NETL CO2 Utilization LCA Guidelines

ISSST 2019 Conference

Timothy J. Skone, P.E.

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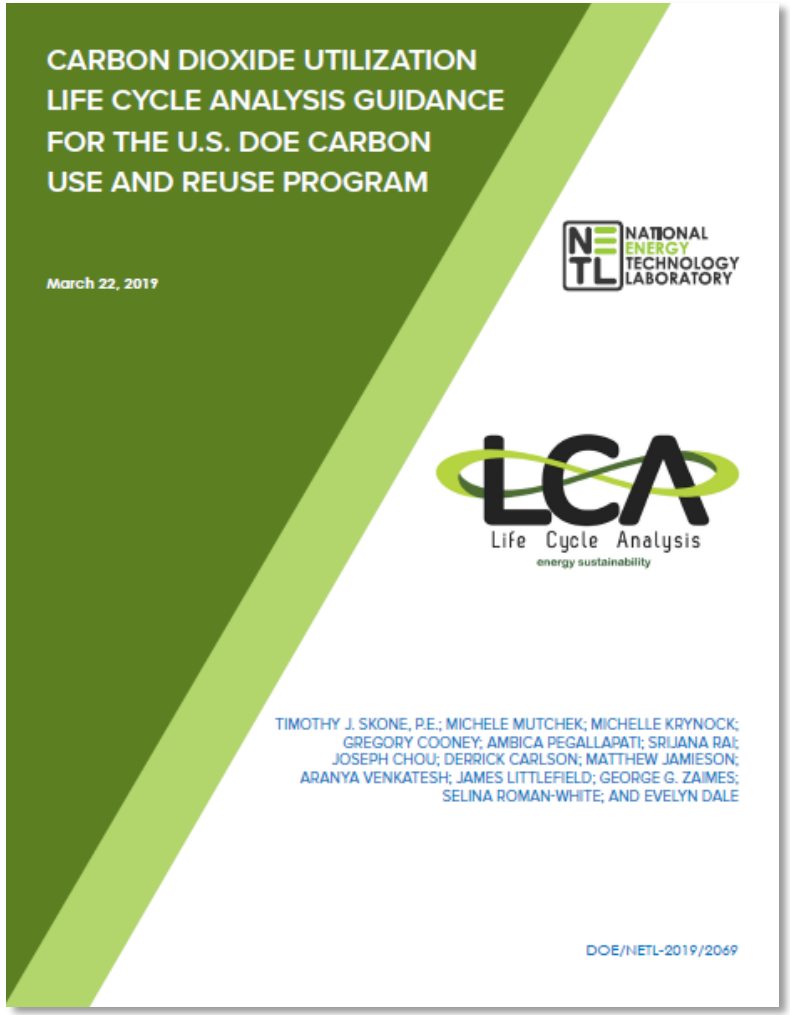
Presentation Agenda

- Motivation for NETL Guidelines
- NETL CO2U LCA Toolkit Goals and Overview
- LCA/TEA CO2U Workshop
- LCA Methods Example Discussion



Motivation – U.S. DOE Carbon Use and Reuse Program FOA Requirements

Applications for Technologies Directed at Utilizing Carbon Dioxide from Coal Fired Power Plants (DE-FOA-0001622), states that the *Principal Investigator* (PI) shall provide

> "…Life Cycle Analysis further demonstrating the potential of the proposed process to be a substantive CO_2 mitigation option, by verifying the **lifecycle GHG reduction potential of the products(s) and technology (on a percent reduction basis) relative to current state-of-the-art pathways**"

CO2U LCA Requirements in U.S. Federal Programs and Policy

- **26 USC 45Q: Credit for carbon oxide sequestration (aka, 45Q)**
  - LCA (GHG analysis) required for tax credit (non-EOR utilization)
  - "(B) Measurement
    - (i) In general For purposes of determining the amount of qualified carbon oxide utilized by the taxpayer under paragraph (2)(B)(ii) or (4)(B)(ii) of subsection (a), such amount shall be equal to the metric tons of qualified carbon oxide which the taxpayer demonstrates, **based upon an analysis of lifecycle greenhouse gas emissions** and subject to such requirements as the Secretary, in consultation with the Secretary of Energy and the Administrator of the Environmental Protection Agency, determines appropriate…

NETL CO2U LCA Toolkit Goals

1. Provide LCA guidance, data, and tools to U.S. DOE Carbon Use and Reuse Program project PIs to complete their project LCA and documentation requirements

2. Foster better decision-making for the U.S. DOE Carbon Use and Reuse Program by providing an analysis and reporting structure for the project LCAs that allows for consistency and transparency

3. Provide LCA guidance, data, and tools to others seeking guidance on conducting LCA in the area of CO2U

4. Contribute to the global discussion on CO2U LCA and LCA methods

Why the need for additional guidance beyond ISO 14040/14044?

- All of the guidance included in the NETL CO2U LCA Toolkit is ISO compliant
- Additional guidance is helpful for handling CO2U systems to
  1. Ensure methodological consistency in applying the ISO standards
     ISO standards provide a broad framework for applying LCA to a wide range of applications. This can lead to inconsistency in modeling choices and results interpretation that can confound or negate study conclusions.
  2. Define study goal & scope based on project Technology Readiness Level (TRL)
     There can be a lot of unknowns in the life cycles of emerging technologies. This guidance aims to assist principal investigators with the expectations of completing their comparative LCAs at different stages of technology development.

NETL CO2U Guidance Key Points

Comparative LCA

LCA goal is to compare the CO2U system to the long-run marginal competitor in the market (comparison system)

Multiproduct functional unit with system expansion

Improve comparability and results interpretation

Default scenarios for CO2 sources

Coal-fired power generation: flue gas, captured CO_2 greenfield and retrofit

Guidance for comparison processes and system

Data quality and representativeness: expectations based on TRL

Three modeling options

1. openLCA with provided data
2. Excel-based documentation sheet
3. Other commercial LCA modeling software

Interpretation requirements

Specific data/figures to provide consistency to study comparisons

NETL CO2U LCA Guidance Toolkit

NATIONAL ENERGY TECHNOLOGY LABORATORY

GUIDANCE DOCUMENT

Analysis requirements and instructions for using the supporting data and tools

DOCUMENTATION SPREADSHEET

Excel file that can be used to document data when not using openLCA

OPENLCA MODEL TRAINING

Provided to PIs to aid in the modeling of their LCA in openLCA

OPENLCA LCI DATABASE

openLCA database that includes NETL unit process data and an example CO2U LCA

LCA
Life Cycle Analysis

SUBJECT MATTER EXPERT SUPPORT

Available to PIs for all phases of the LCA from conception to documentation

OPENLCA CONTRIBUTION TOOL

Excel template that translates openLCA results into required charts

LCA REPORT TEMPLATE

Word report template for summarizing data and results

netl.doe.gov/LCA

LCA@netl.doe.gov

LCA/TEA Workshop: Overview

- Gathering of government, academia, industry, NGOs on April 10-11, 2019
- Discussion of two guidance documents – UM Global CO_2 Initiative and NETL
- Exploration of metrics, best practices, validation
- Next steps for building global toolkit for measuring and reporting
- Target applications: project investment, product marketing, and policy needs

Workshop Organizers

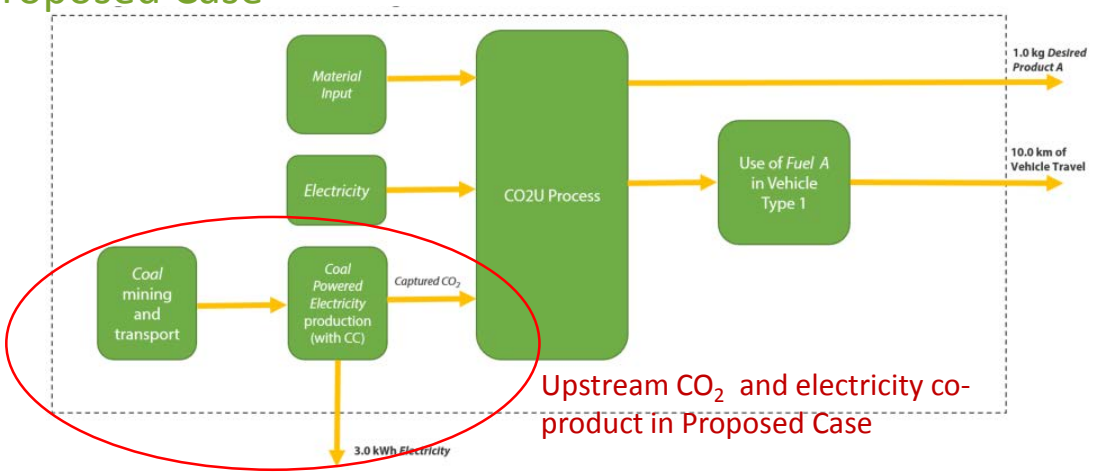
LCA/TEA Workshop: LCA Takeaways

1. General agreement on methods and approach
2. Graduated approach based on TRL; approaches for streamlining
3. Harmonization of data for life cycle inventories and scenario development
4. Standardization of terminology where possible
5. Impact assessment beyond global warming potential
6. Interest in guidance for policymakers, investors, etc. for reviewing LCA results

