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Carbon Management

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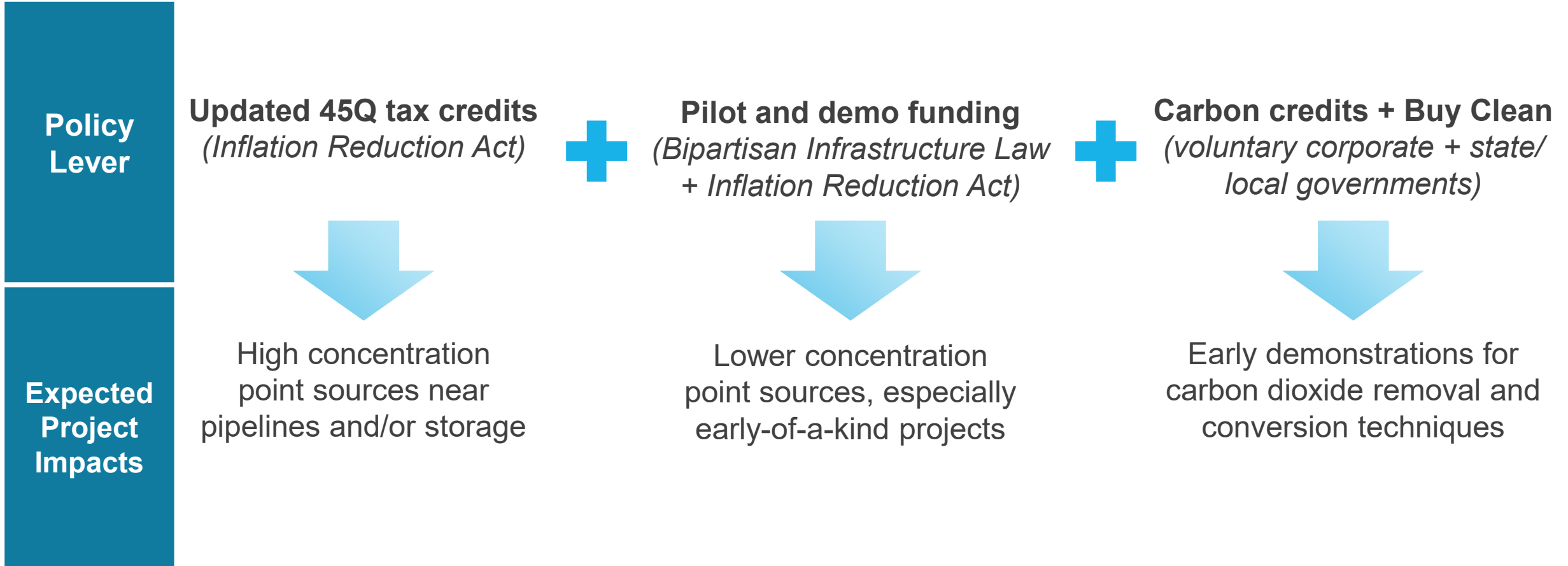


