



Regional Carbon Capture, Use and Storage Policy Development and Deployment

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Madison, WI**

**Brad Crabtree
Vice President, Carbon Management
Great Plains Institute**



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INSTITUTE**

Better Energy.
Better World.

Great Plains Institute: Background

Mission

- *GPI works collaboratively with government, industry, labor, agriculture, NGOs and other stakeholders transform the energy system to benefit the economy and the environment.*

Objectives

- *Increase energy efficiency and productivity.*
- *Decarbonize electricity production.*
- *Electrify the economy and adopt zero and low-carbon fuels.*
- *Capture carbon for beneficial use and permanent storage.*



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GPI: Nearly Two Decades Working on Carbon Capture, Utilization & Storage

- **2002:** Organized first meeting of Midwest industry executives, state officials and NGOs at Dakota Gasification in North Dakota.
- **2005:** Formed regional Coal Gasification Work Group in Midwest.
- **2006:** Released 50-year “energy transition roadmap” for the Upper Midwest focused on energy efficiency, renewable energy and coal-based energy with carbon capture.
- **2006 and 2007:** Organized Midwestern and national public and private delegations to Europe on carbon capture and storage.
- **2006-2009:** Coordinated Midwestern Governors’ Association energy and climate policy initiatives that featured ambitious carbon capture and storage deployment targets.
- **2011:** Launched Carbon Capture Coalition (formerly National Enhanced Oil Recovery Initiative).
- **2015:** Established State Carbon Capture Work Group.
- **2018:** Announced Carbon Capture Leadership Council and Governors’ Partnership on Carbon Capture.



CARBON CAPTURE COALITION

A diverse partnership of 60+ energy, industrial and technology companies, labor unions, and environmental, clean energy and agricultural organizations dedicated to fostering economywide deployment of carbon capture.

Carbon
Capture
Leadership
Council

Brings together top industry, government, labor, NGO and philanthropic leaders to advance a national technology, policy and deployment agenda.

STATE CARBON CAPTURE WORK GROUP

Convened by former Gov. Matt Mead (R-WY) and Gov. Steve Bullock (D-MT), the Work Group brings together officials from 15 states to support carbon capture and CO₂ pipeline infrastructure deployment.

REGIONAL
CARBON
CAPTURE
DEPLOYMENT
INITIATIVE

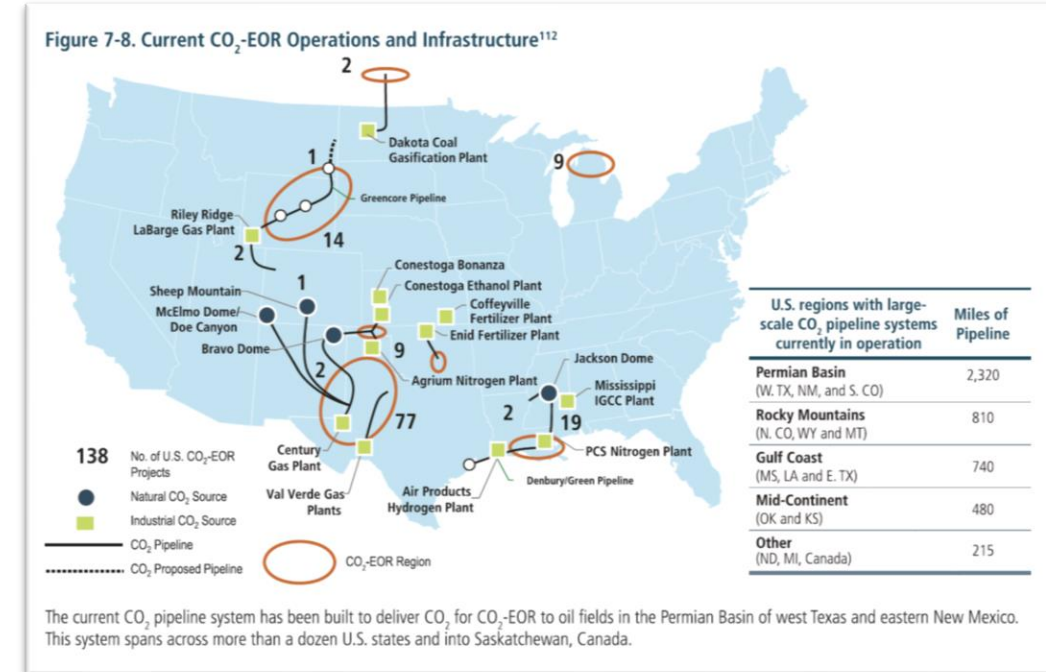
Initiatives of state officials and stakeholders to promote regional-scale deployment of carbon capture and CO₂ pipeline infrastructure in Midwestern and Western states.



