



U.S. DEPARTMENT OF
ENERGY

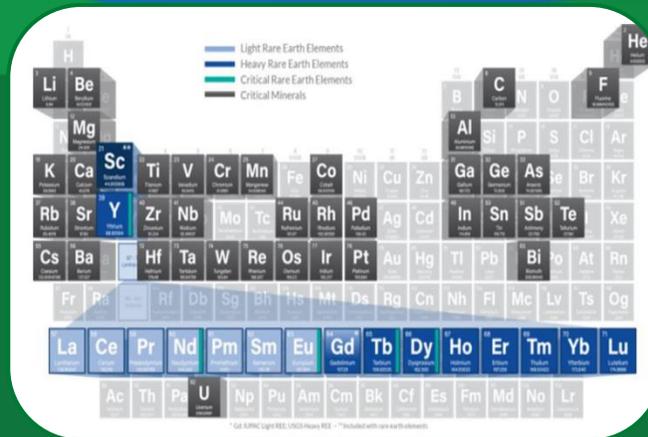
Fossil Energy and
Carbon Management

Billion Dollar Catalysts for Multi-Gigaton Opportunities: Innovations and Demonstrations in Hydrogen, Direct Air Capture, and Carbon Management

John Litynski

*Division Director, Carbon Transport and Storage
U.S. DOE Office of Fossil Energy and Carbon Management*

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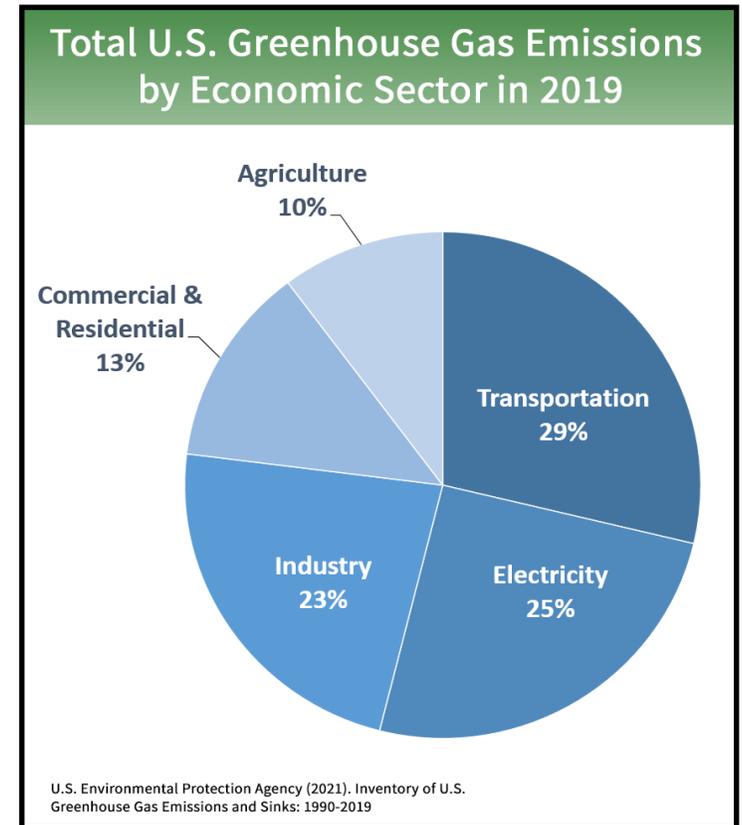
Fossil Energy and Carbon Management (FECM)

Office of Fossil Energy and Carbon Management

DOE-FE is now **DOE-FECM**

New name for our office reflects our new vision

- President Biden's goals:
 - 50 percent emissions reduction by 2030
 - CO₂ emissions-free power sector by 2035
 - Net zero emissions economy by no later than 2050



