Chevron natural gas carbon capture technology testing project

Cooperative Agreement No. DE-FE0031944
August 16, 2022

Mr. Scott McLemore

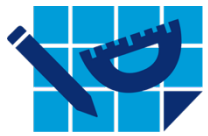
Our strategy to scale CCUS

to generate higher returns and lower carbon

Deploy CCUS to lower the carbon intensity
of our existing assets, and

Grow our CCUS business by
targeting third-party emitters as partners and customers

Our CCUS approach



Leverage
capabilities

Advance
CCUS
at existing assets

Commercialize
investments in
technology

Partnerships
to enable CCUS at scale

Expected capital expenditures **~$10B through 2028**

Projected annual CFFO **>$1B end of decade**

Estimated >30 MMT enabled **CO_2e reductions by 2028**

Advancing CCUS through investments and collaborations

Capture, storage, and utilization

Svante

Carbon Clean Solutions

Carbon Engineering

Carbon Point Solutions*

Schlumberger New Energy

Blue Planet

Academia, government and industry

Department of Energy

CO_2 Capture Project

CCS Consortium

Agency for Science, Technology and Research (A*STAR)

California Carbon Capture Coalition

National Energy Technology Laboratory

Greater Houston Partnership Houston Energy Transition Initiative

Global CCS Institute

Houston CCS Collaboration

Oil and Gas Climate Initiative

Stanford Center for Carbon Storage

Singapore National Research Foundation

Southern States Energy Board – University of Houston Center for Carbon Management in Energy

The University of Texas at Austin

*Acquired by Caterpillar in 2021

Project overview

Award Period

- 10/01/2020 through 04/30/2023

Project Funding

- Total Funding: $20,888,075.00
- Federal Funding: $13,000,000.00
- Cost Share Funding: $7,888,075 (Cash Contribution by Chevron)

Project Participants

- Chevron U.S.A. Inc., Prime Contractor, host site and cost share provider
  - Principal Investigator: Scott McLemore
  - Project Manager: Stan Cross
- Technology Provider: Svante, Inc.; Carbon capture technology provider
- ISBL Engineering, Procurement and Construction: Kiewit Engineering Group Inc (KEGI) and Kiewit Power Constructors (KPC)
- Program Administrator: Electricore, Inc.
- Plant Operation: Offshore Technology Services (OTS)

DOE-NETL Team

- Grants Officer: Lisa Kuzniar, Project Manager: Nicole Shamitko-Klingensmith, Contracting Specialist: Kelly Haught

Project objectives

The project will validate a transformational solid sorbent carbon capture technology at engineering scale under indicative natural gas flue gas conditions and continuous long-term operation at Chevron's Kern River oil field

- Successfully complete the design, construction, commissioning, and long-term testing of an engineering scale plant of approximately 25 tonnes per day (TPD) under steady-state conditions at varying flue gas carbon dioxide (CO_2) concentrations (~4–14%);
- Conduct a techno-economic analysis (TEA) on the VeloxoTherm™ technology as integrated into a nominal 550 MW (net) natural gas combined cycle (NGCC) power plant;
- Conduct a comprehensive gap analysis addressing the current stage of VeloxoTherm™ technology development for NGCC application; and
- Summarize the research, development, and demonstration requirements to close identified gaps to approach achievement of DOE's carbon capture performance goal of CO_2 capture with 95% CO_2 purity at a cost of $30/tonne of CO_2 captured by 2030.

Kern River carbon capture plant

San Joaquin Valley, CA USA

Natural gas-based flue gas testing

Understand and measure capture plant performance on boiler, NGCC and SMR feed flue gas

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Skid-mounted modular design of second-of-a-kind (SOAK) capture plant

