes of DOE's decision to prepare an SEIS, inquired about their interest, and provided an opportunity to contribute any traditional knowledge regarding resources on the North Slope potentially affected by upstream development that was not included in the 2020 EIS (see Appendix A, Agency and Alaska Native Coordination, for a distribution list and sample letter). No Tribes responded requesting additional engagement. DOE held a virtual public meeting on July 20, 2022. DOE placed notification advertisements about the release of the Draft SEIS and virtual public meeting in the *Federal Register*, national and regional newspapers, sent notification letters to the stakeholder list including Tribes, placed hard copies of the Draft SEIS at libraries, and placed an electronic version of the document on DOE's website. No Tribes attended the virtual public meeting.

Section 1.5 of the SEIS describes the Tribal Knowledge gained from past engagement during the FERC 2020 EIS. Those efforts and representative issues and concerns are summarized in Section 1.5 and carried into this SEIS (see Table 1.5-1). This included topics related to climate change and environmental sustainability.

The SEIS does include measures in Section 4.14.5 for reducing or avoiding impacts to subsistence uses as suggested in the comment (e.g., whaling and local group/user coordination): "Similar to mitigation requirements identified in the 2020 EIS, project proponents for upstream development activities involving equipment and material deliveries by barge and for dredging at PTU would be required to coordinate with the NMFS and the Alaskan Eskimo Whaling Commission to avoid or minimize impacts on subsistence whaling and marine mammal hunting. This could require barging activities to be temporarily halted during peak whale hunting times to minimize vessel traffic overlapping subsistence hunts." DOE added additional text to Sections 3.11, 4.14, and 4.19 to further address the potential impacts on subsistence and Alaska Native Tribes (see SOC Sub-Theme – Environmental Justice (4-11c) for additional information).

D.4.5 Appendix B – North Slope Production Study (APP B)

DOE received comments related to the North Slope Production Study provided in Appendix B of the Draft SEIS. Comments relate to existing and recommended study scenarios, study methodology and assumptions, and study conclusions.

Theme	SEIS Location	Sub-Themes
Appendix B (APP B)	Appendix B	Study Scenarios (B-1) Study Methodology and Assumptions (B-2) Study Conclusions (B-3)

APP B Sub-Theme – Study Scenarios (B-1)

Synopsis:

Commenters requested that the Final SEIS discuss and evaluate the PBU saline formation sequestration project under Scenario 2 to be consistent with CEQ guidance on CCUS. They recommended the study identify the other speciated forms of GHGs (e.g., methane [CH_4], nitrous oxide [N_2O], sulfur hexafluoride [SF_6], etc.) that would also be reinjected in the PBU saline formation for CCUS and requested the Final SEIS discuss the air quality impacts associated with the PBU CCUS project in Scenario 2 and their potential impact on nearby environmental justice, tribal, and vulnerable communities.

Commenters noted that by incorporating the PBU CCUS under Scenario 2, approximately 50 percent of the GHG emissions would be mitigated and/or offset. A commenter requested the Final SEIS evaluate an Action Scenario 4, which would reinject by-product CO_2 into the Cook Inlet Basin CCUS to mitigate GHG emissions associated with the Liquefaction Facilities. They claimed Scenario 4 could provide additional mitigation through carbon offsets potentially reaching 75 percent or higher of the total GHG emissions for the Alaska LNG Project.

Response:

In February 2022, the CEQ issued interim ''*Carbon Capture, Utilization, and Sequestration Guidance*,'' to assist federal agencies with the regulation and permitting of CCUS activities in the United States. Key aspects of this guidance include recommendations for facilitating federal government decision-making for CCUS projects, public and tribal engagement, and understanding of environmental impacts including potential impacts on local criteria air pollutants and other emissions resulting from carbon capture retrofits at industrial facilities. This guidance is consistent with CEQ's 2021 CCUS Report, which recognized that the federal government has an existing regulatory framework capable of safeguarding the environment, public health, and public safety for CCUS projects. The guidance includes recommendations for agencies with oversight, including USEPA's Class VI Underground Injection Control (UIC) Program and U.S. Department of Transportation's Pipeline Hazardous Materials Safety Agency (PHMSA). These recommendations focus on building monitoring and verification requirements under the USEPA UIC Program and updating and enforcing criteria for geohazard risks and emergency planning on pipelines.

Consistent with CEQ guidelines, DOE considered and evaluated the reasonably foreseeable direct, indirect and cumulative effects related to reinjection of captured CO_2 in PBU saline formations as part of the Proposed Action (Scenario 2) in the SEIS. DOE notes that pipelines and injection wells that would be used to transport and inject the captured CO_2 would respectively be subject to regulatory requirements, approvals, and safeguards required under USEPA's UIC Program and from the U.S. Department of Transportation's PHMSA. These CCUS activities may also be subject to new requirements aimed at improving monitoring and safety that may result from the federal agency implementation of CEQ's CCUS Guidance recommendations. As presented in the 2020 EIS, the GTP would process natural gas and produce a high-purity by-product CO_2 stream. Air emissions associated with the GTP and generation of the by-product CO_2 stream were addressed in detail as part of the 2020 EIS (see Section 4.15 of the 2020 EIS). The 2020 EIS also included discussion of air quality impacts on nearby environmental justice, tribal, and vulnerable communities. DOE anticipates that the CO_2 that would be processed and captured at the GTP would be highly purified, and as a result does not anticipate other speciated forms of GHGs in more than trace quantities to be present or injected into the saline formations. In addition, captured CO_2 gas would meet pipeline specifications for transport.

Fourth Scenario: The scope of the SEIS is focused on reasonably foreseeable North Slope production activities and GHG emissions as evaluated in the LCA and presented in the SEIS. The Applicant has not proposed CCUS outside of the North Slope. In addition, Project activities outside of the North Slope region of influence, as defined in the SEIS, and that were evaluated under the 2020 EIS are considered out of the scope of the SEIS. Similarly, evaluating the storage of by-product CO_2 in saline formations of the Cook Inlet Basin is considered out of scope. DOE has adequately evaluated the CO_2 emissions related to anticipated North Slope activities under Scenarios 2 and 3, and accounted for project CO_2 through the LCA and presentation of LCA results in Section 4. However, if the Project were to receive DOE approval, the Applicant would have the option to pursue additional decarbonization activities to further reduce the Project GHG footprint. Any decision by the Applicant to implement additional strategies would likely be influenced by a number of factors including regulations and financial considerations.

Note that Section 2.2.2.3 of the SEIS describes the CO_2 Storage model in Production Report 3 as having a "total storage area of 42 square miles". For clarification, this statement has been revised to: "total reservoir study area of 42 square miles."

APP B Sub-Theme – Study Methodology and Assumptions (B-2)

Synopsis:

Commenters questioned various methodologies and assumptions used in the preparation of the North Slope Production Study including:

- Why the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) model was not used to model the condensate production that is produced from the PTU and transported via the TAPS.
- Why the study assumes that the TAPS would still be in operation at the end of the Alaska LNG Project in 2058, and whether the Alaska LNG Project would prevent or postpone the shutdown of the TAPS.
- Why the study assumes that the by-product CO_2 generated as part of the Alaska LNG Project would be geologically stored or utilized as part of EOR operations as opposed to vented to the atmosphere.
- Why DOE used the CO_2 Prophet Model as a tool for estimating the CO_2 injection and oil production using CO_2 EOR at KRU, citing that the CO_2 Prophet Model uses a vertical well design rather than a horizontal well design.

Response:

OPGEE Model: The OPGEE model is a life cycle assessment tool for measuring GHG emissions from the production, processing, and transport of crude petroleum. In contrast, the natural gas condensate production estimates were provided by the operator of the PTU, Exxon, and this information was used in the Gas Supply and Oil Impacts reports.

TAPS: While the Alaska LNG Project would shift the focus from oil to gas production at the PBU, significant production of crude oil and condensate from the PBU and PTU would still take place over DOE's term of authorization.

Production Report 2 provides two cases, 1) Business-As-Usual (no major gas sales), and 2) Oil Production with Major Gas Sales. The Scenario 1 projection of oil and condensate production from PBU and PTU ranges from approximately 215,000 barrels per day in 2029 to approximately 115,000 barrels per day in 2058. The Scenario 2 projection of oil and condensate production from PBU and PTU ranges from approximately 205,000 barrels per day in 2029 to 65,000 barrels per day in 2058. These estimates do not include production rates for numerous other oil fields, such as Alpine, that may be serviced by TAPS. See additional details presented in comment response for ALT Sub-Theme – Alternative Development (3-2) related to TAPS.

CO_2 Venting: The development of the Alaska LNG Project has included detailed plans for management of the by-product CO_2 stream, both in the application approval process and in the design of the GTP that would be built at Prudhoe Bay. The scope of the SEIS is bounded by the Project design proposed by the Applicants within the 2020 EIS, which does not include venting separated CO_2. If DOE exercises its authority to reaffirm the Alaska LNG Order, it is recommended that the following measure be included as an environmental condition of any such export authority: Alaska LNG shall submit to DOE, as part of its monthly report, a statement certifying that the natural gas produced for export in the form of LNG did not result in the venting of byproduct CO_2 into the atmosphere, unless required for emergency, maintenance, or operational exigencies and in compliance with the FERC Order.

The AOGCC provided initial findings and comments on the by-product CO_2 stream in Conservation Order 341 F (AOGCC 2015) on October 15, 2015. This document was prepared in response to BP Alaska's application for major gas sales from the Prudhoe Oil Pool. AOGCC recognized that "an effluent stream from the AK LNG gas treatment plant (GTP) that is nearly pure carbon dioxide will be available for injection" and concluded that captured CO_2 "may prove to be a very valuable resource for enhanced recovery projects on the North Slope". This language treats the by-product CO_2 stream as a valuable commodity to be utilized rather than a waste stream to be vented.

Conservation Order 341 F (AOGCC 2015) also included "Rule 19 CO_2 Utilization Study", which required BP Alaska to develop a study on the possible applications and challenges of utilizing the by-product CO_2 stream for EOR operations on the North Slope. This Rule required a utilization plan for the by-product CO_2 stream to be compressed and reinjected into North Slope oil fields as part of the approval for the Prudhoe Oil Pool to be developed for major gas sales.

The 2020 EIS provided language describing the plan for management of the by-product CO_2 by injecting it into the far western portion of the PBU at West Eileen. Revision of this plan, following the findings in the SEIS, is required to be developed by Hilcorp as part of the Rule 19 CO_2 Utilization Study. The AOGCC issued Conservation Order 341 I.001 (AOGCC 2020), which allowed the delivery of this report to be delayed until the FID for the Alaska LNG Project.

The Gas Treatment Plant Air Quality Modeling Report (Alaska LNG 2017), developed by Alaska LNG, provides detailed information on the equipment that would be installed at the GTP to handle CO_2 separation and compression during major gas sales. The report explains that venting of CO_2 would only happen in low-probability emergency situations. The report goes on to describe reinjection procedures as a means to avoid venting CO_2 and other gases during plant operation.

CO_2 Prophet Model: The operator indicates between 60 percent and 70 percent of wells at KRU are directionally drilled but enter the formation vertically or at a slant with the remainder of the wells entering the formation horizontally. Given the scope and purpose of this study, DOE considered the use of a screening-level model such as CO_2 Prophet to be appropriate for estimating CO_2 injection and utilization into the KRU A and C Sands. The model is capable of providing estimates of CO_2 injection and oil production based on the extensive reservoir characteristic data for the KRU A and C Sands that was gathered for the study.

APP B Sub-Theme – Study Conclusions (B-3)

Synopsis:

Commenters questioned the North Slope Production Study's conclusions, including:

- Inconsistent information in the SEIS and Resource Reports about the total volume of CO_2 that will be captured and utilized/stored over the life of the Alaska LNG Project.
- The validity of the modeling results regarding the volume of CO_2 that is stored over the project life, claiming that neither sequestration nor EOR permanently stores *all* of the injected CO_2; in both cases, some CO_2 returns to the atmosphere.

Commenters also stated the study conclusions support the Project with sufficient gas supply available at PBU and PTU, with additional options for CO_2 management (e.g., CCS, EOR).

Response:

The total volume of CO_2 that will be captured at the GTP over the 30-year project is 190 million metric tons. Including the optional 3 years of operation at the end of the project adds an additional 12 million metric tons for a total captured CO_2 volume of 202 million metric tons of CO_2 over the 33-year project. These volumes were calculated based on the total CO_2 content of the gas stream delivered to the GTP over the life of the Project. The SEIS has been updated to reflect that the project could sequester up to a total of 202 million metric tons of CO_2.

Production Report 2 includes Scenario 3 that describes potential CO_2 EOR operations at KRU. The results of the CO_2 Prophet Model study show that a total of 190 million metric tons of CO_2 could be utilized and stored at KRU over a 30-year project period (Exhibit 6-12) and that a total of 202 million metric tons of CO_2 could be stored when including the optional extended 3-year period (Exhibit 6-13). The modeling results show that a CO_2 EOR project at KRU could store similar volumes of CO_2 that will be captured from the GTP over the life of the Alaska LNG Project – 190 million metric tons over 30 years and 202 million metric tons over 33 years.

During geologic CO_2 sequestration, CO_2 is injected into underground formations where, given the quality of the reservoir seal, it is permanently stored. Rigorous verification of geologic seals is performed during the selection of the storage formation to ensure containment. During CO_2 EOR the produced CO_2 remains in a closed system from the production well, through the processing facility, and back to the injection well for reinjection. The LCA calculated a total of 0.08 percent of the injected CO_2 would be emitted during EOR operations (0.03 percent due to fugitive emissions during compression and 0.05 percent due to reservoir leakage.). With best operating practices, virtually all of the CO_2 injected during EOR operations is ultimately stored in the reservoir formation at the end of the Project.

Section 2.2.2.3 of the SEIS describes the CO_2 Storage model in Production Report 3 as having a "total storage area of 42 square miles". The statement has been revised in the Final SEIS to read: "total reservoir study area of 42 square miles." The CO_2 Storage study is described in greater detail in Production Report 3. The study was developed using an individual sector model area of 6 miles long by 1 mile wide. (A sector model area is a representative area [sector] of the oil field). The sector model included a single injection well capable of injecting up to 50 million cubic feet of CO_2 per day. The GEM Compositional Simulator was then used to model CO_2 injection in this sector model area over a 30-year period.

D.4.6 Appendix C – Life-Cycle Analysis (LCA) Study (APP C)

DOE received comments related to the LCA Study provided in Appendix C of the Draft SEIS. Comments relate to conclusions in the SEIS regarding reduction of GHG emissions; consideration of methane leakage, GHGs from CCS operations, and CO_2 venting; project "substitution;" and inconsistent numbers for by-product CO_2.

Theme	SEIS Location	Sub-Themes
Appendix C (APP C)	Appendix C	Study Scenarios (C-1) Study Methodology and Assumptions (C-2) Study Conclusions (C-3)

APP C Sub-Theme – Study Scenarios (C-1)

Synopsis:

Commenters requested DOE expand the LCA to consider downstream and upstream emissions, claiming currently the project only considers direct emissions from transport itself; that the assumption that "Business as Usual" Scenario 1 makes (that if the pipeline is not built, the same amount of LNG will be supplied to the same countries using existing export terminals) is incorrect and largely drives the results. Commenters stated that results are mainly due to the fact that distance between Alaska and the destination countries is smaller than the Gulf Coast to the destination countries; and that the LCA also does not account for other factors such as effects of the project on supply, demand, consumption, and the energy mix in destination countries. Commenters also claimed that without Alaska LNG, destination countries could receive LNG from Australia and other sources, leading to shorter transportation distances.

Response:

DOE has presented GHG emissions for a second condition under the No Action that does not consider LNG produced from alternative sources located outside the North Slope. This second No Action Alternative (SEIS Non-equivalent Energy Baseline) only considers the projected continuation of oil production from the Project area in Alaska, and no assumption is made about providing the same energy services to society. This No Action analysis is separate from the LCA Study, as energy service provided to society through production of natural gas and oil would not be equivalent to the Proposed Action. Comparing Proposed Action GHG emissions against the No Action Alternative (SEIS Non-equivalent Energy Baseline) scenario results in a potential net increase in GHG emissions that could potentially occur if the Project were authorized, constructed, and operated. Table 2.3-1 and Section 4.19 of the Final SEIS have been updated accordingly. Other concerns raised by commenters, including transportation distances and the impact of global energy demand, are discussed below.

Transportation Distances: The observation that the primary differentiator is ocean transport distance between Scenarios 2 and 3 (with Alaska LNG Project) in comparison to Scenario 1 (Business as Usual without Alaska LNG and using Lower 48 United States as a representative proxy) is partially correct. The comparison across scenarios, Scenario 1 to Scenario 2 and 3, consists of differences in nearly every part of the value chain for both natural gas and oil production and transport, liquefaction technology, and ocean transport distance. Operations within the importing countries, regasification, pipeline transport, and use of the natural gas to produce electricity are equivalent across each scenario. Section 4 of the LCA Study provides GHG contribution analysis graphs for key Scenario results.

All else equivalent, shorter ocean transport distances would result in lower GHG emissions. LNG ocean transport's contribution to the total life cycle emissions across the scenarios ranges between 3 percent and 5 percent of the total GHG contribution on a 100-year GWP timeframe (without CCS). In all 3 scenarios, results for delivery to Mumbai, India have the smallest variance in ocean transport distance, Scenario 1 is modeled as 11,266 miles and Scenarios 2 and 3 are modeled at 10,614 miles, a 652-mile difference; see Exhibit 3-10 in the LCA Study. Comparing the cumulative GHG results for LNG delivered to Mumbai, India in Exhibit 4-4 of the LCA Study affirms a reduction in GHG emission for Scenarios 2 and 3 compared to Scenario 1 with nearly equivalent ocean transport distances. If the transport distance was reduced from 11,266 miles to 1,750 miles (approximately the shipping distance from Port of Doha, Qatar to Port of Mumbai, India) the ocean transport contribution in Scenario 1 would be reduced from 41 to 6 kg CO_2e/MWh electricity and 53 kg of crude oil products consumed – a 35 kg CO_2e reduction. This would result in Scenario 1, delivery to Mumbai, India to have an expected result of 699 kg CO_2e/MWh electricity and 53 kg of crude oil products consumed compared to 681 and 680 for Scenarios 2 and 3 as reported in Exhibit 4-4. This affirms that irrespective of a reduced transport distance for LNG delivered from 1,750 miles or the longest distance modeled of 10,614 miles for Alaska LNG to Mumbai, India, the study conclusion remains valid. Therefore, changes in ocean transport distance are expected to have no impact (as defined within the study's uncertainty bounds) on the study's conclusion that "Exporting LNG from the North Slope would not increase [greenhouse gas] emissions when providing the same services to society (through production of natural gas and oil) as the No Action Alternative."

The following paragraphs address the second portion of the comment with respect to the project's effect on supply, demand, consumption, and the energy mix in destination countries.

Global Energy Demand: The first foundation of the life cycle analysis requires that global energy demand be met in both the Business as Usual (No Action Scenario, no Alaska LNG Project) and the two proposed SEIS scenarios (Scenario 2 and Scenario 3) with the Alaska LNG Project. The second foundation of the life cycle analysis is based on the expected growth in global natural gas consumption to meet international decarbonization goals (refer to Section 2.7 of the LCA Study); therefore, the decision to utilize natural gas has been determined and the question of relevance is if producing natural gas from the North Slope of

Alaska (and utilizing it within the importing country; modeled as 100 percent combustion within this study) will result in a change in greenhouse gas emissions. The LCA Study includes upstream natural gas production, transport, liquefaction, ocean transport of liquefied natural gas, regasification in the importing country, pipeline transport, and use of the imported natural gas in a Natural Gas Combined Cycle power plant for electricity production (modeled both with and without carbon capture as the disposition of carbon capture in the importing countries cannot be determined with confidence, therefore bracketing the GHG emission potential from end-use). For reference, Section 3 within the LCA Study describes the life cycle value chain included and their modeling parameters.

Changes in the global market as directly induced solely by the existence of the Alaska LNG Project cannot be definitively determined. Expansion of the global LNG market has been occurring and global estimates all indicate continued future growth of the global LNG market to meet future energy demands. The originating source of the natural gas to meet growing global demand will be supported by a diverse range of sources, potentially inclusive of Alaskan sourced natural gas, but not exclusively. The LCA Study applied the existing knowledge base for production and liquefaction of natural gas originating from the Lower 48 United States as a representative environmental profile, referred to as a proxy, to satisfy the global energy demand for natural gas in Scenario 1 - Business as Usual. This choice was not intended to imply the Lower 48 as a direct substitution for Alaska LNG production. Clarifying language has been added to Section 4.19.2 of the Final SEIS and LCA for clarification.

See additional information about market conditions in Section D.4.1 Market Conditions theme response.

APP C Sub-Theme – Study Methodology and Assumptions (C-2)

Synopsis:

DOE received various comments regarding the methodology and assumptions used in the LCA Study. These included:

- DOE should provide justification of destination countries chosen and sensitivity of assumptions.
- The substitution assumptions need to be consistent with economic benefits.
- Displacement of Gulf Coast gas would lead to Gulf Coast production decline.
- Questioned the use of International Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4) instead of more current AR5 and AR5 global warming potential (GWP) values.
- The LCA Study should evaluate GHG emissions for the Alaska LNG Project to include destination countries in the European Union, such as France, Spain, Netherlands, and Italy.
- The LCA Study needs to consider methane leakage.
- CCS reductions modeled are unrealistic due to assumptions on capture and deployment rates.
- Occurrence of "Petersburgh" in the LCA Study as the origination port.
- Commenters recommend that the Final SEIS incorporate a model to analyze the economic impacts on electricity and related markets associated with the Alaska LNG Project. It recommends incorporation of the U.S. Energy Information Administration's most recent forecasts into the LCA.

Response:

Destination Countries: The importing countries modeled were selected to represent the most likely receiving destinations based on expected demand growth and geographical proximity to Alaska. The four destination countries modeled – Japan, China, South Korea, and India – represent a range of Alaska LNG transport distances from 4,456 to 10,614 miles. Global sources of LNG are myriad and some sources are geographically closer (shorter ocean transport distance) to the four importing countries modeled within the LCA Study. The market decision on where to source LNG on the global market is very complex and not limited to environmental greenhouse gas projections. The complexity in sourcing is country-specific and depends on numerous factors including temporally-dynamic to short- and long-term contract pricing, environmental performance, country policies, delivery security and reliability, international relationships, and other drivers. These complexities highlight the challenges in predicting future global LNG markets.

The following text has been added in Section 4.19.2 of the Final SEIS to better communicate the justification for the countries selected (and not selected), and how the results are affected by the distances of those countries from the United States within both SEIS and LCA Study:

> "These four countries were chosen to represent geographically proximate delivery destinations from Alaska that, at the time of study initiation, were known or expected to be significant LNG importers. Note that the range of shipping distances to these specific countries (5,000 to 10,000 miles from Alaska) closely approximate those to other emerging LNG importers such as in Europe (about 10,000 miles away via the Panama Canal)."

Substitution Assumptions/Economic Benefits: DOE has presented GHG emissions for a second condition under the No Action that does not consider LNG produced from alternative sources located outside the North Slope. This second No Action Alternative (SEIS Non-equivalent Energy Baseline) only considers the projected continuation of oil production from the Project area in Alaska, and no assumption is made about providing the same energy services to society. This No Action analysis is separate from the LCA Study, as energy service provided to society through production of natural gas and oil would not be equivalent to the Proposed Action. Comparing Proposed Action GHG emissions against the No Action Alternative (SEIS Non-equivalent Energy Baseline) scenario results in a potential net increase in GHG emissions that could potentially occur if the Project were authorized, constructed, and operated. Table 2.3-1 and Section 4.19 of the Final SEIS have been updated accordingly.

Gulf Coast Gas Production Decline: Changes in the global market as directly induced solely by the existence of the Alaska LNG Project cannot be definitively determined. Expansion of the global LNG market has been occurring and global estimates all indicate continued future growth of the global LNG market to meet future energy demands. The originating source of the natural gas to meet growing global demand will be supported by a diverse range of sources, potentially inclusive of Alaskan-sourced natural gas, but not exclusively. The LCA Study applied the existing knowledge base for production and liquefaction of natural gas originating from the Lower 48 United States as a representative environmental profile, referred to as a proxy, to satisfy the global energy demand for natural gas in Scenario 1 - Business as Usual. This choice was not intended to imply the Lower 48 as a direct substitution for Alaska LNG production. The following text has been added to Section 4.19.2 of the Final SEIS for clarification:

> "While the Scenarios discuss 'Lower 48', this categorization creates a *benchmark* representation of alternative natural gas sources. However, by using high-resolution data available from the Lower 48 (e.g., from the USEPA GHG Reporting Program), the LCA Study offers a higher level of data quality and helps to stay consistent with the level of modeling accuracy. It also avoids using far more aggregated data from other regions that would lead to additional uncertainty."

AR4 and GWP: The use and focus on GWP values from the IPCC's Fourth Assessment Report (AR4) in the LCA study was done to maintain consistency with the original FERC 2020 EIS's estimates. The LCA study provides supplemental results on both the Fifth Assessment Report (AR5) and the Sixth Assessment Report (AR6) GWP (100- and 20-year basis) in the LCA Appendix. The study conclusions comparing Scenarios 1, 2, and 3 are maintained regardless of choice of IPCC values. The following text has been added to the LCA Study for clarification:

> (Page 2) "GWP values from the IPCC's Fourth Assessment Report (AR4) are used in the report to maintain consistency with the original FERC Environmental Impact Statement's estimates. Results using GWP values from AR5 and AR6 (100- and 20-year basis) are available in the LCA Appendix."
>
> (Page 35) "Consistent with the original FERC study, the main report shows AR4…."
>
> (Page 70) "The results for AR4 20-year GWP, as well as AR5 and AR6 (for 100- and 20-year GWP) show the same qualitative results as mentioned for AR 100-year GWP in terms of the relative differences in Scenarios as well as the uncertainty."

Export to the European Union: At the outset of the project, Asian markets were identified as the most likely destinations based on geographical proximity to Alaska as well as existing or expected LNG demands in the future. DOE notes that the shipping distance from Alaska to India approaches the distance that would exist to European Union countries.

Methane Leakage: The methane sensitivity analysis aims to quantify the change in overall GHG emissions from an incremental ±5 percent change in methane emissions across all natural gas life cycle stages. A ±5 percent variation in methane emissions results in the total GHG emissions varying by about 1.5 to 5 kg CO_2e per MWh electricity produced and 53 kg of crude-oil products consumed in either direction on a 100- and 20-year basis respectively, which is equivalent to 0.2 percent to 0.7 percent of total life cycle GHG emissions. This sensitivity range can be extrapolated to understand the effect of subsequent higher changes in methane emissions on the overall result. The purpose and utility of the sensitivity analysis has been clarified in Section 4.5.2 of the LCA Study to clarify the purpose is to understand the effect of a change in methane leakage sensitivity on the cumulative results and the choice of ±5 percent change in methane emissions is not intended to imply a known range of direct methane emissions uncertainty within the study. Uncertainty in methane emissions is included within the uncertainty analysis (upper and lower bounds represented by error bars on graphed results) at the parameter level within the study. Details are included in Section 3 of the LCA Study (see Appendix C of this SEIS).

CCS Reduction Modeling: As noted in the LCA study, the power generation stage is modeled based on the NETL baseline fossil energy plant report entitled *Life Cycle Analysis of Natural Gas Extraction and Power Generation* (Littleton et al. 2019). The report models a carbon capture rate of 90 percent for natural gas combined cycle (NGCC) plants with CO_2 capture units. This estimate is consistent with current CCS designs, and major research and demonstration (R&D) organizations are currently pursuing short-term goals of at least 95 percent CO_2 capture (Zhai & Rubin, 2022). In addition, since one cannot accurately predict the implementation or use of CCS around the world, DOE developed models and provided results both with and without CCS to provide a more complete range of results in the SEIS.

Origin Port: Anchorage, Alaska was used as the reference port for estimating these distances, but the wrong city name was listed in the assumptions. The actual port (Nikiski) was not available as a port option at the time the distance calculator was used. However, we note that it would be slightly closer (by about 60 nautical miles) which has a negligible effect on the results. Exhibit 3-10 of the LCA Study has been revised, changing Petersburgh to Nikiski, along with the addition of a footnote to remark that Anchorage was selected in the sea route distance calculator (i.e., Searoutes calculator), approximately 60-mile difference, because an option to select Nikiski was not available at that time in the Searoutes calculator.

Market Conditions: Refer to P&N Sub-Theme – Market Conditions (1-4) for a response comments regard market analysis.

APP C Sub-Theme – Study Conclusions (C-3)

Synopsis:

DOE received various comments regarding the LCA Study conclusions. These included:

- The LCA Study and SEIS had inconsistencies in produced CO_2 reinjection (185 vs 205 million mt CO_2) and the findings regarding CO_2 reinjection are optimistic.
- The LCA Study conclusions should discuss sources and contributions of methane and other greenhouse gases (GHGs).
- A detailed emissions inventory should be provided for all scenarios.
- The LCA Study should consider mid-stream emissions with in-state deliveries.
- The LCA Study should discuss decarbonization strategies for the estimated long-term project-level greenhouse gas emissions over time in the context of science-driven Alaska, national, and international greenhouse gas emissions reduction goals, and ways to address carbon lock-in concerns. This could include DOE using its authority to condition export orders. This should be consistent with White House Climate Policy to discuss opportunities to mitigate methane emissions.

Response:

CO_2 Reinjection: The total volume of CO_2 that would be captured at the GTP over the 30-year project is 190 million metric tons. Including the optional 3 years of operation at the end of the project adds an additional 12 million metric tons for an estimated total captured CO_2 volume of 202 million metric tons of CO_2 over the 33-year project. These volumes were calculated based on the total CO_2 content of the gas stream delivered to the GTP over the life of the Project. The SEIS has been updated to reflect that the project could sequester up to a total of 202 million metric tons of CO_2.

Production Report 2 includes Scenario 3 that describes potential CO_2 EOR operations at KRU. The results of the CO_2 Prophet Model study show that a total of 190 million metric tons of CO_2 could be utilized and stored at KRU over a 30-year project period (Exhibit 6-12) and that a total of 202 million metric tons of CO_2 could be stored when including the optional extended 3-year period (Exhibit 6-13). The modeling results show that a CO_2 EOR project at KRU could store similar volumes of CO_2 that will be captured from the GTP over the life of the Alaska LNG Project – 190 million metric tons over 30 years and 202 million metric tons over 33 years.

The LCA Study has been revised to reflect the average CO_2 injected parameter description in Exhibit 3-5 to say "30-year average" and includes an internal memo explaining the insignificant change to the final conclusions and results if we use a 33-year average CO_2 injected value instead.

To further clarify reinjection questions, the analysis does not assume that all 53 kg of crude oil would be produced through EOR alone. The total quantity of oil produced includes conventional oil production, EOR oil production, or Lower 48 oil production depending on the analyzed scenario. The analysis is consistent with using 0.376 kg of oil produced via EOR per kg of injected CO_2. For the specific case referred to by the comment – Scenario 3, NGCC without CCS to Japan – the total quantity of crude oil produced via EOR is around 17 kg.

The oil produced via EOR per kg of CO_2 injected value used in this analysis is consistent with existing literature. The referenced study (Cooney et al. 2017) models a crude recovery ratio of 2 bbl/tonne CO_2 to represent U.S. operations in 2013 and 4.35 bbl/tonne CO_2 to represent advanced EOR based on best practices. The paper also provides a range for crude recovery from a low of 0.73 bbl/tonne CO_2 in the Gulf Coast to a high of 2.68 bbl/tonne CO_2 in the Mid-Continent. The Alaska LNG LCA study uses a crude recovery ratio of around 2.6 bbl/tonne CO_2 (or 0.376 kg/kg CO_2).

In addition, the gate-to-grave life cycle GHG emissions from geological sequestration of CO_2 are 13.9 kg CO_2 per tonne of CO_2 sequestered, based on NETL's report on gate-to-grave life cycle analysis of saline aquifer sequestration of CO_2 (Skone et al. 2013).

Methane and Other GHG Sources: DOE understands that methane emissions are an important part of assessing emissions from the natural gas supply chain. As a result, we use USEPA's GHGRP data for modeling GHG emissions (including methane) from all stages of the supply chain. Certain updates have been made to GHGRP data to ensure that emissions from significant sources are not underestimated. For example, we use updated throughput-normalized methane emissions data from current literature (Zaimes et al. 2019) for accurately modeling emissions from the liquids unloading process. In the 2019 Natural Gas report (Littlefield et al. 2019), Section 3 and Appendix D provide additional details related to data sources used and modeling of liquids unloading emissions in the NETL Natural Gas model.

Exhibit 4-17 in the LCA Study provides a speciated emissions comparison for Scenario 3 to China to highlight the contributions of methane and other greenhouse gases by key life cycle stages. Exhibit 4-17 is an example of one set of speciated greenhouse gas results. A complete set for each modeled scenario by country of destination is contained in in the Appendix of the LCA Study as Exhibits A-9 through A-20 for 100-year GWP, AR4 results. Results are available in the Appendix of the LCA Study for alternative IPCC GWP values for both 100- and 20-year timeframes.

Detailed Emissions Inventory: Exhibit 4-17 in the LCA Study provides a speciated emissions comparison for Scenario 3 to China to highlight the contributions of methane and other GHGs by key life cycle stages. Exhibit 4-17 is an example of one set of speciated GHG results. A complete set for each modeled scenario by country of destination is contained in the Appendix as Exhibits A-9 through A-20 for 100-year GWP, AR4 results. Results are available in the Appendix of the LCA Study for alternative IPCC GWP values for both 100- and 20-year timeframes.

Mid-stream Emissions: Due to the unknown state of the potential use for natural gas in-state, the LCA Study models in-state natural gas use as 100 percent combusted and assigns the emissions to the proposed Alaska natural gas pipeline delivering the product from the North Slope to the proposed liquefaction facility in Nikiski, Alaska. We recognize this approach may overestimate greenhouse gas emissions related to in-state use that is non-combustion related, (e.g., chemicals production). Due to the uncertain nature of the final disposition of in-state usage the study intentionally modeled 100 percent combustion of the natural gas to account for the GHG emissions.

Decarbonization Strategies: DOE appreciates the importance of future decarbonization strategies to improve environmental performance. The scope of the SEIS is bounded by the project design proposed by the Applicants within the 2020 EIS. The only exception is the inclusion of carbon management for the high purity CO_2 stream from the GTP that was not modeled directly within the 2020 EIS but stated by AGDC and the Applicant to be effectively managed to prevent the direct release of the high purity CO_2 stream to the atmosphere. If DOE exercises its authority to reaffirm the Alaska LNG Order, it is recommended that the following measure be included as an environmental condition of any such export authority: Alaska LNG shall submit to DOE, as part of its monthly report, a statement certifying that the natural gas produced for export in the form of LNG did not result in the venting of by-product CO_2 into the atmosphere, unless required for emergency, maintenance, or operational exigencies and in compliance with the FERC Order.

The development of the Alaska LNG Project has included plans for management of the byproduct CO_2 stream, both in the application approval process and in the design of the GTP that will be built at Prudhoe Bay.

The discussion of CO_2 Venting in Section D.4.5 under APP B Sub-theme – Study Methodology and Assumptions (B-2), details AOGCC's initial findings and comments on the by-product CO_2 stream in Conservation Order 341 F (AOGCC 2015). This document treats the by-product CO_2 stream as a valuable commodity to be utilized rather than a waste stream to be vented.

Conservation Order 341 F (AOGCC 2015) also included "Rule 19 CO_2 Utilization Study" which required BP Alaska to develop a study on the possible applications and challenges of utilizing the byproduct CO_2 stream for EOR operations on the North Slope. This Rule required a utilization plan for the byproduct CO_2 stream to be compressed and reinjected into North Slope oil fields as part of the approval for the Prudhoe Oil Pool to be developed for major gas sales.

The original 2020 EIS provided language describing the plan for management of the byproduct CO_2 by injecting it into the far western portion of the PBU at West Eileen. Revision of this plan, following the findings in the SEIS, is required to be developed by Hilcorp as part of the Rule 19 CO_2 Utilization Study. The AOGCC issued Conservation Order 341 I.001 (AOGCC 2020) which allowed the delivery of this report to be delayed until the project FID for the Alaska LNG Project.

The Gas Treatment Plant Air Quality Modeling Report (Alaska LNG 2017) developed by Alaska LNG, provides detailed information on the equipment that will be installed at the GTP to handle CO_2 separation and compression during major gas sales. The report explains that venting of CO_2 would happen in low-probability emergency situations only. The report goes on to describe reinjection procedures as a means to avoid venting CO_2 and other gases during plant operation.

D.4.7 Impact Analysis (IMP)

DOE received comments related to the impact analysis provided in Chapter 4 of the Draft SEIS. Comments relate to the sufficiency of the impact analysis, geological hazards such as earthquakes, particulate emissions calculations, permafrost, subsistence, and cumulative impacts.

Theme	SEIS Location	Sub-Themes
Impact Analysis (IMP)	Chapter 4	General (4-0) Geologic Resources and Geologic Hazards (4-1) Permafrost (4-2) Water Resources (4-3) Wetlands (4-4) Threatened, Endangered, and Other Special Status Species (4-8) Subsistence (4-14) Air Quality (4-15) Human Health (4-17) Reliability and Safety (4-18) Cumulative Impacts (4-20)

IMP Sub-Theme – General (4-0)

Synopsis:

Commenters claimed the SEIS does not adequately address the broader consequences of building infrastructure to transport and inject by-product CO_2 as the SEIS analysis relies on incomplete project information regarding upstream development activities. They claimed basic project location information is not provided, and DOE must do more to ensure that the upstream impacts of the CO_2 infrastructure associated with the preferred alternative are meaningfully considered and presented to the public for review and comment. Commenters also stated that the SEIS improperly asserts that AGDC can use an alternative means of carbon storage without specifying that further analysis would be necessary if such an alternative means is selected, and that there are unique environmental impacts associated with different CO_2 management schemes, and DOE should not assume that a very broad, non-specific, and under-studied option will be feasible or have the impacts discussed in the SEIS. Commenters stated that under NEPA, changes that would result in significant impacts not evaluated in the EIS would, at a minimum, require further analysis in another supplement; and that DOE's approach of reducing its impacts analysis to statements that would apply no matter the method or location of the carbon storage scheme is antithetical to NEPA's goal of fostering transparency and informed decision-making.

Response:

Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of land disturbance for all activities and actual location for proposed infrastructure. The SEIS reasonably assumes these activities would occur directly adjacent to or within previously disturbed areas (e.g., new wells within existing well pads, expansion of well pads directly adjacent to existing, and use of existing rights-of-way and VSM racks for pipelines). The 2020 EIS was able to use specific design plans prepared by the Applicant for the proposed Alaska LNG Pipeline to obtain estimated acreages of impact. Engineering design of the upstream development activities could occur following approval of the Alaska LNG Pipeline (if approved) as connected actions. The SEIS does use the best available information to characterize upstream development activities at this time and also recommends mitigation measures and other regulatory requirements pertaining to upstream development to minimize the overall level of adverse effects. Additional information was prepared by DOE in consideration of the SEIS, which included the LCA Study to quantify potential life cycle GHG emissions and the North Slope Production study to identify requirements for upstream development to meet the overall proposed pipeline gas needs, as well as identified options for CO_2 sequestration identified within the SEIS. The SEIS echoes the nature of incomplete and unavailable information:

- As stated in Section 2.3 "These scenarios do not represent specific actions that have been planned or proposed by the Applicant or others but are considered to represent a range of reasonable outcomes for the purpose of environmental impact analysis. Ultimately, the North Slope oil field operators, Alaska LNG, or other entities would select development and management options that best meet their operational requirements and economic criteria. Where possible, Chapter 4, Impacts of the Proposed Action, provides quantitative information based on the best existing and available information for the purpose of identifying the range of environmental effects that may occur under the Proposed Action. In the absence of specific planning or design information, DOE has also conducted qualitative analysis where appropriate to describe the types and range of impacts anticipated."
- As stated in Section 4.0, "the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts." This is also re-emphasized in Section 4.21.

IMP Sub-Theme – Geology and Geologic Hazards (4-1)

Synopsis:

A commenter claimed the Draft SEIS fails to address the potential for large-scale CO_2 injection to trigger seismic activity, despite the research linking CO_2 injection to earthquakes. The commenter stated that large-scale CCUS is a risky, and likely unsuccessful, strategy for significantly reducing GHG emissions. The Draft SEIS acknowledges that a large, 6.4-magnitude earthquake occurred in the region in August 2018; as such, DOE should have evaluated the potential for increased earthquake activity under the evaluated scenarios.

Response:

The studies/references provided by the commenter focus on CO_2 injection in the softer Continental Interior rock. Pressure differences from CO_2 injection can put pressure on existing faults and cause increased seismic activity, which in turn can cause reservoir leakage due to adverse impacts on reservoir seals. Sources and historic data show that the KRU is an established unit that has had historic active gas injection wells with no correlation to increased seismic activity. Additionally, due to the properties and location of the KRU, there is minor seismic activity and stronger reservoir seals present minimizing the potential for adverse impacts. The following analysis has been added to the discussion in Section 4.1.4.3:

> "Operations for production and injection wells would have direct impact on oil and CO_2 storage resources as well as the potential for indirect impacts on seismicity from CO_2 injections into the KRU reservoirs for EOR.
>
> Previous studies have found correlation between earthquakes, or seismic activity, and CO_2 injection for EOR (Gan and Frohlick 2013), concluding that large-scale geological storage of CO_2 carries a high probability of triggering earthquakes and finding that "even small- to moderate-sized earthquakes threaten the seal integrity of CO_2 repositories" (Zoback and Gorelick 2012). These studies state that an increased reservoir pressure or pressure build-up could cause stress on pre-existing faults, triggering seismic activity. These studies, however, focus on CO_2 injection into brittle rocks found within the continental interior, or the region between the Rocky Mountain and Appalachia-Ouachita fronts (Zoback and Gorelick 2012). Under Scenario 3, CO_2 injections would occur in the KRU, a historically established reservoir for gas and water injections. In mid-1988, CO_2 rich hydrocarbon miscible injection projects began in the KRU in stages through 1996, which encompassed 260 injection wells covering 70,000 acres (DOE 2005). The project was deemed a success producing incremental oil yields as stated by a 2005 DOE report. The same report identified active injecting of 0.2 Bcf/day and 0.2 MMbbl/day from 2 gas injection wells and 13 water injection wells, respectively. As previously discussed in Section 3.1.4.1, the KRU and the North Slope are characterized as generally inactive in terms of seismicity, with the latest major seismic activity having occurred on August 12, 2018, on previously unknown active right-lateral faults. While a higher seismic risk could be linked to a higher risk of reservoir leakage from an adversely impacted seal capacity, it is not always indicative of high leakage risk. This is evident from Cook Inlet data, where natural gas accumulations indicate various seals have not been breached, even in an area that continues to have strong and frequent seismic activity (Shellenbaum and Clough 2010). Additionally, data from a 2010 ADNR report depicts the North Slope as having good CO_2 reservoir and seal potential (Shellenbaum and Clough 2010). Therefore, while CO_2 EOR injection does have the potential for indirect adverse impact on geological resources and inducing seismic activity, the potential is low in the KRU."

IMP Sub-Theme – Permafrost (4-2)

Synopsis:

Commenters emphasized the importance of protecting permafrost both from an environmental and infrastructure standpoint. They requested the Final SEIS consider implementing monitoring of permafrost during Project construction and operations. They also requested the SEIS disclose the acreage of permafrost disturbance from the potential upstream development activities.

Response:

Impacts to Permafrost: The following text was added to Section 4.2.4:

> "In addition, disturbance to permafrost and thermokarst development can cause the release of carbon in the form of the potent GHGs, CO_2 and CH_4, as well as sequestered atmospheric nitrogen in the form of N_2O (Voigt et al. 2017). Studies from nearby Utqiaġvik, Alaska, show thawing permafrost has the potential to increase CH_4 emissions by around 30 percent (Lara et al. 2019). These GHG emissions occur when frozen peat soils are stripped of their insulative vegetative mat and exposed to warmer in-situ temperatures. Construction activities such as trenching in permafrost soils could result in subsidence causing local changes in drainage patterns and potential irreparable impacts to wetland habitats for fish and wildlife. Once subsidence occurs, thermokarst becomes very difficult, if not impossible, to restore to its previous state. Maintaining the integrity of the insulating active layer is critical in regard to construction and maintenance of infrastructure in areas of continuous and discontinuous permafrost."

Quantification of Permafrost Impacts: As stated in the Section 4.0, "the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts." This is also re-emphasized in Section 4.2.4 in the methodology discussion for the resource and in Section 4.21, Incomplete and Unavailable Information. Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of permafrost disturbance for upstream development activities. The 2020 EIS was able to use specific design plans prepared by the Applicant to obtain estimated acreages of impact.

Mitigation: The following text was added to Section 4.2.5

> "Due to the sensitivity of permafrost and importance of permafrost cover to soil and infrastructure stability, maintaining natural hydrology and fish and wildlife habitats, and carbon sequestration, impacts to permafrost soils in areas of development activities would be avoided wherever possible. This includes placing and proposed pipelines in permafrost areas on VSMs. In addition, DOE would consider requiring Project proponents to implement monitoring of permafrost down to the depth of the active layer and incorporate adaptive management to minimize thawing and thermokarst development of permafrost soils associated with Project construction and operations. Additionally, discharge of hydrostatic test water would be conducted in limited and designated areas to prevent thermal erosion or thermokarst development of permafrost. In areas where topsoil would be disturbed, topsoil would be salvaged, wherever practicable, for use to facilitate restoration of temporarily disturbed areas. This would include salvaging frozen topsoil using equipment such as a frozen topsoil cutter specifically designed to remove frozen

> topsoil. The initial effort required to salvage and replace the topsoil would help facilitate recolonization of native species and, therefore, decrease impacts associated with slower revegetation (e.g., colonization by invasive non-native species, erosion, maintenance and associated costs, long-term impacts to aesthetic value, reseeding, fertilizing, and slower return of wetland functions)."

IMP Sub-Theme – Water Resources (4-3)

Synopsis:

Commenters provided comments regarding sufficiency of analysis, including impacts to freshwater use for construction and operation, flood-related risks, and general support or opposition. Commenters said that sources and volumes of freshwater used for construction and operation should be identified and quantified. They said that indirect and cumulative impacts to water resources should be analyzed in the SEIS. Commenters discussed the uncertainty surrounding potential impacts to floodplains. They said analysis of floodplains should not be dismissed and recommended that flood-related risks to proposed infrastructure be discussed and evaluated in the SEIS. Opposing commenters expressed general concern about permanent impacts to water resources. Commenters in support of the Project stated that delivery of natural gas off the North Slope by pipeline will reduce potential impacts to marine waters, compared to using tankers.

Commenters claimed that plans and mitigation measures to reduce impacts to water resources were generally mentioned in the SEIS but not described in detail. They requested that specific mitigation measures be included in the Final SEIS.

Response:

Water Use and Permanent Impacts to Water Resources: As stated in Section 4.0, "the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts." This is also re-emphasized in Section 4.21, Incomplete and Unavailable Information.

Actual locations and construction design requirements for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of water usage needs and sources of water. The SEIS does state water used for construction would be drawn from permitted surface water sources approved by the Alaska Department of Natural Resources (ADNR), Division of Mining, Land, and Water and that unpermitted sources would also be identified during the permitting process and avoided. The additional permitting requirements by ADNR would serve to reduce impacts to water resources during construction of upstream development projects requiring temporary sources of water. Operations of potential upstream development activities would require water use and disposal of water into injection wells following hydrostatic testing of new pipelines. Similar to construction, adherence to project-specific plans and federal and state permitting requirements (as discussed in Section 2.5.5 of the SEIS) would reduce potential impacts to less-than-significant levels.

Floodplains: The following text has been added to Section 4.3.4

> "As stated in Section 3.3, no floodplain mapping exists for the North Slope. Although no mapping of the floodplains for waterways exists for the Project area, development of infrastructure such as pipelines and ice roads under Scenarios 2 and 3 within areas prone to flooding along waterways could adversely affect the course of floodwaters and the

> infrastructure placed within these locations. For example, proposed VSM and HSM pipeline construction could affect flow of floodwaters and cause debris jams that could also affect the integrity of the pipeline."

Additionally, the following text has been added to Section 4.3.5

> "This would include design of upstream development activities such as VSM and HSM pipeline and ice road locations to avoid or minimize impacts to areas prone to flooding along waterways."

Long-term Water Quality Benefits: The scope of the SEIS is focused on North Slope upstream development activities. Long-term benefits of the Alaska LNG Pipeline, including consideration of tanker transport versus pipeline transport, is discussed in the 2020 EIS.

IMP Sub-Theme – Wetlands (4-4)

Synopsis:

Comments mentioned the insufficient analysis of direct, indirect, and cumulative impacts. Commenters mentioned that the risk of permanent wetland loss and their functions was not adequately considered. They cited wetlands as sites of essential habitats, carbon storage and sequestration, water quality improvement, biodiversity, and other ecosystem services. Commenters suggested including estimates of direct impacts to wetlands, including classification and extent of wetlands. They said that indirect and cumulative impacts should be considered in addition to direct impacts.

Response:

As stated in Section 4.0, "the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts." This is also re-emphasized in Section 4.21, Incomplete and Unavailable Information.

Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of wetland disturbance for upstream development activities. The 2020 EIS was able to use specific design plans prepared by the Applicant to obtain estimated acreages of impact. Additional text has been included in Section 3.4 of the SEIS regarding the important ecological services wetlands provide:

> "Wetlands are among the most productive environments in the world, comparable to rain forests and coral reefs. Many species of wildlife, including a large percentage of threatened and endangered species, depend on wetlands for survival. Wetlands are also important for scientific and educational opportunities and can provide open space for recreation where public access is available.
>
> Wetlands have unique characteristics that set them apart from other environments, providing the basis for wetland identification and classification. These unique characteristics include a layer of soil that is saturated or inundated with water for part of the growing season, soils that contain little or no oxygen, and plants adapted to wet or seasonally saturated conditions (Environmental Laboratory 1987). Wetlands serve many functions, including the storage and slow release of rain, snowmelt, and seasonal

floodwaters to surface waters. Additionally, wetlands provide wildlife habitat, stabilize and retain sediment, and perform an important role in nutrient (e.g., nitrogen and phosphorus) cycling. Wetlands also help to maintain stream flow during dry periods and provide groundwater recharge functions."

IMP Sub-Theme – Threatened, Endangered, and Other Special Status Species (4-8)

Synopsis:

Commenters had both supporting and opposition comments regarding effects to protected species discussed within the SEIS. Opposing comments stated the Project would harm numerous species already struggling to survive, including critically endangered Cook Inlet beluga whales and North Pacific right whale. Supporting comments claimed the Project would reduce impacts to bowhead whales by reducing the need for tanker traffic in the Beaufort Sea as a means of product transport without the Alaska LNG Project.

Response:

Section 4.8 of the SEIS discusses the potential for adverse effects to protected species, including a summary of impacts identified for the Alaska LNG Project in the 2020 EIS. As discussed in Section 4.8, project activities associated with upstream development would be located within or adjacent to currently developed areas associated with human disturbance, and impacts to protected species from construction and operation are unlikely. Consideration of impacts to the Cook Inlet beluga whales, and North Pacific right whale, and other species outside of the North Slope or Beaufort Sea were not considered in the SEIS analysis as their ranges are out of the ROI considered for upstream development activities within the North Slope. However, additional discussion of climate change impacts on biological resources in the Arctic region has been added to Section 3.19 of the SEIS. Long-term benefits of the Alaska LNG Pipeline, including consideration of tanker traffic, are discussed in the 2020 EIS.

IMP Sub-Theme – Subsistence (4-14)

Synopsis:

Commenters in support of the Project discussed the Project's potential to reduce impacts to subsistence hunting and whaling. They said the Mainline Pipeline will be almost completely buried, decreasing impacts to subsistence wildlife and hunters. They said that using a pipeline instead of using tankers will decrease potential impacts to bowhead whales. The Saldovia Native Association commented in support of the Alaska LNG Project stating that the planning, development, and environmental and regulatory efforts that have taken place as part of the Alaska LNG Project would ensure the Project is constructed and operated in manner that would not impact the Kenai Peninsula or their way of life.

Commenters also expressed a range of concerns relating to the assessment of impacts to subsistence. This included:

- Construction activities and upstream development could have negative impacts to subsistence hunting. They said the potential increase in travel into subsistence areas may result in increased competition for local fuel and supplies required for subsistence. The commenters recommended to analyze potential impacts on subsistence hunters and related subsistence resources resulting from Scenarios 2 and 3, and determine whether disproportionate high and adverse effects may result.

- The subsistence harvest timing for only two Alaska Native communities was identified and discussed. The commenters recommended for the Final SEIS to include similar information for other North Slope communities. They cited Atqasuk, Anaktuvik, Pass, Utqiagvik, Wainwright, Point Hope, and Point Lay as other communities that economically engage in and rely on subsistence hunting and harvesting.

- Commenters did not agree with the assumption that communities would use other areas for subsistence if their regions would be impacted. They recommended consultation with subsistence communities and the formation of an Alaska LNG Project Subsistence Advisory Group to address any subsistence-related concerns with the Project.

- The remote geography, regional food equity, and the importance of the traditional indigenous subsistence way-of-life activities are unique to the North Slope. Commenters said the Project has potential to place direct and indirect financial burdens on subsistence users. They recommended consideration of impacts of Scenarios 2 and 3 on regional subsistence economies, including the application of the replacement cost method (RCM) to quantify a lower bound of the monetary cost in the analysis.

Response:

Subsistence Benefits: The scope of the SEIS is focused on North Slope upstream development activities. Proposed pipeline infrastructure analyzed within the SEIS is assumed to be placed aboveground using existing VSM networks or would be constructed aboveground on VSMs directly adjacent to existing networks to minimize effects to permafrost and the potential for thermokarst development and damage to pipelines. The 2020 EIS does describe areas where proposed infrastructure would be buried as part of the Alaska LNG Project. Section 4.14 of the SEIS discusses potential physical barriers to migration between habitat areas or movement to specialized habitats for caribou and other large terrestrial mammal species from aboveground pipelines. Section 4.14 of the SEIS also discloses that marine mammal harvests and waterfowl harvests could be temporarily affected by increased vessel traffic in the Beaufort Sea due to deliveries of equipment during construction of upstream facilities, along with project proponent coordination with the NMFS and the Alaskan Eskimo Whaling Commission to avoid and minimize impacts on subsistence whaling and marine mammal hunting to minimize vessel traffic overlapping with subsistence hunts.

Impact Analysis: Table 4.14-2 of the SEIS acknowledges the types of impacts to subsistence under Scenarios 2 and 3, including potential for resource access and increased costs of travel, as well as potential for increased competition of resources among subsistence users and potential for contamination of subsistence resources. Text was added to Section 4.14.4 regarding the potential for high and adverse impacts:

> "As the primary residents within the ROI include oil and gas industry workers and members of the Kaktovik and Nuiqsut communities, disproportionate high and adverse effects may result from upstream development activities to subsistence users of the Kaktovik and Nuiqsut communities."

Consultation and Coordination: The SEIS includes measures in Section 4.14.5 for reducing or avoiding impacts to subsistence uses as suggested in the comment (e.g., whaling and local group/user coordination):

> "Similar to mitigation requirements identified in the 2020 EIS, project proponents for upstream development activities involving equipment and material deliveries by barge and for dredging at PTU would be required to coordinate with the NMFS and the Alaskan Eskimo Whaling Commission to avoid and minimize impacts on subsistence whaling and marine mammal hunting. This could require barging activities to be temporarily halted during peak whale hunting times to minimize vessel traffic overlapping with subsistence hunts."

In addition, project proponents for upstream development activities would prepare a site-specific Local Subsistence Implementation Plan, as applicable. The Local Subsistence Implementation Plan would include measures to coordinate with local communities, including tribal councils, to identify locations and times where subsistence activities occur, and modify schedules to minimize work, particularly work that could reduce resource availability or user access, to the extent practicable, in those locations and times.

Subsistence Communities: As a supplement to the 2020 EIS, the SEIS focuses on activities on the North Slope, particularly within PTU, PBU, and KRU. The 2020 EIS included a detailed characterization of subsistence communities identifying North Slope Region Use Areas (see Figure 4.14.3-1 of the 2020 EIS). The 2020 EIS utilized subsistence mapping developed by the Alaska Department of Fish and Game and AGDC along with the traditional knowledge data and community surveys. Based on the detailed analysis and information in the 2020 EIS, DOE focused on the likely subsistence users with the focused region of influence where upstream development activities are likely to occur (e.g., PTU, PBU, and KRU). This included two communities: Nuiqsut and Kaktovik. Nuiqset's subsistence use area is located to the west of the land areas within the PTU, PBU, and KRU ROI but extends to the east into the Beaufort Sea, directly north of the ROI (see Figure 4.14-3-3 of the 2020 EIS). Kaktovik's subsistence use area occurs throughout the ROI (see Figure 4.14-3-4 of the 2020 EIS). The other subsistence use areas examined in detail as part of the 2020 EIS are well outside of the ROI and are not documented to be users of the ROI considered in the SEIS.

Subsistence Economics/RCM: The 2020 EIS, which has an overall greater footprint and magnitude of disturbance to subsistence users, did not utilize this method to determine a monetization of ecosystem services. Due to the lack of specific project information of upstream development activities, it would be difficult to determine monetization of resource impacts using any modeling. The SEIS does include consideration of economic hardships related to subsistence users including the potential for increased costs and time to travel and harvest, reduced physical access, and increased competition. It is important to note, as stated in Section 4.0, "the potential development activity scenarios are based on informed hypothetical scenarios analyzed in the North Slope Production Study, not actual actions proposed by the Applicant or others. Where possible, this chapter provides quantitative information based on the best existing and available information. However, specific quantification of impacts to certain resources are unknown due to the lack of specific design for the potential development activities. Where impacts cannot be quantified, the analyses present a qualitative assessment of the potential impacts." This is also re-emphasized in Section 4.21, Incomplete and Unavailable Information. Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis. This includes the lack of quantification of habitat and subsistence resources affected by upstream development activities to directly equate to quantifiable economic loss or use of RCM.

IMP Sub-Theme – Air Quality (4-15)

Synopsis:

Commenters in support of the Project expressed that the Project would improve air quality. They cited the USEPA finding that Fairbanks does not meet air quality standards and without natural gas, the area will continue to rely on sources more associated with air quality hazards such as coal, wood, and oil. Comments recommended the SEIS should also emphasize the Mainline Pipeline offtake and interconnections that would provide natural gas to the Fairbanks North Star Borough (FNSB). These would improve air quality and public health by substituting cleaner burning natural gas with wood/coal-burning heat stoves and coal-fired power-generating facilities.

Comments also expressed a range of concerns relating to the assessment of air quality impacts. This included:

- The SEIS estimates particulate matter emissions, but leaves out discussion of black carbon emissions. Commenters cited a number of construction activities that could be significant sources of black carbon emissions. They recommend including the climate impacts associated with black carbon that will be emitted due to the Project.
- The discussion of particulate matter is flawed. They said that reduction in PBU turbine usage for gas reinjection is not valid to support the assumption that particulate matter emissions would decrease compared to baseline. They cited an AGDC air quality report as not looking at emissions from Scenarios 2 and 3. They said that the SEIS cannot support their conclusions given that the report does not include equipment, emission factors, or construction timing information.
- The SEIS should identify and discuss the FNSB Nonattainment Area and evaluate a focused health impact assessment (HIA) to address the potential health concerns to environmental justice and vulnerable populations in the Fairbanks community.
- Commenters said that construction emissions could cause concern for ambient impact. They recommended to disclose and discuss the maximum ambient impacts expected from the Project to support the SEIS conclusions, including National Ambient Air Quality Standards (NAAQS) and hazardous air pollutants modeling. They also stated the SEIS should provide a basis as to why construction impacts are not cumulatively significant.
- Commenters said that there is no explanation as to why NO_x, $PM_{2.5}$, and PM_{10} emissions from construction are not considered cumulatively significant. They recommend leveraging existing regional models, such as the North Slope-Regional Air Quality Modeling Study.

Response:

Improvements to Air Quality: The SEIS cumulative analysis has been revised to consider the long-term and cumulative benefit through substitution of wood- or coal-burning heat stoves, and coal-fired power generating facilities with cleaner-burning natural gas.

Section 4.19.2.5 of the 2020 EIS discusses in-state gas interconnections along the Mainline Pipeline to allow for future interconnects with lateral pipelines to provide in-state deliveries of natural gas to third-party utility or industrial customers. This includes identification of locations for the following three interconnections based on the execution of binding gas delivery agreements with end-use customers: Fairbanks/North Star Gas Interconnection near MP 441; Anchorage/Matanuska-Susitna Gas Interconnection near MP 764 ; and Kenai Peninsula Gas Interconnection near MP 806. As stated in the 2020 EIS, other future interconnections could be established during the life of the Alaska LNG Project to accommodate industrial or residential growth that could occur in communities.

At this time, the volume of natural gas that would be consumed within Alaska through future offtakes along the Alaska LNG Mainline Pipeline is not known. However, it is possible that any such in-state use of natural gas would offset other fuel sources including wood, oil, and coal. Natural gas is a cleaner-burning fuel compared to wood, oil and coal. Therefore, to the extent that such fuels would be displaced by natural gas supplied from the proposed Alaska LNG Project, there could be long-term, local beneficial impacts to air quality.

Black Carbon and Particulate Matter Emissions: The following text was added to Section 3.15:

> "Black carbon is a by-product of incomplete combustion and is a major component of $PM_{2.5}$. It consists of the sooty black material that is emitted from sources that burn biomass or fossil fuels including natural gas, such as engines and gas flares. It is quickly removed from the atmosphere through wet and dry deposition and typically has an atmospheric residence time of a few days to weeks. Black carbon is small enough to be easily inhaled into the lungs and has been associated with adverse health effects (USEPA 2011). Whether black carbon is itself toxic or functions as an indicator of other co-pollutants is currently under debate. However, black carbon is clearly associated with a range of negative health outcomes including asthma and other respiratory problems, low birth rates, heart attacks, and lung cancer."

The following text was added to Section 4.15:

> "With Project construction and operations, black carbon would be emitted as $PM_{2.5}$ from fossil fuel-fired equipment including engines, boilers, heaters, pumps; vehicles; and flares. Black carbon emissions were not separately quantified due to the lack of available emission factors specific to black carbon; however, as black carbon is a component of $PM_{2.5}$, black carbon emissions are included within the $PM_{2.5}$ emissions estimates presented in this SEIS."

The GHG Sub-Theme – Impact Methodology and Assumptions (4-19b) section of this Appendix discusses black carbon and implications for climate change.

Particulate Matter Emissions: The SEIS uses best available information to estimate potential air quality impacts from construction and operation of the upstream facilities. Since these facilities are in early stages of planning, there is limited information on facility design, construction, and siting. Therefore, DOE used data from resource reports that were developed as part of the 2020 EIS and scaled these data as appropriate to estimate air emissions from construction and operation of the upstream facilities. DOE believes the values presented in the SEIS are reasonable estimates of the emissions that would likely result from construction and operation of the proposed Project. The Final SEIS focuses on upstream facility construction and operations at the PBU, PTU, and KRU. It does not include an assessment of any air quality impacts that may occur as a result of construction and operation of other facilities associated with the Alaska LNG Project. Those impacts are described in the 2020 EIS.

Fairbanks Nonattainment Area and Environmental Justice Communities: As stated in Section 1.3 of the SEIS, the scope of the SEIS is to evaluate upstream development activities within the North Slope of Alaska. The FNSB and associated non-attainment area is located over 400 miles south and outside of the ROI for consideration of these additional upstream development activities. Section 4.15 of the 2020 EIS does consider non-attainment status areas, including those for Fairbanks. Additional details have been included in Section 4.17.4 to characterize the potential for adverse impacts during construction and operations to human health. Similar to the air quality discussion, human health impacts evaluated within the SEIS are focused to communities within the North Slope. It is important to note that the ROI is sparsely populated. Specifically, within the ROI, the primary community/population is Prudhoe Bay in which the population is primarily attributed to the oil and gas industry. Using the Prudhoe Bay Census Designated Place, Prudhoe Bay's total population is 1,414 with 0.28 percent of the population below the poverty level (compared to 9.4 percent on the North Slope and 10.3 percent in the State of Alaska). The total minority population using the Prudhoe Bay Census Designated Place is 22.5 percent (compared to 71.3 in the North Slope and 36.4 percent in the State of Alaska). The next closest community, Nuiqsut, is 7 miles to the western edge of the KRU, outside of the ROI for the environmental justice analysis.

Ambient Air Quality Impacts and NAAQS and Hazardous Air Pollutants Modeling: The air quality resource report cited in the Final SEIS developed air quality modeling for operations of the GTP, Mainline Pipeline compressor stations, and the Liquefaction Facility, but not for construction. The report also did not include any air quality modeling for the upstream facilities. Due to the lack of specific design information for the facilities at the time of preparation of this Final SEIS, DOE did not perform NAAQS or HAP air quality modeling specific to the proposed Project.

Cumulative Air Quality Impacts: DOE has reviewed the Alaska Bureau of Land Management (BLM) North Slope Regional Air Quality Modeling Study and incorporated relevant information into the SEIS.

IMP Sub-Theme – Human Health (4-17)

Synopsis:

Comments suggest the regional health data identified in the Draft SEIS indicates poor health outcomes for Alaska Natives compared to non-Alaska Natives statewide. In addition, impacts to air quality from the Action Scenarios may present an additional burden contributing to the disproportionately high health outcomes for Alaska Natives, including disproportionately high cancer rates, chronic obstructive pulmonary disease and chronic lower respiratory disease. Certain environmental justice and vulnerable communities may experience potential disproportionate high and adverse impacts to human health associated with past, present, and cumulative effects from oil and gas development and climate change on the North Slope and other areas within the project area. They requested that the SEIS include focused HIAs associated with Scenarios 2 and 3 for the North Slope Alaska Native communities, particularly Nuiqsut and Kaktovik.

Response:

The focus of the SEIS is on communities within the North Slope, specifically within the PTU, PBU, and KRU ROI. Human health data in the SEIS was used to supplement the detailed 2020 EIS HIA. This included the most recent information from the Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center to characterize conditions within the North Slope of Alaska; however, the data do not have the resolution to focus specifically on the Nuiqsut and Kaktovik communities. The Alaska Department of Health and Human Services available online Bulletin data (also used in the 2020 EIS) was reviewed but did not have the breakdown of data specific to the North Slope of Alaska as presented in the Alaska Native Tribal Health Consortium, Alaska Native Epidemiology Center used for the SEIS. This data is presented in Section 3.17 of the SEIS. It is also important to note that potential upstream development activities analyzed in the SEIS do not change the air quality outcomes over what was already in the 2020 EIS and respective HIA. Additional details have been included in Section 4.17.4 to characterize the potential for adverse impacts during construction and operations. Section 3.19.3.1 discusses effects of climate change on human society and health.

IMP Sub-Theme – Reliability & Safety (4-18)

Synopsis:

Commenters stated that the reliability and safety impacts section of the SEIS improperly minimizes the dangers of CO_2 transportation and injection. This includes consideration of a leak or uncontrolled blowout of CO_2 and potential impacts to wildlife. They also claimed the existing information in the SEIS does not help inform the public because it does not disclose how much CO_2 might be released under various scenarios and what that level of exposure would mean for species and the climate in addition to human health. Commenters also claimed that DOE also cannot satisfy its obligations under NEPA by relying on the regulations and judgments of other agencies such as PHMSA who recently announced that it will start a new rulemaking process because its current requirements are inadequate to prevent and respond to emergencies.

Response:

DOE's Recommendations for Analyzing Accidents under the National Environmental Policy Act (2002) advise utilizing a "sliding scale" to analyze accidents; that is to discuss potential impacts in proportion to their significance. Factors to consider when undertaking this approach include, among others: 1) probability that accidents will occur; 2) severity of the potential accident consequences; and 3) degree of uncertainty regarding the analyses. As presented in Section 4.18.4, DOE estimated that based on up to 49 total miles of potential new CO_2 pipeline, the likelihood of a small, medium, or catastrophic release occurring to be 0.037 per year, 0.01 per year, and 0.004 per year, respectively. Thus, DOE considers a release from the potential CO_2 pipelines to be unlikely.

The severity of potential accident consequences from CO_2 pipelines are highly dependent upon the location of a release in proximity to receptors, in addition to the size of the release (i.e., small, medium, catastrophic) and atmospheric conditions that dictate how quickly the gas dissipates, and ultimately the potential for exposure to humans or wildlife. Given the remote nature of the potential CO_2 pipelines and injection wells in the North Slope region, there are limited resident human populations or wildlife to be exposed from an accidental release. Oil and gas workers, who are protected by Occupational Safety and Health Administration and other health and safety requirements, would be the most susceptible to experience exposure from an accidental release of gas from a CO_2 or other hazardous liquid pipeline in the area. CO_2 is considered minimally toxic by inhalation and is classified as an asphyxiant, displacing the oxygen in air. The Occupational Safety and Health Administration has identified a concentration of 5,000 parts per million (ppm) (0.5 percent) as the permissible exposure limit for an 8-hour time-weighted average, and the National Institute for Occupational Safety and Health has determined that a concentration of 40,000 ppm (4 percent) is immediately dangerous to life or health (USDA 2020). Given the nature of oil and gas operations on the North Slope, DOE expects that the operators, workers, and emergency response personnel in the area would be trained and aware of hazards present from hazardous liquid pipelines and other industrial facilities in the area. Therefore, DOE considers the potential for adverse consequences from CO_2 exposure from an accidental release to humans or wildlife to be remote.

Any proposed pipelines or injection wells will be required to meet all applicable regulatory and safety requirements. These requirements include conducting accidental release analysis as part of the regulatory approval process. With respect to the potential CO_2 pipelines, it is important to note that many features of the potential pipelines that would be necessary to conduct a meaningful quantitative exposure analysis are unknown at this time. These features include pipeline routing, size and capacity, injection well location, operating pressures, location of shutoff valves, and operating procedures. However, as explained above DOE considers the release from the potential CO_2 pipelines to be unlikely and the potential for adverse consequences from accidental CO_2 exposure to humans or wildlife to be remote.

IMP Sub-Theme – Cumulative Impacts (4-20)

Synopsis:

A commenter stated that all North Slope Production Scenarios would be more accurately reflected in the Cumulative Impacts analysis, which considers past, present, and reasonably foreseeable actions. The commenter considered the Scenarios as representing reasonably foreseeable actions instead of components of the Proposed Action. It stated that the 2020 EIS analyzed the "non-jurisdictional" activities under cumulative impacts analysis whereas the DOE Draft SEIS analyzes these activities under the Proposed Action.

Commenters also discussed the cumulative nature of GHGs related to global effects of climate change.

Commenters also disagreed with the cumulative impacts conclusion that communities as a whole would use other areas within the region for subsistence, away from oil and gas development activities. They requested the Final SEIS consider the unique cumulative impacts caused by remote geography, regional food equity, and the importance of the traditional indigenous subsistence way-of-life activities of the North Slope Alaska Native communities. The Final SEIS should analyze the impacts that the Alaska LNG Project may have on the ability of these communities to maintain their traditional subsistence economies.

Response:

Scenario Analysis: DOE has chosen to evaluate the upstream development activities within the main body of the SEIS as they are "connected actions" to the Alaska LNG Project. These projects are required to supply the product over the operational lifetime of the Alaska LNG project.

Cumulative Nature of GHGs: Regarding comments about global nature of GHGs and climate change, please refer to Section D.4.6 LCA Study and Section D.4.9 GHG theme responses.

Subsistence: Text has been added to 4.20.2.14 regarding cumulative development on the North Slope:

> "Significant adverse impacts could cumulatively occur to specific subsistence users in the ROI. These impacts would also be high and adverse to the specific subsistence users and potentially communities as a whole that rely on subsistence."

D.4.8 Socioeconomics and Environmental Justice (SOC)

DOE received comments related to the socioeconomic and environmental justice analysis provided in Sections 3.11 and 4.11 of the Draft SEIS. Comments relate to workforce growth and stability, population growth, quality of life, state and local economy revenue, trade-offs in the assessment of economic benefits, and the need for more in-depth analysis of impacts to environmental justice populations.

Theme	SEIS Location	Sub-Themes
Socioeconomics and Environmental Justice	Sections 3.11 and 4.11	General (4-11a) Economy and Jobs (4-11b) Environmental Justice (4-11c)

SOC Sub-Theme – General (4-11a)

Synopsis:

Commenters expressed concerns about current job and population loss in Alaska. They said that the trend of outward migration for work is due to job loss in the state. They expressed the desire and need to keep skilled workers in Alaska. Commenters said that the socioeconomic impact would be largely beneficial. Commenters stated that affordable access to energy will improve quality of life for Alaskans. A majority of these comments involved general support for the socioeconomic benefits of the proposed projects.

Commenters opposing the Project said that the quality of life would decrease for Alaskans.

Response:

The 2020 EIS and Section 4.11 of the SEIS provide an analysis of socioeconomics including population, economy, jobs, housing, public services, and environmental justice. The analysis considers the potential impacts, both positive and negative, associated with of the proposed Project.

SOC Sub-Theme – Economy and Jobs (4-11b)

Synopsis:

Commenters discussed employment opportunities, and economic growth and stability. Commenters referred to Alaska's economy not recovering from the 2014 recession that impacted the oil and gas job market. Commenters cite the 2020 EIS' and AGDC website's estimates of number of construction and operation jobs the Project would add. They said that a large number of those projected jobs will be in Alaska and will provide opportunities for residents and local businesses by creating indirect jobs in support and service industries. Commenters expressed concern over the state's revenue sources. They stated that Alaska receives a majority of its state and local revenue from oil taxes and royalties. They noted that the direct and indirect jobs created from the oil and gas industry drives employment income in Alaska's private sector. Commenters said that the Project would generate additional revenue that would reduce the need to generate funds in other ways, such as income tax. Commenters cited wage increases and payroll expenditures as additional benefits of the Project. They also claimed the Alaska LNG Project will provide energy security for our Asian U.S. allies, allowing gas to be diverted from the Gulf Coast to European markets to fill the gap created by Russia's war in Ukraine.

Those in opposition of the Project discussed the inconsistency of the Draft SEIS's LCA with its assessment of economic benefits. They claimed that the loss of natural gas in the Lower 48 would offset the Project's economic benefits.

Response:

A primary benefit of the proposed Project relates to socioeconomic resources; Section 4.11 of the SEIS and Section 4.11 of the 2020 EIS contain discussions of socioeconomic effects, including tax benefits and creation of jobs. DOE does not specify where any potential alternative energy supply could be sourced, and only uses the Lower 48 as a reasonable proxy with adequately specified data to evaluate GHG emissions related to meeting foreign demand for the same volume of LNG exports to the Asian destination countries. It is unlikely the Alaska LNG Project would adversely affect natural gas production in the Lower 48 as sufficient market capacity currently exists which includes domestic and foreign markets.

SOC Sub-Theme – Environmental Justice (4-11c)

Synopsis:

Commenters expressed a range of concerns relating to the assessment of impacts to low-income, minority, or Alaska Native populations. These included:

- Concerns about climate-related impacts to environmental justice communities. They stated that the Final SEIS should evaluate disproportionate direct, indirect, and/or cumulative impacts of climate change to these populations.
- The SEIS should include a focused HIAs associated with Scenarios 2 and 3 for North Slope Alaska Native communities.
- Focused community profiles should be developed for the SEIS analysis which should also include input from environmental justice/Alaska Native communities. The SEIS should identify what site-specific studies were considered to address impacts.
- The smallest U.S. Census Bureau geographic units should be used to identify environmental justice populations as large census tracts can dilute the presence of low-income populations on the North Slope.
- Commenters, including Alaskan Native Corporations, expressed support of the Project because it will provide job opportunities for Alaska Natives.

Response:

Climate Change Effects to Environmental Justice/North Slope Communities: Specific effects of climate change to environmental justice and local communities within the North Slope is presented in Section 3.19.3, Changes to Climate Conditions.

Health Effects to Environmental Justice/North Slope Communities: Specific health effects potentially occurring to environmental justice populations and local communities is presented in Section 3.19.3, Changes to Climate Conditions.

Subsistence Effects to Environmental Justice/North Slope Communities: Specific subsistence effects of the upstream development activities on environmental justice populations and local communities documented as using the ROI for subsistence within the 2020 EIS is presented in Section 3.19.3, Changes to Climate Conditions. Additional text has been included in Section 4.14.4:

> "As the primary residents within the ROI include oil and gas industry workers and members of the Kaktovik and Nuiqsut communities, disproportionate high and adverse effects may result from upstream development activities to subsistence users of the Kaktovik and Nuiqsut communities."

Environmental Justice Analysis Methodology: It is important to note that the ROI is sparsely populated. Specifically, within the ROI, the primary community/population is Prudhoe Bay in which the population is primarily attributed to the oil and gas industry. Using the Prudhoe Bay Census Designated Place (CDP), Prudhoe Bay's total population is 1,414 with 0.28 percent of the population below the poverty level (compared to 9.4 percent on the North Slope and 10.3 percent in the State of Alaska). The total minority population using the Prudhoe Bay CDP is 22.5 percent (compared to 71.3 on the North Slope and 36.4 percent in the State of Alaska). The next closest community, Nuiqsut, is 7 miles to the western edge of the KRU, outside of the ROI for the environmental justice analysis.

Specifically, regarding the assessment and documentation of environmental justice communities within the ROI, additional analysis is included in Section 3.11.8.1 of the Final SEIS. This includes consideration of the Prudhoe Bay CDP (described above) which is the smallest geographical unit published by the U.S. Census Bureau publishes within the ROI and use of the USEPA EJ Screen Tool:

> "The USEPA EJ Screen tool was used to conduct additional analysis for communities within the ROI plus a five-mile radius which includes Prudhoe Bay Census Designated Place (CDP). The EJ Screen tool uses the 80th percentile or higher threshold for Census block groups as a screening tool for EJ Index concerns by combining environmental indicators with demographic indexes. EJ Indexes for Prudhoe Bay CDP are below the 80th percentile exposure for 10 of the 12 environmental indicators: Diesel Particulate Matter; Air Toxics Cancer Risk; Air Toxics Respiratory Hazard Index; Traffic Proximity; Lead Paint; Risk Management Plan Facility Proximity; Hazardous Waste Proximity Superfund Proximity; Underground Storage Tanks and Leaking Underground Storage Tanks; and Wastewater Discharge. The EJ Screen tool does not provide data for Particulate Matter 2.5 or Ozone for the area of analysis (USEPA 2022d)."