One Area of Method Development is Upstream CO_2 and Electricity Co-Product Determination

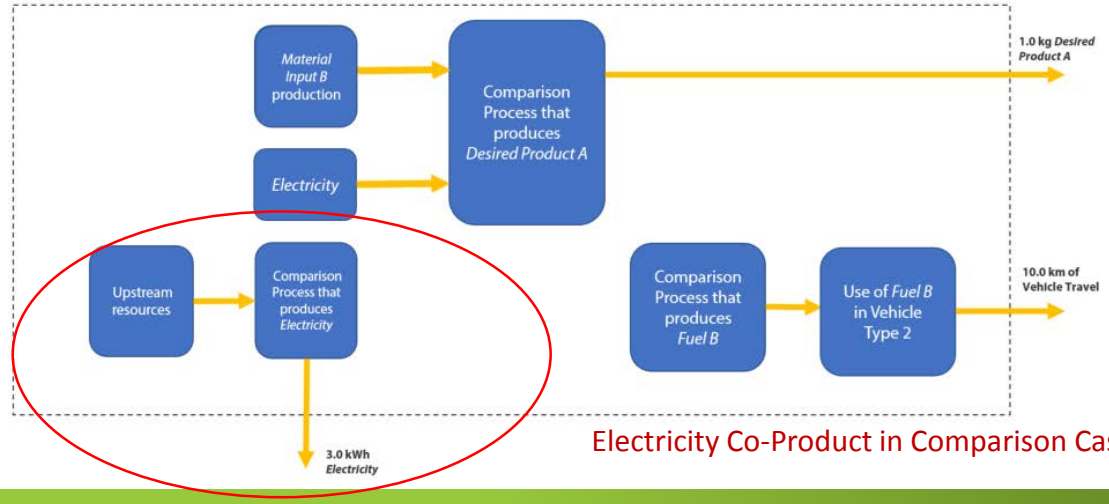
- Including upstream CO_2 in the boundary – results in an electricity co-product in the system boundary
- What should be the source of the electricity in the comparison case?
- How do we maintain functional equivalence between the cases?

Proposed Case



Upstream CO_2 and electricity co-product in Proposed Case

Comparison Case



Electricity Co-Product in Comparison Case

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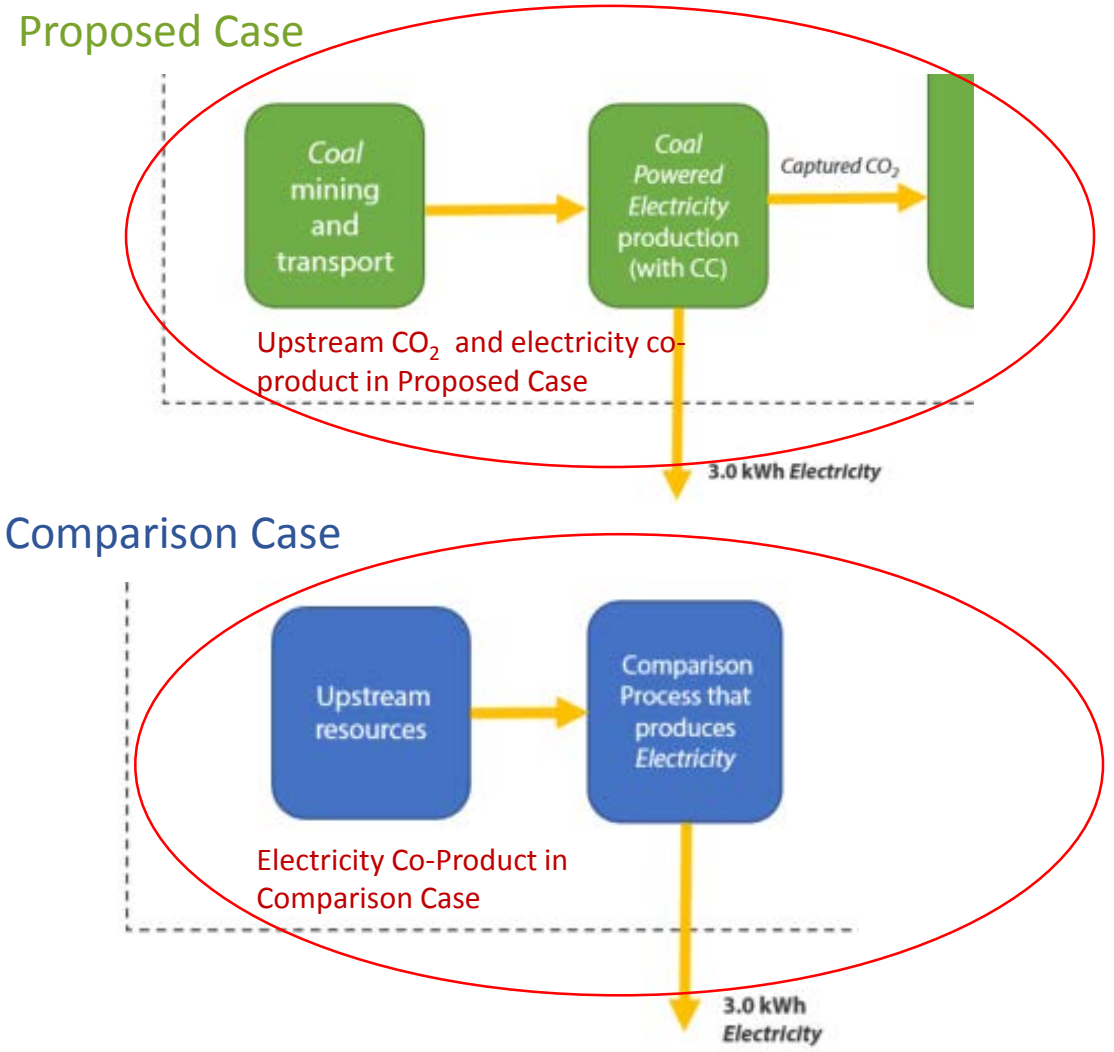
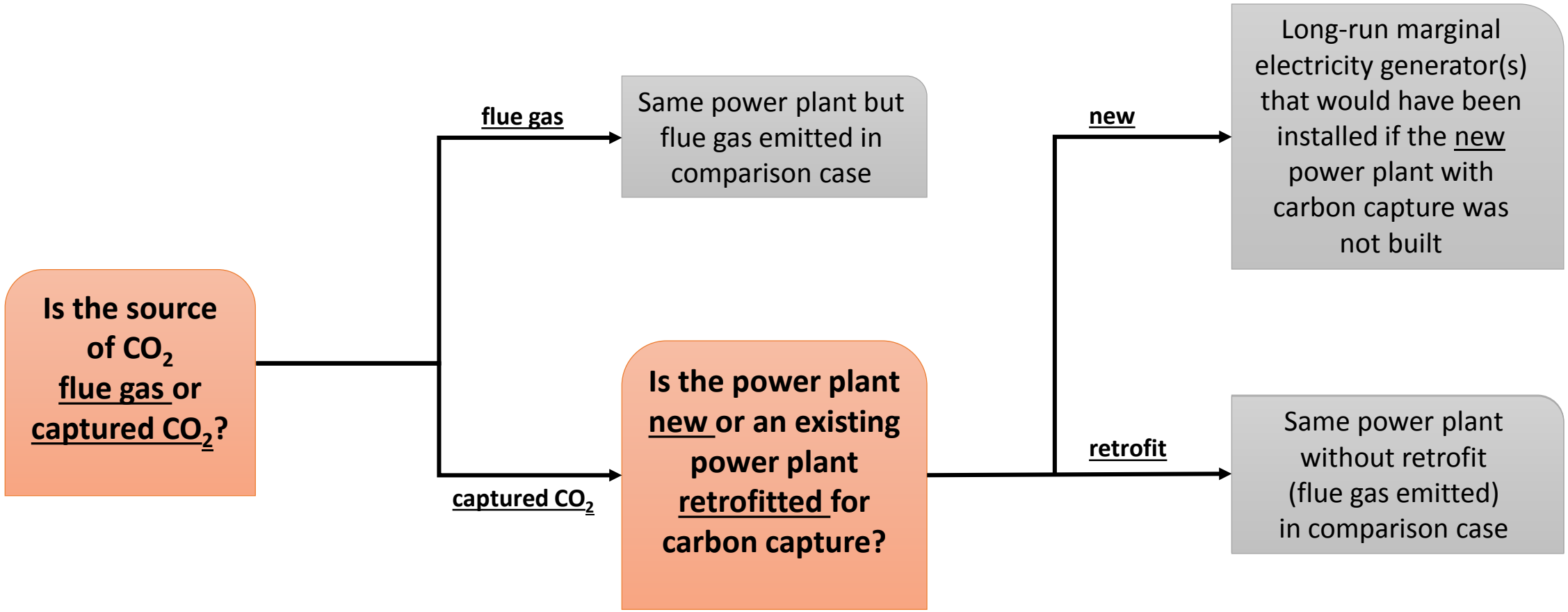
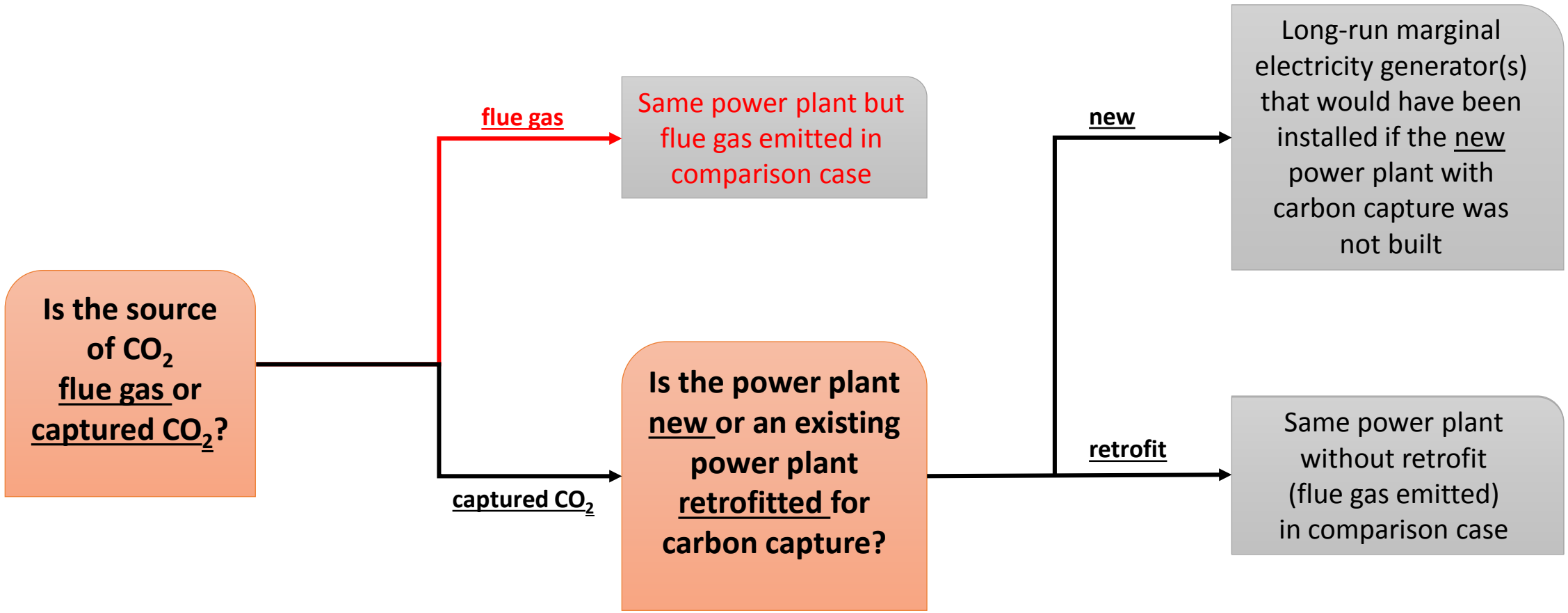