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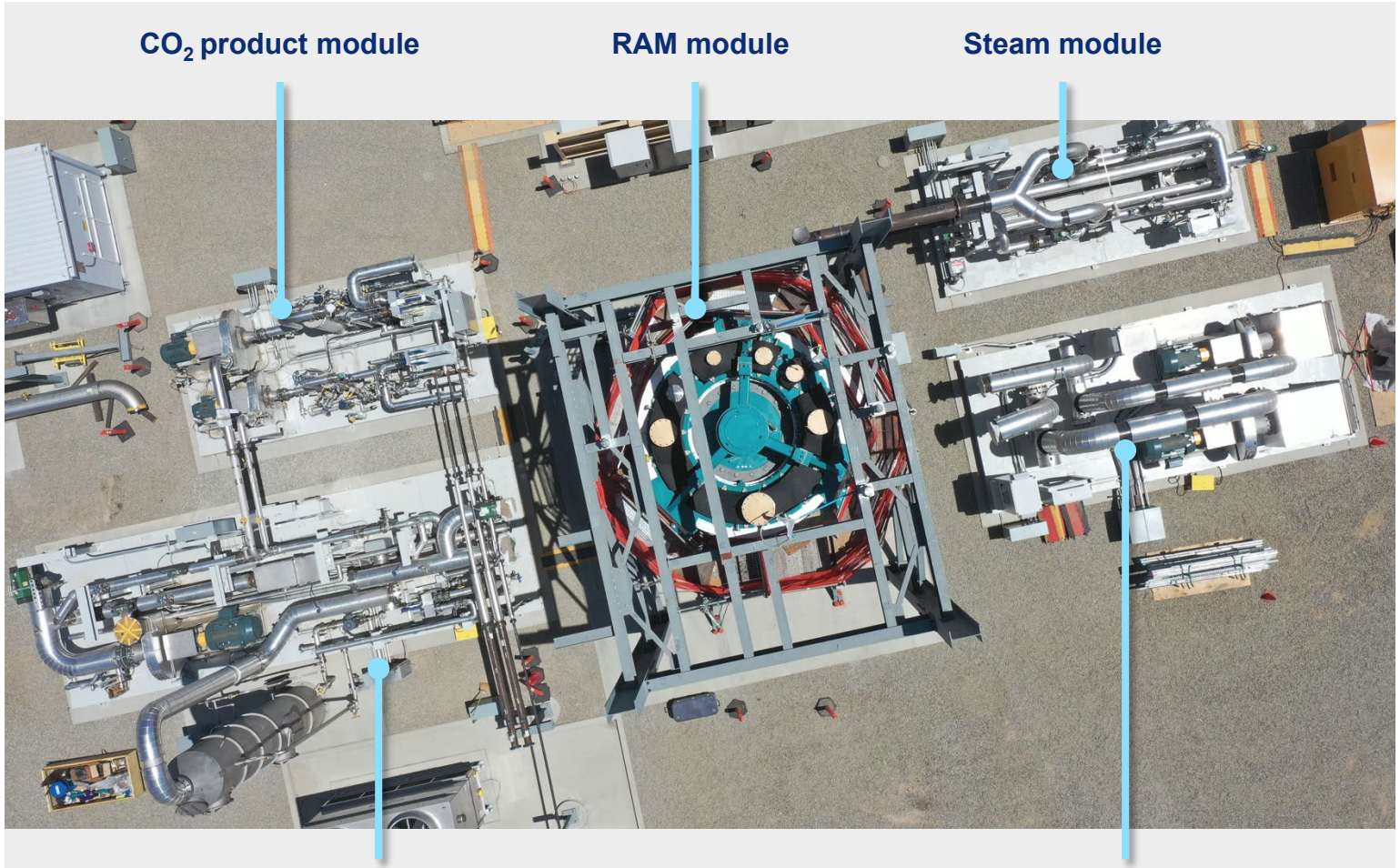
New MOF sorbent beds

95% CO_2 product purity and lower steam ratio compared to conventional solvent technology



Svante has a 15-year first mover advantage…

Svante at a glance

- **15+** Years of research and development creating a commercially viable way to capture CO_2 for hard-to-abate industries using tailor-made nano-materials
- **84%** Of the broader carbon removal and CCUS market targeted through "Picks and Shovels" business model[1]
- **50%** Targeted capital cost advantage of Svante contactor versus equivalent liquid amine carbon capture equipment
- **122** Global patents providing strong IP protection on technology and design
- **160** Best-in-class team of experts led by Mr. Claude Letourneau

