Direct Air Capture Using Novel Structured Adsorbents
DE-FE0031959

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Program Overview

Funding (DOE and Cost Share)
DOE - $2,500,000 / Cost Share - $1,214,202

Overall Project Performance Dates
10/1/2020 – 09/30/2023

Project Participants
– Electricore, Inc.
– Svante, Inc.
– Climeworks AG
– Wintec Energy LTD
– Southern California Gas Company

Overall Project Objectives
The objective of this project is to advance direct air capture (DAC) technology through a novel combination of a vacuum-temperature swing CO₂ adsorption process and structured adsorbent beds (SABs).
Climeworks’ Direct Air Capture (DAC) plant utilizes a vacuum-temperature swing adsorption process to filter the air and capture atmospheric CO₂. Air is drawn into the plant with fans and CO₂ within the air is chemically bound to Svante’s novel solid sorbent material as the filter. One aspect of achieving low-cost DAC is to optimize energy use in this process. Supporting data confirms that TRL 4 was achieved by Climeworks DAC and Svante novel solid sorbent material operation at the Climeworks laboratory.

The proposed project is highly feasible. Materials, process, and system are developed and tested to TRL 4. Climeworks and Svante are leaders in their field with expertise and resources to conduct the work who have successfully collaborated earlier.

The project will advance the technology to TRL 5 and result in a robust TEA on the DAC application.

The field test will highlight gaps in performance that may benefit from further effort.
Technology Background (2)

Climeworks technology demonstrated in 14 plants to date:

Combining Climeworks’ temperature-vacuum swing adsorption technology with Svante’s structured adsorbents:

**Climeworks’ DAC technology**
- Proven technology
- Modular, versatile hardware
- Flexible process

**Svante’s structured adsorbent technology**
- Rapid cycling
- Adaptable geometry
- Active phase flexibility

**Project goals**
- Combined sorbent/process optimization for DAC
- Demonstrate at TRL 5
Technical Approach/Project Scope

The proposed technical approach is to construct and operate an integrated DAC system (IDS), fielding and testing a novel combination of Climeworks’ versatile DAC process and hardware with Svante’s transformational structured adsorbent laminate filter, advancing the process and identifying optimization options for this DAC configuration. Field testing (12 months) will be conducted on a renewable power generation site in Palm Springs, California to capture operational data on the novel process and material combination under real conditions. Data will be used to advise techno-economics and life cycle analysis of the technology.

Project Success Criteria:
• Completed 12-month field demonstration.
• Roadmap to capture costs of $100/tonne of CO₂
• Achieve concentrated CO₂ stream of at least 95% purity
• Submission of TEA, EH&S, State-Point Data Table and LCA Report
Team and Facilities

ELECTRICORE
Deborah Jelen
Claude Letourneau

SVANTE
Pierre Hovington

CLIMEWORKS
Jan Wurzbacher
Daniel Sutter
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Wintec Facility – Field Test Site
Palm Springs, CA

Svante Laminate-Forming Facility

Climeworks Mid-Scale Test Facility
World’s largest multi-purpose DAC test facility
3 lines, 3500 m³/h air, ~25 kg/day CO₂
Progress and Current Status of Project

Plant construction:

- Host site agreement (near Palm Springs)
- PFD, HAZOP completed
- P&ID and permitting underway

Simultaneous optimization of adsorbent and process:

- Proof-of-concept tests of Svante laminates in Climeworks DAC process
- Pathways to laminate adaptations for DAC:
  – Geometry variation
  – Sorbent adaptations
  – Concurrent process optimization
Opportunities for Collaboration

Future perspectives: sorbent portfolio

- Climeworks sorbent test facilities
  - Sorbent DAC performance tests for g to ~100 kg sorbent, structured or granular
  - Single breakthrough and multiple cyclic testing feasible, flexible process
- Svante sorbent test facilities
  - Structured sorbent production facility for novel sorbents
  - Characterization lab for mg to kg scale