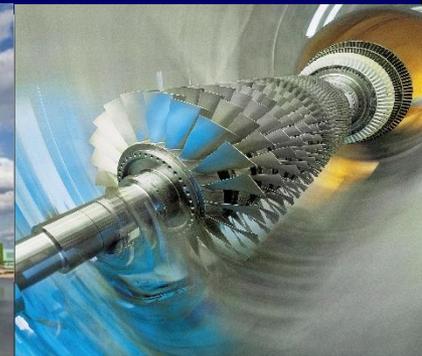




U.S. DEPARTMENT OF
ENERGY

Office of
Fossil Energy



Direct Air Capture & Negative CO₂ Emissions

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Associate Deputy Assistant Secretary

Office of Clean Coal and Carbon
Management

CCUS Roadshow | January 2020 | Washington, DC

MAJOR CCUS DEMONSTRATION PROJECTS

Air Products Facility (Port Arthur, TX) – operations began in 2013



- Built and operated by Air Products and Chemicals Inc. at Valero Oil Refinery
- State-of-the-art system to capture CO₂ from two large **steam methane reformers**
- **Nearly 6.0 million metric tons of CO₂** captured and transported via pipeline to oil fields in eastern Texas for **enhanced oil recovery (EOR)** since March 2013

Petra Nova CCS (Thompsons, TX) – operations began in 2017



- Joint venture by NRG Energy, Inc. (USA) and JX Nippon Oil and Gas Exploration (Japan)
- Demonstrating Mitsubishi Heavy Industries' solvent technology to **capture 90% of CO₂ from 240-MW flue gas stream** (designed to capture/store 1.4 million metric tons of CO₂ per year)
- **Nearly 4 million metric tons of CO₂** used for **EOR** in West Ranch Oil Field in Jackson County, Texas since January 2017

ADM Ethanol Facility (Decatur, IL) – operations began in 2017



- Built and operated by Archer Daniels Midland (ADM) at its existing biofuel plant
- CO₂ from **ethanol biofuels production** captured and stored in **deep saline reservoir**
- **First-ever CCS project** to use new U.S. Environmental Protection Agency (EPA) Underground Injection **Class VI well permit**, specifically for CO₂ storage
- **1.5 million metric tons of CO₂** stored, since April 2017

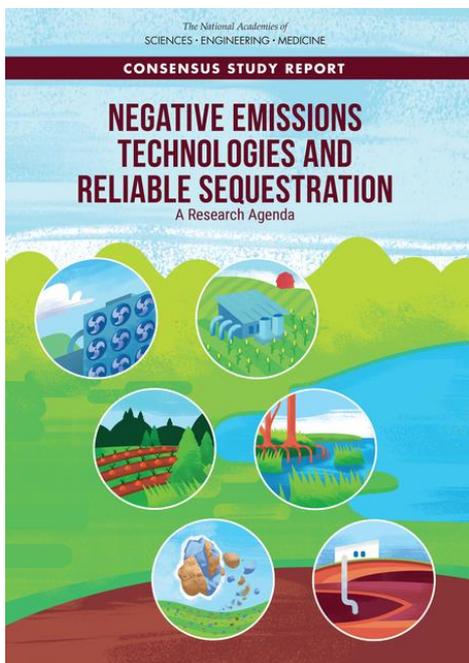


From FY20 Conference Report: “The agreement provides not less than \$20,000,000 for research and development of ***negative emissions technologies***, including not less than \$10,000,000 for direct air capture.”

Negative Emissions Technologies – Technologies that remove carbon from the atmosphere & reliably sequester it. Includes several technologies but FE carbon capture has expertise in:

- **Bioenergy with Carbon Capture and Sequestration (BECCS)**
- **Direct Air Capture** – current projected costs for DAC don’t make a case for deployment

- No single NET can remove enough emissions alone, multiple NETs in concert are needed



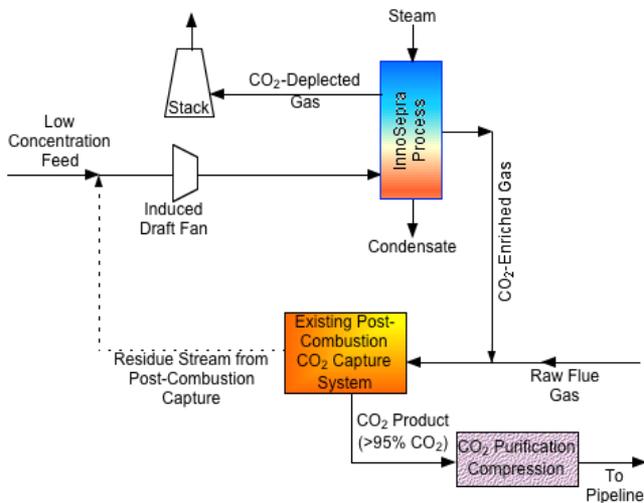
DAC/DILUTE SOURCE CAPTURE: FE/NETL PROJECTS

Past FE Projects:

\$200+/tonne

InnoSeptra LLC

Physical Sorbent
(1-1.5% CO₂ Concentration)