World renowned customers

climeworks, HOLCIM, Chevron, cenovus ENERGY

"Thought leader" investors

TEMASEK, bdc, CARBONDIRECT, U.S. DEPARTMENT OF ENERGY, OGCI OIL AND GAS CLIMATE INITIATIVE, CHART, THE RODA GROUP

Best-in-class partners

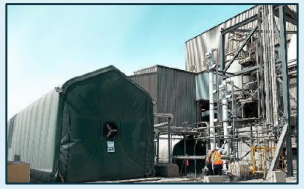
TEN TECHNIP ENERGIES, Kiewit, BASF We create chemistry

Svante footprint

Capture plants | Facilities

Lafarge 200 Series Demo Unit
Richmond, B.C., Canada

Capacity: 365 TPA
Status: Operational
Source: Cement Kiln
Owner: Lafarge



Cenovus Pilot Plant
Lloydminster, SK, Canada

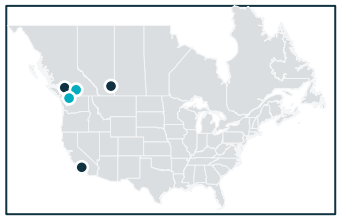
Capacity: 10,000 TPA
Status: Operational
Source: NG boiler
Owner: Cenovus

HQ, Engineering & Manufacturing Facilities
Burnaby, B.C., Canada

Capacity: 10 MTPA
Size: 140,000 sq ft
In-service: Q4 2022
Staff: 250+

Current manufacturing & R&D centres
Burnaby, B.C., Canada

Capacity: 40,000 TPA
Size: 39,000 sq ft
Status: Operational
Staff: 150+



Chevron SOAK 400 Series Plant
San Joaquin, CA, USA

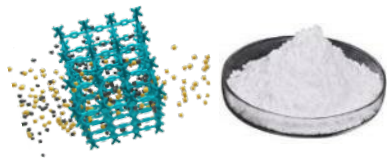
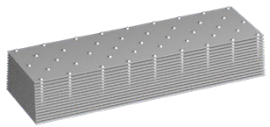
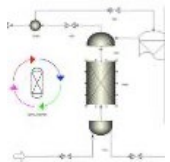
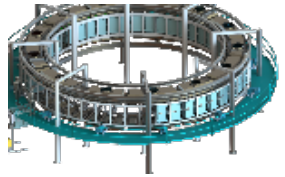
Capacity: 9,125 TPA
Status: Detailed Engineering & Execution
Source: Industrial boilers
Owner: Chevron

Notes: [1] Removal refers to DAC and BECCS and excludes nature-based solutions

Svante carbon capture technology

Svante's technology for the separation of CO_2 from gas streams using solid state technology is comprised of a rapid cycle adsorption process using structured adsorbents (active adsorbent materials formed into a parallel passage contactor), and includes the following critical technology elements:

1. Proprietary adsorbent mat
2. Design and formation of adsorbents into structured adsorbent contactors
3. Design of the dynamic process cycle for performing the gas separation, structured filters with thin-film technology enable rapid cycles of <60 seconds
5. Machine design for carrying out the process cycle and delivering streams to and from the structured adsorbents
6. The overall design, integration and optimization of the entire CO_2 capture plant that goes around the machine and process cycle (items such as fans, heat exchangers, vessels, pre-treatment and post-treatment, use of electricity, steam and waste heat, cooling, management of discharge and effluents, etc..)

