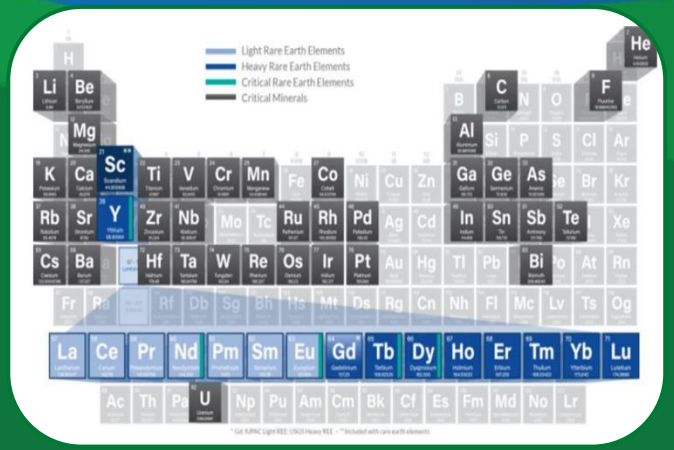
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

CO2 Freight Transport Workshop: Setting the Stage

Sarah Leung, Program Manager - Carbon Transport, US DOE

October 12, 2022
Ronald Reagan Building, Washington, DC





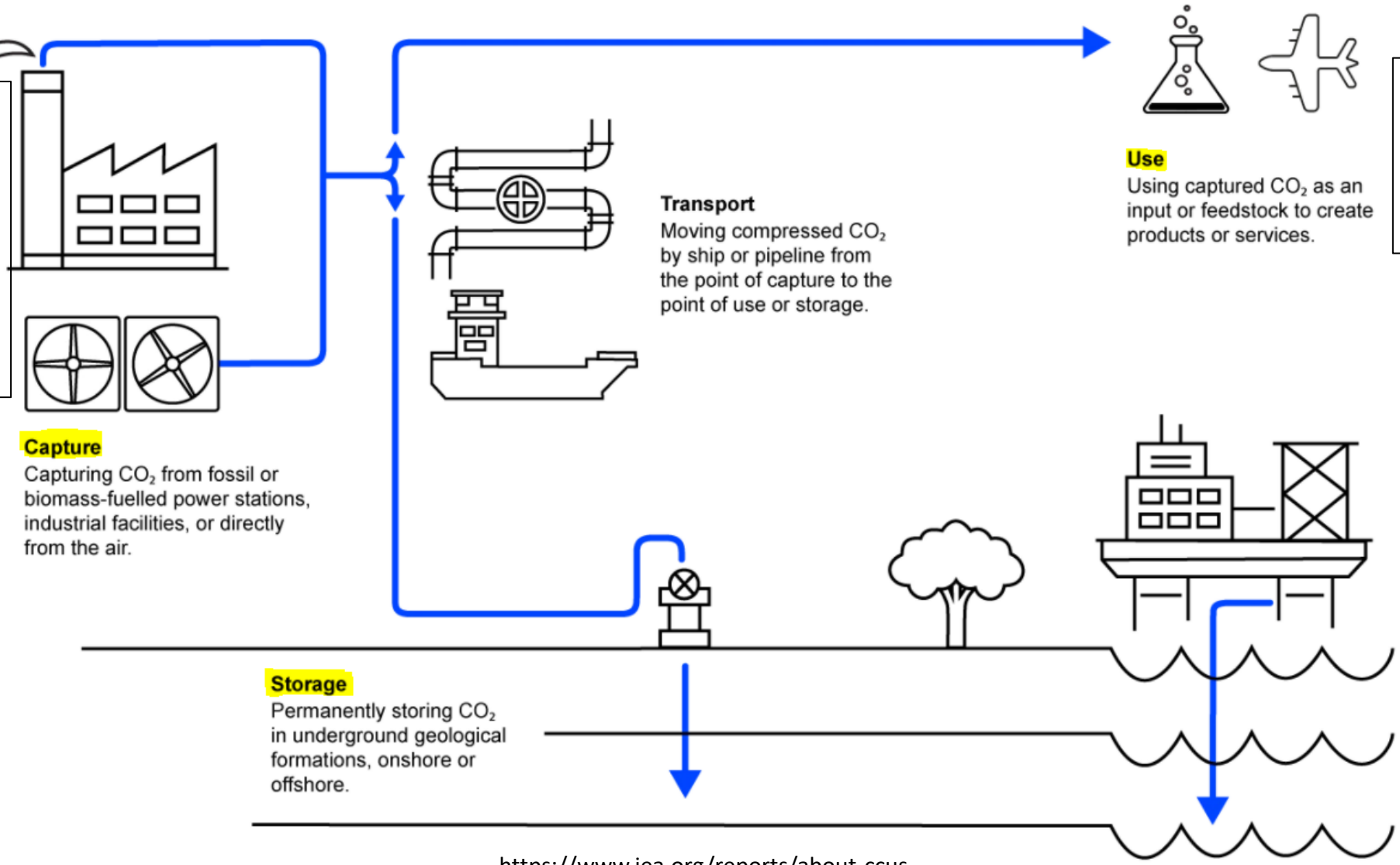
Congressional Report on CO2 Freight Transportation for Cost-Effective Service, in collaboration with DOT