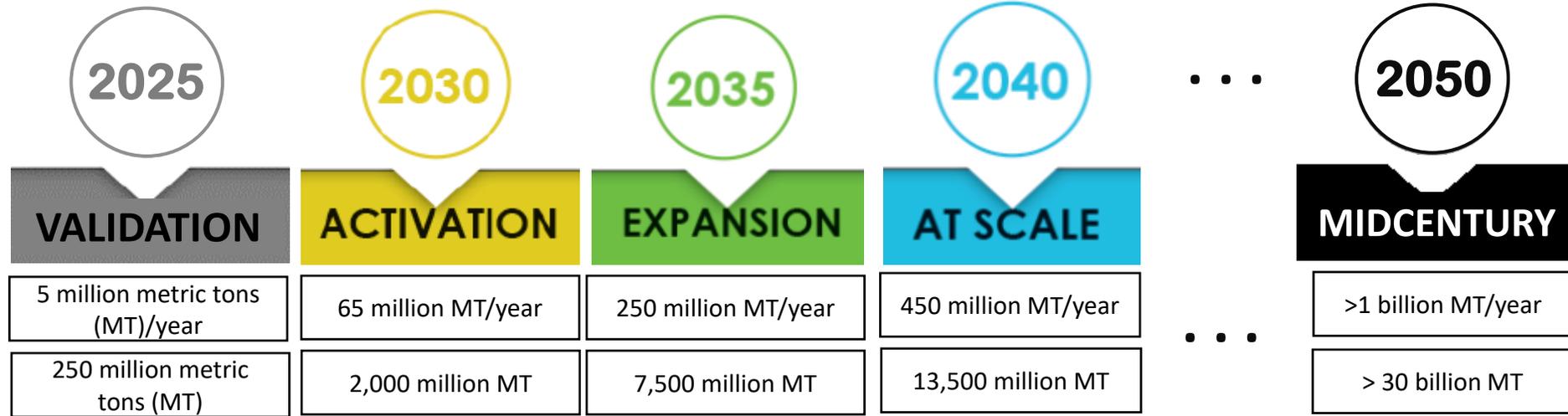
[2022-Strategic-Vision-The-Role-of-Fossil-Energy-and-Carbon-Management-in-Achieving-Net-Zero-Greenhouse-Gas-Emissions_Updated-4.28.22.pdf](#)

Rapid CCS industry growth for decarbonization



CarbonSAFE Targets

Injectivity
Commercial Storage Potential



Biden Administration Executive Order 14008
Tackling the Climate Crisis at Home and Abroad

50-52 percent reduction in economy-wide net greenhouse gas pollution in 2030 from 2005 levels

Net-zero emissions from the power sector by 2035

Net-zero emission economy by 2050

External Metrics and Goals

The National Academies of SCIENCES
ENGINEERING
MEDICINE
↑CCUS 10-fold by 2030

ipcc
INTERGOVERNMENTAL PANEL ON climate change
Cumulatively sequester 350-1,000 GT by 2050

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
- **\$12 billion** in new carbon management RD&D ~ \$7B Managed directly by FECM
- **\$9.5B** for hydrogen hubs and RD&D

Point Source Capture and Direct Air Capture

Regional Direct Air Capture Hubs: \$3.5 billion

DAC Technology Prize Competition: \$115 million

CCUS Integrated Demos: \$2.5 billion (OCED)

Carbon Capture Large Pilot: \$1 billion (OCED)

Carbon Dioxide Utilization, Transport, and Storage

Carbon Storage Validation and Testing: \$2.5 billion

Carbon Utilization Program: \$310 million

Carbon Transport Systems

FEED Studies for Transport Systems: \$100 million

CIFIA – Loans and Future Growth Grants: \$2.1 billion

Hydrogen

Hydrogen Hubs: \$8 billion (OCED)