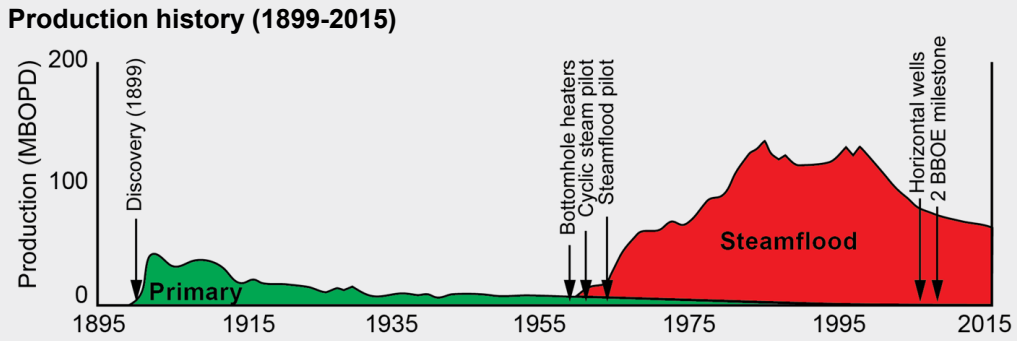
Adsorbents	Structured adsorbent	Process cycle	Adsorption machine	Capture plant process design and energy integration
				

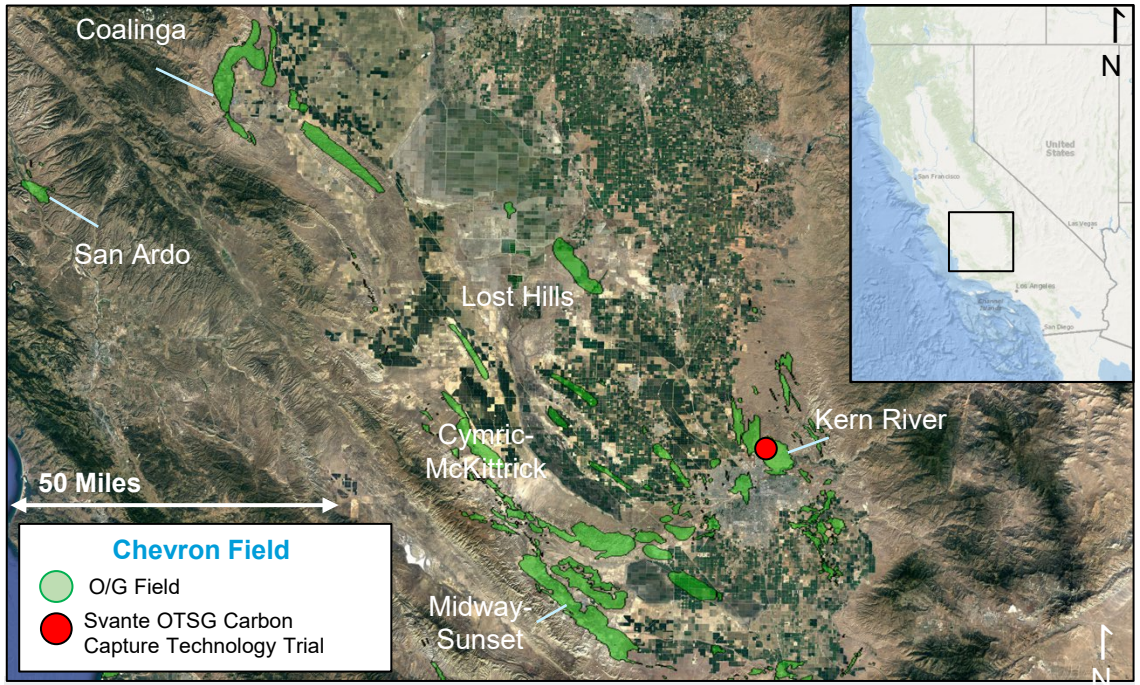
Project location — Kern River Oilfield

Reducing the carbon intensity of our operations through scalable demonstration projects

2.3 BBOE cumulative production

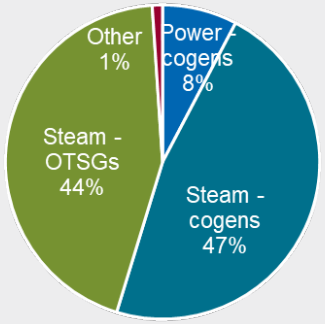
60% OOIP (3.7 BBOE)