House Report 117-98 and Senate Report 117-36

As industrial deployment of CCUS technology expands, the demand for the transportation of captured carbon oxides is anticipated to increase significantly. In preparation to meet this demand, the Department, in collaboration with the Department of Transportation, is directed to review existing freight transportation infrastructure and the capacity of the various modes of freight transportation to provide cost-effective service. The Department is directed to provide to the Committee not later than 180 days after enactment of this Act a report of the findings of the review. This report should ensure that anticipated short- and long-term freight transportation demand associated with the expanded industrial deployment of CCUS technology is met. Additionally, the report should include analysis of locations where CCUS projects are likely to be located and where carbon sequestration or utilization is likely to occur and the unique aspects of those areas for freight transportation infrastructure. ***Finally, in conducting this review, the Department shall consult with stakeholders, including representatives from the various modes of freight transportation.***

What is CCUS? *Carbon Capture, Utilization, Storage*

Applications:
Ethanol, natural gas processing, ammonia, power generation (natural gas/coal), Hard-to-Abate industries (cement, steel), Biomass (BECCS/BiCRS), Hydrogen production w/ CCS, Direct Air Capture (DAC)



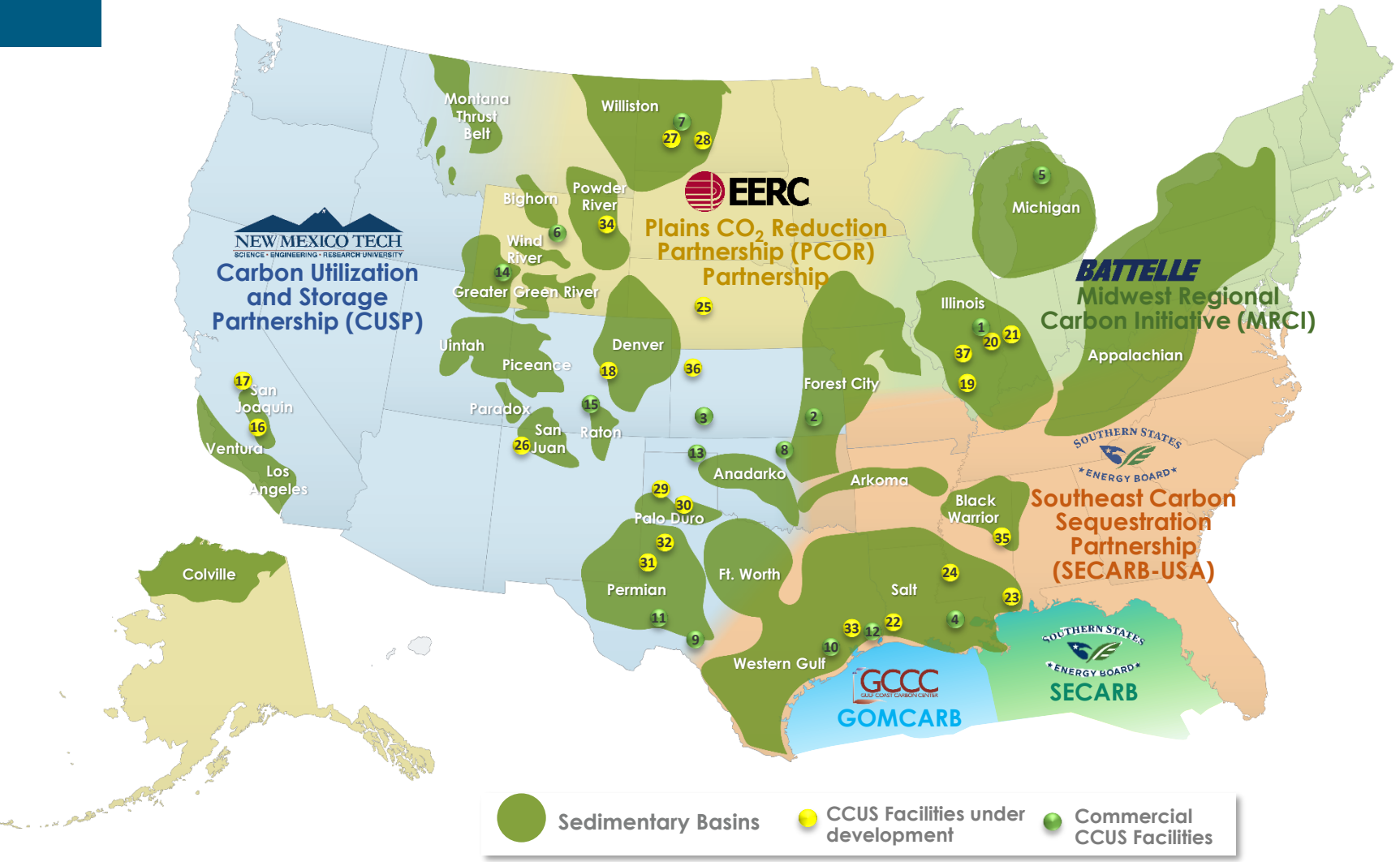
Applications:
Synthetic fuels and chemicals, CO2-stored in cements or building materials, Enhanced Oil Recovery (EOR)

Geologic Carbon Sequestration
(onshore/offshore)

https://www.iea.org/reports/about-ccus

Current U.S. CCUS Projects and Infrastructure

CCUS Facilities, Regional Initiatives and Offshore Partnerships, and Onshore Sedimentary Basins



- DOE is accelerating CCUS deployment through
  - **5 CarbonSAFE projects**
  - **4 Regional Initiatives**
  - **2 Offshore Partnerships**
- Over 5,000 miles of carbon transport pipelines today.
- 36 facilities have the capacity to capture **188 million metric tons** (MT) a year of anthropogenic CO_2.
- CarbonSAFE is developing storage capacity for over **250 million metric tons** (MT).

Data from Global CCS Institute.