Hydrogen Recycling Program: - \$500M

Hydrogen Electrolysis: \$1 billion

Critical Minerals and Materials

Rare Earth Element Demonstration: \$140 million

Rare Earth Mineral Security: \$127 million

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

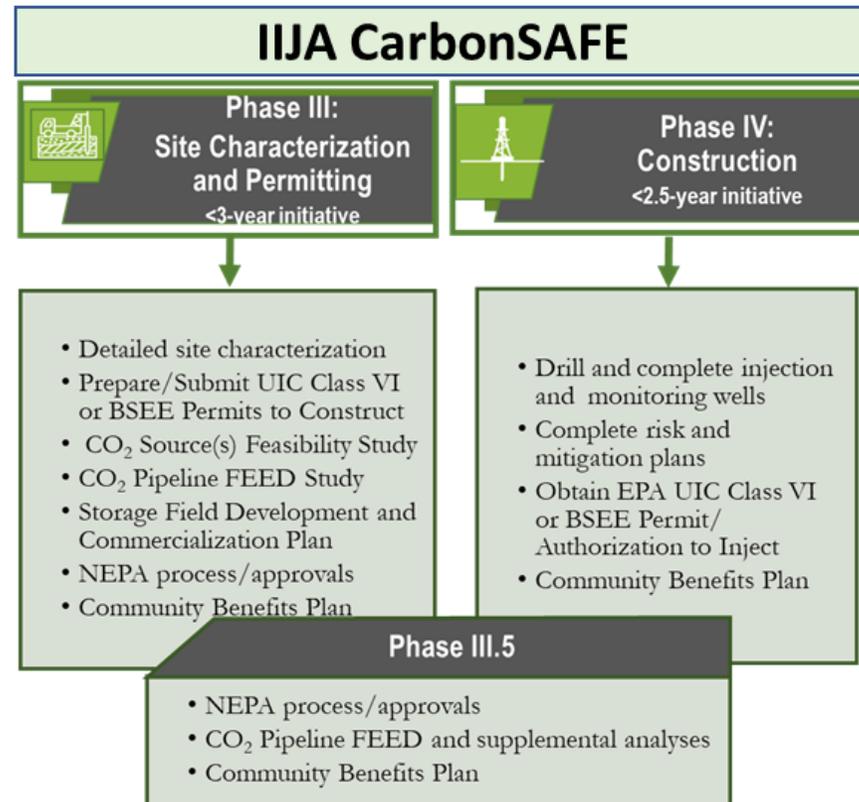
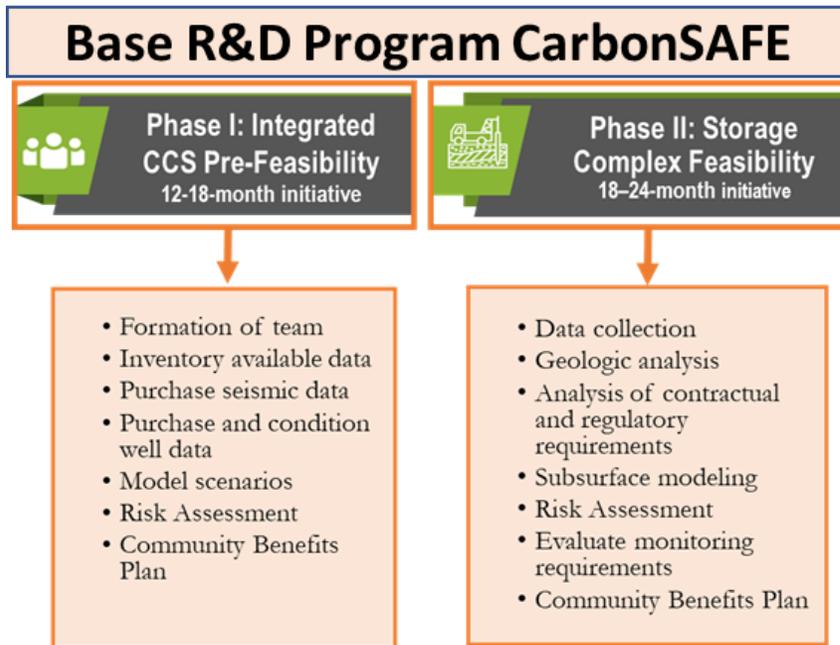


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Dedicated Storage and Hubs Infrastructure

Bipartisan Infrastructure Law (BIL): Storage, Validation and Testing (Section 40305): Carbon Storage Assurance Facility Enterprise (CarbonSAFE): Phases III, III.5, and IV - <https://netl.doe.gov/node/12078>



BIL 40305—Storage Validation and Testing

\$2.5 billion over 5 years

Applications Due: 11/28/2022

New or Expanded large-scale commercialization carbon sequestration facilities

50 MMT Hubs and Large-Scale Storage

20-40 Facilities

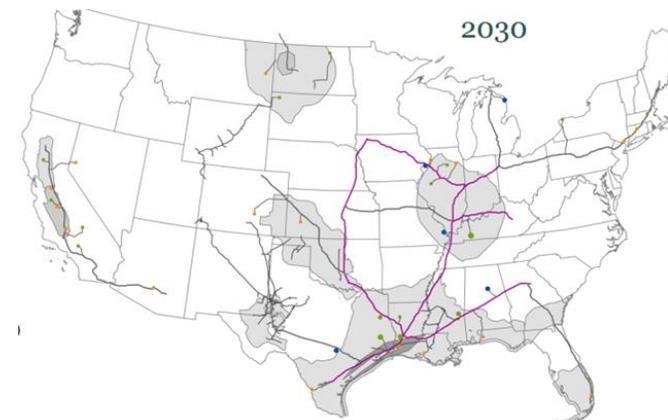
~80-100 Class VI Wells

CO₂ Transport Infrastructure

[Bipartisan Infrastructure Law \(BIL\): Carbon Capture Technology Program, Front-End Engineering and Design for Carbon Dioxide \(CO₂\) Transport](https://netl.doe.gov/node/12080) -<https://netl.doe.gov/node/12080>
[CIFIA Loan Subsidy Guidance](https://www.energy.gov/lpo/cifia-guidance) - <https://www.energy.gov/lpo/cifia-guidance>

