

Fossil Energy and Carbon Management

Developing the CCTUS Infrastructure in the United States

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Industrial Ecosystem and FECM Programs

https://www.energy.gov/fecm/interactive-diagram-carbon-management-provisions



https://www.energy.gov/fecm/carbon-matchmaker



Rapid CCS industry growth for decarbonization





North Dakota CarbonSAFE



CarbonSAFE Project ECO2S, Mississippi



Wyoming CarbonSAFE Project



Illinois Basin CarbonSAFE Project



An Iterative Process Towards Deployment





Moving Forward on CCS Deployment

- Incentives and Funding
- Federal and State Legislation
- Advancing Capture Technologies
- Storage and Hub Infrastructure
- CO₂ Transport Infrastructure
- Basin-scale management



Incentives/Thresholds for CCS

Inflation Reduction Act--45Q Modifications

	Old	New
Commence Construction	January 1, 2026	January 1, 2033
DAC Facility	100,000 metric tons/year*	1,000 metric tons/year
Electric Generator	500,000 metric tons/year*	18,750 metric tons/year
All other facilities	100,000 metric tons/year*	12,500 metric tons/year
Saline Storage Credit	\$50/metric ton	<pre>\$85/metric ton (industry and power); \$180/metric ton (DAC)</pre>
EOR and Conversion Credit	\$35/metric ton	\$60/metric ton (industry and power); \$130/metric ton (DAC)

* Non-EOR Conversion facilities were previously 25,000 metric tons/year regardless of facility/source.

Notes: New Modifications allows up to 5 years for direct pay (up to 12 years certain entities)



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fecm.energy.gov

Bipartisan Infrastructure Law (BIL) Overview

Bipartisan Infrastructure Law Programs | Department of Energy

- For the BIL investments (\$550 billion) approximately 800,000 (new) jobs per year over the next decade
- Appropriated \$12 billion in new carbon management research, development and demonstration (RD&D) over 5 years

Carbon Dioxide Removal - Direct Air Capture Regional Direct Air Capture Hubs: \$3.5 billion DAC Technology Prize Competition: \$115 million **Carbon Dioxide Utilization and Storage** Carbon Storage Validation and Testing: \$2.5 billion Carbon Utilization Program: \$310 million

Front-End Engineering Design Studies Carbon Capture Technology Program: \$100 million

Critical Minerals and Materials Rare Earth Element Demonstration: \$140 million Rare Earth Mineral Security: \$127 million

https://netl.doe.gov/business/solicitations/bil

ENERGY Fossil Energy and Carbon Management

Federal Agencies — Addressing Regulatory, Safety Oversight, and Leasing for CCS

US Council on Environmental Equality (CEQ) - USE IT. Public Law 116-260, 134 Stat 1182.

• Identify challenges and successes for responsible permitting and provide recommendations to improve responsible permitting CCUS and Pipelines. Candidates to serve on the Federal and OCS Task Force.

US EPA - BIL Sec 40306. SECURE GEOLOGIC STORAGE PERMITTING.

- Federal Class VI Permitting Program \$25M (\$5M/yr FY22-26)
- State Permitting Program Grants \$50,000,000 (FY22-26)

Department of Interior SEC. 40307. GEOLOGIC CARBON SEQUESTRATION ON THE OUTER CONTINENTAL SHELF

• Developing regulation for the permitting and leasing of federal offshore assets for CCS. (No funding)

DOT - PHMSA and other offices

- May 2022 PHMSA Announces New Safety Measures to Protect Americans From Carbon Dioxide Pipeline Failures
- Evaluation of Freight (Rail, Trucking, Shipping)

DOI BLM

 National Policy for the Right-of-way Authorizations Necessary for Site Characterization, Capture, Transportation, Injection, and Permanent Geologic Sequestration of Carbon Dioxide in Connection with Carbon Sequestration Projects <u>https://www.blm.gov/policy/im-2022-041</u>