Additional text has been included in Section 3.11.8 to discuss the relationship between environmental justice communities and subsistence use:

> "Although Prudhoe Bay is the only CDP within the ROI, subsistence activities are practiced by environmental justice populations from communities outside of the ROI. The 2020 EIS considered subsistence users from any community within 30 miles of the Project along with any community more than 30 miles from the Project area but with a subsistence use area within 30 miles of the Project area. Using these criteria, DOE identified the communities of Nuiqsut (located 13 miles west of KRU's western boundary) and Kaktovik (approximately 55 miles east of the PTU's eastern boundary) as subsistence users within the ROI. Section 3.14 provides more information regarding subsistence users and activities within the ROI."

Additional context related to environmental justice populations and regulatory framework has also been included in Section 3.11.9:

> "In addition, USEPA's 2016 environmental justice guidance stresses the importance of providing minority or low-income populations with meaningful engagement in environmental review processes. Extensive coordination with and involvement of Nuiqsut and Kaktovik residents occurred during the development of the 2020 EIS to understand community concerns and subsistence use of communities within the North Slope. This included conducting household surveys, subsistence mapping interviews, traditional knowledge workshops, and use of subsistence mapping by ADF&G and AGDC (see Section 4.14 of the 2020 EIS for additional information)….. Section 3.19 includes a discussion of climate change effects to environmental justice populations and Section 4.11 includes a discussion of potential effects of upstream development activities to the communities of Nuiqsut and Kaktovik that rely on portions of the ROI for subsistence."

Regarding impacts to environmental justice populations and subsistence use, the following text has been added to Section 4.11.4.6:

> "This analysis concludes that construction and operation of the upstream facilities considered under Scenarios 2 and 3 could result in disproportionately high and adverse impacts on environmental justice communities, primarily due to potential for impacts to subsistence users of the Kaktovik and Nuiqsut communities…….. Alaska Natives living in remote areas and conditions of poverty, including the communities of Nuiqsut and Kaktovik, can be especially vulnerable to upstream development activities that affect subsistence resources upon which these communities rely for economic, nutritional, and cultural reasons. Often, conditions of poverty amplify adverse impacts on subsistence resource use. For example, if subsistence harvests decrease or subsistence-related travel costs increase, lower income households may be unable to spend more money on fuel and other subsistence-related expenses, and they may be less able to shift to more expensive commercial food sources, thereby potentially experiencing decreased food security. The Alaska Natives of northern Alaska are also disproportionately affected by climate change, both by the fact that climate change effects are more pronounced in this region and by the fact that subsistence activities in the region are particularly dependent on ice, wind, and permafrost conditions (see Section 3.19 for additional information on climate change and regional effects in Alaska). Section 4.17 concludes upstream development activities would have the potential to generate low to moderate adverse effects to human health and safety during construction and operation of new facilities. Disproportionately high and adverse human health and safety impacts on the environmental justice communities of Nuiqsut and Kaktovik are not anticipated to occur due to the distance of the towns to the ROI; however, individual impacts could occur to subsistence users traveling to the ROI for subsistence

activities. BMPs for minimizing air quality impacts during construction and operations would also serve to protect individuals with upper respiratory conditions. In addition, enforcement of required safety training and implementation of safety plans would serve to minimize accidents and accident-related fatalities while also reducing the potential for adverse safety impacts to subsistence users."

Beneficial Effects to Alaska Natives: The upstream development activities analyzed within the SEIS would provide limited socioeconomic benefits to Alaskans, including Alaska Native populations within the ROI considered in the SEIS. The 2020 EIS does present potential benefits of the Alaska LNG Project to residents of Alaska.

D.4.9 Greenhouse Gases and Climate Change (GHG)

DOE received comments related to the Greenhouse Gases and Climate Change analysis provided in Sections 3.19 and 4.19 of the Draft SEIS. Comments relate to concerns about the current effects of climate change in Alaska and the potential contribution from the proposed Project, consideration about the social cost of GHGs, evaluation of black carbon and CO_2 venting, questions about the methodology and conclusions of the analysis, and comments on the LCA.

Theme	SEIS Location	Sub-Themes
Greenhouse Gases & Climate Change (GHG)	Sections 3.19 and 4.19	General (4-19a) Impact Methodology and Assumptions (4-19b) Conclusions (4-19c) Life Cycle Emissions (4-19d) Climate Change Effects (4-19e)[a]

a. The climate change effects theme includes comments related to the impact to species, vegetation, soils, permafrost, and subsistence.

GHG Sub-Theme – General (4-19a)

Synopsis:

Commenters expressed concerns about the existing and current effects of climate change on Alaska and the potential for the project to worsen those effects. Commenters were concerned about methane leaks since methane is a highly intensive GHG. They suggested that the analysis consider the effects of black carbon and CO_2 venting. They expressed concerns about changes to weather patterns, increased wildfires, permafrost thaw, and other aspects of climate change. Commenters stated that the project is not consistent with the Biden administration's commitment to reducing GHG emissions. They said that affirming the order to authorize exports of LNG from the proposed Alaska LNG Project would not only fail to mitigate the impacts of the climate crisis, but it would also worsen the problem.

Commenters supporting the project pointed to the analysis indicating that GHG emissions would not increase due to the project.

Response:

The Final SEIS describes the observed and predicted impacts of climate change on Alaska. It provides detailed estimates of potential life cycle GHG emissions from the proposed Project but, per CEQ guidance, does not translate those emissions into potential climate change impacts. The sub-themes below discuss each of these items (and other concerns raised by commenters) in greater detail.

GHG Sub-Theme – Impact Methodology and Assumptions (4-19b)

Synopsis:

Commenters provided comments regarding the GHG impact methodology and assumptions. This included the lack of discussion and consideration of black carbon relating to climate change and the request for the SEIS to evaluate and disclose the monetized climate damages using the relevant social costs of GHG for the respective net and gross emissions for CO_2, CH_4, and NO_2 for each Scenario, including the No Action alternative.

Response:

Black Carbon: The following text was added to Section 3.19:

> "Black carbon strongly absorbs sunlight and can contribute to atmospheric warming by direct absorption. It can also form mixed clouds with water, but there is considerable uncertainty about the overall effect of these clouds on global warming. Finally, black carbon deposited on the ground can also contribute to warming effects, especially when it is deposited on snow or ice. Black carbon has a strong impact on Arctic regions due to its ability to change the reflective properties of ice and snow. When black carbon is deposited on ice or snow, it darkens the ground, decreasing the reflectiveness of the surface (the albedo) and warming the surface. Black carbon deposited onto ice and snow can increase rates of melting and exacerbate warming, as darker and more absorbent land and water surfaces are exposed as a result."

The following text was added to Section 4.19:

> "Black carbon would be emitted by fossil fuel-fired equipment including engines, boilers, heaters, pumps; vehicles; and flares. Black carbon emissions have not been separately quantified but are included within the $PM_{2.5}$ emissions estimates presented in Section 4.15. Further, there is considerable uncertainty regarding the climate forcing effects of black carbon, and the IPCC and USEPA have not published global warming potential values for black carbon to allow these effects to be quantified."

Social Costs of Greenhouse Gases: The Final SEIS has been updated to include the analysis of the social cost of GHGs. The analysis of the social cost of GHGs considers all the potential alternatives and scenarios for both the No Action and the Proposed Action. Appendix E provides detailed calculations of the social cost of GHGs.

GHG Sub-Theme – Conclusions (4-19c)

Synopsis:

Commenters submitted a range of statements regarding conclusions reached in the GHG analysis. These included:

- DOE conducted a thorough review, and the Project demonstrates the ability to lower GHG emissions.
- DOE failed to consider the significance of the Project's GHG emissions. They claimed that if the Alaska LNG Project moves forward, it will lead to millions of tons of CO_2 emissions per year, both from Project construction and operations and from end use power generation abroad. The SEIS incorrectly estimates Project emissions to be no higher than the No Action Alternative.
- The mere estimation of the tonnage of the Project's GHG emissions is not enough to satisfy the NEPA requirement to assess a project's significance and that DOE must use a method generally accepted in the scientific community such as the social cost of GHGs and global carbon budgets.
- The SEIS should avoid expressing the overall project-level GHG emissions as a percentage of the state or national GHG emissions. They stated this approach diminishes the significance of the notable climate damages caused by substantial project-scale GHG emissions and is misleading given the nature of the climate policy challenge to reduce GHG emissions from a multitude of sources.
- The SEIS should evaluate the Project scenarios incorporating existing and potential policy changes to advance the national 2030 and 2050 net-zero GHG reduction goals, consistent with the long-term strategy of the United States. This includes a discussion of carbon lock-in concerns and challenges the Project poses for achieving climate policy goals, as well as opportunities to address them. DOE has the authority to include environmental and other conditions in its export orders.
- The SEIS should also evaluate local Alaska climate policies and plans to determine appropriate opportunities to achieve the GHG and climate change reduction goals for the Alaska LNG Project. Forms of climate change mitigation should be considered.

Response:

Significance of the Project's GHG Emissions:

The SEIS was prepared in accordance with current CEQ guidance on assessing climate change impacts under NEPA. DOE analyzed the potential GHG impacts of the proposed Project and alternatives based on the most current and best available information, including a range of potential export destinations for the natural gas from the proposed Project and considering that market demand for natural gas would be met by other sources if the Project is not authorized. DOE has presented GHG emissions for a second condition under the No Action that does not consider LNG produced from alternative sources located outside the North Slope. This second No Action Alternative (SEIS Non-equivalent Energy Baseline) only considers the projected continuation of oil production from the Project area in Alaska, and no assumption is made about providing the same energy services to society. This No Action analysis is separate from the LCA Study, as energy service provided to society through production of natural gas and oil would not be equivalent to the Proposed Action. Comparing Proposed Action GHG emissions against the No Action Alternative (SEIS Non-equivalent Energy Baseline) scenario results in a potential net increase in GHG emissions that could potentially occur if the Project were authorized, constructed, and operated. Table 2.3-1 and Section 4.19 of the Final SEIS have been updated accordingly.

Societal Costs: The Final SEIS has been updated to present the social cost of GHGs in Section 4.19.5. The analysis of the social cost of GHGs considers all the potential alternatives and scenarios for both the No Action and the Proposed Action. Appendix E provides detailed calculations of the social cost of GHGs.

The following text was added to Section 3.19.3.2:

> "Climate-driven changes from thawing, flooding, and changes in precipitation are projected to cost the state of Alaska (without adaptation measures) as much as $5.5 billion from 2015 to 2099 in damage to public infrastructure. Other studies suggest that in the next 35 years, accounting as well for cost savings from less heating required, climate changes will cost the state $340 to $700 million, or 0.6 to 1.3 percent of Alaska's Gross Domestic Product over the same period. Related to these economic impacts, ice roads within the North Slope, crucial for the oil and gas industry as well as local communities, are threatened as there are no clear cost-effective alternatives to move supplies, including the industry rigs, north to Prudhoe Bay and other oil and gas locations within the North Slope (Steffen et al. 2021). Impacts to subsistence users from communities within the North Slope are described later within this section."

GHG Emission Comparisons: The Final SEIS does not present Project-related GHG emissions as a percentage of state or national GHG emissions. This is in accordance with CEQ's 2016 guidance on NEPA and climate change that directs agencies to not present project emissions as a percentage of global emissions.

Climate Policy Goals:

DOE has prepared this Final SEIS to evaluate the potential environmental impacts associated with the proposed Project that were not considered to be within the scope of the 2020 EIS and that DOE believes are needed to inform its decision on whether to authorize LNG exports from the proposed Project. This includes evaluation of the Project consistent with two recent Executive Orders: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*.

GHG Sub-Theme – Life Cycle Emissions (4-19d)

Synopsis:

Commenters had a range of statements regarding the LCA study. This included:

- DOE conducted a thorough review and the Project and consideration of the LCA.
- DOE needs to provide a detailed GHG emissions inventory for all scenarios across the entire LNG supply chain including upstream (e.g., construction, production, gathering and boosting, processing, transmission, and storage) and distribution and use of natural gas to downstream end users and identify by reference which were incorporated into the LCA estimates. This also includes the need to identify the LNG carrier marine transportation distances (nautical miles, speed, days at sea, etc.) that would be required between Nikiski, Alaska, and the four destination countries: Japan, China, South Korea, and India.
- DOE needs to consider the midstream analysis to include in-state deliveries of natural gas for energy production and to support long-term development of other industries in the state.
- DOE should include CO_2-equivalent (CO_2-e) emissions associated with permafrost impacts (e.g., degradation and thaw/thermokarst development) from construction of the Mainline Pipeline and the PBU, PTU, and KRU developments discussed in Scenarios 2 and 3.

- DOE should fully consider the potential for methane leaks and opportunities to reduce methane emissions throughout the life cycle of the Alaska LNG Project in the SEIS.

Response:

Detailed GHG Emissions Inventory: DOE prepared a LCA Study to analyze potential GHG emissions across the full LNG supply chain, from production, processing, transport, liquefaction, export and overseas delivery, and end-use (combustion). The LCA is included as Appendix C of the Final SEIS. Within the LCA study, speciated GHG emissions estimates are provided in Appendices A through F, for end-use in an NGCC power generation facility (without CCS) in each of the four destination countries. Appendices A and B present results using 100-year and 20-year global warming potentials (GWP), respectively, from the IPCC's Fourth Assessment Report (AR4); Appendices C and D present results for AR5 100-year and 20-year GWPs; and Appendices E and F present results for AR6 100-year and 20-year GWPs. The LCA study describes all inputs and factors that were used in estimating GHG emissions, including potential export destinations, marine transport distances, and other relevant data.

In-state Deliveries of Natural Gas: Section 4.19.2.5 of the 2020 EIS discusses in-state gas interconnections along the Mainline Pipeline to allow for future interconnects with lateral pipelines to provide in-state deliveries of natural gas to third-party utility or industrial customers. This includes identification of locations for the following three interconnections based on the execution of binding gas delivery agreements with end-use customers: Fairbanks/North Star Gas Interconnection near MP 441; Anchorage/Matanuska-Susitna Gas Interconnection near MP 764; and Kenai Peninsula Gas Interconnection near MP 806. Each of these locations is outside of the ROI for the SEIS, which focuses on the North Slope, however, as stated in the 2020 EIS, other future interconnections could be established during the life of the Alaska LNG Project to accommodate industrial or residential growth that could occur in communities. The cumulative impact analysis in Section 4.20 of the SEIS has been updated to reflect potential long-term benefits.

CO_2-e Emissions from Permafrost Impacts: Section 3.19 of the SEIS has been updated to include a discussion of potential CO_2-e emissions from permafrost disturbance. Actual quantification of impacts to permafrost is not practical due to the lack of specific design for the potential development activities. Actual locations for the proposed facilities have not been identified beyond what is currently presented in the analysis.

Methane: DOE prepared a LCA analyzing potential GHG emissions across the full LNG supply chain, from production, processing, transport, liquefaction, export and overseas delivery, and end-use (combustion). The LCA is included as Appendix C of the Final SEIS. The LCA study includes methane leakage emissions at all stages of the LNG life cycle.

GHG Sub-Theme – Climate Change Effects (4-19e)

Synopsis:

Commenters requested the SEIS provide additional analysis regarding the effects of climate change on wildlife, protected species, vegetation, aquatic resources, soils/permafrost, water resources, wetlands, environmental justice communities, socioeconomic losses, and subsistence. They also requested the SEIS provide additional details on the case studies and lessons learned regarding actual documented incidents of climate change effects to North Slope oil and gas-related infrastructure. Commenters also recommended the SEIS evaluate mitigation measures and incorporate adaptation management planning in project design, construction, and operations, including measures to ensure resilience to protect infrastructure investments from the effects of climate change on the Alaska LNG Project. They also recommended the SEIS evaluate opportunities to ensure infrastructure resilience to climate change effects at all project life cycle stages, including upstream, midstream, and downstream.

Response:

The SEIS was prepared in accordance with current CEQ guidance on assessing climate change impacts under NEPA. CEQ guidance requires agencies to prepare estimates of GHG emissions but does not explicitly require an analysis of the impact of those GHG emissions on global climate change, nor does it require an analysis of the impacts of climate change on natural and other resources. Accordingly, Section 3.19 of the Final SEIS summarizes observed and predicted climate change impacts at a general level, including predicted impacts in the Arctic region including the Project area. Additionally, as the Project design has not yet been finalized, DOE cannot provide specific climate change resiliency measures that would be included in the design, construction, and operations of the proposed Project.

D.4.10 Mitigation (MIT)

DOE received comments related to the discussion of mitigation measures provided in Chapter 6 of the Draft SEIS.

Theme	SEIS Location	Sub-Themes
Mitigation (MIT)	Chapter 6	Mitigation Measures (6-1)

MIT Sub-Theme – Mitigation Measures (6-1)

Synopsis:

Commenters recommended the SEIS describe how the agency has mitigated GHG emissions to the greatest extent possible, given that the current authorization for the Alaska LNG Project is to export 2.55 billion cubic feet per day of natural gas for 30 years. This includes:

- Any measures beyond the PBU CCUS, consistent with the goal of achieving net-zero emissions by 2050. They offered additional mitigation measures could include CCUS at the export facility, enhanced energy efficiency, lower-GHG-emitting technology, and sustainable land management practices. Finally, USEPA recommends considering the evaluation of LCA assumption of CCUS at the destination power generation facilities.
- Consideration of mitigation measures consistent with local, state, and national policies (2030/2050) for Project emission targets and GHG emission reduction goals.
- Consideration of a shorter Project authorization period and mitigation and adaptive management measures to enable consideration of climate policy and to achieve net-zero carbon emissions by 2050.
- Minimization and/or reduction of operational system upsets, gas flaring and venting, and valve leaks.
- Incorporation of innovative technologies in leak detection and continuous monitoring programs for fugitive emissions (e.g., drones, optical and infrared, etc.) consistent with the U.S. Methane Emissions Reduction Action Plan.
- Commitment to adopt relevant best practices and recommended technologies identified in USEPA's voluntary methane programs - Methane Challenge and Natural Gas STAR, which could further reduce potential methane emissions.

- Commenters said the SEIS analysis should incorporate more environmental justice principles and strategies, including Indigenous Traditional Ecological Knowledge, to address environmental justice and tribal concerns. They said that an Environmental Justice Advisory Group should be formed to monitor and address concerns during construction and operation.
- Monitoring of CO_2 pipelines and sequestration networks to improve safety while also reducing the number of incidents that result in CO_2 leakage, consistent with CEQ's proposed guidance on CCUS.

Response:

In the Draft SEIS, DOE considers in detail the LCA GHG emission and mitigation measures that are most likely to occur based on the Applicant's stated intentions, including plans and mitigation measures that are outlined in the 2020 EIS. DOE's evaluation in the Draft SEIS includes potential upstream infrastructure and activities that are reasonably anticipated to be needed to support the Project, including those related to CCUS. As presented in the 2020 EIS, AGDC has not included any plans to incorporate CCUS at the export facility, and thus DOE has not considered this as a likely GHG emission reduction measure that would be implemented by the Applicant. Because of uncertainty related to CO_2 management at destination power generation facilities, two possible end uses of the delivered natural gas were modeled from a NGCC power plant with and without CCUS. As described previously, DOE's scope and focus of the SEIS is on the North Slope production activities, including CO_2 management, and LCA for GHG emissions and project plans. Proposed project plans and related mitigation measures are presented in the 2020 EIS and supporting documents.

As the Project proponent and an independent, public corporation of the State of Alaska, AGDC is ultimately responsible for planning, constructing, and operating the proposed Project in accordance with existing laws and regulations. This includes the mitigation requirements instituted in FERC's Order authorizing AGDC to site, construct, and operate the Alaska LNG Project, including the Liquefaction Facility. DOE's decision under the NGA is to issue an order upon application, unless after opportunity for hearing, the Department finds that the proposed exportation or importation will not be consistent with the public interest. DOE's determination is therefore limited to the Project as proposed by AGDC and authorized by FERC with related requirements. DOE considers it speculative to assume the Applicant would implement measures related to carbon capture at the export facility, enhanced energy efficiency, lower-GHG-emitting technology, and sustainable land management practices that are not already part of the proposed project plans, or otherwise required by regulation or other FERC conditions.

D.5 REGULATORY AGENCY TECHNICAL EDITS AND CLARIFICATION REQUESTS

This section presents specific technical edits and clarifications requested by regulatory agencies along with DOE responses. Although considered substantive, these comments were provided by the regulatory agencies to request clarifications or request edits to specific locations on the Draft SEIS. Tables D-4 and D-5 include technical edits from the USEPA and ADEC, respectively. Section D.4 contains the major themes and related responses to those themes. Section D.6 includes copies of all agency comments.

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
USEPA-1	Draft SEIS; p. 4.17-1. This section should also refer to SPCC and FRP requirements at 40 CFR 112. Note that in Chapter 5.0, Table 5-1 (Relevant Regulatory and Permit Requirements for Upstream Activities), SPCC and FRP requirements under CWA Section 311 are referenced. EPA recommends adding a reference to SPCC and FRP requirements in this narrative in Section 4.17.2.	Text revised to include: Oil Pollution Prevention (40 CFR 112).
USEPA-2	Draft SEIS; p. 4.3-8. In Section 2.2.1.1 Point Thomson Unit (PTU), there is a reference for the need of an SPCC plan and FRP. EPA recommends adding a reference to FRP requirements in this narrative in Section 4.3.5.	Text revised: “Preparation of a Facility Response Plan to demonstrate preparedness for a worst-case oil discharge, and a SPCC Plan to prevent environmental damage from the discharge of oil.”
USEPA-3	Draft SEIS; p. 3.18-6. This section should refer to the SPCC requirements for onshore oil drilling and workover facilities at 40 CFR 112.10. EPA recommends adding the referenced citation to the narrative in Section 3.18.3.2.	Text revised: “Federal regulations under 40 CFR Section 112.10, Spill Prevention, Control, and Countermeasure Plan requirements for onshore oil drilling and workover facilities, require owners or operators of onshore oil drilling and workover facilities to meet specific discharge prevention and containment procedures, including: Positioning or locating mobile drilling or workover equipment so as to prevent a discharge. Providing catchment basins or diversion structures to intercept and contain discharges of fuel, crude oil, or oily drilling fluids. Installation of a blowout prevention assembly and well control system before drilling below any casing string or during workover operations. The assembly and well control system must be capable of controlling any well-head pressure that may be encountered while the assembly and well control system are on the well.”
USEPA-4	Draft SEIS; p. 2-34. The narrative on spill reporting should also refer to 40 CFR 110 reporting requirements to the National Response Center (NRC) as well as the Spill Prevention, Control and Countermeasure (SPCC) reporting requirements under 40 CFR 112.4(a) and (c). EPA recommends adding a reference to federal spill reporting requirements to the narrative in Section 2.7.	Text revised: “In addition, 40 CFR Part 110, Discharge of Oil, requires any person in charge of a vessel or of an onshore or offshore facility shall immediately notify the National Response Center. If direct reporting to the NRC is not practicable, reports may be made to the Coast Guard or USEPA predesignated On-Scene Coordinator for the geographic area where the discharge occurs.”

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
USEPA-5	Draft SEIS; p. 2-10. As we understand, the Point Thomson Unit (PTU) is SPCC-subject at this time. If the aggregate oil storage at the PTU reaches one million gallons or more, then a Facility Response Plan (FRP) will need to be prepared and submitted to EPA's R10 office in Anchorage, AK. See 40 CFR 112.20(a)(2(iv).	Text revised to include: "USEPA noted during the Draft SEIS public comment period that if the aggregate oil storage at the PTU reaches one million gallons or more, then a Facility Response Plan will need to be prepared and submitted to USEPA's Region 10 office in Anchorage in accordance with 40 CFR 112.20(a)2(iv)."
USEPA-6	Draft SEIS; p. 4.20-16. Construction emissions included an over 10,000 tpy increase in regional NOx, over 500 tpy increase in regional PM2.5, and over 1,500 tpy increase in regional PM10 over a multi-year period. The Draft SEIS does not currently provide a basis to explain why these emissions are not cumulatively significant. EPA recommends leveraging existing regional models, such as that developed by the Alaska Bureau of Land Management North Slope Regional Air Quality Modeling (NSRAQM)83 Study 2020 for the North Slope Science Initiative. This study was conducted to estimate regional impacts, particularly secondary air pollutants such as ozone and PM2.5, since the resource report model results already show primary criteria air pollutant increases to not cause significant impacts. The NSRAQM Study provides an incremental increase in ozone and PM2.5 impact regionally from a base and future year, assuming a given increase in annual emissions; these data could be leveraged to provide an estimate of cumulative impacts from project upstream developments.	Construction emissions shown in Table 4.15-5 would occur over the 10-year construction period and are not annual emissions. New Tables 4.15-6 and 4.15-7 have been added to show annual pollutant emissions related to construction of the Proposed Project, for the two scenarios being considered. Accompanying text has also been revised to clarify that these emissions would occur over a multi-year period. Further, text and Table 4.15-8 has been added referencing the NS-RAQM Study results and comparing modeled emissions that would occur under the Proposed Action, to support DOE's conclusion that ambient air quality impacts would be less than significant.
USEPA-7	Draft SEIS; p. 4.15-7 (Table 4.15.5). EPA recommends that the table be labeled to identify the values representing the change in annual emissions from baseline.	Text revised: The table has been revised to clarify that these are total construction emissions, not annual emissions. Accompanying text has also been revised to clarify that these emissions would occur over a period of several years. Tables 4.15-6 and 4.15-7 have been added to show annual pollutant emissions related to construction of the Proposed Project, for the two scenarios being considered.
USEPA-8	Draft SEIS; p. 4.15-7 (Table 4.15-6). EPA recommends adding a "total emissions" row for PTU, PBU, KRU and a "total emissions" row for the sum of all three unit emissions together to provide disclosure of total airshed increase in emissions during construction. The SEIS should clarify whether these values represent maximum annual emissions during the construction period or average annual emissions.	Text revised: Based on the text of the comment, it appears that the comment refers to Table 4.15-5 (construction emissions). Table 4.15-5 and accompanying text has been revised to clarify that the emissions shown would occur over multiple years. Tables 4.15-6 and 4.15-7 have been added to show annual pollutant emissions related to construction of the Proposed Project, for the two scenarios being considered. Both tables include a "total emissions" row.

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
USEPA-9	Draft SEIS; p. 4.15-6. This section notes that air quality impact analysis was carried out in a resource report for upstream activities. Construction emissions, reported in Table 4.15.-5, are relatively high and could cause concern for ambient impact. EPA recommends that the Final SEIS briefly disclose and discuss the maximum ambient impacts expected from the project, using the results from the air quality analysis resource report, to demonstrate why the impacts will be less-than-significant, as indicated in Tables 4.15-3 and 4.15-4.	Please see response to USEPA-6 above.
USEPA-10	Draft SEIS; p 3.15-2 (Table 3.15-1). The footnotes to the table refer to NAAQS being determined at monitors. Although these references correctly indicate the method in which attainment may be determined by a state program, it may be misleading to the public in this context because the NAAQS apply to all areas of ambient air, regardless if a monitor is present to determine attainment. EPA recommends the footnotes be edited to remove the references to monitors, similar to how the form of the NAAQS are described on the EPA NAAQS table	Text revised: References to ambient air quality monitors have been deleted from the table footnotes.
USEPA-11	Draft SEIS; p. 4.4-2 to 4.4-3 (Table 4.4-2 and 4.4-3). In both tables, when describing potential impacts of expansion of gravel pads, the Draft SEIS states "Implementation of the plans and mitigation measures outlined in Section 4.4.5 would reduce these impacts to less-than-significant levels." Section 4.4.5 describes plans to be prepared, but does not explicitly describe any mitigation measures that will be taken to successfully reduce impacts to "less-than-significant levels." EPA recommends that the Final SEIS include the specific mitigation measures that will be implemented to reduce impacts.	No change. Section 4.4.5 contains a list of plans and how they would serve to reduce impacts to water resources. For example, "Preparation of an SPCC Plan that would provide management procedures for the prevention and cleanup of releases of fuels, lubricants, and coolants, as well as potentially hazardous materials to be implemented, reducing potential accidental discharge into wetlands." The plan itself would include specific measures unique to the actual location to reduce or avoid impacts.
USEPA-12	Draft SEIS; p. 4.3-5 to 4.3-7 (Table 4.3-2 and 4.3-3). The Draft SEIS states that several times water use is addressed with "Permitted water sources recharge annually, so no long-term reduction in water availability would be anticipated." We recommend identifying in this section what the permit(s) is/are that would ensure this.	Text revised: Section 2.2.1.1 of the SEIS discusses permitting related to water usage "Permits for water appropriation on a temporary basis and for operational purposes would be required from the ADNR, Division of Mining, Land, and Water". Text has been clarified in Tables 4.3-2 and 4.3-3 to specify ADNR, Division of Mining, Land, and Water.
USEPA-13	Draft SEIS; p. 4.3-5. The Draft SEIS states that no floodplain mapping exists for the North Slope, therefore, potential impacts to floodplains due to upstream development are not assessed. EPA recommends discussing and evaluating potential flood related risks	Text revised: The following text has been added to 4.3.4 "As stated in Section 3.3, no floodplain mapping exists for the North Slope. Although no mapping of the floodplains for waterways exist in the Project area, development of infrastructure such as pipelines and ice roads under Scenarios 2 and 3

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
	to additional infrastructure proposed in Scenarios 2 and 3, such as from ice road river/stream crossings	within areas prone to flooding along waterways could adversely affect the course of floodwaters and could adversely affect the infrastructure placed within these locations. For example, proposed VSM and HSM pipeline construction could affect flow of floodwaters and cause debris jams which could also affect the integrity of the pipeline." Additionally, the following text has been added to 4.3.5 "This would include design of upstream development activities such as VSM and HSM pipeline and ice road locations to avoid or minimize impacts to areas prone to flooding along waterways."
USEPA-14	Draft SEIS; p. 5-4 (Table 5-1). The Draft SEIS states: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under SDWA." EPA recommends removing "under SDWA" from this sentence.	Text revised as requested.
USEPA-15	Draft SEIS; p. 5-4 (Table 5-1). The Draft SEIS Table indicates "USEPA has primacy" over Class VI injection wells. States can have primacy whereas EPA retains direct implementation authority. EPA recommends clarifying this sentence that this does not apply to all states. EPA recommends the change to "USEPA is the permitting authority for Class VI injection wells in the State of Alaska."	Test revised as requested.
USEPA-16	Draft SEIS; p. 5-4 (Table 5-1). The Draft SEIS Table indicates: "USEPA has primacy of the UIC Program…" and "permitting authority for Class II injection wells is given to ADEC, with oversight from USEPA." This language does not accurately describe the authority or transfer of authority to states. EPA recommends making the correction to "USEPA is the permitting authority for the UIC Program in …" and "Primary enforcement authority was granted to Alaska by USEPA. USEPA continues oversight of the state primacy program."	Text revised as requested.
USEPA-17	Draft SEIS; p. 5-4 (Table 5-1). The section describing UIC requirements contains the following sentence at the end of the discussion of Class VI wells: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under SDWA." This sentence is relevant to UIC wells generally and not just Class VI. EPA recommends that this sentence be provided as a separate paragraph or integrated into the introductory paragraph.	Text revised – moved to introduction paragraph.

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
USEPA-18	Draft SEIS; p. 4.19-5. The Draft SEIS notes that a mitigation measure for minimizing GHG emissions could include developing and implementing a US EPA-approved monitoring, reporting and verification plan for CO_2 injection wells per Subpart RR of the Mandatory Reporting of Greenhouse Gases Rule. Subpart RR requirements are focused on accounting of amounts of CO_2 that are geologically sequestered, but do not contain control requirements. EPA recommends describing how this measure would be used to mitigate and minimize GHG emissions.	Text revised: Carbon dioxide could be injected under a Class I UIC permit from the USEPA or under a Class II UIC permit from AOGCC.
USEPA-19	Draft SEIS; p. 3.18-5. The Draft SEIS states: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under the SDWA. USEPA currently has the authority to issue and administer the required UIC permits." EPA recommends clarification that natural 21 gas could be injected under a Class I UIC permit from EPA or under a Class II UIC permit from AOGCC.	Text revised as requested.
USEPA-20	Draft SEIS; p. 2-33. The Draft SEIS states: "Class VI injection wells must also comply with 40 CFR 146.91 in spite of any state program approvals." This sentence is confusing. First, it is not clear why the word "also" is used because the previous sentence was simply describing the SDWA generically. Second, it is not clear why the phrase "in spite of any state program approvals" is mentioned in this sentence as 40 CFR 146.91 describes the minimum reporting requirements for each permitted Class VI well. It is also not clear why a specific requirement for Class VI is called out in this section. EPA recommends elaboration if the word "also" is kept in the sentence. Delete the phrase "in spite of any state program approvals."	Text revised as requested.
USEPA-21	Draft SEIS; p. 2-33: The Draft SEIS states: "The SDWA (under 40 CFR 144) administers the USEPA UIC Program…". This sentence is confusing because the statute does not administer a regulation; rather, the relevant regulatory authority does. EPA recommends using a different wording, such as "The SDWA authorizes USEPA to establish minimum federal requirements for UIC programs."	Text revised as requested.
USEPA-22	Draft SEIS; p. 2-33: The Draft SEIS states: "Through a Memorandum of Agreement with the USEPA, the AOGCC has primacy for Class II wells in Alaska. The UIC program requires the AOGCC to verify the mechanical integrity of injection wells, determine if appropriate injection zones and overlying confining strata are present, determine the presence or absence of	Text revised as requested.

Table D-4. USEPA Technical Edit and Clarifications Comment Responses

ID	Comment	Response
	freshwater aquifers, and ensure their protection, and prepare quarterly reports of both in-house and field monitoring for the USEPA." The terminology used here is not accurate. It's not clear what you would like to convey with this information. AOGCC has been granted primary enforcement responsibility (primacy) by EPA and is therefore administers the Class II program wells in Alaska. The MOA is one part of their EPA-approved UIC program. EPA recommends replacing the statement on the MOA with a statement that conveys that AOGCC has an EPA-approved UIC program and is the permitting authority for Class II wells in Alaska. EPA recommends replacing "The UIC program requires the AOGCC to…" with "AOGCC verifies the integrity…"	
USEPA-23	Draft SEIS; p. 2-33: The Draft SEIS states: "Drill cuttings on the North Slope are typically disposed of through slurry injection into an approved Class II well." It's more accurate to say that wells are permitted (not approved). EPA recommends replacing "approved Class II well" with "permitted Class II well." EPA recommends clarification that this waste could be injected into either a Class I or Class II UIC well.	Text revised as requested.
USEPA-24	Draft SEIS; p. 2-31: The Draft SEIS states: "Under the UIC Program (40 CFR 147) the Region 10…" 40 CFR 147 lists EPA approved primacy programs. It is not clear why this reference is listed here. If DOE is trying to highlight the list of EPA-approved state UIC primacy programs, EPA recommends moving the citation or if planning to highlight the requirements of the Federal UIC program, EPA recommends including a reference to 40 CFR 124, 144, 146, and 148. Alternatively, the CFR reference could be deleted.	Text revised as requested.
USEPA-25	Draft SEIS; p. 2-31: The Draft SEIS states: "Permitting authority for Class II injection wells has been delegated to the individual states, with oversight from USEPA." The authority is not delegated, rather the state is granted primary enforcement authority with EPA approval. Also, Idaho does not have Class II primacy. EPA recommends replacing this sentence with "Alaska, Oregon, and Washington have primary enforcement authority (primacy) for Class II injection wells, with oversight from USEPA."	Text revised as requested.
USEPA-26	Draft SEIS; p 2-10: The Draft SEIS states: "high-pressure gas condensate production field operated by ExxonMobil since 2016." EPA recommends clarifying that Hilcorp has assumed operations for PTU from ExxonMobil.	Text revised as requested.

Table D-5. ADEC Technical Edit and Clarifications Comment Responses

ID	Comment	Response
ADEC-1	Draft SEIS, page S-1. Paragraph four on this page appears to imply that Executive Order 13990 and Executive Order 14008 provide regulatory authority to revisit the FERC EIS. From our understanding, executive orders are more akin to policy statements and should be identified as such, rather than implying regulatory authority. Please identify clearly that the decision to revisit the FERC EIS was a policy decision and not one based on any specific Department of Energy regulatory authority, NEPA regulation or an issue remanded to the department by the court system.	DOE's decision for the Rehearing Order allowed DOE to comply with the two new Executive Orders directing agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change, as well as requiring federal agencies to address climate change and assess, disclose, and mitigate for climate pollution and climate-related risks (see P&N Sub-Theme – Quality of the 2020 EIS and Request for a New Analysis (1-2) for additional information on the Executive Orders). Executive Orders are not laws enacted by Congress, rather they are used by the Executive Office of the President to provide direction to federal agencies and officials as they carry out operations within the executive branch and can have the force and effect of law.
ADEC-2	Draft SEIS, page S-21. This table summarized environmental impacts, including air quality. It is not clear why this item does not have the same language as found in the water resources overview "*Cumulative impacts would be less-than-significant as activities would be subject to state regulatory requirements*." Please add the quoted statement to the air quality summary.	Text revised as requested.
ADEC-3	Draft SEIS, page 1-1. It is not clear in paragraph two on this page which version of the CEQ NEPA regulations this project is being considered under. Please clarify which version of the CEQ NEPA regulations this project is being considered under.	No change. The SEIS is being prepared in accordance with the most recent NEPA regulations along with DOE NEPA procedures as cited in the text.
ADEC-4	Draft SEIS, page 2-11. Paragraph five on this page states "The PTU Expansion Project would require the following authorizations and consultations with various resource agencies:" note that an air quality permit to construct and operate emitting units needed to support gas export to AK LNG may also be required. Please add a State of Alaska air quality construction permit for any new proposed emitting units.	Text revised as requested.
ADEC-5	Draft SEIS, page 2-12. An oil discharge prevention and contingency plan (ODPCP) should be added to the list of state permits. Please add an ODPCP to the list of state permits.	Text revised as requested.
ADEC-6	Draft SEIS, page 2-14. The page cites to the DOE's North Slope Production Studies. These can be found in Appendix C. Please cite to the location in the document where these studies can be found so that the reader can easily refer to them.	Text revised: Reference to the location of the studies is also provided at the end of the first paragraph "All three reports are provided in Appendix B, North Slope Production Study."

Table D-5. ADEC Technical Edit and Clarifications Comment Responses

ID	Comment	Response
ADEC-7	Draft SEIS, page 2-23. Open Burning Plan. Describes measures to be taken during construction to control burning activities that comply with federal, state, and local regulations. Open burning does not typically occur on the North Slope of Alaska. You may want to specify locations where this would take place.	Text revised: Reference to Open Burn Plans have been removed from the document.
ADEC-8	Draft SEIS, page 2-29. The discussion on this page included a mention hydrostatic testing. Please note that discharge of hydrotesting water that contains additives may require an Alaska Pollutant Discharge Elimination System (APDES) permit. Please mention that discharge of hydrotesting water which contains additives may require an APDES permit.	Text revised as requested.
ADEC-9	Draft SEIS, page 2-31. Under 2nd bullet for ADEC, “portable oil and gas operating” should be “portable oil and gas operation”. Please correct definition.	Text revised as requested.
ADEC-10	Draft SEIS, page 3.3-8. Paragraph two on this page notes that almost all of the surface water withdrawn within the North Slope Borough was saline water used for mining. This appears to be a cut and paste from a prior statement about groundwater. It is not clear how this can be correct given the amount of freshwater and ice chips used to make ice roads in the winter. Also, does the word “mining” include oil exploration and development? Please clarify if the quoted statement regarding saline water used for mining is true.	Text revised: Added to Section 3.3.3.1 “Additionally, use of freshwater and ice chips occurs on the North Slope for ice roads in the winter.” Footnote added to Table 3.3-2 for clarification “Mining water is used for the extraction of minerals and rocks that may be in the form of solids, such as coal, iron, sand, and gravel; liquids, such as crude petroleum; and gases, such as natural gas. The category includes quarrying, milling of mined materials, injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activities.”
ADEC-11	Draft SEIS, page 3.3-9. The last paragraph on this page cites to the 2014/2016 Integrated Report, as the last full document available on ADEC website. Please note that the Environmental Protection Agency’s (EPA’s) formatting standards have changed. Now all the parts of the report are provided electronically. Results from Alaska’s Integrated Report for 2020 can now be found on How’s My Waterway. How’s My Waterway integrates data from the Integrated Report with local water quality data, information on aquatic recreation and harvest, and restoration and protection efforts.” Please site to the 2020 Integrated Report as provided on EPA’s web site.	Text revised to reflect 2020 IR: “Per the 2020 Integrated Report, 6 waterways were reclassified as Category 2, 15 waterways were added to Category 3, 3 waterways were added to Category 4, and 11 waterways were added to Category 5.”
ADEC-12	Draft SEIS, page 3.15-2. Tables lists State ozone standard for ozone as 0.075 ppm whereas the State standard is 0.070 ppm per 18 AAC 50.010(4). Revise Table 3.15-1 to match State regulation.	Text revised.

Table D-5. ADEC Technical Edit and Clarifications Comment Responses

ID	Comment	Response
ADEC-13	Draft SEIS, page 3.15-3. Volume 1, Chapter 3 Affected Environment, 3.15.3.3 Air Quality Monitoring and Background Concentrations (page 3.15- 3): This paragraph mentions the Kaktovik air monitoring site and implies that ADEC operates the site. This site is actually operated by BLM. ADEC displays the data on its website and performs audits for BLM for this site under a cooperative agreement. It would be good to clarify that Kaktovik is a BLM- operated site. Please clarify that BLM operates the Kaktovik air monitoring site and that it is not officially part of the Alaska Monitoring Network. While this is a government operated site and is intended to produce PSD quality data, the site is not officially under the State's control.	Text revised: "The closest government operated air quality monitoring system includes one BLM operated monitoring station in North Slope Borough. The monitoring station is located at Kaktovik, approximately 55 miles east of Point Thomson and approximately 110 miles east of Prudhoe Bay. Although this monitoring station is not officially part of the officially part of the Alaska Monitoring Network, the ADEC Air Quality Index website (ADEC 2022b) displays an air quality index and monitored pollutant concentrations at the BLM-Kaktovik site."
ADEC-14	Draft SEIS, page 4.2-5. Paragraph two, bullet one on this page notes that preparation of a Fugitive Dust Plan would mitigate impacts of the project. Similar statements regarding a Fugitive Dust Plan can also be found on pages 4.3-8, 4.4-5, 4.7-6, 4.15-6, 4.17-3, 6-1, 6-2, 6-3, 6-4, and 6-6. Please identify which agency will be responsible for compliance and enforcement of the Fugitive Dust Plan.	DOE believes a Fugitive Dust Plan could reduce potential impacts from upstream development primarily during construction activities and minimally during production activities. DOE expects compliance with a fugitive dust plan to be the responsibility of the appropriate local or state agencies.
ADEC-15	Draft SEIS, page 4.7-4. This table discusses potential aquatic resource impacts within the Prudhoe Bay Unit. Item 4 in the table notes that "the presence of heavy machinery to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. Please note that VSM installation on the North Slope typically takes place during the winter months when ice roads and ice pads would support the heavy equipment. Please revise the statement to acknowledge that VSM placement occurs during the winter months on the North Slope and heavy machinery impacts would be de minimis.	Text revised: "VSM installation on the North Slope, however, typically takes place during the winter months when ice roads and ice pads would support the heavy equipment reducing the potential for impacts to negligible levels. Overall impacts to aquatic resources from pipeline construction would be less-than-significant."
ADEC-16	Draft SEIS, page 4.7-5. Item one in this table notes that "the presence of heavy machinery to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. Please note that VSM installation on the North Slope typically takes place during the winter months when ice roads and ice pads would support the heavy equipment. Please revise the statement to acknowledge that VSM placement occurs during the winter months on the North Slope and heavy machinery impacts would be de minimis.	Text revised: "VSM installation on the North Slope, however, typically takes place during the winter months when ice roads and ice pads would support the heavy equipment reducing the potential for impacts to negligible levels. Overall impacts to aquatic resources from pipeline construction would be less-than-significant."

Table D-5. ADEC Technical Edit and Clarifications Comment Responses

ID	Comment	Response
ADEC-17	Draft SEIS, page 4.15-1. Bullet one under the column "impact rating" refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019. Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.	Text revised as requested.
ADEC-18	Draft SEIS, page 4.15-1. Bullet three under the column "summary of total impacts" refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019. Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.	Text revised as requested.
ADEC-19	Draft SEIS, page, 4.15-1. Bullets seven and eight in this table appear to imply that the federal land managers have regulatory authority to establish visibility thresholds and sulfur deposition thresholds. This conclusion in incorrect. The regulatory authority for these thresholds is set by the Regional Haze Rule under the authority of the EPA. The Regional Haze Rule requires federal land managers to be consulted, but that is the extent of their authority. Please revise to reflect that the regulatory authority to establish visibility thresholds and sulfur deposition thresholds rests with the EPA under the Regional Haze Rule.	Text revised: "The USEPA is the regulatory authority for establishing visibility thresholds and sulfur deposition thresholds under the Regional Haze Rule The established visibility threshold and sulfur deposition threshold at the Arctic National Wildlife Refuge could be exceeded by emissions from the Galbraith Lake Compressor Station. The established nitrogen deposition thresholds at multiple Class I and II areas would also be exceeded by operation of the compressor stations."

Table D-5. ADEC Technical Edit and Clarifications Comment Responses

ID	Comment	Response
ADEC-20	Draft SEIS, page 4.15-2. Bullet one on this page refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019. Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.	Text revised as requested.
ADEC-21	Draft SEIS, page 4.20-2. Item one status notes that BOEM is working under the 2017 – 2022 National Program. Please note that this program expired on June 30, 2022. BOEM released a draft EIS for the 2023 – 2028 OCS Leasing Program on July 1, 2022. Please update this document to reflect the most recent BOEM OCS Leasing Program.	Text revised as requested.
ADEC-22	Draft SEIS, page 4.20-4. Item three in this table cites to an older BLM EIS for the Willow Project. The BLM recently issued a draft supplemental EIS for the Willow Project following litigation of the prior EIS. Please also note that the GMT-2 facility began production in December 2021. Please update this table with the most recent information available on the GMT-2 and Willow projects.	Text revised as requested.
ADEC-23	Draft SEIS, page 4.20-10. Paragraph three on this page notes that saline water is used for "mining." It is not clear what this is referring to. Process water, which is typically saline is reinjected into oil reservoirs. Is this what is meant by mining? Please clarify the meaning of the statement that saline water is used for mining.	Text revised: "….as shown in Table 3.3-2, most of the groundwater withdrawals on the North Slope are saline water used for mining which includes injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activities."
ADEC-24	Draft SEIS, page 5-6. The last item in this table notes that AOGCC is a program within the Alaska Department of Natural Resources. This is incorrect. AOGCC is a program within the Alaska Department of Commerce, Community and Economic Development. Please clarify that AOGCC is a program within the Alaska Department of Commerce, Community and Economic Development.	Text revised as requested.

INTENTIONALLY LEFT BLANK

D.6 ELECTED OFFICIAL AND GOVERNMENTAL AGENCY COMMENTS

This section presents copies of the comments provided by Elected Officials and governmental agencies. Topics raised in these comments are addressed in the theme responses in Section D.4.

D.6.1 ELECTED OFFICIALS

Governor Mike Dunleavy – State of Alaska

STATE CAPITOL
P.O. Box 110001
Juneau, AK 99811-0001
907-465-3500

550 West Seventh Avenue, Suite 1700
Anchorage, AK 99501
907-269-7450

Governor Mike Dunleavy
STATE OF ALASKA

August 10, 2022

Mr. Mark Lusk, NEPA Compliance Officer
U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, WV 26505

Dear Mr. Lusk,

We appreciate the opportunity to comment on the Department of Energy (DOE) draft Supplemental Environmental Impact Statement (SEIS) for the Alaska LNG Project. The Alaska Gasline Development Corporation (AGDC) was established by state statute for the specific purpose of developing the infrastructure to deliver stranded North Slope natural gas to market. On behalf of the State, AGDC has worked diligently to accomplish that goal, including filing over 150,000 pages of documentation with regulatory agencies, answering more than 2,000 agency requests, obtaining all major Federal permits, and obtaining Federal and State of Alaska right-of-way authorizations.

Regulatory and resource agencies for both the State of Alaska and the Federal government have analyzed the project in detail using their expertise and scientific knowledge, and in accordance with their legal requirements. Each agency has clearly concluded the requested authorizations should be provided and permits have been issued.

My team has reviewed the draft SEIS and agrees with DOE's conclusions, including the facts that:

- The Prudhoe Bay Unit (PBU) and Point Thomson Unit (PTU) have sufficient gas to supply the Project for the entire 30-year term of the export license. The upstream reports completed by DOE (SEIS Appendix B) were well done and confirm state and producer assessments of gas availability on the North Slope.
- Potential surface impacts of Alaska LNG on PBU, PTU, and the Kuparuk River Unit (KRU) would be negligible to insignificant. Those locations are producing oil fields with existing gravel pads and infrastructure.
- Alaska LNG delivered to Asian markets would have lower greenhouse gas

Mr. Mark Lusk
August 10, 2022
Page 2 of 3

emissions than Gulf Coast LNG due to shorter transport distance and because the gas is associated with existing oil production.

- The Alaska LNG Project would not increase greenhouse gas emissions compared to the "Business-As-Usual" (no Alaska LNG Project) scenario.
- Any potential cumulative impacts would be mitigated by the permit and authorization conditions, best practice requirements, plans, and consultation.

As noted in the SEIS, Alaska's North Slope natural gas is 'associated gas' and produced conventionally. It is important to note that enough natural gas is already produced on the North Slope – 8 billion cubic feet per day – to meet the energy needs of California, Oregon, and Washington. However this gas is compressed and reinjected because there is currently no infrastructure to bring it to market and unlock the climate benefits it holds. Unlike other LNG projects, Alaska LNG will not require significant new drilling or fracking to produce the natural gas it plans to export.

From our perspective, the greenhouse gas life cycle analysis was conservative in using Gulf Coast LNG as a comparison energy source. If Alaska LNG is compared instead to coal power production, which it would likely be replacing in Asia, it would be expected to reduce global greenhouse gas emissions by 77 million tons per year. Using the Environmental Protection Agency's website calculator, that is equivalent to eliminating 19 coal-fired power plants or building 16,000 wind turbines.

In addition, while this project has been tied up in legal appeals that seem to have the primary goal of delaying the project, energy security has become a global focus. Russia's invasion of Ukraine has had profound negative repercussions in energy markets around the world and has exacerbated what was already an impending global LNG supply shortage. Europe has relied on Russia for 40 percent of the continent's natural gas, and European and Asian nations are now turning to coal and oil energy sources with much higher emissions. Alaska LNG would provide important U.S. allies with a dependable supply of clean energy, allowing them to reduce reliance on adversarial nations for energy and to reduce carbon emissions, while at the same time strengthening common security interests with the U.S.

For 50 years, the U.S. reliably exported LNG from Alaska to Japan without ever missing a scheduled shipment, but today the U.S. lacks a West Coast LNG export terminal to serve the Pacific Rim. All U.S. LNG exports currently originate from the Gulf or East Coasts, generating significant additional unnecessary shipping emissions to reach Asia and subjecting LNG cargos to the vulnerability of a canal transit chokepoint and seasonal hurricane risks. Bringing Alaska LNG online as quickly as possible will enable the U.S. to serve Asian markets once again reliably with clean energy. Further, it would enable existing U.S. LNG facilities to focus on serving European nations in need. Every cargo of U.S. LNG delivered to Europe right now acts as a stabilizing force that weakens Russia's global influence.

Mr. Mark Lusk
August 10, 2022
Page 3 of 3

In Alaska, the Alaska LNG Project is broadly supported by bipartisan groups and Alaska Native communities. Alaska LNG has received resolutions of support from the Alaska Federation of Natives, Alaska Eskimo Whaling Commission, organized labor, and numerous other groups.

Finally, the Alaska LNG Project would be constructed and operated under strict U.S. and Alaska regulatory control, as evidenced by the extensive conditions attached to each of the permits and authorizations.

In summary, Alaska LNG would provide increased energy security for the U.S. and our allies, decrease global greenhouse gas emissions compared to a scenario without an Alaska LNG Project, and is strongly supported by Alaskans as a responsible resource development opportunity.

I urge DOE to finalize the assessment process and reissue or reaffirm the export authorization as soon as possible.

Sincerely,

Mike Dunleavy
Governor

Senator Scott Kawasaki – Alaska State Legislature Interior Delegation

Interior Delegation

Senator Scott Kawasaki
Chair
Senator Robert Myers
Senator Click Bishop

Rep. Bart LeBon
Rep. Steve Thompson
Rep. Mike Prax
Rep. Grier Hopkins
Rep. Adam Wool
Rep. Mike Cronk

ALASKA STATE LEGISLATURE

August 10, 2022

Mark Lusk, NEPA Compliance Officer,
U.S. Department of Energy, National Energy Technology Laboratory
3610 Collins Ferry Road, Morgantown, WV 26505

Dear Mark,

The Interior Delegation of the Alaska State Legislature is in support of the Department of Energy's (DOE) Supplemental Environmental Impact Assessment (SEIS) and the issuance of the export license for the Alaska LNG Project.

The Interior Delegation is composed of those legislators representing the interior of Alaska and the Fairbanks North Star Borough. Members are Senators Kawasaki, Bishop, and Meyers, and Representatives LeBon, Thompson, Prax, Hopkins, Wool, and Cronk. While our politics may vary, we all believe the construction of the AK LNG project is critical to this region for the following 3 reasons:

1. The high cost of fuel: Fuel in Alaska is expensive and getting fuel to the more remote parts of the state makes it even more expensive. The Alaska LNG project will provide our constituents with a long-term, affordable supply of gas for power generation and home heating.

2. Air Quality: Our region can have some of the worst air quality in the nation due to cold weather, dirty sources of fuel, and inversion layers. This project has the potential to dramatically change that by providing affordable, reliable, cleaner, and lower emissions-producing natural gas as a primary fuel source for home and commercial heating for our constituents, removing higher emissions producing fuel sources and thus improving the health of our constituents.

3. Jobs and the Economy: Alaskans need high-paying jobs. While pipeline construction is predicted to employ some 12,000 people, it is the 1,000 or so permanent jobs necessary for the operation of the line that will have a lasting impact on our state economy and we see as being most beneficial. Both construction and permanent jobs put money into the economy that circulates creating more jobs in the support and service industries.

Interior Delegation

Senator Scott Kawasaki
Chair
Senator Robert Myers
Senator Click Bishop

Rep. Bart LeBon
Rep. Steve Thompson
Rep. Mike Prax
Rep. Grier Hopkins
Rep. Adam Wool
Rep. Mike Cronk

ALASKA STATE LEGISLATURE

We have watched the development of this project over the years and are aware of the thousands of pages of analysis and appreciate that DOE wanted to take one more "look" at this project and specifically at a life cycle analysis calculating the greenhouse gas emissions for liquified natural gas exported by vessel to import markets in Asia and other regions. The conclusion that this project's impacts on greenhouse gases and climate change are insignificant should be the assurance needed to issue the export license.

Representative Grier Hopkins

Representative Bart LeBon

Representative Adam Wool

Representative Steve Thompson

Representative Mike Prax

Representative Mike Cronk

Senator Scott Kawasaki

Senator Robert Myers

Senator Click Bishop

Senator Peter A. Micciche – Alaska State Legislature

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Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Comment On: DOE-HQ-2022-0019-0001
Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Document: DOE-HQ-2022-0019-DRAFT-0193
Comment on FR Doc # 2022-13869

Submitter Information

Email: sen.peter.micciche@akleg.gov
Government Agency Type: State
Government Agency: Alaska State Senate

General Comment

See attached file(s)

Attachments

DOE_SEIS support letter

Senator Peter A. Micciche

Alaska State Legislature

Session Address:
Alaska State Capitol, Rm. 111
Juneau, Alaska 99801-1182
Phone: (907) 465-2828
Toll Free: (800) 964-5733

Interim Address:
145 Main Street Loop, Ste. 226
Kenai, Alaska 99611-7771
Phone: (907) 283-7996
Fax: (907) 283-8127

President of the Senate

August 15, 2022

Dear Department of Energy personnel:

Below are my comments in support of the Draft Supplemental Environmental Impact Statement (SEIS) for the Alaska LNG Project and issuance of the export license. I am a State Senator representing District D which is comprised of Kenai, Soldotna, Seward and the communities in between, as well as Nikiski – the general location of the proposed liquification facility. My comments reflect my perspective as a legislator, longtime resident of the Kenai Peninsula and a former superintendent of the ConocoPhillips LNG facility in Nikiski with global LNG experience.

This project has been extensively studied and the information presented in the SEIS confirms that this is a compatible project, supported by the Kenai Peninsula community as well as Alaskans as a whole. The project is well worthy of support to be brought to fruition and is documented to not present a contributing factor to climate change. In fact, your study demonstrates that this project produces less greenhouse gas than LNG produced and transported from the Gulf coast of the U.S.

As the state with the highest cost of energy per unit in the US (as well as air quality issues within the Interior) Alaska and my district economically yearn for the clean, reliable and reasonably priced energy this project will deliver. Anytime we can reduce the cost of energy here in Alaska, it is a win-win for all our citizens.

Construction and operation of the Nikiski liquification plant will bring good construction and permanent, high-paying jobs. This plant and the jobs it creates will bring needed revenue to the local governments as well as revenue to the State of Alaska. All the secondary jobs; retailers, restaurants, and other services that are a result of increased jobs are resources that will directly benefit our citizens across the full spectrum of socioeconomic sectors.

As an aside from the above benefits in respect to recent global events, I can easily provide additional paragraphs on the importance of U.S. produced energy sources to increase energy security for our country, as well as other friendly trade country partners throughout the Pacific rim.

Senator.Peter.Micciche@akleg.gov

I urge the Department to complete the SEIS process, issue the export license and allow us to move forward with the Alaska LNG Project. If there is anything else I can do to support this project, or you need any additional information from me, please contact me through my office.

Sincerely,

Peter A. Micciche
Senate District O
President of the Alaska Senate

Senator.Peter.Micciche@akleg.gov

Senator Lisa Murkowski – U.S. Senate

United States Senate

August 29, 2022

The Honorable Jennifer M. Granholm
Secretary
U.S. Department of Energy
1000 Independence Ave. SW
Washington D.C. 20585

Dear Secretary Granholm:

I write to express my strong support for the Alaska LNG Project (AKLNG) and urge the U.S. Department of Energy (DOE) to complete, without delay, finalization of the draft supplemental environmental impact statement (SEIS) for the project and re-issue the DOE Order for this critical project. Given the United States is on the brink of an economic recession, coupled with record energy prices, completion of the regulatory process for AKLNG should be a top priority.

On June 24, 2022, DOE released a draft SEIS validating previous federal authorizations for AKLNG, and assessing the full life cycle of greenhouse gas emissions. The conclusions highlight the critical role natural gas will play in meeting global emissions reductions, a priority of the Biden administration. As you know, AKLNG is the only federally permitted LNG export project on the West Coast, has 41.1 trillion cubic feet of natural gas readily available, and provides a number of strategic geopolitical benefits. In fact, AKLNG would provide a supply of long-term, clean natural gas critical to our energy security and the growing global demand for energy, given Alaska has enough available gas to reduce our reliance on authoritarian foreign adversaries. Our global network of allies, military strength, world-class energy resources, dynamic economy, and most important, our democratic values and commitment to liberty, will put the United States at a distinct advantage, compared to the dictatorships of countries like China and Russia, if utilized correctly.

AKLNG also provides a significant number of environmental benefits. Given the shorter shipping routes from Alaska to meet the growing liquefied natural gas (LNG) demand of markets in Asia, Alaska natural gas generates less carbon equivalent emissions than other U.S. LNG exports and far fewer emissions than other fuels. Further, AKLNG's associated carbon capture, utilization, and storage (CCUS) capabilities are an important aspect of the project and moving towards a low-carbon future. Alaska's North Slope has the potential for 205 million metric tons of carbon dioxide sequestration, which is the equivalent of planting 4 billion tree seedlings over the course of ten years, or offsetting the annual emissions of 55 coal-fired power plants or 44 million cars. AKLNG would also require no additional drilling and utilize the existing infrastructure on Alaska's North Slope, and the development of spur lines off of AKLNG's pipeline into Alaska's

Page 1 of 2

cities, towns, and villages, would all but alleviate existing air quality issues, such as the presence of particulate matter (PM) 2.5 in Fairbanks.

Lastly, the draft SEIS identifies critical socioeconomic benefits associated with AKLNG. This project would create tremendous employment opportunities for hardworking Americans, including Alaska Natives, and new revenue for the State of Alaska, mirroring the economic boom communities in the state saw following the development of the North Slope in the late 1970s. Just look at the immense support AKLNG has received from the men and women who build this country, including the Laborers' International Union of North America (LIUNA), the Alaska chapter of the National Electrical Contractors Association (NECA), the Alaska chapter of the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO), and affiliates like the Fairbanks Building-Construction Trades Unions, Plumbers & Steamfitters Local 375, Laborers' Local 341, and Laborers' Local 942.

Given the almost eight years of cooperation between all applicable federal agencies, their comprehensive environmental impact assessment, which totals almost 6,000 pages, and their unanimous issuing of permits and approvals for the project, I urge you to recognize the immense geostrategic, environmental, and socioeconomic benefits AKLNG will bring and act promptly to approve it.

Sincerely,

Lisa Murkowski
United States Senator

Dan Sullivan
United States Senator

Page 2 of 2

Senator Gary Stevens – Alaska State Senator

PUBLIC SUBMISSION

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Comment On: DOE-HQ-2022-0019-0001
Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Document: DOE-HQ-2022-0019-DRAFT-0048
Comment on FR Doc # 2022-13869

Submitter Information

Name: Gary Stevens
Address:
Kodiak, AK, 99615
Email: Sen.Gary.Stevens@akleg.gov
Phone: 907-486-4925

General Comment

See attached file(s)

Attachments

Senator Gary Stevens letter of support 8-9-22

SESSION ADDRESS:
Alaska State Capitol
Juneau, Alaska 99801-1182
(907) 465-4925
Fax: (907) 465-3517
Toll Free: 1-800-821-4925

Senator Gary Stevens

Alaska State Legislature

INTERIM ADDRESS:
305 Center Ave, Ste. 1
Kodiak, Alaska 99615
(907) 486-4925
Fax: (907) 486-5264

August 9, 2022

Dear Department of Energy personnel:

I write to you in support of the Draft Supplemental Environmental Impact Statement (SEIS) for the Alaska Liquid Natural Gas (LNG) Project. My comments reflect my perspective as a legislator, educator, and longtime Alaskan.

As you may know, development of an Alaska gasline has been a goal of the state for decades. The project is finally at the stage where we can look forward to its construction and a clean source of energy to fuel Alaska and the nation's economy. This SEIS confirms that the Alaska LNG Project will provide environmental and socioeconomic benefits.

Meeting Alaska's local energy needs has become increasingly challenging over the years. Given the extremely high cost of energy in our state, particularly in small rural communities, the Alaska LNG Project is an opportunity to deliver reliable, low-cost, clean energy to our residents. I can assure you that Alaskans want the type long-term, affordable natural gas the project can deliver. Additionally, the project will provide revenue to the state as well as employment opportunities for our residents. I urge the Department to complete the SEIS process, issue the export license and allow us to move forward with the Alaska LNG Project.

Thank you for your time and your consideration of this letter.

Sincerely,

Senator Gary Stevens

Senator.Gary.Stevens@akleg.gov

Senator David Wilson – Alaska State Senator

PUBLIC SUBMISSION

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Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Document: DOE-HQ-2022-0019-DRAFT-0044
Comment on FR Doc # 2022-13869

Submitter Information

Name: Senator David Wilson
Address:
Wasilla, AK, 99654
Phone: (907)376-4877

General Comment

See attached file(s)

Attachments

AKLNG draft 8.8.22

ALASKA STATE LEGISLATURE

Interim:
Senate District D
600 E. Railroad Avenue
Wasilla AK 99654
Phone: 907-376-4866
Sen.David.Wilson@akleg.gov

Session:
State Capitol, Room 115
Juneau AK 99801-1182
Phone: 907-465-3878
Toll-Free: 800-862-3878
Sen.David.Wilson@akleg.gov

Senator David Wilson

August 8, 2022
U.S. Department of Energy, National Energy Technology Laboratory
ATTN: Mark Lusk, NEPA Compliance Officer
3610 Collins Ferry Road
Morgantown, West Virginia 26505

Dear Mr. Lusk and Department of Energy personnel:

Below are my comments in support of the Draft Supplemental Environmental Impact Statement (SEIS) for the Alaska LNG Project and issuance of the export license. My comments reflect my perspective as a sitting state legislator and a long-time resident.

This project has been extensively studied and the information presented in the SEIS confirms this is a good project that needs to be supported and brought to fruition. Meeting Alaska's local energy needs is challenging. The extremely high cost of energy in small rural communities is particularly alarming. We need the Alaska LNG Project to deliver reliable, low-cost, clean energy to the state and beyond. While the Alaska LNG Project may not provide cheaper gas to the communities I represent, it will help many residents and businesses thrive. As a state Senator, I not only have to look out my constituents but for all of Alaska's citizens and this project will be hugely beneficial. The Alaska LNG project will also provide revenue to the state; perhaps even more importantly, however, it will provide direct and indirect employment. Alaska needs job and with the looming threat of a recession this project becomes even more critical.

Alaskans want long-term, affordable natural gas and the Alaska LNG Project can make this happen. I urge the Department to complete the SEIS process, issue the export license, and allow us to move forward with the Alaska LNG Project.

Thank you for your consideration of my comments.

Regards,

David Wilson

David S. Wilson

Representative Mary Sattler Peltola – Alaska State Representative

MARY PELTOLA
ALASKA, AT LARGE

2314 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-5765

Congress of the United States
House of Representatives
Washington, DC 20515

November 16, 2022

The Honorable Jennifer M. Granholm
Secretary
U.S. Department of Energy
1000 Independence Ave. SW
Washington D.C. 20585

Dear Secretary Granholm:

The Department of Energy 16 months ago ordered a supplemental environmental review of the proposed Alaska LNG project, more than a year after the Federal Energy Regulatory Commission issued its final environmental impact statement and approved the project. FERC approval came after an exhaustive, years-long review that included multiple participating federal agencies — that final EIS stacked up at about 6,000 pages.

It is now increasingly important that the Department complete its supplemental review in an expeditious but responsible manner so as not to impede the opportunity for Alaska natural gas to serve an energy-hungry global market.

The Department of Energy, in issuing its order on June 28, 2021, for a supplemental review, explained it needed to consider the full lifecycle of greenhouse gas emissions related to the project, from production of natural gas to consumption of the fuel. A draft of that review, released in June of this year, determined that the Alaska project would not raise global greenhouse gas emissions more than if it were not built, because Asian buyers would simply get their natural gas from other suppliers if not Alaska.

I write in support of the cleanest gas available for overseas customers, which would be U.S. gas, rather than supplies from countries that may not utilize the same stringent and environmentally responsible production standards as U.S. companies, especially Alaska producers. The proposed Alaska LNG project has access to sufficient North Slope natural gas reserves to supply a significant portion of Asia's energy needs, freeing up other global supplies that could be redirected to aid Europe in its transition away from Russian gas supplies.

In addition to less emissions than other LNG exporting nations, the Alaska project's shorter shipping route to Asia is an environmental bonus over other suppliers that would have to run their fuel-burning tankers weeks longer per delivery.

The project would be good for Alaska, providing jobs and economic development; good for U.S. equipment and technology companies, manufacturers and workers needed to supply the multibillion-dollar undertaking; and good for the world by providing cleaner energy, free of political entanglements.

I urge you to recognize the benefits of this project and the need to move ahead in a timely fashion with completion of the supplemental review to ensure that U.S. energy is in the forefront of global considerations.

Sincerely,

Mary Sattler Peltola

Rep. Mary Sattler Peltola
Representative for All Alaska

Alaska Interior Delegation – State House and Senate

PUBLIC SUBMISSION

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Comment On: DOE-HQ-2022-0019-0001
Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Document: DOE-HQ-2022-0019-DRAFT-0067
Comment on FR Doc # 2022-13869

Submitter Information

Email: joe.hayes@akleg.gov
Government Agency Type: State
Government Agency: Alaska Interior Delegation - State House and Senate

General Comment

See attached file(s)

Attachments

LEG.ID.Support of AGDC Project.08.10.22

Interior Delegation

Senator Scott Kawasaki
Chair
Senator Robert Myers
Senator Click Bishop

Rep. Bart LeBon
Rep. Steve Thompson
Rep. Mike Prax
Rep. Grier Hopkins
Rep. Adam Wool
Rep. Mike Cronk

ALASKA STATE LEGISLATURE

August 10, 2022

Mark Lusk, NEPA Compliance Officer,
U.S. Department of Energy, National Energy Technology Laboratory
3610 Collins Ferry Road, Morgantown, WV 26505

Dear Mark,

The Interior Delegation of the Alaska State Legislature is in support of the Department of Energy's (DOE) Supplemental Environmental Impact Assessment (SEIS) and the issuance of the export license for the Alaska LNG Project.

The Interior Delegation is composed of those legislators representing the interior of Alaska and the Fairbanks North Star Borough. Members are Senators Kawasaki, Bishop, and Meyers, and Representatives LeBon, Thompson, Prax, Hopkins, Wool, and Cronk. While our politics may vary, we all believe the construction of the AK LNG project is critical to this region for the following 3 reasons:

1. The high cost of fuel: Fuel in Alaska is expensive and getting fuel to the more remote parts of the state makes it even more expensive. The Alaska LNG project will provide our constituents with a long-term, affordable supply of gas for power generation and home heating.

2. Air Quality: Our region can have some of the worst air quality in the nation due to cold weather, dirty sources of fuel, and inversion layers. This project has the potential to dramatically change that by providing affordable, reliable, cleaner, and lower emissions-producing natural gas as a primary fuel source for home and commercial heating for our constituents, removing higher emissions producing fuel sources and thus improving the health of our constituents.

3. Jobs and the Economy: Alaskans need high-paying jobs. While pipeline construction is predicted to employ some 12,000 people, it is the 1,000 or so permanent jobs necessary for the operation of the line that will have a lasting impact on our state economy and we see as being most beneficial. Both construction and permanent jobs put money into the economy that circulates creating more jobs in the support and service industries.

Interior Delegation

Senator Scott Kawasaki
Chair
Senator Robert Myers
Senator Click Bishop

Rep. Bart LeBon
Rep. Steve Thompson
Rep. Mike Prax
Rep. Grier Hopkins
Rep. Adam Wool
Rep. Mike Cronk

ALASKA STATE LEGISLATURE

We have watched the development of this project over the years and are aware of the thousands of pages of analysis and appreciate that DOE wanted to take one more "look" at this project and specifically at a life cycle analysis calculating the greenhouse gas emissions for liquified natural gas exported by vessel to import markets in Asia and other regions. The conclusion that this project's impacts on greenhouse gases and climate change are insignificant should be the assurance needed to issue the export license.

Representative Grier Hopkins

Representative Bart LeBon

Representative Adam Wool

Representative Steve Thompson

Representative Mike Prax

Representative Mike Cronk

Senator Scott Kawasaki

Senator Robert Myers

Senator Click Bishop

Brian Gabriel – City of Kenai

PUBLIC SUBMISSION

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Comment On: DOE-HQ-2022-0019-0001
Environmental Impact Statements; Availability, etc.: Alaska Liquefied Natural Gas Project

Document: DOE-HQ-2022-0019-DRAFT-0032
Comment on FR Doc # 2022-13869

Submitter Information

Email: cityclerk@kenai.city
Government Agency Type: Local
Government Agency: City of Kenai

General Comment

Please see attached letter, approved by the City of Kenai Council on August 3, 2022, regarding the Alaska LNG Project.

Attachments

Kenai City Council - Public Comments on Alaska LNG Project

KENAI

City of Kenai | 210 Fidalgo Ave, Kenai, AK 99611-7794 | 907.283.7535 | www.kenai.city

July 18, 2022

U.S. Department of Energy, National Energy Technology Laboratory
Attn: Mark Lusk, EDPA Compliance Officer
3610 Collins Ferry Road
Morgantown, WV 26505

Dear Office of Fossil Energy and Carbon Management Personnel:

I am writing regarding the SEIS published by DOE in draft June 24th regarding the Alaska LNG Project.

A new report, published by the U.S. Department of Energy, examined the effects of Alaska LNG and its important benefits that would result from the completion of the Project. It is estimated that The Alaska LNG Project will create thousands of jobs for our City and outlying communities including roughly 1,000 permanent positions when the project is operational. The socioeconomic benefits from the Alaska LNG would be extremely beneficial to the City of Kenai. These benefits would include employment opportunities, wage increases, state and local tax revenues, payroll expenditures, and workforce growth and stability. Alaska LNG will bolster our local economy well into the future.

The Alaska LNG Project will provide our community along with many other communities across Alaska with a long-term, affordable gas supply for power generation, home heating, and other energy needs. The Cook Inlet Basin, which supplies the vast majority of natural gas to Southcentral Alaska including Anchorage and the Railbelt, which is essential to the future growth of Alaska. We critically need the Alaska LNG Project to deliver clean-burning and reasonably priced energy to maintain our quality of life and to provide increased economic opportunities for the City of Kenai.

The Department of Energy has done a thorough and accurate assessment and demonstrated the Alaska LNG Project offers significant advantages over LNG from the contiguous United States. Over the past 7 years, the Project has been studied extensively, and all major Federal permits and approvals have been issued. It is clearly in the best interest to the residents of Kenai and the State of Alaska that the Project move forward without delay.

Thank you,

Brian Gabriel
Mayor, City of Kenai

Mike Prax – Alaska State Legislature

PUBLIC SUBMISSION

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Comment On: DOE-HQ-2022-0019-0001
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Document: DOE-HQ-2022-0019-DRAFT-0001
Comment on FR Doc # 2022-13869

Submitter Information

Email: gmprax@gmail.com
Government Agency Type: State
Government Agency: Alaska State Legislature

General Comment

Dear Department of Energy personnel:

Below are comments on the Draft SEIS for the Alaska LNG Project. I live in North Pole, Alaska and have been a resident for 39 years. My comments reflect my perspective as a long time resident.

Under the export scenarios the SEIS evaluated, it shows greenhouse gas (GHG) emissions will be higher without the Alaska LNG Project. Since GHG emissions are a concern to me, I strongly support the Alaska LNG Project as a key part of the process to decrease emissions and help move forward with the energy transition. I urge the DOE to complete the SEIS process and uphold the Order allowing export.

In conclusion, DOE has done a thorough and accurate assessment and demonstrated the Alaska LNG Project offers significant advantages over L48 LNG. Over the past 7 years, the Project has been studied extensively, and all major Federal permits and approvals have been issued. It is clearly in the public interest for the Project to move forward, and I urge DOE to reaffirm or reissue the Order without delay.

Thank you, Mike Prax

D.6.2 GOVERNMENTAL AGENCIES

Rebecca Chu – USEPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155, 14-D12
Seattle, WA 98101-3144

REGIONAL ADMINISTRATOR'S DIVISION

August 15, 2022

U.S. Department of Energy
National Energy Technology Laboratory
ATTN: Mark Lusk, NEPA Compliance Officer
3610 Collins Ferry Road
Morgantown, West Virginia 26505

Dear Mr. Lusk:

The U.S. Environmental Protection Agency has reviewed the U.S. Department of Energy's Draft Supplemental Environmental Impact Statement for the Alaska Liquefied Natural Gas Project (CEQ Number 20220090; EPA Project Number 22-0040-DOE). EPA has conducted its review pursuant to the National Environmental Policy Act and our review authority under Section 309 of the Clean Air Act. The CAA Section 309 authorities are unique to EPA and require EPA to, among other things, review and comment publicly on any proposed major federal action subject to NEPA's environmental impact statement requirement.

EPA served as a Cooperating Agency on the Federal Energy Regulatory Commission's development of the Alaska LNG Project EIS. FERC published the Final EIS and DOE adopted FERC's Final EIS (DOE/EIS-0512) on March 16, 2020. DOE's Draft Supplemental EIS (DOE/EIS-0512-S1) supplements the aforementioned Final EIS for the Alaska LNG Project. During our review, EPA participated in meetings hosted by DOE in developing this Draft Supplemental EIS, including the July 20, 2022 virtual public meeting and the July 28, 2022 virtual meeting to discuss the NEPA analysis and the greenhouse gas emissions Life Cycle Analysis.

The Alaska LNG Project, which extends from the North Slope of Alaska to Cook Inlet, would export liquefied natural gas to overseas markets, as well as provide for in-state deliveries. The Draft Supplemental EIS evaluates the potential upstream environmental effects associated with incremental oil and natural gas production Scenarios on the North Slope to support the project's exports of liquefied natural gas. The proposed Scenarios include a No Action (Scenario 1), reinjecting the byproduct carbon dioxide for carbon capture and sequestration (Scenario 2) and enhanced oil recovery (Scenario 3). In addition, a Life Cycle Analysis was developed to estimate the Alaska LNG Project's greenhouse gas emissions from exporting liquefied natural gas to destination countries in Asia.

EPA has identified environmental concerns and deficiencies in the NEPA analysis and mitigation commitments that should be addressed in the Final Supplemental EIS. EPA is providing detailed comments and recommendations (attached) to improve the evaluation of the Alaska LNG Project Scenarios in the Final Supplemental EIS. EPA's most significant recommendations for improving the NEPA analysis include:

Key Scenario Recommendations

- Evaluate the No Action Scenario 1 as the NEPA baseline to compare greenhouse gas emissions against the Action Scenarios. The No Action Scenario 1 should reflect a true "No Action" condition (e.g., critically, the analysis should not presume that the same volume of LNG exports would be substituted elsewhere, such as facilities in the U.S. lower 48 states, if the Alaska LNG Project were not to occur).

