Overview of Carbon Capture, Utilization and Storage (CCUS) and Opportunities for Hydrogen

GCCSI Briefing: The Status of the Hydrogen Economy

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The US: A global leader on CCUS research, development, and deployment

- 40+ year history of CO₂ utilization for EOR
- Over 600 million tons of associated storage with EOR
- Over 4,000 miles of CO₂ pipelines in the United States
- Strong efforts in developing the human capital and enablers for CCUS deployment (scientists, engineers, trades)
  - Broad R&D program engaging Private Industry, Universities, National Laboratories, small business, and the financial community.
- Has successfully invested in major CCUS demonstrations
- Leading one of the most globally recognized and successful RD&D programs on CCUS....
- ...And leveraging this technology, science, and knowledge with other agencies for sound policy development.
CCUS is increasingly becoming widely accepted as a viable option for various point sources to lower their carbon dioxide (CO₂) emissions. 

- DOE Major Demonstration Program
- 45Q tax credit
- Responses to DOE funding opportunities – broader R&D portfolio
- Increased investment interest
- Cost reductions

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
• Over 5.0 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 3.3 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
• 1.3 million metric tons of CO₂ stored, since April 2017
Policy Incentives for CCUS - 45Q tax credits

“Technology push” through R&D is matched with “market pull” through financial incentives

<table>
<thead>
<tr>
<th>Threshold by Facility Type (ktCO₂/y)</th>
<th>Credit in 2026 ($/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Plant</td>
<td></td>
</tr>
<tr>
<td>Dedicated Storage</td>
<td>500</td>
</tr>
<tr>
<td>EOR</td>
<td>500</td>
</tr>
<tr>
<td>Utilization</td>
<td>25</td>
</tr>
<tr>
<td>Industrial Facility</td>
<td>100</td>
</tr>
<tr>
<td>Direct Air Capture</td>
<td>100</td>
</tr>
<tr>
<td>Disposal/injection/use</td>
<td></td>
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</tbody>
</table>

- Credit available to qualified facilities for 12 year period
- Defines qualified Carbon Oxides (CO or CO₂)
- Measured at point of capture and verified at the point of disposal/injection/use
- Qualified facilities:
  - 1) Construction must begin by Jan 1, 2024;
  - 2) Original planning and design includes carbon capture equipment
- Credit can be claimed by owner of capture equipment or transferred to disposal/use entity

Source: McCoy, 2018
INDUSTRIAL PROCESSES: CO₂ AVAILABLE FOR CAPTURE IN THE US

Cost of Capturing CO₂ from Industrial Sources, January 10, 2014, DOE/NETL-2013/1602; [https://www.netl.doe.gov/energy-analysis/details?id=1836](https://www.netl.doe.gov/energy-analysis/details?id=1836)
$200M per Year Investment focused on:

Carbon Capture – Reduce the cost of capture
  • Capital cost
  • Energy penalty
  • Integration

CO₂ Use and Reuse/Utilization – Develop viable carbon utilization alternatives – opportunity for hydrogen?
  • Capital cost
  • Energy requirements
  • Lifecycle assessment

Carbon Storage – Improve the reliability and operations
  • Higher resolution and quantification
  • Geomechanics (pressure and state of stress)
  • Cost
GROWING INDUSTRIAL INTEREST ON CCUS – NOT JUST FOR POWER

OIL AND GAS CLIMATE INITIATIVE (OGCI)

- 13 member companies

- Focused on three objectives:
  - Reducing Energy Value Chain Footprint
  - Accelerating Low-Carbon Solutions
  - Enabling a Circular Carbon Model

- $1+ billion climate investment fund focused on:
  - Reducing methane leakage
  - Reducing carbon dioxide (efficiency)
  - Recycling carbon dioxide (CCUS)
U.S. role in multilateral CCUS partnerships

- **International Energy Agency (IEA)**
  - Working Party on Fossil Fuels (Chair)
  - Greenhouse Gas R&D Programme (GHG) *ExCo member*
  - Clean Coal Centre (CCC) *ExCo Chair*
  - CCS Unit – CCS Roadmap and International CCS Regulatory Network

- **Carbon Sequestration Leadership Forum (CSLF)**
  - *Secretariat and Policy Group Chair*

- **Clean Energy Ministerial (CEM) - CCUS Initiative**
  - *CCUS Initiative Lead*

- **Accelerating CCUS Technologies (ACT) Initiative**

- **Mission Innovation CCUS Initiative**

- **Asia Pacific Economic Cooperation Expert Group on Clean Fossil Energy (APEC EGCFE)**
  - *EGCFE Chair*

- **UN Economic Commission for Europe (UNECE)**
  - *Sustainable Energy Bureau Vice Chair*

- **Global CCS Institute**
KNOWLEDGE SHARING PRODUCTS

Worldwide CCS Project Database

A global leader on CCUS research, development, and deployment
Thank You

Questions?

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