U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

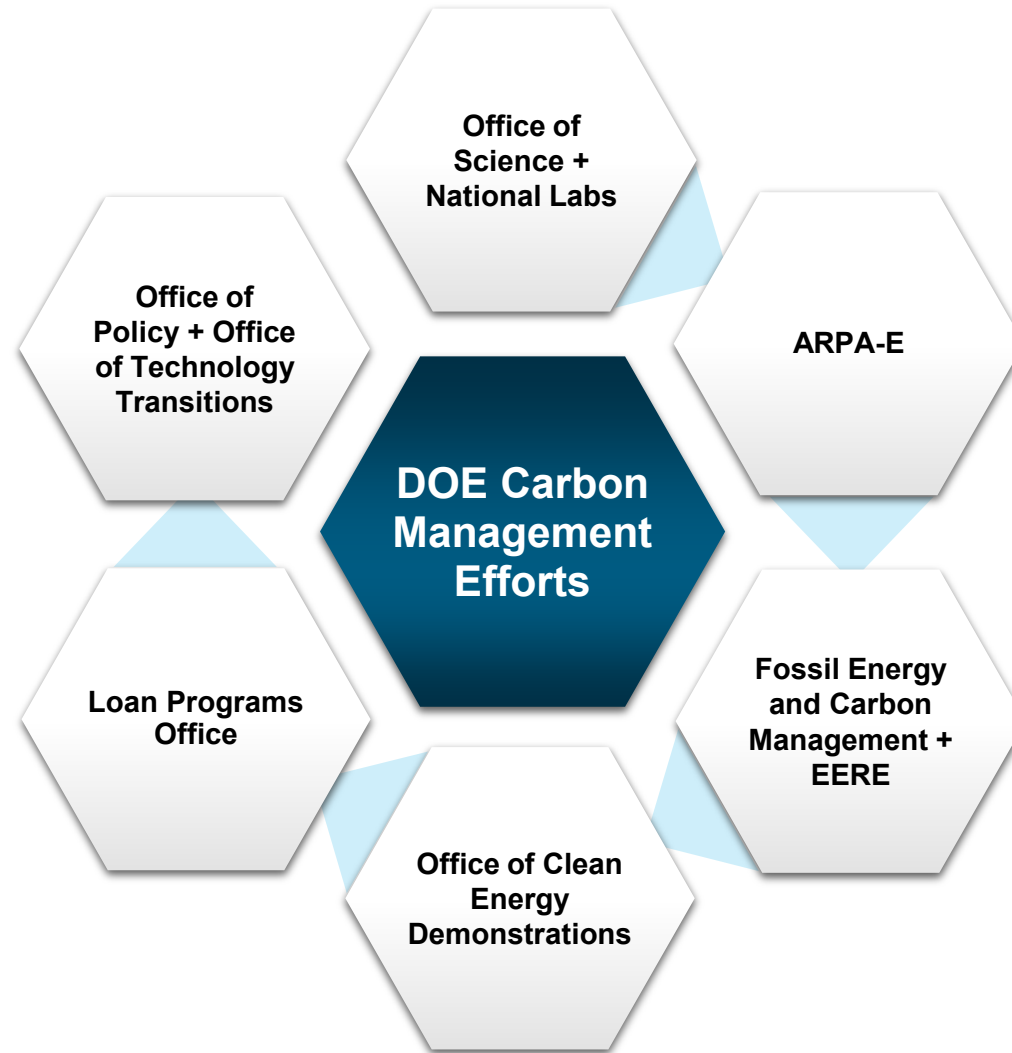


U.S. policy enables full range of projects



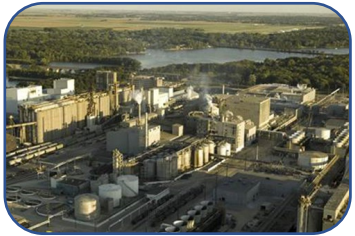


DOE supporting liftoff across offices





Opportunities for the Entire Value Chain: Bipartisan Infrastructure Law (BIL)



Industrial and Power Plant Carbon Capture

- CCUS Integrated Demos: \$2.5 billion (OCED)
- Carbon Capture Large Pilot: \$1 billion (OCED)



Direct Air Capture

- Regional Direct Air Capture Hubs: \$3.5 billion
- DAC Technology Prize Competition: \$115 million



Carbon Transport Systems

- FEED Studies for Transport Systems: \$100 million
- CIFA – Loans and Future Growth Grants: \$2.1 billion



Carbon Dioxide Utilization and Storage

- Carbon Storage Validation and Testing: \$2.5 billion
- Carbon Utilization Program: \$310 million

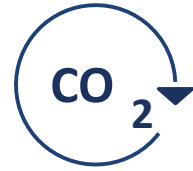
Project Applications Require New Components:

- Community and Stakeholder Engagement
- Diversity, Equity, Inclusion, and Accessibility
- Justice40 Initiative
- Quality jobs

Bipartisan Infrastructure Law Programs at Department of Energy

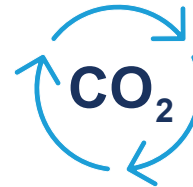


Carbon Management
*Three programs
administered by OCED*



Carbon Capture Demonstration

Projects: Develop six carbon capture facilities to improve costs, emissions reductions, and environmental effects from coal and natural gas



Carbon Capture Large-Scale Pilot

Projects: Establish and test innovative carbon capture pilot projects large enough to support new processes and technology improvements at scale



Regional Direct Air Capture

Hubs: Develop four regional direct air capture hubs to capture and sequester, utilize, or sequester and utilize at least 1,000,000 metric tons of CO₂ annually from a single unit or multiple interconnected units

FECM's Office of Carbon Management

The Office of Carbon Management Technologies

Leads and invests in research, development, demonstration, and deployment across five divisions...



Hydrogen with Carbon Management



Carbon Transport and Storage



CO₂ Conversion



CO₂ Removal



Point-Source Carbon Capture



The Office of Strategic Planning, Analysis, and Engagement

Leads in strategic activities and international, domestic, and intergovernmental coordination across two divisions...