The Electricity in the Comparison Case Depends on How the CO_2 Is Procured for CO2U



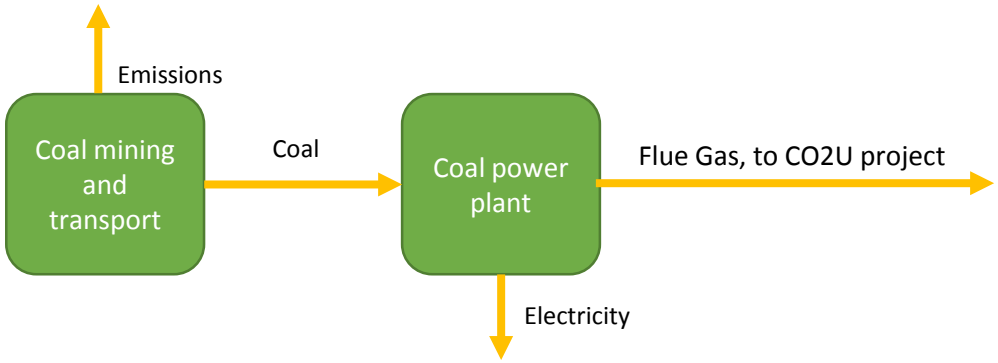
What if the Source of the CO_2 is Flue Gas?



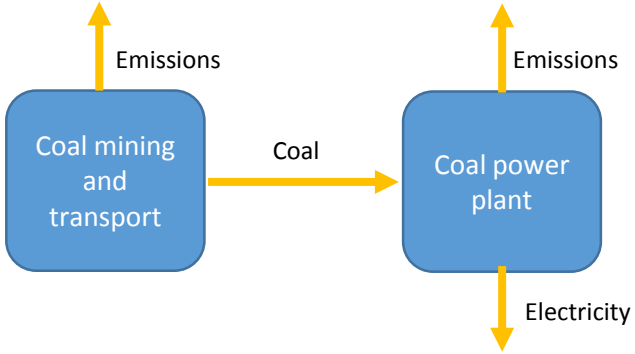
What if the Source of the CO_2 is Flue Gas?

- Assume diversion of flue gas for alternative use does not affect the net electricity output the power plant prior to diversion of the flue gas
- Comparison case is the same power plant with the CO_2 being emitted rather than used