Bipartisan Infrastructure Law (BIL) Overview

- **$12 billion** in new carbon management RD&D: **$7B** Managed directly by FECM
- **$9.5B** for hydrogen hubs and RD&D
- Generally, cost share is 80% government/20% applicant for early TRL R&D and 50%/50% for demonstration projects

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)

Hydrogen
Hydrogen Hubs: $8 billion (OCED)
Hydrogen Recycling Program: $500M
Hydrogen Electrolysis: $1 billion

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

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

https://www.energy.gov/fecm/solicitations-and-business-opportunities

Carbon Storage Assurance Facility Enterprise (CarbonSAFE)

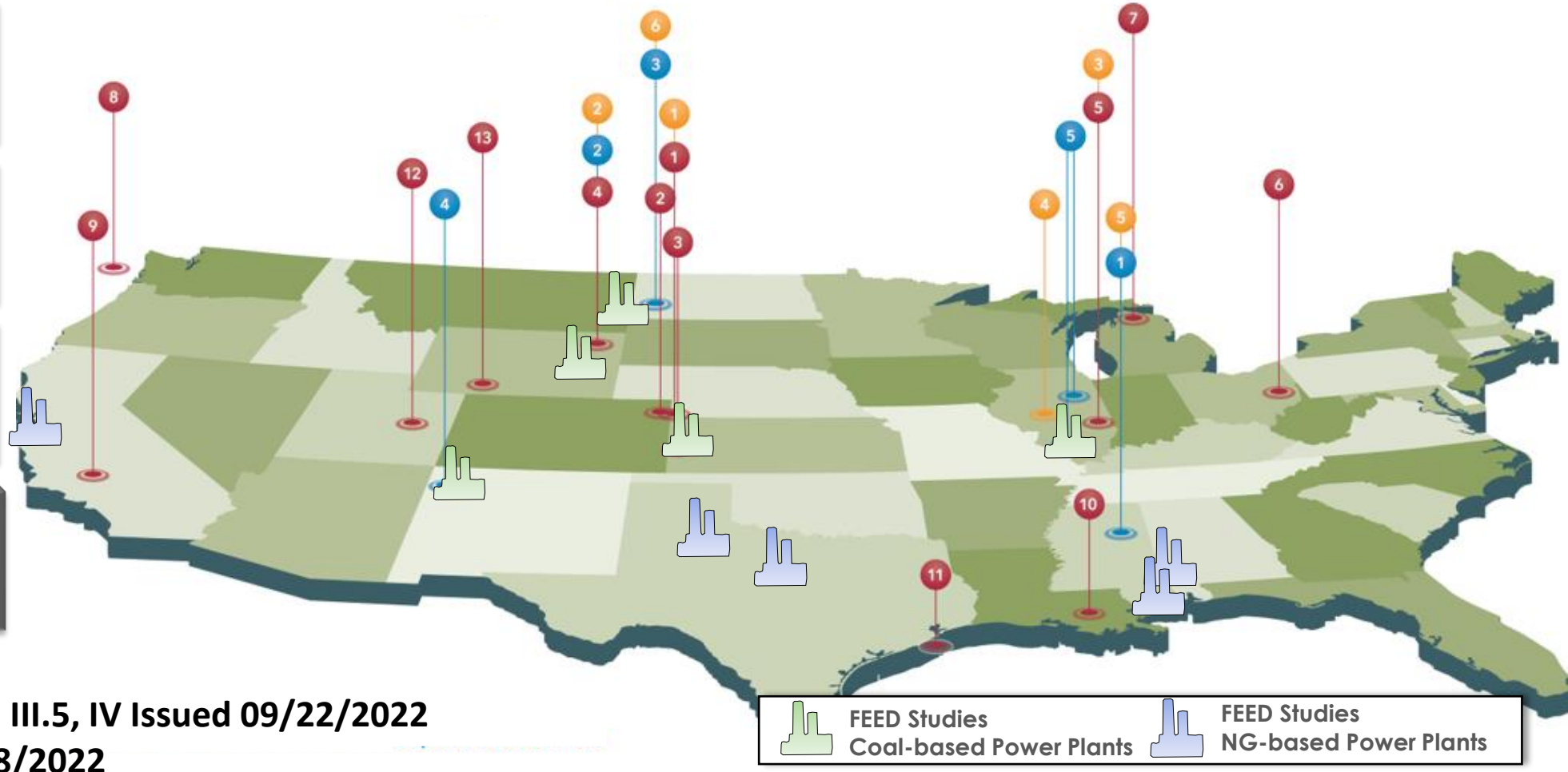
Development Pathway Towards Commercial CO2 Geologic Storage Sites and Hubs