Systems, Economic, and Environmental Analysis



Strategic Engagement



Funding for Carbon Management Approaches



H₂ with Carbon Management

Conversion of carbon-based feedstocks to H₂ coupled with carbon management



Carbon Dioxide Removal

Removal of atmospheric CO₂ and durable store



Carbon Utilization

Conversion of CO₂ to value-added products



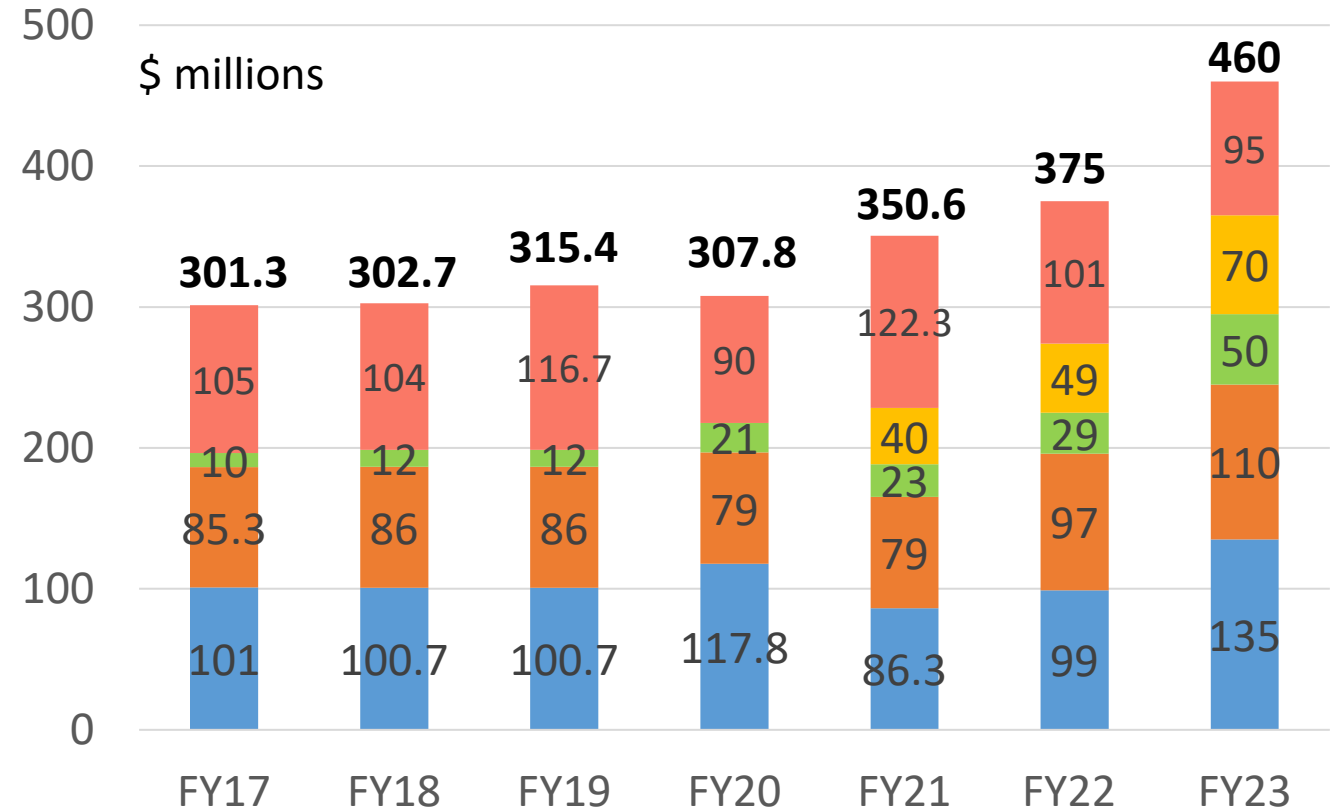
Carbon Storage

Safe, cost-effective, and permanent geologic storage of CO₂



Carbon Capture

Capturing CO₂ from new and existing industrial and power plants



- Hydrogen with Carbon Management
- Carbon Dioxide Removal
- Carbon Utilization

Carbon capture evolution at DOE

1st and 2nd Generation Technologies

2025: \$40/tonne CO₂



2008 -

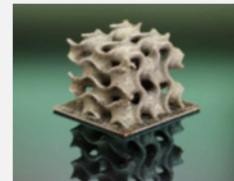
- ✓ Lower CAPEX/OPEX
- ✓ Reduced regeneration energy
- ✓ Increased working capacity

Transformational Technologies

2030: \$30/tonne CO₂



Hollow Fibers



3D Print



Biphase Solvent

2015 -

- ✓ Water Lean Solvents
- ✓ Adv. Membranes
- ✓ Hybrid Systems
- ✓ Process Intensification