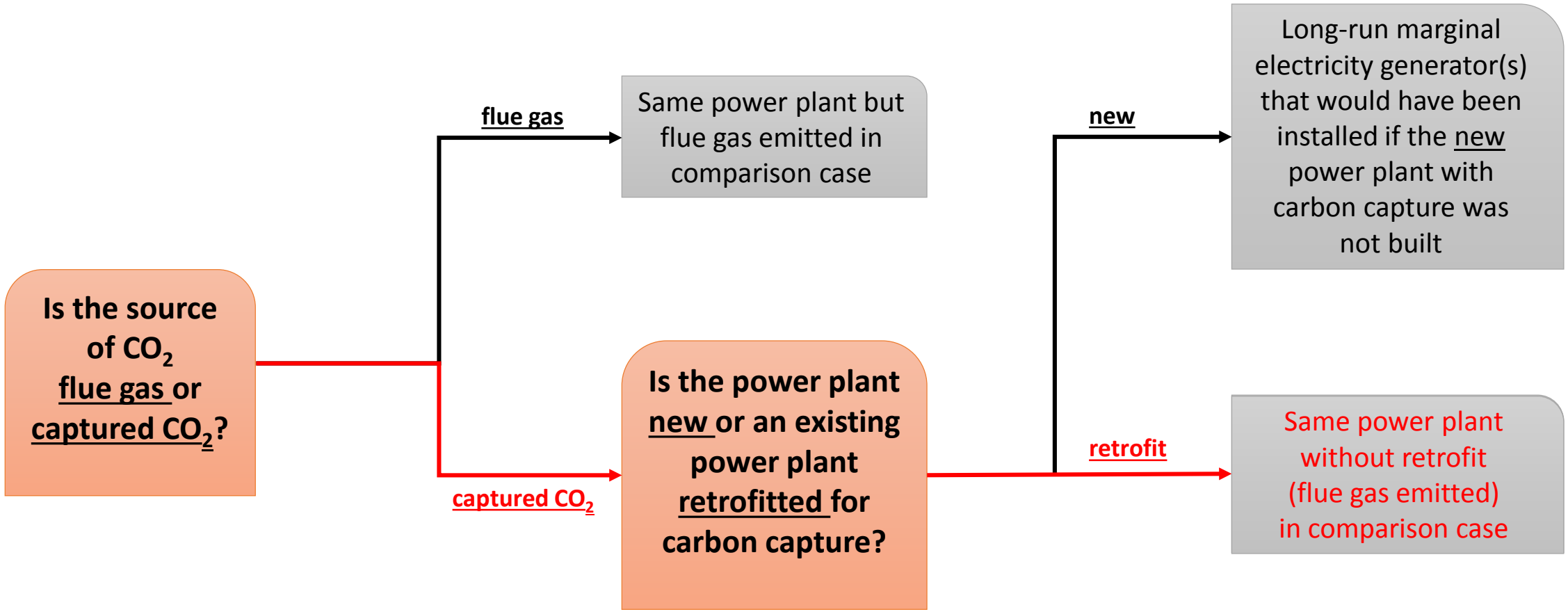
Upstream CO_2 in Proposed Case



Electricity Co-product in Comparison Case



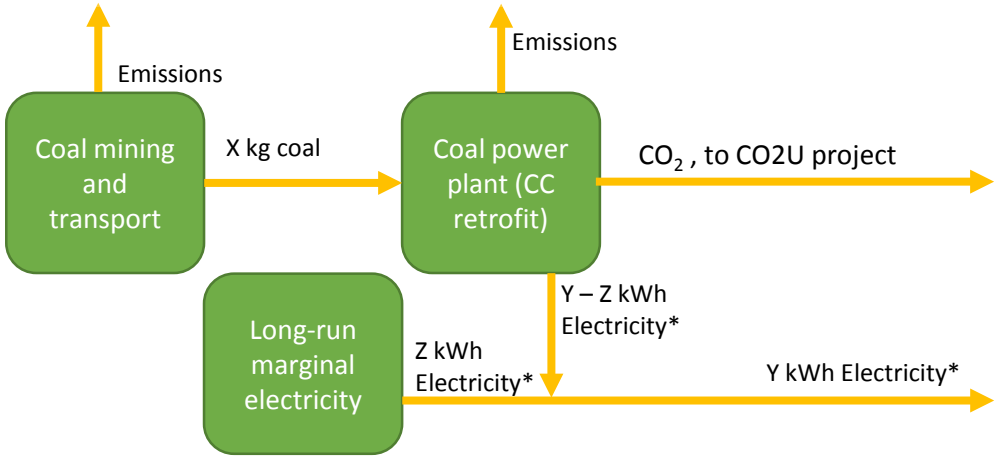
What if the Source of the CO_2 is Captured CO_2 From a Retrofitted Power Plant?



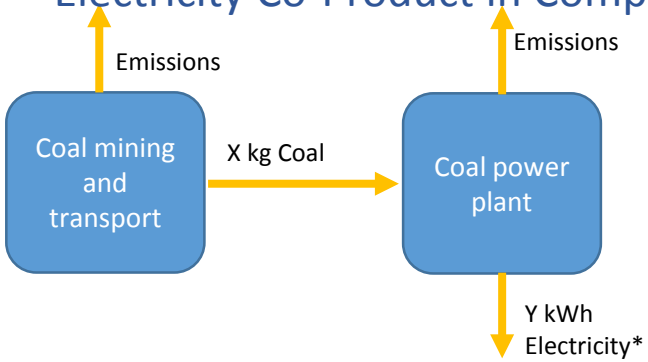
What if the Source of the CO_2 is Captured CO_2 From a Retrofitted Power Plant?

- IF, retrofitting the power plant results in a decrease in the net power output, then the "Proposed CO2U Case" will require "make-up" electricity
- "Make-up" electricity shall be equal to the electricity consumption mix (marginal supplier) in the geographical area defined in the study scope

Upstream CO_2 in Proposed Case



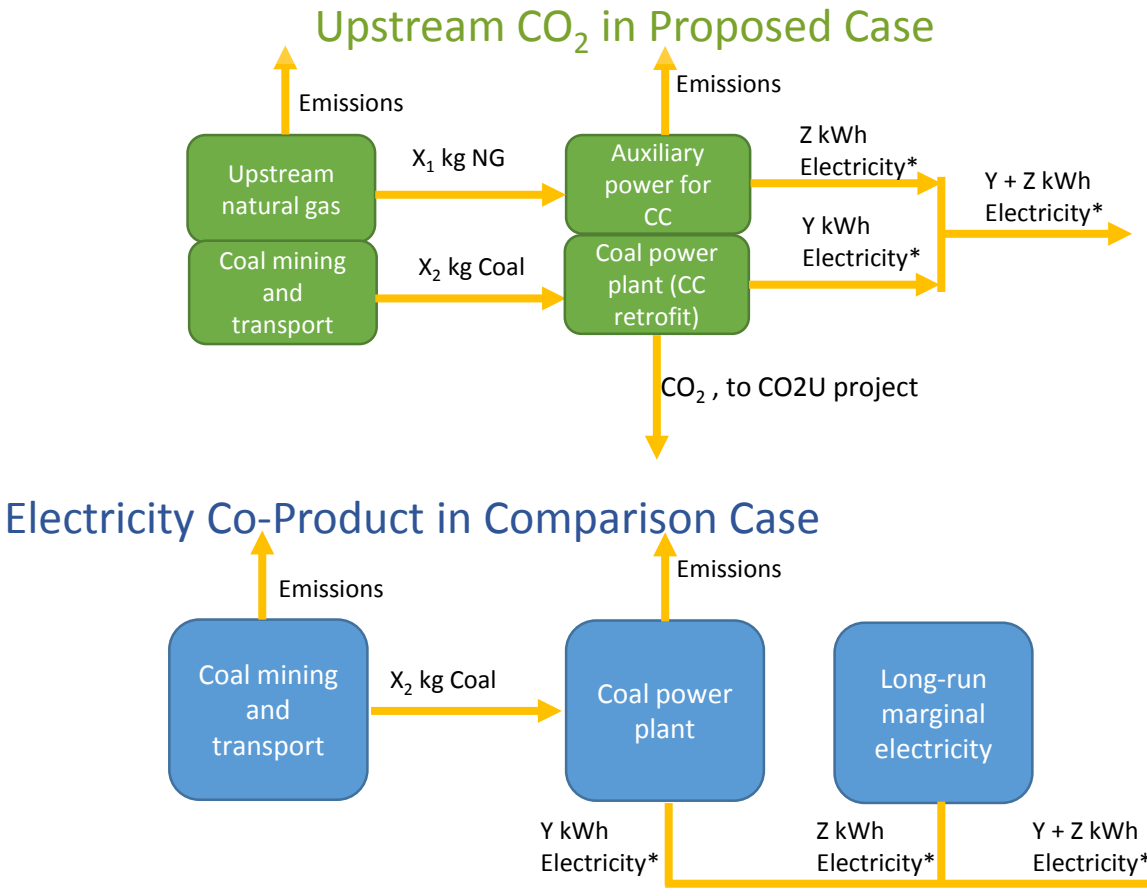
Electricity Co-Product in Comparison Case



*The carbon capture plant loses some of its capacity to run the carbon capture equipment, so make-up electricity in the proposed case is required to have the same amount of electricity output.