States — Addressing Regulatory, Safety Oversight, and Leasing for CCS

California Senate Bill SB 905 - Carbon sequestration: Carbon Capture, Removal, Utilization, and Storage

- Unified permit application and centralized project database
- Defines:
 - financial responsibility,
 - pore space ownership (surface owner)

Wyoming SF0047 Senate Act - Carbon storage and sequestration-liability

- Pore space authority lies with Oil and Gas Conservation Commission
- Certificate of Completion:
 - Until issued: Injector owns CO₂
 - Once issued: title and custody of CO₂ transferred to state

Indiana Senate Bill 442 - Underground CO₂ storage to be considered a public use and service

- Pore space ownership/rights can be acquired if 60% of storage unit already under agreement
- State may obtain ownership after 12 years, if injection has ceased

North Dakota

- Certificate of Completion
 - Until issued: Operator owns CO₂ and pore space
 - Once issued: ownership of site transfers to state (no sooner than 10 years after injection ends)
- EOR can be converted to storage

UIC Class VI Primacy

- EPA has granted primacy to ND and WY
- States of WV, TX, AZ, and LA are seeking primacy for Class VI



Capture Technologies — Diversity of CO2 Streams

Bipartisan Infrastructure Law (BIL): Carbon Capture Demonstration Projects Program Front-End Engineering Design Studies for Integrated Carbon Capture, Storage, and Transport Systems



Cost of Capturing CO₂ from Industrial Sources, 2022, DOE/NETL-2013/1602



Dedicated Storage and Hubs Infrastructure

Bipartisan Infrastructure Law (BIL): Storage, Validation and Testing (Section 40305): Carbon Storage Assurance Facility Enterprise (CarbonSAFE): Phases III, III.5, and IV



Carbon Storage Assurance Facility Enterprise

DEVELOPMENT PATHWAY TOWARDS COMMERCIAL DEDICATED STORAGE SITES AND HUBS





ent CarbonSAFE Notice of Intent Released Nov 2021: https://www.netl.doe.gov/business/solicitations 12

Storage Resources Management System (SRMS)

Commercial viability framework <u>CO2 Storage Resources Management System (spe.org)</u>

- PRMS provided template for SRMS document
- SRMS provides a <u>common</u> <u>terminology</u> for stakeholders
- Improves global communications on storage resources
- Classifies <u>storable quantities</u> in the context of defined projects intended to be <u>matured to commerciality</u>



Carbon STORE

Carbon <u>S</u>torage <u>T</u>echnology and <u>O</u>perations <u>RE</u>search Facility

Leverages DOE investments today to drive down the cost of CCS tomorrow

Key enablers...

- Establish long-term carbon storage field laboratories
- Fast tracks emerging technology validation in subsurface conditions.
- Provides real-world performance feedback for operational improvements and optimization.



CO₂ Transport Infrastructure

Bipartisan Infrastructure Law (BIL): Carbon Capture Technology Program, Front-End Engineering and Design for Carbon Dioxide (CO2) Transport

- CO₂ Transport FEED Studies, \$100 million authorized over 5 years
- New carbon transport buildout or repurposing of existing infrastructure
- Working with DOT PHMSA to inform future regulatory and safety considerations
- Supports CO₂ Transportation Infrastructure and Innovation Program (CIFIA \$2.1 billion loan guarantees)
- CO₂ transport should review all modes of transport (ship, barge, rail, truck)





Modeling from Princeton's Net-Zero America Study (2020)

Considerations/Needs for Repurposing Infrastructure

<u>Repurposing Wellbores:</u>

- Determining optimal infrastructure—CO2 injection versus monitoring versus developing new wells.
- o Requires conducting comprehensive characterization and analysis
- Requirements for maintaining mechanical integrity and protecting ground water extend to monitoring wells.