Scale-up

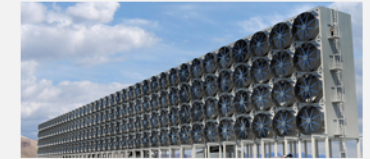


TCM

2018 -

- ✓ Engineering Scale testing
- ✓ FEED studies

Negative Emissions Technologies & Industrial



Carbon Engineering, DAC



Ethanol Plant

2020 -

- ✓ DAC & BiCRS
- ✓ Industrial
- ✓ NG



Point Source Capture: Impact from past 15 years of R&D

In the past 15 years, DOE Carbon Capture Program

awarded

\$1.3 billion



In R&DD funding to ~300 projects

fostered

170+

Issued Patents



570+

Peer-reviewed
Journal Articles



46

Technologies
Validated at TRL 6

5

Technologies
Validated at TRL 7

\$1+ billion

In follow-on Funding



80+

New companies formed /
licensing deals / partnerships



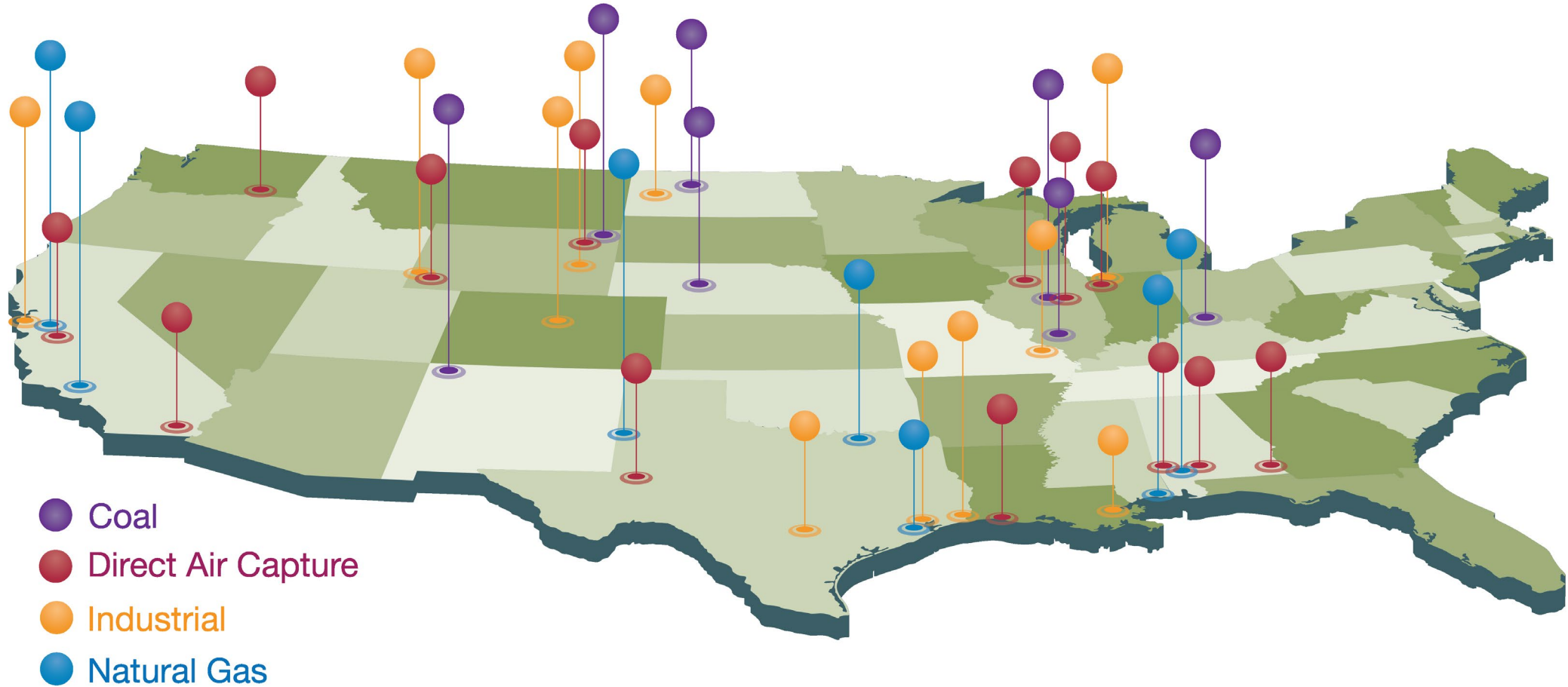
35+

FEEDs_pFEEDs
Funded





FECM FEEDs and Pre-FEEDs... Overall Portfolio



CCS FEEDs for cement plants

Pre-FEEDs



LafargeHolcim Cement Plant
Florence, CO



Balcones Cement Plant,
New Braunfels, TX

1 MTA CO2

Svante's VeloxoTherm™
adsorption-based process

MTR's Polaris membrane



FEEDs



Holcim Ste. Genevieve Cement Plant
Bloomsdale, Missouri

2.9 MTA CO2

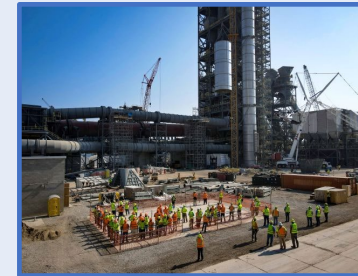
Air Liquide' Cryocap FG



Balcones Cement Plant,
New Braunfels, TX *

1.6 MTA CO2

RTI's Non-Aqueous Solvent



Mitchell Cement Plant
Mitchell, IN

2 MTA CO2

MHI's KS-21



Ash Grove Foreman
Foreman, AR

Air Liquide' Cryocap FG



* Selected projects for integrated Carbon Management under FOA 2738, under negotiations