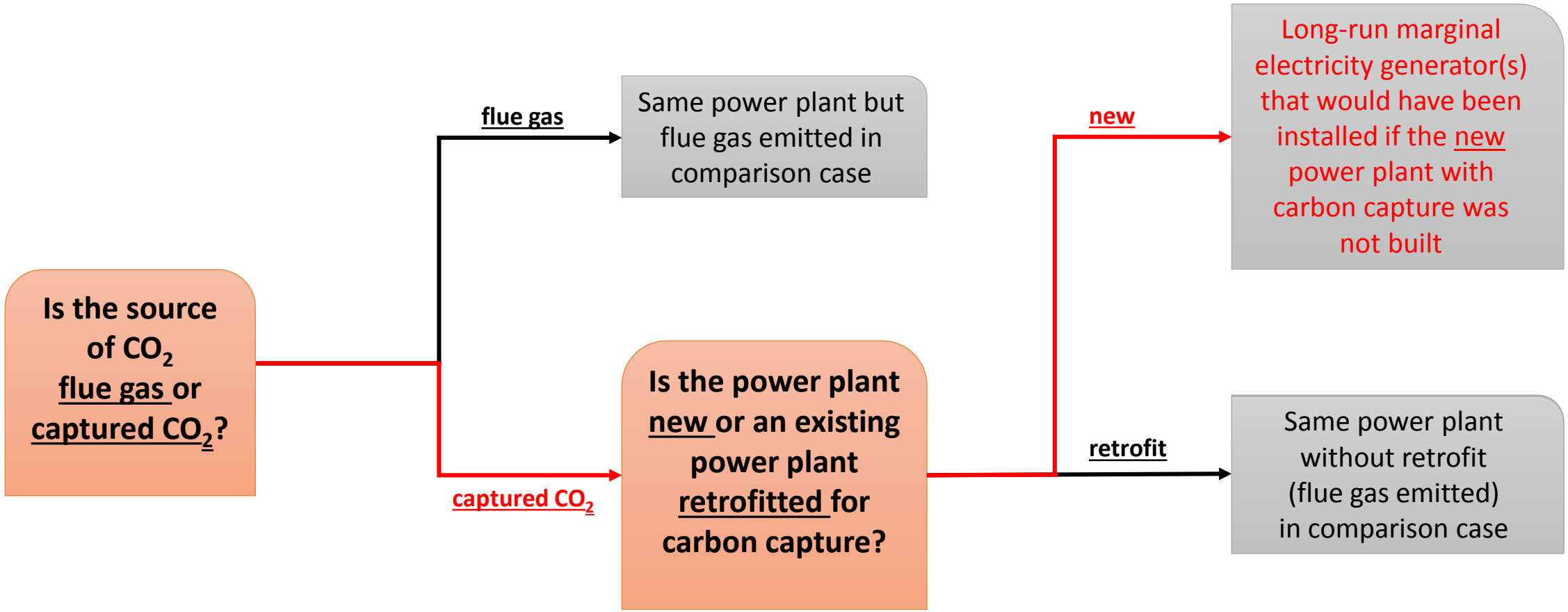
What if the Source of the CO_2 is Captured CO_2 From a Retrofitted Power Plant?

- IF, retrofitting the power plant DOES NOT result in a change in the net power output, then assume external source of heat and power to operate the carbon capture and compression system (e.g., Petra Nova)
- IF, the auxiliary power system produces excess electricity, in turn increasing the net power output of the "Proposed CO2U Case", then additional "make-up" electricity has to be added to the "Comparison Case" to ensure system equivalence



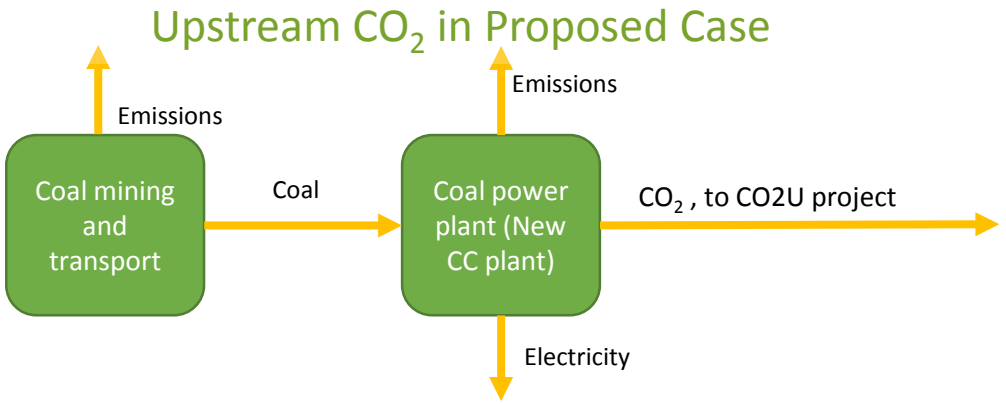
*The carbon capture plant gains capacity by installing auxiliary power to run the carbon capture equipment, so make-up electricity in the comparison case is required to have the same amount of electricity output.

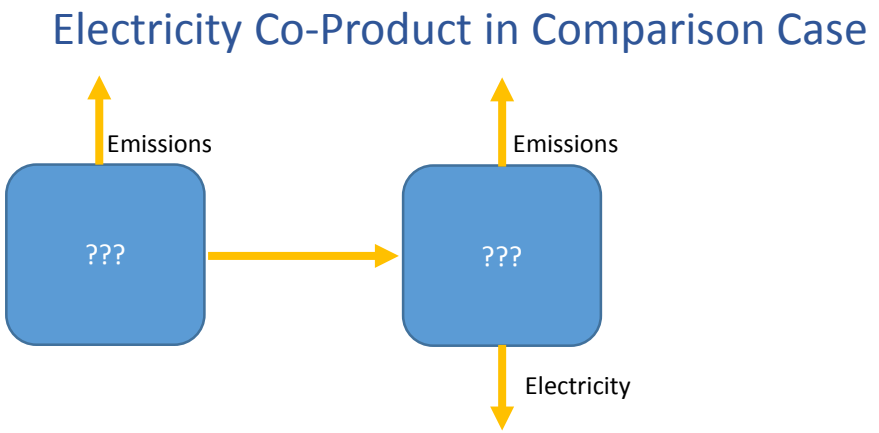
What if the Source of the CO_2 is Captured CO_2 From a New Power Plant?



What if the Source of the CO_2 is Captured CO_2 From a New Power Plant?

- The comparison case is determined based on the long-run marginal electricity generator(s) that would have been installed if the new power plant with carbon capture was not built
- The electricity generator(s) are determined using capacity expansion modelling for the on-line (start) year of the power plant for the stated geographical scope of the study





What if the Source of the CO_2 is Captured CO_2 From a New Power Plant?

1. Determine year of proposed CO2U project deployment (same as power plant on-line [start] year)
2. Compile mix of technologies composing capacity additions for that year
3. Develop weighted emission factors

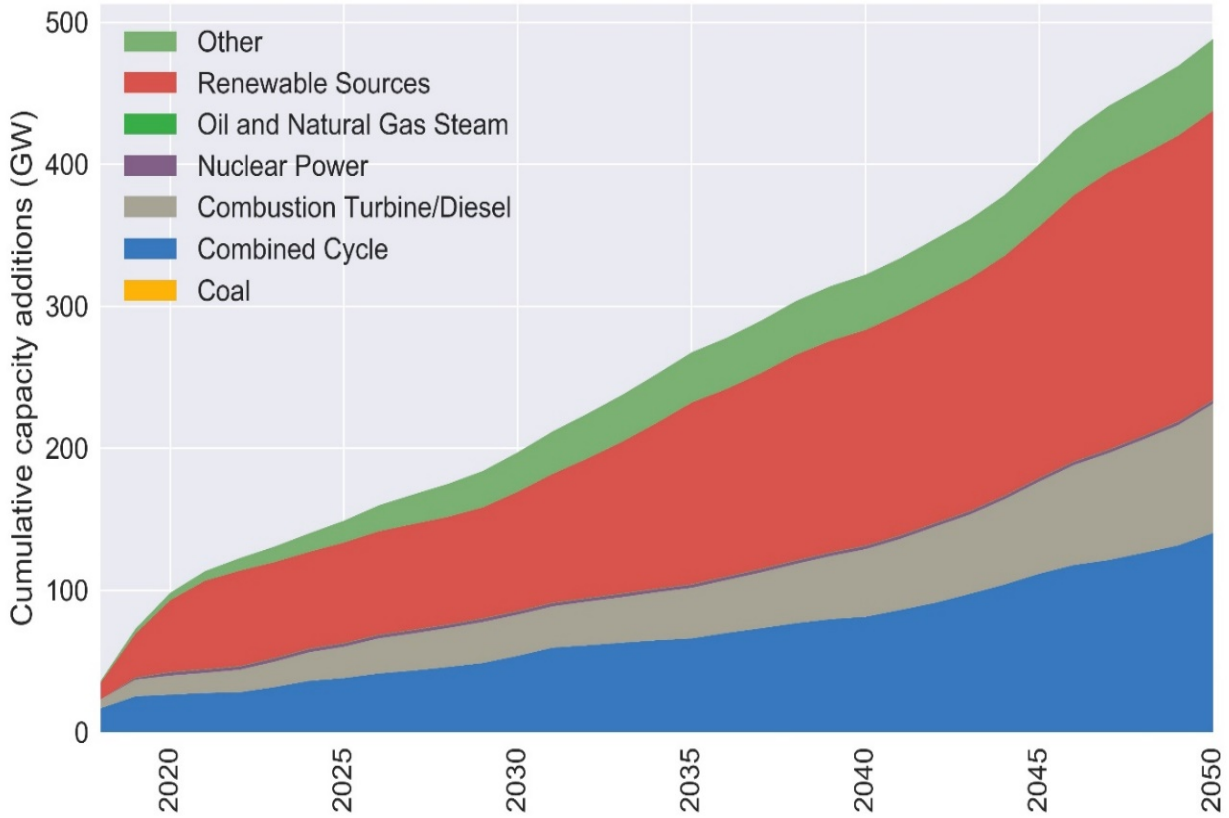


Figure 1. Cumulative capacity additions in the U.S. electric sector, based on the U.S. EIA's Annual Energy Outlook 2018, reference scenario. Source: EIA Annual Energy Outlook 2018, Electricity Generating Capacity