- Evaluate an Action Scenario 4 that considers reinjection of the byproduct carbon dioxide from the Liquefaction Facilities into a saline formation in the Cook Inlet Basin for carbon capture, utilization, and sequestration.
- Evaluate the Range of Scenarios, including the present (Scenario 1) and reasonably foreseeable future actions (Scenarios 2, 3, and 4) in a cumulative effects analysis.

Key Life Cycle Analysis Recommendations

- Identify and discuss potential sources of methane and their contributions to the total Life Cycle Analysis greenhouse gas emissions to provide for a meaningful comparison with other greenhouse gases.
- Develop a detailed emissions inventory, including construction and operations, for each greenhouse gas under Action Scenarios 2 and 3, as well as Scenario 4.
- Develop and include estimates for each greenhouse gas associated with impacts to permafrost soils (e.g., thaw/degradation) from construction activities proposed under Action Scenarios 2 and 3 in the Life Cycle Analysis.
- Discuss and evaluate the midstream greenhouse gas emissions effects associated with in-state deliveries of natural gas in the Life Cycle Analysis, as well as improve the analysis of upstream emissions.
- To provide meaningful net greenhouse gas emissions resulting from all Scenarios, consider national and global natural gas market effects, such as price changes, for purposes of comparison.
- Include and evaluate greenhouse gas emissions associated with exports to European Union destinations in the Life Cycle Analysis.

Key Greenhouse Gases and Climate Change Recommendations

- Apply the Social Cost of Greenhouse Gases, including carbon dioxide, methane, and nitrous oxide to monetize the respective net and gross emissions for all Scenarios.
- Discuss the estimated long-term project-level greenhouse gas emissions over time in the context of science-driven Alaska, national, and international greenhouse gas emissions reduction goals, and ways to address carbon lock-in concerns. This could include DOE using its authority to condition export orders.
- Consistent with the Council on Environmental Quality's guidance on Carbon Capture, Utilization and Sequestration, include monitoring of carbon dioxide pipelines and sequestration networks to improve safety and reduce the number of incidents that may result from carbon dioxide leakage under Scenario 2, as well as Scenario 4.
- Consistent with the White House Office of the Domestic Climate Policy's U.S. Methane Emissions Reduction Action Plan, identify, discuss, and implement opportunities to reduce, minimize, and monitor methane emissions.

Key Environmental Justice Recommendations

- Prepare a focused environmental justice analysis to identify and address the potential disproportionate and adverse impacts associated with public health and subsistence concerns, which may be experienced by the Alaska Native Tribal communities on the North Slope.

- Consistent with national policy, consider collecting and incorporating indigenous traditional ecological knowledge when evaluating environmental justice impacts to support federal decision-making.
- Provide for meaningful engagement, outreach and communication with communities of color, low income, Tribal, and other underserved and vulnerable communities with environmental justice concerns.

Thank you for the opportunity to review the Draft SEIS for the Alaska LNG Project. EPA values our collaborative relationship with DOE on many fronts and looks forward to coordinating with DOE to finalize the SEIS. We would welcome the opportunity to meet with DOE to discuss these comments and recommendations. Should you have any questions regarding this letter, please contact Mark Jen in EPA's Alaska Office at (907) 271-3411 or jen.mark@epa.gov or you may contact me at (206) 553-1774 or chu.rebecca@epa.gov.

Sincerely,

REBECCA CHU Digitally signed by REBECCA CHU Date: 2022.08.15 16:35:17 -07'00'

Rebecca Chu, Chief
Policy and Environmental Review Branch

Enclosure

U.S. Environmental Protection Agency
Detailed Technical Comments Regarding
U.S. Department of Energy's (DOE) Draft Supplemental Environmental Impact Statement
Alaska LNG Project

August 2022

Range of Reasonable Scenarios

No Action Scenario 1

NEPA requires an analysis to include the alternative of no action.[1] The No Action alternative provides a benchmark, enabling the public and decision-makers to compare the magnitude and significance of environmental effects to the action alternatives.[2] The Draft SEIS identifies a No Action case, presented as Scenario 1 in the Draft SEIS, as a "business as usual" scenario that evaluates the remaining North Slope oil production at the Prudhoe Bay Unit (PBU) and Point Thomson Unit (PTU) fields, without construction of the Alaska Liquified Natural Gas (LNG) Project. Under this scenario, there is no development of a pipeline or other means to export LNG to foreign destinations.

EPA recommends that the Final SEIS reevaluate the No Action Scenario 1 to represent a true NEPA "no action" alternative by eliminating the presumption that, if the Alaska LNG Project were not to proceed, LNG facilities located elsewhere in the U.S. lower 48 states would substitute the same volume of LNG exports to the Asian destination countries. Courts have found that it is inconsistent with NEPA for an agency to presume that its actions will have no effect on greenhouse gas (GHG) emissions because, absent the project, another source would provide the same type of energy at the same cost, resulting in similar GHG emissions.[3] Similarly, the "perfect substitution" presumption in the No Action Scenario 1 is not supported by the analysis in the Draft SEIS. EPA recommends that the Final SEIS include a complete comparison table of total GHG emissions associated with all scenarios, including the reevaluated No Action Scenario and Life Cycle Analysis (LCA).

Scenario 4 – CO_2 Sequestration in Cook Inlet

EPA recommends that the Final SEIS evaluate an Action Scenario 4 that considers reinjection of the by-product carbon dioxide (CO_2) from the Liquefaction Facilities into saline formations of the Cook Inlet Basin for carbon capture, utilization, and sequestration. Scenario 4 would provide an opportunity for reducing and/or mitigating GHG emissions associated with the Liquefaction Facilities and would require development of an additional Production Report 4 for Storing Byproduct CO_2 from the Alaska LNG

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[1] 40 CFR §1502.14(c).

[2] Council of Environmental Quality's Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations Accessible at: https://www.energy.gov/sites/default/files/2018/06/f53/G-CEQ-40Questions.pdf.

1. [3] See, e.g., *Mid States Coal. for Progress v. Surface Transp. Bd.*. 345 F.3d 520, 549 (8th Cir. 2003) (holding that the Surface Transportation Board could not approve an extension to a railroad line "without first examining the effects that may occur as a result of the reasonably foreseeable increase in coal consumption" and noting that "the proposition that the demand for coal will be unaffected by an increase in availability and a decrease in price, which is the stated goal of the project, is illogical at best."); *WildEarth Guardians v. BLM*, 870 F.3d 1222, 1236 (10th Cir. 2017) (finding that BLM's assumption that denying proposed coal leases would not affect current or future coal consumption was "arbitrary and capricious because the assumption itself is irrational (i.e., contrary to basic supply and demand principles."); *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1364 (D.C. Cir. 2017) (rejecting FERC's argument that it need not quantify emissions from a natural gas pipeline since it may result in the retirement of dirtier, coal-fired plants.)

Liquefaction Facilities in Cook Inlet, which would be similar to the North Slope Production Reports developed for Scenario 1,[4] Scenario 2,[5] and Scenario 3[6] to support the LCA.

The FERC Final EIS estimated total annual GHG emissions associated with operations of the Liquefaction Facilities to be 7.9 million metric tons (MMTs) CO_2 equivalent (CO_2-e) (with maximum flaring) and 3.9 MMTS CO_2-e (without maximum flaring).[7] Options for the disposition of these GHG emissions were not identified or evaluated in the Final EIS. A study was conducted and identified the Cook Inlet Basin to have a potential capacity for CO_2 sequestration (storage) of 980 TCF.[8]

Cumulative Impacts of Reasonably Foreseeable Future Actions

Consistent with FERC's Final EIS and NEPA regulations, EPA recommends that the Final SEIS evaluate all Scenarios to more accurately reflect the Cumulative Case, which considers the past, present, and reasonably foreseeable future actions. For example, Scenario 1 could represent the "present" Scenario (GHG emissions from oil production but without LNG exports), and Scenarios 2 and 3 (and potentially Scenario 4) would be more appropriately evaluated as "reasonably foreseeable future actions" under a cumulative effects analysis.

Consistent with the CEQ NEPA regulations, cumulative impacts on the environment result from the incremental impact of the action (Alaska LNG Project) when added to other past, present, and reasonably foreseeable future actions.[9] The North Slope Production Studies evaluated three Scenarios, which form the basis of support for the LCA. Scenario 1 represents a No Action. Action Scenarios 2 and 3 involve construction and operation of additional infrastructure associated with supporting future North Slope oil and gas production, which includes the PBU Major Gas Sales Project, the PTU expansion, and the Kuparuk River Unit (KRU) enhanced oil recovery developments. As indicated in the Draft SEIS, these additional activities are not proposed by the project proponent or any North Slope Producer to support the Alaska LNG Project. The PBU and PTU development projects were evaluated in the FERC's Final EIS as "non-jurisdictional" activities under the cumulative impacts analysis.[10]

Greenhouse Gases and Climate Change

The Draft SEIS discusses climate change impacts in Alaska, which includes warming temperatures and changes in precipitation, changes to sea ice and permafrost, soil liquefaction, wildfires, and coastal and river erosion. Climate change poses a severe threat to the nation's security, economy, environment, and to the health of vulnerable communities. Anthropogenic GHG emissions, including CO_2, methane (CH_4), and nitrous oxide (N_2O) are primary causes of climate change.[11] GHG emissions are released

[4] DOE Alaska LNG Project Supplemental Environmental Impact Statement (July 2022). Volume II Appendices. Appendix B1. Production Report 1: Establishing the Sources of Natural Gas Supply for the Alaska LNG Project (May 20, 2022).
Accessible at: https://www.energy.gov/sites/default/files/2022-07/draft-seis-0512-s1-alaska-lng-volume-2-2022-07.pdf.

[5] DOE Alaska LNG Project Supplemental Environmental Impact Statement (July 2022). Volume II Appendices.. Appendix B3. Production Report 3: Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plan at the Prudhoe Bay Unit (April 5, 2022).

[6] DOE Alaska LNG Project Supplemental Environmental Impact Statement (July 2022). Volume II Appendices.. Appendix B2. Production Report 2: Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential (May 20, 2022).

[7] FERC/EIS-0296F Alaska LNG Project Final Environmental Impact Statement (March 2020); p. 4-961; Table 4.15-5-20.
Accessible at: https://www.ferc.gov/industries-data/natural-gas/environment/final-environmental-impact-statement-feis.

[8] D.P. Shellenbaum and J.G. Clough (2010). Alaska Geologic Carbon Sequestration Potential Estimate: Screening Saline Basins and Refining Coal Estimates: California Energy Commission, Public Interest Energy Research Program.
Accessible at: https://dog.dnr.alaska.gov/Documents/ResourceEvaluation/Alaska_Geologic_Carbon_Sequestration_Potential_Estimate.pdf

[9] CEQ 40 CFR §1508.7.

[10] FERC/EIS-0296F Alaska LNG Project Final Environmental Impact Statement (March 2020); p. 4-1158.
Accessible at: https://www.ferc.gov/industries-data/natural-gas/environment/final-environmental-impact-statement-feis.

[11] Intergovernmental Panel on Climate Change, United Nations, *Summary for Policymakers* of Climate Change 2021: The Physical Science Basis SPM–5 (Valerie MassonDelmotte et al. eds.) (2021). Accessible at: https://www.ipcc.ch/report/ar6/wg1/downloads/ report/IPCC_AR6_WGI_SPM.pdf (IPCC Report). Accessible at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf.

through the construction, production, processing, transportation, distribution, and consumption of natural gas.

GHG and Other Emissions

EPA recommends that the Final SEIS include a detailed GHG emissions inventory for Scenarios 2 and 3, as well as Scenario 4, which identifies sources and the corresponding GHG emissions that were used to inform the Alaska LNG Project LCA. This would include evaluating GHG emissions across the entire LNG supply chain - including upstream[12] (*e.g.*, construction, production, gathering and boosting, processing, transmission and storage) and distribution and use of natural gas to downstream end users. In addition, EPA recommends consideration of midstream analysis to include in-state deliveries of natural gas for energy production and to support long-term development of other industries in the state. EPA recommends quantifying all reasonably foreseeable direct and indirect GHG emissions (*e.g.*, CO_2, CH_4, and N_2O), in addition to their global warming potential (GWP) contributions in CO_2-e units attributable to the Action Scenarios.

EPA's Greenhouse Gas Reporting Program (GHGRP) reported GHG emissions data annually and tracks facility-level emissions from the largest sources of GHG emissions in the U.S., including Alaska. The most recent reporting year that is publicly available is 2020 data.[13] The GHGRP data may be useful in preparing a detailed GHG emissions inventory to support the Final SEIS.

Project Construction and Operations

EPA recommends that the Final SEIS include by reference the GHG emissions associated with the construction and operations of the Alaska LNG Project, which were incorporated in the LCA estimates. The additional development proposed under Action Scenarios 2 and 3 would also result in construction-related GHG emissions consisting of fugitive dust, construction equipment and other stationary and mobile-source combustion emissions. Consistent with FERC's Final EIS, EPA recommends including the GHG emissions from construction and operations associated with Scenarios 2 and 3 for each development proposed at PBU, PTU, and KRU to support the evaluation of the Final SEIS.

The construction of the Alaska LNG Project has been scheduled to take approximately eight years. The FERC Final EIS provided GHG emissions estimates (metric tons CO_2-e) associated with the project construction of the Gas Treatment Plant (Table 4.15.4-1; p. 4-932), the Point Thomson Transmission Line (Table 4.15.4-2; p. 4-933), the Prudhoe Bay Transmission Line (Table 4.15.4-3; p. 4-933), the Mainline Pipeline (Table 4.15.4-4; p. 4-934), and the Liquefaction Facilities (Table 4.15.4-5; p. 4-935).[14] The total annual GHG emissions associated with project operations were also provided in the FERC Final EIS (GTP – Table 4.15.5-1, p. 4-937; PTTL and PBTL – Table 4.15.5-10, p. 946; Mainline Pipeline compressor/heater stations – Tables 5-11 to 5-14; and Liquefaction Facilities – Table 4.15-5-20; p. 4-961). EPA recommends that the Final SEIS include summary tables with the estimates of the total GHG emissions associated with the construction and operations of the AK LNG Project and the North Slope developments at PBU, PTU, and KRU.

Permafrost Impacts

EPA recommends that the estimates of CO_2-e emissions associated with permafrost impacts (*e.g.*, degradation and thaw/thermokarsting) from construction of the Mainline Pipeline and the PBU, PTU,

[12] EPA (2022). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. U.S. Environmental Protection Agency, EPA 430-R-22-003. Accessible at: https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissionsand-sinks-1990-2020.
[13] Information regarding EPA's Greenhouse Gas Reporting Program is accessible at: https://www.epa.gov/ghgreporting/find-and-use-ghgrp-data.
[14] FERC/EIS-0296F Alaska LNG Project Final Environmental Impact Statement (March 2020); Section 4.15. Air Quality. Accessible at: https://www.ferc.gov/industries-data/natural-gas/environment/final-environmental-impact-statement-feis.

and KRU developments discussed in Scenarios 2 and 3 be included and evaluated in the Final SEIS to estimate the total GHG emissions.

Construction of the over 800-mile buried Mainline Pipeline would result in direct, indirect, and cumulative impacts to the underlying permafrost soils. Permafrost underlies about 81 percent of Alaska, which 32 percent is continuous; 31 percent is discontinuous; 8 percent is sporadic; and 10 percent is in isolated patches.[15] The Alaska LNG Project would result in significant long-term and permanent impacts to thaw sensitive permafrost (about 6,218 acres) and thaw stable permafrost (about 3,499 acres).[16]

Permafrost degradation/thaw during project construction and operation would be expected to release CO_2 and CH_4 into the atmosphere. The total estimated amount of permafrost thaw that could occur during the life of the project (without climate change) is estimated to be about 221 billion tons, which translates to 2,680 tons (2,431 metric tons) of CH_4 emissions and 67,012 tons (60,792 metric tons) of CO_2-e emissions. An estimated total of about 7.1 million tons of permafrost would be affected by the construction of the Mainline Pipeline trenching (assuming 6-feet wide and 8-feet deep trench along the entire route). This translates into about 85 tons (77 metric tons) of CH_4 emissions and 2,136 tons (1,938 metric tons) of CO_2-e emissions.[17]

The PBU, PTU, and KRU developments discussed under Scenarios 2 and 3 would further result in additional impacts to permafrost soils on the North Slope and would subsequently release GHGs. Consistent with the FERC Final EIS, EPA recommends that the Final SEIS include estimates for the volume of permafrost soils that would be permanently impacted and the associated amount of GHG (*e.g.*, CO_2 and CH_4) emissions for the Action Scenarios.

Methane Reductions

EPA recommends that the Final SEIS evaluate opportunities to reduce methane emissions throughout the life cycle of the Alaska LNG Project. Active and frequent monitoring of fugitive methane emissions associated with pipeline compressors, venting, gas flaring, leaks, and other processing equipment should be incorporated into additional conditions of the DOE Order, if reaffirmed and modified.

The primary component of natural gas is methane, a powerful GHG that, depending on the time frame, is 36 to 87 times as potent as CO_2.[18] In the U.S., methane emissions account for 10.9 percent of anthropogenic GHGs in 2020.[19] However, methane is a "short lived climate forcer," which makes it a particularly destructive greenhouse gas. The Intergovernmental Panel on Climate Change attributes approximately 30 percent of today's climate change to methane emissions.[20] In addition to its climate impacts, methane poses acute and chronic hazards to human health.

EPA recommends that the Final SEIS identify and discuss potential sources of methane and their contributions to the total GHG emissions throughout the life cycle of this project. Potential sources could include production, processing, pipeline transmission and storage, transportation, delivery and regassification of natural gas. EPA recommends including separate estimates for the methane emission

[15] T. Jorgenson *et al.* (2008). Permafrost Characteristics of Alaska. University of Alaska Fairbanks. Institute of Northern Engineering, Fairbanks, Alaska. Accessible at: https://www.researchgate.net/profile/Sergey-Marchenko 3/publication/334524021_Permafrost_Characteristics_of_Alaska_Map/links/5d2f7672a6fdcc2462c86fac/Permafrost-Characteristics-of-Alaska-Map.pdf.
[16] FERC/EIS-0296F March 2020); p. ES-4.
[17] FERC/EIS-0296F March 2020); p. 4-108.
[18] Intergovernmental Panel on Climate Change (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC. Accessible at:* https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_all_final.pdf.
[19] EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. U.S. Environmental Protection Agency, EPA 430-R-22-003. Accessible at: https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-main-text.pdf.
[20] Methane and its byproduct were responsible for 0.97 W/m2 of radiative forcing in 2011. Source: IPCC, Fifth Assessment Report, Working Group I (AR5 WGI, Chapter 8, Table 8.SM.6). Accessible at: https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions?__cf_chl_managed_tk__=pmd_kIV7g0qro37Br.pft6AALmDD6BPb42BQ0lkG2SuFfGk-1632076284-0-gqNtZGzNA2WjcnBszQc9.

4

contributions from the total GHG emissions, which are reported for its GWP in CO_2-e units. Emissions estimates based on GWP may not provide for a meaningful comparison of the actual total methane emissions contributions when compared to other types of GHG emissions, such as CO_2, N_2O, SF_6, etc.

Natural gas and petroleum systems represent the largest industrial source of methane emissions in the United States.[21] The U.S. Methane Emissions Reduction Action Plan[22] focuses on cutting pollution from the largest sources of methane emissions. In particular, the Plan identified reducing methane emissions in the oil and gas sector, which would include the following:

- Updating rules for new and existing oil and gas sources.
- Reducing venting, flaring, and well leaks on public lands and waters.
- Boosting safety of gathering and transmissions pipelines.
- Regulatory, disclosure, and partnership initiatives to reduce methane leaks and ruptures on distribution lines.
- Plugging abandoned oil and gas wells to reduce methane emissions.

Consistent with this Plan, EPA recommends that the Final SEIS identify and discuss opportunities to reduce, minimize, and monitor methane emissions and potential leaks throughout the life cycle of the Alaska LNG Project.

Furthermore, EPA's voluntary methane programs for the oil and natural gas industry include the Methane Challenge[23] and Natural Gas STAR[24] which could further reduce potential GHG emissions attributable to the project. In particular, EPA has developed recommended technologies and practices to reduce methane emissions through the Natural Gas STAR Program.[25]

Black Carbon

EPA recommends that the Final SEIS evaluate the differences in black carbon (BC) emissions between all Scenarios, which should include a discussion of BC impacts in the Alaska arctic environment (Section 3.19) and a qualitative evaluation (Section 4.19). A quantitative evaluation could rely on best estimates of BC emission factors and the calculated fine particulate matter ($PM_{2.5}$) emissions. EPA notes that there may be difficulty in quantifying black carbon emissions from oil and gas development due to gaps in available emissions data.

Black carbon deposited on snow and ice increases surface albedo, resulting in absorption of incidental solar radiation and contributing to advanced snow and ice melt.[26] When considering GHG emissions and climate change impacts for this project, EPA recommends that the Final SEIS evaluate BC emissions, which have been shown to result in a net thermal effect on the Earth's surface.[27,28] Black carbon emissions have a relatively short atmospheric lifetime and can be deposited downwind of their emission

[21] EPA (2021). *Inventory of U.S. Greenhouse Gas Emissions and Sinks:* 1990-2019. Accessible at: https://www.epa.gov/ghgemissions/inventory-usgreenhouse-gas-emissions-and-sinks-1990-2019.
[22] Whitehouse Office of Domestic Climate Policy (November 2021). U.S. Methane Emissions Reduction Action Plan. Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/11/US-Methane-Emissions-Reduction-Action-Plan-1.pdf.
[23] EPA Methane Challenge Program. Accessible at: https://www.epa.gov/natural-gas-star-program/methane-challenge-program.
[24] EPA Natural Gas STAR Program. Accessible at: https://www.epa.gov/natural-gas-star-program/natural-gas-star-program.
[25] EPA Natural Gas STAR Program Recommended Technologies to Reduce Methane Emissions. Accessible at: https://www.epa.gov/natural-gas-star-program/recommended-technologies-reduce-methane-emissions
[26] A.J. Sedlacek (July 1, 2021). North Slope of Alaska Black Carbon Loadings and Mixing State for MOSAiC Field Campaign Report (DOE/SC-ARM-21-014). Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (United States). Atmospheric Radiation Measurement (ARM) Data Center. Accessible at: https://www.osti.gov/biblio/1810321-north-slope-alaska-black-carbon-loadings-mixing-state-mosaic-field-campaign-report.
[27] Arctic Monitoring and Assessment Programme (AMAP) Assessment 2015: Black carbon and ozone as Arctic climate forcers. Accessible at: https://www.amap.no/documents/doc/amap-assessment-2015-black-carbon-and-ozone-as-arctic-climate-forcers/1299
[28] T.C. Bond *et al.* (2013). Bounding the role of black carbon in the climate system: A scientific assessment. Accessible at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/jgrd.50171.

sources leading to local impacts. Whereas, GHGs have a longer atmospheric lifetime and are considered well mixed, and therefore have global impacts.

Gas flaring associated with oil and gas development on the North Slope has been identified as a near-surface source that may significantly impact Arctic BC surface concentrations.[29] There may be significant differences in the climatic impacts of the Scenarios due to the varying degrees to which development takes place in the Arctic compared to the U.S. lower 48 states. Black carbon emitted closer to the surface is likely to have a greater local impact than black carbon emissions injected higher in the atmosphere because concentrations of BC in higher altitude air masses are diluted as they are transported downwind.

Life Cycle Analysis - Midstream

The purpose and need for the Alaska LNG Project are to commercialize the natural gas resources of the North Slope by converting the existing natural gas supply to LNG for export and use within the State of Alaska.[30] FERC's Final EIS identified three gas interconnections along the Mainline Pipeline that would provide for future in-state deliveries of natural gas.[31] EPA recommends that the Final SEIS evaluate the midstream GHG emissions associated with in-state deliveries of natural gas to Alaskan communities and to support long-term economic development; as well as the resulting concomitant induced growth and development that would occur to support additional infrastructure.

Additional reasonably foreseeable future actions along the LNG process value chain are being planned to support Alaska's long-term economic development. Approximately 300 mmcfd is planned to be allocated for the domestic market.[32] EPA recommends that the Final SEIS evaluate additional reasonably foreseeable projects as part of the midstream analysis of GHG emissions for the Alaska LNG Project, which may include, but not be limited to, the following:

- Nutrien Ltd. (formerly Agrium U.S., Inc.), Kenai Nitrogen Operations Facility plans to export fertilizer, clean hydrogen, blue ammonia to foreign markets;[33]
- Trans-Foreland Pipeline Company, LLC plans to import LNG to be stored and to generate boil-off gas at the Kenai LNG Plant to support their Kenai Refinery operations;[34] and
- Donlin Gold Mine plans to construct a natural gas pipeline from the west side of Cook Inlet at Beluga to support their mine operations in southwest Alaska.[35]

LNG Carrier Transits

EPA recommends that the Final SEIS identify the LNG carrier marine transportation distances (nautical miles, speed (knots), times (days), etc.) that would be required between Nikiski, Alaska, and the four destination countries: Japan, China, South Korea, and India. EPA recommends that this information be referenced and evaluated in the Final SEIS to estimate the GHG emissions associated with LNG carrier transits between the Alaska LNG Project Liquefaction Facilities and the destination countries in Asia.

[29] A. Stohl *et al.* (2013). Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions. Accessible at: https://acp.copernicus.org/articles/13/8833/2013/.
[30] FERC/EIS-0296F March 2020): p. ES-1.
[31] FERC/EIS-0296F (March 2020); p. 2-20.
[32] F. Richards, President, Alaska Gasline Development Corporation (February 1, 2022). Alaska LNG Project Update presented to the Fairbanks Economic Development Energy Task Force. Accessible at: https://alaska-lng.com/wp-content/uploads/2022/04/FEDC-1Feb2022_Final-PUBLIC.pdf.
[33] Alaska Department of Environmental Conservation (2020). Public Notice to approve Agrium U.S. Inc.'s application for Air Quality Control Construction Permit AQ0083CPT07 for the Kenai Nitrogen Operations (KNO) Facility. Accessible at: https://aws.state.ak.us/OnlinePublicNotices/Notices/View.aspx?id=200222.
[34] FERC Federal Register Vol. 85, No. 176 (September 10, 2020). Trans-Foreland Pipeline Company, LLC; Notice of Availability of the Environmental Assessment for the Proposed Kenai LNG Cool Down Project [Docket No. CP19–118–000]. Accessible at: https://www.govinfo.gov/content/pkg/FR-2020-09-10/pdf/2020-19999.pdf.
[35] U.S. Army Corps of Engineers and Bureau of Land Management (August 13, 2018). Donlin Gold Project Joint Record of Decision and Permit Evaluation. Accessible at: https://dnr.alaska.gov/mlw/mining/large-mines/donlin/pdf/dg-usace-blm-rod-2018-08-13.pdf.

EPA notes that FERC's Final EIS considered the LNG carrier vessel transits to and from the Liquefaction Facilities during operation as "non-jurisdictional" facilities related to the Alaska LNG Project in the cumulative impacts analysis. The LNG carriers would range in size between 125,000 and 216,000 cubic meters. The estimated number of vessels per month ranges between 17 and 30, with an average of 21vessels per month. One LNG carrier would load while another vessel enters and prepares to load at the second berth.[36]

Life Cycle Analysis - Downstream

The Draft SEIS evaluated life cycle GHG emissions associated with LNG exports to four destination countries. Each country supports numerous LNG facility terminals, for example: Japan = 35; South Korea = 7; China = 18; and India = 7.[37] EPA recommends that the Final SEIS include an inventory of the LNG facilities in each destination country that could potentially receive LNG exports from the Alaska LNG Project and to identify their marine transportation distances from Alaska.

In addition, the LCA presumes a functionally equivalent amount of LNG export would produce 1 megawatt hour (MWH) of electricity for downstream end users at each Asian destination country with and without carbon capture and sequestration (CCS). EPA recommends that the Final SEIS provide additional information to explain the basis for this approach and the presumption that each destination country has similar energy generating capacity, as well as capacity for CCUS.

Global Market Effects

In 2021, the United States became Europe's largest source of LNG, accounting for 26 percent of all LNG imported by European Union member countries and the United Kingdom. In May 2022, the top five destination countries of France (47.8 Bcf), Spain (40.3 Bcf), Netherlands (28.9 Bcf), Japan (24.0 Bcf), and Italy (21.7 Bcf) accounted for 46.4 percent of total U.S. LNG exports. GHG emissions estimates of LNG exports should include global market effects, such as the changing global market trends in U.S. LNG exports to the European Union. EPA recommends that the Final SEIS evaluate GHG emissions for the Alaska LNG Project to include destination countries in the E.U., such as France, Spain, Netherlands, and Italy.

EPA recommends that the Final SEIS incorporate an appropriate model[38] to analyze the economic impacts on electricity and related markets associated with the Alaska LNG Project. The Alaska LNG Project represents a significant increase in national and international LNG exports and the potential economic impacts of this expansion should be evaluated. This large increase in LNG supply will have a significant effect on natural gas prices and the types of electricity used, and subsequently, additional GHG emissions.[39] When combined with a true NEPA no action scenario, this could help in identifying the full net and gross emissions of the project. This modeling should include a "policy" scenario with inputs reflecting implementation of science-based GHG-reduction policies to avoid the worst impacts of climate change. There have been significant changes in the last year in natural gas markets, illustrating the volatility of gas markets over time. For instance, as noted above, the largest importers of US LNG are no longer the four countries examined in this report.[40] International activities have impacted and notably changed natural gas markets and price forecasts. EPA recommends that the Final SEIS include

[36] FERC/EIS-0296F (March 2020); p. 4-1166.
[37] List of LNG Terminals from Wikipedia. Accessible at: https://en.wikipedia.org/wiki/List_of_LNG_terminals.
[38] For example, "The Bureau of Land Management's Modeling Choice for the Federal Coal Programmatic Review" NYU School of Law (June 2016) and describe multiple power sector models available to federal agencies for use in NEPA analysis (which have expanded since 2016). Accessible at: https://policyintegrity.org/files/publications/BLM_Model_Choice.pdf.
[39] U.S. Energy Information Administration. (October 5, 2021). Natural gas explained. Factors affecting natural gas prices. Accessible at: https://www.eia.gov/energyexplained/natural-gas/factors-affecting-natural-gas-prices.php.
[40] U.S. Energy Information Administration (February 22, 2022). Today in Energy. Three countries provide almost 70% of liquefied natural gas received in Europe in 2021. Accessible at: https://www.eia.gov/todayinenergy/detail.php?id=51358

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updated forecasts of prices and trends in LNG and natural gas over the life of the project. In addition, EPA recommends that the Final SEIS incorporate the U.S. Energy Information Administration's most recent forecasts into the LCA.

<u>Social Costs of GHG</u>

Executive Order (E.O.) 13990[41] emphasizes the importance for federal agencies to capture the full costs of GHG emissions, including consideration of global damages. The Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases published a Technical Support Document[42] that included interim estimates for the Social Cost of carbon dioxide, methane, and nitrous oxide (referred to collectively as SC-GHG) for agencies to use "when monetizing the value of changes in GHG emissions resulting from regulations and other relevant federal agency actions until final values are published." Estimates of the social cost of carbon (SC-CO_2) have been published in peer reviewed academic literature for decades, and the SC-GHG metric has been regularly incorporated into federal policy analysis since the late 2000s. The IWG's interim estimates were developed under a robust and transparent process, represent the best available science and economics, and provide essential impact information to the public and decision-makers.

To assess the climate impacts and monetize the potential impacts of GHG emissions, EPA recommends that the Final SEIS evaluate and disclose the monetized climate damages using the relevant SC-GHG for the respective net and gross emissions for CO_2, CH_4, and NO_2 for each Scenario, including the No Action alternative. For example, the SC-CH_4 should be applied to methane emissions. EPA notes that it would not be appropriate to convert methane emissions to CO_2-e units and apply the SC-CO_2. Providing estimates of these emissions separately and individually discloses the different environmental impacts associated with emissions for each of the GHGs.[43] This comparative analysis would illustrate the costs and benefits to society associated with each Scenario, to inform the public, as well as DOE's decision-making.

When applying SC-GHG estimates, EPA recommends that the Final SEIS disclose and discuss any associated assumptions (*e.g.*, the year the monetized values should be discounted to) and uncertainties. Furthermore, EPA recommends against characterizing any SC-GHG estimates as an "upper bound" of climate change impacts in the Final SEIS. IWG's Technical Support Document presents a range of estimates and discount rates and discusses the uncertainties and the many categories of damages that are not yet reflected in existing SC-GHG estimates. Data and modeling limitations associated with the SC-GHG estimates may result in partial accounting of climate change impacts, making it incorrect to assert an upper bound using only one of the SC-GHG estimates.

<u>GHG Reduction Goals</u>

EPA recommends that the Final SEIS avoid expressing the overall project-level GHG emissions as a percentage of the state or national GHG emissions. This approach diminishes the significance of the notable climate damages caused by substantial project-scale GHG emissions and is misleading given the nature of the climate policy challenge to reduce GHG emissions from a multitude of sources.

EPA recommends that the Final SEIS include a discussion of the extent to which the estimated GHG emissions from the project Scenarios are consistent with taking action to achieve science-based national

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[41] Executive Order 13990 (January 20, 2021). Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis. Accessible at: https://www.govinfo.gov/content/pkg/FR-2021-01-25/pdf/2021-01765.pdf.

[42] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government (February 2021). Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

[43] EPA Non-CO_2 Greenhouse Gas Emission Projections & Mitigation. Accessible at: https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases.

GHG reduction targets and any relevant state and locals plans and goals. EPA recommends that the Final SEIS discuss the project-level GHG emissions over time in the context of GHG emissions reduction goals, including the U.S. economy-wide target under the Paris Agreement to achieve a 50 to 52 percent reduction in net GHG emissions from 2005 levels by 2030.[44] For comparison, the Final SEIS should evaluate the project Scenarios incorporating existing and potential policy changes to advance the national 2030 and 2050 net-zero GHG reduction goals, consistent with the *Long Term Strategy of the United States*.[45] EPA recommends that the Final SEIS discuss carbon lock-in concerns and challenges the Project poses for achieving climate policy goals, as well as opportunities to address them. This could include DOE authority to include environmental and other conditions in its export orders. Considering science-driven GHG reduction policies is necessary to provide the public and decision-makers with critical context regarding the project locking in long-term GHG emissions, and essential emissions reduction policies to avoid the worst impacts of climate change.

EPA recommends that the Final SEIS also evaluate local Alaska climate policies and plans to determine appropriate opportunities to achieve the GHG and climate change reduction goals for the Alaska LNG Project. In Alaska, there are approximately 23 examples of local climate policies in the form of plans and assessments, as well as additional task forces, resolutions, and strategies.[46] Over 19 climate action efforts (*i.e.,* plans and strategies) have emerged from Indigenous communities and seven were developed at the scale of Tribal government. Although these actions overwhelmingly focus on assessing and adapting to the current impacts of climate change that threaten traditional indigenous ways of life, inconsistencies with their concerns with climate change mitigation should be considered.

<u>Climate Changes in Alaska</u>

EPA recommends including additional discussions and references to case studies and lessons learned regarding actual documented incidents of climate change effects to North Slope oil and gas related infrastructure. The following are a few recent examples of incidences which may have been affected by climate change effects:

In March 2022, natural gas leaked from seven wells on the drill pad at the Alpine Development Central Facility in the Colville River Unit, which is located on state land and about eight miles from the Native Village of Nuiqsut. Approximately 7.2 million cubic feet of natural gas was released through the gravel from one of its drill pads, known as CD-1.[47] The source of the natural gas was coming up through the annular, the outer annulus of one of the drill wells that were in the process of being drilled. The leak was 3,000 feet below the surface and traceable gas is percolating through the gravel beds around the wells. Approximately 300 employees were evacuated, prompting 20 families from the nearby community of Nuiqsut to leave.[48] The gas leak may have been the result of thawed permafrost regions surrounding each drill well having coalesced into a single large zone referred to as the "thaw bulb." Modelling indicated that permafrost will re-freeze around the wellbore after a well is shut-in. Continued freeze and thaw cycles at the surface can result in cracks and fractures in the permafrost soil directly below the CD-1 pad, which provided a pathway for gas to migrate to the surface.[49]

[44] See U.S. Nationally Determined Contribution (April 20, 2021).
[45] U.S. Department of State and U.S. Executive Office (November 2021). The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050. Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf.
[46] A. Steffen, S. A. Greenlaw, M. Biermann, and A. L. Lovecraft (2021). Alaska's Climate Change Policy Development. Fairbanks: Center for Arctic Policy Studies. Accessible at: https://uaf.edu/caps/our-work/CAPS-alaskas-climate-policy-development-March2021-corrected.pdf.
[47] Alaska Oil and Gas Conservation Commission Situation Report No. 24 (April 7, 2022). Alpine CD 1 Natural Gas Release. Accessible at: https://www.commerce.alaska.gov/web/Portals/18/pub/Situation%20Reports%20-%20CPAI/AOGCC%20SITREP%2024.pdf.
[48] C. Matteson (April 7, 2022). ConocoPhillips Alaska is estimating 7.2M cubic feet of gas released in Alpine leak. Accessible at: https://www.alaskasnewssource.com/2022/04/07/conocophillips-alaska-is-estimating-72m-cubic-feet-gas-released-alpine-leak/.
[49] ConocoPhillips (May 3, 2022). Incident Investigation Report for the Alpine CD-1 Gas Release. Accessible at: https://static.conocophillips.com/files/resources/attachment-a-incident-investigation-report.pdf.

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In 2019, about 25 miles into the Trans-Alaska Pipeline's 800-mile route alongside the Sagavanirktok River, sheets of layered ice or "aufeis" built up in the channel. A new channel formed and scoured away material and eroded the flood control structure, which resulted in a 90-ft section of buried pipeline to be exposed. An exposed pipeline increases the risk of a puncture or spill. The Sag River had been running at record high levels for the past two years due to an unusually warm spring and quick melt. Repairing the damage and building taller barriers is estimated between $10 million and $15 million.[50]

In 2015, the Sag River forced the closure of the Dalton Highway, which is used to haul supplies to the North Slope oil fields. The event was caused by heavy summer rains followed by an extensive winter freezing, trapping the water in place, then a rapid spring warmup and thaw due to record high temperatures to the region. The Sag River had taken out about a half-mile long section of the highway. The Sag River floodwaters also threatened the Deadhorse Airport, forcing the state to excavate large chunks from the highway that were already eroding in order to create a breach/outlet for the floodwaters. The waters trapped three of Deadhorse's numerous camps constructed on elevated gravel pads supporting buildings and equipment, which also lost power and had to relying on diesel powered generators for electricity. A buried telecommunications line carrying local internet and phone service was also damaged along a severed section of highway. The state has estimated the costs of the damage and repairs to the Dalton Highway at $5.1 million.[51]

Climate Change Resiliency

In Alaska, climate change is contributing to environmental and economic concerns, and impacting major infrastructure, such as North Slope oil and gas facilities. Climate change is also increasing risks to communities with environmental justice (EJ) concerns and vulnerable populations, Tribal communities, and resulting in significant socio-economic losses. The potential economic damages to Alaska infrastructure resulting from climate driven changes include flooding, precipitation, near-surface permafrost thaw, and freeze–thaw cycles using high and low future climate scenarios.

A study published in the Proceedings of the National Academy of Sciences quantified the economic impacts of climate change on Alaska public infrastructure. The cumulative estimated expenses from climate-related damage to infrastructure totaled $5.5 billion (2015 to 2099) without adaptation measures.[52] The study suggested that reducing GHG emissions could lessen damages by $1.3 billion. The largest damages were projected for the interior and southcentral Alaska. The largest source of damages resulted from road flooding caused by increased precipitation followed by damages to buildings associated with near-surface permafrost thaw.[53,54] Smaller damages were observed for airports, railroads, and pipelines. Costs associated with adaptation measures for permafrost thaw were not quantified since it would be more expensive than complete infrastructure replacement. Furthermore, this study suggests that climate damages to infrastructure will extend well beyond areas underlain by permafrost and that greater attention to future flooding risks is warranted.

EPA recommends the Final SEIS consider and disclose current climate change impacts in Alaska, evaluate mitigation measures and incorporate adaptation management planning in project design, construction, and operations, including measures to ensure resilience to protect infrastructure

[50] N. Herz, (February 3, 2020). On warming North Slope, one flood response last year cost pipeline operator $10 million. Accessible at: https://alaskapublic.org/2020/02/03/on-a-warming-north-slope-a-spring-flood-did-10-million-in-damage-to-the-trans-alaska-pipeline/.
[51] A. DeMarban (May 21, 2015). 'Epic' flooding on Dalton Highway hinders North Slope oil operations. Anchorage Daily News. Accessible at: https://www.adn.com/environment/article/epic-flooding-north-slope-oil-finds-hindering-daily-operations/2015/05/22/.
[52] A.M. Melvin et. al. (December 27, 2016). Climate change damages to Alaska public infrastructure and the economics of proactive adaptation. *Proceedings of the National Academy of Sciences*, 114, no. 2 (2017): E122-E131. Accessible at https://www.pnas.org/doi/full/10.1073/pnas.1611056113.
[53] US Arctic Research Commission Permafrost Task Force (2003) Climate Change, Permafrost, and Impacts on Civil Infrastructure (US Arctic Research Commission, Arlington, VA), Special Report 01-03. Accessible at: https://permanent.access.gpo.gov/gpo18086/permafrost.pdf.
[54] E. Hong, R. Perkins R, S. Trainor (2014) Thaw settlement hazard of permafrost related to climate warming in Alaska. Arctic 67(1):93–103. Accessible at: https://journalhosting.ucalgary.ca/index.php/arctic/article/view/67413/51320.

investments from the effects of climate change on the Alaska LNG Project. By considering potential climate change impacts, DOE would help ensure that investments made today continue to function and provide benefits, even as the climate changes. EPA recommends the Final SEIS evaluate opportunities to ensure infrastructure resilience to climate change effects at all project lifecycle stages, including upstream, midstream, and downstream.

Carbon Capture, Utilization, and Sequestration

Carbon capture, utilization, and sequestration technologies are potential opportunities to minimize the worst impacts of climate change by reducing emissions of certain GHGs, as well as to protect nearby communities from increases in the cumulative effects of these emissions.

CEQ issued proposed guidance on Carbon Capture, Utilization and Sequestration (CCUS)[55] for Federal agencies to support responsible projects where appropriate and is consistent with CEQ's report to Congress on CCUS.[56] An important aspect of this guidance is to ensure monitoring of CO_2 pipelines and sequestration networks to improve safety while also reducing the number of incidents that result in CO_2 leakage.

The North Slope Production Study Report 3 - Storing By-product CO_2 from the Alaska LNG Project, evaluates Scenario 2, which identified a deep saline reservoir of the Staines Tongue of the Sagavanirktok Formation (4,000 ft to 4,800 ft). The DSEIS states the byproduct CO_2 (350 MMcfd) from the PBU gas treatment plant would be reinjected for carbon capture, utilization, and storage into the reservoir. The total storage capacity of this formation is approximately 42 $mi.^2$ EPA recommends that the Final SEIS discuss and evaluate the PBU saline formation sequestration project under Scenario 2 to be consistent with CEQ guidance on CCUS. In addition, EPA recommends identifying the other speciated forms of GHGs (*e.g.*, CH_4, N_2O, SF_6, etc.) that would also be reinjected in the PBU saline formation for CCUS. EPA recommends that the Final SEIS discuss the air quality impacts associated with the PBU CCUS project in Scenario 2 and their impact on nearby Environmental Justice, Tribal, and vulnerable communities.

EPA notes that by incorporating the PBU CCUS under Scenario 2, approximately 50 percent of the GHG emissions would be mitigated and/or offset. As discussed previously, EPA recommended that the Final SEIS evaluate an Action Scenario 4, which would reinject byproduct CO_2 into the Cook Inlet Basin CCUS to mitigate GHG emissions associated with the Liquefaction Facilities. Scenario 4 could provide additional mitigation through carbon offsets potentially reaching 75 percent or higher of the total GHG emissions for the Alaska LNG Project.

Environmental Justice

E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (February 16, 1994), directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority (people of color) and low-income populations to the greatest extent practicable and permitted by law. The E.O. further directs agencies to develop agency wide environmental justice strategies, including providing people of color and low-income communities access to public information and participation.

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[55] CEQ Guidance (Feb 16, 2022). Carbon Capture, Utilization and Sequestration (CCUS).
Accessible at: https://www.govinfo.gov/content/pkg/FR-2022-02-16/pdf/2022-03205.pdf.
[56] CEQ Report to Congress (June 2021). Carbon Capture, Utilization, and Sequestration.
Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/06/CEQ-CCUS-Permitting-Report.pdf.

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EPA recommends that the Final SEIS include an environmental justice analysis that evaluates the smallest geographical unit that the U.S. Census Bureau publishes data for. EPA cautions against using larger census tracts and/or block groups in the analysis, such as boroughs or cities, as these may dilute the presence of low income populations, particularly on the North Slope. The Draft SEIS EJ analysis within the project region of influence crosses two block groups. Census Tract 3, Block Group 1 included the PBU, KRU, and a portion of the CO_2 pipeline route; and Census Tract 2, Block Group 3 included PTU and the remainder of the CO_2 pipeline route.[57] The Draft SEIS identified minority populations (Alaska Native Indian) in the North Slope Borough is approximately 71 percent, which is double the state's percentage. The Alaska Traditional native communities on the North Slope Borough engage in predominantly a subsistence-based economy. Therefore, the household income of these subsistence-based communities may not be accurately reported in U.S. Census Bureau published data and may not accurately identify the percentage of low income populations in the North Slope Borough communities.

The NEPA Committee of the Federal Interagency Working Group on Environmental Justice has noted that, in some cases, it may be appropriate to use a threshold for identifying low-income populations that exceeds the poverty level.[58] EPA notes that minority and low-income populations can be identified using different approaches. A minority population does not need to meet a 50 percent threshold if "the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis."[59]

EPA's EJScreen: Environmental Justice Screening and Mapping Tool (Version 2.0)[60] provides a useful first step to identifying minority and low-income populations, which may be candidates for further EJ review and meaningful engagement and outreach. Potential EJ concerns may exist when the EJScreen report for the community identifies at least one of the twelve EJ Indexes[61] to be at or above the 80th percentile when compared to the state (Alaska) and national levels. EPA recommends referring to the *Promising Practices for Environmental Justice Methodologies in NEPA Reviews: Report of the Federal Interagency Working Group on Environmental Justice and NEPA Committee*[62] for approaches to addressing information and analysis methods to support identification of communities with environmental justice concerns.

In addition to utilizing EJScreen and other tools, data sources, and methods for informing the EJ analysis, EPA also recommends that the Final SEIS consider the definition of "disadvantaged community" as referenced in E.O. 14008[63] and further described in the Interim Implementation Guidance for the Justice40 Initiative.[64] While the interim guidance directs agencies to consider a range of specific demographic and environmental variables when assessing a community for purposes of the Justice40 Initiative, these variables may also be informative for purposes of identifying and addressing potential impacts to minority and low-income populations as directed by E.O. 12898. EPA recommends

[57] Draft SEIS; p. 3.11-4.
[58] Federal Interagency Working Group on Environmental Justice & NEPA Committee (March 2016). Promising Practices for EJ Methodologies in NEPA Reviews. Accessible at: https://www.epa.gov/sites/default/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.
[59] Council on Environmental Quality (December 1997). Environmental Justice: Guidance Under the National Environmental Policy Act. Accessible at https://www.epa.gov/sites/default/files/2015-02/documents/ej_guidance_nepa_ceq1297.pdf .
[60] EPA Environmental Justice Screening and Mapping Tool (Version 2.0). Accessible at: https://ejscreen.epa.gov/mapper/.
[61] Environmental Justice Indexes: Particulate Matter2.5, Ozone, Diesel PM, Air Toxics (Cancer Risk), Air Toxics (Respiratory Hazard Index), Traffic Proximity, Lead Paint, Superfund Proximity, RMP Facility Proximity, Hazardous Waste Proximity, Underground Storage Tanks, and Wastewater Discharges (information not available for Alaska).
[62] *Promising Practices for Environmental Justice Methodologies in NEPA Reviews: Report of the Federal Interagency Working Group on Environmental Justice and NEPA Committee.* Accessible at: https://www.epa.gov/sites/default/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.
[63] Executive Order 14008 (January 27, 2021). Tackling the Climate Crisis at Home and Abroad. Accessible at: https://www.regulations.gov/document/EPA-HQ-OPPT-2021-0202-0012.
[64] Executive Office of the President. Office of Management and Budget (July 20, 2021). Interim Implementation Guidance for the Justice40 Initiative. Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf (regarding how certain Federal investments might be made toward a goal that 40 percent of the overall benefits of such investments flow to disadvantaged communities). .

that the Final SEIS discuss what site-specific studies were considered or carried out, what issues these surveys identified, and what mitigation measures are being considered to address these impacts.

For the North Slope Borough communities, EPA conducted a preliminary focused EJScreen analysis for Nuiqsut, Kaktovik, Anaktuvuk Pass, Atqasuk, Wainwright, Point Lay, Point Hope, Utqiagvik, and Prudhoe Bay, applying a five mile radius, and identified low income and minority populations (Table 1). The focused EJ analysis identified high population of Alaska Native Tribes (minority populations) and low income populations when compared to state and national averages. EJ Indexes were at or above the 80th percentile for certain communities associated with exposure to lead paint, hazardous wastes, and air toxics.

Table 1. Focused EJ Analysis (EPA EJScreen applying a 5-miles buffer)
Identification of Minority and Low Income Populations in the North Slope Borough Communities

North Slope Borough	Population (5-mi. buffer)	Minority Populations (%)			AK Native (%)	White (%)	Low Income (%)			Household Income (%)	EJ Indexes (At or above 80%)
			AK	US				AK	US	Reported Non-Report	
Prudhoe Bay	374	19	39	40	11	83	9	25	31	0	All below
Utqiagvik (Barrow)	4,456	90			60	11	28			Reported 1356 (30%) Non-Report 3,100 (70%)	Lead Paint (98%) Air Toxics Cancer Risk (87%) Air Toxics Respiratory HI (84%)
Nuiqsut	398	83			75	17	32			Reported 93 (23%) Non-Report 305 (77%)	Lead Paint (86%) Hazardous Waste Proximity (80%)
Kaktovik	237	83			75	17	32			Reported 59 (25%) Non-Report 178 (75%)	Lead Paint (86%) Hazardous Waste Proximity (80%)
Atqasuk	193	94			89	6	31			Reported 41 (21%) Non-Report 152 (79%)	Lead Paint (89%)
Wainwright	460	94			89	6	31			Reported 108 (23%) Non-Report 352 (77%)	Lead Paint (89%)
Anaktuvuk Pass	321	83			75	17	32			Reported 81 (25%) Non-Report 240 (75%)	Lead Paint (86%) Hazardous Waste Proximity (80%)
Point Lay	188	92			80	8	47			Reported 48 (25%) Non-Report 140 (75%)	Lead Paint (87%)
Point Hope	671	92			80	8	47			Reported 152 (23%) Non-Report 519 (77%)	Lead Paint (87%)

EPA recommends that the Final SEIS evaluate whether EJ communities would be affected by direct, indirect, and/or cumulative actions associated with all Scenarios and determine whether there may be disproportionate adverse impacts, such as higher exposure to toxins; changes in existing ecological, cultural, economic, or social resources or access; cumulative or multiple adverse exposures from environmental hazards; or community disruption.

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EPA's Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts[65] presents research on the disproportionate risks to low-income and minority populations posed by climate change. The Draft SEIS[66] recognizes potential negative cumulative effects of climate change to North Slope communities. According to the Fourth National Climate Assessment,[67] the impacts of climate change will not be equally distributed across the U.S. population. Those who are already vulnerable due to a range of social, economic, historical, and political factors have a lower capacity to prepare for, cope with, and recover from climate change impacts. Understanding the comparative risks to vulnerable populations is critical for developing effective and equitable strategies for responding to climate change.

Public Health Impacts

The regional health data identified in the Draft SEIS indicates poor health outcomes for Alaska Natives compared to non-Alaska Natives statewide.[68] Several of these outcomes can be directly caused or exacerbated by environmental factors contributed by past and present oil and gas development on the North Slope. Impacts to air quality from the Action Scenarios may present an additional burden contributing to the disproportionately high health outcomes for Alaska Natives, including disproportionately high cancer rates, Chronic obstructive pulmonary disease (COPD) and Chronic Lower Respiratory Disease (CLRD).

The Alaska Department of Health and Social Services (ADHSS) highlighted various aspects of the health of Alaskans that are impacted by climate change, including mental health and well-being; accidents and injuries; exposure to hazardous materials; food, nutrition, and subsistence activities; infectious diseases and toxins; chronic diseases; water and sanitation; and access to health services.[69]

FERC's Final EIS included a Health Impact Assessment (HIA), which included baseline health data provided by the ADHSS.[70] The HIA rated impacts from Project construction as "high adverse" for one health effects category (infectious disease); "medium adverse" for three HECs (social determinants of health; accidents and injuries; and food, nutrition, and subsistence activity); and "low adverse" for four HECs. The HIA rated impacts from Project operation as "medium adverse" for three HECs (social determinants of health, accidents and injuries, and infectious disease) and "low adverse" for four HECs.

EPA is concerned that certain EJ and vulnerable communities may experience potential disproportionate high and adverse impacts to human health associated with past, present and cumulative effects from oil and gas development on the North Slope and other areas within the project area. As indicated in EPA's preliminary focused EJScreen analysis, the EJ Indexes for the eight North Slope Alaska Native communities represent a higher risk of exposure to lead paint, hazardous waste materials, and air toxics when compared to Prudhoe Bay, a non-Native area. Climate change may result in additional negative synergistic effects to human health.[71] EPA recommends that the Final SEIS include focused HIAs associated with Scenarios 2 and 3 for the North Slope Alaska Native communities, particularly Nuiqsut and Kaktovik.

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[65] EPA (2021). Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430-R-21-003. Accessible at: https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf.
[66] Draft SEIS; p. 4.20-19.
[67] U.S. Global Change Research Program (2018). Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. Accessible at: https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.
[68] Draft SEIS; p. 3.17-1 (Table 3.17-1).
[69] S. Yoder (2018). Assessment of the Potential Health Impacts of Climate Change in Alaska. Juneau, Alaska: Department of Health and Social Services Division of Epidemiology. Accessible at: https://www.commerce.alaska.gov/web/Portals/4/pub/Potential_Health_Impacts_ClimateChange1.2018.pdf.
[70] FERC/EIS-0296F (March 2020); Appendix V.
[71] The State of Alaska Epidemiology Bulletin, Volume 20, No 1 (January 8, 2018) *Assessment of Potential Health Impacts of Climate Change in Alaska.*

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The American Lung Association indicated that Alaska has some of the worst air quality in the nation. Fairbanks is Alaska's second largest city and is now the number one most polluted city for year-round particle pollution and ranks as the number four most polluted city in short-term particle pollution.[72]

A portion of the Fairbanks North Star Borough (FNSB), including the City of Fairbanks and the City of North Pole is designated a Clean Air Act Nonattainment Area for exceedances of the health based 24 hour $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) of 35 micrograms/m^3. Local emissions from wood stoves, burning distillate oil, industrial sources, and mobile emissions contribute to particulate pollution, are dangerous to public health and can increase the risk of premature death and other serious health effects, such as lung cancer, asthma attacks, cardiovascular damage, and developmental and reproductive harm.[73]

EPA recommends that the Final SEIS identify and discuss the FNSB Nonattainment Area and evaluate a focused HIA to address the potential health concerns to EJ and vulnerable populations in the Fairbanks community, as part of the midstream analysis. EPA recommends that the Final SEIS emphasize the mainline pipeline offtake and interconnections would provide natural gas to the FNSB and would improve air quality and public health by substituting cleaner burning natural gas with wood/coal burning heat stoves, and coal fired power generating facilities. The conversion to natural gas could result in reductions in particulate matter emissions, resulting in attainment of the NAAQS for particulate matter in the FNSB.

Subsistence

Pursuant to E.O. 12898, EPA recommends that the Final SEIS analyze the potential impacts specifically on subsistence hunters and related subsistence resources resulting from Action Scenarios 2 and 3, and determine whether disproportionate high and adverse effects may result. In particular, construction activities associated with the Action Scenarios could have negative impacts to subsistence hunters and their ability to access subsistence resources on the North Slope. Development of upstream production facilities and infrastructure may also facilitate travel into a subsistence use area from other communities or urban areas resulting in increased competition for local resources as developed areas could restrict access. Increases in trip frequency, length, and duration due to the factors described above could deplete reserves of fuel and increase competition for supplies that are necessary for subsistence activities.

The Subsistence Harvest Timing for the Alaska Native communities of Nuiqsut and Kaktovik were identified and discussed in the Draft SEIS. EPA recommends including similar information regarding subsistence harvesting for the other North Slope communities, such as Atqasuk, Anaktuvik Pass, Utqiagvik, Wainwright, Point Hope, and Point Lay, which engage in a subsistence-based economy and rely on subsistence hunting and harvesting of subsistence resources by following the traditional migration patterns of caribou herds on the Arctic Coastal Plain and Bowhead whales in the Chukchi and Beaufort Seas during the summer and fall seasons.

EPA does not agree with the assumption that "communities as a whole would use other areas within the region for subsistence, away from oil and gas development activities."[74] This sentiment is in direct contradiction of environmental justice principles and does not reflect an appreciation for subsistence users priorities and values. In order to address the impacts to subsistence hunters and resources, EPA recommends direct consultation and coordination with potentially affected subsistence communities,

[72] American Lung Association, 'Fairbanks Ranks as Most Polluted City in the Nation' (2018). Accessible at: https://www.lung.org/media/press-releases/fairbanks-ranks-as#:~:text=The%20American%20Lung%20Association's%20State.contributing%20to%20poor%20air%20quality.
[73] EPA information regarding Health and Environmental Effects of Particulate Matter (PM).
Accessible at: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.
[74] Draft SEIS; p. 4.22-1.

such as the Tribal Whaling Captains of the Alaska Eskimo Whaling Commission.[75] EPA recommends the establishment of an Alaska LNG Project Subsistence Advisory Group to address caribou subsistence hunting activities, which should include elders, village leaders, hunters, and youths.

Given the high nutritional and cultural value of subsistence foods and resources within Alaska, EPA recommends that the Final SEIS analyze the potential impacts of Scenarios 2 and 3 to the regional subsistence economies. EPA recommends that the Final SEIS consider the unique cumulative impacts caused by remote geography, regional food equity, and the importance of the traditional indigenous subsistence way-of-life activities of the North Slope Alaska Native communities. EPA recommends that the Final SEIS analyze the impacts that the Alaska LNG Project may have on the ability of these communities to maintain their traditional subsistence economies.

The Alaska LNG Project infrastructure has the potential to contribute to the loss of access to traditional subsistence areas. When subsistence foods are not available, nutritionally comparable substitutes must be purchased, which places additional direct financial burdens on subsistence users in the form of lost harvest, as well as an indirect burden from stranded assets that users purchase for hunting and harvesting activities (e.g., fuel, ammunition, snow machines, etc.). EPA recommends that the Final SEIS apply the replacement cost method (RCM) to quantify a lower bound of the monetary cost of replacing subsistence foods that may be impacted or lost due to project activities. RCM is a standard approach for monetizing ecosystem services.[76,77]

Meaningful Engagement and Outreach

Communities with environmental justice concerns include those overburdened, underserved, and vulnerable communities due to social, cultural, economic, and physical factors. Key characteristics may include the following: age (elderly or young); physical and mental disabilities; chronic health/medical conditions; cultural/religious beliefs; limited English proficiency and low education; and limited access to transportation. EPA notes that identifying and addressing concerns from communities of color, indigenous, low-income, overburdened, underserved, and vulnerable populations representing the local communities in Alaska regarding the EJ analysis/review may be challenging.

On July 2, 2021, DOE published in the Federal Register a Notice of Intent to prepare a SEIS for the Alaska LNG Project. The NOI did not provide for the public and stakeholders to submit scoping comments or other opportunities for meaningful engagement early in the NEPA project planning process to express concerns and to understand the potential public health and environmental risks unique to climate-related impacts particularly as concerns members of communities with environmental justice concerns. EPA recommends that the Final SEIS include discussions of ongoing efforts to incorporate EJ principles and strategies in the evaluation of the proposed project consistent with E.O.s 12898 and 14008.

EPA recommends that the Final SEIS include additional information describing what was or will be done to inform these communities with EJ concerns about the project and the potential impacts it will have on their communities; what input has been received to date from the communities; and how that

[75] The Alaska Eskimo Whaling Commission. Accessible at: http://www.aewc-alaska.org/.
[76] Brown, T.C., and Burch, E.S., Jr. 1992. Estimating the economic value of subsistence harvest of wildlife in Alaska. In: Peterson, G.L., Swanson C.S., McCollum, D.W., and Thomas, M.H., eds. Valuing wildlife resources in Alaska. Boulder, Colorado: Westview Press. 203–254. Accessible at: https://www.fs.fed.us/rm/value/docs/estimating_economic_value_subsistence_harvest_wildlife_alaska.pdf.
[77] C. Hougner, J. Colding, T. Söderqvist, (September 20, 2006). Economic valuation of a seed dispersal service in the Stockholm National Urban Park, Sweden, Ecological Economics, Volume 59, Issue 3, 2006, Pages 364-374, ISSN 0921-8009. Accessible at: https://doi.org/10.1016/j.ecolecon.2005.11.007.

input was or will be used in agency decision-making. This additional information would be useful for developing focused Community Profiles as part of the EJ analysis/review for the Alaska LNG project.

For the purpose of long-term monitoring, EPA recommends that the Final SEIS include evaluation and monitoring for EJ concerns during construction and operations of this project and implement adaptive management strategies to ensure that mitigation measures are effective in addressing the project impacts. EPA recommends that an Alaska LNG Project Environmental Justice Advisory Group be established to monitor and address potential EJ concerns throughout the active life cycle of this project in the impacted communities.

Indigenous Traditional Ecological Knowledge

Where appropriate and consistent with national policy and guidance, EPA recommends that the Final SEIS incorporate Indigenous Traditional Ecological Knowledge, as appropriate, to address EJ and Tribal concerns. Indigenous Traditional Ecological Knowledge (ITEK) has been recognized as an important body of knowledge that contributes to western scientific, technical, social, and economic advancements and to the collective understanding of the natural world.[78] ITEK includes observations, oral and written knowledge, practices, and beliefs that promote environmental sustainability and responsible stewardship of natural resources through relationships between humans and environmental systems.

The Fourth National Climate Assessment recognized and incorporated ITEK as an important information source for improving the understanding of climate change and environmental sustainability and for developing comprehensive climate adaptation and natural resource management strategies.[79]

EPA recommends that the Final SEIS identify and disclose how ITEK would be collected and incorporated to address public comments and EJ and Tribal concerns. In addition, EPA recommends that an ITEK Work Group be convened for the Alaska LNG Project to support the Final SEIS.

Tribal Consultation & Coordination

EPA encourages the DOE to consult with federally recognized Tribes and incorporate feedback from them when making decisions regarding this Project. EPA recommends that the Final SEIS describe the issues raised during the consultations and how those issues were addressed. As a general resource, EPA recommends reference to the document Tribal Consultation: Best Practices in Historic Preservation, published by the National Association of Tribal Historic Preservation Officers.[80]

Mitigation, Monitoring and Adaptive Management

Mitigation, monitoring, and adaptive management are particularly important in complying with NEPA requirements. The Draft SEIS (Table 4.19.5) identifies mitigation measures to minimize GHG emissions. EPA recommends that the Final SEIS describe how the agency has mitigated GHG emissions to the greatest extent possible, given that the current authorization for the Alaska LNG Project is to export 2.55 Bcfd of natural gas for 30 years.

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[78] White House Office of Science and Technology Policy and Council on Environmental Quality (CEQ) Memorandum on Indigenous Traditional Ecological Knowledge and Federal Decision Making (November 15, 2021).
Accessible at: https://www.whitehouse.gov/wp-content/uploads/2021/11/111521-OSTP-CEQ-ITEK-Memo.pdf.
[79] Fourth National Climate Assessment, Tribes and Indigenous Peoples, Volume II, Chapter 15 (2018),
Accessible at: https://nca2018.globalchange.gov/downloads/NCA4_Ch15_Tribes-and-Indigenous-Peoples_Full.pdf.
[80] National Association of Tribal Historic Preservation Officers (May 2005). Tribal Consultation: Best Practices In Historic Preservation.
Accessible at: http://npshistory.com/publications/preservation/tribal-consultation.pdf.

As discussed previously, the PBU Carbon Capture, Utilization and Sequestration would substantially mitigate direct GHG emissions associated with the Alaska LNG Project. EPA recommends that the Final SEIS disclose to the public and decision-makers additional opportunities to mitigate the project's GHG emissions, consistent with the goal of achieving net-zero emissions by 2050. Additional mitigation measures could include CCUS at the export facility, enhanced energy efficiency, lower-GHG-emitting technology, and sustainable land management practices. Finally, EPA recommends consider evaluating the LCA assumption of CCUS at the destination power generation facilities.

EPA recommends that the following additional mitigation, monitoring, and adaptive management measures also be evaluated in the Final SEIS, which could be included as special conditions to the DOE Alaska LNG Order, if reaffirmed or modified, to address specific concerns:

<u>GHG and Climate Change</u>

- Evaluate Project emissions targets and GHG emission reduction goals consistent with local, state, and national policies (2030/2050);
- Discuss mitigation and adaptive management measures to achieve net-zero carbon emissions by 2050, including a shorter Project authorization period to enable consideration of climate policy;
- Minimize and/or reduce operational system upsets, gas flaring and venting, valve leaks, etc.;
- Consistent with the U.S. Methane Emissions Reduction Action Plan, incorporate innovative technologies in leak detection and continuous monitoring programs for fugitive emissions (e.g., drones, optical and infrared, etc.)
- Commit to adopting relevant best practices and recommended technologies identified in EPA's voluntary methane programs - Methane Challenge and Natural Gas STAR, which could further reduce potential methane emissions;
- Consistent with CEQ's proposed guidance on CCUS, consider monitoring of CO_2 pipelines and sequestration networks to improve safety while also reducing the number of incidents that result in CO_2 leakage.
- Evaluate additional products in the LNG value chain, such as hydrogen, carbon containing products (cement, steel), fertilizer (nitrogen/ammonia, urea, potash), etc.

<u>Permafrost</u>

- Implement monitoring of permafrost down to the depth of the active layer and incorporate adaptive management to minimize thawing and thermokarsting of permafrost soils associated with project construction and operations. The FERC 2020 Final EIS discloses the potential for permafrost thaw and thermokarst impacts due to gravel roads and pads, other project infrastructure, dust deposition, and compaction due to ice roads and pads.

General Comments – Draft SEIS

The proposed Scenarios 2 and 3 would result in additional construction and operation associated with the Prudhoe Bay Unit, Point Thomson Unit, and Kuparuk River Unit developments, which would result in additional direct, indirect, and cumulative impacts. The impacts to resources have not been quantified to supplement the direct, indirect, and cumulative impacts identified and evaluated in the FERC Final EIS for the Alaska LNG Project. EPA recommends, as appropriate, incorporating quantitative estimates of the direct impacts (as well as indirect and cumulative, if available) for the following resources, consistent with the FERC Final EIS, for DOE's Final SEIS:

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Permafrost Soils

The FERC Final EIS indicated that Alaska LNG Project would result in significant long-term to permanent impacts on thaw sensitive permafrost (about 6,218 acres) and thaw stable permafrost (about 3,499 acres).[81] EPA recommends that the Final SEIS include similar estimates of the direct impacts to thaw sensitive permafrost and thaw stable permafrost resulting from the construction and operations from Scenarios 2 and 3, as well as indirect and cumulative impacts.

Water Resources

EPA recommends that the sources (e.g., lakes, ponds, rivers, groundwater, etc.) and volumes (gallons) of freshwater be identified and quantified in the Final SEIS that would be used for the construction of gravel and ice roads and pads, pipeline hydrostatic testing, and other uses resulting from the construction and operation from Scenarios 2 and 3, as well as indirect and cumulative impacts.

Wetlands

The FERC Final EIS indicated that the Alaska LNG Project would result in impacts to approximately 8,225 acres of wetlands. EPA recommends that the Final SEIS include similar estimates of the direct impacts to wetlands, as well as characterization of the types and the extent (acres) of wetlands impacted from Scenarios 2 and 3, as well as indirect and cumulative impacts. EPA recommends that the Final SEIS evaluate the impacts due to the loss of wetland functions, including but not limited to, carbon storage and sequestration, water quality improvement, biodiversity, and ecosystem services. In particular, wetlands are also a net source of GHG emissions, which should be discussed and estimated in the Final SEIS.

Air Quality

EPA recommends that the Final SEIS include National Ambient Air Quality Standards and Hazardous Air Pollutants modelling associated with the construction and operations of the proposed activities under Scenarios 2 and 3.

Specific Comments – Draft SEIS

Underground Injection Control - Safe Drinking Water Act

Draft SEIS; p 2-10.

The Draft SEIS states: "high-pressure gas condensate production field operated by ExxonMobil since 2016." EPA recommends clarifying that Hilcorp has assumed operations for PTU from ExxonMobil.

Draft SEIS; p. 2-31.

The Draft SEIS states: "Permitting authority for Class II injection wells has been delegated to the individual states, with oversight from USEPA." The authority is not delegated, rather the state is granted primary enforcement authority with EPA approval. Also, Idaho does not have Class II primacy. EPA recommends replacing this sentence with "Alaska, Oregon, and Washington have primary enforcement authority (primacy) for Class II injection wells, with oversight from USEPA."

[81] FERC/EIS-0296F Alaska LNG Project Final Environmental Impact Statement (March 2020); p. ES-4. Accessible at: https://www.ferc.gov/industries-data/natural-gas/environment/final-environmental-impact-statement-feis.

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Draft SEIS; p. 2-31.

The Draft SEIS states: "Under the UIC Program (40 CFR 147) the Region 10…" 40 CFR 147 lists EPA approved primacy programs. It is not clear why this reference is listed here. If DOE is trying to highlight the list of EPA-approved state UIC primacy programs, EPA recommends moving the citation or if planning to highlight the requirements of the Federal UIC program, EPA recommends including a reference to 40 CFR 124, 144, 146, and 148. Alternatively, the CFR reference could be deleted.

Draft SEIS; p. 2-33.

The Draft SEIS states: "Drill cuttings on the North Slope are typically disposed of through slurry injection into an approved Class II well." It's more accurate to say that wells are permitted (not approved). EPA recommends replacing "approved Class II well" with "permitted Class II well." EPA recommends clarification that this waste could be injected into either a Class I or Class II UIC well.

Draft SEIS; p. 2-33.

The Draft SEIS states: "Through a Memorandum of Agreement with the USEPA, the AOGCC has primacy for Class II wells in Alaska. The UIC program requires the AOGCC to verify the mechanical integrity of injection wells, determine if appropriate injection zones and overlying confining strata are present, determine the presence or absence of freshwater aquifers, and ensure their protection, and prepare quarterly reports of both in-house and field monitoring for the USEPA." The terminology used here is not accurate. It's not clear what you would like to convey with this information. AOGCC has been granted primary enforcement responsibility (primacy) by EPA and is therefore administers the Class II program wells in Alaska. The MOA is one part of their EPA-approved UIC program. EPA recommends replacing the statement on the MOA with a statement that conveys that AOGCC has an EPA-approved UIC program and is the permitting authority for Class II wells in Alaska. EPA recommends replacing "The UIC program requires the AOGCC to…" with "AOGCC verifies the integrity…"

Draft SEIS; p. 2-33.

The Draft SEIS states: "The SDWA (under 40 CFR 144) administers the USEPA UIC Program…". This sentence is confusing because the statute does not administer a regulation; rather, the relevant regulatory authority does. EPA recommends using a different wording, such as "The SDWA authorizes USEPA to establish minimum federal requirements for UIC programs."

Draft SEIS; p. 2-33.

The Draft SEIS states: "Class VI injection wells must also comply with 40 CFR 146.91 in spite of any state program approvals." This sentence is confusing. First, it is not clear why the word "also" is used because the previous sentence was simply describing the SDWA generically. Second, it is not clear why the phrase "in spite of any state program approvals" is mentioned in this sentence as 40 CFR 146.91 describes the minimum reporting requirements for each permitted Class VI well. It is also not clear why a specific requirement for Class VI is called out in this section. EPA recommends elaboration if the word "also" is kept in the sentence. Delete the phrase "in spite of any state program approvals."

Draft SEIS; p. 3.18-5.

The Draft SEIS states: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under the SDWA. USEPA currently has the authority to issue and administer the required UIC permits." EPA recommends clarification that natural gas could be injected under a Class I UIC permit from EPA or under a Class II UIC permit from AOGCC.

Draft SEIS; p. 4.19-5.

The Draft SEIS notes that a mitigation measure for minimizing GHG emissions could include developing and implementing a US EPA-approved monitoring, reporting and verification plan for CO_2 injection wells per Subpart RR of the Mandatory Reporting of Greenhouse Gases Rule. Subpart RR requirements are focused on accounting of amounts of CO_2 that are geologically sequestered, but do not contain control requirements. EPA recommends describing how this measure would be used to mitigate and minimize GHG emissions.

Draft SEIS; p. 5-4 (Table 5-1).

The section describing UIC requirements contains the following sentence at the end of the discussion of Class VI wells: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under SDWA." This sentence is relevant to UIC wells generally and not just Class VI. EPA recommends that this sentence be provided as a separate paragraph or integrated into the introductory paragraph.

Draft SEIS; p. 5-4 (Table 5-1).

The Draft SEIS Table indicates: "USEPA has primacy of the UIC Program…" and "permitting authority for Class II injection wells is given to ADEC, with oversight from USEPA." This language does not accurately describe the authority or transfer of authority to states. EPA recommends making the correction to "USEPA is the permitting authority for the UIC Program in …" and "Primary enforcement authority was granted to Alaska by USEPA. USEPA continues oversight of the state primacy program."

Draft SEIS; p. 5-4 (Table 5-1).

The Draft SEIS Table indicates "USEPA has primacy" over Class VI injection wells. States can have primacy whereas EPA retains direct implementation authority. EPA recommends clarifying this sentence that this does not apply to all states. EPA recommends the change to "USEPA is the permitting authority for Class VI injection wells in the State of Alaska."

Draft SEIS; p. 5-4 (Table 5-1).

The Draft SEIS states: "Construction and operation of CO_2 and natural gas injection wells would require the issuance of UIC permits in accordance with 40 CFR 146 under SDWA." EPA recommends removing "under SDWA" from this sentence.

<u>Water Resources</u>

Draft SEIS; p. 4.3-5.

The Draft SEIS states that no floodplain mapping exists for the North Slope, therefore, potential impacts to floodplains due to upstream development are not assessed. EPA recommends discussing and evaluating potential flood related risks to additional infrastructure proposed in Scenarios 2 and 3, such as from ice road river/stream crossings.

Draft SEIS; p. 4.3-5 to 4.3-7 (Table 4.3-2 and 4.3-3).

The Draft SEIS states that several times water use is addressed with "Permitted water sources recharge annually, so no long-term reduction in water availability would be anticipated." We recommend identifying in this section what the permit(s) is/are that would ensure this.

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Draft SEIS; p. 4.4-2 to 4.4-3 (Table 4.4-2 and 4.4-3).

In both tables, when describing potential impacts of expansion of gravel pads, the Draft SEIS states "Implementation of the plans and mitigation measures outlined in Section 4.4.5 would reduce these impacts to less-than-significant levels." Section 4.4.5 describes plans to be prepared, but does not explicitly describe any mitigation measures that will be taken to successfully reduce impacts to "less-than-significant levels." EPA recommends that the Final SEIS include the specific mitigation measures that will be implemented to reduce impacts.

Air Quality

Draft SEIS; p 3.15-2 (Table 3.15-1).

The footnotes to the table refer to NAAQS being determined at monitors. Although these references correctly indicate the method in which attainment may be determined by a state program, it may be misleading to the public in this context because the NAAQS apply to all areas of ambient air, regardless if a monitor is present to determine attainment. EPA recommends the footnotes be edited to remove the references to monitors, similar to how the form of the NAAQS are described on the EPA NAAQS table.[82]

Draft SEIS; p. 4.15-6.

This section notes that air quality impact analysis was carried out in a resource report for upstream activities. Construction emissions, reported in Table 4.15.-5, are relatively high and could cause concern for ambient impact. EPA recommends that the Final SEIS briefly disclose and discuss the maximum ambient impacts expected from the project, using the results from the air quality analysis resource report, to demonstrate why the impacts will be less-than-significant, as indicated in Tables 4.15-3 and 4.15-4.

Draft SEIS; p. 4.15-7 (Table 4.15-6).

EPA recommends adding a "total emissions" row for PTU, PBU, KRU and a "total emissions" row for the sum of all three unit emissions together to provide disclosure of total airshed increase in emissions during construction. The SEIS should clarify whether these values represent maximum annual emissions during the construction period or average annual emissions.

Draft SEIS; p. 4.15-7 (Table 4.15.5).

EPA recommends that the table be labeled to identify the values representing the change in annual emissions from baseline.

Draft SEIS; p. 4.20-16.

Construction emissions included an over 10,000 tpy increase in regional NOx, over 500 tpy increase in regional $PM_{2.5}$, and over 1,500 tpy increase in regional PM_{10} over a multi-year period. The Draft SEIS does not currently provide a basis to explain why these emissions are not cumulatively significant. EPA recommends leveraging existing regional models, such as that developed by the Alaska Bureau of Land Management North Slope Regional Air Quality Modeling (NSRAQM)[83] Study 2020 for the North Slope Science Initiative. This study was conducted to estimate regional impacts, particularly secondary air pollutants such as ozone and $PM_{2.5}$, since the resource report model results already show primary criteria

[82] USEPA. 2022b. NAAQS Table. Accessible at https://www.epa.gov/criteria-air-pollutants/naaqs-table.
[83] Alaska BLM North Slope Regional Air Quality Modeling (NSRAQM) Study 2020, as part of the North Slope Science Initiative. Accessible at: https://catalog.northslopescience.org/dataset/3000.

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air pollutant increases to not cause significant impacts. The NSRAQM Study provides an incremental increase in ozone and $PM_{2.5}$ impact regionally from a base and future year, assuming a given increase in annual emissions; these data could be leveraged to provide an estimate of cumulative impacts from project upstream developments.