Point Source Carbon Capture Portfolio

Components



Testing novel materials & processes with simulated exhaust

Small Pilots



Bench- and Pilot-scale technology testing with real flue gas

Large Pilots



Engineering scale for integrated capture system

Demo



Unit-wide
Carbon transport & storage

No storage

ARPA-E



FECM



IEDO



OCED

25 MW 75 KTA

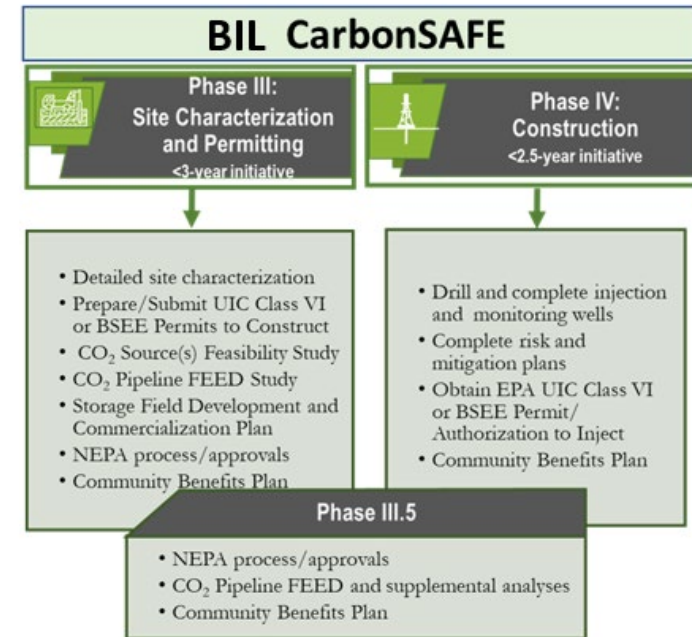
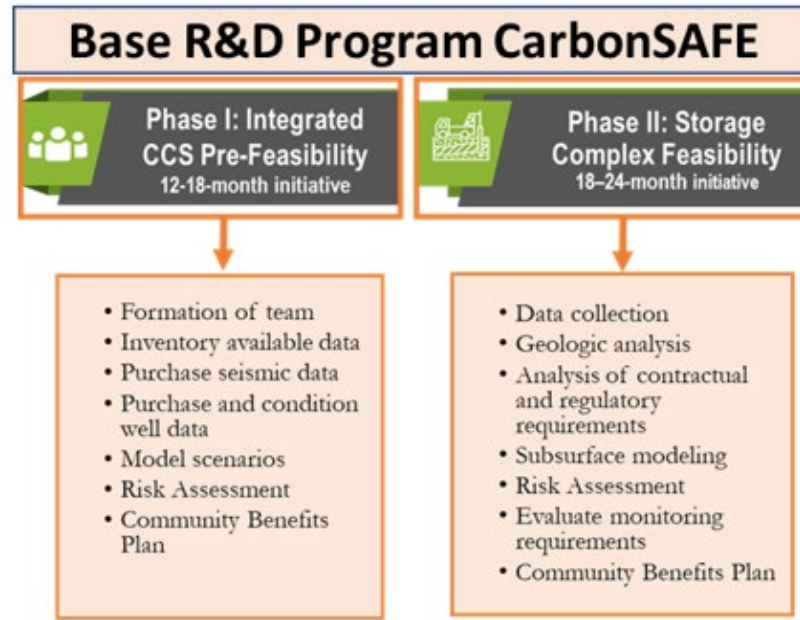
BIL Funded

unit 300+ KTA

Industrial
 Power



DOE is confident that CO₂ storage is technically feasible and safe.



2003

2016

2023

- DOE-led regional partnerships to validate CO₂ geologic storage.
- Completed injection test projects, with no negative impacts to human health or the environment.

- Successful tests led to the CarbonSAFE program.
- Focused on ensuring CO₂ storage sites will be ready for integrated CCS system deployment in the 2025-2030 timeframe.

- BIL builds on last 20+ years of CO₂ research.
- Enables commercial deployment of CO₂ storage.

CTS Program (Base Funding) Integration with BIL

Base Funding

BIL Funding

carbon
BASE

- Data collection & tools to support **CarbonSAFE** site selection.
- Develop basin-scale resource management frameworks.
- Risk-based decision making (permit restriction, leasing, etc).

carbon
SAFE

- \$2.5B BIL funding. 20-40 commercial storage projects; >100 wells.
- Site specific geologic data collection as input to **CarbonBASE** tools.
- Host **CarbonSTORE** projects in different settings.

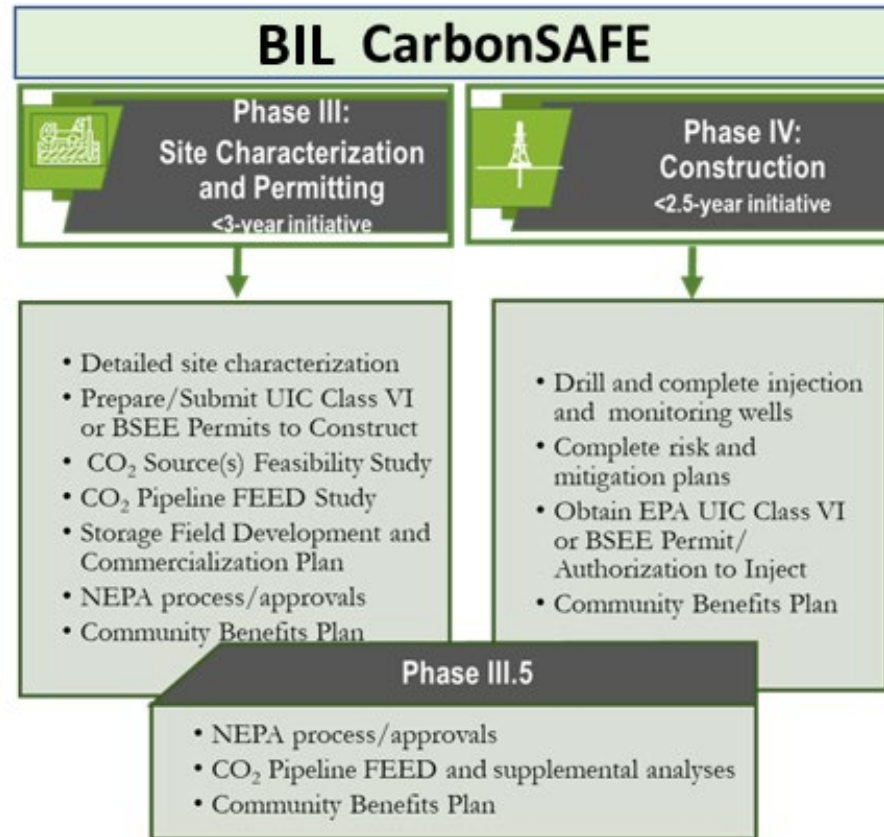
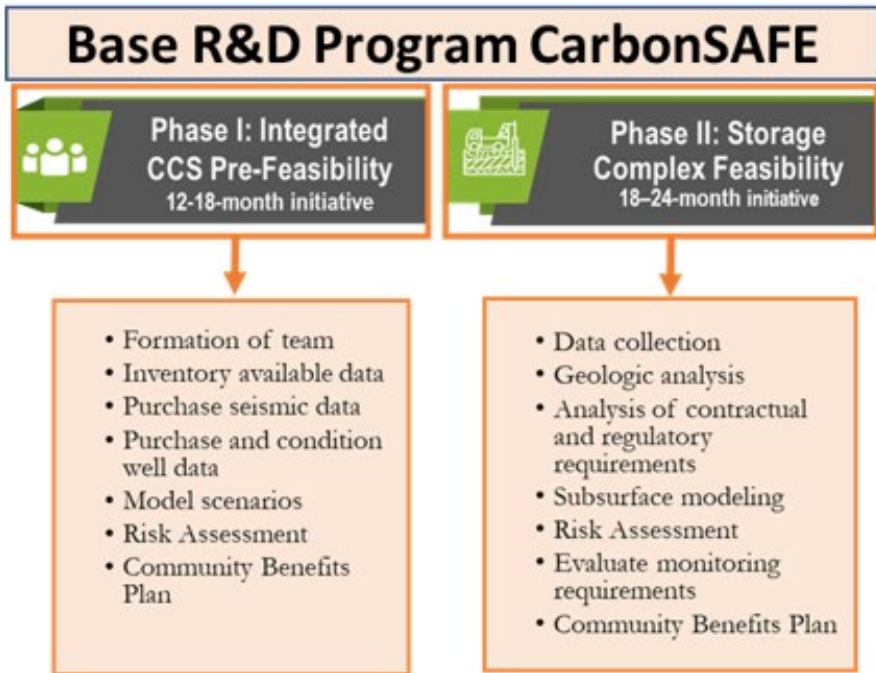
carbon
STORE