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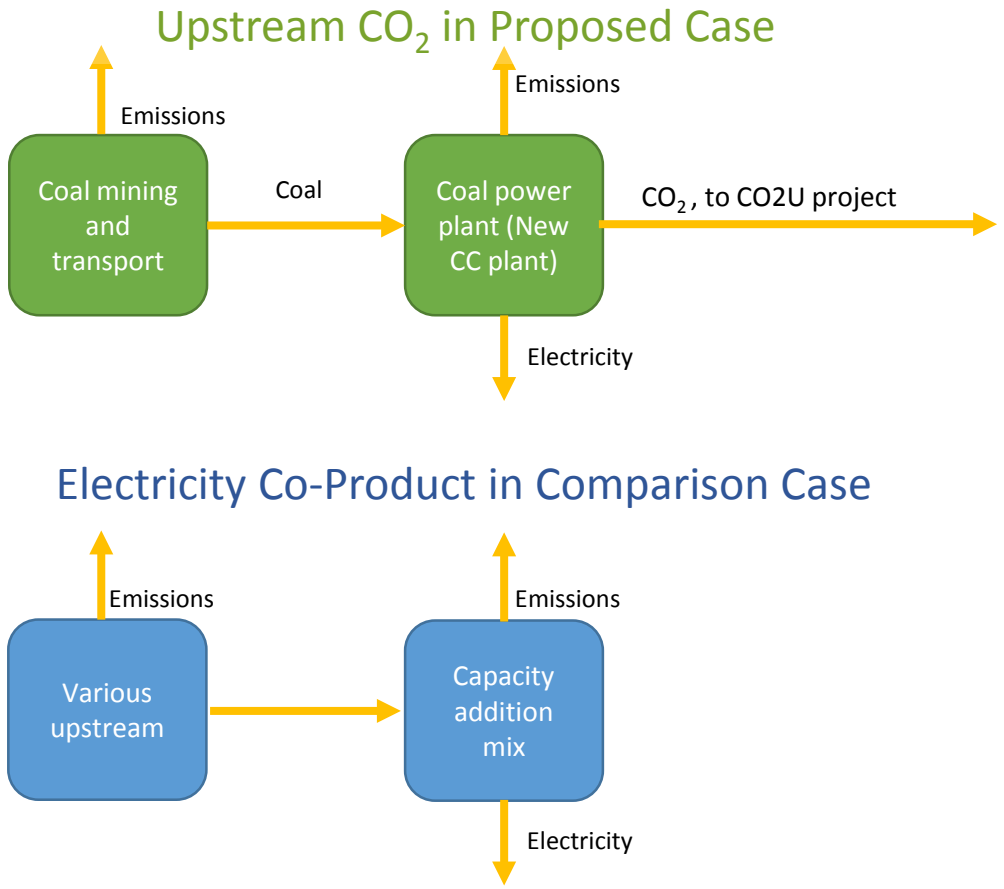


Conclusions

- CO2U systems are unique in that they combine two sectors (electricity and CO2U product)
- Consistent LCA approaches are necessary to ensure comparability and fairness
- The goal of the NETL CO2U Guidance is to determine the environmental preferability of utilizing captured carbon to produce products – this necessitates a consequential LCA approach

Contact Information

Timothy J. Skone, P.E.
Senior Environmental Engineer • U.S. DOE, NETL
(412) 386-4495 • *timothy.skone@netl.doe.gov*

Greg Cooney
Principal Engineer • KeyLogic
gregory.cooney@netl.doe.gov

Michele Mutchek
Senior Engineer • KeyLogic
michele.mutchek@netl.doe.gov

LCA
Life Cycle Analysis
energy sustainability

netl.doe.gov/LCA *LCA@netl.doe.gov* *@NETL_News*

Backup Slides

Guidance Document Development Timeline

- 2017
  - **August** - First exploratory draft of the guidance document is completed
  - **October** - A workshop was held in D.C. with subject matter experts and CO2U project principal investigators
- 2018
  - Second draft of guidance document is finalized based on stakeholder feedback
- 2019
  - **March** – Soft release of guidance document
  - **April** – Final release incorporating feedback from Global CO_2 Initiative TEA/LCA Workshop

Workshop on LCA/TEA for CO_2-based products

Agenda

- Overview of LCA/TEA resources
- Stakeholder interests
- LCA/TEA breakouts to define needs/outcomes
- Examples of firms at various stages of development in the CO2U space
- CO2U-related policy (45Q, LCFS)
- Policy implications for TEA and LCA guidance

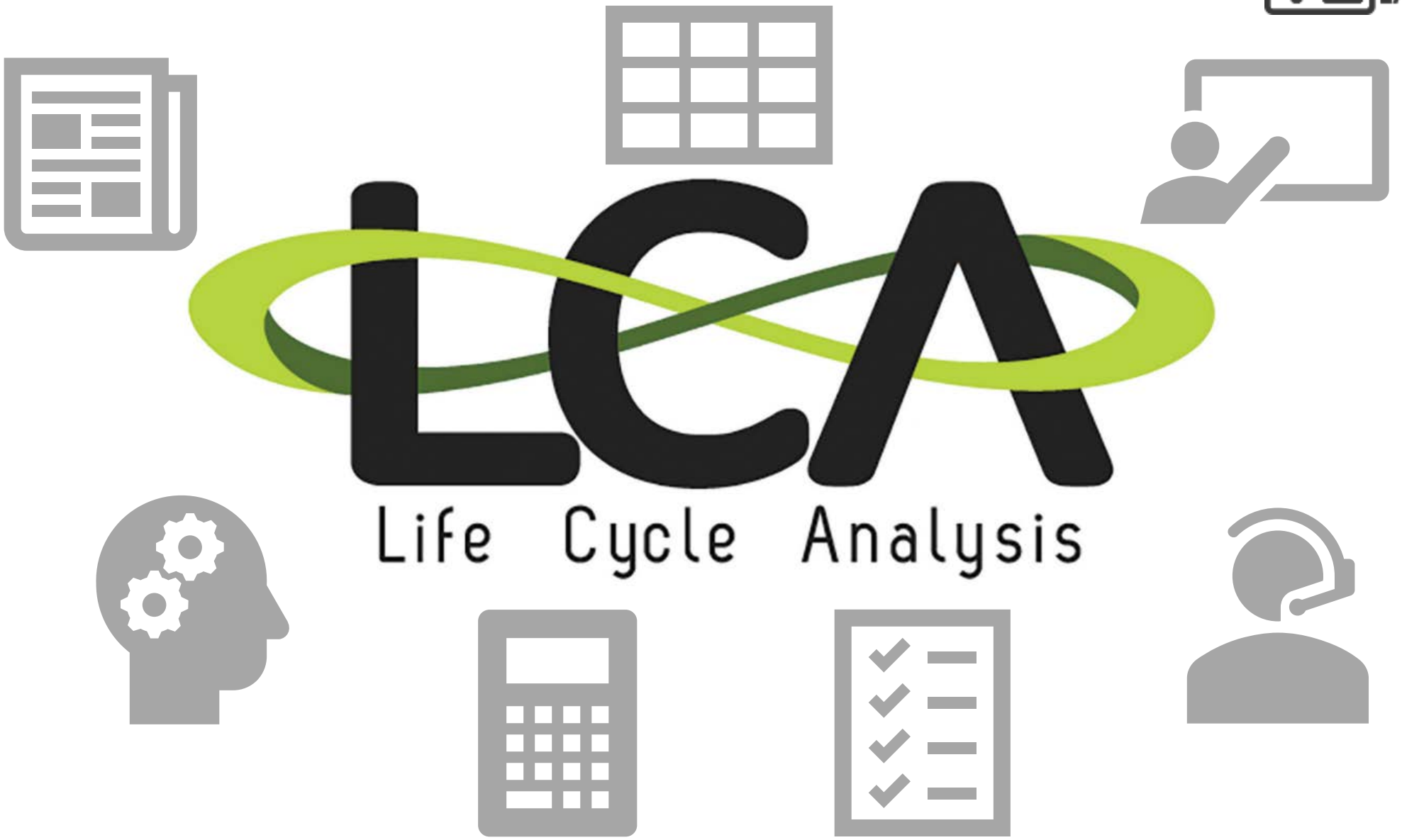
Workshop on LCA/TEA for CO_2-based products