FOA 2730 – Applications Due 11/28/2022
CIFIA has open Consultation Process

- 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 subsidies and Future Growth Grants)
- CO₂ transport should review all modes of transport (ship, barge, rail, truck)



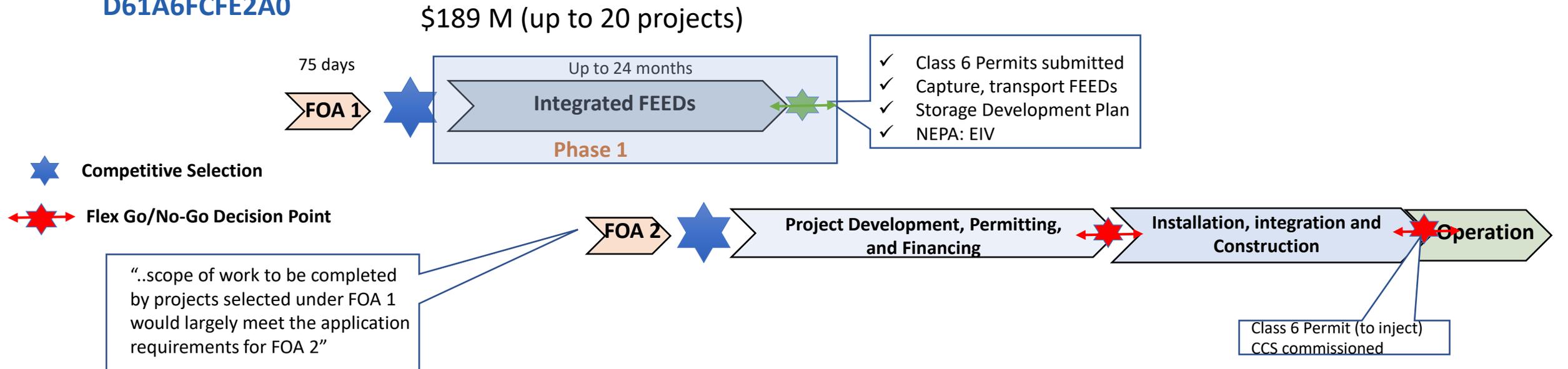
2030: ~11,000+ miles of CO₂ pipelines

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

CCS Demonstrations

[DE-FOA-0002738: BIL: CARBON CAPTURE DEMONSTRATION PROJECTS PROGRAM FRONT-END ENGINEERING DESIGN STUDIES FOR INTEGRATED CARBON CAPTURE, TRANSPORT, AND STORAGE SYSTEMS](https://oced-exchange.energy.gov/submissiondetailsedit.aspx?foaid=82c73432-65b4-4d82-b03c-d61a6fcfe2a0)

[HTTPS://OCED-EXCHANGE.ENERGY.GOV/SUBMISSIONDETAILSEDTIT.ASPX?FOAID=82C73432-65B4-4D82-B03C-D61A6FCFE2A0](https://oced-exchange.energy.gov/submissiondetailsedit.aspx?foaid=82c73432-65b4-4d82-b03c-d61a6fcfe2a0)



- \$2.5 B to demonstrate the construction and operation of **6 facilities to capture carbon dioxide from coal electric generation facilities (2 projects), natural gas electric generation facilities (2 projects), and industrial facilities (2 projects).**
- Shall be designed to further the development, deployment, and commercialization of technologies to capture and sequester carbon dioxide emissions from **new and existing** facilities
- Integrated CCS Project = Capture, Storage/conversion and/or off-take agreements and pipelines (if applicable) are necessary
- FOA2 not released yet and timeline is not public



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Regional Clean Hydrogen Hubs