- Provides field laboratories to test & compare carbon storage technologies, useful for next generation **CarbonSAFE** projects.



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



BIL 40305—Storage Validation and Testing

\$2.5 billion over 5 years

New or Expanded large-scale commercialization carbon sequestration facilities

50 MMT Hubs and Large-Scale Storage

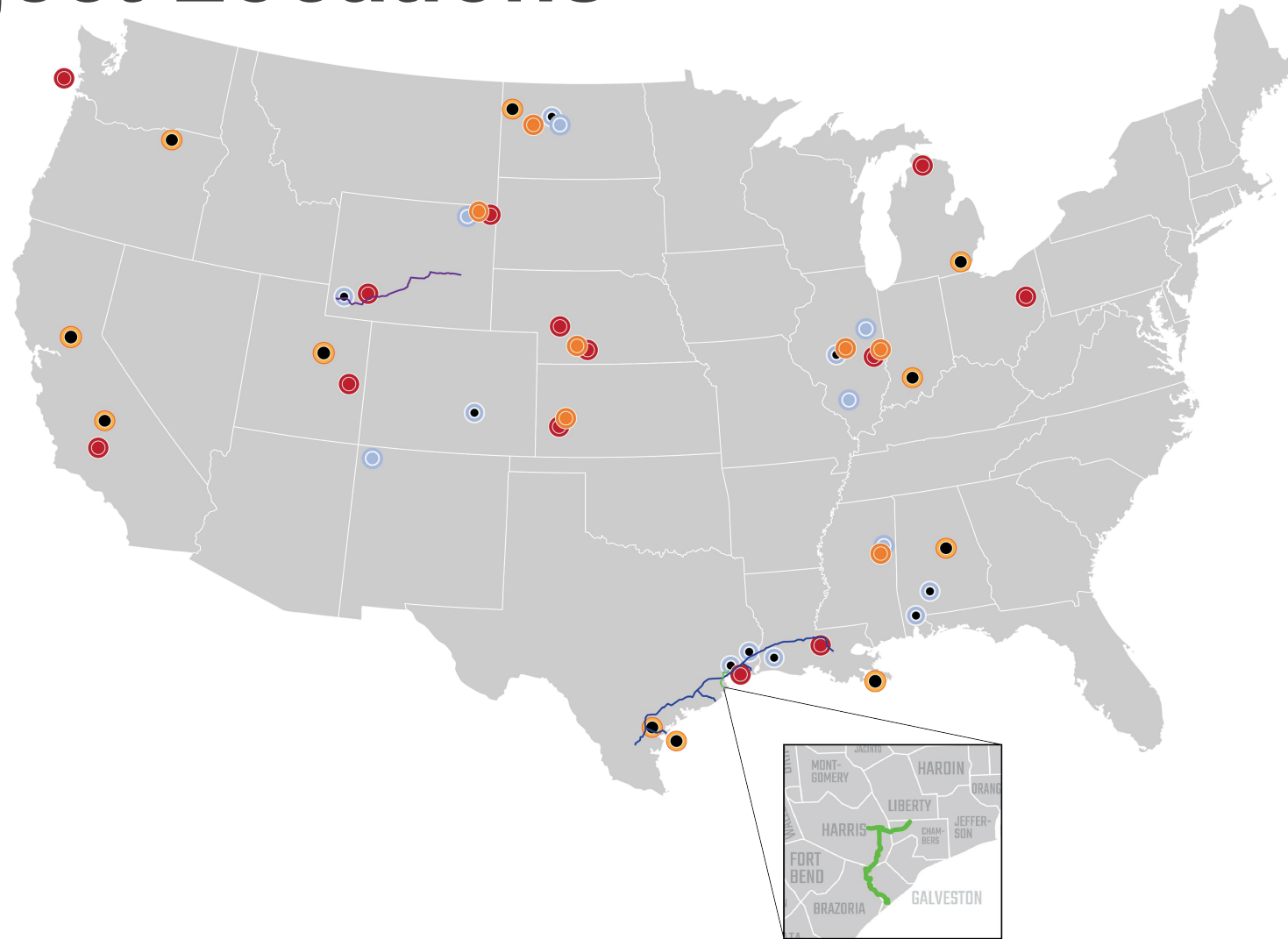
20-40 Facilities

~80-100 Class VI Wells

CarbonSAFE Project Locations

Legend

- FEED Pipeline Study - Selected FOA 2730**
- Carbon Solutions - WyoTECH*
- SSEB - Project Diamond*
- HEP - Gulf Coast Decarb System*
- Phase I**
- Phase II:**