<u>Repurposing Pipelines:</u>

- PHMSA enforces CO2 pipeline safety via 49 CFR Part 195 regulations, which exclude underground storage, injection wells, and production facilities.
- Key considerations of repurposing pipelines to supercritical phase transport are project-specific regarding size and pressure rating.
- Need for studies on corrosion and potential contaminants based on the specifications of CO2 being transported.
- Field laboratories should be developed to allow access for researchers to test various pipeline materials and technologies.



Storage Facilities Decision Support Tools

Technologies to improve performance and reduce the cost



Real-time Visualization, Forecasting, and Virtual Learning for Decision Makers

- Science-based machine learning tools to accelerate field-scale deployment
- Improving efficiency, effectiveness, and safety of carbon storage operations



Site specific risk-based decision support tools for Stakeholders

- Physics-based tools for risk management and uncertainty reduction
- Addressing stakeholder needs for permitting and project start-up
- Providing technical assistance to EPA based on expertise gained through NRAP



Providing stakeholders/community access to CCS data resources

- Data curation and collaboration platform includes public and private data sharing capabilities
- Virtualized CCUS data and models to accelerate CCUS goals



SMART – CS Initiative

Science-informed Machine Learning for Accelerating Real-Time Decisions in Carbon Storage Applications



Carbon Management

SMART Visualization Platform

Develop an experiential visualization platform through a challenge prize offered to outside

Identify new ways to illustrate subsurface rock

Pressure and Stress Improve subsurface visualization of fluid pressures and rock stresses at the scale of the reservoir

Optimizing CO., Storage Develop a workflow for informing CO, storage operational decisions by forecasting plume migration in response to injection and production strategies.

Active Reservoir Management Demonstrate an interactive platform for dynamically learning how a CO., storage reservoir performs under a variety of operational strategies.

The SMART-CS Initiative aims to transform how people interact with subsurface data, improving the efficiency and effectiveness of fieldscale carbon storage by application of sciencebased machine learning and data analytics.

https://edx.netl.doe.gov/smart/

National Risk Assessment Partnership (NRAP) Open-source computational tools and recommended practices for risk assessment



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Addressing commercial-scale deployment:

How can NRAP Open-IAM be used to assess and manage risks such as repurposing existing infrastructure and integration with industry best practices?

How do we assess and manage risks of rapid, basin-scale deployment of commercial –scale projects?

How can adaptive, risk-based design ensure efficient and effective monitoring?

How can quantitative assessment risk and long-term liability inform decisions around investment and financial responsibility?

https://edx.netl.doe.gov/nrap/

Basin-scale Management for Rapid Deployment

Mange subsurface environmental basin-scale risks associated with rapid commercialscale deployment of GCS





US Basin Map: Larson et al. 2021: <u>NZA Annex I - CO2 transport & storage.pdf (princeton.edu)</u> <u>Illinois Basin Model -</u> Birkholzer & Zhou, 2011 Source: Kroll et al. (prototype forthcoming) Operational Forecasting of Induced Seismicity





CCS Data Resources

- Refining, integrating and generating priority data resources to feed carbon storage commercial, R&D (SMART, NRAP, etc), and regulatory models
- CCS Tools
 - Development and deployment of strategic Carbon Capture and Storage (CCS) data visualization and analytical tools to accelerate CCS commercial and regulatory efforts

Core CCS EDX DisCO2ver platform

- Connecting stakeholders across commercial, regulatory, and research domains to a curated collection of CCS data, models, and capabilities (visualization, analysis, etc.)
- Building off the EDX-FECM Integrated Development Environment core but implementing and expediting deployment of key capabilities and resources for the CS community.

Outreach & Capacity Building

- Outreach efforts, training, and capacity building within communities across the US.
- Future CO₂, H₂ and SNG, biomass, and other source points and production/emission rates







For More Information



Office of Fossil Energy and Carbon Management

www.energy.gov/fecm/office-fossil-energy-and-

carbon-management





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Thank You!