Report Objectives and Schedule

- Discuss the uniformities and differences between the various LCA TEA approaches, and
- Recommend what is needed to harmonize the approaches - or why there are differences.
- Propose next steps in guideline development to promote CCU

Action	Due Date
LCA action items for workshop report (conference committee)	May 1, 2019 (DRAFT) May 17 , 2019 (FINAL)
TEA action items for workshop report (conference committee)	May 1, 2019 (DRAFT) May 17, 2019 (FINAL)
Workshop attendee comments on NETL and Global CO2 guidance	May 17, 2019
Release workshop report	TBD
NETL TEA QGESS for CO2U	TBD
Updated NETL LCA guidance document	TBD

NETL CO2U LCA Guidance Toolkit



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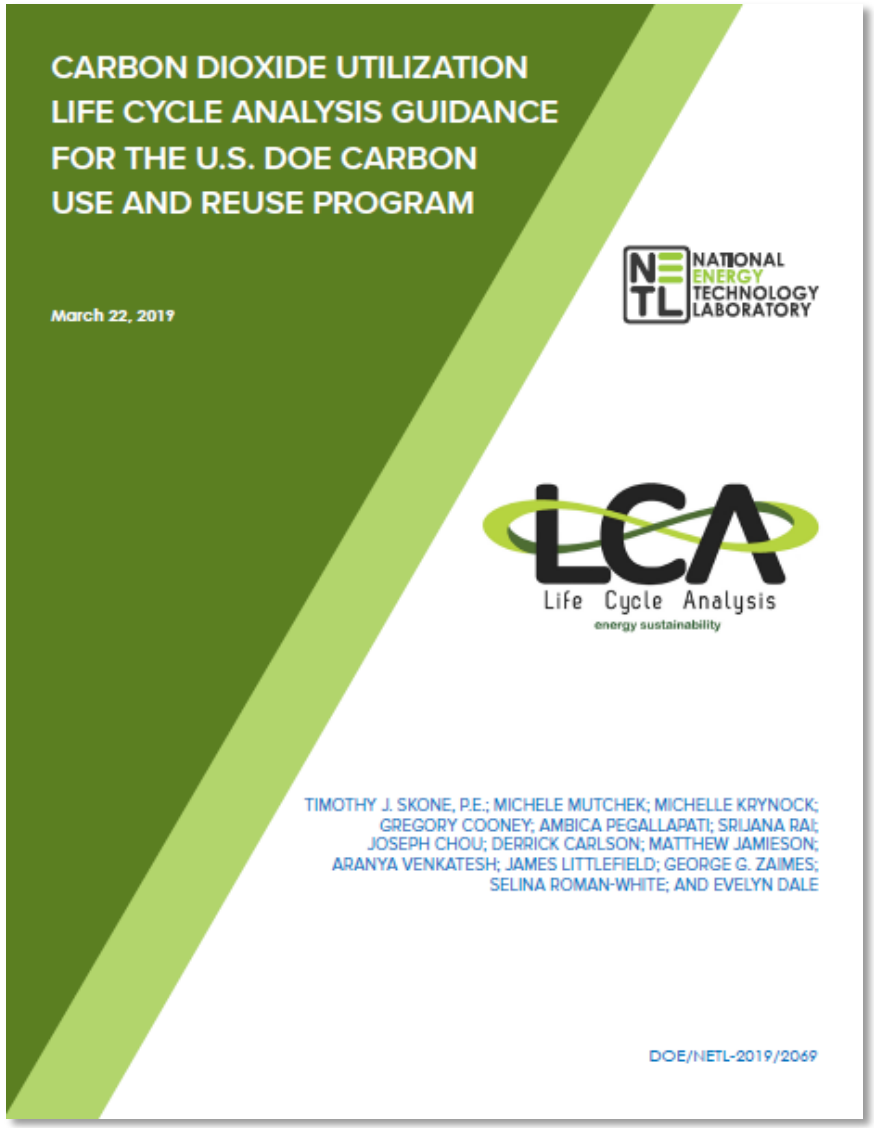

NETL CO2U LCA Guidance Toolkit

OPENLCA LCI DATABASE

openLCA database that includes NETL unit process data and an example CO2U LCA

PROCESS CATEGORY	PROECSS NAME
Fuel Production and Combustion	Diesel, Gasoline, Natural Gas
Materials	Ammonia, Ethanol, Hydrogen, Concrete, Steel
Transportation	Train, Ocean, Pipeline
Grid Electricity	Coal, Natural Gas, Fuel Oil, Nuclear, Geothermal, Wind, Solar
CO_2 Sources	NGCC, SCPC, SubPC – with and without carbon capture

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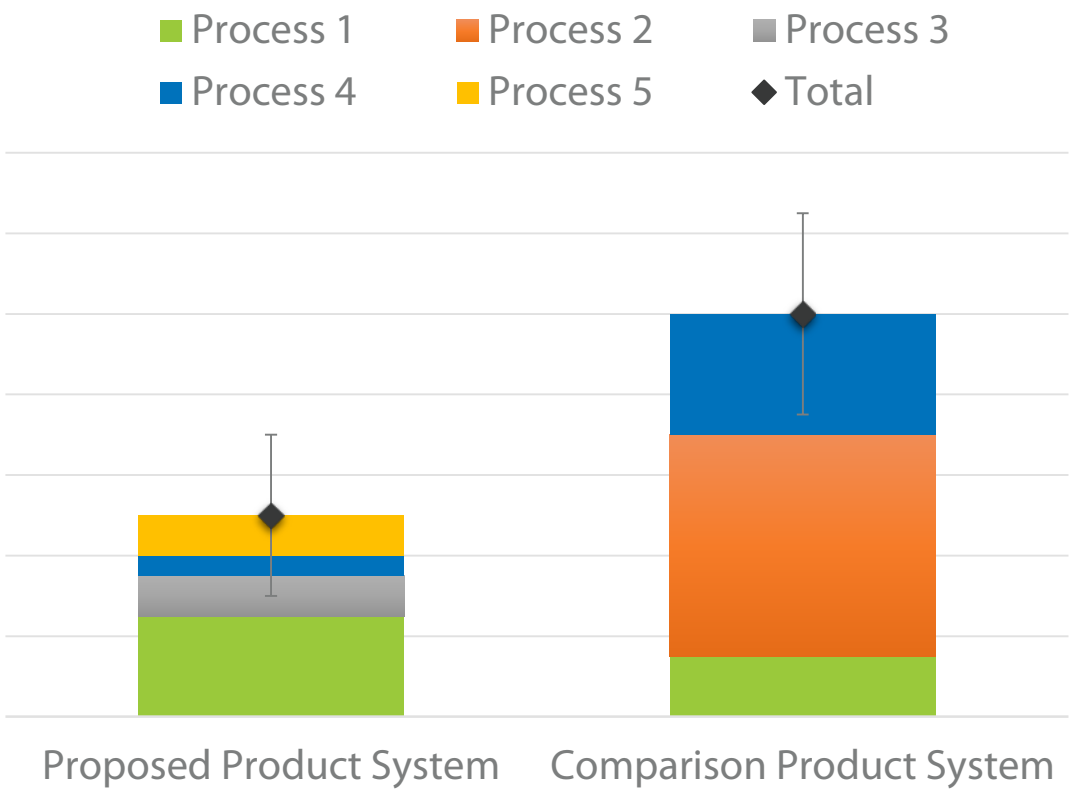
OPENLCA CONTRIBUTION TOOL

