

# Direct Air Capture Using Novel Structured Adsorbents

DE-FE0031959

Presented by:

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U.S. Department of Energy  
National Energy Technology Laboratory  
**Direct Air Capture Kickoff Meeting**  
February 24-25, 2021

# Program Overview

Funding (DOE and Cost Share)

**DOE - \$2,500,000 / Cost Share - \$1,214,202**

Overall Project Performance Dates

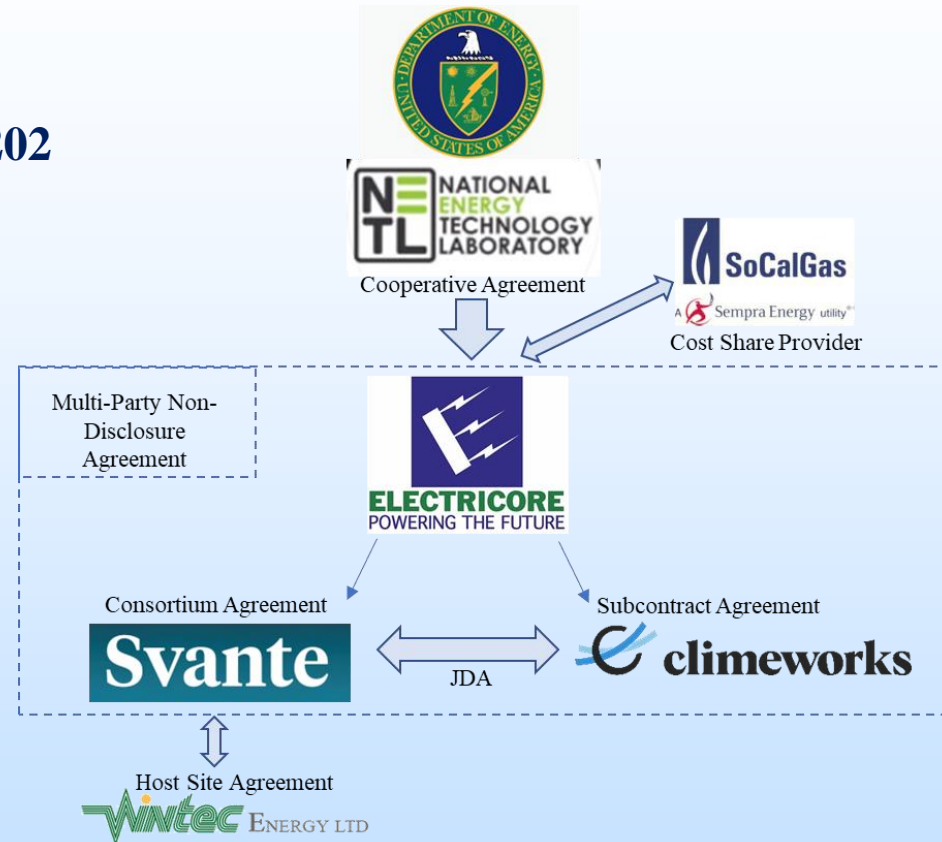
**10/1/2020 – 09/30/2023**

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 CO<sub>2</sub> adsorption process and structured adsorbent beds (SABs).**



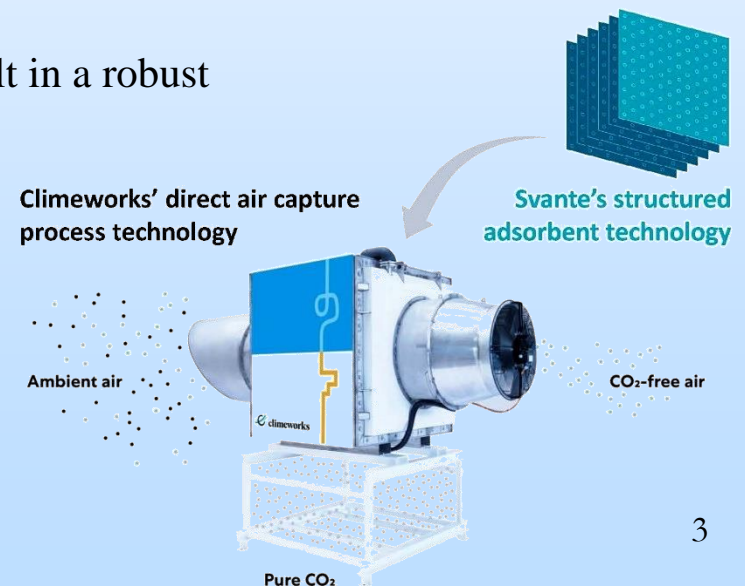
# Technology Background (1)

Climeworks' Direct Air Capture (DAC) plant utilizes a vacuum-temperature swing adsorption process to filter the air and capture atmospheric CO<sub>2</sub>. Air is drawn into the plant with fans and CO<sub>2</sub> 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.