SJVBU GHG emissions

2021



Technical approach

The project will be conducted in three (3) budget periods

- ☑ **Budget Period 1**
  - ☑ Process Engineering
  - ☑ Design Criteria
  - ☑ Sorbent Certification
- ❑ **Budget Period 2**
  - ☑ Detailed Engineering
  - ☑ Procurement, Fabrication and Installation
  - ❑ Pre-Startup Safety Review, Commissioning and Test Planning, (In Progress)
- ❑ **Budget Period 3**
  - ❑ Engineering Scale Testing and Analysis
  - ❑ Technology Assessment

Success criteria

Successful completion
of all work proposed

Completion of engineering scale VeloxoTherm™ testing
with natural gas flue gas

State-point data table

EH&S report

Techno-economic analysis

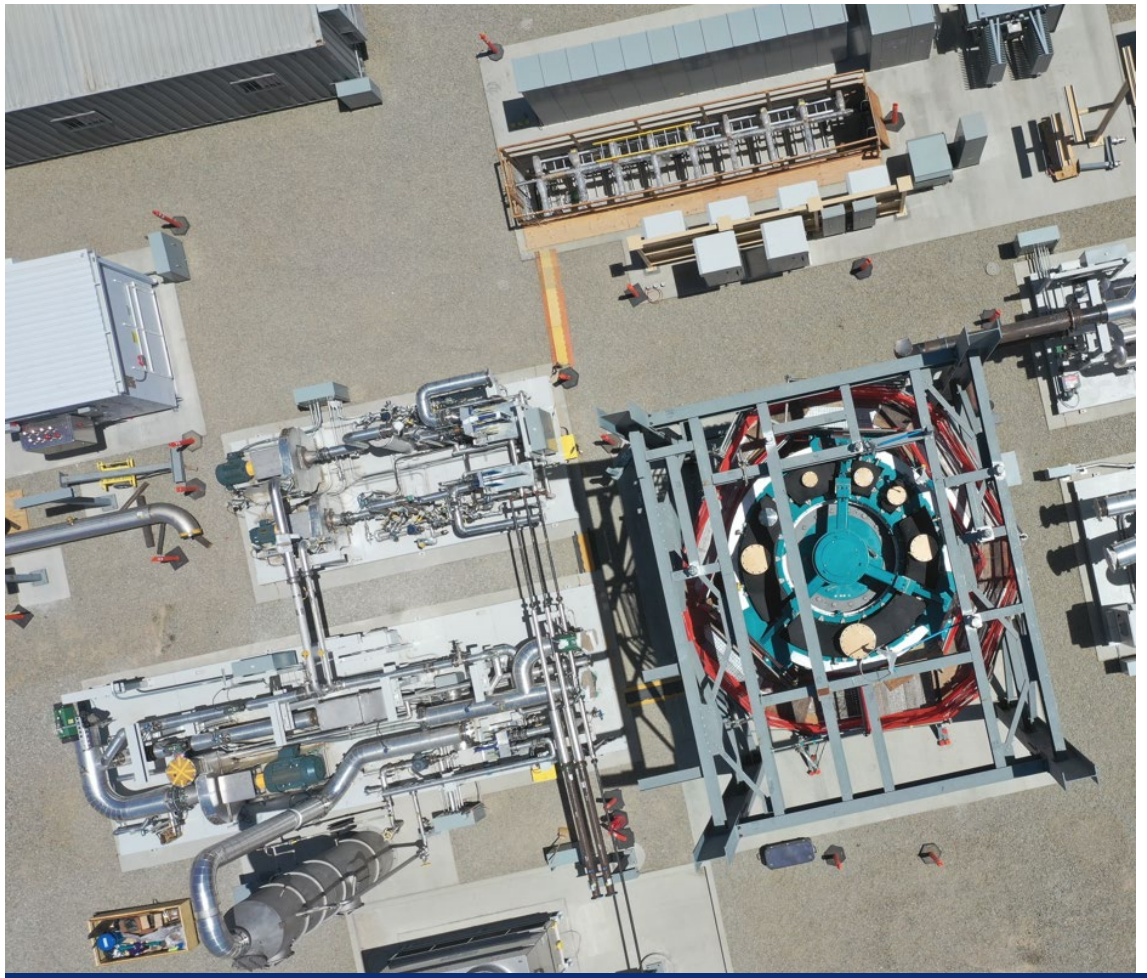
Submission of a final report
that details pathway to achieve DOE's performance goals
(CO_2 capture with 95% CO_2 purity at a cost of $30/tonne of CO_2 captured by 2030)