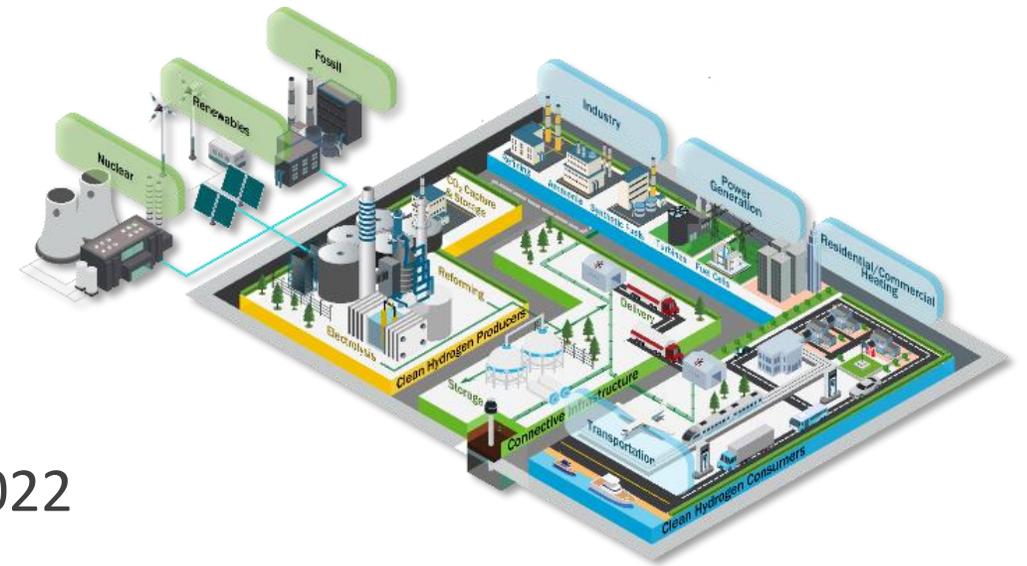
<https://www.energy.gov/oced/regional-clean-hydrogen-hubs>

Build 6-10 regional clean H2Hubs across the country to create networks of hydrogen producers, consumers, and local connective infrastructure to accelerate use of hydrogen

- Feedstock diversity
- End use diversity
- Geographic diversity
- Employment and training

Current Status

- Issued funding announcement in September 2022
 - Planning 6-10 awards ranging from \$400M-\$1.2B
 - Concept papers are due by Nov 7, 2022
 - Full applications are due by April 7, 2023



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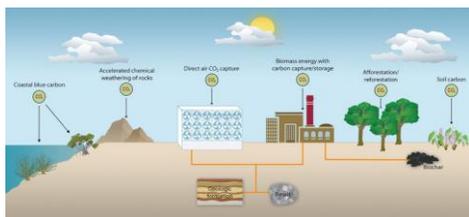
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Direct Air Capture Hubs

Notice of Intent - <https://www.netl.doe.gov/node/11776>

Direct Air Capture Hubs

SEC. 40308. CARBON REMOVAL; *Amended Section 969D of the Energy Policy Act of 2005 (42 U.S.C. 16298d)*



HUB DEFINITION:

a network of direct air capture projects, potential carbon dioxide utilization offtakers, connective carbon dioxide transport infrastructure, subsurface resources, and sequestration infrastructure located within a region.

Regional DAC Hubs

\$3.5 B

FY 22 – FY 26: \$700M / yr.

Each of the 4 regional direct air capture hubs developed shall be a regional direct air capture hub that has the capacity to capture and sequester, utilize, or sequester and utilize at least 1,000,000 metric tons of carbon dioxide from the atmosphere annually from a single unit or multiple interconnected units.

Carbon Capture Large Pilots

Key BIL Sec. 41004(a)

PROJECTS.—There are authorized to be appropriated to the Secretary to carry out activities under section 7 962(b)(2)(B) of the Energy Policy Act of 2005 (42 U.S.C. 8 16292(b)(2)(B))—

- (1) \$387,000,000 for fiscal year 2022;
- (2) \$200,000,000 for fiscal year 2023;
- (3) \$200,000,000 for fiscal year 2024; and
- (4) \$150,000,000 for fiscal year 2025.*



The term “large-scale pilot project” means a pilot project that—

(A) represents the scale of technology development beyond laboratory development and bench scale testing, but not yet advanced to the point of **being tested under real operational conditions at commercial scale**;

(B) represents the scale of technology necessary to gain the operational data needed to understand the technical and performance risks of the technology before the application of that technology at commercial scale or in commercial-scale demonstration; and

(C) **is large enough—**

(i) to **validate scaling factors**; and

(ii) to demonstrate the interaction between major components so that control philosophies for a new process can be developed and enable the technology to **advance from large-scale pilot project application to commercial-scale demonstration** or application.