Bipartisan initiative of governors to provide leadership, focus and a stronger state voice for mutual carbon capture policy and deployment priorities.

Carbon Capture Works: Efforts to Deploy CO₂ Capture and Pipeline Infrastructure Build on Nearly 50 Years of Commercial Experience

- 1972: Val Verde Gas Processing Plants in Texas
- 1982: Koch Nitrogen Company Enid Fertilizer Plant in Oklahoma
- 1986: Exxon Shute Creek Gas Processing Facility in Wyoming
- 2000: Dakota Gasification's Great Plains Synfuels Coal Gasification Plant in North Dakota
- 2003: Core Energy/South Chester Gas Processing Plant in Michigan
- 2009: Chaparral/Conestoga Energy Partners' Arkalon Bioethanol Plant in Kansas
- 2010: Occidental Petroleum's Century gas processing plant in Texas
- 2012: Air Products Port Arthur Refinery Hydrogen Production in Texas
- 2012: Conestoga Energy Partners/PetroSantander Bonanza Bioethanol Plant in Kansas
- 2013: ConocoPhillips Lost Cabin Gas Processing Plant in Wyoming
- 2013: Chaparral/CVR Energy Coffeyville Fertilizer Gasification Plant in Kansas
- 2014: SaskPower Boundary Dam Coal Power Plant Post-Combustion Capture Retrofit in Saskatchewan
- 2015: Shell Quest hydrogen production at bitumen upgrader in Alberta.
- 2016: Emirates Steel's Mussafah direct reduction iron plant in the United Arab Emirates.
- 2017: NRG Petra Nova Coal Plant Post-Combustion Retrofit in Texas
- 2017: Archer Daniels Midland large-scale ethanol capture in Illinois



Nearly 5,000 miles of CO₂ Pipeline Infrastructure in the U.S.



Carbon Capture is Scalable and Delivers Domestic Energy Production, Jobs & Emissions Reduction Benefits

- U.S. oil industry has purchased, transported and injected nearly 1.5 billion tons of CO₂ over the past half century with no fatalities, serious injuries, or major environmental incidents (~65 million tons of CO₂ annually; nearly 4 percent of U.S. oil production).
- Geologically storing industrial and power plant CO₂ through enhanced oil recovery (EOR) results in an estimated net lifecycle emissions reduction of 37 percent, *including the additional oil produced* (IEA analysis).
- Saline geologic storage of CO₂ has been demonstrated successfully at scale (e.g. ADM in Illinois and Equinor in the North Sea) and achieves even greater lifecycle emissions reductions, including potentially atmospheric carbon removal for negative emissions.
- More than a niche: Over a century's worth of U.S. annual stationary source emissions can be stored in oil and gas fields; thousands of years' worth in saline formations.
- Carbon capture provides direct economic and fiscal benefits from oil and other related energy production, and it protects and creates good-paying, highly-skilled jobs across the value chain of capture, pipeline transport, use and storage.



Carbon Capture is Essential to Meeting Mid-Century Climate Goals and Doing So Affordably

- Under the IEA's scenario to limit warming to 2 degrees C, carbon capture contributes 14% of cumulative 2015-2050 CO₂ reductions and 20% annually by 2050.
- Carbon capture is an essential control strategy for industrial sources, not just coal and natural gas power generation:
 - In IEA's 2° scenario, 45% of CO₂ captured comes from industrial sources.
- The IPCC's 5th Assessment finds that carbon mitigation under the 2 degree C scenario costs 138% more, if carbon capture is excluded.
- Recent IPCC modeling of 1.5 degree C scenario: Meeting this goal requires extensive deployment of carbon capture at power and industrial facilities *and* removal of CO₂ from the atmosphere through direct air capture, biomass and carbon capture, and other strategies.



Carbon Capture is Cost-Effective: Preliminary Revised Estimates of Capture Costs Compare Favorably to Other Low and Zero-Carbon Options*

Capture Category	Equipment Needed	Industry Examples	Cost Range
Pure CO2 emissions	Compression & Dehydration	Ethanol, Natural Gas Processing, Ammonia*	\$15-20/MT
CO2 emissions @ 20-50% concentration	Amine CO2 separation equipment plus Compression and Dehydration	Hydrogen Plants, Cement, Fluidized Catalytic Crackers (Refineries), Blast Furnace Gas Combustion (Steel)	\$40-55
CO2 emissions @ ~13-15% concentration		Pulverized Coal Power Plants	\$50-65
CO2 emissions @ ~4%		Natural Gas Combined Cycle Power Plants	\$65-75

*These figures are approximate, partly because plant sizes and difficulty of accessing vent stacks vary so much, but also very much depending on who is doing the estimating and on what methodology. Here we are trying to show range of what our research shows to be reasonable ranges, with mistakes or unrealistic assumptions corrected.