Oil Spill Prevention and Preparedness – CWA 311

Draft SEIS; p. 2-10.

As we understand, the Point Thomson Unit (PTU) is SPCC-subject at this time. If the aggregate oil storage at the PTU reaches one million gallons or more, then a Facility Response Plan (FRP) will need to be prepared and submitted to EPA's R10 office in Anchorage, AK. See 40 CFR 112.20(a)(2(iv).

Draft SEIS; p. 2-34.

The narrative on spill reporting should also refer to 40 CFR 110 reporting requirements to the National Response Center (NRC) as well as the Spill Prevention, Control and Countermeasure (SPCC) reporting requirements under 40 CFR 112.4(a) and (c). EPA recommends adding a reference to federal spill reporting requirements to the narrative in Section 2.7.

Draft SEIS; p. 3-18.6.

This section should refer to the SPCC requirements for onshore oil drilling and workover facilities at 40 CFR 112.10. EPA recommends adding the referenced citation to the narrative in Section 3.18.3.2.

Draft SEIS; p. 4.3-8.

In Section 2.2.1.1 Point Thomson Unit (PTU), there is a reference for the need of an SPCC plan and FRP. EPA recommends adding a reference to FRP requirements in this narrative in Section 4.3.5.

Draft SEIS; p. 4.17-1.

This section should also refer to SPCC and FRP requirements at 40 CFR 112. Note that in Chapter 5.0, Table 5-1 (Relevant Regulatory and Permit Requirements for Upstream Activities), SPCC and FRP requirements under CWA Section 311 are referenced. EPA recommends adding a reference to SPCC and FRP requirements in this narrative in Section 4.17.2.

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Vasilios Gialopsos – Department of Natural Resources

PUBLIC SUBMISSION

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Submitter Information

Email: dnr.commissioner@alaska.gov
Government Agency Type: State
Government Agency: State of Alaska, Department of Natural Resources, Office of the Commissioner

General Comment

Please see the attached comment from the State of Alaska, Department of Natural Resources.

Attachments

8.15.22 Alaska LNG Supplemental EIS

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Natural Resources

OFFICE OF THE COMMISSIONER

550 West 7th Avenue, Suite 1400
Anchorage, AK 99501-3561
Main: 907.269.8431

August 15, 2022

U.S. Department of Energy
National Energy Technology Laboratory
ATTN: Mark Lusk, NEPA Compliance Officer
3610 Collins Ferry Road
Morgantown, WV 26505

Re: Alaska LNG Supplemental Environmental Impact Statement

Dear Mr. Lusk:

The State of Alaska Department of Natural Resources (DNR) submits this letter of support for the Alaska LNG project and, subject to the following comments, the July 2022 Supplemental Environmental Impact Statement (SEIS) prepared by the U.S. Department of Energy (DOE). We encourage DOE to timely complete this review and affirm the order authorizing export of LNG for the Alaska LNG project. Specifically, we believe the analyses contained in the SEIS strongly supports a conclusion that the export of LNG from Alaska through the Alaska LNG project is in the public interest because of its limited and mitigatable environmental impacts, and its positive environmental and economic benefits.

DNR appreciates the information DOE has gathered confirming that the Prudhoe Bay Unit and Point Thomson Unit have sufficient natural gas volumes available to facilitate the exports contemplated by the project. DNR also appreciates DOE's analysis of the Environmental Impacts from North Slope development associated with the Project and agrees with the conclusion that impacts of the project will be less-than-significant or negligible across all nineteen categories evaluated. For many of these categories and areas, DNR has the primary responsibility of managing and mitigating impacts associated with the project in most areas. DNR anticipates a continued effort with the project, consistent with the SEIS, the Final Environmental Impact Statement published by the Federal Energy Regulatory Commission in March 2020, and State of Alaska laws and regulations, to ensure this responsibility is robustly carried out.

Regarding lifecycle greenhouse gas emissions, DNR agrees with the conclusion reached by DOE – that construction and operation of the Alaska LNG project will result in benefits in greenhouse gas emissions, primarily associated with markets that are able to utilize Alaska-sourced natural gas rather than alternative natural gas sources or alternative forms of energy. However, DNR notes that an analysis of this scope may not be a valid basis for federal decision making outside of direct statutory or regulatory authority and reserves the right to challenge its incorporation in future analyses. The

Department of the Interior, in an ongoing National Environmental Policy Act (NEPA) review, has in fact acknowledged this issue, stating: "*Due to past court decisions of impacts on non-OCS activities and pending litigation on the social cost of carbon, this section [Oil and Gas Program Life Cycle GHG Emission Estimates] is not being used for decision making on the National OCS Program.*"[1]

Finally, we appreciate DOE's acknowledgement of the social and economic benefits that the project can provide, both in terms of economic activity and energy supplies for in-state use. Additionally, DNR is in the process of assessing the carbon capture, utilization, and storage potential of both the North Slope and Cook Inlet, and how the state would best manage a regulatory framework to support development of these activities. While not necessary for analysis by DOE, this and other developments will even further strengthen the environmental case for the development of Alaska's natural gas resources.

Sincerely,

Vasilios Gialopsos
Acting Commissioner

[1] Department of the Interior Bureau of Ocean Energy Management Draft Programmatic Environmental Impact Statement for the 2023-2028 National Outer Continental Shelf Oil and Gas Leasing Program, Chapter 2, page 30. https://www.boem.gov/sites/default/files/documents/oil-gas-energy/national-program/2023-2028-NationalOCSOilGasLeasingDraftPEISVol1.pdf

Robert Henszey – U.S. Fish and Wildlife Service

From: Lusk, Mark W.
To: Robert Naumann; Melissa Secor
Subject: FW: Letter delivered to Kenai NWR
Date: Wednesday, June 29, 2022 8:51:19 AM
Attachments: 20220624 DOE SEIS for AK LNG Available 20220701.pdf

FYI – see address correction below

From: Henszey, Bob <bob_henszey@fws.gov>
Sent: Tuesday, June 28, 2022 9:31 PM
To: Lusk, Mark W. <Mark.Lusk@NETL.DOE.GOV>
Subject: [EXTERNAL] FW: Letter delivered to Kenai NWR

Hello Mark,

Could you please update my physical mailing address to the Fairbanks address listed below in my signature line? The last two lines are for our Kenai National Wildlife Refuge.

My office will be doing the "heavy lifting" for the AK LNG SEIS review with help from our Air Quality Branch in Fort Collins.

Thanks,
Bob

Robert J. Henszey, Ph.D.
Branch Chief
Conservation Planning Assistance
US Fish & Wildlife Service
101 12th Avenue, Room 110
Fairbanks, AK 99701
Phone: 907-456-0323, Fax: 907-456-0208
Bob_Henszey@fws.gov

"Water Always Wins," Dr. Who 2009.11.15

From: Lutto, Ashley L <ashley_lutto@fws.gov>
Sent: Tuesday, June 28, 2022 11:22 AM
To: Henszey, Bob <bob_henszey@fws.gov>
Subject: Letter delivered to Kenai NWR

Hi Bob,

We received a letter from Department of Energy/NETL addressed to you at our Po Box here in Soldotna. Do you want me to scan and email you a copy or forward the letter to your physical address?

Take care,
Ashley

Ashley Lutto *(she/her)*
Administrative Support Assistant
Kenai National Wildlife Refuge
PO BOX 2139 / 33398-B Ski Hill Road
Soldotna, AK 99669
Office: (907) 260-2803
Cell: (907) 953-2508

Pasquale Scida – U.S. Department of Interior

United States Department of the Interior
OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
1011 E. Tudor Road
Anchorage, Alaska 99503

August 12, 2022

IN REPLY REFER TO:
ER 22/0290

Mark Lusk
NEPA Compliance Officer
3610 Collins Ferry Road
Morgantown, WV 26505

Subject: Alaska Liquified Natural Gas (LNG) Project Draft Supplemental Environmental Impact Statement

Dear Mark Lusk:

The U.S. Department of the Interior (DOI) has reviewed the U.S. Department of Energy's (DOE) Draft Supplemental Environmental Impact Statement (Draft SEIS) for the proposed Alaska LNG Project (proposed project). The DOI provides the following comments and recommendations, which are submitted in accordance with the provisions of the National Environmental Policy Act of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d), Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Marine Mammal Protection Act (16 U.S.C. 1361-1407), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Alaska National Interest Lands Conservation Act (ANILCA; 94 Stat. 2371), National Wildlife Refuge System Administration Act of 1966 (68 Stat. 718, as amended; 16 U.S.C. 668 et seq.), Clean Air Act (42 U.S.C. §7401 et seq.), and Wilderness Act (16 U.S.C. §1131 (1997)).

The Draft SEIS addresses potential upstream environmental effects associated with incremental natural gas production on the North Slope of Alaska. The Draft SEIS also includes a life cycle analysis (LCA) calculating greenhouse gas (GHG) emissions associated with exporting LNG from the proposed project. Specifically, the LCA examines the life cycle GHG emissions for LNG exported from Alaska by vessel to import markets in Asia and potentially in other regions. The DOI appreciates the opportunity to re-examine the project's potential effects to DOI trust resources as they relate to GHG emissions resulting from specific aspects of the proposed infrastructure in Alaska.

Background

Multiple DOI bureaus, including the U.S. Fish and Wildlife Service (USFWS), have participated as cooperating agencies for the Alaska LNG Project. The DOI and its bureaus previously commented on the proposed project from 2014 to 2019 in regard to scoping, draft resource reports, and formal comments on the 2019 Draft Environmental Impact Statement (EIS). In the

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attached enclosure, the DOI re-submits our prior comments on the Draft EIS (dated November 4, 2019) with particular emphasis on the proposed project's potential effects to USFWS trust resources (see Enclosure 2 of the 2019 letter for specific comments).

The DOI's trust resources include natural resources that USFWS is entrusted to protect for the benefit of the American people. Within the proposed project area, these resources include species listed as threatened or endangered under the ESA and their designated critical habitat, migratory birds (including bald and golden eagles), certain marine mammals, inter-jurisdictional fish, wetland habitats used by these species, and lands managed by the USFWS (i.e., national wildlife refuges). Additionally, the DOI's U.S. Geological Survey (USGS) possesses technical expertise in geology and conducts field-based research assessing the oil and gas resources of Alaska's North Slope.

General Comments

The following comments and recommendations on the Draft SEIS address the need to protect DOI trust resources, minimize GHG emissions, and avoid and minimize the proposed project's potential impacts on fish and wildlife habitat.

<u>Threatened and Endangered Species</u>

The purpose of the ESA is to conserve threatened and endangered species and the ecosystems upon which they depend. Projects that may affect listed species and/or designated critical habitat must be evaluated under section 7(a)(2) of the ESA to ensure Federal agencies authorizing, funding, and/or conducting projects are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. In this case, ESA-listed species and/or designated critical habitat occur within the project area, and we understand consultation was completed June 17, 2020. If the project plans change after this consultation was completed, the DOI recommends contacting the USFWS Northern Alaska Fish and Wildlife Field Office, Consultation Branch at 907-456-0277, for additional guidance.

<u>Wetlands and Permafrost</u>

Wetlands are important habitats for DOI trust resources throughout the proposed project area. On the North Slope, wetland resources are formed primarily from permafrost-related landforms (defined as soils $\leq 0°$ C for ≥ 2 years), such as patterned ground (polygonal wetlands), thaw lakes, and beaded streams. These wetlands occur within the proposed project area's Region of Influence (ROI), including the Point Thomson, Prudhoe Bay, and Kuparuk River Oil and Gas Lease Units and existing pipeline right of ways. They provide important and unique habitats for a variety of wildlife species designated as DOI trust resources.

In the Arctic, climate and disturbance affect habitats through the interdependencies of permafrost, hydrology, and vegetation. While extensive permafrost on the North Slope provides resilience for this landscape, anthropogenic disturbance, such as trenching, causes degradation of permafrost soils and can result in irreversible hydrologic and biologic impacts to wildlife habitats. Climate change and industrial development on the North Slope can exacerbate these

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impacts through further degradation of permafrost soils and alteration of hydrology (Raynolds et al. 2014).

Within the ROI, the Draft SEIS summarizes the type and area of wetlands in the pipeline right of way (Table 3.4-1) as comprised primarily of Freshwater Emergent Wetlands (917.5 acres or 95% of total wetland ROI acreage). These wetlands typically consist of deep, frozen peat substrates called Histels, overlain with thick vegetative mats or tussocks of graminoid/moss cover. These deep peat wetlands are generally considered carbon sinks (Schuur et al. 2018). In northern wetlands, cold temperatures and water saturation drastically slow carbon decomposition, so they are even more efficient at accumulating carbon than temperate peatlands (Mitsch and Gosselink 2007; Holden 2005). In lower latitudes, total carbon budget (total soil carbon after sequestration gains verses metabolized and respired losses) in peatlands has been estimated at 3.178 ± 0.309 grams of carbon per acre, with 90 to 99% of that carbon found in peat soils that ranged from 1 to 5 m in depth (Weishampel et al. 2009). On average, northern peatlands sequester carbon at a rate of 22,700 to 153,800 grams per acre per year (23 to 154 kilograms per acre per year) (Yu et al. 2011).

Within the ROI, the proposed project could result in the potential permanent loss of 917 acres of peat wetlands, which represent approximately 20,800 to 141,000 kilograms of carbon emissions that would otherwise be sequestered from the atmosphere per year. These wetlands are also essential habitats to the DOI's trust species, providing habitat for migratory birds, bald and golden eagles, anadromous fish, and the food webs that support them. Although avoidance and some mitigative actions are included in the proposal, the amount of permanent wetland loss associated with this project is large and will likely result in cumulative negative effects to trust species reliant upon these habitats as well as a reduction in the ecosystem's capacity to sequester carbon.

The wetlands described above are not only a storehouse of atmospheric carbon (Gorham 1991) sequestered over time by peat-forming vegetation and frozen into place, but they also represent a potential source of emissions into the atmosphere (Schuur et al. 2018). Trenching in permafrost soils increases the potential for thermokarst (i.e., subsidence produced by melting ice in permafrost) above the buried utility (Hjiort et al. 2018; Kanevski et al. 2017). The alteration of soil ice to water triggers a cascade of changes in the substrate resulting in alteration and even drainage of important wetland habitats relied upon by trust species. While permafrost soils can either be thaw-stable or thaw-sensitive, the majority of the ROI are considered thaw-sensitive (EIS 2020).

A growing body of data indicates that surface disturbance and subsequent thermokarst activity in these ancient soils cause the release of carbon in the form of the potent GHGs, carbon dioxide (CO_2) and methane (CH_4) (Gao et al. 2013; Riley et al. 2011), as well as sequestered atmospheric nitrogen in the form of nitrous oxide (N_2O) (Voigt et al. 2017). Studies from nearby Utqiaġvik, Alaska, show thawing permafrost has the potential to increase CH_4 emissions by around 30% (Lara et al. 2019). These GHG emissions occur when frozen peat soils are stripped of their insulative vegetative mat and exposed to warmer in-situ temperatures. The practice of burying utility lines triggers this process and has a very high likelihood of increasing the local rate of GHG emissions. Although nitrogen dynamics are uncertain, the release of carbon to the atmosphere from melting permafrost and soil decomposition is far greater than the increased uptake of carbon from vegetative growth resulting from an increase in the availability of nitrogen (Koven et al. 2015).

The DOI has observed several additional problems with trenching utilities (e.g., pipelines and cables) in permafrost soils compared to elevating the utilities on Vertical Support Members (VSMs) or by other means. Trenching in permafrost soils will result in subsidence causing local changes in drainage patterns and irreparable impacts to wetland habitats for fish and wildlife (Figure 1). Once subsidence occurs, thermokarst becomes very difficult, if not impossible, to restore to its previous state. Climate change, with warming temperatures and longer periods of thaw, exacerbates the formation of thermokarst landforms. Hence, maintaining the integrity of the insulating active layer is critical (Raynolds et al. 2014), especially in regard to construction and maintenance of infrastructure in areas of continuous and discontinuous permafrost. These changes in hydrology across the landscape can have irreversible effects on wildlife, especially migratory species, which rely on consistent conditions during migratory stopovers for feeding, breeding, and rearing habitats.

The DOI recommends avoiding impacts to permafrost soils in the ROI wherever possible, thereby maintaining natural hydrology and fish and wildlife habitats. As stated above, trenching the pipeline through permafrost soils will likely lead to GHG emissions, irreversible subsidence of tundra, alteration of the existing hydrologic flow, significant habitat degradation, and a reduction in the region's ability to sequester atmospheric carbon. Therefore, we recommend placing the proposed pipeline on VSMs throughout areas comprised of permafrost soils. An example to emulate is the Trans-Alaska Pipeline, which has used VSMs for more than 40 years to avoid thermokarst issues. This VSM use has also served to minimize GHG emissions by reducing thermokarst processes. The DOI also recommends avoiding thaw-sensitive permafrost soils, typically found in Histels. Restricting trenching activities to areas with 'thaw-stable' permafrost with coarse substrates is less likely to cause subsidence or thermokarsting. This is also true for areas of discontinuous permafrost south of the Alaska Range (outside of this ROI). Examples of thaw-stable permafrost include the Sagavanirktok River and adjacent floodplain, or other rivers with heavy bed loads, deep gravels, and coarse substrates. Spring flooding and ice flow within the river may cause erosion and/or upheaval of the pipeline, so the pipeline in these areas (e.g., floodplain) should be buried below the maximum scour depth expected in the channel to protect the pipeline as the channel meanders across the floodplain.

Compensatory mitigation for the permanent loss of wetland functions, including carbon sequestration, should be required (Page and Wilcher 1990). The DOI recommends offsetting GHG emissions by compensating for wetland losses and inevitable permafrost subsidence in thaw-sensitive soils due to pipeline burial. Purchasing wetland credits of similar 'peatlands,' even far removed from the project footprint, will help achieve a no 'net gain' of GHG emissions to the atmosphere by replacing lost on-site carbon sequestration with off-site carbon sequestration. Purchasing compensatory mitigation credits will additionally support a no net loss of habitat for trust species, which is important even though it would likely occur off-site. Carbon credits are being developed in certain jurisdictions for the purpose of offsetting 'new' GHG emissions that would, but for the proposed action, remain sequestered in frozen peat.

Figure 1. Ponding in wetland tundra along a utilities trench with mounded overburden to compensate for subsidence (left). Advanced subsidence and vertical erosion due to trenching and subsequent thaw of ice-rich permafrost on an incline (right). Both examples underwent several restoration attempts prior to photograph dates.

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Specific Comments

The DOI offers additional, specific comments below on the Draft SEIS Volume II, Appendix B North Slope Production Study.

B2. Production Report 2, Section 6.4 CO_2 Prophet Model, Page 20-21: The Draft SEIS describes reservoir modeling in this section. The CO_2 Prophet reservoir model is used routinely for reconnaissance-level assessments. The CO_2 Prophet model was designed to work with vertical-well CO_2-EOR injection and production patterns. The reservoir model may not work well with CO_2-miscible reservoirs developed with horizontal and deviated wells, such as those used to develop fields on the North Slope of Alaska (Warwick et al., 2019). The DOI recommends the DOE consider adding a discussion in the Final SEIS of the limitations of using the CO_2 Prophet reservoir model to estimate oil recovery and CO_2 retention in Kuparuk River oil reservoir which utilize horizontal and deviated wells.

B3. Production Report 3, Section 8.2 Sector Model Design, Page 25: The Draft SEIS notes a sector model was constructed to represent storage patterns. The DOI recommends the DOE mention what modeling software was used to create the sector storage model in the Final SEIS.

We appreciate this opportunity to provide comments and recommendations, and we would welcome an opportunity to discuss our comments with you. Should the project plans change, we would appreciate an opportunity to review the changes. For questions concerning the general comments, please contact Bob Henszey, USFWS Conservation Planning Assistance Branch Manager, at (907) 456-0323 or bob_henszey@fws.gov, or Amy Tippery, USFWS Biologist, at (907) 456-0558 or amy_tippery@fws.gov. If you have any questions regarding the specific comments, please contact Jon Janowicz, USGS Manager for Environmental Document Reviews, at (609) 771-3941 or jjanowicz@usgs.gov.

Sincerely,

PASQUALE SCIDA Digitally signed by PASQUALE SCIDA
Date: 2022.08.12 21:00:06 -04'00'

Pat Scida
Acting Regional Environmental Officer - Alaska

Electronic distribution:

Enclosure:
DOI Comments on Alaska LNG Project Draft EIS, November 4, 2019

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Enclosure

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
1689 C Street, Suite 119
Anchorage, Alaska 99501-5126

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November 4, 2019

Kimberly D. Bose
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: COMMENTS on Draft Environmental Impact Statement for the proposed Alaska LNG Project, FERC No: CP17-178-000

Dear Secretary Bose:

The U.S. Department of the Interior (DOI) has reviewed the Federal Energy Regulatory Commission's (FERC) Draft Environmental Impact Statement (EIS) released on June 28, 2019, for the Alaska Liquefied Natural Gas (LNG) Project (Project) proposed by the Alaska Gasline Development Corporation (AGDC). The DOI appreciates the opportunity to provide comments and recommendations, which are submitted in accordance with the National Environmental Policy Act (83 Stat. 852; 42 U.S.C. 4321 et seq.; NEPA), National Park Service Organic Act (16 U.S.C. § 1 et seq.), Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.; ESA), Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d), Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Marine Mammal Protection Act (16 U.S.C. 1361-1407; MMPA), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Federal Land Policy and Management Act (43 U.S.C. § 1732; FLPMA), Mineral Leasing Act (30 U.S.C. § 185; MLA), Alaska National Interest Lands Conservation Act (94 Stat. 2371; ANILCA), National Wildlife Refuge System Administration Act (68 Stat. 718, as amended; 16 U.S.C. 668 et seq.), Clean Air Act (42 U.S.C. §7401 et seq.), Wilderness Act (16 U.S.C. §1131), National Historic Preservation Act (16 U.S.C. § 470 to 470w-6; NHPA), and National Invasive Species Act (16 U.S.C. 4701 et seq.).

The FERC is the lead federal agency developing an EIS to assess the impacts of constructing and operating the proposed Alaska LNG project, FERC docket CP17-178. There are ten cooperating agencies with jurisdiction by law or special expertise with respect to environmental resources and impacts associated with the Project. These agencies, which include the DOI's Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (FWS), and National Park Service (NPS), have provided comments, suggestions, and recommendations throughout the development of the Draft EIS.

From 2014 through 2018, the FWS submitted approximately 30 documents to the FERC ranging from formal letters to comment matrices and emails containing comments. They provided scoping comments in mid-2014, followed by a number of comments on draft resource reports from late 2014 through 2016. The FWS also provided comments on individual chapters of the Draft EIS during its development in 2018. In addition, they participated in several cooperating agency meetings with the FERC and individual planning meetings with the AGDC to discuss mitigation measures for FWS trust resources.

The NPS has been a cooperating agency on this EIS for the Alaska LNG project since April 14, 2017, and the FERC has been very responsive to many NPS comments on previous drafts, which were largely incorporated in the Draft EIS. In the Draft EIS, the FERC proposed the Denali Alternative as a minor route modification for the natural gas pipeline to go through Denali National Park and Preserve (DNPP).

The AGDC submitted an application to the BLM for a right-of-way (ROW) across federal lands for the Project's main natural gas pipeline. The EIS is a necessary component of the ROW decision process, and the BLM has participated as a cooperating agency in all phases to date. Their enclosed comments are provided to ensure that the Final EIS will allow the BLM to issue a decision in compliance with NEPA.

Background

The AGDC is requesting authorization from the FERC to construct and operate new gas treatment facilities on the North Slope and an 806.6-mile-long, 42-inch-diameter natural gas pipeline from Prudhoe Bay to a liquefaction facility at Nikiski, Alaska. From Nikiski, tanker ships would transport the natural gas through Cook Inlet for export. Additional infrastructure would include a 62.5 mile, 32-inch-diameter natural gas pipeline from Point Thomson to Prudhoe Bay and eight compressor/heater stations between Prudhoe Bay and Nikiski.

Project construction would impact about 35,548 acres of land, with approximately 8,504 acres retained for project operation. About 16,479 acres would be permanently affected beyond the 30-year life of the Project. Additionally, the Project would result in significant long-term to permanent impacts on thaw sensitive permafrost (6,377 acres), thaw stable permafrost (3,415 acres), and forest (12,474 acres) as well as convert about 4,162 acres of wetland to upland. The pipeline would also cross six major rivers (i.e., the Middle Fork Koyukuk, Yukon, Tanana, Nenana, Chulitna, and Deshka Rivers).

In the Draft EIS, the Denali Alternative, the minor route modification through DNPP was analyzed. On August 16, 2019, during the public review period for the Draft EIS, the AGDC informed the FERC that they were adopting the Denali Alternative route into the Mainline route, and the FERC has indicated that this change requested by the applicant would become effective immediately.

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General Comments

Below, the DOI offers comments on the Draft EIS, emphasizing issues related to fish and wildlife resources, cultural resources, and conservation units managed by the FWS, the NPS, and the BLM. Given each bureaus' unique authorities and trust responsibilities, by necessity these comments frequently highlight specific issues that are of greatest importance to each bureau. Where applicable, we also highlight issues shared by two or more bureaus.

Fish and Wildlife Resources

The three DOI bureaus serving as cooperating agencies for the proposed Project manage fish and wildlife resources on their respective conservation units. Additionally, the FWS has specific species management responsibilities, described below.

The FWS's trust resources are natural resources they are entrusted to protect for the benefit of the American people. Within the proposed Project area, these include species listed as threatened or endangered under the ESA and their designated critical habitat, migratory birds (including bald and golden eagles), certain marine mammals protected under the MMPA, inter-jurisdictional fish, wetland habitats used by these species, and lands managed by the FWS (e.g., national wildlife refuges).

Threatened and Endangered Species: The FWS received a Biological Assessment (BA) and request to initiate formal consultation pursuant to section 7(a)(2) of the ESA on July 11, 2019. After reviewing the BA (also provided in the Draft EIS Appendix O), the FWS requested additional information regarding the project description on July 31, 2019. Once this information is received and the initiation package is deemed complete, formal ESA consultation can be initiated.

Caribou: The DOI recognizes the State of Alaska is the primary manager of caribou in the state and that caribou are not a federal trust resource. However, the Central Arctic caribou herd's annual range and seasonal migration routes include refuge lands, so the FWS offers some recommendations to help minimize potential impacts related to National Wildlife Refuge management purposes and bureau responsibilities under ANILCA.

Cultural Resources

The NPS, the FWS, and the BLM also manage historic properties and cultural resources on their respective conservation units. Section 106 of the NHPA and the implementing regulations in 36 CFR 800 require that adverse effects on historic properties are resolved, or a plan to resolve them is codified in an agreement document, prior to the issuance of any permit, authorization, or expenditure of federal funds for a project. Given the scale of this Project and the present stage of development of many of the Project plans, not all potential adverse effects on historic properties can be identified, much less resolved. Accordingly, the BLM and the NPS recommend development of an agreement document, pursuant to 36 CFR 800.4(c) or 36 CFR 800.14(b).

The guidance provided by the Advisory Council on Historic Preservation (ACHP) on how to implement agreement documents provides an excellent framework for the FERC, the State Historic Preservation Officer (SHPO), the BLM, the NPS, and other participating agencies to develop an agreement and plan to resolve the anticipated adverse effects associated with the construction and operation of the Project. The BLM-preferred practice is to conduct consultation and initiate a NHPA agreement document in parallel with development of a NEPA document. The resulting record of decision (ROD) then incorporates decisions on the mitigation of adverse effects to historic properties. The BLM does not authorize a grant of right-of-way until the expected adverse effects have been resolved or, in the case of a phased identification and evaluation as allowed under 36 CFR 800.4(b)(2), an agreement document has been executed. The presence and general nature of anticipated adverse effects should be disclosed in the Final EIS and accompanied by a description of how those effects will be mitigated in the ROD. In this case, mitigation would occur through the development and execution of a phased Section 106 process that is developed through consultation and codified in an agreement document between the FERC, the SHPO, the BLM, the NPS, and other signatories. The FERC, or the AGDC by delegation, should provide the BLM and the NPS with a draft agreement document 30 days prior to ROD signing to aid in assessing proposed mitigation measures.

DOI Managed Lands

Air Quality: The NPS and the FWS each have conservation units that may be affected by facilities associated with the proposed Project, including two that are designated as Class I areas, which are provided special air quality and visibility protection. The FERC has accepted many of the DOI's editorial recommendations for the air quality sections of the document provided during previous reviews of the preliminary administrative drafts of the Draft EIS. We appreciate the FERC's efforts to address the DOI's recommendations, as we believe this strengthens the air quality analysis sections of the document with respect to potential air impacts to conservation units managed by DOI bureaus in Alaska. Additionally, we commend the FERC's outreach to cooperating agencies to ensure that both the air analysis and mitigation recommendations address any outstanding concerns.

Land Use Plans: While the authority to issue a ROW for a natural gas pipeline comes from the MLA, the guiding statute for the BLM administration of lands is the FLPMA, which requires the BLM to develop and maintain resource management plans (RMPs). Any authorizations by the BLM, such as granting of a ROW or authorizing a sale of mineral materials, must be in conformance with the existing RMP.

The Central Yukon RMP is currently under revision to replace both the 1991 Utility Corridor RMP and the 1986 Central Yukon RMP. This RMP revision is expected to be finalized prior to completion of the ROD for the Project, but no decision has yet been made regarding the standard operating procedures. Given this uncertainty, the BLM has identified several mitigation measures drawn from current best management practices to help mitigate the impacts of constructing and operating a major pipeline. These practices are included in Enclosure 1 as agency recommended mitigation measures which may be adopted in the ROD, as needed, to ensure conformance with the RMP requirements in effect at that time.

Summary of Bureau-Specific Comments

Detailed FWS comments focus primarily on trust species managed by the bureau as well as issues related to National Wildlife Refuges potentially impacted by the Project (Enclosure 2).

The attached NPS comments (Enclosure 3) primarily address the adoption of the Denali Alternative by the FERC and AGDC and the ongoing concerns not previously incorporated in the Draft EIS. Comment topics for the Denali Alternative focus on recreation and visual resources, ground temperature changes and permafrost, revegetation and invasive species, and cultural resources. Other comments regarding the Draft EIS apply more broadly and relate to noise, air quality and visual impacts of the pipeline operations, and the Healy Compression Station operations.

Recommended BLM mitigation measures and comments on the Draft EIS are found in Enclosures 1 and 4, respectively. A common thread in the BLM comments is that the scale and complexity of the Draft EIS resulted in inconsistencies that challenge the reader. Some sections include detailed information and analysis that would be better suited in other sections or perhaps cross-referenced more effectively. The FWS also noticed a number of inconsistent statements in discussions throughout the Draft EIS, referenced resource reports, and appendices.

The DOI recommends making a concerted editorial effort towards integrating the various sections into a unified and consistent document. To that end, each of the bureaus have provided detailed comments on specific sections of the Draft EIS. Many of the bureau-specific comments and recommendations in the enclosures apply to the Draft EIS more broadly, emphasizing actions that would help avoid and/or minimize potential adverse impacts to DOI trust resources and each bureau's ability to meet their land management responsibilities.

Collectively, DOI bureau comments address the following topics, which are generally presented in the order described in the Draft EIS:

- Project Description (BLM)
- Alternatives (FWS, NPS, BLM)
- Geologic Resources and Geologic Hazards (BLM)
- Soils and Permafrost (FWS, NPS, BLM)
- Groundwater Resources (BLM)
- Freshwater Resources (FWS, BLM)
- Marine Water Resources (FWS)
- Wetlands (FWS, BLM)
- Vegetation and Restoration (FWS, NPS, BLM)
- Non-Native Invasive Species (FWS, NPS, BLM)
- Terrestrial Wildlife (FWS, BLM)
- Avian Resources (FWS, NPS, BLM)
- Threatened, Endangered, and Other Special Status Species (FWS, BLM)
- Land Use, Recreation and Special Use Areas (NPS, BLM)
- Visual Resources (NPS, BLM)
- Cultural Resources (NPS, BLM)

- Air Quality (FWS, NPS, BLM)
- Noise (NPS, BLM)
- Cumulative Impacts (FWS, BLM)

Thank you for the opportunity to collaborate and provide comments on this large and complex proposed Project. As planning progresses, the bureaus look forward to working closely with the FERC as cooperating agencies to address the issues and recommendations noted above and in the attached enclosures.

If you have any questions or need additional detail regarding the NPS comments, please contact Sharon Kim, Regional Environmental Protection Specialist (907-644-3361 or sharon_kim@nps.gov). For questions regarding the FWS comments, please contact Dr. Bob Henszey, Planning and Consultation Branch Chief (907-456-0323 or bob_henszey@fws.gov). For questions regarding the BLM comments, please contact Earle Williams, Natural Gas Pipelines Project Manager (907-271-5762 or e1willia@blm.gov).

Sincerely,

Philip C. Johnson

Philip Johnson
Regional Environmental Officer – Alaska

Enclosure 1: BLM Alaska Recommended Mitigation Measures - Alaska LNG Draft EIS
Enclosure 2: U.S. Fish and Wildlife Service Specific Comments and Recommendations on the Alaska LNG Draft Environmental Impact Statement (DEIS)
Enclosure 3: National Park Service Comments on Alaska LNG Pipeline Draft EIS and Associated References
Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

Enclosure 1: BLM Alaska Recommended Mitigation Measures - Alaska LNG Draft EIS

Number	Topic	Measure
1	Air Quality & Noise	Between May 15 and September 30, restrict activities such as equipment maintenance near the Galbraith Lake campground between the hours of 9:00 p.m. and 8:00 a.m. to ensure that a noise level of 45 dBA (when measured 100 ft from the campsite pad closest to an area of noise generating activity) is not exceeded.
2	Air Quality & Noise	Compressor stations will be constructed using sound absorbing materials and methods. Contribution to the soundscape measured 1/4 mile from the compressor station will not exceed 55 dBA.
3	Visual Resources	All permanent structures or facilities shall be painted a camouflaging color in accordance with BLM's Visual Resource Management standards. The Permittee will consult with the Authorized Officer to determine the appropriate color for a given site. Color options can be found at https://doiportal.doi.net/blm/WO200/250/blm-vrm/Case%20Studies/Standard%20Environmental%20Colors.jpg.
4	Fuel Handling	All fuel containers shall be marked with the responsible party's name, product type, and dates filled or brought on the lease. In bulk storage or staging areas, a single label will be sufficient. Refueling equipment and storing/maintaining equipment within 100 feet of the active floodplain of any waterbody is prohibited, except for watercraft and aircraft. Fuel storage stations shall be located outside the 100-year floodplain of water bodies, unless otherwise approved by the Authorized Officer. The BLM Authorized Officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions. During equipment storage or maintenance, the lessee will ensure that the site is protected from leaking or dripping fuel and hazardous substances by the placement of drip pans or other surface liners designed to catch and hold fluids under the equipment, or by creating an area for storage or maintenance using an impermeable liner. During fuel or hazardous substance transfer, the lessee will ensure that a secondary containment or a surface liner is placed under all container or vehicle fuel tank inlet and outlet points, hose connections, and hose ends.

Enclosure 2: U.S. Fish and Wildlife Service Specific Comments and Recommendations on the Alaska LNG Draft Environmental Impact Statement (DEIS)

In this attachment, we first describe the U.S. Fish and Wildlife Service's (Service) trust resources that may be affected by the proposed Alaska LNG Project (Project). We then provide recommendations for consideration that will avoid, minimize, or provide a more complete understanding of these potential impacts.

Potentially Affected Fish and Wildlife Trust Resources: The Service's trust resources are natural resources we are entrusted to protect for the benefit of the American people. Within the proposed Project area these resources include species listed as threatened or endangered under the Endangered Species Act (ESA) and their designated critical habitat, migratory birds (including bald and golden eagles), certain marine mammals (northern sea otter, Pacific walrus, and polar bear) protected under the Marine Mammals Protection Act (MMPA), inter-jurisdictional fish, wetland habitats used by these species, and lands managed by the Service (e.g., national wildlife refuges).

Threatened and Endangered Species: The proposed Project would take place within the range of ESA-threatened spectacled (*Somateria fischeri*) and Alaska-breeding Steller's eiders (*Polysticta stelleri*), polar bears (*Ursus maritimus*), the southwest distinct population segment of northern sea otters (*Enhydra lutris kenyoni*), and the endangered short-tailed albatross (*Phoebastria albatrus*), as well as designated spectacled eider, polar bear, and sea otter critical habitat.

The Service received a Biological Assessment (BA) and request to initiate formal consultation pursuant to section 7(a)(2) of the ESA on July 11, 2019. After reviewing the BA (also provided in the DEIS Appendix O), the Service requested additional information regarding the Project description on July 31, 2019. Once this information is received and the initiation package is deemed complete, formal ESA consultation can be initiated.

Pacific Walrus: On October 4, 2017, the Service determined the Pacific walrus (*Odobenus rosmarus divergens*) does not warrant listing as threatened or endangered under the ESA (82 FR 46618), but are provided specific protections under the MMPA. Because walrus can occur in the action area (e.g., swimming and/or feeding offshore or hauled-out on land), potential incidental take is likely to occur. We encourage contacting the Service's Marine Mammals Management Program in Anchorage to develop an appropriate mitigation plan to minimize any potential effects on walrus and ensure compliance with the MMPA.

Eagles and Their Nests: Bald and golden eagle nests are located throughout the Project footprint. High concentrations of golden eagles are located along the Dalton Highway corridor and the Parks Highway corridor near Denali National Park and Preserve. Bald eagles are along coastal, lake, and riverine habitats anywhere along the Project footprint south of the Brooks Range. Staff in our Fairbanks and Anchorage Fish and Wildlife Conservation Offices are available to discuss known successful avoidance and minimization measures to address many potential impacts to eagles, which are most easily implemented through early project coordination. We also encourage contacting the Service's Migratory Birds Management Program in Anchorage to discuss the appropriate permits needed related to potential impacts to eagles and their nests, which both have special protections under the Bald and Golden Eagle Protection Act, and to develop an appropriate plan for mitigation, if needed.

Other Migratory Birds: Extensive wetland, boreal forest, tidal flats, riverine, and mountain cliff habitats dominate the landscape within and surrounding the proposed Project area. These habitats provide nesting, brood-rearing, and spring and fall migration staging areas for over 150 species of migratory birds including waterfowl, shorebirds, passerines, and raptors returning from wintering areas in North and South America, Asia, Africa and Australia. The Service considers 21 of these Birds of Conservation Concern.[1] The area also supports overwintering habitat for at least 19 resident bird species.

Interjurisdictional Fish: The Mainline Pipeline alone crosses 607 waterbodies (523 along the right-of-way, 70 along access roads, 5 at material sites). Many of these crossings contain resident and/or anadromous fish and potential impacts to fisheries resources can be significant. Except as noted below, the Service is deferring to the Alaska Department of Fish and Game, and the National Marine Fisheries Service for their expertise and recommendations for minimizing potential impacts to our shared fisheries resources.

Wetlands: A large portion of the Project footprint includes wetlands regulated by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA). One of the more important functions of wetlands from a fish and wildlife perspective is providing habitat (e.g., staging, nesting, feeding, and brood-rearing areas for birds, foraging sites for mammals, feeding and rearing habitat for fish). Additional wetland benefits include reducing flood peaks, recharging groundwater aquifers, filtering pollutants, and supporting unique plant communities that contribute to biological diversity (USEPA 2015, National Research Council 1995).

Lands Managed by the Service: The Arctic National Wildlife Refuge is located adjacent to the Point Thomson Unit Gas Transmission Line (PTTL) and the Mainline Pipeline, and as such may incur impacts associated with the Project. Specifically, the Central Arctic caribou herd (CAH) roams over 34,000 square miles in northeastern Alaska. In 2010, the herd numbered 68,000 animals and has since declined to an estimated 28,000 animals in 2017. The CAH uses refuge lands primarily during winter and mid-summer (after calving) as well as during the herd's northerly spring and southerly fall migrations (Nicholson et al. 2016).

In addition to managing refuge lands for fish and wildlife, we are also responsible for preserving, protecting, and enhancing air quality and air quality-related values for lands managed by the Service. The proposed Project could affect the air quality for Arctic, Kanuti, Yukon Flats, Kenai, Tuxedni, and Kodiak National Wildlife Refuges (NWRs). Tuxedni NWR is designated a Class I air quality area, while the other refuges are designated Class II nationally protected air quality areas by the Clean Air Act.

Comments and Recommendations: The Service appreciates the information provided by the Alaska Gasline Development Corporation (AGDC) and the Federal Energy Regulatory Commission (FERC) during the Project scoping process and the development of this DEIS. As noted by the FERC, the Service also noticed a number of inconsistent statements throughout the

[1] https://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

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DEIS, referenced resource reports, and appendices. The Service focused efforts for this review on the plans and actions presented in the DEIS Project Description, Alternatives, and Conclusions and Recommendations (i.e., Sections 2, 3, and 5). The Service only reviewed other sections of the DEIS when there were concerns with the Project description, alternatives, or conclusions and recommendations within those sections. Based on our review, we offer the following comments and recommendations in the same order as they are described in the DEIS. The following are submitted for consideration and early adoption into the Project's design to help minimize the proposed Project's impacts on fish, wildlife, and their habitats.

Soils:

Salvaging Topsoil: Salvaging topsoil (i.e., the surface layer containing native plant roots, rhizomes and other vegetative propagules, seeds, and soil microbes), and later spreading it as a top dressing on the reclaimed site, is a well-recognized restoration method to enhance native plant species reestablishment and maintain biodiversity. Thus, the Service concurs with the statement that "By not segregating and saving the surface organic layer along a large portion of the Mainline Pipeline right-of-way, erosion and permafrost thaw related impacts would be significantly increased" (page 4-95 Section 4.2.5.2 of the DEIS).

Current construction plans as outlined by the ADGC, however, are to salvage topsoil for only a small portion of the Project footprint (about 190 miles of the Mainline Pipeline and for material sites). In the Revegetation Plan (AGDC 2018c), the AGDC cites several reasons why salvaging the topsoil in most Project areas will not be feasible, notably in frozen conditions, including "limitations of cost, logistics, and available technology" (Section 4.1.3). The DEIS also states "surface organic layer soil segregation would not occur in the winter, as the surface organic layer profile would be frozen and bonded to the underlying mineral soil" as well as indicates that "conventional excavation equipment would not be able to fully separate frozen organics from the mineral soil underneath unless the active layer is thawed" (page 4-95, Section 4.2.5.2).

We believe the AGDC's proposed rehabilitation approach may curtail restoration and site stability. Because impacts to soils associated with the construction of the pipeline and ancillary facilities (e.g., roads, work pads, additional temporary workspaces, etc.) could be significant, long-term, and in some cases permanent, the Service recommends salvaging topsoil wherever practicable and using it to enhance Project restoration. Topsoil is more conducive to plant establishment than the granular fill proposed (i.e., combination of gravels, sands, and fines) for about 37 percent of the Project right-of-way restoration.

The Service considers salvaging frozen topsoil to be practicable; the technology is available and there are a number of benefits from using topsoil for reclamation. Equipment, such as a frozen topsoil cutter specifically designed to remove frozen topsoil, has been used by the pipeline industry for more than a decade in western Canada to meet mandated topsoil conservation requirements (Energy East 2016). The initial effort required to salvage and replace the topsoil will facilitate recolonization of native species and, therefore, decrease impacts associated with slower revegetation (e.g., colonization by invasive non-native species, erosion, maintenance and associated costs, long-term impacts to aesthetic value, reseeding, fertilizing, and slower return of wetland functions).

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Erosion Control Materials: We appreciate the FERC's recommendation to *not* use synthetic monofilament mesh/netted erosion control materials in, and adjacent to, sensitive wildlife habitat (FERC 2013, Section IV.F.4.h). However, we recommend applying this requirement to the entire Project footprint when erosion control materials are needed. The plastic in these materials perpetuates in the environment and can disperse into sensitive areas. It also poses a significant threat to wildlife through ingestion and strangulation.

<u>Freshwater Resources</u>:

Temporary Bridges: The Service supports the FERC's recommendation for the AGDC to install temporary bridge structures capable of withstanding a 10-year flood event rather than the proposed 2-year flood event. This recommendation will substantially reduce the likelihood of temporary bridge washouts and the resulting degradation of fish habitat from debris washing downstream. The 2-year flood event recurrence interval has a 50 percent chance of occurring in any given year, while the 10-year flood event recurrence interval has a 10 percent chance of occurring in any given year (i.e., five times less likely a temporary bridge will fail due to a flood event).

Permanent Water Crossings: The Service supports the FERC's recommendation for the AGDC to develop a Culvert Design and Maintenance Plan for all fish bearing streams following the guidance in *Anadromous Salmonid Passage Facility Design* (NMFS 2011). In addition to considering hydraulics and fish passage, we also recommend the Project Culvert Design and Maintenance Plan include provisions for maintaining the floodplain integrity both up and downstream from the crossing (USFWS 2019). Floodplains are an important component of the aquatic ecosystem with many benefits beyond enhancing fish habitat. When considering floodplain connectivity (U.S. Forest Service 2008, Figure 2.5, page 2-6), options for water crossings range from no connectivity (simple high discharge passage) to preserving full functioning of all floodplain processes (full-span crossing). Thus, the Service recommends constructing stream crossings that preserve floodplain connectivity to the greatest extent possible.

Pipeline Burial Depth in Floodplains: The Service appreciates the mitigation measures for addressing potential vertical scour damage to the pipeline buried under the 108 waterbodies assessed as having high susceptibility to vertical scour. The Service also recommends developing similar mitigation measures for channel migration within the channel meander belt to minimize potential future actions required to protect the pipeline from riverbank erosion and the natural process of channel migration across the floodplain required to maintain healthy fish and wildlife habitat (Naiman et al. 2010, Mouw et al. 2012).

The Service was unable to review the *Onshore Geohazard Assessment Methodology and Results Summary* (WorleyParsons 2018), which analyzed the potential for channel migration and avulsion (rapid abandonment of an existing river channel), because the document is "Privileged." However, all of the 108 waterbodies susceptible to vertical scour are likely susceptible to substantial channel migration during the life of the Project. Most, if not all, of these waterbody crossings are for unregulated rivers and streams (i.e., no dams or diversions to regulate the flow), so the channels are free to migrate during high-flows without limitations, and will likely require river training structures to protect the pipeline, which have the potential to degrade fish habitat.

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For example, the Tanana River near the mouth of the Chena River moved 2,000 feet between 1938 and 2007 before switching to eroding new areas (Henszey 2019), and sections of the Trans-Alaska Pipeline System (TAPS) in the Sagavanirktok River meander belt were exposed to minor damage due to erosion during the 2015 spring flood event (Romanovsky et al. 2017, Toniolo et al. 2017).

Unlike aboveground streams crossings, such as roads that can adversely impact fish and wildlife habitat (Blanton and Marcus 2009), buried pipelines can potentially cross floodplains with minimal disturbance to fish and wildlife habitat. The proposed mitigation for vertical scour in the waterbody thalweg is 5-feet or greater compared to the typical 3 feet of overland burial depth (Section 4.1.3.10). The Service recommends burying the pipeline in the meander belt within the floodplain at the same elevation as the depth under the river or stream (e.g., at least 5 feet below the expected maximum-scour depth) by including the same scour mitigation measures within the meander belt. This would allow the channel to migrate freely across the meander belt without exposing a shallow buried pipe, which would require potentially expensive long-term protection measures and potentially degrade fish and wildlife habitat. As per the Service's standard practice, we do not recommend attempting to maintain the current channel planform by hardening the bank or using river training structures in Alaska's unregulated rivers because these measures are likely to fail at some point during the life of the Project and often adversely affect fish and wildlife habitat.

<u>Marine Water Resources</u>:

Spill Response: The DEIS states the Project would not result in significant adverse effects to marine waters in part due to the implementation of various plans including the Spill Prevention, Control, and Countermeasure Plan (SPCCP) and the Project Procedures and Waste Management Plan. However, the SPCCP plan does not discuss response associated with spills in an iced environment. Because of the severity of impacts to our trust resources that can result from an oil spill, the Service recommends expanding the plan to include measures to respond, contain, control, and clean up a spill in difficult sea ice situations. The potential for serious impacts from spills, coupled with the unique challenges of under-ice spills, spills in broken ice conditions, and spills during stormy conditions, warrant an in depth implementable spill response plan.

Shoreline Impacts: Shoreline areas are important for many species of birds, offering breeding and resting sites as well as rich sources of food for migratory stopovers. Numerous species of shorebirds rely on intertidal habitats within the Cook Inlet Basin Subregion for feeding and migratory stopovers, including Pribilof rock sandpiper (*Calidris ptilocnemis ptilocnemis*), an endemic species of the Bering Sea that winters primarily within this region (Ruthrauff et al. 2012, TNC 2003).

The DEIS states construction of offshore facilities in Prudhoe Bay and Cook Inlet would result in permanent loss of marine habitat, but the impacts would be insignificant because the impacts would encompass about 0.1 percent of the total water environments for both waterbodies. To ensure an accurate assessment of shoreline impacts, we recommend recalculating total impacted shoreline in both the Prudhoe Bay and the Cook Inlet systems to confirm the total impact assessed in the DEIS, including shoreline already impacted by previous activities and the shoreline potentially impacted by the Project. Lumping both the Prudhoe Bay and Cook Inlet systems together, including previous impacts to the systems, is not an accurate assessment of impact. Since these are two very different marine environments, the Service recommends determining the significance separately for each system.

Wetlands:

Temporary Granular Fill: The AGDC proposes to not remove granular fill (i.e., combination of gravels, sands, and fines) placed in wetlands for "temporary" work pads within and outside the construction right-of-way. Thus, the natural functions of these wetlands, including wildlife habitat, would be permanently lost even though the work pads are no longer needed. Standard wetland mitigation practice includes reclaiming wetland functions when the purpose and need for impacting the affected wetlands is no longer required. The Service recommends the AGDC reconsider their proposal to not remove fill placed in wetlands for temporary Project needs and reclaim wetland functions wherever practicable. An alternative would be to acknowledge the temporary work pads as a permanent loss in wetland and necessitate compensation.

Hydrostatic Test Water Discharge: The Service estimates about 23 acre-feet of water will be discharged into wetlands and uplands after hydrostatic testing a 20-mile section of 42-inch diameter pipeline. Discharging such a large volume of water as a point source on the landscape during the bird-nesting season could destroy eggs and nestlings of ground-nesting birds. In addition to the proposed energy dissipation devices and sediment debris removal mitigation for discharging hydrostatic test water, we recommend avoiding discharging test water into nesting habitat during the bird-nesting season. If possible, the Service also suggests reusing the test water in the next section of tested pipeline to minimize the number of discharges required on the landscape.

The Service also has concerns regarding the discharge of test water on permafrost soils. The relatively warm test water may have sufficient heat to cause thermal erosion or thermokarsting of the frozen soils and impact wildlife habitat. Using "natural" temperature water to thaw frozen ground was a standard practice during the gold dredging era (Boswell 1979). Boswell (1979) also describes how they tested water at natural temperature rather than steam or hot water for thawing, and they concluded the ground could be thawed with cold water, and it would remain thawed indefinitely. Based on this past experience, the Service recommends developing additional mitigation measures to avoid impacting wildlife habitat by thawing permafrost soils with discharged hydrostatic test water.

String Bogs: String bogs, or "strangmoor," are characterized by peat deposits, acidic waters, and layers of thick sphagnum moss formed over thousands of years of wetland succession (Heinselman 1965, Viereck et al. 1992) and, therefore, are susceptible to anthropogenic damage and destruction. They are a unique form of bog habitat, formed in sloped areas and oriented perpendicular to the direction of drainage. String bogs consist of alternate, low ridges separated with water-filled linear depressions underlain with extensive, deep peat substrate. The depressions support a variety of aquatic vegetation and open water habitats, while the ridges may support brush and small trees (Viereck et al. 1992).

The proposed Project will bisect about 1.0 mile of string bog habitat in 19 separate locations, disturbing about 3 acres. The AGDC proposes installing the Mainline Pipeline in string bog

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habitats using Modes 2, 3, 4, and 5A with short crossings treated as wet-ditch open-cut crossings. The proposed crossings would damage the peat substrate of the bogs, accumulated over thousands of years, resulting in permanent and irreversible impacts to string bog habitats. Since string bogs form over centuries and their restoration is not feasible, the Service recommends avoiding the permanent loss of this unique wetland habitat by selecting an alternate pipeline alignment that avoids string bogs, or minimizing impacts to this wetland habitat by using vertical support members (VSMs) to elevate the pipeline.

Permanent Loss of Wetland Functions: In 2008, the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers jointly promulgated regulation revising and clarifying requirements regarding compensatory mitigation. The purpose of this mitigation is to offset unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. After employing the AGDC's and the FERC's avoidance and minimization measures for wetland impacts, the proposed Project would permanently convert about 4,162 acres of wetland to upland. Compensatory mitigation of these wetland functions should be recognized.

Both Section 5.1.4 (second to last paragraph) and the Draft Wetland Mitigation Plan (AGDC 2017) suggest compensation may include credit for restoration of Project impacts. This impression may be an artifact of summarizing the definition of compensation. As noted in the previous paragraph, compensation cannot be generated by reducing Project impacts, but can only be generated on areas adjacent or contiguous to the Project impacts (i.e., on-site compensation) or generated in the same geographic area if practicable (i.e., off-site compensation).

Permanent loss of wetland functions can be compensated by third party mitigation providers (i.e., wetland banks and in-lieu fee programs), or by permittee-responsible mitigation ([PRM] e.g., AGDC-sponsored compensatory mitigation projects). Third party mitigation providers are unavailable for most of the pipeline route,[1] and it appears they will continue to be unavailable into at least the near future.[2] The PRM opportunities at the scale required to compensate for the permanent loss of wetland habitat proposed by the Project (i.e., 4,162 acres) will likely be difficult to identify and implement. Regardless of the compensation provider(s) chosen by the AGDC, the USACE may not require compensation for all Project permanent wetland losses.[3] Based on these precedents, the Service recommends the FERC employ all practicable wetland avoidance and minimization measures. Otherwise, the Project may result in substantial uncompensated permanent wetland impacts, which will adversely affect our trust resources.

Vegetation:

Revegetation and Restoration: The Service appreciates the thoroughness of the Revegetation and Restoration Plans (AGDC 2018b 2018c), and thanks the AGDC for setting revegetation

[1] See Alaska District's banks and in-lieu fee sites at https://ribits.usace.army.mil.
[2] For example, the prospectus for the only potential North Slope mitigation bank (i.e., the Charles Etok Edwardsen Mitigation Bank) was recently found by the USACE to not have potential as written).
[3] The 28 March 2019 provisional permit for AGDC's similar Alaska Stand Alone Pipeline would require about 281 acres of compensation for about 7,939 acres of permanent waters of the US losses, including wetlands. Wetlands compensation is based on 145.2 credits (roughly equal to or less than acres) for the North Slope, 80.39 acres for the Interior, and 54.43 acres for South-central Alaska.

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goals that include site stability and restoration of wildlife habitat. Natural colonization of disturbed sites, the Project's primary reclamation method, is an effective method to achieve species biodiversity and richness, and we commend the AGDC for recognizing the importance of this practice to overall habitat restoration. While this approach will be suitable for some areas of the Project, the Service has concerns regarding the ability to achieve timely and successful revegetation and site restoration without salvaging the topsoil for a larger portion of the Project footprint (see our Soils discussion above). This is of particular concern in areas of permafrost and a shorter growing season.

For example, areas with cold soils (e.g., continuous and discontinuous permafrost, or high-altitudes) generally have a thin topsoil layer (i.e., the surface layer containing native plant roots, rhizomes and other vegetative propagules, seeds, and soil microbes). Once these soils are disturbed (removed, mixed with inorganic soils, and replaced), the natural recolonization process may take considerable time before there is sufficient plant cover to minimize or prevent thermal erosion, subsidence, and ponding. In areas with a very short growing season, like the North Slope, the natural recolonization may take more than the three-year span suggested by the AGDC (ABR 2012a, ABR 2012b, Kidd 2014, Raynolds et al. 2014). Restoration projects within the North Slope oil fields typically require 10 to 30 years of recovery before the sites are deemed stable. The Revegetation Plan indicates this area of the Mainline Pipeline will immediately receive fertilizer and seed application. While soil fertilization of a disturbed site may initially increase plant growth, once the nitrogen is absorbed, vegetation will dieback and natural recovery may still take decades (Bishop et al. 2001, Streever et al. 2011).

Invasive Plant Species: The Service appreciates the AGDC's and the FERC's recognition of potential impacts to Alaska's fish and wildlife habitat from invasive species and we appreciate that many of our previous comments have been incorporated into this section of the DEIS. The AGDC's effort and commitment to minimize impacts from invasive species from Project activities is also commendable. The DEIS references two separate plans developed by the AGDC: the *Noxious/Invasive Plant and Animal Control Plan* (Project Invasives Plan in AGDC 2018a) and the *Invasive Species Prevention Management Plan* (ISPMP, in Appendix B of AGDC 2018c). While there is considerable overlap between the two plans with distinctions as to where each plan would be applied on the ground, the Service finds the ISPMP to be the more thorough plan. Therefore, we recommend the Project Invasives Plan adopt the language and data sheets of the ISPMP. Additionally, if possible, we recommend combining the plans under one title to minimize misunderstandings in the analysis of the DEIS and to provide equal protection to all impacted areas (including city/borough, native, and private lands). This may also allow for efficiencies during construction and inspection activities. In summary, the Service suggests incorporating the invasive animal component of the Project Invasives Plan with the ISPMP to manage all invasive species across the entire Project footprint.

<u>Terrestrial Wildlife Using Lands Managed by the Service</u>:

Caribou: The CAH roams over 34,000 square miles in northeastern Alaska, including the Arctic National Wildlife Refuge (Refuge). The CAH uses refuge lands primarily during winter and mid-summer (after calving) as well as during the herd's northerly spring and southerly fall migrations (Nicholson et al. 2016).

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Given the Refuge's management goals for caribou as well as caribou's vital importance as a subsistence resource to federally-qualified subsistence users and caribou's recent decline in abundance, the Service recommends the FERC examine all potential impacts of the proposed Project on the CAH. This includes examining disturbance due to construction and traffic, potential displacement from coastal insect relief habitat, delayed or displaced migratory movements, and reduced access to subsistence hunters. Depending on location, the proposed east-west alignment of the PTTL would likely impact coastal areas used for insect relief during the period of mosquito harassment (late June-July) and might delay or disrupt north-south movements of the herd traveling to and from these areas. The Mainline Pipeline will intersect with migration routes used by a majority of the CAH during spring and fall migrations, particularly in the northern Brooks Range foothills. Thus, mitigation measures, such as locating the PTTL farther from the coast and raising all pipelines in caribou habitat at least 7 feet above ground, is recommended. Recent published research (Wilson et al. 2016) documented the effects of the Red Dog Mine industrial road on caribou movements during migration and Nicholson et al. (2016) documented seasonal movements and migration routes of the CAH. The Service recommends including this research as well as other possible impacts to the CAH in the Final Environmental Impact Statement (FEIS).

Avian Resources:

Migratory Bird Conservation Plan: The DEIS states the AGDC has developed mitigation measures to avoid, minimize, or mitigate impacts on migratory bird resources. Some of these measures are described in a *Migratory Bird Conservation Plan* (MBCP) developed for the Project (Section 7.1.2). The MBCP as it stands provides minimization measures for ESA-protected birds, eagles, the Service's Birds of Conservation Concern, and the Bureau of Land Management's Alaska's Sensitive and Watch List birds. However, the FERC's 2011 Memorandum of Understanding (MOU)[1] with the Service states projects should "…avoid or minimize, to the extent possible, impacts on migratory birds and their habitats, with emphasis on, *but not exclusive to* [emphasis added], species of concern…" The Project will likely affect all species of nesting birds, not only species of concern. For example, clearing and grading schedules in the MBCP Table 3 indicate over 500 miles of the right-of-way is proposed to be cleared of vegetation during the summer when birds are nesting. Clearing vegetation during the nesting season will result in bird mortality and loss of productivity regardless of intent.[2] The Service recommends conducting all vegetation clearing and associated ground disturbance outside the nesting season when practicable to minimize adult, nestling, and fledgling mortality. The Service also recommends reassessing the lost migratory bird productivity due to permanent habitat loss in the FEIS. In contrast to the proposed initial clearing during the nesting season, we appreciate that operational vegetation maintenance is scheduled outside the breeding season.

[1] Required by Executive Order 13186 to further the purposes of the migratory bird conventions, the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), the Fish and Wildlife Coordination Act, the Endangered Species Act (ESA), the National Environmental Policy Act (NEPA), and other pertinent statutes.
[2] "Intent" is addressed in the M-Opinion (https://www.doi.gov/sites/doi.gov/files/uploads/m-37050.pdf) for the incidental or unintentional take of migratory birds, but the M-Opinion does not address voluntary avoidance and minimization measures to help reduce incidental or unintentional take of migratory birds.

Impact Assessment to Migratory Birds: The 2011 MOU also specifies the MBCP objectives should address migratory bird habitat and population management, including national (Rosenberg et al. 2016) and regional (BPFWG 1999) conservation plans.

The DEIS, however does not address potential population-level impacts from the Project. For example, the rusty blackbird population has declined by 88 percent range wide over the past four decades, with additional qualitative evidence that this decline has been continuing for a century or more (Greenberg and Droege 1999, Niven et al. 2004, Sauer et al. 2008, Greenberg et al. 2011). Therefore, the Service recommends the DEIS also analyze and disclose potential population-level impacts from the permanent loss of important migratory bird habitat from the proposed Project.

Full Life-cycle Conservation of Migratory Birds: In addition to conserving migratory bird breeding habitat, Rosenberg et al. (2016) recognizes the importance of understanding and addressing issues faced by migratory birds throughout their lives and during their full annual migratory cycles. Full life-cycle conservation of migratory birds requires actions that provide habitat and reduce mortality throughout the year and across their range (Spindler and Kessel 1980, Kessel 1998, BPFWG 1999). When evaluating potential Project impacts, the Service recommends the DEIS consider impacts to migratory birds throughout their entire life cycle, including impacts to breeding, wintering, and migratory habitat.

North Slope Littoral Areas: Creating littoral areas for waterbirds in depleted mine sites south of the Brooks Range often works well if constructed properly and actively managed until stable. However, experience on the North Slope has shown creating littoral areas often fails when pushing overburden material into the excavation along the edges because the material either does not subside (i.e., does not create wetlands) or subsides too much (i.e., is too deep to support aquatic vegetation). When overburden is limited (i.e., single-cell sites), there may also be insufficient material to create a successful or meaningful littoral area. In addition, on the North Slope it may take 15 to 30 years to fill the excavation with water if the excavation is not connected to a stream or river. The Service therefore does not recommend creating littoral areas on the North Slope by placing overburden in deeply excavated material sites as it rarely produces functional habitat.

Avian Avoidance and Minimization Plans: Several plans are missing minimization measures and risk assessments for migratory bird resources. The SPCCP does not contain any reference to managing threats to wildlife from spills. The Service recommends the AGDC incorporate wildlife management procedures into the SPCCP to include mitigation measures and a risk assessment. In addition, there is no mention of migratory birds in the *Wetland and Waterbody Construction and Mitigation Procedures* (WWCMP), or the *Winter and Permafrost Construction Plan*. "Wildlife" are only mentioned in the WWCMP discussion regarding non-use of synthetic monofilament materials in designated areas and "sensitive wildlife" habitat, unless designed to minimize harm to wildlife. Finally, the Service recommends developing a Lighting Plan to minimize attracting migrating birds at night and considering methods to mitigate the impacts of powerlines (e.g., from collisions or electrocutions).

Hydrostatic Test Water Discharge: Adverse impacts from discharging hydrostatic test water on ground-nesting birds is not assessed in the DEIS. No assessment of the acreage flooded, water

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depth, time of year, or periodicity of testing is presented. As discussed above in Wetlands, the Service estimates about 23 acre-feet of water will be discharged into wetland and upland habitats after hydrostatic testing a 20-mile length of 42-inch diameter pipeline. To avoid destroying eggs and nestlings of ground-nesting birds, we recommend not discharging during the breeding season.

Air Quality:

Effects on National Wildlife Refuge (NWR) Lands: When conducting air quality analyses, the DEIS acknowledges there will be impacts from the construction and operation of the Project facilities to the air quality of lands managed by the Service, including the Arctic, Kanuti, Yukon Flats, Kenai, Tuxedni, and Kodiak NWRs. These impacts include temporary and short-term impacts from construction, moderate and significant cumulative and long-term visibility impacts, and nitrogen and sulfur deposition on refuge lands. The Service recommends the AGDC reduce emissions and/or improve mitigation plans at each facility to reduce construction and operational emissions of nitrogen oxides (NO_X), sulfur oxides (SO_X), and inhalable particulate matter ($PM_{2.5}$ and PM_{10}) to reduce the predicted visibility impacts, and the sulfur and nitrogen deposition impacts to levels below the Federal Land Manager threshold guidelines (USFS et al. 2010).

Updated Analyses: The FERC identified that the emission estimates are not consistent with the revised Project schedule submitted by the AGDC in November 2018, and recommended the AGDC file updated construction emission calculations to reflect the revised construction schedule. If the updated emissions are significantly different, the Service recommends revising the air quality related values (AQRV) model and reevaluating the potential impacts on refuge lands and the fish and wildlife using these protected areas. The Service also recommends the updated AQRV analysis include all short-term emissions, such as the maximum flare event.

Cumulative Impacts:

Assessment of Prior Impacts: Cumulative impacts are an assessment of "the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions…" (40 CFR §1508.7 [2019]). In other words, the cumulative fish and wildlife impact assessment describes and analyzes how the original state of the system has been, and is predicted to be, altered by impacts from various actions. Action impacts include anthropogenic and natural changes. The DEIS considered the impacts of past projects as already part of the affected environment (i.e., environmental baseline), which is described and evaluated in the environmental analyses section of the DEIS. For example, the AGDC states "impacts due to construction of the TAPS have become part of the environmental baseline, while ongoing operational impacts associated with the TAPS have the potential to contribute to cumulative effects."

The environmental baseline condition considered in this DEIS does incorporate previous actions, but the ongoing impacts of individual past actions were not evaluated. For example, the TAPS and the Dalton Highway impacted the original state of fish and wildlife habitat by their ongoing presence on the landscape, not just during their construction. These actions fragmented the original state of fish and wildlife habitat, which remains fragmented, and as such should be included in the discussion of cumulative effects. Therefore, the Service recommends the AGDC evaluate both past and ongoing impacts of these projects, as appropriate, during discussions of environmental baseline and cumulative effects on fish and wildlife assessed in the FEIS.

Assessment Area: The Service acknowledges the usefulness of using hydrological unit code 12 (HUC12) watershed boundaries for assessing impacts to stationary resources including wetlands. However, these boundaries are not as useful for assessing bird and wildlife impacts. Limiting the boundary to HUC12 watersheds underestimates the overall impacts from various actions to bird and wildlife populations. The Avian Resources Section (4.6.2) describes migratory-bird populations by Ecoregions/Subregions and the Terrestrial Wildlife Section (4.6.1) describes wildlife populations by habitat type/subregion. The Service recommends using the same regions for describing migratory birds and terrestrial wildlife within the FEIS.

Alternatives:

Approach to Analyses: Alternatives as defined under 40 CFR §1502.14 (Alternatives including the proposed action), should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public. During our review, the Service found a number of inconsistent comparisons among the alternatives affecting our trust resources, especially for the level of impacts, which makes alternative comparisons difficult. The Fairbanks Alternative is used as an example below.

The DEIS states the Fairbanks Alternative would increase the length of the Mainline Pipeline by 37.5 miles, resulting in a greater overall environmental impact. Table 3.6.3-1 indicates land disturbed for the Mainline Pipeline construction is a difference of 403 acres. The provided alternative analyses tables do not indicate the number of miles for access routes required for the preferred route (Appendix B, Volume 2 [pages B-92-B-103]). Nor is there an acreage indication/comparison between the alternatives. The preferred alternative appears to require 2 helipads, 9 mine sites, camps, 2 mainline block valves, and a compressor station. It is difficult to evaluate the impacts of the two alternative routes on fish and wildlife habitat without knowing the amount of land disturbed by each alternative.

The preferred pipeline alignment traverses a near pristine habitat for fish and wildlife through the Lower Tolovana watershed, while the Fairbanks Alternative follows a disturbed and fragmented area. The highway system from Fairbanks could support the development and construction of the route without impacting the sensitive Minto Flats in the Lower Tolovana watershed. The Minto Flats provides breeding habitat for multitudes of waterfowl, including sensitive trumpeter swans. Studies in Alaska have examined the effects of disturbance on nesting activities (Banko 1960, Bollinger 1982, ADF&G 1986, Hansen et al. 1971). The Tolovana watershed also includes the Chatanika River, which is a major spawning area for Yukon River Chinook salmon (Brown et al. 2017). The preferred route would result in habitat fragmentation and increased human disturbance, has the potential to introduce invasive species, and potentially increases the likelihood of future development, all of which have negative impacts to wildlife and their habitat. The Tanana Valley Watershed Association is currently evaluating the condition of the Tolovana watershed,[1] and preliminary results suggest portions of the upper watershed are in poor to fair condition, while the Minto Flats in the lower watershed is near pristine. The alternatives as presented do not assess this information; therefore, the conclusion that the preferred alternative is significantly less impactful on habitat and wildlife is not supported within the DEIS.

In addition, the overall impacts to wetlands from a Fairbanks lateral originating from the preferred alignment near Minto Flats have not been assessed in Section 3.6.3. The DEIS states "However, it should be noted that, because wetland and waterbody crossings on a future lateral were not available for inclusion in our review, the combined impacts for the Mainline Pipeline plus the lateral could decrease or increase the overall differences between the Fairbanks Alternative and the proposed route."

The Service recommends providing the total number of wetlands acres impacted under each alternative within the FEIS to help differentiate impact differences among the alternatives, such as the Fairbanks alignment. Until the full range of effects are quantified, choosing among the alternatives based on unquantified impacts to wetlands is not possible.

Aboveground Pipeline Alternative: The Service appreciates the FERC considering an aboveground pipeline alternative (Section 3.7.1). Early during the scoping stage, when much less information was available, we requested a simplistic analysis comparing the environmental impact of a trenched versus an elevated pipeline on the Arctic Coastal Plain (ACP). As Project details and resource information were provided, and after thorough review of known impacts on wildlife habitat from past trenching projects in permafrost, we now recommend conducting an analysis to compare a trenched pipeline versus constructing an elevated pipeline, only when traversing thaw-sensitive permafrost (but for the entire length of the proposed Mainline Pipeline). Thaw-sensitive permafrost is subject to the same vulnerabilities regardless of geographic location. This was the approach taken by the 800-mile TAPS from Prudhoe Bay to the Port of Valdez. The TAPS has transported processed oil with few problems for over 40 years. The few problems the TAPS experienced included subsidence associated with ice-rich (i.e., thaw-sensitive) permafrost. About 52 percent (420 miles) of the TAPS line is elevated on VSMs, while about 58 percent (about 470 miles) of the Mainline Pipeline could be elevated over thaw-sensitive permafrost (based on the proportion of Mainline Pipeline right-of-way construction acres in the DEIS Table 4.2.4-2).

The Service appreciates the AGDC proposing to construct the 62.5-mile PTTL and the 1.0-mile Prudhoe Bay Unit Gas Transmission Line (PBTL) entirely on VSMs. These pipelines will almost exclusively traverse thaw-sensitive permafrost, and will permanently impact less than one acre of wildlife habitat per pile of pipeline. This level of permanent impact has often been considered *de minimis* by the USACE for pipelines employing VSMs on the ACP and is often considered to be the least environmentally damaging practicable alternative (LEDPA). When constructed on ice or snow pads, the 24 to 26-inch diameter boreholes for the TAPS VSM piles permanently impacted 3.7 ft^2 per VSM pile (McFadden and Bennett 1991), which is in line with the ADGC's estimated 2 acres of permanent impacts for 60 miles of VSM piles (DEIS Section 3.7.1; i.e., 0.03 acres per pipeline mile). Many pipelines on the ACP do not require service roads

[1] Tanana Valley Watershed Association's preliminary Tolovana Watershed assessment: http://www.escapewrap.com/wrap-map-tolovana

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because the elevated pipelines require little long-term maintenance that cannot be conducted during the winter with an ice/snow road. In contrast, the proposed trenched Mainline Pipeline would disturb a much larger permanent-impact footprint for the pipeline (2,662 acres), access roads (3,016 acres), and material sites (5,855 acres), which is about 14.3 acres of wildlife habitat impacts per pipeline mile and over 475 times more impact than an elevated pipeline. In addition, the pipeline trench would need to be revegetated post construction and likely would require remediation over an extended period to address subsidence issues.

The Service agrees there may be other issues to consider when evaluating buried versus elevated pipelines (e.g., wildlife movement patterns and gas stream condensation). However, the proposed Project would parallel the existing TAPS for much of the thaw-sensitive soils, so elevating the new pipeline in this area would not be a novel impact to wildlife. Additionally, the concern for gas stream condensation appears to be addressed for the elevated PTTL. For these reasons, the Service recommends the FERC reevaluate the alternative for elevating the Mainline Pipeline when traversing thaw-sensitive permafrost. We believe an elevated pipeline meets the FERC's criteria for offering a significant environmental advantage over the proposed action and is technically and economically feasible. The Service agrees the initial cost of elevating the Mainline Pipeline may be more expensive, but the costs for mitigating unavoidable permanent wetland losses and for the long-term operational costs of remediating pipeline subsidence and other post-construction activities may far exceed the initial construction costs of VSMs.

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Enclosure 3: National Park Service Comments on Alaska LNG Pipeline Draft EIS and Associated References

Comment Number	Section Number	Topic	Page #	Original Text	Suggested Edits	Comment	Full Citation / References
1	3.6.2	Denali Alternative	3-22	Table 3.6.2-1 lists 0.8 miles of new access roads under the Denali Alternative	There are no new access roads shown on the Denali Alternative Route project footprint maps included in AGDC's 8/16/19 Project Description Change Notification. If the maps are correct, there should be **0 miles of new access roads listed for the Denali Alternative in Table 3.6.2-1.**	If the number of miles of access roads listed in Table 3.6.2-1 changes to zero, the length of new access roads stated on page 3-25 would also change. Current text states, "It would reduce the length of new access roads by 1.9 miles...."	
2	3.6.2	Denali Alternative	3-24	"With respect to recreational use, the Denali Alternative would have a greater impact than the proposed route due to temporary disruptions of traffic and the increase in noise during construction, in an area with relatively high recreational use...."	*(NOTE: text in red font indicates new language to be added to the FEIS. Denali National Park and Preserve is referred to as DNPP as it was in the DEIS.)* Please insert the following description of long-term recreational impacts in addition to the temporary impacts described in this paragraph: "This area of DNPP has been proposed for recreational trail development since 1997. The introduction of a pipeline corridor would alter the range of options available to the NPS for planning recreational opportunities in this area, including trails."	The discussion of recreational impacts on page 3-24 deals only with temporary impacts from construction, such as traffic delays. There would also be long-term impacts from the Denali Alternative on the choices that the NPS has for providing recreational opportunities on park lands between the George Parks Highway and the Nenana River. Because this location is easily accessible and not within the designated wilderness area, it is very attractive for trail, campground, and other recreational facility development. Construction of a pipeline in the same area would permanently alter the recreational experience and management options available to the NPS in this area.	National Park Service. 1997. Final Entrance Area and Road Corridor Development Concept Plan/ Environmental Impact Statement, Denali National Park and Preserve, Alaska. Denver Service Center, National Park Service, U.S. Department of the Interior.
3	4.2.5.2	Permafrost	4-104	"AGDC has developed a Project Pipeline Operation and Maintenance Plan that describes operational monitoring methods that would be used on the Mainline Pipeline to determine if altering conditions (including permafrost changes) create an unacceptable risk to the pipeline."	"AGDC has developed a Project Pipeline Operation and Maintenance Plan that describes operational monitoring methods that would be used on the Mainline Pipeline to determine if altering conditions (including permafrost changes) create an unacceptable risk to the pipeline or to adjacent permafrost along the Denali alignment if it is being affected by the pipeline's temperature."	Monitoring should include assessing risk to natural and cultural resources, including soil and groundcover, due to permafrost changes along the Denali alignment.	
4	4.2.5.2	Permafrost	4-105	"AGDC would implement a quality-based adaptive management approach to assess maintenance issues identified during SCADA inspections and surveys. Potential maintenance techniques that would be used based on site-specific conditions include:"	Among the adaptive management techniques listed to address changes due to permafrost thawing, please include adjustment of pipeline gas temperatures to match ground temperatures to the extent possible.	The DEIS states on page 4-104: "The Gas Control Center would control gas temperature during operation of Mainline Facilities by heating and/or cooling gas at compressor and heater stations to maintain the geographic temperatures outlined above. This would include adjusting gas temperatures for seasonal variations in discontinuous permafrost areas to match ground temperatures to the extent possible." This technique should be reflected in the list of potential adaptive management techniques on page 4-105.	