Phase I: Integrated CCS Pre-Feasibility: 18 month

Phase II: Storage Complex Feasibility: 18-24 month

Phase III: Site Characterization : 3 year

Phase IV: Construction of Storage Complex: 2.5 year



Current Status:

- **BIL FOA 2711 Phase III, III.5, IV Issued 09/22/2022**
- **Applications Due 11/28/2022**

Rapid CCUS and CDR Industry Growth Needed for Achieving U.S. Decarbonization Goals

CarbonSAFE Targets	2025 VALIDATION	2030 ACTIVATION	2035 EXPANSION	2040 AT SCALE	. . .	2050 MIDCENTURY
Injectivity	5 million metric tons (MT)/year	65 million MT/year	250 million MT/year	450 million MT/year	. . .	> 1 billion MT/year
Commercial Storage Potential	250 million metric tons (MT)	2,000 million MT	7,500 million MT	13,500 million MT	. . .	> 30 billion MT

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 10X by 2030**

IPCC INTERGOVERNMENTAL PANEL ON climate change

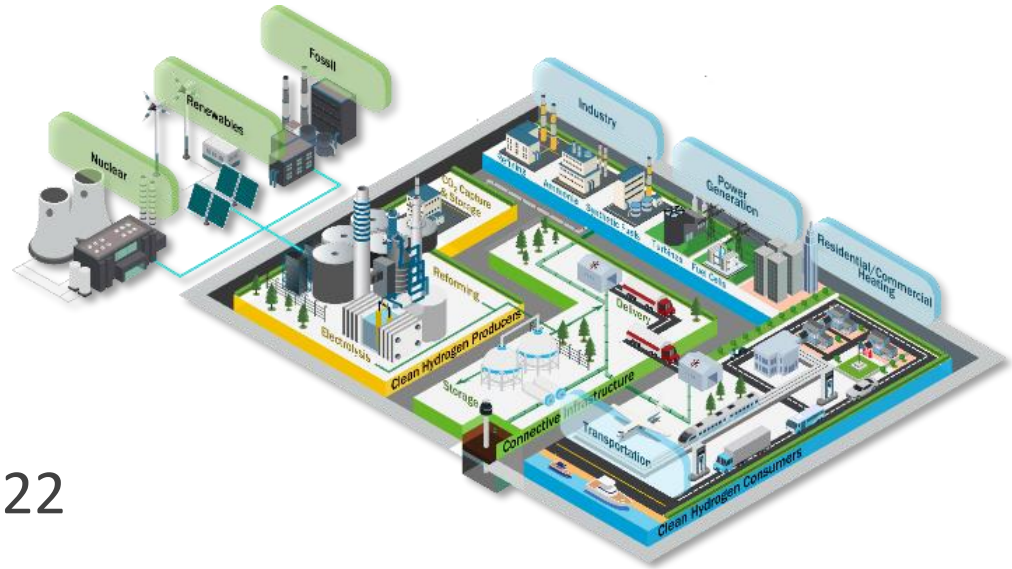
Cumulatively sequester 350-1000 GT by 2050