Carbon Capture Unites Diverse Interests as Reflected in 60+ Coalition Membership

- AFL-CIO
- Air Liquide
- Air Products
- AK Steel
- American Carbon Registry
- ArcelorMittal
- Arch Coal
- Archer Daniels Midland Co.
- Baker Hughes, a GE Company
- Bipartisan Policy Center
- Carbon Wrangler LLC
- Center for Carbon Removal
- Clean Air Task Force
- ClearPath Foundation
- Cloud Peak Energy
- Conestoga Energy Partners
- Core Energy LLC
- EBR Development LLC
- EnergyBlue Project
- Energy Innovation Reform Project
- Glenrock Petroleum
- Great River Energy
- Greene Street Capital
- Impact Natural Resources LLC
- ION Engineering LLC
- International Brotherhood of Boilermakers
- International Brotherhood of Electrical Workers
- Jackson Hole Center for Global Affairs
- Jupiter Oxygen Corporation
- Lake Charles Methanol
- LanzaTech
- Linde LLC
- Mitsubishi Heavy Industries America, Inc.
- National Audubon Society
- National Farmers Union
- National Wildlife Federation
- NET Power
- New Steel International, Inc.
- NRG Energy
- Occidental Petroleum Corporation
- Peabody Energy
- Prairie State Generating Company
- Praxair, Inc.
- Renewable Fuels Association
- Shell
- SMART Transportation Division (of Sheet Metal, Air, Rail and Transportation Workers)
- Summit Power Group
- Tenaska Energy
- The Nature Conservancy
- Third Way
- Thunderbolt Clean Energy, LLC
- United Mine Workers of America
- United Steel Workers
- Utility Workers Union of America
- White Energy
- Wyoming Outdoor Council

Observers

- Algae Biomass Organization
- Carbon Engineering
- Carbon Utilization Research Council
- Cornerpost CO₂, LLC
- Enhanced Oil Recovery Institute, University of Wyoming
- Institute for Clean Air Companies
- Melzer Consulting
- Tellus Operating Group
- World Resources Institute

- S. 1535, the FUTURE Act (Furthering carbon capture, Utilization, Technology, Underground storage, and Reduced Emissions), was introduced with one quarter of U.S. Senators cosponsoring the legislation: 18 Democrats, 6 Republicans and 1 Independent
- The same legislation in the House gained 50 cosponsors: 35 Republicans and 15 Democrats.
- Support spanned entire political spectrum and all regions of the country.

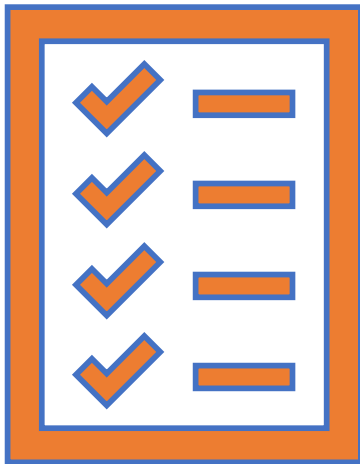
**Carbon Capture
Coalition and
Partners Marshaled
Unparalleled
Bipartisan Support
for Reform of the
45Q Tax Credit**

Key Provisions of 45Q Reform in S. 1535, the FUTURE Act

- Increases the value of the tax credit over ten years from:
 - \$10 to \$35 for every metric ton of CO₂ stored through enhanced oil recovery;
 - \$20 to \$50 per ton for CO₂ stored in other geologic formations; and
 - \$10 to \$35 per ton of CO₂ emissions reduced through beneficial use.
- Extends the tax credit for any project beginning construction by end of 2023, with a 12-year period to claim the credit once operational.
- Expands credit beyond geologic storage to include emissions reductions achieved through beneficial use of CO₂ to make fuels, chemicals, products, etc. while reducing emissions, subject to lifecycle analysis.
- Allows for direct air capture to qualify in addition to power plant and industrial capture.
- Makes carbon monoxide capture eligible in addition to CO₂, enabling carbon utilization projects with CO.
- Lowers eligibility threshold for industrial facilities to 100,000 tons of CO₂ captured annually so more industries and regions can participate effectively (e.g. ethanol production in the Midwest and Great Plains).
- Establishes eligibility range for non-EOR carbon utilization projects of 25,000-500,000 tons.
- Increases flexibility so tax-exempt electric cooperatives, municipal utilities and project developers that lack tax appetite can monetize the credit.