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Comment Number	Section Number	Topic	Page #	Original Text	Suggested Edits	Comment	Full Citation / References
5	4.5.2.3	Restoration/ Revegetation		"According to the Revegetation Plan, AGDC would incorporate a variety of revegetation methods for streambank restoration, including salvaging and transplanting native plants at or near the site before construction."	Please add the following sentence at the end of the revegetation paragraph quoted at left: "In addition, revegetation in DNPP would be done in consultation with the NPS, following NPS guidelines and specifications (NPS 2006, Densmore et al. 2000)."	This clarification should be added with the Denali Alternative as the proposed action.	NPS 2006. Management policies 2006. U.S. Department of the Interior, National Park Service, Washington, D.C. Densmore, R.V., M.E. Vander Meer, N.G. Dunkle, 2000. Native Plant Revegetation Manual for Denali National Park and Preserve. Information and Technology Report. USGS/BRD/ ITR-2000-006. USGS Alaska Science Center, Anchorage, Alaska. March 2000.
6	4.5.8.1	Non-native Invasive Species	4-266	"The federal Noxious Weed Act and Executive Order 13112 would apply to Project activities on BLM land. The Carlson-Foley Act of 1968 (43 USC 1241–1243) further authorizes the BLM to manage noxious weeds and coordinate with other federal and state agencies in managing noxious weeds on federal lands."	As the Denali Alternative has been selected as the proposed alignment, please include the NPS in references to authorizations for managing non-native invasive species on federal lands: "The federal Noxious Weed Act and Executive Order 13112 would apply to Project activities on BLM and NPS lands. The Carlson-Foley Act of 1968 (43 USC 1241-1243) further authorizes the BLM and the NPS to manage noxious weeds and coordinate with other federal and state agencies in managing noxious weeds on federal lands."		
7	4.5.8.1	Non-native Invasive Species	4-266	"The BLM is in the process of finalizing invasive species stipulations that would apply to AGDC's application for a right-of-way grant on federal lands, which make up a substantial portion of the Project area (see section 4.9.2) (Williams, 2018). The BLM anticipates developing stipulations based on those in Best Management Practices: Controlling the Spread of Invasive Plants During Road Maintenance (BLM, 2018b; Graziano et al., 2017). AGDC has prepared an ISPMP to be implemented on BLM and state lands. Plans regarding invasive species management would be finalized with the BLM right-of-way grant and the state right-of-way lease."	Please add a requirement that non-native invasive species management in DNPP would follow NPS guidelines and stipulations.	This clarification should be added with the Denali Alternative as the proposed action.	

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Comment Number	Section Number	Topic	Page #	Original Text	Suggested Edits	Comment	Full Citation / References
8	4.6.2.3	Avian Resources; Impacts and Mitigation; Vegetation Clearing	4-326	"A waiver of the clearing restriction would need to come from FERC, based on any input provided by the USFWS. Because AGDC has not clearly indicated that it would comply with the operational vegetation clearing timing requirements of FERC's Plan, we recommend that:..."	"A waiver of the clearing restriction would need to come from FERC, based on any input provided by the USFWS, in consultation with the responsible land management agency."	Section VII.A.5 of FERC's Plan prohibits applicants from conducting vegetation mowing or clearing for right-of-way maintenance in the migratory bird nesting season, unless specifically approved in writing by the responsible land management agency or USFWS. Table 4.6.2-3 indicates that the recommended timelines for avoiding vegetation clearing should be adapted to local conditions, including avoiding disturbance of early- and late-nesting bird species. Land management agencies should be consulted in addition to the USFWS prior to waiving vegetation clearing restrictions, in part due to their in-depth knowledge of avian populations on the lands they manage.	
9	4.6.2.3 and Migratory Bird Conservation Plan, section 7.2	Avian Resources; Impacts and Mitigation; Collisions	4-333 and 10/22/18 draft Migratory Bird Conservation Plan, page 37	"To minimize the potential for bird collisions with Project facilities, AGDC would implement measures as described in its Migratory Bird Conservation Plan. These measures include:"	Please add the following bullet point: "design buildings and facility modules to reduce the reflectivity of glass and other reflective surfaces"		Loss, S. R., T. Will, S. S. Loss, and P. P. Marra. 2014. Bird-building collisions in the United States: Estimates of annual mortality and species vulnerability. The Condor: Ornithological Applications 116: 8-23. USFWS 2016 Report. Reducing bird collisions with buildings and building glass best practices. Division of Migratory Bird Management, Falls Church, VA. pgs 1-17.
10	4.9.4.1	Recreation Areas; Denali NP&P	4-525	"AGDC would work with the USFWS and NPS **during construction** to minimize impacts on access to resources and recreation opportunities within the DNPP. Additionally, AGDC would work with USFWS and NPS to develop a construction schedule and site-specific coordination plans to mitigate for potential impacts."	As the Denali Alternative was selected as the proposed route, please change the wording of this section to require consultation with NPS regarding minimizing impacts on access to resources and recreational opportunities **prior to construction.**	Please also include mitigation of impacts on access to the planned Nenana River Trail because the trail could be built before pipeline construction begins. The trail would traverse the area of DNPP between the George Parks Highway and the Nenana River.	
11	4.13.1	Cultural Resources Surveys	4-685	"AGDC submitted 22 reports to FERC, the Alaska SHPO, and the BLM providing the results of the archaeological studies conducted between 2013 and 2019, including site evaluations on BLM lands, an assessment of submerged resources in Cook Inlet, and a survey of portions of the Denali Alternative (which was also provided to the NPS)."	Not Applicable	If the Denali Alternative alignment is changed and includes any previously unsurveyed areas, **an additional cultural resource survey would be needed for the new** alignment.	

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Comment Number	Section Number	Topic	Page #	Original Text	Suggested Edits	Comment	Full Citation / References
12	4.16.3.2	Noise; Mainline Facilities	4-948	"AGDC has estimated three average daily helicopter trips and six peak daily helicopter trips during construction to transport personnel to and from construction spreads, and one average daily helicopter trip during operation at each of the compressor stations, heater station, and MLV sites."	**Please add a table including the type(s) of aircraft and expected duration of flight time that will occur along the pipeline corridor on a typical day.**	On page 4-941 the DEIS cites the DNPP Backcountry Management Plan, which contains noise standards such as maximum sound levels and percentage of time motorized noise may be audible in the backcountry. Information on helicopter type and flight duration would allow the NPS to assess compliance with the Backcountry Management Plan and the 2006 NPS Soundscape Management Policy. Using previously collected data we estimate that helicopters can be detected within a 10 kilometer radius of helipads at multiple locations. Two are within audible distance of Gates of the Arctic National Park & Preserve (MLV6, Coldfoot Compressor Station) and seven within audible distance of DNPP (Healy Compressor Station, MLV16, MLV17, MLV18, MLV19, Honolulu Creek Compressor Station, MLV22). Each of these locations should be included in the table.	NPS 2006. Management Policies 2006. U.S. Department of the Interior, National Park Service. Washington, D.C. NPS 2006. Denali National Park and Preserve Backcountry Management Plan. Denali Park, AK. https://parkplanning.nps.gov/documentsList.cfm?projectID=10016
13	4.16.3.2; Table 4.16.3-4	Noise; Mainline Facilities; Healy Compressor Station	4-952	Table 4.16.3-4 Existing Ambient Ldn (dBA) = 52.0 Predicted Increase in Ambient Noise Level (dB) = 10.0	In Table 4.16.3-4 and throughout section 4.16, predicted increases in ambient noise levels are calculated incorrectly. **Ambient sound levels should be reported using Leq, and the differences should be recalculated.** The correct values for this table would be: Existing Ambient Leq (dBA) = **45.6** Predicted Increase in Ambient Noise Level (dB) = **16.0**	**Ambient sound levels should be reported as Leq throughout the EIS, and difference calculations should be updated. This includes sections 4.6.1.3, 4.16.3.1, Table 4.16.3-1, Table 4.16.3-2, Table 4.16.3-3, Table 4.16.3-4, Table 4.16.3-5, 4.16.4.1, Table 4.16.4-2, and Table 4.16.4-3.** The only accepted use of the day-night level (Ldn) metric within the field of acoustics is to apply a 10 dB penalty to night-time noise added to an environment as the result of an action. This is because Ldn reflects that urban communities are typically 10 dBA quieter at night than during the day and so changes will be more obvious/annoying/disruptive at night. Using Ldn to penalize the existing ambient noise levels is redundant: field measurements already document the conditions that occur at night. Reporting ambient levels as Ldn incorporates a significant, undue bias into every analysis of this type presented in the document. In the case of Table 4.16.3-4, the bias results in a 6.0 dB difference. This means the DEIS reports the difference to be only half as large as it actually would be.	Rossing, T. ed., 2007. Springer handbook of acoustics. Springer Science & Business Media.
14	5.2	FERC staff's recommended mitigation	5-60; #75	"If the noise attributable to operation of all equipment at the Coldfoot and Healy Compressor Stations under interim or full horsepower load conditions exceeds an Ldn of 55 dBA at any nearby NSAs, AGDC shall file a report on what changes are needed and shall install the additional noise controls to meet the level within 1 year of the in-service date."	"If the noise attributable to operation of all equipment at the Coldfoot and Healy Compressor Stations under interim or full horsepower load conditions exceeds an Ldn of 55 dBA at any nearby NSAs or exceeds an Leq, 1s of 40 dB at the boundary of DNPP (*section 4.16.2.1*), AGDC shall file a report on what changes are needed and shall install the additional noise controls to meet the acceptable level within 1 year of the in-service date."	Thank you for acknowledging NPS management policies and plans in the DEIS. The Denali Backcountry Management Plan Zone B is adjacent to the Healy Compressor Station. Compressor noise that exceeds the numeric management standard for the area (an Leq, 1s of 40 dB) also indicates that additional noise controls would be required. Analogous text in section 4.16.4.2 regarding the Coldfoot and Healy Compressor stations should also be updated.	NPS 2006. Denali National Park and Preserve Backcountry Management Plan. Denali Park, AK. https://parkplanning.nps.gov/documentsList.cfm?projectID=10016
15	Appendix E; Appendix E-1c	Denali Alternative visual simulation imagery	E-21 through E-38	Visual impact simulations	Simulation images should be presented in a larger format to adequately convey the predicted visual impacts of the project. **Panoramic Visual Simulation images should be high resolution, approximately 13 inches wide by 4.5 inches high.**		

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16	Appendix E; Appendix E-1c	Denali Alternative visual simulation imagery	E-21 through E-25 E-28 through E-30	Visual impact simulations for the following KOPs: - Mount Healy Overlook Trail Summit - Government Hill - Intersection of George Parks Highway and the DNPP Park Road	In the Denali Alternative alignment, the pipeline would be aboveground where it crosses the Park Road Fault, near the intersection of the George Parks Highway and the Park Road. None of the visual simulations show the aboveground section of the pipeline, although it would be visible from the Mount Healy Overlook Trail Summit, Government Hill, and Parks Highway Intersection KOPs. **Please include visual simulations of these KOPs that depict the aboveground section of the pipeline.**		
17	Appendix E; Appendix E-1c	Denali Alternative visual simulation imagery	E-33 through E-35	Visual impact simulations for the Nenana River Pedestrian Bridge KOP	Project footprint maps of the proposed Denali Alternative indicate that the pipeline corridor would be adjacent to the highway to the south of the west-east highway crossing, within view of the Nenana River Pedestrian Bridge KOP. **The visual simulations should show a long swath of cleared vegetation adjacent to the highway as far south as the highway can be seen from the KOP.** It is unlikely that any screening trees would remain in this area between the highway and the pipeline corridor after construction.	With the Denali Alternative as the proposed alignment, the NPS would work with the applicant to identify feasible visual resource mitigations in this area, including the potential to retain screening trees.	
18	Appendix E; Appendix E-1c	Denali Alternative visual simulation imagery	E-23, E-35	Winter visual impact simulations for the Nenana River Pedestrian Bridge KOP and the Intersection of George Parks Highway and the DNPP Park Road KOP	For KOPs with deciduous screening vegetation between the KOP and the pipeline, **the winter simulations should more accurately show that screening is less effective when leaves are off the trees and shrubs.**		

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Comment Number	Section Number	Topic	Page #	Original Text	Suggested Edits	Comment	Full Citation / References
19	5.2	General Comment - Mitigation Recommendations/Requirements Applies to language in Requirement #72 on page 5-59 and corollary language in Chapter 4 on page 4-937, as well as throughout the document.	5-59, 4-937, 5-38	Prior to construction, AGDC shall file with the Secretary, for the review and written approval of the Director of the OEP, **a Class I and Sensitive Class II** Mitigation Plan developed in consultation with the FLMs and ADEC to reduce operational emissions of NOx and SOx associated with the GTP, Mainline Facilities, and Liquefaction Facilities to ensure that the predicted visibility impacts and deposition impacts are below the associated NPS thresholds. The Plan shall demonstrate this by including all relevant data, such as updated impact tables, applicable enforcement mechanisms, BACT information provided to ADEC and FLMs, and a narrative discussing any additional mitigation measures. (section 4.15.5.3)[24]	Prior to construction, AGDC shall file with the Secretary, for the review and written approval of the Director of the OEP, a Visibility and Deposition Air Quality Mitigation Plan ~~a Class I and Sensitive Class II Mitigation Plan~~ developed in consultation with the FLMs and ADEC to reduce operational emissions of NOx and SOx associated with the GTP, Mainline Facilities, and Liquefaction Facilities to ensure that the predicted visibility impacts and deposition impacts are below the associated ~~NPS~~ FLM thresholds. The Plan shall demonstrate this by including all relevant data, such as updated impact tables, applicable enforcement mechanisms, BACT information provided to ADEC and FLMs, and a narrative discussing any additional	We agree with FERC's conclusion that emissions from AK LNG associated facilities would contribute to visibility and nitrogen deposition impacts in nearby units of the National Park System particularly for DNPP and Lake Clark National Park & Preserve (NPP), and that mitigation in the form of improved emission controls is necessary to alleviate these impacts. As such, we support FERC's inclusion of Requirement # 72 presented in Chapter 5.0, with the suggested changes which would strengthen and clarify the requirement (see column to the left). We recommend that corollary language in Chapter 4 on page 4-937 is also revised to reflect the recommended changes and throughout the document wherever reference is made to the "Class I and Sensitive Class II Mitigation Plan." We appreciate FERC's initiative to collaborate with the NPS to address predicted impacts to units of the National Park System. Reductions in ongoing operational emissions may be achievable for all AK LNG facilities, including the mainline facilities subject to minor source permitting requirements as well as the two major Prevention Significant Deterioration (PSD) sources (GTP and liquefaction facility). Reductions in the emission limitations for these facilities would ensure the project moves forward in a more environmentally responsible manner by protecting park resources and values.	
					mitigation measures or emission limitations achieved at other similar facilities which are lower than those initially proposed by AGDC. (Section 4.15.5.3)	We note that we have conducted our own preliminary CALPUFF assessment of the liquefaction facility plus all compressor and heater stations within the existing CALPUFF modeling domain. These preliminary results indicate that nitrogen deposition is a significant concern in DNPP and Lake Clark NPP. In the maximum modeled meteorological year (2002), nitrogen deposition is 0.0133 kg/ha/yr or 166.5% of the nitrogen Deposition Analysis Threshold (DAT) at DNPP and is 0.0130 kg/ha/yr or 159.8% of the nitrogen DAT at Lake Clark NPP. As noted in the DEIS analysis, ". . . in natural environments, nitrogen deposition can result in harmful nitrogen fertilization. Excess nitrogen can disrupt nutrient cycling in the ecosystem and create competitive advantages for some species at the expense of others. This can lead to shifts in species composition and declines in biodiversity, particularly for lichen species, which are important for wildlife forage and habitat in Alaska. Changes related to nitrogen deposition can also stress vegetation, leading to increases in disease and insect outbreaks." The NPS results support and supplement the analyses presented in the DEIS and underscore the need for additional NOx emission reductions called for in proposed Requirement #72.	
20	5.2	General Comment - Mitigation Recommendations/Requirements		Not Applicable	Not Applicable	We agree with FERC's inclusion of requirement #70 to complete "revised CALPUFF air dispersion modeling for the GTP, Mainline Facilities, and Liquefaction Facilities that includes the modeled source (e.g., LNG Plant) and all other air emission generating sources proposed by AGDC associated with the Project," as it fully discloses project impacts and supports the need for reduced emissions. See comment above regarding preliminary NPS modeling results.	
21	4.15 Air Quality	Permitting and analysis requirements	4-908	While air-quality-related-value analyses are only required for projects that require PSD permitting to assess impacts on Class I areas, AGDC also assessed impacts on Class II nationally designated protected areas to more fully disclose potential Project impacts.	Delete Statement	Please remove this statement from the document. An "AQRV impact analysis" is a term specific to air quality regulations that refers to an environmental effects or environmental impacts assessment, and these air quality assessments are also required under the provisions of NEPA. Environmental impacts to be considered under NEPA include impacts to Nationally Designated Protected Areas, such as units of the National Park System, regardless of their status under the Clean Air Act.	

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22	4.15 Air Quality	Table Titles	Table 4.15.5-7, page 4-910, etc.	NPS **Class I** Deposition Analysis Thresholds	NPS Deposition Analysis Thresholds	Please remove the term "Class I" from this and all other tables in the document that refer to the DAT. The DAT is an environmental threshold used to determine whether the impact of an air pollution source is insignificant and is irrespective of the area's status under the CAA. (See https://irma.nps.gov/DataStore/Reference/Profile/2180652.)	U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2011. Federal land managers' interagency guidance for nitrogen and sulfur deposition analyses: November 2011. Natural Resource Report NPS/NRSS/ARD/NRR-2011/465. National Park Service, Denver, Colorado. https://irma.nps.gov/DataStore/Reference/Profile/2180652
23	4.15	Modeling Analysis Requirements: Maximum Flaring Events	4-910	Not Applicable		The analysis disclosed maximum flaring event modeling results for National Ambient Air Quality Standards (NAAQS) and air toxics exposure impacts. A maximum flare modeling analysis should also be disclosed for visibility and deposition impacts per analysis recommendations in FERC requirement #70.	
24	4.15 Air Quality	Mitigation Requirements	4-914	AGDC has not yet submitted Minor NSR permit applications for the eight compressor stations and the heater station, and has stated that these applications are currently under development. AGDC would apply for a Title V operating permit within 180 days of commencing operation at each station.	AGDC has not yet submitted Minor NSR permit applications for the eight compressor stations and the heater station, and has stated that these applications are currently under development. AGDC would apply for a Title V operating permit within 180 days of commencing operation at each station. The facility permits should consider any emission limitations agreed to under the mitigation plan called for by FERC Requirement #72.	Note, per recommended mitigation requirement 72, the proponent should consider whether lower NOx emissions can be achieved at the mainline compressor and heater stations prior to constructing and finalizing minor source construction permits and associated Title V Operating Permits.	
25	4.15 Air Quality	Regional Haze Modeling Results	4-935, etc.	Not Applicable	Not Applicable	Alaska LNG Resource Report No. 9 states: "*As noted in Section 6.5 above, CALPUFF uses measurements of background ammonia concentrations to estimate secondary particulate formation which contributes to the amount of regional haze and visibility degradation predicted by the model. CALPUFF simulates each modeled source individually; thus, the background ammonia concentration is assumed by the model to be fully available to react with emissions from each source. This can lead to the model overestimating secondary particulate formation and regional haze impacts because, in reality, the total emissions from the combination of emission units compete for the available ammonia. Therefore actual secondary particulate formation would be less due to less background ammonia availability. Despite the inherent conservatism in the model, far-field cumulative regional haze impacts were determined by conventional utilization of CALPUFF.* *Regional haze impacts due to the Liquefaction Facility were refined by subtracting the offsite regional haze impact from the cumulative regional haze impact, as shown below. This was accomplished by conventional utilization of CALPUFF for the cumulative and existing source groups noted below and post-processing using the POSTUTIL program.*"	

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						We have previously commented that the subtraction method is an inappropriate application of the CALPUFF modeling system for single-source analyses for several reasons. First, the background ammonia value included in the CALPUFF model is meant to represent ambient background ammonia concentrations. Presumably, the background ammonia concentration should represent what is available after reaction with existing pollutants from existing sources, as it is by definition, ambient ammonia. Second, the application of POSTUTIL with the MNITRATE=1 is to prevent overlapping puffs in a given CALPUFF cell from using all available ammonia in that particular cell. In other words, this switch repartitions the available ammonia among the puffs present in the cell to prevent over estimation of particulate nitrate formation. Direct impacts of the Liquefaction Facility alone should be modeled in a single CALPUFF modeling run, as this is how the model was intended to be used for single source applications. It is unclear whether this issue was ever corrected, or if it is relevant to the results reported in the DEIS, but given the reporting of results, it is assumed the issue is still relevant. Please clarify this in the document and correct the issue in subsequent modeling performed pursuant to recommended requirement 70.	
26	5.2	Mitigation Requirements	5-38	We also recommend that AGDC file a **Class I and Sensitive Class II** Mitigation Plan, developed in consultation with FLMs and ADEC, to reduce operational emissions to ensure that the predicted visibility and deposition impacts at Class I and II areas are below NPS thresholds.	We also recommend that AGDC file ~~a Class I and Sensitive Class II~~ a Visibility and Deposition Air Quality Mitigation Plan, developed in consultation with FLMs and ADEC, to reduce operational emissions to ensure that the predicted visibility and deposition impacts at Class I and II areas are below NPS thresholds.	Please see Comment #19 above and revise accordingly.	

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Literature Cited

Densmore, R.V., M.E. Vander Meer, and N.G. Dunkle, 2000. Native Plant Revegetation Manual for Denali National Park and Preserve. Information and Technology Report. USGS/BRD/ ITR-2000-006. USGS Alaska Science Center, Anchorage, Alaska. March 2000.

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Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

NUMBER	DOCUMENT TITLE	DOCUMENT SECTION	DOCUMENT PAGE	COMMENT
1.	Appendix S Visual Resources	Table S-1	5	The Sag [Sagavanirktok] River Overlook and Happy Valley Wayside are on state lands. The BLM has interpretive panels at these locations but the lands were conveyed to the state many years ago.
2.	Appendix S Visual Resources ACRONYMS AND ABBREVIATIONS		14	Add any missing acronyms used in Appendix S to the List of Acronyms page.
3.	Appendix S Visual Resources - KOP 3, KOP 10, and KOP 11	Project Activities Generating Impacts	S-10, S-18, S-20	Mitigation measures that have the potential to alter the landscape should blend in with the surrounding landscape and match color, form, line and texture.
4.	Appendix S Visual Resources - KOP 5: Atigun Pass and KOP 6: Base of Atigun Pass	Visual Impacts During Operation	S-12 S-13	This states that the Revegetation Plan will be followed. The Revegetation Plan is still in draft form. The Revegetation Plan should state that where there is currently no vegetation or minimal vegetation, no new vegetation will be introduced that create contrasts to the existing visuals of the area.
5.	02 Alaska LNG DEIS Volume 2	4.7 Aquatic Resources	4-396	The Kanuti River provides anadromous habitat downstream of the pipeline crossing.
6.	02 Alaska LNG DEIS Volume 2	4.7 Aquatic Resources	4-396	The genus species of inconnu/sheefish is *Stenodus leucichthys*
7.	02 Alaska LNG DEIS Volume 2	4.7 Aquatic Resources	4-396	Lingcod (*Ophiodon elongatus*) are a marine species and are not found in the Tanana River.
8.	Alaska LNG Project Draft EIS	4.3.1.5 Impacts and Mitigation - Groundwater Quality	4-125	Paragraph 3 lists the contents of an SPCC prepared by the AGDC for this Draft EIS. The plan is not appended to the Draft EIS and therefore in not available for review. As part of the comment resolution process for the Preliminary Draft EIS, it was agreed that the SPCC would be referred to as an SPCC template because that version of the plan was missing significant required sections. It is recommended that either the text in this paragraph be revised to reference a template SPCC or provide the plan for review.

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9.	Alaska LNG Project Draft EIS	4.4.2 General Impacts and Mitigation	4-229	The first paragraph indicates that, "Adherence to the fueling, storage, containment, and cleanup measures discussed in the Project Procedures and SPCC Plan would decrease the potential for an incidental release into wetlands and reduce the impacts if a release should occur." The Project Procedures Plan is not appended to the Draft EIS and therefore is not available for review. It is recognized that facility specific SPCCs will be developed. However, the current SPCC is incomplete and should be referenced as a template SPCC.
10.	Alaska LNG Project Draft EIS	4.5.2.2 Disturbance	4-250	Paragraph 4 briefly discusses potential impacts of spills on vegetation. The general SPCC is described as a template and future facility specific SPCCs are included in the text. The Project Waste Management Plan, not appended to the Draft EIS is also referenced as a source of procedures to be applied in preventing or minimizing potential damage to the environment via spills.
11.	Alaska LNG Project Draft EIS	4.9.6.3 Impacts and Mitigation - Project Generated Waste	4-550	All of the plans listed in previous comments as not appended to the Draft EIS and thus not available for review are provided as references in Section 4.9.6 that contains much of the information on spill mitigation and waste management applicable to the facilities included in this project. Therefore, it's not possible to verify the adequacy of these plans, as they pertain to the entire project.
12.	Alaska LNG DEIS Volume 1	4.1.3.10	4-42	Not considering the impacts of climate change, especially for areas underlain by permafrost, is certain to underestimate the impacts of some actions. This should at least be acknowledged in the text.
13.	Alaska LNG DEIS Volume 1	4.1.3.10	4-43	The lack of locations, equipment, and implementation techniques of mitigation measures does not allow for a robust analysis of impacts
14.	Alaska LNG DEIS Volume 1	4.2.2.1	4-69	Not considering the impacts of climate change on permafrost and permafrost alterations does not adequately convey potential future impacts. Given the visibility of permafrost degradation to residents of interior and northern Alaska, there should be some discussion and analysis in the Final EIS.
15.	Alaska LNG DEIS Volume 2	4.7.1.6	4-405	The description of fuel storage and refueling activities is inconsistent with the required stipulations established in the Utility Corridor RMP. The BLM Recommended Mitigation Measure 4 will

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				allow for fueling within a floodplain provided the fuel containment system is designed appropriately for the hydrologic conditions.
16.	Alaska LNG DEIS Volume 2	4.7.1.6	4-408	While the impacts of road crossings may be localized, the impacts up and downstream are frequently not minor. Changes in sediment regime upstream and downstream of road crossings can be considerable and long lasting.
17.	Alaska LNG DEIS Volume 2	4.7.1.6	4-415	While the impacts of spills may be localized, the impacts have the potential to be anything but "minor" in that localized area. This should be reflected in the analysis.
18.	Alaska LNG DEIS Volume 2	4.7.1.6	4-415	Using the words "minor" and "death" in the same sentence does not seem to adequately convey impacts to the public.
19.	Alaska LNG DEIS Volume 2	4.7.1	4-389	Given the lack of surveys within the project area, and no details on how it was determined that flow was insufficient to support fish, it should be assumed that all non-surveyed areas are fish bearing until surveyed to show otherwise.
20.	Alaska LNG DEIS Volume 2	4.9.1.2	4-513	The comparison of the acres of open land affected by the project to the acreage of all lands in Alaska does not provide the reader with a useful context. Using a metric such as the acreage of open land within the utility corridor would be more meaningful.
21.	Alaska LNG DEIS Volume 2	4.9.1.2	4-514	The Draft EIS states "Although AGDC states that the Alaska Forest Resources and Practices Act (AS 41.17) is not applicable to the Project." It is unusual to allow the applicant to determine which regulations are applicable to their projects, and is likely to raise public objections. The Final EIS should state whether the Alaska Department of Natural Resources, Division of Forestry, considers AS 41.17 to be applicable.
22.	Alaska LNG DEIS Volume 2	4.9.1.2	4-515	The administrative Draft EIS stated that "Mainline Facilities would affect 40 acres of open water", whereas the Draft EIS estimates impacts at 264 acres. It is not evident where the increase comes from nor which water bodies are affected. Please explain the six-fold increase and whether the increased acreage has been propagated into the cumulative impacts analysis.

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23.	Alaska LNG DEIS Volume 2	4.9.1.2	4-516	As was previously commented, information provided on reclamation (especially regarding riparian vegetation) indicates that impacts would be long-lasting and potentially have impacts on water quality that extend beyond "minor and temporary"
24.	Alaska LNG DEIS Appendix D	VI.D.2		Depending upon the type of intended aircraft, the size stated for helicopter landing zones (170'x300') may be excessive and could result in unnecessary vegetation clearing. Department of Interior guidelines for a helispot call for a safety circle of 110 feet with a 30'x30' touchdown pad for Type I helicopters, with smaller LZ requirements for Type II and Type III helicopters.
25.	Volume 1	2.2.2.4	2-71 and GLOBAL	VEGETATION CLEARING AND MIGRATORY BIRDS: Although the following is stated here: "Vegetation clearing would be conducted in accordance with the clearing windows identified in the Project Migratory Bird Conservation Plan," information that does not support this assertion is found in various places throughout the document. In keeping with our policy on special status species (SSS) the BLM may require that nest surveys are conducted prior to clearing within the nesting periods. Since a current Project Migratory Bird Conservation Plan has not been provided it is difficult to determine whether impacts on avian species (esp. SSS) would be significant. A definitive assessment cannot be made regarding impacts until the final plan is provided including mitigation measures that would reduce impacts. ***Global: For avian species and throughout the document no calls on the significance of impacts on a given resource can be made until mitigation measures, as provided in final Plans or elsewhere, are finalized.***

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26.	Volume 1	2.2.2.3	2-70 and GLOBAL	The current wording about ice road impacts on vegetation does not address how compaction associated with work pad construction can damage and alter underlying vegetation and hydrology, regardless of construction techniques. Suitably constructed ice work pads can support heavy loads without permanent destruction of underlying vegetation. However, changes to underlying vegetation and hydrology within the entirety of the disturbance footprint AND the surrounding disturbance buffer would be apparent for an extended time period. Also, where mention of a disturbance footprint is made, the document should also acknowledge the likely spatial extent of the edge effect on the given resource.
27.	Volume 1	4.2.4	4-87	RECLAMATION/REVEGETATION TIMELINE: The length of this revegetation process could take decades depending on site specific factors, including ground ice content, ground temperature, thermal boundary conditions at the ground surface, and work pad material type and pad properties such as fines content, moisture content, thickness, and thermal conductivity.
28.	Volume 1	4.2.5.1	4-89	LACK OF RECLAMATION OF WORK PADS: The reclamation methods described for the Gas Treatment Plant (GTP) on page 4-90 should be applied to work pad reclamation. These methods would allow for speedier reclamation than that described for those sites (i.e. decades)- see section 4.2.4
29.	Volume 1	4.2.5.2	4-95 and GLOBAL	Regarding the separation of the surface organic layer, in the statement "AGDC has noted that conventional excavation equipment would not be able to fully separate frozen organics from the mineral soil underneath unless the active layer is thawed." and the related discussion, it is unclear why AGDC is maintaining that winter segregation of topsoil is not feasible or practicable. See the following INGAA Foundation document as reference to successful winter segregation: https://www.ingaa.org/File.aspx?id=21144 (pp 12). Also, why are other seasons not being considered for topsoil removal? ***Global: The***

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				applicant should provide explanation of why organics can't be separated and stockpiled in the winter AND why other seasons (late summer, autumn) are not being considered as appropriate for clearing.
30.	Volume 1	4.2.5.2	4-96 thru 4-109 and GLOBAL	Interactions of soils, permafrost, hydrology, and vegetation effects need to be acknowledged. Currently these sections are not cross-referenced and are sometimes contradictory.
31.	Volume 1	4.2.5.2	4-112	BLASTING: The Draft EIS states "Blasting operations in permafrost would be conducted in the winter, which would dissipate any heating due to blasting or other conventional trenching construction methods." Additional blasting impacts are addressed later in the document (esp. under subsistence sections); cross-reference them here for consistency.
32.	Volume 2	4.6.1.2	4-285 AND GLOBAL	BLASTING AND NOISE: Impacts of blasting and noise are discussed here and in several other sections of the document, however these sections are not well-linked to one another and provide various incongruous information. Cross-reference all sections related to noise impacts and blasting and clearly define sensitive time periods (wildlife and hunting) to be avoided in the Plan. Conclusions about noise impact significance cannot be drawn until Plans/mitigation measures are finalized. Provide the Baseline Noise Level Report for review with plans if possible.
33.	Volume 2	4.6.1.2	4-297 and across species	WILDLIFE IMPACTS: There should be some mention of the link between increased predation and road/infrastructure (pad) berm height (see Roby 1978). Berm height should be mentioned as a general impact on other species (advantage to predator, disadvantage to prey species)

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34.	Volume 2	4.6.1.2	4-306	The reference to a 40-dBA isopleth in Volume 2 needs a citation/cross reference to Volume 3 where more detail is provided. Without that linkage there is no context to understand the information in Volume 2. Roby, D. D. 1978. Behavioral patterns of barren-ground caribou of the Central Arctic Herd adjacent to the Trans-Alaska Oil Pipeline. M.S. thesis, University of Alaska, Fairbanks. 200 pp.
35.	Volume 2	4.6.1.2	4-306 and GLOBAL	WILDLIFE HABITUATION: In regards to sheep in this section, as well as in other portions of the wildlife section, there are inferences that: "individuals [animals] would be expected to habituate" to human activity. This may be true in some cases but the extent to which it would occur would vary with species and individual animal. Unless there are concrete references that can be used to substantiate the assumption that habituation will occur (per species), assertions regarding this assumption should be stated as potential effects not presumed to be true.
36.	Volume 2	4.6.2	Global	BLM SSS: There is no mention in this section of the BLM policy on special status species. It would be expected to be mentioned in the section that describes fish and wildlife species of concern. This policy is what drives the special status species list and should be mentioned in this section. Policy and current list are both readily available on BLM websites. **UPDATE:** this information is provided in Section 4.8.2 which is appropriate, however it should be cross-referenced here (note: most SSS are avian species).
37.	Volume 2	4.6.2	Global	BIRDS AND OPEN PIPES: One bird-related mitigation measure that is not addressed in either the Draft EIS or the project plans is the need to prevent open pipes associated with all infrastructure. Open pipes provide attractive but dangerous habitat for nesting birds. Considerable information is available about this hazard. For instance: https://www.partnersinflight.org/resources/death-pipes/

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38.	Volume 2	4.8.2.2	4-503	HAZING AND BLASTING: The Draft EIS states: "To reduce noise disturbance impacts on birds and small mammals from blasting, AGDC committed to performing non-lethal hazing to clear areas of wildlife prior to blasting" (see section 4.6.1). Response: As previously mentioned in another section, it would be best to avoid blasting during sensitive time periods for wildlife (e.g. lambing, calving, nesting) and subsistence hunting activities. Hazing animals is also energetically taxing and should be avoided. Provide alternate methods for avoiding noise impacts and describe these measures in the appropriate mitigation measures and plans.
39.	Volume 2	4.8.2.2	4-503	WATER WITHDRAWAL AND BIRD HABITAT: Water withdrawals section: Should also mention other species (esp. waterfowl and shore-nesting birds) whose habitat (esp. nesting) may be impacted.
40.	Volume 2	4.10.2.1	590	VISUAL IMPACTS: The Draft EIS states : "Depending on viewer sensitivity, the visual impacts of the Mainline Pipeline would vary from low north of the Brooks Range (between Nenana and Clear) and in the Susitna River valley (south of Talkeetna) to high in the Brooks Range (from Galbraith Lake to south of Coldfoot) and Alaska Range (from Clear to Talkeetna), including the DNPP and Denali State Park. Due to their higher visual sensitivity, recreational visitors would generally perceive higher visual impacts, particularly in more heavily visited recreational areas, such as near Denali State Park and DNPP." Response: There are errors in the first sentence since Nenana and Clear are not north of the Brooks Range. Other visually sensitive resource areas should also be noted here (i.e. cross-reference Table S-1 in Appendix S), consider the Galbraith/Atigun area in addition to DNPP and Denali State Park.
41.	Volume 3	4.16.3.2	4-948	BLM's Utility Corridor Resource Management Plan (RMP) requires that aircraft associated with BLM-permitted activities observe altitude restrictions in some places along the proposed Right of Way. It should be noted that the BLM's Grant of Right of Way will likely include stipulations to ensure compliance with the RMP.

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42.	Volume 3	4.19.4.5	4-1130	Non-Native Invasive Species: Draft EIS statement: "Because the northern sub-regions have no known occurrences of NNIS, cumulative impacts on native vegetation as a result of NNIS are less likely in this area under current conditions." Response: This is erroneous, there are some occurrences of NNIS in northern sub-regions (visit the Alaska Exotic Plants Information Clearinghouse (AKEPIC) at https://accs.uaa.alaska.edu/invasive-species/non-native-plants/). Also note that other factors, not just climate change, could cause expansion; there are a plethora of human activities (including road maintenance activities) that are currently expanding the range of several NNIS species that are currently present. An updated and/or current Invasive Species Plan needs to be provided to determine whether impacts will be appropriately mitigated.
43.	Volume 3	4.19.4.6	4-1132 and GLOBAL	WILDLIFE MOVEMENT: Physical barriers also create areas where natural predation is higher. Reduced berm height for roads, ice roads and other infrastructure built on gravel workpads above normal ground level would help mitigate the potential increase in predation. Add the projected impacts of berm height here and in other sections where impacts to prey species (esp. caribou and moose) are mentioned (see above comment and reference to Roby 1978)
44.	Volume 3	4.19.4.6	4-1133 and GLOBAL	BIRDS AND OPEN PIPES: Add open pipes associated with infrastructure to the list of activities (and/or infrastructure placement) that could impact birds. Also add to other sections where impacts on avian species are mentioned.
45.	Appendix M. Winter and Permafrost Construction Plan	2.2 Project Procedures, Table 2.6-2 AND 4.1.2	13, 37	**Relevant/Unresolved Comment from previous review:** V1.B.2.h: The statement that soil will be stockpiled and replaced "except in areas where standing water is present or soils are saturated or frozen" is of concern; a substantial portion of the clearing will occur during winter months. We do not agree that it is not feasible to stockpile the cumulative topsoil (organic and mineral soils to a depth of 1 ft) in the winter (a brief description of why winter topsoil salvage is not feasible is provided on pg 37). There is strong evidence that winter salvage is actually preferable for harvesting topsoil http://www.cif-ifc.org/wp-content/uploads/2018/03/3_17-0012-A-guide-to-soil-salvage_nov_29_acc-1.pdf

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46.	Appendix M. Winter and Permafrost Construction Plan	Universal and esp Section 3.2 Construction Seasons	17, 18	**Relevant/Unresolved Comment from previous review(s):** Section 3.2 provides some dates and details regarding the seasonal parameters involving construction. There is specific mention of needing to meet the snow/freeze depths required by the North Slope Borough. Note that BLM land use plans also typically have snow depth and freeze down restrictions on overland travel, including on lands outside the North Slope Borough.
47.	Appendix P	Table P-1	P-5	While Clear Creek chum salmon (Hogatza River drainage) are on the BLM watch List, this stream is not in close proximity to the project. Recommend it be removed from Table P-1.
48.	4.0 Environmental Analysis	4.7.1.5 Commercial and Recreational Fisheries	4-402	Under the heading "Mainline Facilities," citations are needed to substantiate the existence of commercial fisheries at mainline milepost (MP) 90.3 and MP 229.1.
49.	Summary of Landfills, Mines, and Spill/Release Sites near Mainline Facilities	Table R-2	R-6	The footnote for the Regulatory Status column directs the reader to see Section 4.9.6.1 for definitions of the entries listed under that column. There is no definition for 'Inactive' mines within Section 4.9.6.1. More importantly, Linda Creek, Minnie Creek, and Slate Creek mines are shown as 'Inactive'. They are all active mine sites. Also, Minnie Creek is on lands administered by BLM, not ADNR/BLM.
50.	Summary of Landfills, Mines, and Spill/Release Sites near Mainline Facilities	Table R-2	R-7	The South Fork Koyukuk River mine is active, not 'Inactive' as shown under Regulatory Status
51.	Summary of Landfills, Mines, and Spill/Release Sites near Mainline Facilities	Table R-2	R-8	The Prospect Creek mine is active, not 'Inactive' as shown under Regulatory Status

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52.	Alaska LNG Project DEIS	4.1.2.1	PDF: 232 Page 4-11	Last sentence seems to state the ADNR mining claims include Federal mining claims, which is incorrect. Also, all Federal mining claims are unpatented. "ADNR mining claims include those purchased by individuals or mining companies and federal mining claims, which are mostly unpatented and grant exclusive rights to locatable minerals at a particular site."
53.	Alaska LNG Project DEIS	4.1.2.1	PDF: 233 Page 4-12	Federal mining claims are not included on the figure (as they likely wouldn't be seen at the map's scale); therefore, the figure should instead be titled ADNR Mining Claims and Leases in the Project Area.
54.	Alaska LNG Project DEIS	4.1.2.1	PDF: 235 Page 4-14	First non-bulleted paragraph: Change 'BLM' to 'Federal'. There are no BLM mining claims; rather, BLM adjudicates federal mining claims.
55.	Alaska LNG Project DEIS	4.1.2.1	PDF: 236 Page 4-15	First paragraph states that Project construction will require 26.6M CY of granular fill. The total, using the volumes provided for each facility, is 31.3M CY. It appears the volume for the Liquefaction Facilities was not included. This should be corrected in the Final EIS.
56.	Alaska LNG Project DEIS	4.1.2.3	PDF: 238 Page 4-17	Last paragraph, first sentence states that there are no mining claims within the project area. That is incorrect. Mining claims at Linda Creek extend to Middle Fork Koyukuk River. Sheet 52 shows the Mainline running across Linda Creek and, as such, across federal mining claim AKFF 054169 and/or AKFF 054168. The Mainline also appears to cross several state mining claims near Livengood and east of Denali NP.
57.	Alaska LNG Project DEIS	4.1.2.3	PDF: 238 Page 4-17	Last paragraph, second sentence: wording of sentence implies that AGDC is a permitting agency. Recommend removing "AGDC has stated that".
58.	Alaska LNG Project DEIS	4.1.2.3	PDF: 240 Page 4-19	The first paragraph on this page does not accurately paraphrase Federal or state mining law. Recommend deleting it or editing to correctly describe Federal mining law. The BLM does not prevent staking of mining claims. Unless an area is withdrawn from mineral entry, or some law prevents staking of mining claims, claims may be staked. Existing claims will not be 'cancelled', unless a claim holder wishes to relinquish or fails to maintain their claims. Compensation may or may not be involved for a voluntary claim relinquishment. A validity exam may be

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				performed by a BLM certified mineral examiner at the proponent's expense.
59.	Alaska LNG Project DEIS	4.1.2.3	PDF: 240 Page 4-19	Except for the first sentence, paragraph two is speculative, contains incorrect information, and could be considered pre-decisional. As such, it should be deleted.
60.	Alaska LNG Project DEIS	4.1.2.3	PDF: 240 Page 4-19	Third paragraph: Given that several mining claims were overlooked previously, verify that no mining claims exist within the proposed ROW for the Alaska Stand Alone Gas Pipeline (ASAP) that Alaska LNG intends to collocate with. In last sentence, change "of" to "or" after 'BLM State Director'.
61.	Appendix B	Volume 1	B-3 - B-19	North arrows are missing from maps.
62.	Alaska LNG Project DEIS	4.1.2.3	PDF: 240 Page 4-19	First paragraph: Suggest changing "Existing mining claims are a prior existing right to mine," to "Existing mining claims include a prior existing right to mine," or something similar.
63.	Alaska LNG Project DEIS	4.1.2.3	PDF: 241 Page 4-20	First paragraph: Suggest changing "(material)" to "(mineral material)". Same for paragraphs three, four, five, and the bulleted paragraph, and all subsequent references to 'material' when used as a term for 'mineral materials'. The BLM is not sure how test holes themselves cause contamination; spills from construction equipment are impacts, whether they somehow spill into test holes or not. As part of reclamation, both overburden and topsoils are used, whether stockpiled for later use or used immediately, as part of concurrent reclamation.
64.	Alaska LNG Project DEIS	4.1.3.1		There are several mineral material pits along or near the proposed Mainline. Mineral materials aren't really discussed, other than as sources for LNG construction. How will Mainline crossings of active pits be addressed? What are the Mainline impacts to existing and future mineral material operations?

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65.	Alaska LNG Project DEIS	4.1.3.1	PDF: 243 Page 4-22	Last paragraph: Since August of 2018, there have been several earthquakes of 5.0 or greater near the project area (including two greater than 6.0), roughly 50 miles southeast of Point Thomson. Recommend updating this paragraph to reflect seismic activity that has occurred since August 2018.
66.	Alaska LNG Project DEIS	4.1.3.1 Figure 4.1.3-1	PDF: 244 Page 4-23	Recommend updating the figure to include earthquakes of 6.0+ that have occurred since the figure was produced in October 2017.
67.	Alaska LNG Project DEIS	4.1.3.1 Table 4.1.3-1	PDF:245 Page 4-24	Recommend updating the table to account for the August 2018 earthquakes.
68.	Alaska LNG Project DEIS	4.1.3.8	PDF: 258 Page 4-37	It should be noted that magnesiocarpholite, an asbestiform-like mineral, was encountered at MP 222 on the Dalton Highway (LNG MP 193). Although this mineral is not a regulated serpentine or amphibole asbestos mineral, due to its rarity, any health concerns are unknown at this time.
69.	Alaska LNG Project DEIS	4.18.6.2	PDF: 360 Page 4-1044	First paragraph: As the Richter Scale is a bit outdated, verify that the magnitudes are correct for the Richter Scale. Otherwise, use the Moment Magnitude scale when referring to earthquake magnitude.
70.	Alaska LNG Project DEIS	4.18.6.2	PDF: 362 Page 4-1046	Second complete paragraph states that only one earthquake greater than magnitude 6.0 has occurred within 100 miles of the GTP site since 2015. According to the UAF Alaska Earthquake Center Monthly Seismicity Report for August 2018, there were two similar events, one within 86 miles of Deadhorse and one within 108 miles. The analysis should either incorporate the more distant earthquake or state why it is below the threshold for inclusion. Also, as earthquakes are occurring almost daily in the northern project area that are 2.5 or greater, the numbers discussed in this paragraph are inaccurate. Recommend using a bracketed time frame when discussing the number and magnitude of earthquakes. For example, instead of saying "since 2015", which is open-ended, perhaps use language such as "between January 2015 and January 2019".
71.	Alaska LNG Project DEIS	4.18.6.2	PDF: 364 Page 4-1048	First full paragraph: As recommended above, use a time bracket instead of an open-ended time reference. Depending on when the paragraph was written, the numbers of earthquakes for each

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				magnitude may be significantly greater. In the last month of 2018, there were about 6,000 earthquakes in the area.
72.	Alaska LNG Project DEIS	4.18.6.2	PDF: 371 Page 4-1055	First full paragraph, last sentence: What valves would move into a fail-safe position?
73.	Alaska LNG Project DEIS	4.18.6.2	PDF: 373 Page 4-1057	First full paragraph, last sentence: What valves would move into a fail-safe position?
74.	Alaska LNG Project DEIS	5.1.1	PDF: 479 Page 5-1	First paragraph under 5.1.1: The Mainline crosses at least one, possibly two, federal mining claims and several state mining claims (see row 9 above). Also, existing mining claims are not a prior right. Instead, active mining claims come with prior existing rights.
75.	Alaska LNG Project DEIS	5.1.1	PDF: 479 Page 5-1	Second paragraph under 5.1.1: As stated above in row 12, most of this paragraph is speculative and borders on being pre-decisional. Consider removing the third and fourth sentences.
76.	DEIS Volume 1	4.1.6	4-56	Excavation at material sources presents a large risk of potential disturbance for paleontological materials and should be noted in the first paragraph.
77.	DEIS Volume 1	4.1.6	4-56	Indirect effects could also include degradation of paleontological resources once they are exposed (e.g., weather from wind, water, freeze-thaws, etc.) and should be noted in the first paragraph.
78.	DEIS Volume 1	4.1.6	4-56	The fossils that could be encountered include both large and small terrestrial vertebrate species. Currently the second paragraph just suggests that "large" vertebrate fossils could be encountered. The second paragraph should include the full range of species that could be encountered in Mesozoic through Pleistocene geologic deposits, which would include both large and small vertebrate species.
79.	DEIS Volume 1	4.1.6	4-56	It is unclear the relevance of the information this sentence is conveying: "Traditional knowledge regarding paleontological resources was obtained from residents of the Nuiqsut community, which primarily related to the unanticipated findings of Pleistocene-age mammal fossils in the Colville River region (Braund, 2016)". The Colville River and associated "region" is well outside of the project footprint. If the purpose of the interviews was to generally assess traditional knowledge about fossil

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				locales on the North Slope, then it should state that; or, the sentence could be removed as there is no discussion of this information in the following sections.
80.	DEIS Volume 1	4.1.6	4-56	Where did the survey that is referenced in the third paragraph occur? How many areas were surveyed? Acres?
81.	DEIS Volume 1	4.1.6.1	4-57	The first mention of the potential fossil yield classification (PFYC) system is in this paragraph and the text just discusses the results. Suggest introducing the PFYC system in the previous section, and explain that a PFYC model was created for the project.
82.	DEIS Volume 1			The first paragraph should be more explicit about why the project is unlikely to encounter the fossil resources that are described here.
83.	DEIS Volume 1	4.1.7	4-59	This sentence misstates the potential adverse effects: "Therefore, with implementation of the PRUDP and PRMP during construction and operation, the Project would not have significant adverse effects on paleontological resources." Recommend revising to say "The Project could have significant adverse effects to paleontological resources, but the implementation of the PRUDP and PRMP will minimize and mitigate those effects."
84.	DEIS Volume 1	4.1.7	4-59	The conclusion seems to be copied from another section. It needs to be revised to actually reflect the summary of the previous discussion and how paleontological resources will be affected by the project.
85.	DEIS Volume 3	4.13	4-685	NEPA requires a broader consideration of "cultural resources" than does the National Historic Preservation Act (NHPA). That discussion seems to be entirely lacking throughout the Cultural Resources section, which is entirely focused on the NHPA. This section should be revised to be more inclusive of a broader range of resources than just "historic properties" which are narrowly defined under 36 CFR 800.16(l)(1) and does not capture other resource types such as Sacred Sites, cultural landscapes, traditional use areas, etc.
86.	DEIS Volume 3	4.13	4-685	Have the acronyms "NRHP" and "ACHP" been defined prior to this section?

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87.	DEIS Volume 3	4.13	4-685	Taking historic properties into account and affording the Advisory Council on Historic Preservation (ACHP) an opportunity to comment are only part of what's required by Section 106 of the NHPA. This first paragraph should be expanded to note that consultation, inventory, evaluation, assessment of effects, and resolution of adverse effects are all part of the required steps, pursuant to 36 CFR 800.3 through 800.6.
88.	DEIS Volume 3	4.13	4-685	Information, analyses, and recommendations are not authorized by 36 CFR 800.2(a)(3); the ability for a lead federal agency to shift some of the Section 106 obligations to the applicant is authorized. This sentence needs revised to reflect that fact.
89.	DEIS Volume 3	4.13	4-685	If historic properties are defined in the second paragraph, it should use the language directly from 36 CFR 800.16(l)(1) which reads "Historic property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places.... This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization"
90.	DEIS Volume 3	4.13	4-685	Note that the current language in the second paragraph is also inaccurate as the definition of "tribe" includes ANSCA Village and Regional Corporations, pursuant to 36 CFR 800.16(m). Therefore, "locations of traditional value" can be identified by ANCSA corporations as well as federally recognized tribes.
91.	DEIS Volume 3	4.13.1	4-685	Has the abbreviation "APE" been previously explained? If not, there should be an explanation here as to what it is and how it's relevant to cultural resources.
92.	DEIS Volume 3	4.13.1	4-685	"To date, AGDC has surveyed approximately 27,925 acres of the terrestrial direct APE." Include the approximate percentage of the Project footprint that AGDC's survey has covered.
93.	DEIS Volume 3	4.13.1	4-685	The Draft EIS states: "A database inventory of shipwrecks and remote-sensing data was completed to assess the potential for submerged resources along the offshore Mainline Pipeline route, Marine Terminal and approach channel, and two offshore dredged material placement areas in

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Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

				Cook Inlet." Describe what the results of the inventory were.
94.	DEIS Volume 3	4.13.1	4-685	The Draft EIS states: "AGDC would survey the remaining Mainline Pipeline route and ancillary facilities for archaeological and aboveground historic architectural resources, and submit the results of surveys in future survey reports." This sentence is a direct indication that FERC plans to complete the Section 106 inventory obligations using a phased approach, pursuant to 36 CFR 800.4(2), but that is never directly stated in this section, and should be.
95.	DEIS Volume 3	4.13.1.1	4-686	This paragraph is confusing. It doesn't matter what was previously identified vs. found during AGDC's surveys. What matters is how many resources are located within the APE(s), what the potential impacts may be to those resources, and what the resolution of adverse effects may be.
96.	DEIS Volume 3	4.13.1.1	4-686	The Draft EIS states: "In a letter dated May 16, 2019, the Alaska SHPO requested additional documentation of the site." Is not relevant to this section nor does it provide any information regarding what resources are present and what the impacts may be.
97.	DEIS Volume 3	4.13.1.2	4-686	According to the Draft EIS: "Archaeological surveys resulted in the identification of 117 archaeological resources." It is unclear if this statement is just referencing AGDC's surveys, or if this is inclusive of all known resources along the mainline facility. It is also confusing in that this is referencing sites within the direct APE, not the indirect APE (which has not yet been surveyed, per previous section). Also, because this section is NHPA-focused, and the NHPA only applies to historic properties, this section should use the number of NRHP-eligible properties within the direct APE, rather than "archaeological resources and other sites". The status of "Alaska SHPO comments" seems irrelevant to the analysis.
98.	DEIS Volume 3	4.13.1.2	4-686	Footnote 102 should be moved to "Highways" rather than attached to "burial site"
99.	DEIS Volume 3	4.13.1.2	4-686	Suggest including a separate paragraph for the Gallagher Flint Station National Historic Landmark (NHL) as NHL's have additional status and considerations under 36 CFR 800.10, particularly

Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

				for the agency official (FERC) " to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to [NHL's]", and requires the involvement of the ACHP and the Secretary of the Interior.
100.	DEIS Volume 3	4.13.1.2	4-686	"AGDC has not yet identified how the NRHP-eligible sites would be avoided or mitigated or how the burial would be avoided." This is problematic as the NHPA requires that adverse effects are resolved (or a plan to resolve them are codified in an agreement document), prior to the issuance of any permit, authorization, or expenditure of federal funds for a project. In previous sections, it's clear that FERC (through AGDC) intends to use a phased approach to identification, which requires either an executed MOA or PA, pursuant to 36 CFR 800.4(b)(2). In either case, this should be disclosed in the DEIS so the public may be aware of FERC's intentions for Section 106 compliance. Any potential agreement document should be discussed in the Impacts and Mitigation section (4.13.5).
101.	DEIS Volume 3	4.13.1.2	4-686	"Above Ground Resources" need to be defined, as it is confusing to read that none were identified in the direct APE of the mainline. Table 4.13.1-1 suggests there are, in fact, many above ground resources within the mainline facilities.
102.	DEIS Volume 3	4.13.1.2	4-686	This section explains the methods used to investigate offshore resources, and SHPO's recommendations for avoidance, without disclosing whether offshore resources are present or what they may be. The section should be revised so that resources are discussed prior to SHPO's recommendations for avoidance.
103.	DEIS Volume 3	4.13.1-1	4-687	The title makes it unclear what resources this table is listing. Is it all known resources within the direct APE? Or is it just resources that were identified by AGDC survey? The table should be revised to reflect all known resources in the direct APE (whether they were identified by AGDC survey or by other surveys). The site numbers should be ordered in some way, preferably from north to south (or vice versa), or ordered based on NRHP status. The "Eligibility Recommendation" should note that they are AGDC's recommendations, not the recommendations from land owners or managers, and whom concurrence is required from.

Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

104.	DEIS Volume 3	4.13.1.3	4-692	The section on Archaeological Sites should be revised for clarity. One historic property is present within the Liquefaction Facilities, and, provisionally, will be impacted by the project. However, this is not clearly disclosed, nor are potential resolution measures discussed that would minimize or mitigate adverse impacts.
105.	DEIS Volume 3	4.13.2	4-693	Recommend making the Alaska Native Tribal Consultations a separate section as many of the concerns voiced by Tribal entities are relevant to other sections of the DEIS, not just cultural resources. This would also highlight FERC's efforts for tribal consultation for the project as a whole.
106.	DEIS Volume 3	4.13.2-1	4-694	The requirements for tribal consultation under Section 106 are more inclusive than just federally recognized tribes, and includes ANCSA Village and Regional corporations. This section should indicate the extent of consultation with those entities.
107.	DEIS Volume 3	4.13.5	4-698	"To date, AGDC has not filed any SHPO or BLM comments on the plan." This doesn't seem relevant to the purposes of the DEIS, which is to disclose affected resources and potential mitigations to the public. Recommend deleting or re-wording.
108.	DEIS Volume 3	4.13.5	4-698	"Project construction and operation could potentially affect historic properties (i.e., cultural resources listed on, or eligible for, the NRHP)." Sentence is problematic. Historic properties have a very specific definition under 36 CFR 800.16(l)(1); they are not 'cultural resources listed on, or eligible for NRHP'. It may be unnecessary to redefine historic properties here, as the definition is at the beginning of the Cultural section. If it is redefined here, it should use the accurate definition following the CFR citation.
109.	DEIS Volume 3	4.13.5	4-698	"Direct effects could include destruction or damage" is an incomplete definition of "adverse effects." Per 36 CFR 800.5, adverse effects could include physical destruction of or damage; alteration of a property, including restoration, rehabilitation, repair, maintenance, or stabilization that is not consistent with the Secretary's standards; removal of the property from its historic location; change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance; and introduction of visual,

Enclosure **4**: BLM Specific Comments – Alaska LNG Draft EIS

				atmospheric or audible elements that diminish the integrity of the property's significant historic features. The Project may not result in all of these potential types of adverse effects to historic properties within the APE, but will, provisionally, have more than just "destruction or damage."
110.	DEIS Volume 3	4.13.5	4-698	"Indirect effects could include the introduction of visual, atmospheric, or audible elements that affect the setting or character of a historic property." This definition needs revision. In March 2019, the D.C. circuit court issued an opinion that clarified the meaning of the term "directly" in the NHPA as referring to the causality, and not the physicality, of the effect to historic properties. This means that if the effect comes from the undertaking at the same time and place with no intervening cause, it is considered "direct" regardless of its specific type (e.g., whether it is visual, physical, auditory, etc.). "Indirect" effects to historic properties are those caused by the undertaking that are later in time or farther removed in distance but are still reasonably foreseeable.
111.	DEIS Volume 3	4.13.5	4-698	"If NRHP-eligible resources are identified that cannot be avoided, AGDC would prepare treatment plans." Linear historic properties have been identified that cannot be avoided and the project MUST cross (e.g., XBP-00114, SAG-00098, LIV-00556, LIV-00764, FAI-02177, FAI-02366, HEA-00450, TYP-00084). This section should be edited to more fully disclose to the public that some impacts to historic properties cannot be avoided.
112.	DEIS Volume 3	4.13.5	4-698	"Treatment plan implementation would only occur after Project authorization and after FERC provides written notification to proceed." This statement could be interpreted as being in conflict with the legal requirements of the NHPA, which requires that Section 106 compliance is completed prior to the issuance of any federal permit, license, or approval. This section should be edited to make clear how Section 106 compliance will be achieved; either by resolving all adverse impacts prior to the issuance of a certificate or by developing an

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Enclosure 4: BLM Specific Comments – Alaska LNG Draft EIS

				agreement document in compliance with 36 CFR 800.
113.	DEIS Volume 3	4.13.5	4-698	Instead of "recommending" that AGDC completes the steps listed in bullet items a) through d), FERC should require that the steps are completed, in order to be in compliance with the NHPA.
114.	DEIS Volume 3	4.13.5	4-698	FERC should also disclose that they intend to develop an agreement document pursuant to 36 CFR 800.6(c) or 36 CFR 800.14(b) or whether the Commission has delegated this responsibility to AGDC.

Alaska Department of Environmental Conservation

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Submitter Information

Email: gary.mendivil@alaska.gov
Government Agency Type: State
Government Agency: Alaska Department of Environmental Conservation

General Comment

Attached in PDF format are the comments from the Alaska Department of Environmental Conservation.

Attachments

ADEC Comment Letter DOE Alaska LNG SEIS

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Environmental Conservation

OFFICE OF THE COMMISSIONER

P.O. Box 111800
Juneau, Alaska 99811-1800
Main: (907) 465-5065
Fax: (907) 465-5070

August 15, 2022

U.S. Department of Energy
National Energy Technology Laboratory
ATTN: Mark Lusk, NEPA Compliance Officer
3610 Collins Ferry Road
Morgantown, WV 26505

Re: Alaska LNG Supplemental Environmental Impact Statement

Dear Mr. Lusk:

The State of Alaska, Department of Environmental Conservation would like to submit the following comments on the Department of Energy's Supplemental Environmental Impact Statement for the Alaska LNG Project. The Alaska LNG EIS that was completed in 2020 by the Federal Energy Regulatory Commission (FERC) was the culmination of a multi-year process with extensive public engagement. Although this department was not allowed to participate as a cooperating agency on the FERC EIS, we contributed significant time and resources to review of the FERC EIS, since our Air Quality Division would be intimately involved in the air quality permitting process for the project.

We understand that the Department of Energy' Supplemental EIS on the Alaska LNG process is specifically looking at the lifecycle greenhouse gas emissions associated with the project. The department agrees that based on the lower carbon intensity of North Slope natural gas the proposed project would not increase greenhouse gas emissions.

The Alaska Department of Environmental Conservation reviewed the proposed scenarios and the technical appendices in the SEIS and offers technical comments and input in the attached table.

Sincerely,

Environmental Program Specialist IV

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
			SUMMARY DOCUMENT	
S-1		ADEC	Paragraph four on this page appears to imply that Executive Order 13990 and Executive Order 14008 provide regulatory authority to revisit the FERC EIS. From our understanding, executive orders are more akin to policy statements and should be identified as such, rather than implying regulatory authority.	Please identify clearly that the decision to revisit the FERC EIS was a policy decision and not one based on any specific Department of Energy regulatory authority, NEPA regulation or an issue remanded to the department by the court system.
S-21	Table 5-3	ADEC	This table summarized environmental impacts, including air quality. It is not clear why this item does not have the same language as found in the water resources overview "*Cumulative impacts would be less-than-significant as activities would be subject to state regulatory requirements.*"	Please add the quoted statement to the air quality summary.
			VOLUME ONE	
1-1		ADEC	It is not clear in paragraph two on this page which version of the CEQ NEPA regulations this project is being considered under.	Please clarify which version of the CEQ NEPA regulations this project is being considered under.
2-11		ADEC	Paragraph five on this page states "The PTU Expansion Project would require the following authorizations and consultations with various resource agencies:" note that an air quality permit to construct and operate emitting units needed to support gas export to AK LNG may also be required.	Please add a State of Alaska air quality construction permit for any new proposed emitting units.

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
2-12		ADEC	An oil discharge prevention and contingency plan (ODPCP) should be added to the list of state permits.	Please add an ODPCP to the list of state permits
2-14		ADEC	The page cites to the DOE's North Slope Production Studies. These can be found in Appendix C.	Please cite to the location in the document where these studies can be found so that the reader can easily refer to them.
2-23	Table 2.5-1	ADEC	Open Burning Plan. Describes measures to be taken during construction to control burning activities that comply with federal, state, and local regulations. Open burning does not typically occur on the North Slope of Alaska.	You may want to specify locations where this would take place.
2-29		ADEC	The discussion on this page included a mention hydrostatic testing. Please note that discharge of hydrotesting water that contains additives may require an Alaska Pollutant Discharge Elimination System (APDES) permit.	Please mention that discharge of hydrotesting water which contains additives may require an APDES permit.
2-31		ADEC	Under 2nd bullet for ADEC, "portable oil and gas operating" should be "portable oil and gas <u>operation</u>".	Please correct definition.
3.3-8		ADEC	Paragraph two on this page notes that almost all of the surface water withdrawn within the North Slope Borough was saline water used for mining. This appears to be a cut and paste from a prior statement about groundwater. It is not clear how this can be correct given the amount of freshwater and ice chips used to make ice roads in the winter. Also, does the word "mining" include oil exploration and development?	Please clarify if the quoted statement regarding saline water used for mining is true.

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
3.3-9		ADEC	The last paragraph on this page cites to the 2014/2016 Integrated Report, as the last full document available on ADEC website. Please note that the Environmental Protection Agency's (EPA's) formatting standards have changed. Now all the parts of the report are provided electronically. Results from Alaska's Integrated Report for 2020 can now be found on How's My Waterway. How's My Waterway integrates data from the Integrated Report with local water quality data, information on aquatic recreation and harvest, and restoration and protection efforts."	Please site to the 2020 Integrated Report as provided on EPA's web site.
3.15-2	Table 3.15-1	ADEC	Tables lists State ozone standard for ozone as 0.075 ppm whereas the State standard is 0.070 ppm per18 AAC 50.010(4).	Revise Table 3.15-1 to match State regulation.
3.15-3		ADEC	Volume I, Chapter 3 Affected Environment, 3.15.3.3 Air Quality Monitoring and Background Concentrations (page 3.15-3): This paragraph mentions the Kaktovik air monitoring site and implies that ADEC operates the site. This site is actually operated by BLM. ADEC displays the data on its website and performs audits for BLM for this site under a cooperative agreement. It would be good to clarify that Kaktovik is a BLM-operated site.	Please clarify that BLM operates the Kaktovik air monitoring site and that it is not officially part of the Alaska Monitoring Network. While this is a government operated site and is intended to produce PSD quality data, the site is not officially under the State's control.
4.2-5		ADEC	Paragraph two, bullet one on this page notes that preparation of a Fugitive Dust Plan would mitigate impacts of the project. Similar statements regarding a Fugitive Dust Plan can also be found on pages 4.3-8, 4.4-5, 4.7-6, 4.15-6, 4.17-3, 6-1, 6-2, 6-3, 6-4, and 6-6.	Please identify which agency will be responsible for compliance and enforcement of the Fugitive Dust Plan.

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
4.7-4	Table 4.7-3	ADEC	This table discusses potential aquatic resource impacts within the Prudhoe Bay Unit. Item 4 in the table notes that "the presence of heavy machinery to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. Please note that VSM installation on the North Slope typically takes place during the winter months when ice roads and ice pads would support the heavy equipment.	Please revise the statement to acknowledge that VSM placement occurs during the winter months on the North Slope and heavy machinery impacts would be de minimis.
4.7-5	Table 4.7-4	ADEC	Item one in this table notes that "the presence of heavy machinery to emplace VSMs would have the potential to increase erosion and sedimentation into surface waters. Please note that VSM installation on the North Slope typically takes place during the winter months when ice roads and ice pads would support the heavy equipment.	Please revise the statement to acknowledge that VSM placement occurs during the winter months on the North Slope and heavy machinery impacts would be de minimis.
4.15-1	Table 4.15-1	ADEC	Bullet one under the column "impact rating" refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019.	Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
4.15-1	Table 4.15-1	ADEC	Bullet three under the column "summary of total impacts" refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019.	Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.
4.15-1	Table 4.15-1	ADEC	Bullets seven and eight in this table appear to imply that the federal land managers have regulatory authority to establish visibility thresholds and sulfur deposition thresholds. This conclusion in incorrect. The regulatory authority for these thresholds is set by the Regional Haze Rule under the authority of the EPA. The Regional Haze Rule requires federal land managers to be consulted, but that is the extent of their authority.	Please revise to reflect that the regulatory authority to establish visibility thresholds and sulfur deposition thresholds rests with the EPA under the Regional Haze Rule.
4.15-2		ADEC	Bullet one on this page refers to "Class II national designated protected areas." This "Class II designated protection area" was a construct to allow federal land managers to have additional oversight through the NEPA process regarding air quality impacts from oil and gas projects in Alaska. This was accomplished through a 2011 memorandum of understanding between federal agencies. This MOU allowing the designation of "Class II designated protections areas" or "sensitive Class II areas" was rescinded in 2019.	Please remove any reference to Class II designated protected areas from this discussion. Class II area designations are the jurisdiction of the States for air quality concerns.

Comments on Alaska LNG draft Supplemental EIS

Page #	Table or figure	Agency	Comment	Suggestion if applicable
4.20-2		ADEC	Item one status notes that BOEM is working under the 2017 – 2022 National Program. Please note that this program expired on June 30, 2022. BOEM released a draft EIS for the 2023 – 2028 OCS Leasing Program on July 1, 2022.	Please update this document to reflect the most recent BOEM OCS Leasing Program.
4.20-4	Table 4.20-1	ADEC	Item three in this table cites to an older BLM EIS for the Willow Project. The BLM recently issued a draft supplemental EIS for the Willow Project following litigation of the prior EIS. Please also note that the GMT-2 facility began production in December 2021.	Please update this table with the most recent information available on the GMT-2 and Willow projects.

Page #	Row # or Line #	Reviewer Name/ Agency	Comment	Suggestion if applicable
4.20-10		ADEC	Paragraph three on this page notes that saline water is used for "mining." It is not clear what this is referring to. Process water, which is typically saline is reinjected into oil reservoirs. Is this what is meant by mining?	Please clarify the meaning of the statement that saline water is used for mining.
5-6	Table 5-1	ADEC	The last item in this table notes that AOGCC is a program within the Alaska Department of Natural Resources. This is incorrect. AOGCC is a program within the Alaska Department of Commerce, Community and Economic Development.	Please clarify that AOGCC is a program within the Alaska Department of Commerce, Community and Economic Development.

Comments on Alaska LNG draft Supplemental EIS

Page #	Row # or Line #	Reviewer Name/ Agency	Comment	Suggestion if applicable
			VOLUME 2 - APPENDICES	
v		ADEC	Please note the ADEC mean the Alaska Department of Environmental Conservation.	Please insert the missing word in the department's name.
Lifecycle GHG Emissions page 20		ADEC	Paragraph one on this page notes that the OPGEE model was not used in modeling the Point Thomson Unit (PTU) because of the lack of oil production occurring at this site. It is not clear why this differentiation was made since the condensate from Point Thomson is transported via pipeline to the TransAlaska Pipeline System (TAPS) and mixed with crude oil for transport to Valdez.	Please explain why the Point Thomson Unit (PTU) was not used in the OPGEE modeling.
Lifecycle GHG Emissions page 29	Exhibit 3-10	ADEC	Please note that there is no Alaska port named "Petersburgh" associated with an LNG facility. Did you mean Nikiski?	Please correct the name of the port facility.
Lifecycle GHG Emissions page 30	Exhibit 3-11	ADEC	Please note that there is no Alaska port named "Petersburgh" associated with an LNG facility. Did you mean Nikiski?	Please correct the name of the port facility.
Page #	Row # or Line #	Reviewer Name/ Agency	Comment	Suggestion if applicable

Comments on Alaska LNG draft Supplemental EIS

Page #	Row # or Line #	Reviewer Name/ Agency	Comment	Suggestion if applicable
Lifecycle GHG emissions page 40		ADEC	Paragraph two on this page notes that natural gas liquids are separated at the GTP and then combined with the oil product for export. This appears to conflict the explanation on PDF page 214, paragraph one where it is noted that the Point Thomson condensate was not used in the OPGEE model.	Please clarify to eliminate this conflict.
Lifecycle GHG Emissions page 68		ADEC	This page discusses methane leakage sensitivity. It is not clear what data this analysis based on.	Please clarify what data was used for the analysis.

D.7 REFERENCES

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40 CFR 147. "State, Tribal, and EPA-Administered Underground Injection Control Programs." Environmental Protection Agency, Code of Federal Regulations. Accessed April 6, 2022 at https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-147?toc=1 .

87 FR 38730. "Notice of Availability for the Draft Supplemental Environmental Impact Statement for the Alaska LNG Project." U.S. Department of Energy, Federal Register. Accessed November 28, 2022 at https://www.govinfo.gov/content/pkg/FR-2022-06-29/pdf/2022-13869.pdf

87 FR 39517. "Pesticide Reregistration Performance Measures and Goals; Annual Progress Report for 2019; Notice of Availability." Environmental Protection Agency, Federal Register. Accessed November 28, 2022 at https://www.govinfo.gov/content/pkg/FR-2022-07-01/pdf/2022-14149.pdf

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Littleton et al. 2019. J. Littlefield, S. Roman-White, D. Augustine, A. Pegallapati, G. G. Zaimes, S. Rai, G. Cooney, T. J. Skone, "Life Cycle Analysis of Natural Gas Extraction and Power Generation," National Energy Technology Laboratory, Pittsburgh, April 5, 2019. Accessed on November 18, 2022 at https://www.osti.gov/biblio/1529553.

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U.S. Department of Energy

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Alaska LNG Project

Final
Supplemental Environmental Impact Statement

APPENDIX E
SOCIAL COST OF GREENHOUSE GASES

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APPENDIX E SOCIAL COST OF GREENHOUSE GASES

E.1 SUMMARY TABLES BY COUNTRY AND CCS USE

Table E.1-1. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to Japan without CCS on End Use NGCC Power Plant

LNG Destination Country: Japan	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O without CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			23,784	92,855	141,577	278,171
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		33,606	131,650	200,895	395,890
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				22,025	86,901	132,849	261,188
Alaskan Oil Production and End Use			849		5,179	19,876	30,160	60,325
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		30,190	119,076	182,020	358,740
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				21,997	86,790	132,677	260,852
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,994	95,362
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		30,149	119,006	181,946	358,597
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		17,712	69,207	105,531	207,518
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		187%	184%	184%	182%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		20,482	80,636	123,193	242,219
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		216%	215%	214%	212%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,416	-12,574	-18,875	-37,150
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%
Total, Scenario 3 minus Scenario 1	0		0		-3,457	-12,644	-18,949	-37,293
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%

Table E.1-2. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to Japan with CCS on End Use NGCC Power Plant

LNG Destination Country: Japan	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O with CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,996
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,996
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			10,480	38,198	57,201	111,977
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		20,302	76,993	116,519	229,697
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				8,748	32,356	48,645	95,332
Alaskan Oil Production and End Use			849		5,179	19,877	30,161	60,326
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		16,913	64,532	97,817	192,885
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				8,720	32,244	48,473	94,995
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,995	95,363
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		16,872	64,460	97,743	192,741
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		4,435	14,663	21,328	41,662
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		47%	39%	37%	37%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		7,205	26,090	38,990	76,362
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		76%	69%	68%	67%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,389	-12,461	-18,702	-36,812
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%
Total, Scenario 3 minus Scenario 1	0		0		-3,430	-12,533	-18,776	-36,956
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%

Table E.1-3. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to South Korea without CCS on End Use NGCC Power Plant

LNG Destination Country: South Korea	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O without CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			23,887	93,280	142,233	279,464
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		33,709	132,075	201,551	397,183
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				22,113	87,261	133,405	262,283
Alaskan Oil Production and End Use			849		5,179	19,876	30,160	60,325
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		30,278	119,436	182,576	359,835
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				22,085	87,149	133,233	261,946
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,994	95,362
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		30,237	119,365	182,502	359,691
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		17,800	69,567	106,087	208,613
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		188%	185%	185%	183%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		20,570	80,995	123,749	243,313
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		217%	216%	215%	213%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,431	-12,639	-18,975	-37,348
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%
Total, Scenario 3 minus Scenario 1	0		0		-3,472	-12,710	-19,049	-37,492
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%

Table E.1-4. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to South Korea with CCS on End Use NGCC Power Plant

LNG Destination Country: South Korea	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O with CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			10,611	38,738	58,034	113,617
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		20,433	77,533	117,352	231,336
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				8,861	32,821	49,364	96,747
Alaskan Oil Production and End Use			849		5,179	19,877	30,161	60,326
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		17,026	64,997	98,536	194,300
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				8,834	32,709	49,192	96,411
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,995	95,363
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		16,986	64,925	98,462	194,157
Results Comparison: Alaska Oil and Gas Production Only: <u>Non-LCA System Boundary</u> (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		4,548	15,128	22,047	43,078
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		48%	40%	38%	38%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		7,319	26,555	39,709	77,779
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		77%	71%	69%	68%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: <u>LCA System Boundary</u> (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,407	-12,536	-18,816	-37,036
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%
Total, Scenario 3 minus Scenario 1	0		0		-3,447	-12,608	-18,890	-37,179
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%

Table E.1-5. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to China without CCS on End Use NGCC Power Plant

LNG Destination Country: China	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O without CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			23,892	93,299	142,262	279,521
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		33,714	132,094	201,580	397,240
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				22,117	87,278	133,431	262,334
Alaskan Oil Production and End Use			849		5,179	19,876	30,160	60,325
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		30,282	119,453	182,602	359,886
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				22,089	87,166	133,259	261,997
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,994	95,362
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		30,241	119,382	182,528	359,742
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		17,804	69,584	106,113	208,664
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		188%	185%	185%	183%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		20,574	81,012	123,775	243,364
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		217%	216%	215%	213%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,432	-12,641	-18,978	-37,354
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%
Total, Scenario 3 minus Scenario 1	0		0		-3,473	-12,712	-19,052	-37,498
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-10%	-10%	-9%	-9%

Table E.1-6. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to China with CCS on End Use NGCC Power Plant

LNG Destination Country: China	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O with CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			10,617	38,761	58,070	113,689
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		20,439	77,556	117,388	231,408
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				8,866	32,843	49,397	96,813
Alaskan Oil Production and End Use			849		5,179	19,877	30,161	60,326
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		17,031	65,019	98,569	194,366
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				8,839	32,731	49,225	96,477
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,995	95,363
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		16,991	64,947	98,495	194,223
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		4,553	15,150	22,080	43,144
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		48%	40%	38%	38%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		7,324	26,577	39,742	77,845
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		77%	71%	69%	68%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-3,408	-12,537	-18,819	-37,042
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%
Total, Scenario 3 minus Scenario 1	0		0		-3,448	-12,609	-18,893	-37,185
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-17%	-16%	-16%	-16%

Table E.1-7. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to India without CCS on End Use NGCC Power Plant

LNG Destination Country: India	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O without CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,995
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			23,852	93,135	142,009	279,022
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		33,674	131,930	201,327	396,741
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				22,572	89,147	136,316	268,017
Alaskan Oil Production and End Use			849		5,179	19,876	30,160	60,325
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		30,737	121,322	185,487	365,569
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				22,544	89,035	136,144	267,680
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,994	95,361
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		30,696	121,251	185,413	365,424
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		18,259	71,453	108,998	214,347
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		192%	190%	190%	188%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		21,029	82,881	126,660	249,046
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		222%	221%	220%	218%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-2,937	-10,608	-15,840	-31,172
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-9%	-8%	-8%	-8%
Total, Scenario 3 minus Scenario 1	0		0		-2,978	-10,679	-15,914	-31,317
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-9%	-8%	-8%	-8%

Table E.1-8. Summary and Comparison of Cumulative Social Cost (SC) of Life Cycle Greenhouse Gas Emissions for LNG Delivery to India with CCS on End Use NGCC Power Plant

LNG Destination Country: India	Gas Produced in Each Scenario, TCF		Oil Produced in Each Scenario, MMbbl		Cumulative Social Cost of CO_2, CH_4, and N_2O with CCS on End Use NGCC Power Plant, $1,000,000 Dollars, 2020$			
	In Alaska	Not In Alaska	In Alaska	Not In Alaska	5% Avg	3% Avg	2.5% Avg	95th Perc
NEPA No Action Definition (Non-LCA System Boundary: non-equivalent service to society.)								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,996
Scenario 1: "Business as Usual"								
Alaskan Oil Production and End Use			1,356		9,492	37,570	57,478	113,996
Global Proxy based on US Lower 48 LNG Export and End Use		27.8			10,556	38,524	57,709	112,980
Global Proxy based on US Average Crude Oil Production and End Use				47	330	1,225	1,840	3,724
Total	27.8		1,402		20,378	77,319	117,027	230,700
Scenario 2: Reduced Gas Injection								
Alaskan Natural Gas Production and End Use	27.8				9,581	35,616	53,620	105,107
Alaskan Oil Production and End Use			849		5,179	19,877	30,161	60,326
Global Proxy based on US Average Crude Oil Production and End Use				554	2,986	12,299	19,011	37,227
Total	27.8		1,402		17,746	67,792	102,792	202,660
Scenario 3: Use and Storage of By-Product CO_2								
Alaskan Natural Gas Production and End Use	27.8				9,553	35,505	53,449	104,770
Alaskan Oil Production and End Use			1,360*		7,977	31,416	47,995	95,363
Global Proxy based on US Average Crude Oil Production and End Use				42	175	800	1,275	2,383
Total	27.8		1,011 to 1,491* [LCA Value: 1,402]		17,705	67,721	102,719	202,516
Results Comparison: Alaska Oil and Gas Production Only: Non-LCA System Boundary (Caution: comparison does not provide equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	27.8		-506		5,268	17,923	26,303	51,437
Total, Scenario 1 to Scenario 2, *Percent Change*	∞%		-37%		55%	48%	46%	45%
Total, Scenario 3 minus Scenario 1	27.8		-3876 to 93* [LCA Value: 5]		8,038	29,351	43,966	86,137
Total, Scenario 1 to Scenario 3, *Percent Change*	∞%		-29% to 7%* [LCA Value: 0.4%]		85%	78%	76%	76%
Results Comparison: Alaska and Global Proxy Oil and Gas Production: LCA System Boundary (Note: comparison provides equivalent service to society.)								
Total, Scenario 2 minus Scenario 1	0		0		-2,632	-9,527	-14,235	-28,040
Total, Scenario 1 to Scenario 2, *Percent Change*	0%		0%		-13%	-12%	-12%	-12%
Total, Scenario 3 minus Scenario 1	0		0		-2,673	-9,598	-14,308	-28,184
Total, Scenario 1 to Scenario 3, *Percent Change*	0%		0%		-13%	-12%	-12%	-12%

E.2 SC-GHG $/TON VALUES FOR CO_2, CH_4 AND N_2O

Table E.2-1. Per ton SC-CO_2 Value (2020$/metric ton CO_2)[1,2]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2024	16	55	82	166
2025	17	56	83	169
2026	17	57	84	173
2027	18	59	86	176
2028	18	60	87	180
2029	19	61	88	183
2030	19	62	89	187
2031	20	63	91	191
2032	21	64	92	194
2033	21	65	94	198
2034	22	66	95	202
2035	22	67	96	206
2036	23	69	98	210
2037	23	70	99	213
2038	24	71	100	217
2039	25	72	102	221
2040	25	73	103	225
2041	26	74	104	228
2042	26	75	106	232
2043	27	77	107	235
2044	28	78	108	239
2045	28	79	110	242
2046	29	80	111	246
2047	30	81	112	249
2048	30	82	114	253
2049	31	84	115	256
2050	32	85	116	260
2051	32	85	118	260
2052	33	86	119	261
2053	34	87	120	262
2054	34	88	121	263
2055	35	89	122	265
2056	35	90	123	267
2057	36	91	124	269
2058	37	92	125	271

Table E.2-1. Per ton SC-CO_2 Value (2020$/metric ton CO_2)[1,2]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2059	37	92	127	273
2060	38	93	128	275
2061	39	95	129	280

[1] Values from 2020–2050 are from Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, Interim Estimates under E.O. 13990. Interagency Working Group on Social Cost of Carbon, United States Government. February 2021.