- Phase II - Existing
- Phase II - Selected FOA 2610
- Phase III:**
- Phase III - Existing
- Phase III - Selected FOA 2711

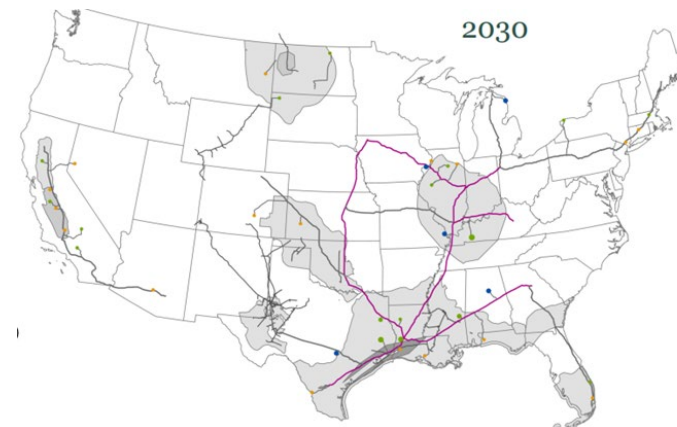




CO₂ Transport Infrastructure

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

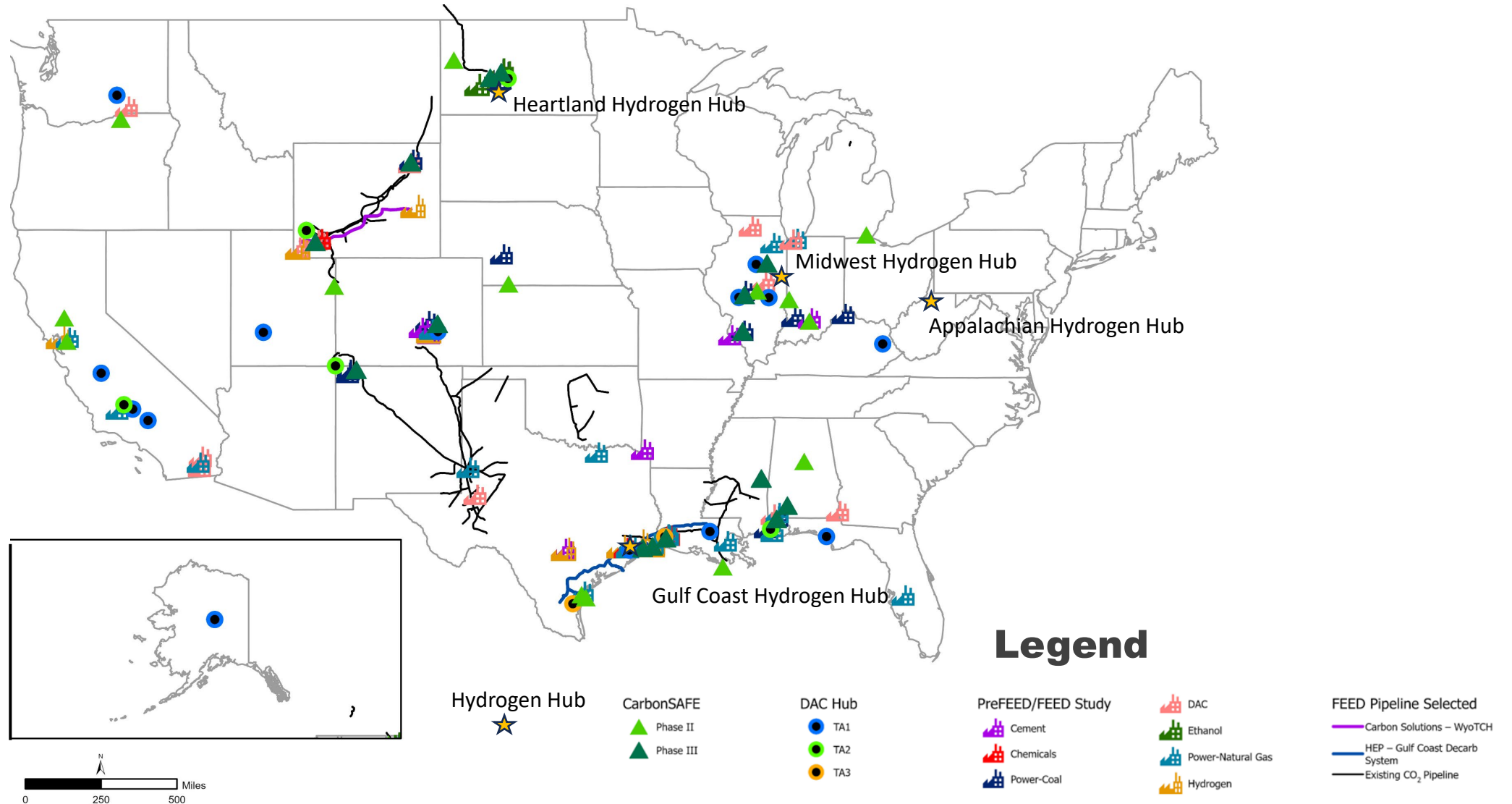
- CO₂ Transport FEED Studies, \$100 million authorized over 5 years
- New carbon transport buildout or repurposing of existing infrastructure
- Working with DOT PHMSA to inform future regulatory and safety considerations
- CO₂ transport should review all modes of transport (ship, barge, rail, truck)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