BIL: 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

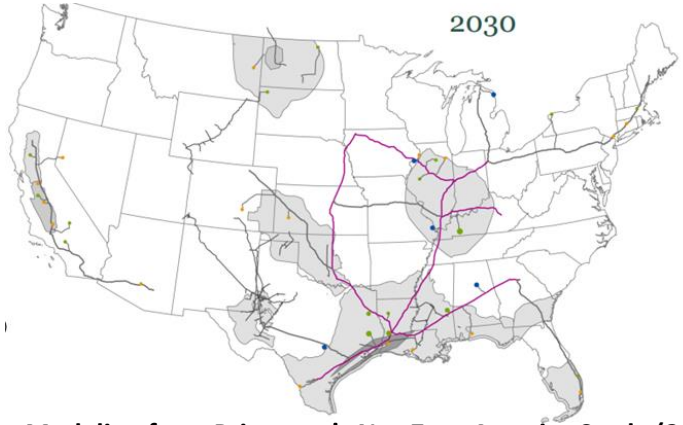


Current Status

- 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

Bipartisan Infrastructure Law:
CO2 Transport Front-End Engineering Design (FEED) Studies

- **$100 million** authorized over 5 years
- New carbon transport buildout or repurposing of existing infrastructure
- Successful FEED studies can apply for DOE Loan Program Office (LPO)'s **loan/loan guarantees through CIFIA**
- Working with DOT PHMSA to inform future regulatory and safety considerations
- First funding opportunity is focused on pipelines
- Eligible projects across all modes of transport (**ship, barge, rail, truck, inter-modal applications**)



2030: ~11,000+ miles of CO2 pipelines

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

<u>Current Status: OPEN</u>

- **FOA 2730 Issued 09/22/2022**
- **Applications Due 11/28/2022**

Inflation Reduction Act (IRA): Incentives/Thresholds

CCUS: 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	$85/metric ton (industry and power); $180/metric ton (DAC)
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)

Text - H.R.5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022 | Congress.gov | Library of Congress

U.S. Government Hydrogen Program and Funding

Inflation Reduction Act (IRA) - Hydrogen Provisions, 45V

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 CO_2 per kg of H_2	Credit Value ($)
4 - 2.5 kg CO_2	$0.60 / kg of H_2
2.5 - 1.5 kg CO_2	$0.75 / kg of H_2
1.5 - 0.45 kg CO_2	$1.00 / kg of H_2
0.45 - 0 kg CO_2	$3.00 / kg of H_2

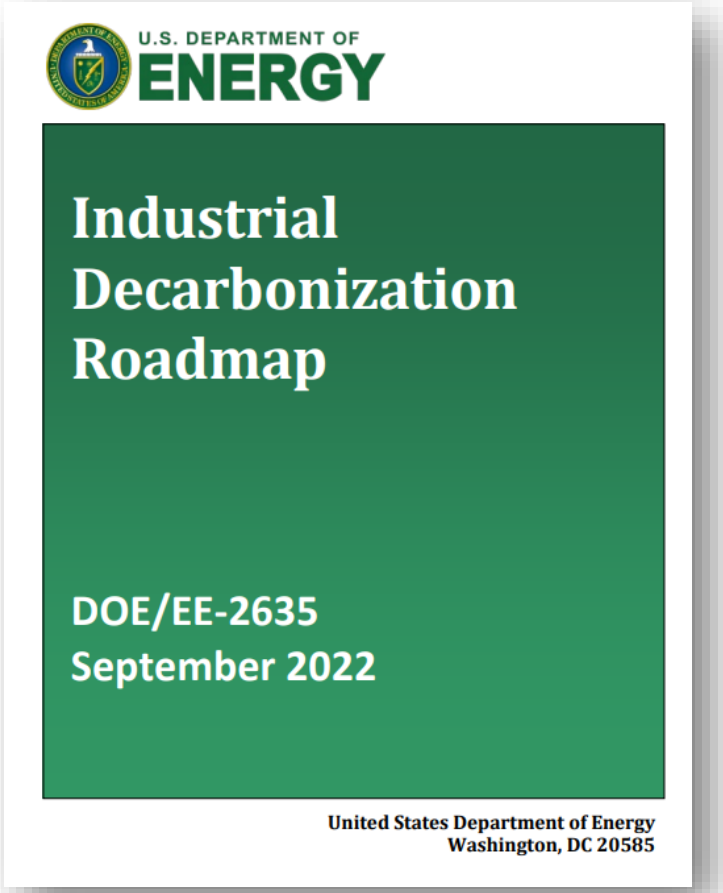
The clean hydrogen production tax credit will provide up to $3 per kg of qualified clean hydrogen produced based on a scaled metric of carbon intensity beginning at the base value of $0.60 per kg of hydrogen produced (seen above).

