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 CO₂e reductions by 2028

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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
  - CO₂ Capture Project
  - CCS Consortium
- National Energy Technology Laboratory
  - Greater Houston Partnership Houston Energy Transition Initiative
  - Global CCS Institute
- Agency for Science, Technology and Research (A*STAR)
  - Houston CCS Collaboration
- California Carbon Capture Coalition
- 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

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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 (CO₂) 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 CO₂ capture with 95% CO₂ purity at a cost of $30/tonne of CO₂ captured by 2030.
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

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

New MOF sorbent beds

95% CO₂ 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 CO₂ 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
- **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
- TEMASEK
- cnEnergy
- CARBON DIRECT
- OGI
- THE RODA GROUP
- CHART
- The Climate Group
- DECC

“Thought leader” investors

- bdc
- Chevron
- Cenovus
- TEMASEK
- Holcim

Best-in-class partners

- Chevron
- Cenovus
- Holcim
- TEMASEK
- bdc

Svante footprint

- **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

- **Chevron SOAK 400 Series Plant**
  - San Joaquin, CA, USA
  - Capacity: 9,125 TPA
  - Status: Detailed Engineering & Execution
  - Source: Industrial boilers
  - Owner: Chevron

- **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+

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

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Svante’s technology for the separation of CO₂ 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
4. Capture plant process design and energy integration
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 CO₂ 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.)
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)

Production history (1899-2015)

OTSG stack
Capture plant

SJVBU GHG emissions
2021
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

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**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 (CO₂ capture with 95% CO₂ purity at a cost of $30/tonne of CO₂ captured by 2030)**
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

<table>
<thead>
<tr>
<th>Budget period</th>
<th>Task</th>
<th>Milestone description</th>
<th>Planned completion date</th>
<th>Actual completion date</th>
<th>Verification method</th>
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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% CO₂ feed flue gas composition.

2. Base Performance and Steady State Testing – Includes base performance on an ~8% CO₂ 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 CO₂ product back to the feed flue gas to increase the CO₂ 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 CO₂ 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% CO₂ concentration.
Thank you

Thank you to our project sponsors

U.S. Department of Energy

Office of Fossil Energy

NETL – National Energy Technology Laboratory
Grants Officer
Lisa Kuzniar

Program Manager
Nicole Shamitko-Klingensmith

Contract Specialist
Kelly Haught
Questions and answers