2030: ~11,000+ miles of CO₂ pipelines

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

DOE announced project funding under Bipartisan Infrastructure Law



Continuation of Regional Technical Assistance on Carbon Storage



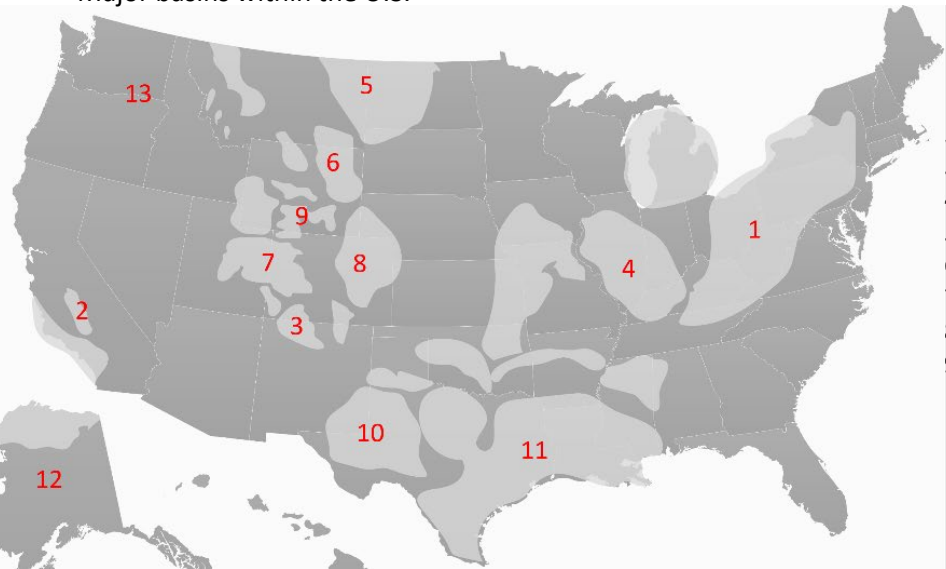
FOA 3014: Regional Initiative for Technical Assistance Partnerships (RITAP) to Advance Deployment of Basin-Scale Carbon Transport and Storage and Community Engagement

Selected projects will have the capability to provide technical assistance to project developers, regulators, community groups, labor organizations specific to individual U.S. geologic basins where multiple proposed carbon storage facilities will be located.

Key Activities:

- Expand and strengthen technical assistance on CCS/CDR to stakeholders and affected communities
- Help train the next generation of technical professionals in geologic storage of captured CO₂
- Continue carbon storage resource assessments
- Identify value-added crosscutting opportunities such as integration with geothermal energy or critical mineral recovery

Major basins within the U.S.



1. Appalachian-North
2. Central Valley (CA)
3. San Juan River-Raton-Black Mesa
4. Illinois
5. Williston
6. Powder River
7. Uinta
8. Denver
9. Green River-Wind River
10. Permian
11. Gulf Coast (Onshore/Offshore)
12. Alaska
13. Columbia River Basalts

The projects funded under DE-FOA-0003014 will build on the knowledge and experience gained from the Regional Carbon Sequestration Partnerships (2003-2019) and subsequent Regional Initiative Technical Assistance projects.

Submission deadline for full applications: 01/30/2024



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A collage of four images on the left side of the slide. The top image shows an industrial oil rig against a blue sky. The middle image shows two scientists in white lab coats working with laboratory glassware, including a beaker with blue liquid. The bottom-left image shows two people in outdoor gear kneeling in a field, examining a soil sample. The bottom-right image shows a large stack of white, circular components, possibly parts of a turbine or engine.

Thank You!

Questions?

Contact Sarah Forbes, Acting Director

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