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 CO_2e per kg of hydrogen.

Sources: Fuel Cell & Hydrogen Energy Association (link), WhiteHouse.gov (link)

Industrial Decarbonization Roadmap

Carbon Capture, Utilization, and Storage is one of four strategies for decarbonizing US Industry.



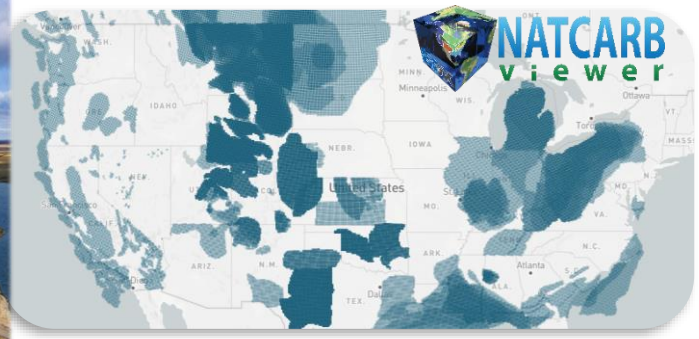
- Iron and Steel Manufacturing
- Chemical Manufacturing
- Food and Beverage Manufacturing
- Petroleum Refining
- Cement Manufacturing

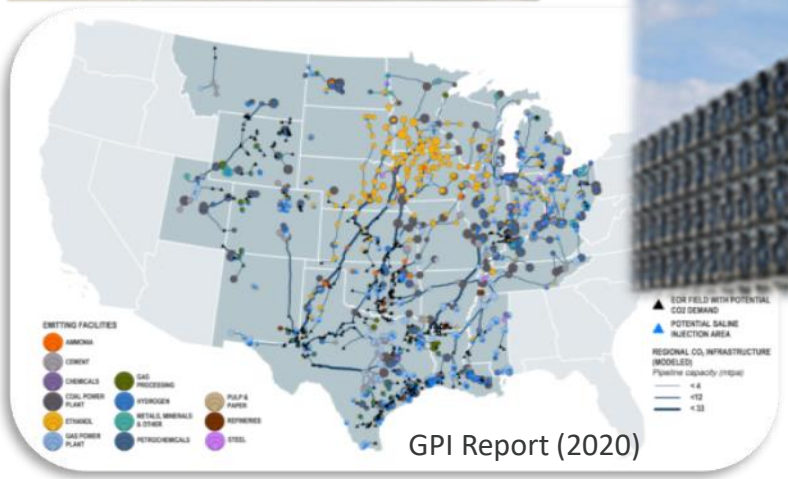
https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf

Moving Forward on CCUS Deployment

- **Incentives and Funding for Infrastructure**
  - ❖ *Catalyst for Industry Business Models*
- **Federal and State Legislation for CCUS**
  - ❖ *Permitting and Pore Space*
- **Advancing Capture Technologies**
  - ❖ *Industrial (Multiple Point-Sources) and DAC*
- **Dedicated Storage and Hub Infrastructure**
  - ❖ *Storage Facilities for Capture Sources*
- **CO_2 Transport Infrastructure**
  - ❖ *Multi-modal transport solutions and innovative business models*
- **Basin-scale management**
  - ❖ *Enabling Operators to better manage assets and optimization of pore space*

North Dakota CarbonSAFE Phase III:
Site Characterization and Permitting





GPI Report (2020)

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Questions?

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