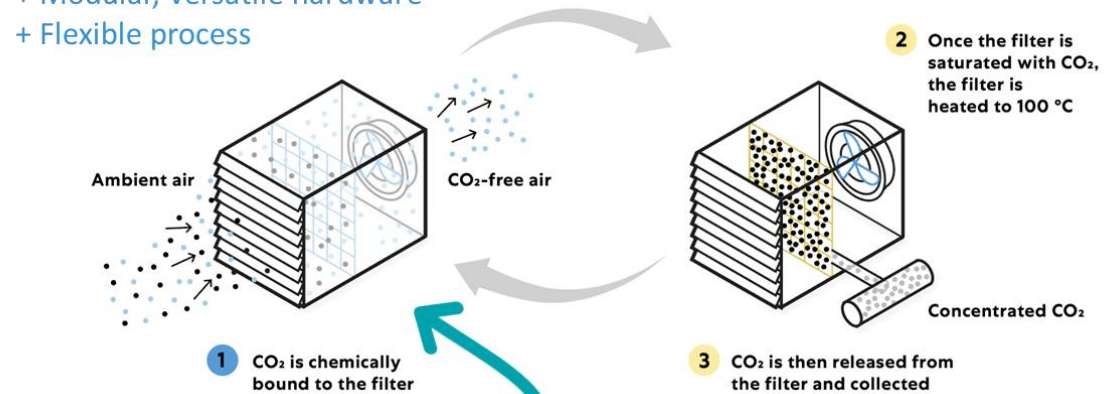
# Technology Background (2)

**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



**Project goals**

- + Combined sorbent/process optimization for DAC
- + Demonstrate at TRL 5

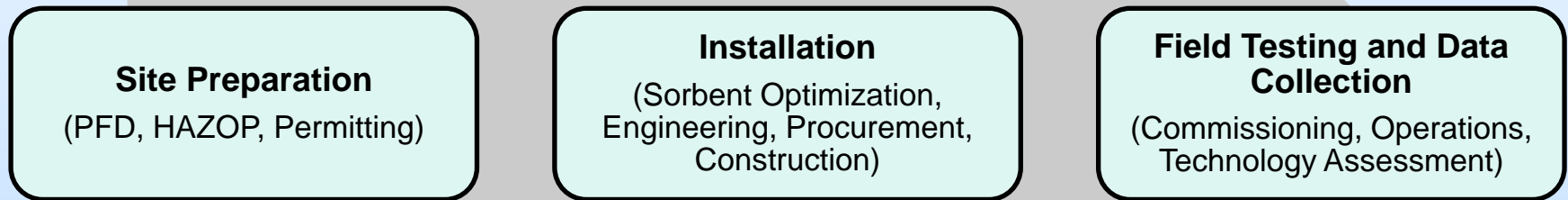
**Svante's structured adsorbent technology**

- + Rapid cycling
- + Adaptable geometry
- + Active phase flexibility



# 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 CO<sub>2</sub>
- Achieve concentrated CO<sub>2</sub> stream of at least 95% purity
- Submission of TEA, EH&S, State-Point Data Table and LCA Report



# Team and Facilities

## ELECTRICORE



Deborah Jelen

## SVANTE



Claude Letourneau



Pierre Hovington



Jan Wurzbacher

## CLIMEWORKS



Daniel Sutter



Adelaide Calbry-Muzyka



Wintec Facility  
– Field Test Site



Svante Laminate-Forming Facility

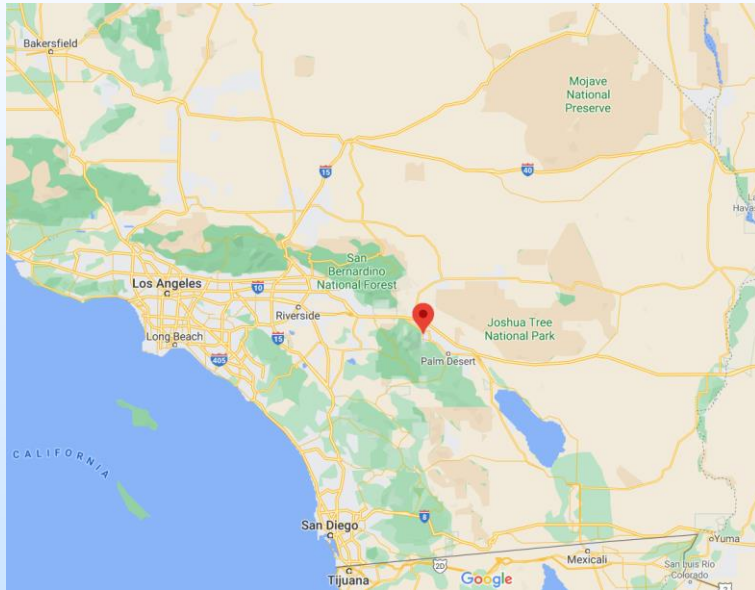


Climeworks Mid-Scale Test Facility 6

World's largest multi-purpose DAC test facility  
3 lines, 3500 m<sup>3</sup>/h air, ~25 kg/day CO<sub>2</sub>

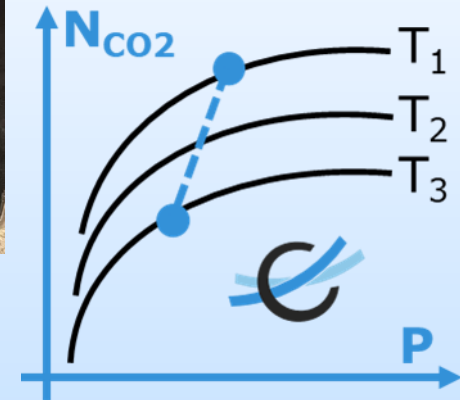
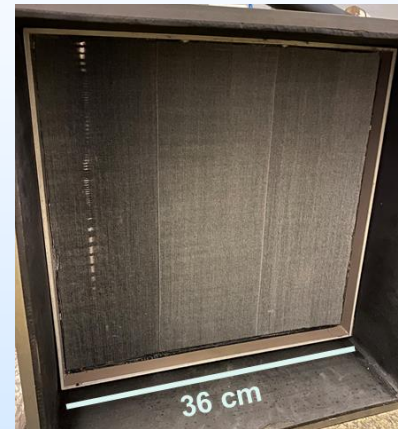
# Progress and Current Status of Project

## 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