<https://uscode.house.gov/view.xhtml?hl=false&edition=prelim&req=granuleid%3AUSC-prelim-title42-section16292&num=0&saved=%7CKHRpdGxIOjQyIHNIY3Rpb246MTYyOTMgZWRRpdGlvbjpwcmVsaW0p%7C%7C%7C0%7Cfalse%7Cprelim>



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fecm.energy.gov

Inflation Reduction Act for CCS – Highlights

Sec. 13104 - EXTENSION AND MODIFICATION OF CREDIT FOR CARBON OXIDE SEQUESTRATION. (45Q)

DOE Loan Programs Office

- \$11.7 billion in total for LPO to support issuing new loans.
- Authorizes New loan program, the Energy Infrastructure Reinvestment (EIR) Financing Program (Sec.1706)
 - Loans up to \$250 billion retool, repower, repurpose or replace energy infrastructure to mitigate GHGs
- Enhanced **Title 17 Innovative Clean Energy Loan Guarantee Program**
 - Additional \$40 billion of loan authority through 2026 - \$3.6 billion in credit subsidy

USDA SEC. 22004. USDA ASSISTANCE FOR RURAL ELECTRIC COOPERATIVES - \$9.7B

Multiple provisions that benefit, CCS, hydrogen, and CDR

EIR Legislation Language:
Guarantee loans to projects that retool, repower, repurpose, or replace energy infrastructure that has ceased operations, or enable operating energy infrastructure to **avoid, reduce, utilize, or sequester air pollutants or anthropogenic emissions of greenhouse gases.**



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U.S. Government Hydrogen Program and Funding

Inflation Reduction Act (IRA) - Hydrogen Provisions

On August 16, 2022, President Biden signed the IRA into law. The bill raises \$737 billion in revenue and authorizes \$369 billion for energy security and climate change-related spending, including for hydrogen specifically. According to White House analysis, the IRA sets the U.S. on track to decrease GHG by about 40% below 2005 levels by 2030. Key hydrogen-related funding covered in the bill includes:

Hydrogen Production and Storage

- Expands IRS Section 45V to introduce a new 10-year **clean hydrogen production tax credit (PTC)** of up to \$3/kg multiplied by an applicable percentage for qualified facilities producing hydrogen after December 31, 2022. *See further details on right.*
- Expands IRS Section 48 **investment tax credit (ITC)** to include “energy storage technology”, which can include hydrogen energy. The ITC starts at 6% but can increase to 40% if certain requirements are satisfied. Construction of facilities must begin before January 1, 2025. Generally, taxpayers cannot claim both the ITC and PTC for the same project.
- The IRA also includes a “direct pay option” for the same amounts instead of a tax credit. The direct payment for hydrogen and carbon capture facilities will be available for only the first 5 years of production.

Hydrogen Fuel Cell Technology

- \$2 billion in grants administered by DOE for domestic production of efficient hybrid, plug-in electric hybrid, plug-in electric drive, and **hydrogen fuel cell** EVs, with a 50% recipient cost share requirement and up to 3% of funding reserved for program administration
- Revised tax credit available for EVs and hydrogen fuel cell vehicles, for a maximum credit of \$7,000 for qualified taxpayers.

Kg of CO2 per kg of H2	Credit Value (\$)
4 - 2.5 kg CO2	\$0.60 / kg of H2
2.5 - 1.5 kg CO2	\$0.75 / kg of H2
1.5 - 0.45 kg CO2	\$1.00 / kg of H2
0.45 - 0 kg CO2	\$3.00 / kg of H2

The clean hydrogen production tax credit will provide up to \$3 per kg of qualified clean hydrogen produced based on a scaled metric of carbon intensity beginning at the base value of \$0.60 per kg of hydrogen produced (seen above).

The term ‘qualified clean hydrogen’ denotes hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of not greater than 4 kg of CO2e per kg of hydrogen.

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
<https://www.blm.gov/policy/im-2022-041>

For More Information

NETL Carbon Storage

<https://netl.doe.gov/coal/carbon-storage>

 @NationalEnergyTechnologyLaboratory

 @NETL_News

Technology Area	Project Count
Storage Complex Efficiency and Security	26
Monitoring, Verification, Accounting, and Assessment	24
Characterization Field Projects	25
Regional Carbon Sequestration Partnerships Initiative	15
Fit-for-Purpose Projects	14
Wellbore Integrity and Mitigation	6
Risk and Integration Tools	5

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