Excel template that translates openLCA results into required charts



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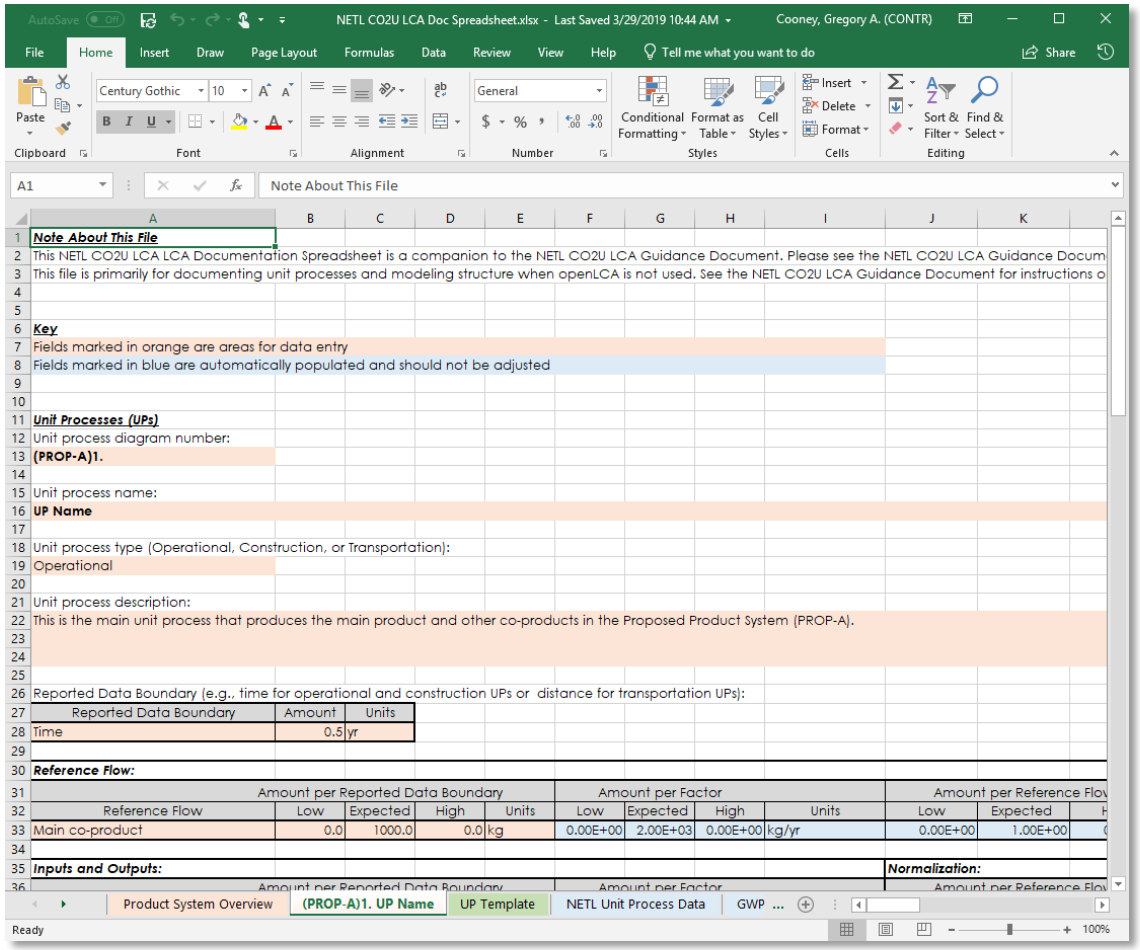

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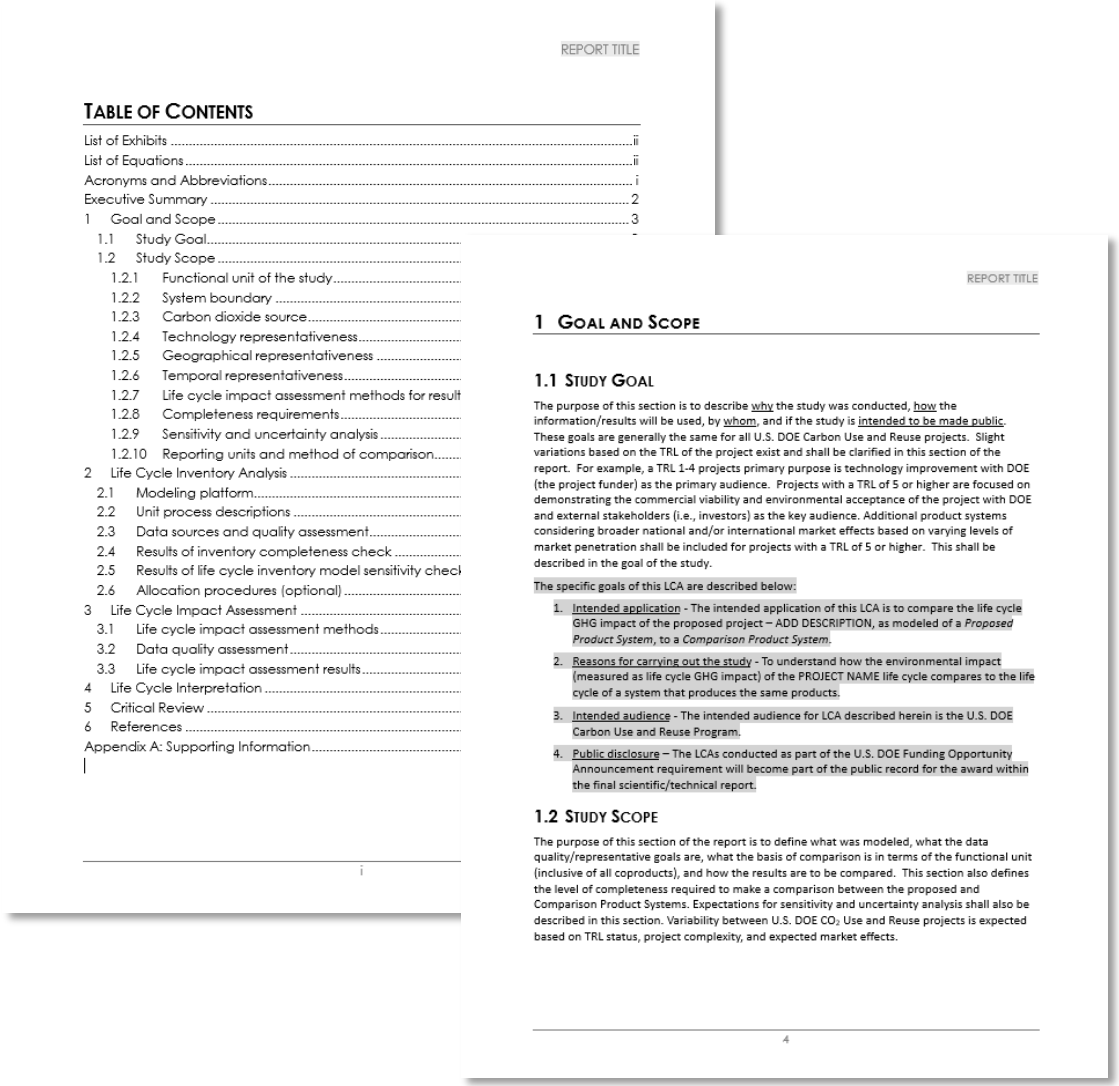
LCA REPORT TEMPLATE

Word report template for summarizing data and results



REPORT TITLE

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REPORT TITLE

1 Goal and Scope

1.1 Study Goal

The purpose of this section is to describe why the study was conducted, how the information/results will be used, by whom, and if the study is intended to be made public. These goals are generally the same for all U.S. DOE Carbon Use and Reuse projects. Slight variations based on the TRL of the project exist and shall be clarified in this section of the report. For example, a TRL 1-4 projects primary purpose is technology improvement with DOE (the project funder) as the primary audience. Projects with a TRL of 5 or higher are focused on demonstrating the commercial viability and environmental acceptance of the project with DOE and external stakeholders (i.e., investors) as the key audience. Additional product systems considering broader national and/or international market effects based on varying levels of market penetration shall be included for projects with a TRL of 5 or higher. This shall be described in the goal of the study.

The specific goals of this LCA are described below:

1. Intended application - The intended application of this LCA is to compare the life cycle GHG impact of the proposed project – ADD DESCRIPTION, as modeled of a *Proposed Product System*, to a *Comparison Product System*.
2. Reasons for carrying out the study - To understand how the environmental impact (measured as life cycle GHG impact) of the PROJECT NAME life cycle compares to the life cycle of a system that produces the same products.
3. Intended audience - The intended audience for LCA described herein is the U.S. DOE Carbon Use and Reuse Program.
4. Public disclosure – The LCAs conducted as part of the U.S. DOE Funding Opportunity Announcement requirement will become part of the public record for the award within the final scientific/technical report.

1.2 Study Scope

The purpose of this section of the report is to define what was modeled, what the data quality/representative goals are, what the basis of comparison is in terms of the functional unit (inclusive of all coproducts), and how the results are to be compared. This section also defines the level of completeness required to make a comparison between the proposed and Comparison Product Systems. Expectations for sensitivity and uncertainty analysis shall also be described in this section. Variability between U.S. DOE CO_2 Use and Reuse projects is expected based on TRL status, project complexity, and expected market effects.

4

NETL CO2U LCA Guidance Toolkit

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Provided to PIs to aid in the modeling of their LCA in openLCA

SUBJECT MATTER EXPERT SUPPORT

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