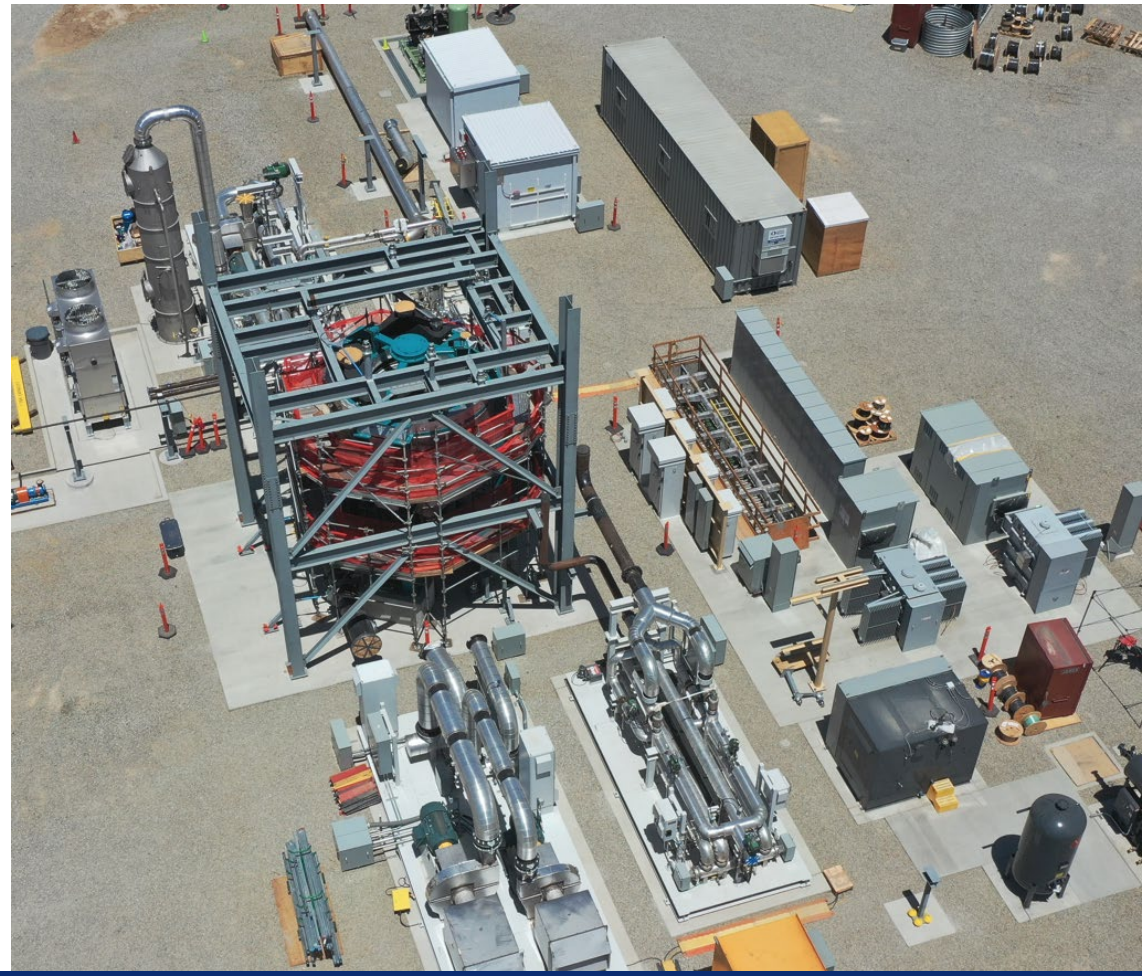
Progress and current status of project

Project has advanced well into late stage of construction:

- Detailed Engineering completed
- All ISBL skids received at site and set
- All ISBL/OSBL equipment received and installed
- RAM sub-assemblies received and erected
- Modules interconnection piping completed
- 1st set of SAB completed
- Commissioning beds completed
- Modules Electrical interconnection is complete
- System turnovers for Commissioning, with commissioning underway

Progress and current status of project





Field construction work is complete and now in commissioning

RAM erection at site with interconnection piping

Structured absorbent bed (SAB) manufacturing progress

1st set completed; being stored at Svante until needed on site
Commissioning beds completed; on site

Project milestones – budget periods 2 & 3

Milestone log					
Budget period	Task	Milestone description	Planned completion date	Actual completion date	Verification method
2	4.0	Detailed Engineering	12/31/2021	12/31/2021	RPPR File
2	4.1	Rotary Seal Validation Testing	07/26/2021	09/14/2021	Design Validation Test Report Submitted
2	5.1	Sorbent Procurement (Phase II)	12/31/2021	01/14/2022	Purchase Order and Receiving Report
2	5.3	SAB Manufacturing	09/30/2022		Hardware Shipment
2	5.4	Shop testing and inspection report	05/31/2022	05/31/2022	Shop testing and inspection report file
2	5.5	System Installation	08/18/2022		Turnover Package
2	6.1	Pre-Startup Safety Review (PSSR)	09/30/2022		Continuation Application
2	6.3	Test Plan	07/18/2022	07/19/2022	Final Test Plan
3	7.1	Start-up and operator hand-off	10/21/2022		RPPR File
3	7.2	Parametric testing and steady state operation performance report	07/18/2023		Updated Test Report
3	7.3	14% Indicative Coal Flue Gas Feed Testing	01/31/2023		Preliminary Test Report
3	7.4	4% Indicative NGCC Flue Gas Feed Testing	05/12/2023		Updated Test Report
3	7.6	System Decommissioning	06/30/2023		Final Report file
3	8.1	Technology EH&S Risk Assessment	07/18/2023		Topical Report and summary in Final Report
3	8.2	Techno-Economic Analysis (TEA)	07/18/2023		Topical Report and summary in Final Report
3	8.3	State-Point Data Table	01/31/2023		State-Point Data Table file
3	1.0	Draft Final Report	07/30/2023		Final Report file

Final test plan

FINAL test plan covers the performance testing of SOPO objectives

1. Plant Start-up and Ramp-up –Includes operator training, commissioning and plant start-up to name-plate capacity based on an ~8% CO_2 feed flue gas composition.
2. Base Performance and Steady State Testing –Includes base performance on an ~8% CO_2 feed flue gas composition under a steady state. This will be the basis of the acceptance test.
3. 14% Indicative Coal Flue Gas Feed Testing –Includes the indicative coal-fired flue gas feed testing by recycling part of the CO_2 product back to the feed flue gas to increase the CO_2 concentration to ~14% under a steady state.
4. 4% Indicative NGCC Flue Gas Feed Testing –Includes the indicative natural gas-fired combined cycle (NGCC) flue gas feed testing by introducing air to dilute the feed gas CO_2 concentration to ~4% under a steady state.
5. Load Following & Intermittence Testing –Includes assessment of the project technology to provide quick start-up and shutdown capabilities, and simulated load following, and high turndown ratio performed on the slip stream of flue gas from the existing natural gas-fired steam generator at ~8% CO_2 concentration.

Thank you

Thank you to our project sponsors

U.S. Department of Energy

Office of Fossil Energy

NETL – National Energy Technology Laboratory

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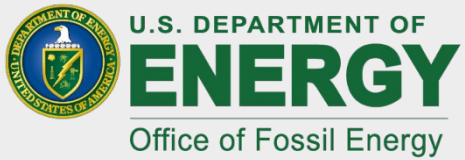

Questions and answers