[2] Values from 2051–2070 are from Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Furnaces, Appendix 14A. U.S. Department of Energy. June 2022.

Table E.2-2. Per ton SC-CH_4 Value (2020$/metric ton CH_4)[1,2]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2024	775	1,673	2,175	4,420
2025	802	1,720	2,230	4,548
2026	829	1,767	2,286	4,677
2027	856	1,814	2,341	4,805
2028	884	1,861	2,397	4,934
2029	911	1,908	2,452	5,062
2030	938	1,954	2,508	5,190
2031	972	2,010	2,572	5,344
2032	1,007	2,065	2,635	5,498
2033	1,041	2,121	2,699	5,652
2034	1,075	2,176	2,763	5,806
2035	1,110	2,231	2,827	5,959
2036	1,144	2,287	2,891	6,113
2037	1,179	2,342	2,955	6,267
2038	1,213	2,397	3,019	6,421
2039	1,247	2,453	3,083	6,574
2040	1,282	2,508	3,147	6,728
2041	1,319	2,564	3,210	6,873
2042	1,357	2,620	3,273	7,018
2043	1,394	2,676	3,336	7,162
2044	1,432	2,732	3,399	7,307
2045	1,469	2,788	3,462	7,452
2046	1,507	2,844	3,524	7,596
2047	1,544	2,900	3,587	7,741
2048	1,582	2,955	3,650	7,886
2049	1,619	3,011	3,713	8,031

Table E.2-2. Per ton SC-CH_4 Value (2020$/metric ton CH_4)[1,2]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2050	1,657	3,067	3,776	8,175
2051	1,680	3,096	3,807	8,193
2052	1,703	3,128	3,841	8,228
2053	1,726	3,159	3,874	8,263
2054	1,749	3,190	3,908	8,297
2055	1,772	3,221	3,942	8,332
2056	1,797	3,256	3,979	8,373
2057	1,823	3,291	4,017	8,415
2058	1,848	3,326	4,055	8,456
2059	1,873	3,360	4,092	8,497
2060	1,899	3,395	4,130	8,539
2061	2,021	3,548	4,296	9,067

1 Values from 2020–2050 are from Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, Interim Estimates under E.O. 13990. Interagency Working Group on Social Cost of Carbon, United States Government. February 2021.
2 Values from 2051–2070 are from Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Furnaces, Appendix 14A. U.S. Department of Energy. June 2022.

Table E.2-3. Per ton SC-N_2O Value (2020$/metric ton N_2O)[1]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2024	6,587	20,154	29,358	53,087
2025	6,789	20,591	29,914	54,295
2026	6,991	21,028	30,471	55,502
2027	7,193	21,465	31,028	56,710
2028	7,395	21,902	31,585	57,918
2029	7,597	22,339	32,141	59,125
2030	7,799	22,776	32,698	60,333
2031	8,047	23,268	33,309	61,692
2032	8,295	23,760	33,921	63,051
2033	8,542	24,252	34,532	64,410
2034	8,790	24,744	35,144	65,770
2035	9,038	25,236	35,755	67,129
2036	9,285	25,728	36,366	68,488
2037	9,533	26,219	36,978	69,847
2038	9,781	26,711	37,589	71,206
2039	10,029	27,203	38,201	72,565
2040	10,276	27,695	38,812	73,924
2041	10,567	28,225	39,456	75,349

Table E.2-3. Per ton SC-N_2O Value (2020$/metric ton N_2O)[1]

Year of Emissions	5% Average	3% Average	2.5% Average	3% 95th Percentile
2042	10,857	28,754	40,100	76,773
2043	11,147	29,283	40,745	78,197
2044	11,437	29,813	41,389	79,621
2045	11,727	30,342	42,033	81,045
2046	12,018	30,872	42,677	82,470
2047	12,308	31,401	43,321	83,894
2048	12,598	31,930	43,965	85,318
2049	12,888	32,460	44,610	86,742
2050	13,179	32,989	45,254	88,166
2051	13,479	33,426	45,727	88,606
2052	13,798	33,954	46,354	89,984
2053	14,118	34,483	46,981	91,362
2054	14,438	35,011	47,609	92,739
2055	14,758	35,539	48,236	94,117
2056	15,091	36,092	48,890	95,463
2057	15,425	36,644	49,544	96,808
2058	15,758	37,196	50,199	98,154
2059	16,091	37,748	50,853	99,499
2060	16,424	38,300	51,507	100,845
2061	17,077	39,165	52,485	103,794

[1] Values from 2020–2050 are from Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, Interim Estimates under E.O. 13990. Interagency Working Group on Social Cost of Carbon, United States Government. February 2021.

E.3 SC-GHG CALCULATIONS BY SCENARIO, COUNTRY, GHG, AND CCS USE

Table E.3-1. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,237	10,886,945	-	$569,396	$2,015,910	$3,000,706	$6,084,697	$160,999	$570,007	$848,462	$1,720,473	$0	$0	$0	$0
2030	37,415,751	27,217,362	-	$540,619	$1,935,381	$2,886,969	$5,850,640	$393,263	$1,407,856	$2,100,069	$4,255,934	$0	$0	$0	$0
2031	36,359,335	48,991,251	1,132,527	$515,428	$1,859,779	$2,778,722	$5,632,875	$694,498	$2,505,901	$3,744,102	$7,589,842	$16,055	$57,929	$86,552	$175,454
2032	35,340,205	59,878,196	2,607,672	$491,070	$1,786,915	$2,674,496	$5,422,205	$832,038	$3,027,636	$4,531,497	$9,187,039	$36,235	$131,852	$197,345	$400,092
2033	34,352,146	65,321,669	3,493,073	$467,542	$1,716,484	$2,573,805	$5,217,774	$889,046	$3,263,948	$4,894,171	$9,921,758	$47,542	$174,539	$261,716	$530,566
2034	33,388,943	65,321,669	3,490,712	$444,743	$1,648,185	$2,476,200	$5,018,740	$870,090	$3,224,486	$4,844,404	$9,818,594	$46,497	$172,313	$258,879	$524,694
2035	32,463,026	65,321,669	3,102,972	$422,904	$1,582,633	$2,382,535	$4,827,121	$850,961	$3,184,554	$4,794,105	$9,713,069	$40,423	$151,276	$227,734	$461,399
2036	31,561,966	65,321,669	2,606,622	$401,832	$1,519,213	$2,291,893	$4,641,095	$831,645	$3,144,213	$4,743,377	$9,605,362	$33,186	$125,468	$189,282	$383,296
2037	30,691,977	65,321,669	2,202,617	$381,654	$1,458,217	$2,204,706	$4,461,614	$812,273	$3,103,520	$4,692,271	$9,495,644	$27,389	$104,649	$158,221	$320,189
2038	29,840,630	65,321,669	1,887,545	$362,184	$1,399,043	$2,120,076	$4,286,951	$792,828	$3,062,530	$4,640,883	$9,384,213	$22,910	$88,495	$134,104	$271,168
2039	29,007,926	65,321,669	1,528,400	$343,461	$1,341,691	$2,037,948	$4,117,126	$773,424	$3,021,295	$4,589,165	$9,271,175	$18,097	$70,692	$107,378	$216,927
2040	28,218,722	65,321,669	1,164,795	$325,756	$1,287,290	$1,960,058	$3,955,705	$754,070	$2,979,864	$4,537,210	$9,156,802	$13,446	$53,136	$80,906	$163,281
2041	27,441,946	65,321,669	777,579	$309,438	$1,234,420	$1,883,708	$3,792,883	$736,573	$2,938,363	$4,483,899	$9,028,421	$8,768	$34,978	$53,376	$107,473
2042	26,696,241	65,321,669	444,144	$293,860	$1,183,870	$1,810,692	$3,637,214	$719,032	$2,896,751	$4,430,490	$8,899,713	$4,889	$19,696	$30,124	$60,512
2043	25,969,178	65,321,669	176,293	$278,884	$1,135,057	$1,740,104	$3,486,937	$701,492	$2,855,070	$4,376,978	$8,770,880	$1,893	$7,705	$11,813	$23,671
2044	25,266,973	65,321,669	-	$264,574	$1,088,232	$1,672,359	$3,342,799	$683,991	$2,813,360	$4,323,481	$8,642,002	$0	$0	$0	$0
2045	24,583,410	65,321,669	-	$250,858	$1,043,083	$1,606,984	$3,203,887	$666,567	$2,771,623	$4,269,989	$8,513,191	$0	$0	$0	$0
2046	23,924,704	65,321,669	-	$237,803	$999,876	$1,544,347	$3,070,912	$649,273	$2,729,964	$4,216,535	$8,384,518	$0	$0	$0	$0
2047	23,278,426	65,321,669	-	$225,257	$958,048	$1,483,605	$2,942,212	$632,094	$2,688,381	$4,163,148	$8,256,151	$0	$0	$0	$0
2048	22,657,005	65,321,669	-	$213,342	$918,086	$1,425,503	$2,819,272	$615,078	$2,646,904	$4,109,821	$8,128,150	$0	$0	$0	$0
2049	22,041,798	65,321,669	-	$201,870	$879,197	$1,368,856	$2,699,670	$598,250	$2,605,532	$4,056,654	$8,000,569	$0	$0	$0	$0
2050	21,463,877	65,321,669	-	$191,116	$842,614	$1,315,544	$2,587,151	$581,629	$2,564,354	$4,003,636	$7,873,556	$0	$0	$0	$0
2051	20,885,955	65,321,669	-	$179,017	$799,223	$1,265,296	$2,444,683	$559,882	$2,499,604	$3,957,263	$7,645,846	$0	$0	$0	$0
2052	20,332,891	65,321,669	-	$171,164	$764,285	$1,211,931	$2,319,516	$549,884	$2,455,350	$3,893,463	$7,451,702	$0	$0	$0	$0
2053	19,798,469	65,321,669	-	$163,539	$730,923	$1,160,969	$2,201,169	$539,568	$2,411,554	$3,830,420	$7,262,381	$0	$0	$0	$0
2054	19,270,261	65,321,669	-	$151,596	$698,640	$1,111,622	$2,087,981	$513,875	$2,368,226	$3,768,137	$7,077,767	$0	$0	$0	$0
2055	18,766,910	65,321,669	-	$144,741	$668,081	$1,064,910	$1,989,229	$503,799	$2,325,377	$3,706,613	$6,923,874	$0	$0	$0	$0
2056	18,275,988	65,321,669	-	$134,243	$638,752	$1,020,052	$1,894,964	$479,808	$2,283,014	$3,645,849	$6,772,942	$0	$0	$0	$0
2057	17,803,708	65,321,669	-	$128,105	$610,834	$977,338	$1,805,653	$470,016	$2,241,147	$3,585,844	$6,624,928	$0	$0	$0	$0
2058	17,337,642	58,517,328	-	$122,111	$583,865	$936,028	$1,719,862	$412,145	$1,970,637	$3,159,243	$5,804,812	$0	$0	$0	$0
2059	16,902,648	46,852,744	-	$113,379	$552,637	$904,530	$1,639,889	$314,276	$1,531,863	$2,507,284	$4,545,638	$0	$0	$0	$0
2060	16,467,653	37,521,077	-	$108,044	$528,414	$866,528	$1,562,515	$246,175	$1,203,977	$1,974,359	$3,560,147	$0	$0	$0	$0
2061	16,032,658	29,939,098	-	$102,817	$510,213	$829,492	$1,503,787	$191,999	$952,763	$1,548,979	$2,808,144	$0	$0	$0	$0
TOTALS:	842,342,204	1,952,845,716	24,614,950	$9,252,347	$36,919,093	$56,588,512	$112,268,730	$20,020,540	$82,249,623	$126,971,803	$250,095,235	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-2. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-3. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-4. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,189	10,943,241	-	$569,396	$2,015,908	$3,000,702	$6,084,689	$161,832	$572,954	$852,849	$1,729,369	$0	$0	$0	$0
2030	37,415,704	27,358,102	-	$540,618	$1,935,379	$2,886,965	$5,850,632	$395,296	$1,415,136	$2,110,929	$4,277,942	$0	$0	$0	$0
2031	36,359,290	49,244,584	1,132,527	$515,428	$1,859,776	$2,778,719	$5,632,868	$698,089	$2,518,859	$3,763,463	$7,629,089	$16,055	$57,929	$86,552	$175,454
2032	35,340,161	60,187,825	2,607,672	$491,070	$1,786,913	$2,674,493	$5,422,198	$836,341	$3,043,291	$4,554,929	$9,234,545	$36,235	$131,852	$197,345	$400,092
2033	34,352,103	65,659,446	3,493,073	$467,541	$1,716,482	$2,573,802	$5,217,767	$893,643	$3,280,826	$4,919,478	$9,973,064	$47,542	$174,539	$261,716	$530,566
2034	33,388,902	65,659,446	3,490,712	$444,743	$1,648,183	$2,476,197	$5,018,734	$874,589	$3,241,160	$4,869,455	$9,869,366	$46,497	$172,313	$258,879	$524,694
2035	32,462,986	65,659,446	3,102,972	$422,903	$1,582,631	$2,382,532	$4,827,115	$855,361	$3,201,021	$4,818,895	$9,763,295	$40,423	$151,276	$227,734	$461,399
2036	31,561,927	65,659,446	2,606,622	$401,832	$1,519,211	$2,291,890	$4,641,090	$835,945	$3,160,471	$4,767,905	$9,655,031	$33,186	$125,468	$189,282	$383,296
2037	30,691,938	65,659,446	2,202,617	$381,653	$1,458,215	$2,204,703	$4,461,609	$816,474	$3,119,568	$4,716,535	$9,544,746	$27,389	$104,649	$158,221	$320,189
2038	29,840,593	65,659,446	1,887,545	$362,184	$1,399,041	$2,120,073	$4,286,946	$796,928	$3,078,366	$4,664,881	$9,432,738	$22,910	$88,495	$134,104	$271,168
2039	29,007,890	65,659,446	1,528,400	$343,460	$1,341,690	$2,037,946	$4,117,121	$777,423	$3,036,918	$4,612,896	$9,319,116	$18,097	$70,692	$107,378	$216,927
2040	28,218,686	65,659,446	1,164,795	$325,755	$1,287,289	$1,960,056	$3,955,700	$757,970	$2,995,273	$4,560,671	$9,204,151	$13,446	$53,136	$80,906	$163,281
2041	27,441,911	65,659,446	777,579	$309,437	$1,234,419	$1,883,705	$3,792,878	$740,382	$2,953,557	$4,507,085	$9,075,107	$8,768	$34,978	$53,376	$107,473
2042	26,696,207	65,659,446	444,144	$293,860	$1,183,868	$1,810,690	$3,637,209	$722,750	$2,911,730	$4,453,400	$8,945,733	$4,889	$19,696	$30,124	$60,512
2043	25,969,146	65,659,446	176,293	$278,883	$1,135,056	$1,740,102	$3,486,933	$705,119	$2,869,834	$4,399,612	$8,816,234	$1,893	$7,705	$11,813	$23,671
2044	25,266,941	65,659,446	-	$264,573	$1,088,230	$1,672,357	$3,342,795	$687,528	$2,827,908	$4,345,838	$8,686,690	$0	$0	$0	$0
2045	24,583,379	65,659,446	-	$250,858	$1,043,082	$1,606,982	$3,203,883	$670,013	$2,785,955	$4,292,069	$8,557,212	$0	$0	$0	$0
2046	23,924,674	65,659,446	-	$237,802	$999,875	$1,544,346	$3,070,908	$652,630	$2,744,081	$4,238,339	$8,427,874	$0	$0	$0	$0
2047	23,278,397	65,659,446	-	$225,256	$958,047	$1,483,603	$2,942,208	$635,362	$2,702,283	$4,184,676	$8,298,844	$0	$0	$0	$0
2048	22,656,977	65,659,446	-	$213,341	$918,085	$1,425,501	$2,819,268	$618,259	$2,660,591	$4,131,073	$8,170,180	$0	$0	$0	$0
2049	22,041,771	65,659,446	-	$201,870	$879,196	$1,368,854	$2,699,666	$601,343	$2,619,005	$4,077,631	$8,041,940	$0	$0	$0	$0
2050	21,463,850	65,659,446	-	$191,116	$842,613	$1,315,543	$2,587,148	$584,637	$2,577,614	$4,024,339	$7,914,270	$0	$0	$0	$0
2051	20,885,929	65,659,446	-	$179,016	$799,222	$1,265,294	$2,444,680	$562,777	$2,512,529	$3,977,726	$7,685,383	$0	$0	$0	$0
2052	20,332,865	65,659,446	-	$171,164	$764,284	$1,211,929	$2,319,513	$552,727	$2,468,047	$3,913,596	$7,490,235	$0	$0	$0	$0
2053	19,798,444	65,659,446	-	$163,539	$730,922	$1,160,968	$2,201,166	$542,359	$2,424,024	$3,850,227	$7,299,935	$0	$0	$0	$0
2054	19,270,237	65,659,446	-	$151,596	$698,639	$1,111,620	$2,087,979	$516,532	$2,380,472	$3,787,622	$7,114,366	$0	$0	$0	$0
2055	18,766,887	65,659,446	-	$144,741	$668,080	$1,064,908	$1,989,226	$506,404	$2,337,401	$3,725,780	$6,959,678	$0	$0	$0	$0
2056	18,275,965	65,659,446	-	$134,243	$638,751	$1,020,051	$1,894,961	$482,289	$2,294,820	$3,664,702	$6,807,965	$0	$0	$0	$0
2057	17,803,686	65,659,446	-	$128,105	$610,834	$977,336	$1,805,651	$472,447	$2,252,735	$3,604,386	$6,659,185	$0	$0	$0	$0
2058	17,337,621	58,819,920	-	$122,111	$583,864	$936,026	$1,719,860	$414,276	$1,980,827	$3,175,580	$5,834,828	$0	$0	$0	$0
2059	16,902,627	47,095,019	-	$113,378	$552,636	$904,529	$1,639,887	$315,901	$1,539,784	$2,520,249	$4,569,143	$0	$0	$0	$0
2060	16,467,632	37,715,098	-	$108,044	$528,414	$866,527	$1,562,513	$247,448	$1,210,203	$1,984,568	$3,578,556	$0	$0	$0	$0
2061	16,032,638	30,093,913	-	$102,817	$510,213	$829,491	$1,503,785	$192,992	$957,690	$1,556,988	$2,822,665	$0	$0	$0	$0
TOTALS:	842,341,150	1,962,943,850	24,614,950	$9,252,335	$36,919,047	$56,588,441	$112,268,589	$20,124,066	$82,674,934	$127,628,372	$251,388,474	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-5. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-6. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-7. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,157	10,945,707	-	$569,395	$2,015,906	$3,000,699	$6,084,684	$161,868	$573,083	$853,041	$1,729,759	$0	$0	$0	$0
2030	37,415,673	27,364,267	-	$540,618	$1,935,377	$2,886,963	$5,850,627	$395,385	$1,415,454	$2,111,405	$4,278,906	$0	$0	$0	$0
2031	36,359,259	49,255,680	1,132,527	$515,427	$1,859,775	$2,778,716	$5,632,863	$698,247	$2,519,426	$3,764,311	$7,630,808	$16,055	$57,929	$86,552	$175,454
2032	35,340,131	60,201,387	2,607,672	$491,069	$1,786,912	$2,674,491	$5,422,194	$836,529	$3,043,977	$4,555,955	$9,236,626	$36,235	$131,852	$197,345	$400,092
2033	34,352,074	65,674,240	3,493,073	$467,541	$1,716,481	$2,573,800	$5,217,763	$893,844	$3,281,565	$4,920,587	$9,975,311	$47,542	$174,539	$261,716	$530,566
2034	33,388,874	65,674,240	3,490,712	$444,742	$1,648,181	$2,476,195	$5,018,730	$874,786	$3,241,890	$4,870,552	$9,871,589	$46,497	$172,313	$258,879	$524,694
2035	32,462,959	65,674,240	3,102,972	$422,903	$1,582,630	$2,382,530	$4,827,111	$855,554	$3,201,742	$4,819,981	$9,765,495	$40,423	$151,276	$227,734	$461,399
2036	31,561,900	65,674,240	2,606,622	$401,831	$1,519,210	$2,291,888	$4,641,086	$836,134	$3,161,183	$4,768,979	$9,657,206	$33,186	$125,468	$189,282	$383,296
2037	30,691,913	65,674,240	2,202,617	$381,653	$1,458,214	$2,204,701	$4,461,605	$816,658	$3,120,271	$4,717,598	$9,546,897	$27,389	$104,649	$158,221	$320,189
2038	29,840,568	65,674,240	1,887,545	$362,184	$1,399,040	$2,120,071	$4,286,943	$797,107	$3,079,060	$4,665,932	$9,434,864	$22,910	$88,495	$134,104	$271,168
2039	29,007,866	65,674,240	1,528,400	$343,460	$1,341,688	$2,037,944	$4,117,118	$777,598	$3,037,603	$4,613,935	$9,321,216	$18,097	$70,692	$107,378	$216,927
2040	28,218,663	65,674,240	1,164,795	$325,755	$1,287,288	$1,960,054	$3,955,697	$758,140	$2,995,948	$4,561,699	$9,206,225	$13,446	$53,136	$80,906	$163,281
2041	27,441,888	65,674,240	777,579	$309,437	$1,234,418	$1,883,704	$3,792,875	$740,549	$2,954,223	$4,508,101	$9,077,152	$8,768	$34,978	$53,376	$107,473
2042	26,696,185	65,674,240	444,144	$293,860	$1,183,868	$1,810,688	$3,637,206	$722,913	$2,912,386	$4,454,404	$8,947,749	$4,889	$19,696	$30,124	$60,512
2043	25,969,124	65,674,240	176,293	$278,883	$1,135,055	$1,740,101	$3,486,930	$705,278	$2,870,481	$4,400,603	$8,818,220	$1,893	$7,705	$11,813	$23,671
2044	25,266,920	65,674,240	-	$264,573	$1,088,229	$1,672,355	$3,342,792	$687,683	$2,828,545	$4,346,817	$8,688,647	$0	$0	$0	$0
2045	24,583,358	65,674,240	-	$250,858	$1,043,081	$1,606,981	$3,203,880	$670,164	$2,786,583	$4,293,036	$8,559,140	$0	$0	$0	$0
2046	23,924,654	65,674,240	-	$237,802	$999,874	$1,544,344	$3,070,906	$652,777	$2,744,699	$4,239,294	$8,429,773	$0	$0	$0	$0
2047	23,278,377	65,674,240	-	$225,256	$958,046	$1,483,602	$2,942,206	$635,505	$2,702,891	$4,185,619	$8,300,714	$0	$0	$0	$0
2048	22,656,958	65,674,240	-	$213,341	$918,084	$1,425,500	$2,819,266	$618,398	$2,661,191	$4,132,004	$8,172,021	$0	$0	$0	$0
2049	22,041,752	65,674,240	-	$201,870	$879,195	$1,368,853	$2,699,664	$601,479	$2,619,595	$4,078,550	$8,043,752	$0	$0	$0	$0
2050	21,463,832	65,674,240	-	$191,116	$842,613	$1,315,542	$2,587,146	$584,769	$2,578,195	$4,025,245	$7,916,053	$0	$0	$0	$0
2051	20,885,912	65,674,240	-	$179,016	$799,222	$1,265,293	$2,444,678	$562,904	$2,513,095	$3,978,622	$7,687,114	$0	$0	$0	$0
2052	20,332,849	65,674,240	-	$171,164	$764,283	$1,211,928	$2,319,511	$552,852	$2,468,603	$3,914,477	$7,491,922	$0	$0	$0	$0
2053	19,798,428	65,674,240	-	$163,538	$730,921	$1,160,967	$2,201,164	$542,481	$2,424,570	$3,851,095	$7,301,580	$0	$0	$0	$0
2054	19,270,221	65,674,240	-	$151,596	$698,639	$1,111,619	$2,087,977	$516,648	$2,381,009	$3,788,475	$7,115,969	$0	$0	$0	$0
2055	18,766,871	65,674,240	-	$144,741	$668,079	$1,064,907	$1,989,224	$506,518	$2,337,928	$3,726,620	$6,961,246	$0	$0	$0	$0
2056	18,275,950	65,674,240	-	$134,243	$638,751	$1,020,050	$1,894,960	$482,398	$2,295,337	$3,665,527	$6,809,498	$0	$0	$0	$0
2057	17,803,671	65,674,240	-	$128,105	$610,833	$977,336	$1,805,649	$472,553	$2,253,243	$3,605,199	$6,660,685	$0	$0	$0	$0
2058	17,337,606	58,833,173	-	$122,111	$583,863	$936,026	$1,719,859	$414,370	$1,981,274	$3,176,295	$5,836,143	$0	$0	$0	$0
2059	16,902,612	47,105,630	-	$113,378	$552,636	$904,529	$1,639,886	$315,972	$1,540,131	$2,520,817	$4,570,173	$0	$0	$0	$0
2060	16,467,619	37,723,596	-	$108,044	$528,413	$866,526	$1,562,512	$247,504	$1,210,475	$1,985,016	$3,579,363	$0	$0	$0	$0
2061	16,032,625	30,100,693	-	$102,817	$510,212	$829,490	$1,503,784	$193,035	$957,906	$1,557,339	$2,823,301	$0	$0	$0	$0
TOTALS:	842,340,449	1,963,386,132	24,614,950	$9,252,327	$36,919,016	$56,588,394	$112,268,496	$20,128,600	$82,693,562	$127,657,128	$251,445,116	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-8. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-9. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-10. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,131	10,923,993	-	$569,395	$2,015,905	$3,000,697	$6,084,680	$161,547	$571,946	$851,349	$1,726,327	$0	$0	$0	$0
2030	37,415,648	27,309,982	-	$540,618	$1,935,376	$2,886,961	$5,850,624	$394,601	$1,412,646	$2,107,216	$4,270,417	$0	$0	$0	$0
2031	36,359,235	49,157,968	1,132,527	$515,427	$1,859,773	$2,778,715	$5,632,860	$696,861	$2,514,428	$3,756,844	$7,615,670	$16,055	$57,929	$86,552	$175,454
2032	35,340,108	60,081,961	2,607,672	$491,069	$1,786,910	$2,674,489	$5,422,190	$834,870	$3,037,939	$4,546,917	$9,218,303	$36,235	$131,852	$197,345	$400,092
2033	34,352,051	65,543,957	3,493,073	$467,541	$1,716,479	$2,573,798	$5,217,759	$892,071	$3,275,055	$4,910,825	$9,955,522	$47,542	$174,539	$261,716	$530,566
2034	33,388,852	65,543,957	3,490,712	$444,742	$1,648,180	$2,476,194	$5,018,726	$873,050	$3,235,459	$4,860,890	$9,852,006	$46,497	$172,313	$258,879	$524,694
2035	32,462,937	65,543,957	3,102,972	$422,902	$1,582,629	$2,382,528	$4,827,108	$853,857	$3,195,391	$4,810,419	$9,746,122	$40,423	$151,276	$227,734	$461,399
2036	31,561,879	65,543,957	2,606,622	$401,831	$1,519,209	$2,291,887	$4,641,083	$834,475	$3,154,912	$4,759,518	$9,638,049	$33,186	$125,468	$189,282	$383,296
2037	30,691,893	65,543,957	2,202,617	$381,653	$1,458,213	$2,204,700	$4,461,602	$815,037	$3,114,081	$4,708,239	$9,527,958	$27,389	$104,649	$158,221	$320,189
2038	29,840,548	65,543,957	1,887,545	$362,183	$1,399,039	$2,120,070	$4,286,940	$795,526	$3,072,952	$4,656,676	$9,416,147	$22,910	$88,495	$134,104	$271,168
2039	29,007,847	65,543,957	1,528,400	$343,460	$1,341,688	$2,037,943	$4,117,115	$776,056	$3,031,577	$4,604,782	$9,302,725	$18,097	$70,692	$107,378	$216,927
2040	28,218,644	65,543,957	1,164,795	$325,755	$1,287,287	$1,960,053	$3,955,694	$756,636	$2,990,005	$4,552,650	$9,187,962	$13,446	$53,136	$80,906	$163,281
2041	27,441,870	65,543,957	777,579	$309,437	$1,234,417	$1,883,702	$3,792,873	$739,079	$2,948,362	$4,499,158	$9,059,145	$8,768	$34,978	$53,376	$107,473
2042	26,696,167	65,543,957	444,144	$293,860	$1,183,867	$1,810,687	$3,637,204	$721,479	$2,906,609	$4,445,567	$8,929,998	$4,889	$19,696	$30,124	$60,512
2043	25,969,107	65,543,957	176,293	$278,883	$1,135,054	$1,740,100	$3,486,927	$703,879	$2,864,786	$4,391,873	$8,800,727	$1,893	$7,705	$11,813	$23,671
2044	25,266,903	65,543,957	-	$264,573	$1,088,229	$1,672,354	$3,342,790	$686,319	$2,822,934	$4,338,194	$8,671,411	$0	$0	$0	$0
2045	24,583,342	65,543,957	-	$250,858	$1,043,080	$1,606,980	$3,203,878	$668,835	$2,781,055	$4,284,520	$8,542,161	$0	$0	$0	$0
2046	23,924,638	65,543,957	-	$237,802	$999,874	$1,544,343	$3,070,904	$651,482	$2,739,254	$4,230,884	$8,413,050	$0	$0	$0	$0
2047	23,278,362	65,543,957	-	$225,256	$958,045	$1,483,601	$2,942,204	$634,245	$2,697,530	$4,177,316	$8,284,247	$0	$0	$0	$0
2048	22,656,943	65,543,957	-	$213,341	$918,084	$1,425,499	$2,819,264	$617,171	$2,655,912	$4,123,807	$8,155,810	$0	$0	$0	$0
2049	22,041,738	65,543,957	-	$201,870	$879,194	$1,368,852	$2,699,662	$600,286	$2,614,398	$4,070,459	$8,027,795	$0	$0	$0	$0
2050	21,463,818	65,543,957	-	$191,116	$842,612	$1,315,541	$2,587,144	$583,609	$2,573,080	$4,017,260	$7,900,349	$0	$0	$0	$0
2051	20,885,898	65,543,957	-	$179,016	$799,221	$1,265,292	$2,444,677	$561,787	$2,508,110	$3,970,729	$7,671,865	$0	$0	$0	$0
2052	20,332,835	65,543,957	-	$171,164	$764,283	$1,211,928	$2,319,509	$551,755	$2,463,706	$3,906,712	$7,477,060	$0	$0	$0	$0
2053	19,798,415	65,543,957	-	$163,538	$730,921	$1,160,966	$2,201,163	$541,405	$2,419,761	$3,843,455	$7,287,095	$0	$0	$0	$0
2054	19,270,208	65,543,957	-	$151,596	$698,638	$1,111,619	$2,087,976	$515,623	$2,376,285	$3,780,960	$7,101,853	$0	$0	$0	$0
2055	18,766,859	65,543,957	-	$144,741	$668,079	$1,064,907	$1,989,223	$505,513	$2,333,290	$3,719,227	$6,947,436	$0	$0	$0	$0
2056	18,275,938	65,543,957	-	$134,243	$638,750	$1,020,049	$1,894,959	$481,441	$2,290,783	$3,658,256	$6,795,990	$0	$0	$0	$0
2057	17,803,659	65,543,957	-	$128,105	$610,833	$977,335	$1,805,648	$471,616	$2,248,773	$3,598,047	$6,647,472	$0	$0	$0	$0
2058	17,337,595	58,716,462	-	$122,111	$583,863	$936,025	$1,719,858	$413,548	$1,977,343	$3,169,994	$5,824,565	$0	$0	$0	$0
2059	16,902,601	47,012,184	-	$113,378	$552,635	$904,528	$1,639,885	$315,346	$1,537,076	$2,515,816	$4,561,106	$0	$0	$0	$0
2060	16,467,608	37,648,761	-	$108,044	$528,413	$866,525	$1,562,511	$247,013	$1,208,074	$1,981,078	$3,572,262	$0	$0	$0	$0
2061	16,032,614	30,040,980	-	$102,817	$510,212	$829,490	$1,503,783	$192,652	$956,006	$1,554,250	$2,817,700	$0	$0	$0	$0
TOTALS:	842,339,891	1,959,491,220	24,614,950	$9,252,321	$36,918,992	$56,588,357	$112,268,422	$20,088,669	$82,529,517	$127,403,886	$250,946,306	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-11. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-12. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-13. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,271	3,652,343	-	$569,397	$2,015,912	$3,000,708	$6,084,702	$54,012	$191,225	$284,641	$577,183	$0	$0	$0	$0
2030	37,415,783	9,130,857	-	$540,619	$1,935,383	$2,886,971	$5,850,645	$131,931	$472,306	$704,530	$1,427,777	$0	$0	$0	$0
2031	36,359,367	16,435,543	1,132,527	$515,429	$1,859,780	$2,778,725	$5,632,880	$232,990	$840,677	$1,256,068	$2,546,234	$16,055	$57,929	$86,552	$175,454
2032	35,340,236	20,087,886	2,607,672	$491,071	$1,786,917	$2,674,499	$5,422,210	$279,131	$1,015,709	$1,520,223	$3,082,060	$36,235	$131,852	$197,345	$400,092
2033	34,352,176	21,914,058	3,493,073	$467,542	$1,716,486	$2,573,808	$5,217,778	$298,256	$1,094,986	$1,641,892	$3,328,543	$47,542	$174,539	$261,716	$530,566
2034	33,388,973	21,914,058	3,490,712	$444,744	$1,648,186	$2,476,203	$5,018,744	$291,897	$1,081,748	$1,625,197	$3,293,933	$46,497	$172,313	$258,879	$524,694
2035	32,463,055	21,914,058	3,102,972	$422,904	$1,582,635	$2,382,537	$4,827,125	$285,480	$1,068,351	$1,608,322	$3,258,532	$40,423	$151,276	$227,734	$461,399
2036	31,561,994	21,914,058	2,606,622	$401,832	$1,519,214	$2,291,895	$4,641,100	$279,000	$1,054,818	$1,591,304	$3,222,399	$33,186	$125,468	$189,282	$383,296
2037	30,692,004	21,914,058	2,202,617	$381,654	$1,458,218	$2,204,708	$4,461,618	$272,501	$1,041,166	$1,574,159	$3,185,591	$27,389	$104,649	$158,221	$320,189
2038	29,840,656	21,914,058	1,887,545	$362,185	$1,399,044	$2,120,077	$4,286,955	$265,977	$1,027,415	$1,556,920	$3,148,208	$22,910	$88,495	$134,104	$271,168
2039	29,007,952	21,914,058	1,528,400	$343,461	$1,341,692	$2,037,950	$4,117,130	$259,468	$1,013,582	$1,539,569	$3,110,286	$18,097	$70,692	$107,378	$216,927
2040	28,218,747	21,914,058	1,164,795	$325,756	$1,287,292	$1,960,060	$3,955,708	$252,975	$999,682	$1,522,139	$3,071,916	$13,446	$53,136	$80,906	$163,281
2041	27,441,970	21,914,058	777,579	$309,438	$1,234,421	$1,883,709	$3,792,886	$247,105	$985,759	$1,504,255	$3,028,847	$8,768	$34,978	$53,376	$107,473
2042	26,696,264	21,914,058	444,144	$293,861	$1,183,871	$1,810,694	$3,637,217	$241,220	$971,800	$1,486,337	$2,985,668	$4,889	$19,696	$30,124	$60,512
2043	25,969,201	21,914,058	176,293	$278,884	$1,135,058	$1,740,106	$3,486,940	$235,336	$957,817	$1,468,385	$2,942,447	$1,893	$7,705	$11,813	$23,671
2044	25,266,995	21,914,058	-	$264,574	$1,088,233	$1,672,360	$3,342,802	$229,465	$943,824	$1,450,438	$2,899,211	$0	$0	$0	$0
2045	24,583,431	21,914,058	-	$250,858	$1,043,084	$1,606,986	$3,203,890	$223,619	$929,822	$1,432,492	$2,855,998	$0	$0	$0	$0
2046	23,924,725	21,914,058	-	$237,803	$999,877	$1,544,349	$3,070,915	$217,818	$915,846	$1,414,560	$2,812,831	$0	$0	$0	$0
2047	23,278,446	21,914,058	-	$225,257	$958,049	$1,483,606	$2,942,215	$212,054	$901,896	$1,396,649	$2,769,767	$0	$0	$0	$0
2048	22,657,025	21,914,058	-	$213,342	$918,087	$1,425,504	$2,819,274	$206,346	$887,981	$1,378,759	$2,726,825	$0	$0	$0	$0
2049	22,041,818	21,914,058	-	$201,870	$879,198	$1,368,857	$2,699,672	$200,700	$874,102	$1,360,923	$2,684,024	$0	$0	$0	$0
2050	21,463,896	21,914,058	-	$191,116	$842,615	$1,315,545	$2,587,153	$195,125	$860,287	$1,343,136	$2,641,414	$0	$0	$0	$0
2051	20,885,974	21,914,058	-	$179,017	$799,224	$1,265,297	$2,444,686	$187,829	$838,565	$1,327,579	$2,565,022	$0	$0	$0	$0
2052	20,332,909	21,914,058	-	$171,164	$764,286	$1,211,932	$2,319,518	$184,475	$823,719	$1,306,176	$2,499,891	$0	$0	$0	$0
2053	19,798,486	21,914,058	-	$163,539	$730,923	$1,160,970	$2,201,171	$181,014	$809,026	$1,285,026	$2,436,377	$0	$0	$0	$0
2054	19,270,278	21,914,058	-	$151,596	$698,641	$1,111,623	$2,087,983	$172,394	$794,491	$1,264,131	$2,374,443	$0	$0	$0	$0
2055	18,766,927	21,914,058	-	$144,741	$668,081	$1,064,911	$1,989,230	$169,014	$780,115	$1,243,491	$2,322,815	$0	$0	$0	$0
2056	18,276,004	21,914,058	-	$134,243	$638,752	$1,020,053	$1,894,966	$160,966	$765,904	$1,223,106	$2,272,181	$0	$0	$0	$0
2057	17,803,724	21,914,058	-	$128,105	$610,835	$977,338	$1,805,655	$157,681	$751,858	$1,202,976	$2,222,525	$0	$0	$0	$0
2058	17,337,658	19,631,344	-	$122,111	$583,865	$936,028	$1,719,864	$138,266	$661,108	$1,059,860	$1,947,393	$0	$0	$0	$0
2059	16,902,663	15,718,119	-	$113,379	$552,637	$904,531	$1,639,891	$105,433	$513,908	$841,141	$1,524,967	$0	$0	$0	$0
2060	16,467,668	12,587,539	-	$108,044	$528,415	$866,529	$1,562,517	$82,587	$403,909	$662,356	$1,194,355	$0	$0	$0	$0
2061	16,032,673	10,043,943	-	$102,817	$510,214	$829,493	$1,503,788	$64,412	$319,632	$519,650	$942,074	$0	$0	$0	$0
TOTALS:	842,342,944	655,139,023	24,614,950	$9,252,355	$36,919,125	$56,588,562	$112,268,828	$6,716,474	$27,593,034	$42,596,393	$83,901,737	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-14. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-15. Scenario 1: "Business as Usual": LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-16. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,194	3,723,719	-	$569,396	$2,015,908	$3,000,702	$6,084,690	$55,067	$194,962	$290,204	$588,462	$0	$0	$0	$0
2030	37,415,708	9,309,297	-	$540,618	$1,935,379	$2,886,966	$5,850,633	$134,510	$481,536	$718,298	$1,455,679	$0	$0	$0	$0
2031	36,359,294	16,756,734	1,132,527	$515,428	$1,859,776	$2,778,719	$5,632,869	$237,543	$857,106	$1,280,615	$2,595,993	$16,055	$57,929	$86,552	$175,454
2032	35,340,165	20,480,453	2,607,672	$491,070	$1,786,913	$2,674,493	$5,422,199	$284,586	$1,035,558	$1,549,932	$3,142,291	$36,235	$131,852	$197,345	$400,092
2033	34,352,107	22,342,312	3,493,073	$467,542	$1,716,482	$2,573,803	$5,217,768	$304,085	$1,116,385	$1,673,979	$3,393,591	$47,542	$174,539	$261,716	$530,566
2034	33,388,906	22,342,312	3,490,712	$444,743	$1,648,183	$2,476,198	$5,018,734	$297,601	$1,102,888	$1,656,957	$3,358,305	$46,497	$172,313	$258,879	$524,694
2035	32,462,990	22,342,312	3,102,972	$422,903	$1,582,632	$2,382,532	$4,827,116	$291,059	$1,089,230	$1,639,753	$3,322,212	$40,423	$151,276	$227,734	$461,399
2036	31,561,930	22,342,312	2,606,622	$401,832	$1,519,211	$2,291,891	$4,641,090	$284,452	$1,075,432	$1,622,402	$3,285,372	$33,186	$125,468	$189,282	$383,296
2037	30,691,942	22,342,312	2,202,617	$381,654	$1,458,215	$2,204,704	$4,461,609	$277,826	$1,061,513	$1,604,922	$3,247,845	$27,389	$104,649	$158,221	$320,189
2038	29,840,596	22,342,312	1,887,545	$362,184	$1,399,041	$2,120,073	$4,286,947	$271,175	$1,047,493	$1,587,346	$3,209,731	$22,910	$88,495	$134,104	$271,168
2039	29,007,893	22,342,312	1,528,400	$343,460	$1,341,690	$2,037,946	$4,117,122	$264,538	$1,033,389	$1,569,656	$3,171,069	$18,097	$70,692	$107,378	$216,927
2040	28,218,690	22,342,312	1,164,795	$325,755	$1,287,289	$1,960,056	$3,955,700	$257,919	$1,019,219	$1,551,886	$3,131,949	$13,446	$53,136	$80,906	$163,281
2041	27,441,915	22,342,312	777,579	$309,437	$1,234,419	$1,883,705	$3,792,879	$251,934	$1,005,024	$1,533,652	$3,088,038	$8,768	$34,978	$53,376	$107,473
2042	26,696,210	22,342,312	444,144	$293,860	$1,183,869	$1,810,690	$3,637,210	$245,934	$990,791	$1,515,384	$3,044,015	$4,889	$19,696	$30,124	$60,512
2043	25,969,149	22,342,312	176,293	$278,884	$1,135,056	$1,740,103	$3,486,933	$239,935	$976,535	$1,497,081	$2,999,950	$1,893	$7,705	$11,813	$23,671
2044	25,266,944	22,342,312	-	$264,573	$1,088,230	$1,672,357	$3,342,795	$233,949	$962,268	$1,478,783	$2,955,869	$0	$0	$0	$0
2045	24,583,382	22,342,312	-	$250,858	$1,043,082	$1,606,983	$3,203,884	$227,989	$947,993	$1,460,487	$2,911,811	$0	$0	$0	$0
2046	23,924,676	22,342,312	-	$237,802	$999,875	$1,544,346	$3,070,909	$222,074	$933,744	$1,442,204	$2,867,800	$0	$0	$0	$0
2047	23,278,399	22,342,312	-	$225,256	$958,047	$1,483,603	$2,942,209	$216,198	$919,521	$1,423,943	$2,823,895	$0	$0	$0	$0
2048	22,656,979	22,342,312	-	$213,341	$918,085	$1,425,502	$2,819,268	$210,378	$905,334	$1,405,704	$2,780,114	$0	$0	$0	$0
2049	22,041,773	22,342,312	-	$201,870	$879,196	$1,368,854	$2,699,667	$204,623	$891,184	$1,387,519	$2,736,477	$0	$0	$0	$0
2050	21,463,853	22,342,312	-	$191,116	$842,613	$1,315,543	$2,587,148	$198,938	$877,099	$1,369,385	$2,693,033	$0	$0	$0	$0
2051	20,885,932	22,342,312	-	$179,016	$799,223	$1,265,294	$2,444,681	$191,499	$854,952	$1,353,523	$2,615,149	$0	$0	$0	$0
2052	20,332,868	22,342,312	-	$171,164	$764,284	$1,211,930	$2,319,513	$188,080	$839,816	$1,331,701	$2,548,745	$0	$0	$0	$0
2053	19,798,447	22,342,312	-	$163,539	$730,922	$1,160,968	$2,201,166	$184,551	$824,836	$1,310,139	$2,483,990	$0	$0	$0	$0
2054	19,270,239	22,342,312	-	$151,596	$698,639	$1,111,620	$2,087,979	$175,763	$810,017	$1,288,836	$2,420,846	$0	$0	$0	$0
2055	18,766,889	22,342,312	-	$144,741	$668,080	$1,064,908	$1,989,226	$172,317	$795,361	$1,267,792	$2,368,209	$0	$0	$0	$0
2056	18,275,967	22,342,312	-	$134,243	$638,751	$1,020,051	$1,894,962	$164,111	$780,871	$1,247,009	$2,316,585	$0	$0	$0	$0
2057	17,803,688	22,342,312	-	$128,105	$610,834	$977,336	$1,805,651	$160,762	$766,551	$1,226,485	$2,265,959	$0	$0	$0	$0
2058	17,337,623	20,014,988	-	$122,111	$583,864	$936,026	$1,719,860	$140,968	$674,027	$1,080,573	$1,985,450	$0	$0	$0	$0
2059	16,902,629	16,025,289	-	$113,378	$552,636	$904,529	$1,639,887	$107,493	$523,951	$857,579	$1,554,768	$0	$0	$0	$0
2060	16,467,634	12,833,530	-	$108,044	$528,414	$866,527	$1,562,514	$84,201	$411,803	$675,300	$1,217,696	$0	$0	$0	$0
2061	16,032,640	10,240,226	-	$102,817	$510,213	$829,491	$1,503,785	$65,670	$325,879	$529,805	$960,484	$0	$0	$0	$0
TOTALS:	842,341,252	667,942,040	24,614,950	$9,252,336	$36,919,051	$56,588,448	$112,268,603	$6,847,730	$28,132,269	$43,428,830	$85,541,382	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-17. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-18. Scenario 1: "Business as Usual": LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons): Alaskan Oil Production and End Use: without Alaska LNG Export Project	N_2O Emissions (Metric Tons): Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	N_2O Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-19. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,248	3,726,846	-	$569,397	$2,015,911	$3,000,706	$6,084,699	$55,114	$195,126	$290,447	$588,956	$0	$0	$0	$0
2030	37,415,761	9,317,114	-	$540,619	$1,935,382	$2,886,970	$5,850,641	$134,623	$481,941	$718,901	$1,456,902	$0	$0	$0	$0
2031	36,359,346	16,770,805	1,132,527	$515,429	$1,859,779	$2,778,723	$5,632,877	$237,742	$857,826	$1,281,690	$2,598,173	$16,055	$57,929	$86,552	$175,454
2032	35,340,215	20,497,650	2,607,672	$491,070	$1,786,916	$2,674,497	$5,422,206	$284,825	$1,036,428	$1,551,233	$3,144,930	$36,235	$131,852	$197,345	$400,092
2033	34,352,156	22,361,073	3,493,073	$467,542	$1,716,485	$2,573,806	$5,217,775	$304,340	$1,117,323	$1,675,384	$3,396,441	$47,542	$174,539	$261,716	$530,566
2034	33,388,953	22,361,073	3,490,712	$444,743	$1,648,185	$2,476,201	$5,018,741	$297,851	$1,103,814	$1,658,348	$3,361,125	$46,497	$172,313	$258,879	$524,694
2035	32,463,036	22,361,073	3,102,972	$422,904	$1,582,634	$2,382,535	$4,827,123	$291,303	$1,090,144	$1,641,130	$3,325,001	$40,423	$151,276	$227,734	$461,399
2036	31,561,975	22,361,073	2,606,622	$401,832	$1,519,214	$2,291,894	$4,641,097	$284,691	$1,076,335	$1,623,764	$3,288,131	$33,186	$125,468	$189,282	$383,296
2037	30,691,986	22,361,073	2,202,617	$381,654	$1,458,217	$2,204,707	$4,461,616	$278,059	$1,062,404	$1,606,270	$3,250,572	$27,389	$104,649	$158,221	$320,189
2038	29,840,639	22,361,073	1,887,545	$362,184	$1,399,043	$2,120,076	$4,286,953	$271,403	$1,048,373	$1,588,678	$3,212,427	$22,910	$88,495	$134,104	$271,168
2039	29,007,935	22,361,073	1,528,400	$343,461	$1,341,692	$2,037,949	$4,117,128	$264,760	$1,034,257	$1,570,974	$3,173,731	$18,097	$70,692	$107,378	$216,927
2040	28,218,730	22,361,073	1,164,795	$325,756	$1,287,291	$1,960,059	$3,955,706	$258,135	$1,020,074	$1,553,189	$3,134,579	$13,446	$53,136	$80,906	$163,281
2041	27,441,954	22,361,073	777,579	$309,438	$1,234,421	$1,883,708	$3,792,884	$252,145	$1,005,868	$1,534,939	$3,090,631	$8,768	$34,978	$53,376	$107,473
2042	26,696,248	22,361,073	444,144	$293,860	$1,183,870	$1,810,693	$3,637,215	$246,141	$991,623	$1,516,656	$3,046,571	$4,889	$19,696	$30,124	$60,512
2043	25,969,186	22,361,073	176,293	$278,884	$1,135,058	$1,740,105	$3,486,938	$240,136	$977,355	$1,498,338	$3,002,469	$1,893	$7,705	$11,813	$23,671
2044	25,266,980	22,361,073	-	$264,574	$1,088,232	$1,672,359	$3,342,800	$234,145	$963,076	$1,480,025	$2,958,351	$0	$0	$0	$0
2045	24,583,417	22,361,073	-	$250,858	$1,043,084	$1,606,985	$3,203,888	$228,181	$948,789	$1,461,713	$2,914,256	$0	$0	$0	$0
2046	23,924,710	22,361,073	-	$237,803	$999,877	$1,544,348	$3,070,913	$222,261	$934,528	$1,443,415	$2,870,209	$0	$0	$0	$0
2047	23,278,433	22,361,073	-	$225,257	$958,048	$1,483,605	$2,942,213	$216,380	$920,293	$1,425,139	$2,826,266	$0	$0	$0	$0
2048	22,657,012	22,361,073	-	$213,342	$918,086	$1,425,504	$2,819,272	$210,555	$906,095	$1,406,884	$2,782,448	$0	$0	$0	$0
2049	22,041,805	22,361,073	-	$201,870	$879,197	$1,368,856	$2,699,671	$204,794	$891,932	$1,388,684	$2,738,774	$0	$0	$0	$0
2050	21,463,883	22,361,073	-	$191,116	$842,615	$1,315,545	$2,587,152	$199,105	$877,836	$1,370,534	$2,695,295	$0	$0	$0	$0
2051	20,885,962	22,361,073	-	$179,017	$799,224	$1,265,296	$2,444,684	$191,660	$855,670	$1,354,660	$2,617,345	$0	$0	$0	$0
2052	20,332,897	22,361,073	-	$171,164	$764,285	$1,211,931	$2,319,517	$188,238	$840,521	$1,332,820	$2,550,885	$0	$0	$0	$0
2053	19,798,475	22,361,073	-	$163,539	$730,923	$1,160,970	$2,201,170	$184,706	$825,529	$1,311,239	$2,486,076	$0	$0	$0	$0
2054	19,270,267	22,361,073	-	$151,596	$698,640	$1,111,622	$2,087,982	$175,911	$810,697	$1,289,918	$2,422,879	$0	$0	$0	$0
2055	18,766,916	22,361,073	-	$144,741	$668,081	$1,064,910	$1,989,229	$172,462	$796,029	$1,268,857	$2,370,198	$0	$0	$0	$0
2056	18,275,993	22,361,073	-	$134,243	$638,752	$1,020,052	$1,894,964	$164,249	$781,527	$1,248,056	$2,318,530	$0	$0	$0	$0
2057	17,803,713	22,361,073	-	$128,105	$610,835	$977,338	$1,805,654	$160,897	$767,195	$1,227,515	$2,267,861	$0	$0	$0	$0
2058	17,337,647	20,031,795	-	$122,111	$583,865	$936,028	$1,719,863	$141,086	$674,593	$1,081,480	$1,987,117	$0	$0	$0	$0
2059	16,902,653	16,038,746	-	$113,379	$552,637	$904,531	$1,639,890	$107,584	$524,391	$858,299	$1,556,074	$0	$0	$0	$0
2060	16,467,658	12,844,307	-	$108,044	$528,414	$866,528	$1,562,516	$84,271	$412,148	$675,867	$1,218,718	$0	$0	$0	$0
2061	16,032,663	10,248,825	-	$102,817	$510,214	$829,492	$1,503,787	$65,726	$326,152	$530,250	$961,291	$0	$0	$0	$0
TOTALS:	842,342,449	668,502,916	24,614,950	$9,252,349	$36,919,104	$56,588,529	$112,268,763	$6,853,480	$28,155,892	$43,465,298	$85,613,212	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-20. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,123	-	$14,070	$32,444	$42,735	$86,097	$28,632	$66,020	$86,962	$175,201	$0	$0	$0	$0
2030	19,160	100,308	-	$13,411	$31,362	$41,431	$83,289	$70,209	$164,186	$216,897	$436,031	$0	$0	$0	$0
2031	18,620	180,555	885	$12,867	$30,427	$40,280	$80,908	$124,769	$295,057	$390,597	$784,572	$611	$1,446	$1,914	$3,844
2032	18,098	220,678	2,037	$12,332	$29,504	$39,145	$78,547	$150,369	$359,768	$477,326	$957,780	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,739	2,728	$11,806	$28,591	$38,023	$76,200	$161,562	$391,260	$520,335	$1,042,791	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,739	2,727	$11,289	$27,684	$36,909	$73,863	$158,949	$389,783	$519,661	$1,039,965	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,739	2,424	$10,788	$26,797	$35,819	$71,570	$156,219	$388,061	$518,710	$1,036,418	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,739	2,036	$10,298	$25,923	$34,744	$69,300	$153,388	$386,108	$517,496	$1,032,196	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,739	1,720	$9,824	$25,066	$33,690	$67,072	$150,472	$383,940	$516,033	$1,027,341	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,739	1,474	$9,362	$24,221	$32,648	$64,866	$147,487	$381,570	$514,333	$1,021,893	$903	$2,337	$3,150	$6,258
2039	14,855	240,739	1,194	$8,913	$23,387	$31,618	$62,686	$144,444	$379,013	$512,409	$1,015,891	$716	$1,879	$2,541	$5,038
2040	14,451	240,739	910	$8,485	$22,587	$30,630	$60,589	$141,357	$376,281	$510,273	$1,009,371	$534	$1,422	$1,928	$3,815
2041	14,053	240,739	607	$8,089	$21,801	$29,642	$58,435	$138,565	$373,465	$507,793	$1,001,048	$350	$942	$1,281	$2,526
2042	13,671	240,739	347	$7,707	$21,040	$28,685	$56,354	$135,718	$370,494	$505,130	$992,354	$196	$534	$728	$1,430
2043	13,299	240,739	138	$7,338	$20,294	$27,747	$54,320	$132,828	$367,379	$502,294	$983,317	$76	$210	$287	$562
2044	12,939	240,739	-	$6,982	$19,571	$26,836	$52,348	$129,905	$364,131	$499,297	$973,965	$0	$0	$0	$0
2045	12,589	240,739	-	$6,639	$18,865	$25,945	$50,428	$126,960	$360,761	$496,147	$964,323	$0	$0	$0	$0
2046	12,252	240,739	-	$6,311	$18,183	$25,082	$48,572	$124,001	$357,278	$492,854	$954,417	$0	$0	$0	$0
2047	11,921	240,739	-	$5,993	$17,514	$24,235	$46,758	$121,035	$353,692	$489,426	$944,269	$0	$0	$0	$0
2048	11,603	240,739	-	$5,690	$16,869	$23,417	$45,010	$118,071	$350,012	$485,872	$933,903	$0	$0	$0	$0
2049	11,288	240,739	-	$5,397	$16,234	$22,609	$43,293	$115,114	$346,246	$482,201	$923,340	$0	$0	$0	$0
2050	10,992	240,739	-	$5,121	$15,633	$21,843	$41,667	$112,172	$342,403	$478,419	$912,600	$0	$0	$0	$0
2051	10,696	240,739	-	$4,813	$14,907	$20,905	$39,450	$108,329	$335,539	$470,528	$887,943	$0	$0	$0	$0
2052	10,412	240,739	-	$4,523	$14,236	$20,032	$37,446	$104,583	$329,133	$463,152	$865,763	$0	$0	$0	$0
2053	10,139	240,739	-	$4,251	$13,591	$19,193	$35,550	$100,948	$322,714	$455,738	$844,123	$0	$0	$0	$0
2054	9,868	240,739	-	$3,993	$12,969	$18,386	$33,732	$97,422	$316,389	$448,524	$822,909	$0	$0	$0	$0
2055	9,610	240,739	-	$3,753	$12,382	$17,621	$32,029	$94,003	$310,159	$441,392	$802,311	$0	$0	$0	$0
2056	9,359	240,739	-	$3,530	$11,834	$16,898	$30,431	$90,790	$304,397	$434,668	$782,775	$0	$0	$0	$0
2057	9,117	240,739	-	$3,322	$11,313	$16,214	$28,926	$87,718	$298,708	$428,116	$763,788	$0	$0	$0	$0
2058	8,879	215,662	-	$3,123	$10,809	$15,550	$27,482	$75,865	$262,562	$377,706	$667,535	$0	$0	$0	$0
2059	8,656	172,673	-	$2,939	$10,336	$14,925	$26,138	$58,632	$206,187	$297,732	$521,420	$0	$0	$0	$0
2060	8,433	138,282	-	$2,765	$9,878	$14,318	$24,846	$45,339	$161,981	$234,777	$407,410	$0	$0	$0	$0
2061	8,210	110,339	-	$2,728	$9,758	$14,146	$24,937	$36,668	$131,140	$190,112	$335,131	$0	$0	$0	$0
TOTALS:	431,361	7,197,106	19,226	$238,454	$646,011	$881,901	$1,713,137	$3,742,524	$10,525,816	$14,482,909	$27,864,094	$12,351	$30,856	$41,304	$82,415

Table E.3-21. Scenario 1: "Business as Usual": LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$163	$527	$777	$1,394	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$398	$1,304	$1,927	$3,454	$0	$0	$0	$0
2031	13	123	2	$75	$250	$370	$662	$704	$2,328	$3,448	$6,172	$14	$47	$69	$124
2032	13	150	6	$72	$241	$357	$638	$844	$2,820	$4,186	$7,485	$32	$107	$159	$284
2033	12	164	8	$69	$232	$345	$616	$903	$3,049	$4,536	$8,098	$42	$142	$211	$377
2034	12	164	8	$65	$223	$333	$593	$885	$3,020	$4,504	$8,028	$41	$140	$209	$373
2035	12	164	7	$62	$215	$321	$571	$867	$2,991	$4,470	$7,955	$36	$124	$185	$329
2036	11	164	6	$59	$207	$310	$550	$848	$2,960	$4,436	$7,880	$29	$103	$154	$274
2037	11	164	5	$56	$199	$299	$530	$829	$2,929	$4,400	$7,802	$24	$86	$129	$229
2038	11	164	4	$54	$191	$288	$510	$810	$2,897	$4,364	$7,723	$20	$73	$110	$194
2039	11	164	3	$51	$184	$278	$490	$791	$2,864	$4,327	$7,641	$16	$58	$88	$156
2040	10	164	3	$48	$177	$268	$472	$772	$2,831	$4,289	$7,557	$12	$44	$67	$117
2041	10	164	2	$46	$170	$258	$454	$756	$2,801	$4,254	$7,478	$8	$29	$44	$77
2042	10	164	1	$44	$164	$249	$437	$740	$2,771	$4,218	$7,398	$4	$16	$25	$44
2043	9	164	0	$42	$157	$240	$420	$724	$2,740	$4,181	$7,316	$2	$6	$10	$17
2044	9	164	-	$40	$151	$232	$404	$707	$2,708	$4,143	$7,232	$0	$0	$0	$0
2045	9	164	-	$38	$146	$223	$389	$691	$2,676	$4,105	$7,147	$0	$0	$0	$0
2046	9	164	-	$36	$140	$215	$374	$674	$2,643	$4,067	$7,061	$0	$0	$0	$0
2047	8	164	-	$34	$134	$207	$359	$657	$2,610	$4,027	$6,973	$0	$0	$0	$0
2048	8	164	-	$32	$129	$200	$345	$641	$2,577	$3,988	$6,885	$0	$0	$0	$0
2049	8	164	-	$30	$124	$193	$331	$624	$2,543	$3,947	$6,796	$0	$0	$0	$0
2050	8	164	-	$29	$119	$186	$319	$608	$2,509	$3,907	$6,707	$0	$0	$0	$0
2051	8	164	-	$27	$114	$178	$302	$592	$2,469	$3,851	$6,544	$0	$0	$0	$0
2052	7	164	-	$26	$110	$171	$290	$577	$2,435	$3,809	$6,452	$0	$0	$0	$0
2053	7	164	-	$25	$105	$165	$279	$563	$2,400	$3,766	$6,360	$0	$0	$0	$0
2054	7	164	-	$23	$101	$159	$267	$548	$2,366	$3,723	$6,268	$0	$0	$0	$0
2055	7	164	-	$22	$97	$153	$256	$533	$2,332	$3,680	$6,176	$0	$0	$0	$0
2056	7	164	-	$21	$93	$147	$246	$520	$2,299	$3,639	$6,081	$0	$0	$0	$0
2057	6	164	-	$20	$89	$142	$236	$506	$2,266	$3,598	$5,987	$0	$0	$0	$0
2058	6	147	-	$19	$86	$136	$226	$441	$2,001	$3,186	$5,280	$0	$0	$0	$0
2059	6	118	-	$18	$82	$131	$217	$343	$1,578	$2,521	$4,161	$0	$0	$0	$0
2060	6	94	-	$17	$79	$127	$208	$267	$1,245	$1,995	$3,279	$0	$0	$0	$0
2061	6	75	-	$16	$76	$122	$202	$211	$986	$1,583	$2,614	$0	$0	$0	$0
TOTALS:	306	4,904	54	$1,378	$5,113	$7,783	$13,595	$20,739	$79,476	$121,853	$211,381	$281	$975	$1,460	$2,595

Table E.3-22. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Oil Production and End Use: without Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Carbon Dioxide (CO_2) Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Oil Production and End Use: without Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
				5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	38,503,254	3,699,315	-	$569,397	$2,015,911	$3,000,707	$6,084,700	$54,706	$193,685	$288,302	$584,606	$0	$0	$0	$0
2030	37,415,767	9,248,287	-	$540,619	$1,935,382	$2,886,970	$5,850,642	$133,628	$478,380	$713,590	$1,446,140	$0	$0	$0	$0
2031	36,359,351	16,646,917	1,132,527	$515,429	$1,859,779	$2,778,723	$5,632,878	$235,986	$851,489	$1,272,222	$2,578,980	$16,055	$57,929	$86,552	$175,454
2032	35,340,221	20,346,232	2,607,672	$491,070	$1,786,916	$2,674,498	$5,422,207	$282,721	$1,028,771	$1,539,774	$3,121,698	$36,235	$131,852	$197,345	$400,092
2033	34,352,161	22,195,890	3,493,073	$467,542	$1,716,485	$2,573,807	$5,217,776	$302,092	$1,109,069	$1,663,008	$3,371,351	$47,542	$174,539	$261,716	$530,566
2034	33,388,958	22,195,890	3,490,712	$444,743	$1,648,186	$2,476,202	$5,018,742	$295,651	$1,095,660	$1,646,098	$3,336,296	$46,497	$172,313	$258,879	$524,694
2035	32,463,041	22,195,890	3,102,972	$422,904	$1,582,634	$2,382,536	$4,827,123	$289,151	$1,082,091	$1,629,006	$3,300,439	$40,423	$151,276	$227,734	$461,399
2036	31,561,980	22,195,890	2,606,622	$401,832	$1,519,214	$2,291,894	$4,641,098	$282,588	$1,068,384	$1,611,769	$3,263,841	$33,186	$125,468	$189,282	$383,296
2037	30,691,990	22,195,890	2,202,617	$381,654	$1,458,217	$2,204,707	$4,461,616	$276,005	$1,054,556	$1,594,404	$3,226,560	$27,389	$104,649	$158,221	$320,189
2038	29,840,644	22,195,890	1,887,545	$362,184	$1,399,044	$2,120,077	$4,286,953	$269,398	$1,040,628	$1,576,943	$3,188,696	$22,910	$88,495	$134,104	$271,168
2039	29,007,939	22,195,890	1,528,400	$343,461	$1,341,692	$2,037,949	$4,117,128	$262,805	$1,026,617	$1,559,369	$3,150,287	$18,097	$70,692	$107,378	$216,927
2040	28,218,734	22,195,890	1,164,795	$325,756	$1,287,291	$1,960,059	$3,955,707	$256,228	$1,012,539	$1,541,715	$3,111,423	$13,446	$53,136	$80,906	$163,281
2041	27,441,958	22,195,890	777,579	$309,438	$1,234,421	$1,883,708	$3,792,885	$250,283	$998,437	$1,523,601	$3,067,800	$8,768	$34,978	$53,376	$107,473
2042	26,696,253	22,195,890	444,144	$293,861	$1,183,870	$1,810,693	$3,637,215	$244,323	$984,298	$1,505,453	$3,024,066	$4,889	$19,696	$30,124	$60,512
2043	25,969,190	22,195,890	176,293	$278,884	$1,135,058	$1,740,105	$3,486,939	$238,362	$970,135	$1,487,270	$2,980,290	$1,893	$7,705	$11,813	$23,671
2044	25,266,984	22,195,890	-	$264,574	$1,088,232	$1,672,360	$3,342,801	$232,416	$955,962	$1,469,091	$2,936,498	$0	$0	$0	$0
2045	24,583,421	22,195,890	-	$250,858	$1,043,084	$1,606,985	$3,203,889	$226,495	$941,780	$1,450,915	$2,892,728	$0	$0	$0	$0
2046	23,924,714	22,195,890	-	$237,803	$999,877	$1,544,348	$3,070,913	$220,619	$927,625	$1,432,752	$2,849,006	$0	$0	$0	$0
2047	23,278,436	22,195,890	-	$225,257	$958,048	$1,483,605	$2,942,213	$214,781	$913,495	$1,414,612	$2,805,388	$0	$0	$0	$0
2048	22,657,015	22,195,890	-	$213,342	$918,087	$1,425,504	$2,819,273	$209,000	$899,401	$1,396,491	$2,761,894	$0	$0	$0	$0
2049	22,041,808	22,195,890	-	$201,870	$879,197	$1,368,857	$2,699,671	$203,282	$885,343	$1,378,425	$2,718,543	$0	$0	$0	$0
2050	21,463,886	22,195,890	-	$191,116	$842,615	$1,315,545	$2,587,152	$197,634	$871,351	$1,360,410	$2,675,384	$0	$0	$0	$0
2051	20,885,965	22,195,890	-	$179,017	$799,224	$1,265,296	$2,444,685	$190,244	$849,349	$1,344,653	$2,598,010	$0	$0	$0	$0
2052	20,332,900	22,195,890	-	$171,164	$764,285	$1,211,931	$2,319,517	$186,847	$834,312	$1,322,974	$2,532,041	$0	$0	$0	$0
2053	19,798,478	22,195,890	-	$163,539	$730,923	$1,160,970	$2,201,170	$183,342	$819,431	$1,301,553	$2,467,711	$0	$0	$0	$0
2054	19,270,270	22,195,890	-	$151,596	$698,640	$1,111,622	$2,087,982	$174,611	$804,708	$1,280,389	$2,404,981	$0	$0	$0	$0
2055	18,766,919	22,195,890	-	$144,741	$668,081	$1,064,910	$1,989,229	$171,188	$790,148	$1,259,484	$2,352,689	$0	$0	$0	$0
2056	18,275,996	22,195,890	-	$134,243	$638,752	$1,020,052	$1,894,965	$163,036	$775,754	$1,238,836	$2,301,403	$0	$0	$0	$0
2057	17,803,716	22,195,890	-	$128,105	$610,835	$977,338	$1,805,654	$159,709	$761,527	$1,218,447	$2,251,109	$0	$0	$0	$0
2058	17,337,650	19,883,818	-	$122,111	$583,865	$936,028	$1,719,863	$140,044	$669,610	$1,073,491	$1,972,438	$0	$0	$0	$0
2059	16,902,655	15,920,266	-	$113,379	$552,637	$904,531	$1,639,890	$106,789	$520,517	$851,959	$1,544,579	$0	$0	$0	$0
2060	16,467,660	12,749,425	-	$108,044	$528,415	$866,528	$1,562,516	$83,649	$409,104	$670,875	$1,209,715	$0	$0	$0	$0
2061	16,032,666	10,173,116	-	$102,817	$510,214	$829,492	$1,503,787	$65,240	$323,743	$526,333	$954,190	$0	$0	$0	$0
TOTALS:	842,342,580	663,564,628	24,614,950	$9,252,351	$36,919,109	$56,588,538	$112,268,780	$6,802,853	$27,947,902	$43,144,216	$84,980,780	$317,330	$1,192,729	$1,797,429	$3,638,722

Table E.3-23. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	19,717	40,016	-	$14,070	$32,444	$42,735	$86,097	$28,555	$65,844	$86,729	$174,733	$0	$0	$0	$0
2030	19,161	100,040	-	$13,411	$31,362	$41,431	$83,289	$70,021	$163,748	$216,317	$434,866	$0	$0	$0	$0
2031	18,620	180,072	885	$12,867	$30,427	$40,280	$80,908	$124,436	$294,269	$389,554	$782,476	$611	$1,446	$1,914	$3,844
2032	18,098	220,088	2,037	$12,332	$29,504	$39,145	$78,547	$149,967	$358,807	$476,050	$955,221	$1,388	$3,321	$4,406	$8,840
2033	17,592	240,096	2,728	$11,806	$28,591	$38,023	$76,200	$161,130	$390,214	$518,945	$1,040,005	$1,831	$4,434	$5,897	$11,818
2034	17,098	240,096	2,727	$11,289	$27,684	$36,909	$73,863	$158,524	$388,742	$518,273	$1,037,186	$1,800	$4,415	$5,886	$11,778
2035	16,624	240,096	2,424	$10,788	$26,797	$35,819	$71,570	$155,801	$387,024	$517,324	$1,033,649	$1,573	$3,907	$5,222	$10,434
2036	16,163	240,096	2,036	$10,298	$25,923	$34,744	$69,300	$152,978	$385,076	$516,113	$1,029,438	$1,297	$3,265	$4,377	$8,730
2037	15,717	240,096	1,720	$9,824	$25,066	$33,690	$67,073	$150,070	$382,914	$514,654	$1,024,596	$1,075	$2,744	$3,688	$7,342
2038	15,281	240,096	1,474	$9,362	$24,221	$32,648	$64,866	$147,093	$380,550	$512,959	$1,019,162	$903	$2,337	$3,150	$6,258
2039	14,855	240,096	1,194	$8,913	$23,387	$31,618	$62,686	$144,058	$378,000	$511,040	$1,013,176	$716	$1,879	$2,541	$5,038
2040	14,451	240,096	910	$8,485	$22,587	$30,630	$60,589	$140,980	$375,275	$508,910	$1,006,674	$534	$1,422	$1,928	$3,815
2041	14,053	240,096	607	$8,089	$21,801	$29,642	$58,435	$138,195	$372,467	$506,436	$998,374	$350	$942	$1,281	$2,526
2042	13,671	240,096	347	$7,707	$21,040	$28,685	$56,354	$135,355	$369,504	$503,780	$989,703	$196	$534	$728	$1,430
2043	13,299	240,096	138	$7,338	$20,294	$27,747	$54,320	$132,473	$366,397	$500,952	$980,690	$76	$210	$287	$562
2044	12,939	240,096	-	$6,982	$19,571	$26,836	$52,348	$129,558	$363,158	$497,963	$971,362	$0	$0	$0	$0
2045	12,589	240,096	-	$6,639	$18,865	$25,945	$50,428	$126,621	$359,797	$494,822	$961,746	$0	$0	$0	$0
2046	12,252	240,096	-	$6,311	$18,183	$25,082	$48,572	$123,669	$356,324	$491,537	$951,867	$0	$0	$0	$0
2047	11,921	240,096	-	$5,993	$17,514	$24,235	$46,758	$120,712	$352,747	$488,118	$941,746	$0	$0	$0	$0
2048	11,603	240,096	-	$5,690	$16,869	$23,417	$45,010	$117,755	$349,077	$484,574	$931,408	$0	$0	$0	$0
2049	11,288	240,096	-	$5,397	$16,234	$22,609	$43,293	$114,807	$345,321	$480,912	$920,873	$0	$0	$0	$0
2050	10,992	240,096	-	$5,121	$15,633	$21,843	$41,667	$111,872	$341,488	$477,141	$910,162	$0	$0	$0	$0
2051	10,696	240,096	-	$4,813	$14,907	$20,905	$39,450	$108,040	$334,643	$469,271	$885,571	$0	$0	$0	$0
2052	10,412	240,096	-	$4,523	$14,236	$20,032	$37,446	$104,304	$328,254	$461,914	$863,450	$0	$0	$0	$0
2053	10,139	240,096	-	$4,251	$13,591	$19,193	$35,550	$100,678	$321,851	$454,520	$841,867	$0	$0	$0	$0
2054	9,868	240,096	-	$3,993	$12,969	$18,386	$33,732	$97,162	$315,544	$447,326	$820,710	$0	$0	$0	$0
2055	9,610	240,096	-	$3,753	$12,382	$17,621	$32,029	$93,752	$309,330	$440,212	$800,167	$0	$0	$0	$0
2056	9,359	240,096	-	$3,530	$11,834	$16,898	$30,431	$90,547	$303,584	$433,506	$780,684	$0	$0	$0	$0
2057	9,117	240,096	-	$3,322	$11,313	$16,214	$28,926	$87,483	$297,910	$426,972	$761,747	$0	$0	$0	$0
2058	8,879	215,086	-	$3,123	$10,809	$15,550	$27,482	$75,662	$261,860	$376,697	$665,751	$0	$0	$0	$0
2059	8,656	172,212	-	$2,939	$10,336	$14,925	$26,138	$58,476	$205,636	$296,936	$520,027	$0	$0	$0	$0
2060	8,433	137,912	-	$2,765	$9,878	$14,318	$24,846	$45,218	$161,549	$234,150	$406,322	$0	$0	$0	$0
2061	8,210	110,044	-	$2,728	$9,758	$14,146	$24,937	$36,570	$130,790	$189,604	$334,236	$0	$0	$0	$0
TOTALS:	431,361	7,177,877	19,226	$238,454	$646,011	$881,901	$1,713,138	$3,732,525	$10,497,693	$14,444,213	$27,789,645	$12,351	$30,856	$41,304	$82,415