Fixed-bed laboratory unit for testing structured sorbents

\$300+/tonne

The Ohio State University

Membranes
(<1% CO₂ concentration)



Continuous membrane fabrication machine at OSU

<https://www.netl.doe.gov/research/coal/project-information/proj?k=FE0026919>

\$200+/tonne**

Carbon Engineering

Wet scrubbing air contactor
(400 ppm Direct Air Capture)



Carbon Engineering's research pilot facility in Squamish, BC



DOE EFFORTS IN FY19 AND FY2020

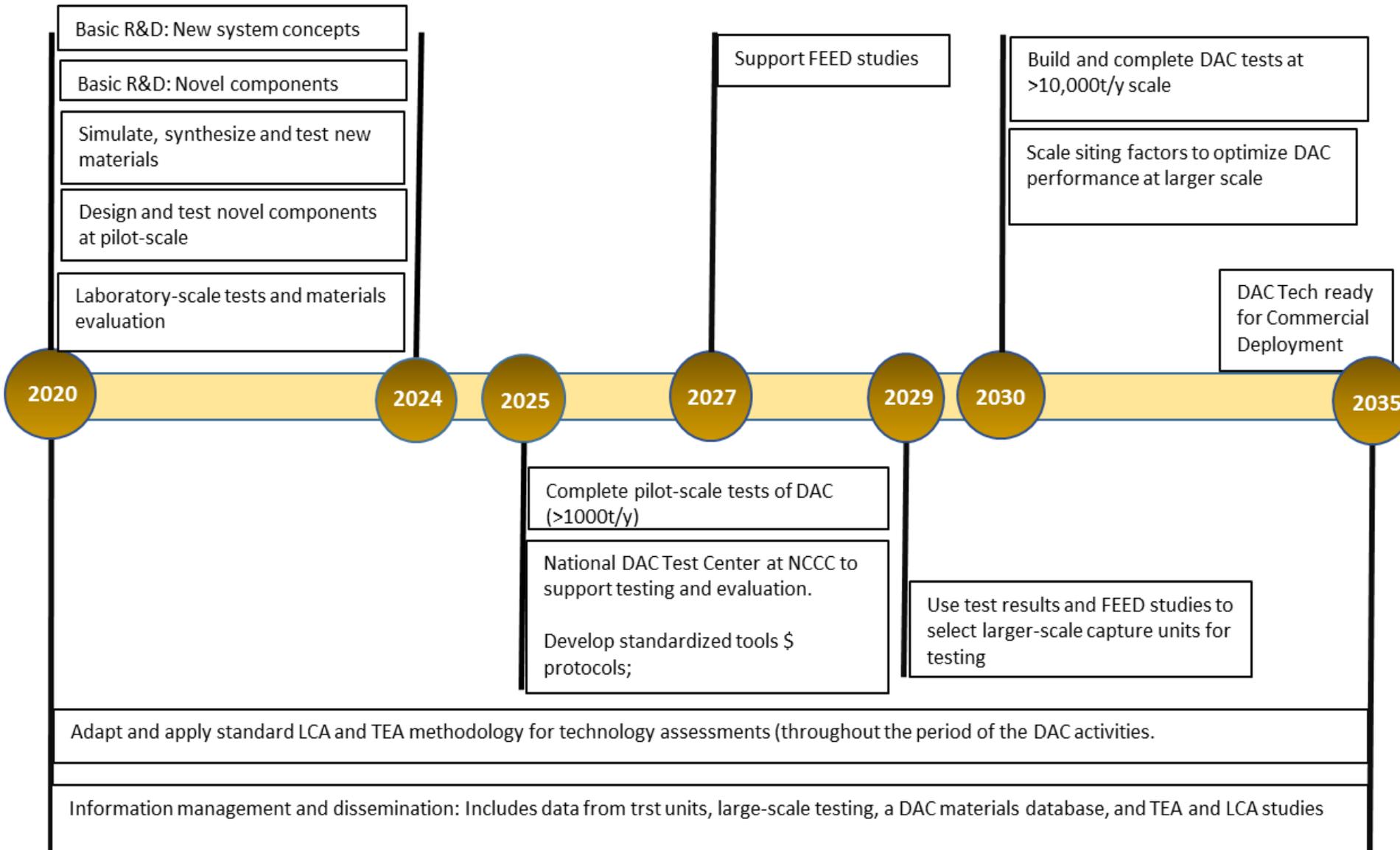
- **Workshop** for DAC R&D Priorities - July 24, 2019
- **Techno economic assessment (TEA) - Baseline for DAC – FY2019 (In progress)**
- **Carbon Engineering** Techno-economic assessment – FY2020 (in progress)
- **BECCS Request for Information (RFI)** – Impact of Biomass Co-firing Contaminants on Capture Systems – Released 1/2020

Funding Opportunities

- **University Coal Fossil Energy Research on Materials** – novel DAC materials – (FY2019)
- **SBIR** - novel DAC materials - 2020
- **Direct Air Capture** – release date ~ May 2020
- **BECCS** - Request For Proposals – release date ~ April 2020



FE R&D PLAN FOR DAC - DRAFT





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Questions?

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