Table E.3-24. Scenario 1: "Business as Usual": LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Oil Production and End Use: without Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Oil Production and End Use: without Alaska LNG Export Project	Global Proxy based on US Lower 48 LNG Export and End Use: LCA System Expansion	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2025	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2026	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2027	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2028	-	-	-	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2029	14	27	-	$83	$269	$397	$713	$161	$521	$768	$1,379	$0	$0	$0	$0
2030	14	68	-	$79	$259	$383	$686	$394	$1,290	$1,906	$3,417	$0	$0	$0	$0
2031	13	122	2	$75	$250	$370	$662	$696	$2,303	$3,411	$6,105	$14	$47	$69	$124
2032	13	149	6	$72	$241	$357	$638	$835	$2,790	$4,141	$7,404	$32	$107	$159	$284
2033	12	162	8	$69	$232	$345	$616	$894	$3,016	$4,487	$8,011	$42	$142	$211	$377
2034	12	162	8	$65	$223	$333	$593	$876	$2,988	$4,455	$7,942	$41	$140	$209	$373
2035	12	162	7	$62	$215	$321	$571	$858	$2,958	$4,422	$7,870	$36	$124	$185	$329
2036	11	162	6	$59	$207	$310	$550	$839	$2,928	$4,388	$7,795	$29	$103	$154	$274
2037	11	162	5	$56	$199	$299	$530	$820	$2,897	$4,353	$7,718	$24	$86	$129	$229
2038	11	162	4	$54	$191	$288	$510	$802	$2,866	$4,317	$7,639	$20	$73	$110	$194
2039	11	162	3	$51	$184	$278	$490	$783	$2,834	$4,280	$7,558	$16	$58	$88	$156
2040	10	162	3	$48	$177	$268	$472	$764	$2,801	$4,243	$7,476	$12	$44	$67	$117
2041	10	162	2	$46	$170	$258	$454	$748	$2,771	$4,208	$7,398	$8	$29	$44	$77
2042	10	162	1	$44	$164	$249	$437	$732	$2,741	$4,172	$7,318	$4	$16	$25	$44
2043	9	162	0	$42	$157	$240	$420	$716	$2,710	$4,136	$7,237	$2	$6	$10	$17
2044	9	162	-	$40	$151	$232	$404	$700	$2,679	$4,099	$7,154	$0	$0	$0	$0
2045	9	162	-	$38	$146	$223	$389	$683	$2,647	$4,061	$7,070	$0	$0	$0	$0
2046	9	162	-	$36	$140	$215	$374	$667	$2,615	$4,023	$6,985	$0	$0	$0	$0
2047	8	162	-	$34	$134	$207	$359	$650	$2,582	$3,984	$6,898	$0	$0	$0	$0
2048	8	162	-	$32	$129	$200	$345	$634	$2,549	$3,945	$6,811	$0	$0	$0	$0
2049	8	162	-	$30	$124	$193	$331	$618	$2,516	$3,905	$6,723	$0	$0	$0	$0
2050	8	162	-	$29	$119	$186	$319	$601	$2,482	$3,865	$6,634	$0	$0	$0	$0
2051	8	162	-	$27	$114	$178	$302	$586	$2,442	$3,810	$6,473	$0	$0	$0	$0
2052	7	162	-	$26	$110	$171	$290	$571	$2,408	$3,768	$6,382	$0	$0	$0	$0
2053	7	162	-	$25	$105	$165	$279	$557	$2,375	$3,726	$6,291	$0	$0	$0	$0
2054	7	162	-	$23	$101	$159	$267	$542	$2,341	$3,683	$6,200	$0	$0	$0	$0
2055	7	162	-	$22	$97	$153	$256	$528	$2,307	$3,641	$6,109	$0	$0	$0	$0
2056	7	162	-	$21	$93	$147	$246	$514	$2,274	$3,600	$6,016	$0	$0	$0	$0
2057	6	162	-	$20	$89	$142	$236	$500	$2,242	$3,559	$5,923	$0	$0	$0	$0
2058	6	145	-	$19	$86	$136	$226	$436	$1,979	$3,152	$5,223	$0	$0	$0	$0
2059	6	116	-	$18	$82	$131	$217	$340	$1,561	$2,494	$4,116	$0	$0	$0	$0
2060	6	93	-	$17	$79	$127	$208	$264	$1,232	$1,974	$3,243	$0	$0	$0	$0
2061	6	74	-	$16	$76	$122	$202	$209	$976	$1,566	$2,586	$0	$0	$0	$0
TOTALS:	306	4,851	54	$1,378	$5,113	$7,783	$13,595	$20,516	$78,621	$120,542	$209,107	$281	$975	$1,460	$2,595

Table E.3-25. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,848,543	30,285,078	724,062	$160,431	$567,996	$845,469	$1,714,404	$447,864	$1,585,633	$2,360,233	$4,785,975	$10,708	$37,910	$56,429	$114,424
2030	26,357,675	28,465,374	1,715,711	$380,841	$1,363,387	$2,033,737	$4,121,506	$411,295	$1,472,411	$2,196,365	$4,451,084	$24,790	$88,748	$132,383	$268,283
2031	47,143,607	26,620,673	3,892,356	$668,306	$2,411,394	$3,602,898	$7,303,600	$377,374	$1,361,646	$2,034,456	$4,124,138	$55,178	$199,094	$297,469	$603,013
2032	57,566,137	24,985,939	6,222,733	$799,911	$2,910,730	$4,356,523	$8,832,303	$347,192	$1,263,370	$1,890,900	$3,833,562	$86,468	$314,642	$470,928	$954,746
2033	62,757,744	23,456,188	7,879,418	$854,150	$3,135,835	$4,702,071	$9,532,322	$319,245	$1,172,042	$1,757,435	$3,562,778	$107,241	$393,713	$590,359	$1,196,811
2034	62,757,744	22,026,420	8,564,391	$835,938	$3,097,922	$4,654,258	$9,433,207	$293,394	$1,087,294	$1,633,530	$3,310,823	$114,078	$422,766	$635,155	$1,287,326
2035	62,757,744	20,601,652	8,890,219	$817,560	$3,059,558	$4,605,932	$9,331,824	$268,383	$1,004,369	$1,512,002	$3,063,383	$115,815	$433,415	$652,473	$1,321,940
2036	62,757,744	19,276,867	9,023,488	$799,002	$3,020,800	$4,557,195	$9,228,344	$245,424	$927,878	$1,399,803	$2,834,607	$114,883	$434,339	$655,247	$1,326,878
2037	62,757,744	18,037,069	9,186,140	$780,391	$2,981,704	$4,508,096	$9,122,933	$224,290	$856,965	$1,295,662	$2,622,003	$114,229	$436,446	$659,871	$1,335,366
2038	62,757,744	16,872,258	9,374,763	$761,709	$2,942,323	$4,458,725	$9,015,875	$204,783	$791,036	$1,198,717	$2,423,895	$113,784	$439,525	$666,045	$1,346,793
2039	62,757,744	15,787,434	9,451,104	$743,066	$2,902,707	$4,409,037	$8,907,274	$186,927	$730,209	$1,109,144	$2,240,728	$111,903	$437,138	$663,986	$1,341,405
2040	62,757,744	14,777,598	9,481,011	$724,472	$2,862,902	$4,359,121	$8,797,390	$170,592	$674,129	$1,026,444	$2,071,526	$109,448	$432,508	$658,546	$1,329,050
2041	62,757,744	13,837,751	9,424,345	$707,662	$2,823,030	$4,307,903	$8,674,049	$156,036	$622,463	$949,870	$1,912,582	$106,270	$423,935	$646,919	$1,302,584
2042	62,757,744	12,952,895	9,389,979	$690,809	$2,783,051	$4,256,590	$8,550,392	$142,580	$574,408	$878,540	$1,764,760	$103,361	$416,407	$636,882	$1,279,332
2043	62,757,744	12,128,029	9,373,976	$673,957	$2,743,007	$4,205,179	$8,426,616	$130,243	$530,090	$812,657	$1,628,456	$100,667	$409,716	$628,118	$1,258,664
2044	62,757,744	11,353,155	9,418,049	$657,144	$2,702,934	$4,153,781	$8,302,797	$118,880	$488,973	$751,437	$1,502,013	$98,618	$405,629	$623,358	$1,246,000
2045	62,757,744	10,633,272	9,596,441	$640,403	$2,662,835	$4,102,389	$8,179,042	$108,506	$451,174	$695,083	$1,385,805	$97,926	$407,181	$627,306	$1,250,677
2046	62,757,744	9,963,381	9,743,352	$623,789	$2,622,811	$4,051,033	$8,055,419	$99,032	$416,396	$643,140	$1,278,873	$96,845	$407,200	$628,937	$1,250,631
2047	62,757,744	9,333,483	9,858,782	$607,283	$2,582,860	$3,999,742	$7,932,091	$90,317	$384,129	$594,851	$1,179,680	$95,400	$405,748	$628,330	$1,246,073
2048	62,757,744	8,748,578	9,947,978	$590,936	$2,543,011	$3,948,508	$7,809,114	$82,378	$354,502	$550,431	$1,088,609	$93,672	$403,103	$625,894	$1,237,854
2049	62,757,744	8,188,669	10,016,187	$574,768	$2,503,262	$3,897,428	$7,686,541	$74,996	$326,627	$508,539	$1,002,945	$91,733	$399,523	$622,033	$1,226,778
2050	62,757,744	7,678,752	10,063,409	$558,800	$2,463,701	$3,846,490	$7,564,513	$68,372	$301,447	$470,639	$925,559	$89,605	$395,062	$616,797	$1,212,994
2051	62,757,744	7,198,830	10,079,149	$537,906	$2,401,492	$3,801,937	$7,345,741	$61,702	$275,471	$436,114	$842,617	$86,390	$385,689	$610,607	$1,179,756
2052	62,757,744	6,743,904	10,089,643	$528,300	$2,358,976	$3,740,641	$7,159,217	$56,771	$253,494	$401,967	$769,325	$84,936	$379,256	$601,388	$1,150,996
2053	62,757,744	6,323,972	10,079,149	$518,390	$2,316,899	$3,680,073	$6,977,327	$52,237	$233,469	$370,834	$703,091	$83,256	$372,103	$591,035	$1,120,587
2054	62,757,744	5,934,036	10,042,421	$493,705	$2,275,272	$3,620,235	$6,799,960	$46,682	$215,137	$342,310	$642,968	$79,002	$364,086	$579,306	$1,088,122
2055	62,757,744	5,559,097	10,010,940	$484,024	$2,234,104	$3,561,126	$6,652,107	$42,875	$197,897	$315,445	$589,245	$77,210	$356,378	$568,061	$1,061,126
2056	62,757,744	5,214,153	9,958,472	$460,975	$2,193,404	$3,502,747	$6,507,099	$38,300	$182,236	$291,022	$540,635	$73,148	$348,052	$555,820	$1,032,554
2057	62,757,744	4,894,205	9,895,510	$451,568	$2,153,180	$3,445,097	$6,364,894	$35,216	$167,917	$268,668	$496,371	$71,202	$339,509	$543,216	$1,003,603
2058	56,220,479	4,589,254	9,822,055	$395,968	$1,893,288	$3,035,241	$5,576,968	$32,323	$154,548	$247,765	$455,246	$69,178	$330,769	$530,275	$974,330
2059	45,013,739	4,265,973	9,794,072	$301,940	$1,471,736	$2,408,871	$4,367,218	$28,615	$139,477	$228,290	$413,883	$65,696	$320,220	$524,121	$950,218
2060	36,048,347	3,949,914	9,758,510	$236,513	$1,156,720	$1,896,864	$3,420,408	$25,915	$126,745	$207,844	$374,783	$64,025	$313,131	$513,493	$925,926
2061	28,763,966	3,635,150	9,721,588	$184,463	$915,367	$1,488,180	$2,697,923	$23,312	$115,683	$188,074	$340,960	$62,344	$309,374	$502,972	$911,838
TOTALS:	1,878,723,077	424,319,000	290,489,403	$19,273,191	$79,155,603	$122,187,522	$240,683,425	$5,012,051	$19,439,270	$29,568,210	$59,162,906	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-26. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-27. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-28. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
Year of Emissions	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,896,188	30,285,040	724,062	$161,136	$570,491	$849,182	$1,721,933	$447,863	$1,585,631	$2,360,230	$4,785,969	$10,708	$37,910	$56,429	$114,424
2030	26,476,787	28,465,338	1,715,711	$382,562	$1,369,548	$2,042,927	$4,140,132	$411,295	$1,472,409	$2,196,362	$4,451,078	$24,790	$88,748	$132,383	$268,283
2031	47,358,008	26,620,640	3,892,356	$671,345	$2,422,360	$3,619,284	$7,336,816	$377,373	$1,361,645	$2,034,453	$4,124,133	$55,178	$199,094	$297,469	$603,013
2032	57,828,183	24,985,908	6,222,733	$803,552	$2,923,980	$4,376,355	$8,872,508	$347,192	$1,263,368	$1,890,898	$3,833,558	$86,468	$314,642	$470,928	$954,746
2033	63,043,613	23,456,159	7,879,418	$858,041	$3,150,119	$4,723,489	$9,575,743	$319,245	$1,172,041	$1,757,433	$3,562,774	$107,241	$393,713	$590,359	$1,196,811
2034	63,043,613	22,026,393	8,564,391	$839,746	$3,112,034	$4,675,459	$9,476,176	$293,393	$1,087,293	$1,633,528	$3,310,819	$114,078	$422,766	$635,155	$1,287,326
2035	63,043,613	20,601,626	8,890,219	$821,284	$3,073,494	$4,626,913	$9,374,331	$268,382	$1,004,368	$1,512,000	$3,063,379	$115,815	$433,415	$652,473	$1,321,940
2036	63,043,613	19,276,843	9,023,488	$802,642	$3,034,560	$4,577,954	$9,270,380	$245,424	$927,877	$1,399,801	$2,834,604	$114,883	$434,339	$655,247	$1,326,878
2037	63,043,613	18,037,046	9,186,140	$783,946	$2,995,286	$4,528,631	$9,164,489	$224,290	$856,964	$1,295,661	$2,621,999	$114,229	$436,446	$659,871	$1,335,366
2038	63,043,613	16,872,237	9,374,763	$765,178	$2,955,726	$4,479,035	$9,056,944	$204,783	$791,035	$1,198,715	$2,423,892	$113,784	$439,525	$666,045	$1,346,793
2039	63,043,613	15,787,415	9,451,104	$746,451	$2,915,929	$4,429,121	$8,947,848	$186,927	$730,209	$1,109,143	$2,240,725	$111,903	$437,138	$663,986	$1,341,405
2040	63,043,613	14,777,580	9,481,011	$727,772	$2,875,943	$4,378,977	$8,837,463	$170,592	$674,128	$1,026,443	$2,071,523	$109,448	$432,508	$658,546	$1,329,050
2041	63,043,613	13,837,734	9,424,345	$710,885	$2,835,889	$4,327,526	$8,713,560	$156,036	$622,462	$949,869	$1,912,580	$106,270	$423,935	$646,919	$1,302,584
2042	63,043,613	12,952,879	9,389,979	$693,956	$2,795,728	$4,275,979	$8,589,340	$142,580	$574,408	$878,539	$1,764,757	$103,361	$416,407	$636,882	$1,279,332
2043	63,043,613	12,128,014	9,373,976	$677,027	$2,755,501	$4,224,334	$8,465,000	$130,243	$530,090	$812,656	$1,628,454	$100,667	$409,716	$628,118	$1,258,664
2044	63,043,613	11,353,141	9,418,049	$660,137	$2,715,246	$4,172,702	$8,340,617	$118,880	$488,972	$751,437	$1,502,011	$98,618	$405,629	$623,358	$1,246,000
2045	63,043,613	10,633,259	9,596,441	$643,321	$2,674,964	$4,121,076	$8,216,298	$108,506	$451,173	$695,082	$1,385,803	$97,926	$407,181	$627,306	$1,250,677
2046	63,043,613	9,963,368	9,743,352	$626,630	$2,634,758	$4,069,486	$8,092,112	$99,032	$416,395	$643,139	$1,278,872	$96,845	$407,200	$628,937	$1,250,631
2047	63,043,613	9,333,471	9,858,782	$610,050	$2,594,625	$4,017,961	$7,968,223	$90,317	$384,129	$594,850	$1,179,678	$95,400	$405,748	$628,330	$1,246,073
2048	63,043,613	8,748,567	9,947,978	$593,628	$2,554,595	$3,966,494	$7,844,685	$82,378	$354,501	$550,431	$1,088,608	$93,672	$403,103	$625,894	$1,237,854
2049	63,043,613	8,188,659	10,016,187	$577,386	$2,514,665	$3,915,181	$7,721,554	$74,996	$326,627	$508,538	$1,002,943	$91,733	$399,523	$622,033	$1,226,778
2050	63,043,613	7,678,742	10,063,409	$561,345	$2,474,923	$3,864,011	$7,598,970	$68,372	$301,447	$470,638	$925,558	$89,605	$395,062	$616,797	$1,212,994
2051	63,043,613	7,198,821	10,079,149	$540,356	$2,412,431	$3,819,256	$7,379,202	$61,702	$275,471	$436,113	$842,616	$86,390	$385,689	$610,607	$1,179,756
2052	63,043,613	6,743,896	10,089,643	$530,707	$2,369,721	$3,757,680	$7,191,828	$56,771	$253,494	$401,966	$769,324	$84,936	$379,256	$601,388	$1,150,996
2053	63,043,613	6,323,964	10,079,149	$520,751	$2,327,453	$3,696,836	$7,009,110	$52,237	$233,469	$370,833	$703,090	$83,256	$372,103	$591,035	$1,120,587
2054	63,043,613	5,934,028	10,042,421	$495,954	$2,285,636	$3,636,725	$6,830,934	$46,682	$215,137	$342,310	$642,967	$79,002	$364,086	$579,306	$1,088,122
2055	63,043,613	5,559,090	10,010,940	$486,229	$2,244,280	$3,577,347	$6,682,408	$42,875	$197,897	$315,445	$589,245	$77,210	$356,378	$568,061	$1,061,126
2056	63,043,613	5,214,146	9,958,472	$463,075	$2,203,395	$3,518,702	$6,536,739	$38,300	$182,236	$291,021	$540,634	$73,148	$348,052	$555,820	$1,032,554
2057	63,043,613	4,894,198	9,895,510	$453,625	$2,162,988	$3,460,790	$6,393,887	$35,216	$167,917	$268,668	$496,370	$71,202	$339,509	$543,216	$1,003,603
2058	56,476,570	4,589,248	9,822,055	$397,772	$1,901,912	$3,049,067	$5,602,372	$32,323	$154,548	$247,765	$455,245	$69,178	$330,769	$530,275	$974,330
2059	45,218,782	4,265,968	9,794,072	$303,316	$1,478,440	$2,419,844	$4,387,111	$28,615	$139,477	$228,290	$413,883	$65,696	$320,220	$524,121	$950,218
2060	36,212,551	3,949,909	9,758,510	$237,590	$1,161,989	$1,905,504	$3,435,989	$25,915	$126,745	$207,844	$374,783	$64,025	$313,131	$513,493	$925,926
2061	28,894,989	3,635,145	9,721,588	$185,303	$919,536	$1,494,959	$2,710,212	$23,312	$115,683	$188,074	$340,959	$62,344	$309,374	$502,972	$911,838
TOTALS:	1,887,269,366	424,318,473	290,489,403	$19,360,808	$79,515,554	$122,743,192	$241,777,923	$5,012,045	$19,439,245	$29,568,173	$59,162,832	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-29. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-30. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-31. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,898,408	30,285,039	724,062	$161,169	$570,607	$849,355	$1,722,284	$447,863	$1,585,631	$2,360,230	$4,785,969	$10,708	$37,910	$56,429	$114,424
2030	26,482,338	28,465,337	1,715,711	$382,642	$1,369,835	$2,043,356	$4,141,000	$411,295	$1,472,409	$2,196,362	$4,451,078	$24,790	$88,748	$132,383	$268,283
2031	47,367,999	26,620,639	3,892,356	$671,487	$2,422,871	$3,620,047	$7,338,364	$377,373	$1,361,645	$2,034,453	$4,124,133	$55,178	$199,094	$297,469	$603,013
2032	57,840,394	24,985,907	6,222,733	$803,722	$2,924,598	$4,377,279	$8,874,382	$347,192	$1,263,368	$1,890,898	$3,833,557	$86,468	$314,642	$470,928	$954,746
2033	63,056,933	23,456,157	7,879,418	$858,222	$3,150,785	$4,724,487	$9,577,766	$319,245	$1,172,041	$1,757,433	$3,562,774	$107,241	$393,713	$590,359	$1,196,811
2034	63,056,933	22,026,391	8,564,391	$839,923	$3,112,691	$4,676,447	$9,478,178	$293,393	$1,087,293	$1,633,528	$3,310,819	$114,078	$422,766	$635,155	$1,287,326
2035	63,056,933	20,601,625	8,890,219	$821,458	$3,074,144	$4,627,891	$9,376,312	$268,382	$1,004,368	$1,512,000	$3,063,379	$115,815	$433,415	$652,473	$1,321,940
2036	63,056,933	19,276,842	9,023,488	$802,811	$3,035,201	$4,578,921	$9,272,339	$245,424	$927,877	$1,399,801	$2,834,604	$114,883	$434,339	$655,247	$1,326,878
2037	63,056,933	18,037,045	9,186,140	$784,111	$2,995,919	$4,529,588	$9,166,426	$224,290	$856,964	$1,295,661	$2,621,999	$114,229	$436,446	$659,871	$1,335,366
2038	63,056,933	16,872,236	9,374,763	$765,340	$2,956,351	$4,479,981	$9,058,857	$204,783	$791,035	$1,198,715	$2,423,892	$113,784	$439,525	$666,045	$1,346,793
2039	63,056,933	15,787,414	9,451,104	$746,609	$2,916,545	$4,430,057	$8,949,739	$186,927	$730,208	$1,109,143	$2,240,725	$111,903	$437,138	$663,986	$1,341,405
2040	63,056,933	14,777,579	9,481,011	$727,926	$2,876,551	$4,379,902	$8,839,331	$170,592	$674,128	$1,026,443	$2,071,523	$109,448	$432,508	$658,546	$1,329,050
2041	63,056,933	13,837,733	9,424,345	$711,036	$2,836,488	$4,328,440	$8,715,401	$156,035	$622,462	$949,869	$1,912,579	$106,270	$423,935	$646,919	$1,302,584
2042	63,056,933	12,952,878	9,389,979	$694,103	$2,796,319	$4,276,883	$8,591,155	$142,580	$574,408	$878,538	$1,764,757	$103,361	$416,407	$636,882	$1,279,332
2043	63,056,933	12,128,013	9,373,976	$677,170	$2,756,084	$4,225,226	$8,466,789	$130,243	$530,090	$812,656	$1,628,454	$100,667	$409,716	$628,118	$1,258,664
2044	63,056,933	11,353,140	9,418,049	$660,277	$2,715,820	$4,173,584	$8,342,379	$118,880	$488,972	$751,436	$1,502,011	$98,618	$405,629	$623,358	$1,246,000
2045	63,056,933	10,633,258	9,596,441	$643,456	$2,675,529	$4,121,947	$8,218,034	$108,506	$451,173	$695,082	$1,385,803	$97,926	$407,181	$627,306	$1,250,677
2046	63,056,933	9,963,368	9,743,352	$626,762	$2,635,315	$4,070,346	$8,093,822	$99,032	$416,395	$643,139	$1,278,872	$96,845	$407,200	$628,937	$1,250,631
2047	63,056,933	9,333,471	9,858,782	$610,179	$2,595,174	$4,018,810	$7,969,906	$90,317	$384,129	$594,850	$1,179,678	$95,400	$405,748	$628,330	$1,246,073
2048	63,056,933	8,748,567	9,947,978	$593,753	$2,555,135	$3,967,332	$7,846,343	$82,378	$354,501	$550,431	$1,088,608	$93,672	$403,103	$625,894	$1,237,854
2049	63,056,933	8,188,658	10,016,187	$577,508	$2,515,196	$3,916,008	$7,723,185	$74,996	$326,627	$508,538	$1,002,943	$91,733	$399,523	$622,033	$1,226,778
2050	63,056,933	7,678,742	10,063,409	$561,464	$2,475,446	$3,864,828	$7,600,575	$68,372	$301,447	$470,638	$925,558	$89,605	$395,062	$616,797	$1,212,994
2051	63,056,933	7,198,821	10,079,149	$540,470	$2,412,941	$3,820,063	$7,380,761	$61,702	$275,471	$436,113	$842,616	$86,390	$385,689	$610,607	$1,179,756
2052	63,056,933	6,743,895	10,089,643	$530,819	$2,370,222	$3,758,474	$7,193,348	$56,771	$253,494	$401,966	$769,324	$84,936	$379,256	$601,388	$1,150,996
2053	63,056,933	6,323,964	10,079,149	$520,861	$2,327,944	$3,697,618	$7,010,591	$52,237	$233,469	$370,833	$703,090	$83,256	$372,103	$591,035	$1,120,587
2054	63,056,933	5,934,028	10,042,421	$496,058	$2,286,119	$3,637,494	$6,832,378	$46,682	$215,137	$342,310	$642,967	$79,002	$364,086	$579,306	$1,088,122
2055	63,056,933	5,559,089	10,010,940	$486,332	$2,244,755	$3,578,103	$6,683,820	$42,875	$197,897	$315,445	$589,245	$77,210	$356,378	$568,061	$1,061,126
2056	63,056,933	5,214,146	9,958,472	$463,173	$2,203,861	$3,519,446	$6,538,120	$38,300	$182,236	$291,021	$540,634	$73,148	$348,052	$555,820	$1,032,554
2057	63,056,933	4,894,198	9,895,510	$453,721	$2,163,445	$3,461,521	$6,395,238	$35,216	$167,917	$268,668	$496,370	$71,202	$339,509	$543,216	$1,003,603
2058	56,488,503	4,589,248	9,822,055	$397,856	$1,902,314	$3,049,711	$5,603,556	$32,323	$154,548	$247,765	$455,245	$69,178	$330,769	$530,275	$974,330
2059	45,228,336	4,265,968	9,794,072	$303,380	$1,478,753	$2,420,355	$4,388,038	$28,615	$139,477	$228,290	$413,883	$65,696	$320,220	$524,121	$950,218
2060	36,220,203	3,949,908	9,758,510	$237,640	$1,162,234	$1,905,907	$3,436,715	$25,915	$126,745	$207,844	$374,783	$64,025	$313,131	$513,493	$925,926
2061	28,901,094	3,635,145	9,721,588	$185,342	$919,730	$1,495,275	$2,710,785	$23,312	$115,683	$188,074	$340,959	$62,344	$309,374	$502,972	$911,838
TOTALS:	1,887,667,604	424,318,448	290,489,403	$19,364,890	$79,532,327	$122,769,085	$241,828,925	$5,012,045	$19,439,244	$29,568,171	$59,162,829	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-32. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-33. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-34. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	11,145,805	30,284,844	724,062	$164,827	$583,560	$868,636	$1,761,380	$447,861	$1,585,621	$2,360,215	$4,785,938	$10,708	$37,910	$56,429	$114,424
2030	27,100,831	28,465,154	1,715,711	$391,579	$1,401,828	$2,091,078	$4,237,713	$411,292	$1,472,399	$2,196,348	$4,451,049	$24,790	$88,748	$132,383	$268,283
2031	48,481,288	26,620,468	3,892,356	$687,269	$2,479,816	$3,705,129	$7,510,837	$377,371	$1,361,636	$2,034,440	$4,124,106	$55,178	$199,094	$297,469	$603,013
2032	59,201,080	24,985,746	6,222,733	$822,629	$2,993,398	$4,480,254	$9,083,150	$347,190	$1,263,360	$1,890,886	$3,833,533	$86,468	$314,642	$470,928	$954,746
2033	64,541,318	23,456,006	7,879,418	$878,425	$3,224,956	$4,835,704	$9,803,230	$319,243	$1,172,033	$1,757,421	$3,562,751	$107,241	$393,713	$590,359	$1,196,811
2034	64,541,318	22,026,250	8,564,391	$859,695	$3,185,965	$4,786,532	$9,701,298	$293,391	$1,087,286	$1,633,517	$3,310,797	$114,078	$422,766	$635,155	$1,287,326
2035	64,541,318	20,601,492	8,890,219	$840,795	$3,146,510	$4,736,833	$9,597,034	$268,381	$1,004,361	$1,511,990	$3,063,359	$115,815	$433,415	$652,473	$1,321,940
2036	64,541,318	19,276,718	9,023,488	$821,710	$3,106,651	$4,686,711	$9,490,614	$245,422	$927,871	$1,399,792	$2,834,585	$114,883	$434,339	$655,247	$1,326,878
2037	64,541,318	18,036,929	9,186,140	$802,570	$3,066,444	$4,636,216	$9,382,207	$224,289	$856,959	$1,295,652	$2,621,982	$114,229	$436,446	$659,871	$1,335,366
2038	64,541,318	16,872,127	9,374,763	$783,357	$3,025,944	$4,585,442	$9,272,107	$204,782	$791,030	$1,198,707	$2,423,876	$113,784	$439,525	$666,045	$1,346,793
2039	64,541,318	15,787,312	9,451,104	$764,184	$2,985,202	$4,534,342	$9,160,419	$186,925	$730,204	$1,109,136	$2,240,710	$111,903	$437,138	$663,986	$1,341,405
2040	64,541,318	14,777,484	9,481,011	$745,062	$2,944,266	$4,483,007	$9,047,412	$170,591	$674,124	$1,026,436	$2,071,510	$109,448	$432,508	$658,546	$1,329,050
2041	64,541,318	13,837,644	9,424,345	$727,774	$2,903,260	$4,430,333	$8,920,565	$156,034	$622,458	$949,862	$1,912,567	$106,270	$423,935	$646,919	$1,302,584
2042	64,541,318	12,952,795	9,389,979	$710,442	$2,862,146	$4,377,562	$8,793,394	$142,579	$574,404	$878,533	$1,764,746	$103,361	$416,407	$636,882	$1,279,332
2043	64,541,318	12,127,935	9,373,976	$693,111	$2,820,963	$4,324,690	$8,666,101	$130,242	$530,086	$812,651	$1,628,444	$100,667	$409,716	$628,118	$1,258,664
2044	64,541,318	11,353,067	9,418,049	$675,820	$2,779,751	$4,271,831	$8,538,762	$118,879	$488,969	$751,432	$1,502,001	$98,618	$405,629	$623,358	$1,246,000
2045	64,541,318	10,633,190	9,596,441	$658,604	$2,738,512	$4,218,979	$8,411,490	$108,505	$451,170	$695,077	$1,385,794	$97,926	$407,181	$627,306	$1,250,677
2046	64,541,318	9,963,304	9,743,352	$641,517	$2,697,351	$4,166,163	$8,284,354	$99,032	$416,393	$643,135	$1,278,863	$96,845	$407,200	$628,937	$1,250,631
2047	64,541,318	9,333,411	9,858,782	$624,542	$2,656,265	$4,113,414	$8,157,521	$90,316	$384,126	$594,847	$1,179,671	$95,400	$405,748	$628,330	$1,246,073
2048	64,541,318	8,748,510	9,947,978	$607,730	$2,615,284	$4,060,724	$8,031,049	$82,377	$354,499	$550,427	$1,088,601	$93,672	$403,103	$625,894	$1,237,854
2049	64,541,318	8,188,606	10,016,187	$591,103	$2,574,405	$4,008,192	$7,904,992	$74,996	$326,625	$508,535	$1,002,937	$91,733	$399,523	$622,033	$1,226,778
2050	64,541,318	7,678,693	10,063,409	$574,681	$2,533,719	$3,955,807	$7,779,496	$68,372	$301,445	$470,635	$925,552	$89,605	$395,062	$616,797	$1,212,994
2051	64,541,318	7,198,774	10,079,149	$553,193	$2,469,743	$3,909,988	$7,554,507	$61,702	$275,469	$436,110	$842,610	$86,390	$385,689	$610,607	$1,179,756
2052	64,541,318	6,743,852	10,089,643	$543,315	$2,426,018	$3,846,950	$7,362,682	$56,770	$253,492	$401,964	$769,319	$84,936	$379,256	$601,388	$1,150,996
2053	64,541,318	6,323,923	10,079,149	$533,123	$2,382,745	$3,784,661	$7,175,623	$52,237	$233,467	$370,831	$703,086	$83,256	$372,103	$591,035	$1,120,587
2054	64,541,318	5,933,990	10,042,421	$507,736	$2,339,935	$3,723,122	$6,993,214	$46,682	$215,136	$342,307	$642,963	$79,002	$364,086	$579,306	$1,088,122
2055	64,541,318	5,559,054	10,010,940	$497,780	$2,297,597	$3,662,333	$6,841,160	$42,875	$197,896	$315,443	$589,241	$77,210	$356,378	$568,061	$1,061,126
2056	64,541,318	5,214,112	9,958,472	$474,076	$2,255,741	$3,602,295	$6,692,030	$38,299	$182,235	$291,019	$540,630	$73,148	$348,052	$555,820	$1,032,554
2057	64,541,318	4,894,167	9,895,510	$464,401	$2,214,373	$3,543,007	$6,545,784	$35,216	$167,916	$268,666	$496,367	$71,202	$339,509	$543,216	$1,003,603
2058	57,818,264	4,589,219	9,822,055	$407,221	$1,947,095	$3,121,502	$5,735,466	$32,322	$154,547	$247,764	$455,242	$69,178	$330,769	$530,275	$974,330
2059	46,293,029	4,265,940	9,794,072	$310,522	$1,513,563	$2,477,331	$4,491,334	$28,615	$139,476	$228,288	$413,880	$65,696	$320,220	$524,121	$950,218
2060	37,072,841	3,949,883	9,758,510	$243,234	$1,189,594	$1,950,773	$3,517,616	$25,915	$126,744	$207,843	$374,780	$64,025	$313,131	$513,493	$925,926
2061	29,581,438	3,635,122	9,721,588	$189,705	$941,381	$1,530,474	$2,774,598	$23,312	$115,682	$188,073	$340,957	$62,344	$309,374	$502,972	$911,838
TOTALS:	1,932,044,529	424,315,719	290,489,403	$19,819,842	$81,401,387	$125,654,422	$247,512,148	$5,012,013	$19,439,119	$29,567,981	$59,162,448	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-35. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-36. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-37. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
				5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,628,617	30,285,807	724,062	$53,661	$189,983	$282,792	$573,433	$447,875	$1,585,671	$2,360,290	$4,786,090	$10,708	$37,910	$56,429	$114,424
2030	8,307,861	28,466,059	1,715,711	$120,040	$429,736	$641,028	$1,299,087	$411,305	$1,472,446	$2,196,418	$4,451,191	$24,790	$88,748	$132,383	$268,283
2031	14,653,940	26,621,314	3,892,356	$207,734	$749,548	$1,119,911	$2,270,223	$377,383	$1,361,679	$2,034,505	$4,124,238	$55,178	$199,094	$297,469	$603,013
2032	17,856,545	24,986,540	6,222,733	$248,126	$902,885	$1,351,358	$2,739,708	$347,201	$1,263,400	$1,890,946	$3,833,655	$86,468	$314,642	$470,928	$954,746
2033	19,438,189	23,456,752	7,879,418	$264,559	$971,274	$1,456,390	$2,952,481	$319,253	$1,172,071	$1,757,477	$3,562,864	$107,241	$393,713	$590,359	$1,196,811
2034	19,438,189	22,026,950	8,564,391	$258,918	$959,531	$1,441,581	$2,921,782	$293,401	$1,087,321	$1,633,569	$3,310,902	$114,078	$422,766	$635,155	$1,287,326
2035	19,438,189	20,602,147	8,890,219	$253,226	$947,648	$1,426,613	$2,890,380	$268,389	$1,004,393	$1,512,038	$3,063,456	$115,815	$433,415	$652,473	$1,321,940
2036	19,438,189	19,277,331	9,023,488	$247,478	$935,644	$1,411,517	$2,858,329	$245,430	$927,901	$1,399,836	$2,834,676	$114,883	$434,339	$655,247	$1,326,878
2037	19,438,189	18,037,503	9,186,140	$241,713	$923,534	$1,396,309	$2,825,680	$224,296	$856,986	$1,295,693	$2,622,066	$114,229	$436,446	$659,871	$1,335,366
2038	19,438,189	16,872,664	9,374,763	$235,927	$911,337	$1,381,017	$2,792,521	$204,788	$791,055	$1,198,746	$2,423,953	$113,784	$439,525	$666,045	$1,346,793
2039	19,438,189	15,787,814	9,451,104	$230,153	$899,066	$1,365,627	$2,758,883	$186,931	$730,227	$1,109,171	$2,240,782	$111,903	$437,138	$663,986	$1,341,405
2040	19,438,189	14,777,954	9,481,011	$224,394	$886,737	$1,350,167	$2,724,848	$170,596	$674,145	$1,026,469	$2,071,576	$109,448	$432,508	$658,546	$1,329,050
2041	19,438,189	13,838,084	9,424,345	$219,187	$874,388	$1,334,303	$2,686,645	$156,039	$622,478	$949,893	$1,912,628	$106,270	$423,935	$646,919	$1,302,584
2042	19,438,189	12,953,206	9,389,979	$213,967	$862,005	$1,318,409	$2,648,345	$142,583	$574,422	$878,561	$1,764,802	$103,361	$416,407	$636,882	$1,279,332
2043	19,438,189	12,128,321	9,373,976	$208,747	$849,602	$1,302,486	$2,610,007	$130,246	$530,103	$812,677	$1,628,496	$100,667	$409,716	$628,118	$1,258,664
2044	19,438,189	11,353,428	9,418,049	$203,540	$837,190	$1,286,566	$2,571,656	$118,883	$488,985	$751,456	$1,502,049	$98,618	$405,629	$623,358	$1,246,000
2045	19,438,189	10,633,528	9,596,441	$198,355	$824,770	$1,270,648	$2,533,325	$108,508	$451,185	$695,099	$1,385,838	$97,926	$407,181	$627,306	$1,250,677
2046	19,438,189	9,963,620	9,743,352	$193,208	$812,373	$1,254,741	$2,495,035	$99,035	$416,406	$643,155	$1,278,904	$96,845	$407,200	$628,937	$1,250,631
2047	19,438,189	9,333,708	9,858,782	$188,096	$799,999	$1,238,855	$2,456,836	$90,319	$384,138	$594,866	$1,179,708	$95,400	$405,748	$628,330	$1,246,073
2048	19,438,189	8,748,789	9,947,978	$183,033	$787,656	$1,222,986	$2,418,746	$82,380	$354,510	$550,445	$1,088,635	$93,672	$403,103	$625,894	$1,237,854
2049	19,438,189	8,188,866	10,016,187	$178,025	$775,345	$1,207,165	$2,380,781	$74,998	$326,635	$508,551	$1,002,969	$91,733	$399,523	$622,033	$1,226,778
2050	19,438,189	7,678,937	10,063,409	$173,079	$763,091	$1,191,388	$2,342,985	$68,374	$301,455	$470,650	$925,582	$89,605	$395,062	$616,797	$1,212,994
2051	19,438,189	7,199,003	10,079,149	$166,608	$743,823	$1,177,588	$2,275,224	$61,704	$275,478	$436,124	$842,637	$86,390	$385,689	$610,607	$1,179,756
2052	19,438,189	6,744,066	10,089,643	$163,632	$730,654	$1,158,603	$2,217,451	$56,772	$253,500	$401,976	$769,343	$84,936	$379,256	$601,388	$1,150,996
2053	19,438,189	6,324,124	10,079,149	$160,563	$717,622	$1,139,843	$2,161,113	$52,238	$233,475	$370,843	$703,108	$83,256	$372,103	$591,035	$1,120,587
2054	19,438,189	5,934,178	10,042,421	$152,917	$704,728	$1,121,309	$2,106,177	$46,683	$215,143	$342,318	$642,983	$79,002	$364,086	$579,306	$1,088,122
2055	19,438,189	5,559,230	10,010,940	$149,919	$691,977	$1,103,001	$2,060,382	$42,876	$197,902	$315,453	$589,259	$77,210	$356,378	$568,061	$1,061,126
2056	19,438,189	5,214,278	9,958,472	$142,780	$679,371	$1,084,919	$2,015,468	$38,301	$182,241	$291,029	$540,648	$73,148	$348,052	$555,820	$1,032,554
2057	19,438,189	4,894,322	9,895,510	$139,866	$666,912	$1,067,063	$1,971,422	$35,217	$167,921	$268,675	$496,382	$71,202	$339,509	$543,216	$1,003,603
2058	17,413,377	4,589,365	9,822,055	$122,645	$586,415	$940,116	$1,727,375	$32,323	$154,552	$247,771	$455,257	$69,178	$330,769	$530,275	$974,330
2059	13,942,272	4,266,076	9,794,072	$93,521	$455,846	$746,109	$1,352,675	$28,616	$139,481	$228,295	$413,893	$65,696	$320,220	$524,121	$950,218
2060	11,165,388	3,950,009	9,758,510	$73,256	$358,275	$587,523	$1,059,416	$25,916	$126,748	$207,849	$374,792	$64,025	$313,131	$513,493	$925,926
2061	8,909,170	3,635,237	9,721,588	$57,134	$283,520	$460,939	$835,638	$23,313	$115,686	$188,079	$340,968	$62,344	$309,374	$502,972	$911,838
TOTALS:	583,648,878	424,329,210	290,489,403	$5,996,113	$24,609,889	$37,983,273	$74,827,063	$5,012,172	$19,439,737	$29,568,921	$59,164,329	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-38. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-39. Scenario 2: Reduced Gas Injection: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-40. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
				5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,690,239	30,285,767	724,062	$54,572	$193,209	$287,595	$583,171	$447,874	$1,585,669	$2,360,287	$4,786,084	$10,708	$37,910	$56,429	$114,424
2030	8,461,914	28,466,022	1,715,711	$122,266	$437,704	$652,914	$1,323,176	$411,305	$1,472,444	$2,196,415	$4,451,185	$24,790	$88,748	$132,383	$268,283
2031	14,931,236	26,621,280	3,892,356	$211,665	$763,732	$1,141,103	$2,313,183	$377,382	$1,361,677	$2,034,502	$4,124,232	$55,178	$199,094	$297,469	$603,013
2032	18,195,462	24,986,508	6,222,733	$252,835	$920,022	$1,377,007	$2,791,708	$347,200	$1,263,399	$1,890,943	$3,833,650	$86,468	$314,642	$470,928	$954,746
2033	19,807,917	23,456,722	7,879,418	$269,591	$989,748	$1,484,091	$3,008,640	$319,252	$1,172,069	$1,757,475	$3,562,859	$107,241	$393,713	$590,359	$1,196,811
2034	19,807,917	22,026,922	8,564,391	$263,843	$977,782	$1,469,000	$2,977,356	$293,400	$1,087,319	$1,633,567	$3,310,898	$114,078	$422,766	$635,155	$1,287,326
2035	19,807,917	20,602,121	8,890,219	$258,042	$965,673	$1,453,748	$2,945,357	$268,389	$1,004,392	$1,512,036	$3,063,452	$115,815	$433,415	$652,473	$1,321,940
2036	19,807,917	19,277,306	9,023,488	$252,185	$953,440	$1,438,365	$2,912,697	$245,430	$927,900	$1,399,834	$2,834,672	$114,883	$434,339	$655,247	$1,326,878
2037	19,807,917	18,037,479	9,186,140	$246,311	$941,101	$1,422,868	$2,879,426	$224,296	$856,985	$1,295,692	$2,622,062	$114,229	$436,446	$659,871	$1,335,366
2038	19,807,917	16,872,642	9,374,763	$240,414	$928,671	$1,407,285	$2,845,636	$204,788	$791,054	$1,198,744	$2,423,950	$113,784	$439,525	$666,045	$1,346,793
2039	19,807,917	15,787,794	9,451,104	$234,530	$916,167	$1,391,603	$2,811,359	$186,931	$730,226	$1,109,169	$2,240,779	$111,903	$437,138	$663,986	$1,341,405
2040	19,807,917	14,777,935	9,481,011	$228,662	$903,604	$1,375,848	$2,776,677	$170,596	$674,144	$1,026,468	$2,071,573	$109,448	$432,508	$658,546	$1,329,050
2041	19,807,917	13,838,066	9,424,345	$223,356	$891,019	$1,359,682	$2,737,747	$156,039	$622,477	$949,891	$1,912,625	$106,270	$423,935	$646,919	$1,302,584
2042	19,807,917	12,953,190	9,389,979	$218,037	$878,401	$1,343,487	$2,698,718	$142,583	$574,421	$878,560	$1,764,800	$103,361	$416,407	$636,882	$1,279,332
2043	19,807,917	12,128,305	9,373,976	$212,718	$865,762	$1,327,260	$2,659,651	$130,246	$530,102	$812,676	$1,628,493	$100,667	$409,716	$628,118	$1,258,664
2044	19,807,917	11,353,413	9,418,049	$207,411	$853,114	$1,311,037	$2,620,571	$118,883	$488,984	$751,455	$1,502,047	$98,618	$405,629	$623,358	$1,246,000
2045	19,807,917	10,633,514	9,596,441	$202,127	$840,457	$1,294,817	$2,581,511	$108,508	$451,184	$695,098	$1,385,836	$97,926	$407,181	$627,306	$1,250,677
2046	19,807,917	9,963,608	9,743,352	$196,883	$827,825	$1,278,608	$2,542,492	$99,035	$416,405	$643,154	$1,278,902	$96,845	$407,200	$628,937	$1,250,631
2047	19,807,917	9,333,696	9,858,782	$191,674	$815,215	$1,262,419	$2,503,567	$90,319	$384,138	$594,865	$1,179,707	$95,400	$405,748	$628,330	$1,246,073
2048	19,807,917	8,748,777	9,947,978	$186,514	$802,638	$1,246,248	$2,464,752	$82,380	$354,510	$550,444	$1,088,634	$93,672	$403,103	$625,894	$1,237,854
2049	19,807,917	8,188,856	10,016,187	$181,411	$790,092	$1,230,126	$2,426,065	$74,998	$326,635	$508,550	$1,002,967	$91,733	$399,523	$622,033	$1,226,778
2050	19,807,917	7,678,927	10,063,409	$176,371	$777,606	$1,214,049	$2,387,550	$68,374	$301,454	$470,650	$925,580	$89,605	$395,062	$616,797	$1,212,994
2051	19,807,917	7,198,994	10,079,149	$169,777	$757,971	$1,199,987	$2,318,500	$61,704	$275,477	$436,123	$842,636	$86,390	$385,689	$610,607	$1,179,756
2052	19,807,917	6,744,057	10,089,643	$166,745	$744,552	$1,180,640	$2,259,628	$56,772	$253,500	$401,976	$769,342	$84,936	$379,256	$601,388	$1,150,996
2053	19,807,917	6,324,116	10,079,149	$163,617	$731,271	$1,161,523	$2,202,219	$52,238	$233,475	$370,842	$703,107	$83,256	$372,103	$591,035	$1,120,587
2054	19,807,917	5,934,171	10,042,421	$155,826	$718,133	$1,142,637	$2,146,238	$46,683	$215,142	$342,318	$642,982	$79,002	$364,086	$579,306	$1,088,122
2055	19,807,917	5,559,223	10,010,940	$152,770	$705,139	$1,123,981	$2,099,572	$42,876	$197,902	$315,453	$589,259	$77,210	$356,378	$568,061	$1,061,126
2056	19,807,917	5,214,271	9,958,472	$145,495	$692,293	$1,105,555	$2,053,803	$38,300	$182,241	$291,028	$540,647	$73,148	$348,052	$555,820	$1,032,554
2057	19,807,917	4,894,316	9,895,510	$142,526	$679,598	$1,087,359	$2,008,920	$35,217	$167,921	$268,674	$496,382	$71,202	$339,509	$543,216	$1,003,603
2058	17,744,592	4,589,359	9,822,055	$124,977	$597,569	$957,998	$1,760,231	$32,323	$154,552	$247,771	$455,256	$69,178	$330,769	$530,275	$974,330
2059	14,207,464	4,266,070	9,794,072	$95,300	$464,517	$760,300	$1,378,403	$28,616	$139,480	$228,295	$413,893	$65,696	$320,220	$524,121	$950,218
2060	11,377,762	3,950,004	9,758,510	$74,649	$365,090	$598,698	$1,079,567	$25,916	$126,748	$207,849	$374,792	$64,025	$313,131	$513,493	$925,926
2061	9,078,628	3,635,233	9,721,588	$58,221	$288,913	$469,707	$851,532	$23,313	$115,685	$188,078	$340,967	$62,344	$309,374	$502,972	$911,838
TOTALS:	594,702,207	424,328,661	290,489,403	$6,109,432	$25,075,431	$38,701,948	$76,242,630	$5,012,165	$19,439,712	$29,568,883	$59,164,253	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-41. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-42. Scenario 2: Reduced Gas Injection: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	N_2O Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	N_2O Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-43. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,693,110	30,285,766	724,062	$54,615	$193,360	$287,818	$583,625	$447,874	$1,585,669	$2,360,286	$4,786,084	$10,708	$37,910	$56,429	$114,424
2030	8,469,094	28,466,020	1,715,711	$122,370	$438,076	$653,468	$1,324,298	$411,305	$1,472,444	$2,196,415	$4,451,185	$24,790	$88,748	$132,383	$268,283
2031	14,944,160	26,621,278	3,892,356	$211,848	$764,393	$1,142,091	$2,315,185	$377,382	$1,361,677	$2,034,502	$4,124,232	$55,178	$199,094	$297,469	$603,013
2032	18,211,258	24,986,507	6,222,733	$253,055	$920,820	$1,378,202	$2,794,131	$347,200	$1,263,399	$1,890,943	$3,833,649	$86,468	$314,642	$470,928	$954,746
2033	19,825,148	23,456,721	7,879,418	$269,826	$990,609	$1,485,382	$3,011,257	$319,252	$1,172,069	$1,757,475	$3,562,859	$107,241	$393,713	$590,359	$1,196,811
2034	19,825,148	22,026,921	8,564,391	$264,072	$978,633	$1,470,278	$2,979,947	$293,400	$1,087,319	$1,633,567	$3,310,898	$114,078	$422,766	$635,155	$1,287,326
2035	19,825,148	20,602,120	8,890,219	$258,267	$966,513	$1,455,012	$2,947,920	$268,389	$1,004,392	$1,512,036	$3,063,452	$115,815	$433,415	$652,473	$1,321,940
2036	19,825,148	19,277,305	9,023,488	$252,404	$954,270	$1,439,616	$2,915,231	$245,430	$927,900	$1,399,834	$2,834,672	$114,883	$434,339	$655,247	$1,326,878
2037	19,825,148	18,037,478	9,186,140	$246,525	$941,919	$1,424,106	$2,881,931	$224,296	$856,985	$1,295,692	$2,622,062	$114,229	$436,446	$659,871	$1,335,366
2038	19,825,148	16,872,641	9,374,763	$240,624	$929,479	$1,408,510	$2,848,112	$204,788	$791,054	$1,198,744	$2,423,950	$113,784	$439,525	$666,045	$1,346,793
2039	19,825,148	15,787,793	9,451,104	$234,734	$916,964	$1,392,813	$2,813,805	$186,931	$730,226	$1,109,169	$2,240,778	$111,903	$437,138	$663,986	$1,341,405
2040	19,825,148	14,777,934	9,481,011	$228,861	$904,390	$1,377,045	$2,779,092	$170,596	$674,144	$1,026,468	$2,071,573	$109,448	$432,508	$658,546	$1,329,050
2041	19,825,148	13,838,065	9,424,345	$223,550	$891,794	$1,360,865	$2,740,129	$156,039	$622,477	$949,891	$1,912,625	$106,270	$423,935	$646,919	$1,302,584
2042	19,825,148	12,953,189	9,389,979	$218,226	$879,165	$1,344,655	$2,701,066	$142,583	$574,421	$878,560	$1,764,800	$103,361	$416,407	$636,882	$1,279,332
2043	19,825,148	12,128,304	9,373,976	$212,903	$866,515	$1,328,414	$2,661,965	$130,246	$530,102	$812,676	$1,628,493	$100,667	$409,716	$628,118	$1,258,664
2044	19,825,148	11,353,413	9,418,049	$207,592	$853,856	$1,312,178	$2,622,850	$118,883	$488,984	$751,455	$1,502,047	$98,618	$405,629	$623,358	$1,246,000
2045	19,825,148	10,633,513	9,596,441	$202,303	$841,189	$1,295,943	$2,583,756	$108,508	$451,184	$695,098	$1,385,836	$97,926	$407,181	$627,306	$1,250,677
2046	19,825,148	9,963,607	9,743,352	$197,055	$828,545	$1,279,720	$2,544,704	$99,035	$416,405	$643,154	$1,278,902	$96,845	$407,200	$628,937	$1,250,631
2047	19,825,148	9,333,695	9,858,782	$191,841	$815,925	$1,263,517	$2,505,745	$90,319	$384,138	$594,865	$1,179,707	$95,400	$405,748	$628,330	$1,246,073
2048	19,825,148	8,748,777	9,947,978	$186,676	$803,336	$1,247,332	$2,466,896	$82,380	$354,510	$550,444	$1,088,634	$93,672	$403,103	$625,894	$1,237,854
2049	19,825,148	8,188,855	10,016,187	$181,569	$790,780	$1,231,196	$2,428,175	$74,998	$326,635	$508,550	$1,002,967	$91,733	$399,523	$622,033	$1,226,778
2050	19,825,148	7,678,926	10,063,409	$176,525	$778,282	$1,215,105	$2,389,627	$68,374	$301,454	$470,650	$925,580	$89,605	$395,062	$616,797	$1,212,994
2051	19,825,148	7,198,994	10,079,149	$169,924	$758,631	$1,201,031	$2,320,517	$61,704	$275,477	$436,123	$842,636	$86,390	$385,689	$610,607	$1,179,756
2052	19,825,148	6,744,057	10,089,643	$166,890	$745,200	$1,181,667	$2,261,594	$56,772	$253,500	$401,976	$769,342	$84,936	$379,256	$601,388	$1,150,996
2053	19,825,148	6,324,116	10,079,149	$163,759	$731,907	$1,162,534	$2,204,135	$52,238	$233,475	$370,842	$703,107	$83,256	$372,103	$591,035	$1,120,587
2054	19,825,148	5,934,170	10,042,421	$155,961	$718,757	$1,143,631	$2,148,105	$46,683	$215,142	$342,318	$642,982	$79,002	$364,086	$579,306	$1,088,122
2055	19,825,148	5,559,223	10,010,940	$152,903	$705,753	$1,124,958	$2,101,398	$42,876	$197,902	$315,453	$589,259	$77,210	$356,378	$568,061	$1,061,126
2056	19,825,148	5,214,271	9,958,472	$145,622	$692,896	$1,106,516	$2,055,590	$38,300	$182,241	$291,028	$540,647	$73,148	$348,052	$555,820	$1,032,554
2057	19,825,148	4,894,316	9,895,510	$142,650	$680,189	$1,088,305	$2,010,668	$35,217	$167,921	$268,674	$496,382	$71,202	$339,509	$543,216	$1,003,603
2058	17,760,029	4,589,358	9,822,055	$125,086	$598,089	$958,831	$1,761,762	$32,323	$154,552	$247,771	$455,256	$69,178	$330,769	$530,275	$974,330
2059	14,219,824	4,266,070	9,794,072	$95,383	$464,921	$760,961	$1,379,603	$28,616	$139,480	$228,295	$413,893	$65,696	$320,220	$524,121	$950,218
2060	11,387,660	3,950,003	9,758,510	$74,714	$365,407	$599,219	$1,080,506	$25,916	$126,748	$207,849	$374,792	$64,025	$313,131	$513,493	$925,926
2061	9,086,526	3,635,233	9,721,588	$58,272	$289,164	$470,116	$852,273	$23,313	$115,685	$188,078	$340,967	$62,344	$309,374	$502,972	$911,838
TOTALS:	595,217,362	424,328,639	290,489,403	$6,114,713	$25,097,128	$38,735,443	$76,308,605	$5,012,165	$19,439,711	$29,568,881	$59,164,250	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-44. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,619	20,081	566	$21,136	$48,737	$64,196	$129,335	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	73,735	18,875	1,340	$51,609	$120,690	$159,437	$320,519	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	132,383	17,651	3,040	$91,481	$216,336	$286,386	$575,248	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	161,797	16,568	4,860	$110,248	$263,776	$349,967	$702,228	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	176,502	15,553	6,154	$118,452	$286,859	$381,493	$764,540	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	176,502	14,605	6,690	$116,536	$285,776	$380,998	$762,468	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	176,502	13,660	6,944	$114,534	$284,513	$380,301	$759,868	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	176,502	12,782	7,048	$112,459	$283,082	$379,411	$756,773	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	176,502	11,960	7,175	$110,321	$281,492	$378,338	$753,213	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	176,502	11,188	7,322	$108,133	$279,755	$377,092	$749,218	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	176,502	10,468	7,382	$105,902	$277,880	$375,682	$744,818	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	176,502	9,799	7,405	$103,639	$275,877	$374,116	$740,038	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	176,502	9,175	7,361	$101,591	$273,812	$372,297	$733,936	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	176,502	8,589	7,334	$99,504	$271,634	$370,345	$727,562	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	176,502	8,042	7,322	$97,385	$269,350	$368,266	$720,936	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	176,502	7,528	7,356	$95,242	$266,969	$366,068	$714,079	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	176,502	7,051	7,496	$93,083	$264,498	$363,759	$707,010	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	176,502	6,606	7,610	$90,913	$261,945	$361,344	$699,747	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	176,502	6,189	7,701	$88,739	$259,316	$358,831	$692,307	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	176,502	5,801	7,770	$86,566	$256,618	$356,226	$684,707	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	176,502	5,430	7,823	$84,398	$253,857	$353,534	$676,963	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	176,502	5,092	7,860	$82,241	$251,039	$350,761	$669,089	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	176,502	4,773	7,873	$79,423	$246,006	$344,976	$651,011	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	176,502	4,472	7,881	$76,677	$241,310	$339,568	$634,749	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	176,502	4,193	7,873	$74,012	$236,603	$334,132	$618,883	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	176,502	3,935	7,844	$71,427	$231,966	$328,843	$603,330	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	176,502	3,686	7,819	$68,920	$227,398	$323,614	$588,228	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	176,502	3,457	7,778	$66,564	$223,174	$318,684	$573,905	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	176,502	3,245	7,729	$64,312	$219,003	$313,881	$559,985	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	158,117	3,043	7,672	$55,622	$192,502	$276,922	$489,415	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	126,598	2,829	7,650	$42,987	$151,170	$218,287	$382,288	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	101,384	2,619	7,622	$33,241	$118,759	$172,131	$298,700	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	80,897	2,410	7,593	$26,884	$96,148	$139,384	$245,707	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,277,871	281,355	226,896	$2,744,766	$7,719,150	$10,620,975	$20,434,254	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-45. Scenario 2: Reduced Gas Injection: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	N_2O Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	N_2O Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	14	2	$93	$302	$445	$799	$84	$272	$401	$720	$9	$30	$45	$81
2030	25	13	4	$145	$476	$703	$1,260	$77	$253	$374	$670	$22	$72	$106	$189
2031	41	12	9	$235	$777	$1,151	$2,061	$71	$235	$348	$622	$49	$161	$238	$427
2032	49	12	14	$275	$918	$1,363	$2,437	$65	$218	$324	$579	$76	$255	$379	$677
2033	53	11	17	$290	$978	$1,455	$2,597	$60	$203	$302	$539	$95	$320	$476	$850
2034	53	10	19	$284	$969	$1,444	$2,574	$55	$189	$282	$502	$101	$345	$514	$916
2035	53	10	19	$278	$959	$1,433	$2,551	$51	$175	$262	$465	$103	$354	$529	$942
2036	53	9	20	$272	$949	$1,422	$2,527	$46	$162	$243	$431	$102	$356	$533	$947
2037	53	8	20	$266	$939	$1,411	$2,502	$42	$150	$225	$400	$101	$358	$539	$955
2038	53	8	20	$260	$929	$1,399	$2,476	$39	$139	$209	$370	$101	$362	$545	$965
2039	53	7	21	$254	$919	$1,387	$2,450	$35	$128	$194	$343	$100	$361	$545	$962
2040	53	7	21	$248	$908	$1,375	$2,423	$32	$119	$180	$317	$98	$358	$542	$955
2041	53	6	21	$243	$898	$1,364	$2,398	$30	$110	$167	$294	$95	$352	$534	$939
2042	53	6	21	$237	$888	$1,353	$2,372	$27	$102	$155	$272	$93	$347	$528	$925
2043	53	6	20	$232	$878	$1,341	$2,346	$25	$94	$144	$252	$90	$342	$522	$914
2044	53	5	21	$227	$868	$1,329	$2,319	$23	$87	$134	$233	$89	$340	$520	$907
2045	53	5	21	$221	$858	$1,316	$2,292	$21	$81	$124	$216	$88	$342	$525	$914
2046	53	5	21	$216	$848	$1,304	$2,264	$19	$75	$115	$200	$87	$343	$528	$917
2047	53	4	22	$211	$837	$1,291	$2,236	$17	$69	$107	$185	$86	$343	$529	$916
2048	53	4	22	$205	$826	$1,279	$2,208	$16	$64	$99	$171	$85	$342	$528	$913
2049	53	4	22	$200	$816	$1,266	$2,179	$15	$59	$92	$158	$83	$339	$527	$907
2050	53	4	22	$195	$805	$1,253	$2,151	$13	$55	$85	$146	$82	$336	$524	$899
2051	53	3	22	$190	$792	$1,235	$2,098	$12	$50	$79	$134	$80	$331	$517	$879
2052	53	3	22	$185	$781	$1,221	$2,069	$11	$47	$73	$124	$78	$327	$512	$867
2053	53	3	22	$180	$770	$1,208	$2,039	$10	$43	$68	$114	$76	$322	$506	$854
2054	53	3	22	$176	$759	$1,194	$2,010	$9	$40	$63	$106	$73	$317	$498	$839
2055	53	3	22	$171	$748	$1,180	$1,980	$8	$37	$58	$98	$71	$311	$491	$824
2056	53	2	22	$167	$737	$1,167	$1,950	$8	$34	$54	$90	$69	$305	$483	$807
2057	53	2	22	$162	$727	$1,154	$1,920	$7	$32	$50	$83	$67	$299	$474	$789
2058	47	2	21	$141	$642	$1,022	$1,693	$6	$29	$46	$77	$64	$292	$465	$771
2059	38	2	21	$110	$506	$808	$1,334	$6	$27	$43	$70	$62	$287	$459	$757
2060	30	2	21	$86	$399	$640	$1,051	$5	$24	$39	$64	$60	$282	$452	$742
2061	24	2	21	$68	$316	$508	$838	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	1,626	198	635	$6,975	$26,521	$40,597	$70,522	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-46. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	11,628	-	-	$191	$644	$949	$1,926	$0	$0	$0	$0	$0	$0	$0	$0
2025	229,041	-	-	$3,691	$12,547	$18,536	$37,616	$0	$0	$0	$0	$0	$0	$0	$0
2026	341,071	-	-	$5,385	$18,483	$27,353	$55,512	$0	$0	$0	$0	$0	$0	$0	$0
2027	469,946	-	-	$7,265	$25,185	$37,339	$75,770	$0	$0	$0	$0	$0	$0	$0	$0
2028	765,307	-	-	$11,576	$40,545	$60,229	$122,184	$0	$0	$0	$0	$0	$0	$0	$0
2029	4,013,079	30,285,564	724,062	$59,347	$210,112	$312,755	$634,190	$447,871	$1,585,658	$2,360,271	$4,786,052	$10,708	$37,910	$56,429	$114,424
2030	9,269,014	28,465,830	1,715,711	$133,928	$479,453	$715,190	$1,449,381	$411,302	$1,472,434	$2,196,400	$4,451,155	$24,790	$88,748	$132,383	$268,283
2031	16,384,017	26,621,100	3,892,356	$232,259	$838,042	$1,252,130	$2,538,251	$377,380	$1,361,668	$2,034,488	$4,124,205	$55,178	$199,094	$297,469	$603,013
2032	19,971,083	24,986,340	6,222,733	$277,508	$1,009,803	$1,511,383	$3,064,139	$347,198	$1,263,390	$1,890,931	$3,833,624	$86,468	$314,642	$470,928	$954,746
2033	21,744,957	23,456,564	7,879,418	$295,955	$1,086,537	$1,629,223	$3,302,858	$319,250	$1,172,061	$1,757,463	$3,562,836	$107,241	$393,713	$590,359	$1,196,811
2034	21,744,957	22,026,773	8,564,391	$289,644	$1,073,400	$1,612,656	$3,268,516	$293,398	$1,087,312	$1,633,556	$3,310,876	$114,078	$422,766	$635,155	$1,287,326
2035	21,744,957	20,601,982	8,890,219	$283,277	$1,060,108	$1,595,911	$3,233,388	$268,387	$1,004,385	$1,512,026	$3,063,432	$115,815	$433,415	$652,473	$1,321,940
2036	21,744,957	19,277,176	9,023,488	$276,847	$1,046,678	$1,579,025	$3,197,533	$245,428	$927,893	$1,399,825	$2,834,653	$114,883	$434,339	$655,247	$1,326,878
2037	21,744,957	18,037,358	9,186,140	$270,398	$1,033,132	$1,562,012	$3,161,009	$224,294	$856,979	$1,295,683	$2,622,045	$114,229	$436,446	$659,871	$1,335,366
2038	21,744,957	16,872,528	9,374,763	$263,925	$1,019,487	$1,544,906	$3,123,915	$204,787	$791,049	$1,198,736	$2,423,934	$113,784	$439,525	$666,045	$1,346,793
2039	21,744,957	15,787,687	9,451,104	$257,465	$1,005,760	$1,527,689	$3,086,285	$186,930	$730,221	$1,109,162	$2,240,764	$111,903	$437,138	$663,986	$1,341,405
2040	21,744,957	14,777,835	9,481,011	$251,023	$991,968	$1,510,394	$3,048,212	$170,595	$674,140	$1,026,461	$2,071,559	$109,448	$432,508	$658,546	$1,329,050
2041	21,744,957	13,837,973	9,424,345	$245,198	$978,153	$1,492,647	$3,005,475	$156,038	$622,473	$949,885	$1,912,613	$106,270	$423,935	$646,919	$1,302,584
2042	21,744,957	12,953,103	9,389,979	$239,359	$964,301	$1,474,868	$2,962,629	$142,582	$574,418	$878,554	$1,764,788	$103,361	$416,407	$636,882	$1,279,332
2043	21,744,957	12,128,223	9,373,976	$233,520	$950,426	$1,457,054	$2,919,742	$130,245	$530,099	$812,670	$1,628,482	$100,667	$409,716	$628,118	$1,258,664
2044	21,744,957	11,353,337	9,418,049	$227,694	$936,541	$1,439,245	$2,876,840	$118,882	$488,981	$751,450	$1,502,037	$98,618	$405,629	$623,358	$1,246,000
2045	21,744,957	10,633,442	9,596,441	$221,894	$922,647	$1,421,439	$2,833,960	$108,508	$451,181	$695,094	$1,385,827	$97,926	$407,181	$627,306	$1,250,677
2046	21,744,957	9,963,541	9,743,352	$216,137	$908,779	$1,403,644	$2,791,126	$99,034	$416,403	$643,150	$1,278,894	$96,845	$407,200	$628,937	$1,250,631
2047	21,744,957	9,333,633	9,858,782	$210,418	$894,936	$1,385,872	$2,748,394	$90,318	$384,135	$594,861	$1,179,699	$95,400	$405,748	$628,330	$1,246,073
2048	21,744,957	8,748,718	9,947,978	$204,754	$881,129	$1,368,120	$2,705,783	$82,379	$354,507	$550,440	$1,088,626	$93,672	$403,103	$625,894	$1,237,854
2049	21,744,957	8,188,800	10,016,187	$199,152	$867,356	$1,350,421	$2,663,313	$74,997	$326,632	$508,547	$1,002,961	$91,733	$399,523	$622,033	$1,226,778
2050	21,744,957	7,678,875	10,063,409	$193,619	$853,649	$1,332,772	$2,621,031	$68,373	$301,452	$470,647	$925,574	$89,605	$395,062	$616,797	$1,212,994
2051	21,744,957	7,198,945	10,079,149	$186,379	$832,094	$1,317,335	$2,545,229	$61,703	$275,475	$436,121	$842,630	$86,390	$385,689	$610,607	$1,179,756
2052	21,744,957	6,744,012	10,089,643	$183,051	$817,363	$1,296,096	$2,480,600	$56,772	$253,498	$401,973	$769,337	$84,936	$379,256	$601,388	$1,150,996
2053	21,744,957	6,324,074	10,079,149	$179,617	$802,783	$1,275,110	$2,417,577	$52,238	$233,473	$370,840	$703,103	$83,256	$372,103	$591,035	$1,120,587
2054	21,744,957	5,934,131	10,042,421	$171,064	$788,360	$1,254,377	$2,356,121	$46,683	$215,141	$342,315	$642,978	$79,002	$364,086	$579,306	$1,088,122
2055	21,744,957	5,559,186	10,010,940	$167,710	$774,096	$1,233,896	$2,304,891	$42,876	$197,901	$315,450	$589,255	$77,210	$356,378	$568,061	$1,061,126
2056	21,744,957	5,214,236	9,958,472	$159,724	$759,994	$1,213,668	$2,254,647	$38,300	$182,239	$291,026	$540,643	$73,148	$348,052	$555,820	$1,032,554
2057	21,744,957	4,894,283	9,895,510	$156,464	$746,056	$1,193,693	$2,205,375	$35,216	$167,920	$268,672	$496,378	$71,202	$339,509	$543,216	$1,003,603
2058	19,479,858	4,589,328	9,822,055	$137,199	$656,006	$1,051,682	$1,932,366	$32,323	$154,551	$247,769	$455,253	$69,178	$330,769	$530,275	$974,330
2059	15,596,830	4,266,042	9,794,072	$104,619	$509,943	$834,651	$1,513,199	$28,616	$139,479	$228,293	$413,890	$65,696	$320,220	$524,121	$950,218
2060	12,490,407	3,949,977	9,758,510	$81,949	$400,792	$657,245	$1,185,139	$25,916	$126,747	$207,848	$374,789	$64,025	$313,131	$513,493	$925,926
2061	9,966,439	3,635,208	9,721,588	$63,915	$317,166	$515,640	$934,804	$23,313	$115,685	$188,077	$340,965	$62,344	$309,374	$502,972	$911,838
TOTALS:	652,611,655	424,325,806	290,489,403	$6,703,119	$27,514,451	$42,467,155	$83,658,924	$5,012,132	$19,439,581	$29,568,684	$59,163,855	$2,869,010	$11,962,314	$18,543,755	$36,336,678

Table E.3-47. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$13	$17	$34	$0	$0	$0	$0	$0	$0	$0	$0
2025	185	-	-	$142	$309	$403	$819	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$316	$413	$837	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$323	$423	$856	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$341	$448	$905	$0	$0	$0	$0	$0	$0	$0	$0
2029	30,940	20,081	566	$22,078	$50,909	$67,058	$135,100	$14,330	$33,042	$43,523	$87,686	$404	$931	$1,226	$2,470
2030	77,036	18,875	1,340	$53,920	$126,094	$166,575	$334,868	$13,211	$30,894	$40,813	$82,047	$938	$2,194	$2,898	$5,825
2031	138,324	17,651	3,040	$95,587	$226,045	$299,240	$601,067	$12,198	$28,846	$38,186	$76,702	$2,101	$4,968	$6,577	$13,211
2032	169,059	16,568	4,860	$115,196	$275,615	$365,675	$733,747	$11,289	$27,010	$35,836	$71,906	$3,312	$7,924	$10,513	$21,095
2033	184,425	15,553	6,154	$123,769	$299,735	$398,616	$798,856	$10,438	$25,278	$33,617	$67,370	$4,130	$10,003	$13,302	$26,659
2034	184,425	14,605	6,690	$121,767	$298,603	$398,100	$796,691	$9,643	$23,647	$31,527	$63,092	$4,417	$10,831	$14,440	$28,898
2035	184,425	13,660	6,944	$119,675	$297,284	$397,371	$793,975	$8,864	$22,020	$29,433	$58,810	$4,506	$11,193	$14,962	$29,895
2036	184,425	12,782	7,048	$117,507	$295,788	$396,441	$790,740	$8,144	$20,500	$27,476	$54,804	$4,491	$11,304	$15,151	$30,219
2037	184,425	11,960	7,175	$115,273	$294,127	$395,320	$787,021	$7,475	$19,074	$25,636	$51,038	$4,485	$11,443	$15,380	$30,619
2038	184,425	11,188	7,322	$112,986	$292,311	$394,018	$782,847	$6,854	$17,732	$23,902	$47,489	$4,486	$11,606	$15,644	$31,082
2039	184,425	10,468	7,382	$110,655	$290,352	$392,544	$778,249	$6,281	$16,481	$22,281	$44,175	$4,429	$11,622	$15,713	$31,152
2040	184,425	9,799	7,405	$108,290	$288,259	$390,908	$773,254	$5,754	$15,315	$20,769	$41,084	$4,348	$11,575	$15,697	$31,050
2041	184,425	9,175	7,361	$106,151	$286,102	$389,008	$766,879	$5,281	$14,234	$19,354	$38,154	$4,237	$11,420	$15,527	$30,610
2042	184,425	8,589	7,334	$103,970	$283,826	$386,968	$760,218	$4,842	$13,218	$18,021	$35,404	$4,135	$11,287	$15,389	$30,233
2043	184,425	8,042	7,322	$101,756	$281,440	$384,796	$753,295	$4,437	$12,272	$16,779	$32,847	$4,040	$11,173	$15,277	$29,907
2044	184,425	7,528	7,356	$99,517	$278,952	$382,499	$746,131	$4,062	$11,386	$15,613	$30,456	$3,970	$11,127	$15,257	$29,761
2045	184,425	7,051	7,496	$97,261	$276,370	$380,086	$738,744	$3,718	$10,566	$14,531	$28,243	$3,953	$11,233	$15,448	$30,025
2046	184,425	6,606	7,610	$94,994	$273,702	$377,563	$731,155	$3,403	$9,805	$13,525	$26,191	$3,920	$11,294	$15,580	$30,171
2047	184,425	6,189	7,701	$92,722	$270,955	$374,937	$723,382	$3,111	$9,093	$12,582	$24,275	$3,872	$11,314	$15,655	$30,204
2048	184,425	5,801	7,770	$90,451	$268,136	$372,215	$715,441	$2,845	$8,434	$11,708	$22,504	$3,811	$11,297	$15,682	$30,143
2049	184,425	5,430	7,823	$88,186	$265,251	$369,402	$707,348	$2,596	$7,809	$10,876	$20,825	$3,741	$11,252	$15,670	$30,006
2050	184,425	5,092	7,860	$85,932	$262,307	$366,505	$699,121	$2,372	$7,242	$10,118	$19,301	$3,663	$11,180	$15,621	$29,797
2051	184,425	4,773	7,873	$82,988	$257,048	$360,460	$680,231	$2,148	$6,653	$9,330	$17,606	$3,543	$10,973	$15,387	$29,037
2052	184,425	4,472	7,881	$80,119	$252,141	$354,809	$663,240	$1,943	$6,114	$8,603	$16,081	$3,424	$10,775	$15,162	$28,342
2053	184,425	4,193	7,873	$77,334	$247,223	$349,129	$646,662	$1,758	$5,621	$7,938	$14,703	$3,301	$10,553	$14,904	$27,604
2054	184,425	3,935	7,844	$74,633	$242,378	$343,603	$630,410	$1,592	$5,171	$7,331	$13,450	$3,174	$10,309	$14,614	$26,813
2055	184,425	3,686	7,819	$72,014	$237,605	$338,139	$614,631	$1,439	$4,749	$6,758	$12,285	$3,053	$10,074	$14,337	$26,060
2056	184,425	3,457	7,778	$69,552	$233,191	$332,988	$599,665	$1,304	$4,372	$6,242	$11,242	$2,933	$9,835	$14,044	$25,292
2057	184,425	3,245	7,729	$67,198	$228,833	$327,969	$585,119	$1,182	$4,027	$5,771	$10,296	$2,816	$9,590	$13,745	$24,522
2058	165,214	3,043	7,672	$58,118	$201,142	$289,351	$511,382	$1,070	$3,705	$5,329	$9,419	$2,699	$9,340	$13,436	$23,746
2059	132,281	2,829	7,650	$44,917	$157,955	$228,085	$399,447	$960	$3,378	$4,877	$8,542	$2,598	$9,135	$13,190	$23,101
2060	105,934	2,619	7,622	$34,733	$124,090	$179,857	$312,107	$859	$3,068	$4,447	$7,716	$2,499	$8,929	$12,941	$22,457
2061	84,528	2,410	7,593	$28,091	$100,463	$145,640	$256,736	$801	$2,865	$4,153	$7,321	$2,523	$9,025	$13,083	$23,063
TOTALS:	5,514,715	281,355	226,896	$2,867,926	$8,065,536	$11,097,581	$21,351,211	$166,208	$433,620	$586,887	$1,153,064	$113,950	$326,708	$451,453	$863,071

Table E.3-48. Scenario 2: Reduced Gas Injection: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	19	14	2	$113	$367	$541	$970	$84	$272	$401	$720	$9	$30	$45	$81
2030	33	13	4	$194	$636	$940	$1,684	$77	$253	$374	$670	$22	$72	$106	$189
2031	56	12	9	$321	$1,063	$1,574	$2,818	$71	$235	$348	$622	$49	$161	$238	$427
2032	67	12	14	$379	$1,265	$1,877	$3,356	$65	$218	$324	$579	$76	$255	$379	$677
2033	73	11	17	$401	$1,352	$2,011	$3,591	$60	$203	$302	$539	$95	$320	$476	$850
2034	73	10	19	$393	$1,339	$1,997	$3,560	$55	$189	$282	$502	$101	$345	$514	$916
2035	73	10	19	$384	$1,326	$1,982	$3,527	$51	$175	$262	$465	$103	$354	$529	$942
2036	73	9	20	$376	$1,313	$1,967	$3,494	$46	$162	$243	$431	$102	$356	$533	$947
2037	73	8	20	$368	$1,299	$1,951	$3,460	$42	$150	$225	$400	$101	$358	$539	$955
2038	73	8	20	$359	$1,284	$1,935	$3,424	$39	$139	$209	$370	$101	$362	$545	$965
2039	73	7	21	$351	$1,270	$1,919	$3,388	$35	$128	$194	$343	$100	$361	$545	$962
2040	73	7	21	$342	$1,255	$1,902	$3,351	$32	$119	$180	$317	$98	$358	$542	$955
2041	73	6	21	$335	$1,242	$1,886	$3,316	$30	$110	$167	$294	$95	$352	$534	$939
2042	73	6	21	$328	$1,229	$1,870	$3,280	$27	$102	$155	$272	$93	$347	$528	$925
2043	73	6	20	$321	$1,215	$1,854	$3,244	$25	$94	$144	$252	$90	$342	$522	$914
2044	73	5	21	$314	$1,201	$1,837	$3,207	$23	$87	$134	$233	$89	$340	$520	$907
2045	73	5	21	$306	$1,186	$1,820	$3,169	$21	$81	$124	$216	$88	$342	$525	$914
2046	73	5	21	$299	$1,172	$1,803	$3,131	$19	$75	$115	$200	$87	$343	$528	$917
2047	73	4	22	$291	$1,157	$1,786	$3,092	$17	$69	$107	$185	$86	$343	$529	$916
2048	73	4	22	$284	$1,143	$1,768	$3,053	$16	$64	$99	$171	$85	$342	$528	$913
2049	73	4	22	$277	$1,128	$1,750	$3,013	$15	$59	$92	$158	$83	$339	$527	$907
2050	73	4	22	$270	$1,113	$1,732	$2,974	$13	$55	$85	$146	$82	$336	$524	$899
2051	73	3	22	$263	$1,095	$1,708	$2,901	$12	$50	$79	$134	$80	$331	$517	$879
2052	73	3	22	$256	$1,079	$1,689	$2,861	$11	$47	$73	$124	$78	$327	$512	$867
2053	73	3	22	$249	$1,064	$1,670	$2,820	$10	$43	$68	$114	$76	$322	$506	$854
2054	73	3	22	$243	$1,049	$1,651	$2,779	$9	$40	$63	$106	$73	$317	$498	$839
2055	73	3	22	$237	$1,034	$1,632	$2,738	$8	$37	$58	$98	$71	$311	$491	$824
2056	73	2	22	$230	$1,019	$1,614	$2,696	$8	$34	$54	$90	$69	$305	$483	$807
2057	73	2	22	$224	$1,005	$1,595	$2,655	$7	$32	$50	$83	$67	$299	$474	$789
2058	65	2	21	$195	$887	$1,413	$2,341	$6	$29	$46	$77	$64	$292	$465	$771
2059	52	2	21	$152	$700	$1,118	$1,845	$6	$27	$43	$70	$62	$287	$459	$757
2060	42	2	21	$118	$552	$885	$1,454	$5	$24	$39	$64	$60	$282	$452	$742
2061	33	2	21	$94	$437	$702	$1,159	$5	$22	$36	$59	$60	$279	$447	$739
TOTALS:	2,228	198	635	$9,520	$36,275	$55,551	$96,464	$953	$3,424	$5,173	$9,105	$2,595	$10,109	$15,559	$26,883

Table E.3-49. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,833,297	30,614,615	444,668	$160,206	$567,198	$844,281	$1,711,995	$452,737	$1,602,886	$2,385,915	$4,838,052	$6,576	$23,281	$34,655	$70,271
2030	26,319,561	30,115,125	97,591	$380,291	$1,361,416	$2,030,796	$4,115,547	$435,133	$1,557,746	$2,323,659	$4,709,053	$1,410	$5,048	$7,530	$15,260
2031	47,075,002	30,564,599	-	$667,333	$2,407,884	$3,597,655	$7,292,972	$433,283	$1,563,378	$2,335,866	$4,735,141	$0	$0	$0	$0
2032	57,482,286	31,291,117	-	$798,746	$2,906,491	$4,350,178	$8,819,438	$434,806	$1,582,180	$2,368,067	$4,800,958	$0	$0	$0	$0
2033	62,666,270	31,440,000	-	$852,905	$3,131,265	$4,695,217	$9,518,428	$427,907	$1,570,972	$2,355,615	$4,775,446	$0	$0	$0	$0
2034	62,666,270	30,704,280	-	$834,719	$3,093,407	$4,647,474	$9,419,457	$408,983	$1,515,661	$2,277,100	$4,615,204	$0	$0	$0	$0
2035	62,666,270	29,609,656	-	$816,368	$3,055,098	$4,599,219	$9,318,222	$385,732	$1,443,526	$2,173,119	$4,402,837	$0	$0	$0	$0
2036	62,666,270	28,419,907	-	$797,838	$3,016,397	$4,550,553	$9,214,893	$361,829	$1,367,972	$2,063,730	$4,179,065	$0	$0	$0	$0
2037	62,666,270	27,344,915	-	$779,254	$2,977,358	$4,501,525	$9,109,636	$340,033	$1,299,193	$1,964,276	$3,975,060	$0	$0	$0	$0
2038	62,666,270	26,371,226	-	$760,599	$2,938,035	$4,452,226	$9,002,734	$320,075	$1,236,384	$1,873,586	$3,788,532	$0	$0	$0	$0
2039	62,666,270	25,363,755	-	$741,983	$2,898,476	$4,402,611	$8,894,292	$300,313	$1,173,139	$1,781,927	$3,599,905	$0	$0	$0	$0
2040	62,666,270	24,384,223	-	$723,416	$2,858,730	$4,352,767	$8,784,568	$281,490	$1,112,367	$1,693,716	$3,418,184	$0	$0	$0	$0
2041	62,666,270	23,386,959	-	$706,630	$2,818,915	$4,301,624	$8,661,406	$263,713	$1,052,015	$1,605,360	$3,232,424	$0	$0	$0	$0
2042	62,666,270	22,467,281	-	$689,803	$2,778,995	$4,250,386	$8,537,929	$247,310	$996,333	$1,523,860	$3,061,042	$0	$0	$0	$0
2043	62,666,270	21,626,200	-	$672,975	$2,739,009	$4,199,049	$8,414,334	$232,244	$945,235	$1,449,097	$2,903,796	$0	$0	$0	$0
2044	62,666,270	20,862,366	36,990	$656,186	$2,698,994	$4,147,727	$8,290,695	$218,452	$898,528	$1,380,829	$2,760,074	$387	$1,593	$2,448	$4,894
2045	62,666,270	20,188,533	185,213	$639,470	$2,658,953	$4,096,410	$8,167,120	$206,011	$856,607	$1,319,697	$2,631,115	$1,890	$7,859	$12,107	$24,138
2046	62,666,270	19,553,774	310,350	$622,879	$2,618,988	$4,045,128	$8,043,678	$194,357	$817,204	$1,262,203	$2,509,871	$3,085	$12,970	$20,033	$39,836
2047	62,666,270	18,937,839	423,681	$606,398	$2,579,095	$3,993,912	$7,920,530	$183,254	$779,406	$1,206,966	$2,393,596	$4,100	$17,437	$27,002	$53,550
2048	62,666,270	18,311,467	568,756	$590,075	$2,539,305	$3,942,753	$7,797,731	$172,423	$742,000	$1,152,096	$2,278,545	$5,355	$23,047	$35,784	$70,772
2049	62,666,270	17,718,628	681,038	$573,930	$2,499,614	$3,891,747	$7,675,337	$162,276	$706,755	$1,100,375	$2,170,170	$6,237	$27,165	$42,294	$83,413
2050	62,666,270	17,188,132	756,330	$557,986	$2,460,110	$3,840,884	$7,553,487	$153,045	$674,760	$1,053,479	$2,071,774	$6,734	$29,691	$46,356	$91,164
2051	62,666,270	16,681,482	803,289	$537,122	$2,397,992	$3,796,396	$7,335,034	$142,979	$638,335	$1,010,584	$1,952,553	$6,885	$30,739	$48,664	$94,024
2052	62,666,270	16,099,384	954,922	$527,530	$2,355,537	$3,735,189	$7,148,782	$135,526	$605,153	$959,595	$1,836,570	$8,039	$35,894	$56,918	$108,935
2053	62,666,270	15,505,265	1,134,888	$517,634	$2,313,522	$3,674,709	$6,967,157	$128,076	$572,425	$909,219	$1,723,856	$9,374	$41,898	$66,549	$126,175
2054	62,666,270	14,982,508	1,240,087	$492,985	$2,271,955	$3,614,958	$6,790,048	$117,865	$543,188	$864,279	$1,623,392	$9,756	$44,959	$71,535	$134,367
2055	62,666,270	14,532,756	1,287,308	$483,319	$2,230,848	$3,555,935	$6,642,411	$112,085	$517,349	$824,647	$1,540,423	$9,928	$45,827	$73,047	$136,450
2056	62,666,270	14,180,902	1,236,414	$460,304	$2,190,207	$3,497,641	$6,497,614	$104,163	$495,627	$791,490	$1,470,361	$9,082	$43,213	$69,009	$128,199
2057	62,666,270	13,777,130	1,258,451	$450,910	$2,150,041	$3,440,076	$6,355,617	$99,132	$472,685	$756,298	$1,397,277	$9,055	$43,177	$69,083	$127,632
2058	56,138,534	13,179,122	1,499,018	$395,391	$1,890,529	$3,030,817	$5,568,840	$92,822	$443,822	$711,517	$1,307,345	$10,558	$50,481	$80,929	$148,700
2059	44,948,128	12,059,942	2,343,581	$301,500	$1,469,591	$2,405,360	$4,360,852	$80,895	$394,303	$645,377	$1,170,052	$15,720	$76,624	$125,415	$227,373
2060	35,995,804	11,072,599	3,042,575	$236,168	$1,155,034	$1,894,099	$3,415,423	$72,647	$355,298	$582,640	$1,050,612	$19,962	$97,630	$160,100	$288,691
2061	28,722,041	10,086,410	3,740,208	$184,194	$914,032	$1,486,011	$2,693,990	$64,684	$320,984	$521,847	$946,057	$23,986	$119,026	$193,510	$350,814
TOTALS:	1,876,225,902	698,622,096	22,045,357	$19,248,904	$79,053,292	$122,028,760	$240,371,846	$7,766,284	$30,853,420	$47,228,030	$93,868,339	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-50. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-51. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-52. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,880,942	30,614,577	444,668	$160,910	$569,692	$847,994	$1,719,524	$452,737	$1,602,884	$2,385,912	$4,838,046	$6,576	$23,281	$34,655	$70,271
2030	26,438,674	30,115,090	97,591	$382,012	$1,367,577	$2,039,987	$4,134,172	$435,132	$1,557,745	$2,323,656	$4,709,047	$1,410	$5,048	$7,530	$15,260
2031	47,289,403	30,564,566	-	$670,373	$2,418,851	$3,614,041	$7,326,187	$433,282	$1,563,376	$2,335,863	$4,735,136	$0	$0	$0	$0
2032	57,744,333	31,291,086	-	$802,387	$2,919,741	$4,370,009	$8,859,643	$434,806	$1,582,179	$2,368,065	$4,800,953	$0	$0	$0	$0
2033	62,952,139	31,439,971	-	$856,796	$3,145,549	$4,716,636	$9,561,849	$427,907	$1,570,971	$2,355,613	$4,775,441	$0	$0	$0	$0
2034	62,952,139	30,704,253	-	$838,527	$3,107,518	$4,668,675	$9,462,426	$408,983	$1,515,660	$2,277,098	$4,615,200	$0	$0	$0	$0
2035	62,952,139	29,609,631	-	$820,093	$3,069,035	$4,620,200	$9,360,729	$385,732	$1,443,525	$2,173,118	$4,402,833	$0	$0	$0	$0
2036	62,952,139	28,419,883	-	$801,477	$3,030,157	$4,571,312	$9,256,929	$361,829	$1,367,971	$2,063,729	$4,179,061	$0	$0	$0	$0
2037	62,952,139	27,344,892	-	$782,808	$2,990,940	$4,522,060	$9,151,192	$340,033	$1,299,192	$1,964,274	$3,975,057	$0	$0	$0	$0
2038	62,952,139	26,371,206	-	$764,068	$2,951,437	$4,472,536	$9,043,803	$320,075	$1,236,383	$1,873,585	$3,788,529	$0	$0	$0	$0
2039	62,952,139	25,363,736	-	$745,368	$2,911,698	$4,422,694	$8,934,865	$300,313	$1,173,138	$1,781,926	$3,599,902	$0	$0	$0	$0
2040	62,952,139	24,384,204	-	$726,716	$2,871,770	$4,372,623	$8,824,641	$281,490	$1,112,366	$1,693,714	$3,418,182	$0	$0	$0	$0
2041	62,952,139	23,386,942	-	$709,854	$2,831,774	$4,321,247	$8,700,917	$263,713	$1,052,014	$1,605,358	$3,232,421	$0	$0	$0	$0
2042	62,952,139	22,467,265	-	$692,949	$2,791,672	$4,269,775	$8,576,878	$247,310	$996,332	$1,523,859	$3,061,039	$0	$0	$0	$0
2043	62,952,139	21,626,185	-	$676,045	$2,751,503	$4,218,204	$8,452,718	$232,244	$945,234	$1,449,096	$2,903,794	$0	$0	$0	$0
2044	62,952,139	20,862,352	36,990	$659,179	$2,711,306	$4,166,648	$8,328,515	$218,452	$898,528	$1,380,828	$2,760,072	$387	$1,593	$2,448	$4,894
2045	62,952,139	20,188,520	185,213	$642,387	$2,671,083	$4,115,096	$8,204,377	$206,011	$856,607	$1,319,696	$2,631,113	$1,890	$7,859	$12,107	$24,138
2046	62,952,139	19,553,762	310,350	$625,721	$2,630,935	$4,063,581	$8,080,371	$194,357	$817,203	$1,262,202	$2,509,869	$3,085	$12,970	$20,033	$39,836
2047	62,952,139	18,937,828	423,681	$609,165	$2,590,861	$4,012,131	$7,956,661	$183,254	$779,406	$1,206,965	$2,393,594	$4,100	$17,437	$27,002	$53,550
2048	62,952,139	18,311,457	568,756	$592,766	$2,550,888	$3,960,738	$7,833,303	$172,423	$742,000	$1,152,096	$2,278,543	$5,355	$23,047	$35,784	$70,772
2049	62,952,139	17,718,618	681,038	$576,548	$2,511,016	$3,909,500	$7,710,350	$162,276	$706,755	$1,100,375	$2,170,169	$6,237	$27,165	$42,294	$83,413
2050	62,952,139	17,188,123	756,330	$560,531	$2,471,332	$3,858,405	$7,587,944	$153,044	$674,760	$1,053,479	$2,071,773	$6,734	$29,691	$46,356	$91,164
2051	62,952,139	16,681,474	803,289	$539,572	$2,408,931	$3,813,714	$7,368,495	$142,979	$638,334	$1,010,583	$1,952,552	$6,885	$30,739	$48,664	$94,024
2052	62,952,139	16,099,375	954,922	$529,937	$2,366,283	$3,752,228	$7,181,393	$135,526	$605,153	$959,595	$1,836,569	$8,039	$35,894	$56,918	$108,935
2053	62,952,139	15,505,257	1,134,888	$519,996	$2,324,075	$3,691,473	$6,998,940	$128,076	$572,425	$909,218	$1,723,855	$9,374	$41,898	$66,549	$126,175
2054	62,952,139	14,982,501	1,240,087	$495,234	$2,282,319	$3,631,449	$6,821,023	$117,865	$543,188	$864,279	$1,623,392	$9,756	$44,959	$71,535	$134,367
2055	62,952,139	14,532,749	1,287,308	$485,524	$2,241,024	$3,572,157	$6,672,712	$112,085	$517,349	$824,646	$1,540,422	$9,928	$45,827	$73,047	$136,450
2056	62,952,139	14,180,895	1,236,414	$462,403	$2,200,198	$3,513,597	$6,527,255	$104,163	$495,627	$791,489	$1,470,360	$9,082	$43,213	$69,009	$128,199
2057	62,952,139	13,777,125	1,258,451	$452,967	$2,159,849	$3,455,768	$6,384,610	$99,132	$472,685	$756,298	$1,397,277	$9,055	$43,177	$69,083	$127,632
2058	56,394,625	13,179,117	1,499,018	$397,195	$1,899,153	$3,044,642	$5,594,243	$92,822	$443,822	$711,516	$1,307,344	$10,558	$50,481	$80,929	$148,700
2059	45,153,171	12,059,937	2,343,581	$302,876	$1,476,295	$2,416,332	$4,380,746	$80,895	$394,303	$645,377	$1,170,051	$15,720	$76,624	$125,415	$227,373
2060	36,160,009	11,072,594	3,042,575	$237,245	$1,160,303	$1,902,740	$3,431,003	$72,647	$355,298	$582,640	$1,050,611	$19,962	$97,630	$160,100	$288,691
2061	28,853,064	10,086,405	3,740,208	$185,034	$918,202	$1,492,790	$2,706,280	$64,684	$320,984	$521,847	$946,057	$23,986	$119,026	$193,510	$350,814
TOTALS:	1,884,772,191	698,621,575	22,045,357	$19,336,520	$79,413,243	$122,584,430	$241,466,344	$7,766,278	$30,853,396	$47,227,993	$93,868,266	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-53. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-54. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-55. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	10,883,162	30,614,575	444,668	$160,943	$569,809	$848,167	$1,719,875	$452,737	$1,602,884	$2,385,912	$4,838,046	$6,576	$23,281	$34,655	$70,271
2030	26,444,224	30,115,088	97,591	$382,092	$1,367,864	$2,040,415	$4,135,040	$435,132	$1,557,744	$2,323,656	$4,709,047	$1,410	$5,048	$7,530	$15,260
2031	47,299,394	30,564,565	-	$670,514	$2,419,362	$3,614,804	$7,327,735	$433,282	$1,563,376	$2,335,863	$4,735,135	$0	$0	$0	$0
2032	57,756,543	31,291,084	-	$802,557	$2,920,358	$4,370,933	$8,861,517	$434,806	$1,582,179	$2,368,065	$4,800,953	$0	$0	$0	$0
2033	62,965,460	31,439,969	-	$856,977	$3,146,214	$4,717,634	$9,563,872	$427,907	$1,570,971	$2,355,613	$4,775,441	$0	$0	$0	$0
2034	62,965,460	30,704,251	-	$838,705	$3,108,176	$4,669,663	$9,464,429	$408,983	$1,515,660	$2,277,098	$4,615,200	$0	$0	$0	$0
2035	62,965,460	29,609,629	-	$820,266	$3,069,684	$4,621,177	$9,362,710	$385,732	$1,443,525	$2,173,117	$4,402,833	$0	$0	$0	$0
2036	62,965,460	28,419,881	-	$801,647	$3,030,798	$4,572,279	$9,258,888	$361,829	$1,367,971	$2,063,729	$4,179,061	$0	$0	$0	$0
2037	62,965,460	27,344,891	-	$782,974	$2,991,573	$4,523,017	$9,153,128	$340,033	$1,299,192	$1,964,274	$3,975,057	$0	$0	$0	$0
2038	62,965,460	26,371,204	-	$764,230	$2,952,062	$4,473,482	$9,045,716	$320,075	$1,236,383	$1,873,585	$3,788,528	$0	$0	$0	$0
2039	62,965,460	25,363,735	-	$745,526	$2,912,314	$4,423,630	$8,936,756	$300,313	$1,173,138	$1,781,926	$3,599,902	$0	$0	$0	$0
2040	62,965,460	24,384,203	-	$726,870	$2,872,378	$4,373,549	$8,826,508	$281,490	$1,112,366	$1,693,714	$3,418,181	$0	$0	$0	$0
2041	62,965,460	23,386,941	-	$710,004	$2,832,374	$4,322,161	$8,702,758	$263,713	$1,052,014	$1,605,358	$3,232,421	$0	$0	$0	$0
2042	62,965,460	22,467,264	-	$693,096	$2,792,263	$4,270,679	$8,578,692	$247,310	$996,332	$1,523,859	$3,061,039	$0	$0	$0	$0
2043	62,965,460	21,626,184	-	$676,188	$2,752,086	$4,219,097	$8,454,507	$232,244	$945,234	$1,449,096	$2,903,794	$0	$0	$0	$0
2044	62,965,460	20,862,351	36,990	$659,319	$2,711,880	$4,167,529	$8,330,278	$218,452	$898,527	$1,380,828	$2,760,072	$387	$1,593	$2,448	$4,894
2045	62,965,460	20,188,519	185,213	$642,523	$2,671,648	$4,115,967	$8,206,113	$206,011	$856,606	$1,319,696	$2,631,113	$1,890	$7,859	$12,107	$24,138
2046	62,965,460	19,553,761	310,350	$625,853	$2,631,492	$4,064,441	$8,082,081	$194,357	$817,203	$1,262,202	$2,509,869	$3,085	$12,970	$20,033	$39,836
2047	62,965,460	18,937,827	423,681	$609,293	$2,591,409	$4,012,980	$7,958,345	$183,254	$779,406	$1,206,965	$2,393,594	$4,100	$17,437	$27,002	$53,550
2048	62,965,460	18,311,456	568,756	$592,892	$2,551,428	$3,961,577	$7,834,960	$172,423	$742,000	$1,152,096	$2,278,543	$5,355	$23,047	$35,784	$70,772
2049	62,965,460	17,718,617	681,038	$576,670	$2,511,548	$3,910,327	$7,711,982	$162,276	$706,755	$1,100,375	$2,170,168	$6,237	$27,165	$42,294	$83,413
2050	62,965,460	17,188,122	756,330	$560,650	$2,471,855	$3,859,221	$7,589,550	$153,044	$674,760	$1,053,479	$2,071,772	$6,734	$29,691	$46,356	$91,164
2051	62,965,460	16,681,473	803,289	$539,686	$2,409,441	$3,814,521	$7,370,054	$142,979	$638,334	$1,010,583	$1,952,552	$6,885	$30,739	$48,664	$94,024
2052	62,965,460	16,099,375	954,922	$530,049	$2,366,784	$3,753,022	$7,182,913	$135,526	$605,153	$959,594	$1,836,569	$8,039	$35,894	$56,918	$108,935
2053	62,965,460	15,505,256	1,134,888	$520,106	$2,324,567	$3,692,254	$7,000,421	$128,076	$572,425	$909,218	$1,723,855	$9,374	$41,898	$66,549	$126,175
2054	62,965,460	14,982,500	1,240,087	$495,339	$2,282,802	$3,632,217	$6,822,466	$117,865	$543,188	$864,278	$1,623,392	$9,756	$44,959	$71,535	$134,367
2055	62,965,460	14,532,749	1,287,308	$485,626	$2,241,498	$3,572,913	$6,674,124	$112,085	$517,349	$824,646	$1,540,422	$9,928	$45,827	$73,047	$136,450
2056	62,965,460	14,180,895	1,236,414	$462,501	$2,200,664	$3,514,340	$6,528,636	$104,163	$495,627	$791,489	$1,470,360	$9,082	$43,213	$69,009	$128,199
2057	62,965,460	13,777,124	1,258,451	$453,062	$2,160,306	$3,456,500	$6,385,961	$99,132	$472,685	$756,298	$1,397,277	$9,055	$43,177	$69,083	$127,632
2058	56,406,558	13,179,116	1,499,018	$397,279	$1,899,555	$3,045,287	$5,595,427	$92,822	$443,822	$711,516	$1,307,344	$10,558	$50,481	$80,929	$148,700
2059	45,162,726	12,059,936	2,343,581	$302,940	$1,476,608	$2,416,844	$4,381,673	$80,895	$394,303	$645,377	$1,170,051	$15,720	$76,624	$125,415	$227,373
2060	36,167,660	11,072,594	3,042,575	$237,295	$1,160,548	$1,903,142	$3,431,729	$72,647	$355,298	$582,640	$1,050,611	$19,962	$97,630	$160,100	$288,691
2061	28,859,169	10,086,405	3,740,208	$185,074	$918,396	$1,493,106	$2,706,852	$64,684	$320,983	$521,847	$946,057	$23,986	$119,026	$193,510	$350,814
TOTALS:	1,885,170,429	698,621,539	22,045,357	$19,340,603	$79,430,016	$122,610,323	$241,517,345	$7,766,278	$30,853,394	$47,227,991	$93,868,261	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-56. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-57. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-58. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	11,130,560	30,614,381	444,668	$164,602	$582,762	$867,447	$1,758,971	$452,734	$1,602,874	$2,385,897	$4,838,015	$6,576	$23,281	$34,655	$70,271
2030	27,062,718	30,114,905	97,591	$391,028	$1,399,856	$2,088,137	$4,231,753	$435,129	$1,557,735	$2,323,642	$4,709,018	$1,410	$5,048	$7,530	$15,260
2031	48,412,683	30,564,394	-	$686,296	$2,476,307	$3,699,886	$7,500,209	$433,280	$1,563,368	$2,335,850	$4,735,109	$0	$0	$0	$0
2032	59,117,230	31,290,924	-	$821,464	$2,989,159	$4,473,908	$9,070,285	$434,803	$1,582,171	$2,368,053	$4,800,929	$0	$0	$0	$0
2033	64,449,845	31,439,819	-	$877,180	$3,220,385	$4,828,850	$9,789,336	$427,905	$1,570,963	$2,355,602	$4,775,418	$0	$0	$0	$0
2034	64,449,845	30,704,110	-	$858,477	$3,181,450	$4,779,748	$9,687,549	$408,981	$1,515,653	$2,277,087	$4,615,179	$0	$0	$0	$0
2035	64,449,845	29,609,497	-	$839,604	$3,142,051	$4,730,120	$9,583,432	$385,730	$1,443,519	$2,173,108	$4,402,813	$0	$0	$0	$0
2036	64,449,845	28,419,758	-	$820,545	$3,102,248	$4,680,069	$9,477,163	$361,827	$1,367,965	$2,063,720	$4,179,043	$0	$0	$0	$0
2037	64,449,845	27,344,775	-	$801,432	$3,062,098	$4,629,645	$9,368,910	$340,032	$1,299,187	$1,964,266	$3,975,040	$0	$0	$0	$0
2038	64,449,845	26,371,096	-	$782,246	$3,021,656	$4,578,943	$9,258,965	$320,074	$1,236,378	$1,873,577	$3,788,513	$0	$0	$0	$0
2039	64,449,845	25,363,634	-	$763,101	$2,980,971	$4,527,916	$9,147,436	$300,311	$1,173,133	$1,781,919	$3,599,888	$0	$0	$0	$0
2040	64,449,845	24,384,109	-	$744,006	$2,940,093	$4,476,653	$9,034,589	$281,489	$1,112,362	$1,693,708	$3,418,168	$0	$0	$0	$0
2041	64,449,845	23,386,852	-	$726,742	$2,899,146	$4,424,054	$8,907,922	$263,712	$1,052,010	$1,605,352	$3,232,409	$0	$0	$0	$0
2042	64,449,845	22,467,181	-	$709,435	$2,858,089	$4,371,358	$8,780,932	$247,309	$996,328	$1,523,853	$3,061,028	$0	$0	$0	$0
2043	64,449,845	21,626,106	-	$692,129	$2,816,965	$4,318,560	$8,653,818	$232,243	$945,231	$1,449,090	$2,903,783	$0	$0	$0	$0
2044	64,449,845	20,862,279	36,990	$674,862	$2,775,812	$4,265,777	$8,526,660	$218,451	$898,524	$1,380,823	$2,760,062	$387	$1,593	$2,448	$4,894
2045	64,449,845	20,188,451	185,213	$657,670	$2,734,631	$4,212,999	$8,399,568	$206,010	$856,604	$1,319,692	$2,631,104	$1,890	$7,859	$12,107	$24,138
2046	64,449,845	19,553,697	310,350	$640,607	$2,693,529	$4,160,259	$8,272,613	$194,356	$817,200	$1,262,198	$2,509,861	$3,085	$12,970	$20,033	$39,836
2047	64,449,845	18,937,768	423,681	$623,657	$2,652,500	$4,107,584	$8,145,960	$183,254	$779,403	$1,206,961	$2,393,587	$4,100	$17,437	$27,002	$53,550
2048	64,449,845	18,311,400	568,756	$606,869	$2,611,577	$4,054,969	$8,019,666	$172,423	$741,998	$1,152,092	$2,278,536	$5,355	$23,047	$35,784	$70,772
2049	64,449,845	17,718,565	681,038	$590,265	$2,570,757	$4,002,512	$7,893,789	$162,276	$706,753	$1,100,371	$2,170,162	$6,237	$27,165	$42,294	$83,413
2050	64,449,845	17,188,073	756,330	$573,867	$2,530,128	$3,950,201	$7,768,470	$153,044	$674,758	$1,053,476	$2,071,767	$6,734	$29,691	$46,356	$91,164
2051	64,449,845	16,681,427	803,289	$552,409	$2,466,242	$3,904,447	$7,543,800	$142,979	$638,333	$1,010,580	$1,952,547	$6,885	$30,739	$48,664	$94,024
2052	64,449,845	16,099,332	954,922	$542,545	$2,422,579	$3,841,498	$7,352,247	$135,526	$605,151	$959,592	$1,836,564	$8,039	$35,894	$56,918	$108,935
2053	64,449,845	15,505,216	1,134,888	$532,367	$2,379,368	$3,779,297	$7,165,453	$128,076	$572,424	$909,216	$1,723,850	$9,374	$41,898	$66,549	$126,175
2054	64,449,845	14,982,463	1,240,087	$507,016	$2,336,618	$3,717,845	$6,983,303	$117,865	$543,187	$864,276	$1,623,388	$9,756	$44,959	$71,535	$134,367
2055	64,449,845	14,532,713	1,287,308	$497,075	$2,294,341	$3,657,142	$6,831,464	$112,085	$517,348	$824,644	$1,540,418	$9,928	$45,827	$73,047	$136,450
2056	64,449,845	14,180,862	1,236,414	$473,404	$2,252,544	$3,597,189	$6,682,546	$104,163	$495,626	$791,487	$1,470,357	$9,082	$43,213	$69,009	$128,199
2057	64,449,845	13,777,093	1,258,451	$463,743	$2,211,235	$3,537,985	$6,536,507	$99,132	$472,684	$756,296	$1,397,274	$9,055	$43,177	$69,083	$127,632
2058	57,736,320	13,179,087	1,499,018	$406,644	$1,944,336	$3,117,078	$5,727,337	$92,822	$443,821	$711,515	$1,307,341	$10,558	$50,481	$80,929	$148,700
2059	46,227,419	12,059,909	2,343,581	$310,082	$1,511,418	$2,473,820	$4,484,969	$80,895	$394,302	$645,376	$1,170,048	$15,720	$76,624	$125,415	$227,373
2060	37,020,298	11,072,569	3,042,575	$242,889	$1,187,908	$1,948,008	$3,512,631	$72,647	$355,297	$582,639	$1,050,609	$19,962	$97,630	$160,100	$288,691
2061	29,539,512	10,086,382	3,740,208	$189,437	$940,047	$1,528,305	$2,770,665	$64,684	$320,983	$521,846	$946,054	$23,986	$119,026	$193,510	$350,814
TOTALS:	1,929,547,355	698,618,825	22,045,357	$19,795,555	$81,299,075	$125,495,660	$247,200,568	$7,766,245	$30,853,270	$47,227,802	$93,867,883	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-59. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-60. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant without CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-61. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,613,372	30,615,344	444,668	$53,436	$189,185	$281,604	$571,024	$452,748	$1,602,925	$2,385,972	$4,838,167	$6,576	$23,281	$34,655	$70,271
2030	8,269,747	30,115,810	97,591	$119,489	$427,764	$638,087	$1,293,127	$435,142	$1,557,782	$2,323,711	$4,709,160	$1,410	$5,048	$7,530	$15,260
2031	14,585,335	30,565,240	-	$206,761	$746,039	$1,114,668	$2,259,595	$433,292	$1,563,411	$2,335,915	$4,735,240	$0	$0	$0	$0
2032	17,772,694	31,291,718	-	$246,961	$898,645	$1,345,012	$2,726,843	$434,814	$1,582,211	$2,368,113	$4,801,050	$0	$0	$0	$0
2033	19,346,715	31,440,564	-	$263,314	$966,703	$1,449,536	$2,938,587	$427,915	$1,571,000	$2,355,658	$4,775,531	$0	$0	$0	$0
2034	19,346,715	30,704,810	-	$257,700	$955,016	$1,434,797	$2,908,033	$408,990	$1,515,687	$2,277,139	$4,615,284	$0	$0	$0	$0
2035	19,346,715	29,610,152	-	$252,034	$943,189	$1,419,899	$2,876,779	$385,739	$1,443,551	$2,173,156	$4,402,910	$0	$0	$0	$0
2036	19,346,715	28,420,371	-	$246,313	$931,241	$1,404,875	$2,844,878	$361,835	$1,367,995	$2,063,764	$4,179,133	$0	$0	$0	$0
2037	19,346,715	27,345,349	-	$240,576	$919,188	$1,389,738	$2,812,383	$340,039	$1,299,214	$1,964,307	$3,975,124	$0	$0	$0	$0
2038	19,346,715	26,371,632	-	$234,817	$907,048	$1,374,519	$2,779,379	$320,080	$1,236,403	$1,873,615	$3,788,590	$0	$0	$0	$0
2039	19,346,715	25,364,135	-	$229,070	$894,835	$1,359,201	$2,745,900	$300,317	$1,173,156	$1,781,954	$3,599,959	$0	$0	$0	$0
2040	19,346,715	24,384,578	-	$223,338	$882,565	$1,343,813	$2,712,026	$281,494	$1,112,383	$1,693,740	$3,418,234	$0	$0	$0	$0
2041	19,346,715	23,387,292	-	$218,155	$870,273	$1,328,024	$2,674,002	$263,717	$1,052,030	$1,605,382	$3,232,470	$0	$0	$0	$0
2042	19,346,715	22,467,592	-	$212,960	$857,948	$1,312,205	$2,635,882	$247,313	$996,347	$1,523,881	$3,061,084	$0	$0	$0	$0
2043	19,346,715	21,626,492	-	$207,765	$845,604	$1,296,356	$2,597,725	$232,248	$945,248	$1,449,116	$2,903,835	$0	$0	$0	$0
2044	19,346,715	20,862,640	36,990	$202,582	$833,250	$1,280,512	$2,559,554	$218,455	$898,540	$1,380,847	$2,760,110	$387	$1,593	$2,448	$4,894
2045	19,346,715	20,188,789	185,213	$197,421	$820,888	$1,264,669	$2,521,403	$206,014	$856,618	$1,319,714	$2,631,149	$1,890	$7,859	$12,107	$24,138
2046	19,346,715	19,554,014	310,350	$192,299	$808,550	$1,248,837	$2,483,294	$194,360	$817,214	$1,262,218	$2,509,902	$3,085	$12,970	$20,033	$39,836
2047	19,346,715	18,938,064	423,681	$187,211	$796,234	$1,233,025	$2,445,274	$183,257	$779,416	$1,206,980	$2,393,624	$4,100	$17,437	$27,002	$53,550
2048	19,346,715	18,311,678	568,756	$182,171	$783,950	$1,217,231	$2,407,363	$172,425	$742,009	$1,152,110	$2,278,571	$5,355	$23,047	$35,784	$70,772
2049	19,346,715	17,718,825	681,038	$177,187	$771,696	$1,201,484	$2,369,577	$162,278	$706,763	$1,100,388	$2,170,194	$6,237	$27,165	$42,294	$83,413
2050	19,346,715	17,188,317	756,330	$172,265	$759,500	$1,185,781	$2,331,959	$153,046	$674,767	$1,053,491	$2,071,796	$6,734	$29,691	$46,356	$91,164
2051	19,346,715	16,681,656	803,289	$165,824	$740,323	$1,172,047	$2,264,517	$142,981	$638,341	$1,010,594	$1,952,574	$6,885	$30,739	$48,664	$94,024
2052	19,346,715	16,099,546	954,922	$162,862	$727,216	$1,153,150	$2,207,016	$135,527	$605,159	$959,605	$1,836,588	$8,039	$35,894	$56,918	$108,935
2053	19,346,715	15,505,417	1,134,888	$159,807	$714,245	$1,134,479	$2,150,944	$128,077	$572,431	$909,228	$1,723,873	$9,374	$41,898	$66,549	$126,175
2054	19,346,715	14,982,651	1,240,087	$152,197	$701,412	$1,116,032	$2,096,265	$117,866	$543,194	$864,287	$1,623,408	$9,756	$44,959	$71,535	$134,367
2055	19,346,715	14,532,890	1,287,308	$149,213	$688,721	$1,097,810	$2,050,686	$112,086	$517,354	$824,654	$1,540,437	$9,928	$45,827	$73,047	$136,450
2056	19,346,715	14,181,027	1,236,414	$142,108	$676,174	$1,079,813	$2,005,983	$104,164	$495,632	$791,497	$1,470,374	$9,082	$43,213	$69,009	$128,199
2057	19,346,715	13,777,248	1,258,451	$139,208	$663,774	$1,062,041	$1,962,145	$99,133	$472,689	$756,304	$1,397,289	$9,055	$43,177	$69,083	$127,632
2058	17,331,432	13,179,233	1,499,018	$122,067	$583,656	$935,692	$1,719,246	$92,823	$443,826	$711,523	$1,307,356	$10,558	$50,481	$80,929	$148,700
2059	13,876,662	12,060,045	2,343,581	$93,081	$453,701	$742,597	$1,346,309	$80,896	$394,306	$645,383	$1,170,062	$15,720	$76,624	$125,415	$227,373
2060	11,112,845	11,072,694	3,042,575	$72,911	$356,589	$584,758	$1,054,430	$72,648	$355,301	$582,645	$1,050,621	$19,962	$97,630	$160,100	$288,691
2061	8,867,245	10,086,497	3,740,208	$56,866	$282,186	$458,770	$831,705	$64,685	$320,986	$521,852	$946,065	$23,986	$119,026	$193,510	$350,814
TOTALS:	581,151,703	698,632,310	22,045,357	$5,971,826	$24,507,577	$37,824,512	$74,515,483	$7,766,405	$30,853,888	$47,228,741	$93,869,763	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-62. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	CH_4 Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
				5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-63. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: Japan, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-64. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,674,993	30,615,304	444,668	$54,347	$192,411	$286,406	$580,762	$452,747	$1,602,923	$2,385,969	$4,838,161	$6,576	$23,281	$34,655	$70,271
2030	8,423,800	30,115,773	97,591	$121,715	$435,733	$649,974	$1,317,216	$435,142	$1,557,780	$2,323,709	$4,709,154	$1,410	$5,048	$7,530	$15,260
2031	14,862,631	30,565,206	-	$210,692	$760,223	$1,135,860	$2,302,554	$433,291	$1,563,409	$2,335,912	$4,735,235	$0	$0	$0	$0
2032	18,111,611	31,291,686	-	$251,670	$915,782	$1,370,661	$2,778,843	$434,814	$1,582,209	$2,368,110	$4,801,045	$0	$0	$0	$0
2033	19,716,443	31,440,534	-	$268,346	$985,178	$1,477,238	$2,994,746	$427,914	$1,570,999	$2,355,655	$4,775,527	$0	$0	$0	$0
2034	19,716,443	30,704,782	-	$262,625	$973,267	$1,462,217	$2,963,607	$408,990	$1,515,686	$2,277,137	$4,615,280	$0	$0	$0	$0
2035	19,716,443	29,610,125	-	$256,851	$961,214	$1,447,034	$2,931,756	$385,738	$1,443,549	$2,173,154	$4,402,906	$0	$0	$0	$0
2036	19,716,443	28,420,346	-	$251,021	$949,037	$1,431,723	$2,899,246	$361,835	$1,367,993	$2,063,762	$4,179,129	$0	$0	$0	$0
2037	19,716,443	27,345,325	-	$245,173	$936,755	$1,416,297	$2,866,129	$340,038	$1,299,213	$1,964,305	$3,975,120	$0	$0	$0	$0
2038	19,716,443	26,371,611	-	$239,304	$924,382	$1,400,786	$2,832,495	$320,080	$1,236,402	$1,873,614	$3,788,587	$0	$0	$0	$0
2039	19,716,443	25,364,115	-	$233,447	$911,936	$1,385,176	$2,798,376	$300,317	$1,173,156	$1,781,953	$3,599,956	$0	$0	$0	$0
2040	19,716,443	24,384,559	-	$227,606	$899,431	$1,369,494	$2,763,854	$281,494	$1,112,382	$1,693,739	$3,418,231	$0	$0	$0	$0
2041	19,716,443	23,387,274	-	$222,324	$886,904	$1,353,403	$2,725,104	$263,717	$1,052,029	$1,605,381	$3,232,467	$0	$0	$0	$0
2042	19,716,443	22,467,576	-	$217,030	$874,344	$1,337,282	$2,686,255	$247,313	$996,346	$1,523,880	$3,061,082	$0	$0	$0	$0
2043	19,716,443	21,626,476	-	$211,736	$861,764	$1,321,130	$2,647,369	$232,247	$945,247	$1,449,115	$2,903,833	$0	$0	$0	$0
2044	19,716,443	20,862,625	36,990	$206,453	$849,174	$1,304,983	$2,608,469	$218,455	$898,539	$1,380,846	$2,760,108	$387	$1,593	$2,448	$4,894
2045	19,716,443	20,188,775	185,213	$201,194	$836,576	$1,288,837	$2,569,589	$206,014	$856,617	$1,319,713	$2,631,147	$1,890	$7,859	$12,107	$24,138
2046	19,716,443	19,554,001	310,350	$195,974	$824,002	$1,272,703	$2,530,751	$194,359	$817,213	$1,262,217	$2,509,900	$3,085	$12,970	$20,033	$39,836
2047	19,716,443	18,938,052	423,681	$190,789	$811,451	$1,256,589	$2,492,005	$183,257	$779,415	$1,206,980	$2,393,623	$4,100	$17,437	$27,002	$53,550
2048	19,716,443	18,311,667	568,756	$185,653	$798,931	$1,240,493	$2,453,370	$172,425	$742,008	$1,152,109	$2,278,570	$5,355	$23,047	$35,784	$70,772
2049	19,716,443	17,718,814	681,038	$180,573	$786,444	$1,224,445	$2,414,861	$162,278	$706,763	$1,100,387	$2,170,193	$6,237	$27,165	$42,294	$83,413
2050	19,716,443	17,188,307	756,330	$175,557	$774,015	$1,208,442	$2,376,524	$153,046	$674,767	$1,053,490	$2,071,795	$6,734	$29,691	$46,356	$91,164
2051	19,716,443	16,681,646	803,289	$168,993	$754,471	$1,194,445	$2,307,793	$142,981	$638,341	$1,010,594	$1,952,573	$6,885	$30,739	$48,664	$94,024
2052	19,716,443	16,099,537	954,922	$165,975	$741,114	$1,175,188	$2,249,193	$135,527	$605,159	$959,604	$1,836,587	$8,039	$35,894	$56,918	$108,935
2053	19,716,443	15,505,409	1,134,888	$162,861	$727,894	$1,156,159	$2,192,049	$128,077	$572,431	$909,227	$1,723,872	$9,374	$41,898	$66,549	$126,175
2054	19,716,443	14,982,643	1,240,087	$155,106	$714,816	$1,137,360	$2,136,326	$117,866	$543,193	$864,287	$1,623,407	$9,756	$44,959	$71,535	$134,367
2055	19,716,443	14,532,883	1,287,308	$152,065	$701,883	$1,118,790	$2,089,876	$112,086	$517,354	$824,654	$1,540,436	$9,928	$45,827	$73,047	$136,450
2056	19,716,443	14,181,020	1,236,414	$144,824	$689,096	$1,100,449	$2,044,319	$104,164	$495,631	$791,496	$1,470,373	$9,082	$43,213	$69,009	$128,199
2057	19,716,443	13,777,242	1,258,451	$141,868	$676,459	$1,082,337	$1,999,643	$99,133	$472,689	$756,304	$1,397,289	$9,055	$43,177	$69,083	$127,632
2058	17,662,647	13,179,227	1,499,018	$124,400	$594,810	$953,574	$1,752,102	$92,823	$443,825	$711,522	$1,307,355	$10,558	$50,481	$80,929	$148,700
2059	14,141,854	12,060,039	2,343,581	$94,860	$462,372	$756,789	$1,372,038	$80,896	$394,306	$645,382	$1,170,061	$15,720	$76,624	$125,415	$227,373
2060	11,325,219	11,072,689	3,042,575	$74,305	$363,404	$595,933	$1,074,581	$72,648	$355,301	$582,645	$1,050,620	$19,962	$97,630	$160,100	$288,691
2061	9,036,703	10,086,492	3,740,208	$57,952	$287,578	$467,538	$847,600	$64,685	$320,986	$521,851	$946,065	$23,986	$119,026	$193,510	$350,814
TOTALS:	592,205,033	698,631,759	22,045,357	$6,085,145	$24,973,120	$38,543,187	$75,931,051	$7,766,398	$30,853,863	$47,228,703	$93,869,686	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-65. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-66. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: South Korea, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion. Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-67. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	Carbon Dioxide (CO_2) Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,677,865	30,615,303	444,668	$54,389	$192,562	$286,630	$581,216	$452,747	$1,602,922	$2,385,968	$4,838,161	$6,576	$23,281	$34,655	$70,271
2030	8,430,980	30,115,772	97,591	$121,819	$436,104	$650,528	$1,318,339	$435,142	$1,557,780	$2,323,708	$4,709,154	$1,410	$5,048	$7,530	$15,260
2031	14,875,555	30,565,204	-	$210,875	$760,884	$1,136,848	$2,304,557	$433,291	$1,563,409	$2,335,912	$4,735,235	$0	$0	$0	$0
2032	18,127,407	31,291,685	-	$251,890	$916,580	$1,371,856	$2,781,266	$434,814	$1,582,209	$2,368,110	$4,801,045	$0	$0	$0	$0
2033	19,733,675	31,440,533	-	$268,581	$986,039	$1,478,529	$2,997,363	$427,914	$1,570,999	$2,355,655	$4,775,527	$0	$0	$0	$0
2034	19,733,675	30,704,781	-	$262,854	$974,117	$1,463,495	$2,966,197	$408,990	$1,515,686	$2,277,137	$4,615,280	$0	$0	$0	$0
2035	19,733,675	29,610,124	-	$257,075	$962,054	$1,448,299	$2,934,318	$385,738	$1,443,549	$2,173,154	$4,402,906	$0	$0	$0	$0
2036	19,733,675	28,420,345	-	$251,240	$949,867	$1,432,974	$2,901,780	$361,834	$1,367,993	$2,063,762	$4,179,129	$0	$0	$0	$0
2037	19,733,675	27,345,324	-	$245,388	$937,573	$1,417,535	$2,868,634	$340,038	$1,299,213	$1,964,305	$3,975,120	$0	$0	$0	$0
2038	19,733,675	26,371,610	-	$239,513	$925,190	$1,402,011	$2,834,971	$320,080	$1,236,402	$1,873,613	$3,788,587	$0	$0	$0	$0
2039	19,733,675	25,364,114	-	$233,651	$912,733	$1,386,387	$2,800,822	$300,317	$1,173,156	$1,781,953	$3,599,956	$0	$0	$0	$0
2040	19,733,675	24,384,558	-	$227,805	$900,217	$1,370,691	$2,766,270	$281,494	$1,112,382	$1,693,739	$3,418,231	$0	$0	$0	$0
2041	19,733,675	23,387,273	-	$222,519	$887,679	$1,354,586	$2,727,486	$263,717	$1,052,029	$1,605,381	$3,232,467	$0	$0	$0	$0
2042	19,733,675	22,467,575	-	$217,220	$875,108	$1,338,451	$2,688,603	$247,313	$996,346	$1,523,880	$3,061,082	$0	$0	$0	$0
2043	19,733,675	21,626,476	-	$211,921	$862,517	$1,322,285	$2,649,683	$232,247	$945,247	$1,449,115	$2,903,833	$0	$0	$0	$0
2044	19,733,675	20,862,624	36,990	$206,634	$849,916	$1,306,124	$2,610,749	$218,455	$898,539	$1,380,846	$2,760,108	$387	$1,593	$2,448	$4,894
2045	19,733,675	20,188,774	185,213	$201,370	$837,307	$1,289,964	$2,571,835	$206,014	$856,617	$1,319,713	$2,631,147	$1,890	$7,859	$12,107	$24,138
2046	19,733,675	19,554,000	310,350	$196,145	$824,722	$1,273,815	$2,532,963	$194,359	$817,213	$1,262,217	$2,509,900	$3,085	$12,970	$20,033	$39,836
2047	19,733,675	18,938,052	423,681	$190,955	$812,160	$1,257,687	$2,494,183	$183,257	$779,415	$1,206,980	$2,393,623	$4,100	$17,437	$27,002	$53,550
2048	19,733,675	18,311,666	568,756	$185,815	$799,630	$1,241,577	$2,455,514	$172,425	$742,008	$1,152,109	$2,278,570	$5,355	$23,047	$35,784	$70,772
2049	19,733,675	17,718,814	681,038	$180,731	$787,131	$1,225,515	$2,416,972	$162,278	$706,763	$1,100,387	$2,170,193	$6,237	$27,165	$42,294	$83,413
2050	19,733,675	17,188,307	756,330	$175,710	$774,691	$1,209,498	$2,378,601	$153,046	$674,767	$1,053,490	$2,071,795	$6,734	$29,691	$46,356	$91,164
2051	19,733,675	16,681,646	803,289	$169,140	$755,130	$1,195,489	$2,309,810	$142,981	$638,341	$1,010,594	$1,952,573	$6,885	$30,739	$48,664	$94,024
2052	19,733,675	16,099,537	954,922	$166,120	$741,761	$1,176,215	$2,251,159	$135,527	$605,159	$959,604	$1,836,587	$8,039	$35,894	$56,918	$108,935
2053	19,733,675	15,505,408	1,134,888	$163,004	$728,530	$1,157,170	$2,193,965	$128,077	$572,431	$909,227	$1,723,872	$9,374	$41,898	$66,549	$126,175
2054	19,733,675	14,982,643	1,240,087	$155,242	$715,441	$1,138,354	$2,138,193	$117,866	$543,193	$864,287	$1,623,407	$9,756	$44,959	$71,535	$134,367
2055	19,733,675	14,532,882	1,287,308	$152,198	$702,496	$1,119,768	$2,091,702	$112,086	$517,354	$824,654	$1,540,436	$9,928	$45,827	$73,047	$136,450
2056	19,733,675	14,181,020	1,236,414	$144,950	$689,699	$1,101,411	$2,046,106	$104,164	$495,631	$791,496	$1,470,373	$9,082	$43,213	$69,009	$128,199
2057	19,733,675	13,777,242	1,258,451	$141,992	$677,050	$1,083,283	$2,001,391	$99,133	$472,689	$756,304	$1,397,289	$9,055	$43,177	$69,083	$127,632
2058	17,678,084	13,179,227	1,499,018	$124,509	$595,329	$954,407	$1,753,634	$92,823	$443,825	$711,522	$1,307,355	$10,558	$50,481	$80,929	$148,700
2059	14,154,213	12,060,039	2,343,581	$94,943	$462,776	$757,450	$1,373,237	$80,896	$394,306	$645,382	$1,170,061	$15,720	$76,624	$125,415	$227,373
2060	11,335,117	11,072,689	3,042,575	$74,369	$363,721	$596,454	$1,075,520	$72,648	$355,301	$582,645	$1,050,620	$19,962	$97,630	$160,100	$288,691
2061	9,044,601	10,086,492	3,740,208	$58,003	$287,830	$467,946	$848,340	$64,685	$320,986	$521,851	$946,065	$23,986	$119,026	$193,510	$350,814
TOTALS:	592,720,188	698,631,738	22,045,357	$6,090,426	$24,994,817	$38,576,681	$75,997,025	$7,766,398	$30,853,862	$47,228,701	$93,869,683	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-68. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	29,585	20,266	347	$21,112	$48,680	$64,121	$129,184	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	73,648	19,362	76	$51,549	$120,549	$159,250	$320,143	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	132,227	18,769	-	$91,373	$216,081	$286,049	$574,572	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	161,607	18,355	-	$110,118	$263,466	$349,556	$701,403	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	176,295	17,816	-	$118,313	$286,522	$381,045	$763,642	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	176,295	17,065	-	$116,399	$285,440	$380,551	$761,572	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	176,295	16,214	-	$114,400	$284,179	$379,854	$758,975	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	176,295	15,373	-	$112,327	$282,749	$378,965	$755,883	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	176,295	14,598	-	$110,192	$281,161	$377,894	$752,327	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	176,295	13,880	-	$108,005	$279,426	$376,649	$748,338	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	176,295	13,182	-	$105,777	$277,553	$375,240	$743,942	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	176,295	12,521	-	$103,517	$275,552	$373,676	$739,168	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	176,295	11,882	-	$101,472	$273,490	$371,859	$733,073	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	176,295	11,285	-	$99,387	$271,315	$369,909	$726,707	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	176,295	10,734	-	$97,271	$269,034	$367,833	$720,089	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	176,295	10,231	29	$95,130	$266,655	$365,638	$713,240	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	176,295	9,797	145	$92,973	$264,187	$363,331	$706,179	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	176,295	9,389	242	$90,806	$261,637	$360,920	$698,925	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	176,295	8,998	331	$88,635	$259,011	$358,409	$691,494	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	176,295	8,629	444	$86,464	$256,316	$355,807	$683,903	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	176,295	8,271	532	$84,299	$253,558	$353,118	$676,167	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	176,295	7,943	591	$82,144	$250,744	$350,349	$668,302	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	176,295	7,627	627	$79,330	$245,717	$344,571	$650,246	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	176,295	7,320	746	$76,587	$241,026	$339,169	$634,003	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	176,295	7,029	886	$73,925	$236,325	$333,739	$618,156	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	176,295	6,755	969	$71,343	$231,693	$328,457	$602,621	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	176,295	6,495	1,005	$68,839	$227,131	$323,234	$587,537	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	176,295	6,254	966	$66,486	$222,912	$318,310	$573,231	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	176,295	6,022	983	$64,236	$218,745	$313,512	$559,326	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	157,931	5,787	1,171	$55,556	$192,275	$276,596	$488,839	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	126,450	5,521	1,831	$42,937	$150,992	$218,031	$381,839	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	101,265	5,265	2,377	$33,202	$118,620	$171,929	$298,349	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	80,802	5,010	2,921	$26,852	$96,035	$139,220	$245,419	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,271,671	363,643	17,219	$2,741,543	$7,710,083	$10,608,498	$20,410,250	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-69. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: China, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons): Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	N_2O Emissions (Metric Tons): Alaskan Oil Production and End Use: with Alaska LNG Export Project	N_2O Emissions (Metric Tons): Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project, Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Alaskan Oil Production and End Use: with Alaska LNG Export Project, Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion, Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$): 5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	16	15	1	$93	$300	$442	$793	$90	$291	$429	$770	$6	$19	$28	$50
2030	25	16	0	$143	$470	$695	$1,245	$92	$300	$444	$796	$1	$4	$6	$11
2031	41	18	-	$232	$767	$1,136	$2,033	$103	$342	$506	$906	$0	$0	$0	$0
2032	48	21	-	$271	$906	$1,345	$2,404	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	52	22	-	$286	$964	$1,434	$2,561	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	52	23	-	$280	$955	$1,424	$2,539	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	52	23	-	$274	$946	$1,414	$2,516	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	52	22	-	$268	$936	$1,403	$2,492	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	52	22	-	$262	$926	$1,392	$2,467	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	52	22	-	$256	$916	$1,380	$2,442	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	52	21	-	$250	$906	$1,368	$2,416	$102	$369	$557	$983	$0	$0	$0	$0
2040	52	21	-	$244	$895	$1,356	$2,390	$97	$357	$541	$953	$0	$0	$0	$0
2041	52	20	-	$239	$886	$1,345	$2,365	$93	$344	$523	$919	$0	$0	$0	$0
2042	52	20	-	$234	$876	$1,334	$2,339	$89	$333	$506	$888	$0	$0	$0	$0
2043	52	19	-	$229	$866	$1,322	$2,313	$85	$322	$492	$860	$0	$0	$0	$0
2044	52	19	0	$224	$856	$1,310	$2,287	$82	$313	$480	$837	$0	$1	$2	$4
2045	52	19	0	$218	$846	$1,298	$2,260	$80	$308	$473	$823	$2	$7	$10	$18
2046	52	19	1	$213	$836	$1,286	$2,233	$77	$302	$465	$808	$3	$11	$17	$29
2047	52	19	1	$208	$825	$1,274	$2,205	$75	$296	$457	$792	$4	$15	$23	$39
2048	52	18	1	$203	$815	$1,261	$2,177	$72	$290	$449	$775	$5	$20	$30	$52
2049	52	18	1	$197	$804	$1,248	$2,149	$70	$284	$440	$758	$6	$23	$36	$62
2050	52	18	2	$192	$794	$1,235	$2,121	$67	$277	$431	$740	$6	$25	$39	$68
2051	52	18	2	$187	$781	$1,218	$2,069	$65	$269	$420	$714	$6	$26	$41	$70
2052	52	18	2	$183	$770	$1,204	$2,040	$62	$262	$410	$695	$7	$31	$48	$82
2053	52	17	2	$178	$759	$1,191	$2,011	$60	$255	$400	$676	$9	$36	$57	$96
2054	52	17	3	$173	$748	$1,177	$1,982	$57	$248	$390	$657	$9	$39	$62	$104
2055	52	17	3	$169	$737	$1,164	$1,953	$55	$241	$381	$639	$9	$40	$63	$106
2056	52	17	3	$164	$727	$1,151	$1,923	$53	$235	$371	$620	$9	$38	$60	$100
2057	52	16	3	$160	$717	$1,138	$1,893	$51	$228	$362	$602	$8	$38	$60	$100
2058	46	16	3	$139	$633	$1,008	$1,670	$49	$221	$351	$582	$10	$45	$71	$118
2059	37	16	5	$109	$499	$797	$1,316	$46	$213	$340	$562	$15	$69	$110	$181
2060	30	16	7	$84	$394	$631	$1,037	$44	$206	$330	$542	$19	$88	$141	$231
2061	24	15	8	$67	$312	$500	$827	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	1,604	617	48	$6,883	$26,168	$40,055	$69,582	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

Table E.3-70. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Carbon Dioxide (CO_2)

Year of Emissions	Carbon Dioxide (CO_2) Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-CO2 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	59,127	-	-	$972	$3,273	$4,827	$9,794	$0	$0	$0	$0	$0	$0	$0	$0
2025	276,541	-	-	$4,456	$15,149	$22,380	$45,417	$0	$0	$0	$0	$0	$0	$0	$0
2026	388,570	-	-	$6,135	$21,057	$31,162	$63,243	$0	$0	$0	$0	$0	$0	$0	$0
2027	517,445	-	-	$8,000	$27,730	$41,113	$83,428	$0	$0	$0	$0	$0	$0	$0	$0
2028	812,806	-	-	$12,295	$43,061	$63,967	$129,767	$0	$0	$0	$0	$0	$0	$0	$0
2029	3,997,833	30,615,101	444,668	$59,121	$209,314	$311,567	$631,781	$452,744	$1,602,912	$2,385,953	$4,838,129	$6,576	$23,281	$34,655	$70,271
2030	9,230,901	30,115,582	97,591	$133,377	$477,481	$712,249	$1,443,421	$435,139	$1,557,770	$2,323,694	$4,709,124	$1,410	$5,048	$7,530	$15,260
2031	16,315,412	30,565,026	-	$231,287	$834,533	$1,246,887	$2,527,623	$433,289	$1,563,400	$2,335,898	$4,735,207	$0	$0	$0	$0
2032	19,887,232	31,291,518	-	$276,343	$1,005,563	$1,505,037	$3,051,274	$434,812	$1,582,201	$2,368,098	$4,801,020	$0	$0	$0	$0
2033	21,653,484	31,440,376	-	$294,710	$1,081,966	$1,622,369	$3,288,964	$427,912	$1,570,991	$2,355,644	$4,775,503	$0	$0	$0	$0
2034	21,653,484	30,704,633	-	$288,426	$1,068,885	$1,605,872	$3,254,766	$408,988	$1,515,679	$2,277,126	$4,615,258	$0	$0	$0	$0
2035	21,653,484	29,609,987	-	$282,085	$1,055,648	$1,589,198	$3,219,786	$385,736	$1,443,542	$2,173,144	$4,402,886	$0	$0	$0	$0
2036	21,653,484	28,420,216	-	$275,682	$1,042,275	$1,572,382	$3,184,082	$361,833	$1,367,987	$2,063,753	$4,179,110	$0	$0	$0	$0
2037	21,653,484	27,345,204	-	$269,261	$1,028,786	$1,555,441	$3,147,712	$340,037	$1,299,207	$1,964,296	$3,975,103	$0	$0	$0	$0
2038	21,653,484	26,371,497	-	$262,815	$1,015,198	$1,538,407	$3,110,773	$320,078	$1,236,397	$1,873,605	$3,788,570	$0	$0	$0	$0
2039	21,653,484	25,364,009	-	$256,382	$1,001,529	$1,521,263	$3,073,302	$300,316	$1,173,151	$1,781,945	$3,599,941	$0	$0	$0	$0
2040	21,653,484	24,384,460	-	$249,967	$987,795	$1,504,040	$3,035,389	$281,493	$1,112,378	$1,693,732	$3,418,217	$0	$0	$0	$0
2041	21,653,484	23,387,181	-	$244,167	$974,038	$1,486,368	$2,992,832	$263,716	$1,052,025	$1,605,375	$3,232,454	$0	$0	$0	$0
2042	21,653,484	22,467,488	-	$238,352	$960,244	$1,468,663	$2,950,166	$247,312	$996,342	$1,523,874	$3,061,070	$0	$0	$0	$0
2043	21,653,484	21,626,394	-	$232,537	$946,427	$1,450,925	$2,907,460	$232,247	$945,243	$1,449,110	$2,903,822	$0	$0	$0	$0
2044	21,653,484	20,862,548	36,990	$226,736	$932,601	$1,433,191	$2,864,738	$218,454	$898,536	$1,380,841	$2,760,098	$387	$1,593	$2,448	$4,894
2045	21,653,484	20,188,703	185,213	$220,960	$918,765	$1,415,459	$2,822,038	$206,013	$856,614	$1,319,708	$2,631,137	$1,890	$7,859	$12,107	$24,138
2046	21,653,484	19,553,934	310,350	$215,228	$904,956	$1,397,740	$2,779,384	$194,359	$817,210	$1,262,213	$2,509,892	$3,085	$12,970	$20,033	$39,836
2047	21,653,484	18,937,989	423,681	$209,533	$891,172	$1,380,042	$2,736,832	$183,256	$779,413	$1,206,976	$2,393,615	$4,100	$17,437	$27,002	$53,550
2048	21,653,484	18,311,608	568,756	$203,892	$877,422	$1,362,365	$2,694,401	$172,425	$742,006	$1,152,105	$2,278,562	$5,355	$23,047	$35,784	$70,772
2049	21,653,484	17,718,759	681,038	$198,314	$863,708	$1,344,741	$2,652,109	$162,278	$706,761	$1,100,383	$2,170,186	$6,237	$27,165	$42,294	$83,413
2050	21,653,484	17,188,255	756,330	$192,804	$850,058	$1,327,166	$2,610,005	$153,046	$674,765	$1,053,487	$2,071,788	$6,734	$29,691	$46,356	$91,164
2051	21,653,484	16,681,598	803,289	$185,595	$828,594	$1,311,793	$2,534,522	$142,980	$638,339	$1,010,591	$1,952,567	$6,885	$30,739	$48,664	$94,024
2052	21,653,484	16,099,492	954,922	$182,281	$813,924	$1,290,644	$2,470,165	$135,527	$605,157	$959,601	$1,836,582	$8,039	$35,894	$56,918	$108,935
2053	21,653,484	15,505,366	1,134,888	$178,862	$799,406	$1,269,746	$2,407,407	$128,077	$572,429	$909,225	$1,723,867	$9,374	$41,898	$66,549	$126,175
2054	21,653,484	14,982,603	1,240,087	$170,344	$785,043	$1,249,100	$2,346,210	$117,866	$543,192	$864,284	$1,623,403	$9,756	$44,959	$71,535	$134,367
2055	21,653,484	14,532,845	1,287,308	$167,004	$770,839	$1,228,705	$2,295,196	$112,086	$517,353	$824,652	$1,540,432	$9,928	$45,827	$73,047	$136,450
2056	21,653,484	14,180,985	1,236,414	$159,052	$756,796	$1,208,563	$2,245,163	$104,164	$495,630	$791,494	$1,470,369	$9,082	$43,213	$69,009	$128,199
2057	21,653,484	13,777,209	1,258,451	$155,806	$742,918	$1,188,672	$2,196,098	$99,133	$472,688	$756,302	$1,397,285	$9,055	$43,177	$69,083	$127,632
2058	19,397,913	13,179,196	1,499,018	$136,622	$653,247	$1,047,258	$1,924,237	$92,823	$443,824	$711,521	$1,307,352	$10,558	$50,481	$80,929	$148,700
2059	15,531,219	12,060,010	2,343,581	$104,179	$507,797	$831,140	$1,506,834	$80,895	$394,305	$645,381	$1,170,058	$15,720	$76,624	$125,415	$227,373
2060	12,437,864	11,072,662	3,042,575	$81,605	$399,106	$654,480	$1,180,153	$72,648	$355,300	$582,643	$1,050,618	$19,962	$97,630	$160,100	$288,691
2061	9,924,514	10,086,468	3,740,208	$63,646	$315,832	$513,471	$930,872	$64,684	$320,985	$521,850	$946,063	$23,986	$119,026	$193,510	$350,814
TOTALS:	650,114,481	698,628,901	22,045,357	$6,678,831	$27,412,140	$42,308,393	$83,347,344	$7,766,364	$30,853,732	$47,228,504	$93,869,288	$168,120	$777,560	$1,242,970	$2,324,659

Table E.3-71. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Methane (CH_4)

Year of Emissions	CH_4 Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion — Present Value (in Base Year: 2024) of Estimated SC-CH4 by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	8	-	-	$6	$14	$18	$36	$0	$0	$0	$0	$0	$0	$0	$0
2025	186	-	-	$142	$310	$404	$820	$0	$0	$0	$0	$0	$0	$0	$0
2026	190	-	-	$143	$317	$414	$838	$0	$0	$0	$0	$0	$0	$0	$0
2027	195	-	-	$144	$324	$424	$858	$0	$0	$0	$0	$0	$0	$0	$0
2028	207	-	-	$150	$342	$449	$907	$0	$0	$0	$0	$0	$0	$0	$0
2029	30,905	20,266	347	$22,054	$50,853	$66,983	$134,949	$14,462	$33,347	$43,924	$88,494	$248	$571	$753	$1,517
2030	76,949	19,362	76	$53,859	$125,952	$166,388	$334,492	$13,552	$31,693	$41,867	$84,167	$53	$125	$165	$331
2031	138,169	18,769	-	$95,479	$225,791	$298,903	$600,390	$12,970	$30,672	$40,604	$81,559	$0	$0	$0	$0
2032	168,869	18,355	-	$115,067	$275,305	$365,264	$732,922	$12,507	$29,923	$39,701	$79,662	$0	$0	$0	$0
2033	184,217	17,816	-	$123,629	$299,397	$398,168	$797,958	$11,956	$28,955	$38,508	$77,172	$0	$0	$0	$0
2034	184,217	17,065	-	$121,630	$298,267	$397,652	$795,795	$11,267	$27,630	$36,836	$73,717	$0	$0	$0	$0
2035	184,217	16,214	-	$119,541	$296,949	$396,924	$793,081	$10,521	$26,135	$34,935	$69,802	$0	$0	$0	$0
2036	184,217	15,373	-	$117,374	$295,455	$395,995	$789,851	$9,795	$24,656	$33,047	$65,915	$0	$0	$0	$0
2037	184,217	14,598	-	$115,144	$293,796	$394,875	$786,135	$9,124	$23,281	$31,291	$62,296	$0	$0	$0	$0
2038	184,217	13,880	-	$112,859	$291,983	$393,575	$781,966	$8,503	$21,999	$29,654	$58,917	$0	$0	$0	$0
2039	184,217	13,182	-	$110,531	$290,026	$392,103	$777,373	$7,910	$20,754	$28,059	$55,628	$0	$0	$0	$0
2040	184,217	12,521	-	$108,169	$287,935	$390,468	$772,385	$7,352	$19,571	$26,541	$52,500	$0	$0	$0	$0
2041	184,217	11,882	-	$106,032	$285,780	$388,570	$766,016	$6,839	$18,433	$25,063	$49,408	$0	$0	$0	$0
2042	184,217	11,285	-	$103,853	$283,507	$386,532	$759,363	$6,362	$17,368	$23,679	$46,520	$0	$0	$0	$0
2043	184,217	10,734	-	$101,642	$281,123	$384,363	$752,448	$5,922	$16,380	$22,396	$43,843	$0	$0	$0	$0
2044	184,217	10,231	29	$99,405	$278,638	$382,069	$745,291	$5,521	$15,475	$21,219	$41,391	$16	$44	$60	$117
2045	184,217	9,797	145	$97,152	$276,059	$379,659	$737,913	$5,167	$14,681	$20,191	$39,244	$76	$217	$298	$579
2046	184,217	9,389	242	$94,887	$273,394	$377,139	$730,333	$4,836	$13,934	$19,221	$37,221	$125	$360	$496	$961
2047	184,217	8,998	331	$92,618	$270,650	$374,516	$722,568	$4,524	$13,220	$18,294	$35,294	$166	$486	$673	$1,298
2048	184,217	8,629	444	$90,349	$267,834	$371,796	$714,636	$4,232	$12,545	$17,415	$33,473	$218	$646	$897	$1,723
2049	184,217	8,271	532	$88,087	$264,953	$368,987	$706,553	$3,955	$11,896	$16,567	$31,723	$254	$765	$1,065	$2,040
2050	184,217	7,943	591	$85,835	$262,012	$366,093	$698,334	$3,701	$11,297	$15,784	$30,109	$275	$840	$1,174	$2,239
2051	184,217	7,627	627	$82,895	$256,759	$360,055	$679,466	$3,432	$10,630	$14,906	$28,130	$282	$875	$1,226	$2,314
2052	184,217	7,320	746	$80,028	$251,857	$354,410	$662,494	$3,180	$10,008	$14,083	$26,325	$324	$1,020	$1,435	$2,682
2053	184,217	7,029	886	$77,247	$246,945	$348,737	$645,934	$2,948	$9,423	$13,307	$24,648	$372	$1,188	$1,678	$3,108
2054	184,217	6,755	969	$74,549	$242,105	$343,217	$629,701	$2,734	$8,877	$12,585	$23,090	$392	$1,273	$1,805	$3,311
2055	184,217	6,495	1,005	$71,933	$237,338	$337,759	$613,939	$2,536	$8,368	$11,908	$21,645	$393	$1,295	$1,844	$3,351
2056	184,217	6,254	966	$69,474	$232,929	$332,614	$598,991	$2,358	$7,907	$11,291	$20,334	$364	$1,221	$1,744	$3,140
2057	184,217	6,022	983	$67,123	$228,575	$327,600	$584,461	$2,194	$7,472	$10,710	$19,107	$358	$1,220	$1,748	$3,119
2058	165,028	5,787	1,171	$58,053	$200,916	$289,026	$510,807	$2,036	$7,045	$10,134	$17,911	$412	$1,425	$2,051	$3,624
2059	132,132	5,521	1,831	$44,866	$157,777	$227,829	$398,998	$1,875	$6,592	$9,519	$16,671	$622	$2,186	$3,156	$5,528
2060	105,815	5,265	2,377	$34,694	$123,950	$179,655	$311,756	$1,726	$6,167	$8,939	$15,512	$779	$2,784	$4,035	$7,002
2061	84,433	5,010	2,921	$28,059	$100,350	$145,476	$256,447	$1,665	$5,954	$8,631	$15,216	$971	$3,472	$5,034	$8,873
TOTALS:	5,508,515	363,643	17,219	$2,864,702	$8,056,468	$11,085,105	$21,327,207	$207,662	$552,291	$750,808	$1,466,643	$6,700	$22,013	$31,335	$56,859

Table E.3-72. Scenario 3: Use and Storage of By-Product CO_2: LNG Destination Country: India, End Use: Natural Gas Combined Cycle (NGCC) Power Plant with CCS, Social Cost (SC) of Nitrous Oxide (N_2O)

Year of Emissions	N_2O Emissions (Metric Tons)			Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Alaskan Oil Production and End Use: with Alaska LNG Export Project Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)				Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion Present Value (in Base Year: 2024) of Estimated SC-N2O by emissions year ($1,000, 2020$)			
	Alaskan Natural Gas Production and End Use: from Alaska LNG Export Project	Alaskan Oil Production and End Use: with Alaska LNG Export Project	Global Proxy based on US Average Crude Oil Production and End Use: LCA System Expansion	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile	5% Average	3% Average	2.5% Average	3%, 95th Percentile
2024	0	-	-	$0	$1	$2	$4	$0	$0	$0	$0	$0	$0	$0	$0
2025	4	-	-	$23	$72	$106	$191	$0	$0	$0	$0	$0	$0	$0	$0
2026	6	-	-	$41	$129	$188	$340	$0	$0	$0	$0	$0	$0	$0	$0
2027	10	-	-	$61	$194	$285	$513	$0	$0	$0	$0	$0	$0	$0	$0
2028	21	-	-	$126	$403	$593	$1,066	$0	$0	$0	$0	$0	$0	$0	$0
2029	19	15	1	$113	$364	$537	$964	$90	$291	$429	$770	$6	$19	$28	$50
2030	33	16	0	$192	$630	$931	$1,669	$92	$300	$444	$796	$1	$4	$6	$11
2031	56	18	-	$318	$1,053	$1,559	$2,791	$103	$342	$506	$906	$0	$0	$0	$0
2032	67	21	-	$375	$1,252	$1,859	$3,323	$116	$388	$576	$1,030	$0	$0	$0	$0
2033	72	22	-	$397	$1,338	$1,991	$3,555	$123	$416	$619	$1,106	$0	$0	$0	$0
2034	72	23	-	$389	$1,326	$1,977	$3,524	$123	$418	$624	$1,112	$0	$0	$0	$0
2035	72	23	-	$380	$1,313	$1,962	$3,492	$119	$411	$614	$1,093	$0	$0	$0	$0
2036	72	22	-	$372	$1,299	$1,947	$3,459	$114	$399	$598	$1,062	$0	$0	$0	$0
2037	72	22	-	$364	$1,286	$1,932	$3,425	$110	$389	$584	$1,036	$0	$0	$0	$0
2038	72	22	-	$356	$1,272	$1,916	$3,390	$106	$380	$572	$1,012	$0	$0	$0	$0
2039	72	21	-	$347	$1,257	$1,899	$3,354	$102	$369	$557	$983	$0	$0	$0	$0
2040	72	21	-	$339	$1,243	$1,883	$3,317	$97	$357	$541	$953	$0	$0	$0	$0
2041	72	20	-	$332	$1,230	$1,867	$3,283	$93	$344	$523	$919	$0	$0	$0	$0
2042	72	20	-	$325	$1,216	$1,851	$3,247	$89	$333	$506	$888	$0	$0	$0	$0
2043	72	19	-	$318	$1,203	$1,835	$3,211	$85	$322	$492	$860	$0	$0	$0	$0
2044	72	19	0	$310	$1,189	$1,819	$3,174	$82	$313	$480	$837	$0	$1	$2	$4
2045	72	19	0	$303	$1,174	$1,802	$3,137	$80	$308	$473	$823	$2	$7	$10	$18
2046	72	19	1	$296	$1,160	$1,785	$3,099	$77	$302	$465	$808	$3	$11	$17	$29
2047	72	19	1	$289	$1,146	$1,768	$3,061	$75	$296	$457	$792	$4	$15	$23	$39
2048	72	18	1	$281	$1,131	$1,750	$3,022	$72	$290	$449	$775	$5	$20	$30	$52
2049	72	18	1	$274	$1,116	$1,733	$2,983	$70	$284	$440	$758	$6	$23	$36	$62
2050	72	18	2	$267	$1,101	$1,715	$2,944	$67	$277	$431	$740	$6	$25	$39	$68
2051	72	18	2	$260	$1,084	$1,690	$2,872	$65	$269	$420	$714	$6	$26	$41	$70
2052	72	18	2	$253	$1,069	$1,672	$2,832	$62	$262	$410	$695	$7	$31	$48	$82
2053	72	17	2	$247	$1,054	$1,653	$2,792	$60	$255	$400	$676	$9	$36	$57	$96
2054	72	17	3	$241	$1,039	$1,634	$2,751	$57	$248	$390	$657	$9	$39	$62	$104
2055	72	17	3	$234	$1,024	$1,615	$2,711	$55	$241	$381	$639	$9	$40	$63	$106
2056	72	17	3	$228	$1,009	$1,597	$2,669	$53	$235	$371	$620	$9	$38	$60	$100
2057	72	16	3	$222	$995	$1,579	$2,628	$51	$228	$362	$602	$8	$38	$60	$100
2058	65	16	3	$193	$878	$1,399	$2,318	$49	$221	$351	$582	$10	$45	$71	$118
2059	52	16	5	$151	$693	$1,107	$1,826	$46	$213	$340	$562	$15	$69	$110	$181
2060	41	16	7	$117	$547	$876	$1,439	$44	$206	$330	$542	$19	$88	$141	$231
2061	33	15	8	$93	$433	$695	$1,147	$43	$200	$321	$531	$23	$107	$172	$284
TOTALS:	2,206	617	48	$9,428	$35,922	$55,009	$95,524	$2,670	$10,108	$15,458	$26,879	$156	$681	$1,076	$1,804

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