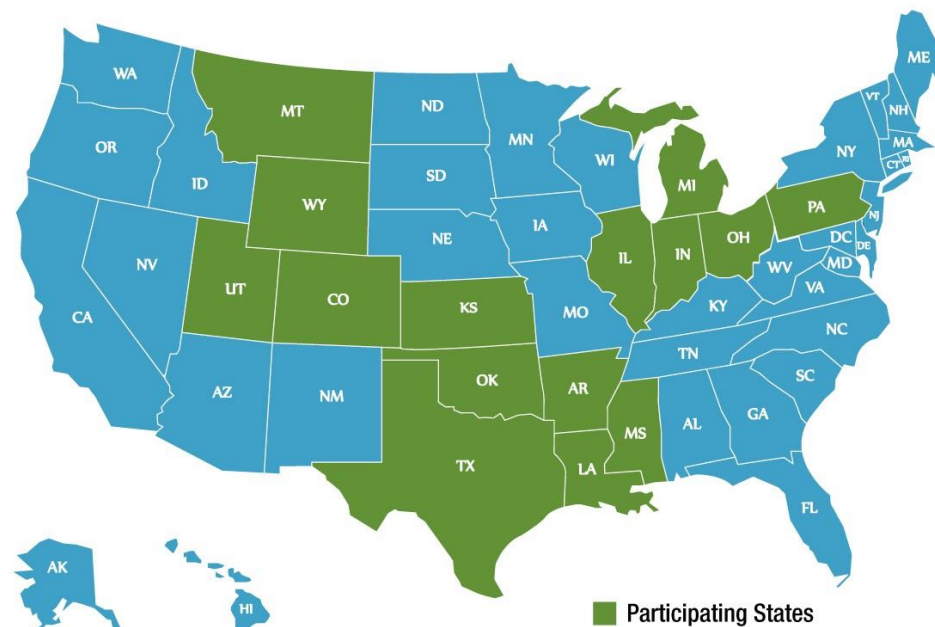


Federal Policy Agenda Going Forward



- Ensure effective implementation of 45Q by the U.S. Treasury to provide the investment certainty and business model flexibility intended by Congress;
- Provide a portfolio of federal carbon capture policies to complement 45Q, similar to wind and solar;
- Incorporate CO₂ pipeline infrastructure into national infrastructure legislation, including measures for federal financing of extra capacity; and
- Support a robust U.S. Department of Energy budget for carbon capture, utilization, removal and storage R&D, demonstration and deployment to ensure that lower-cost next-generation technologies enter the market.

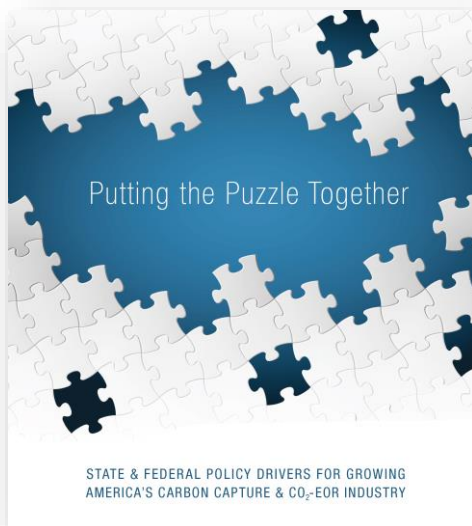
- Co-convened by former Governor Matt Mead (R-WY) and Governor Steve Bullock (D-MT). Staffed by Great Plains Institute.
- Launched in 2015:
 - Officials from 15 states*
 - Leading industry and NGO stakeholders and experts
- Objectives:
 - Help policymakers better understand states' potential for carbon capture, CO₂-EOR and other storage and utilization;
 - Recommend state and federal strategies and policies;
 - Support implementation of policy recommendations and project deployment.



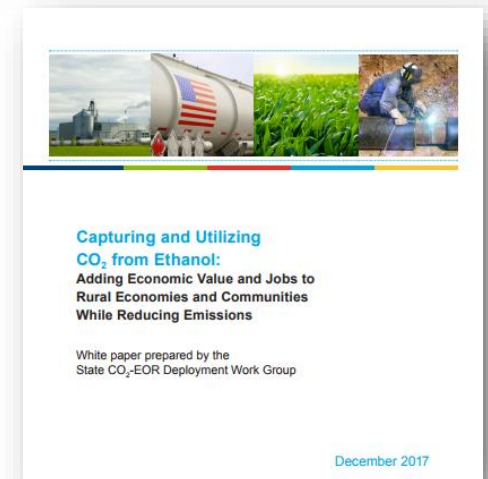
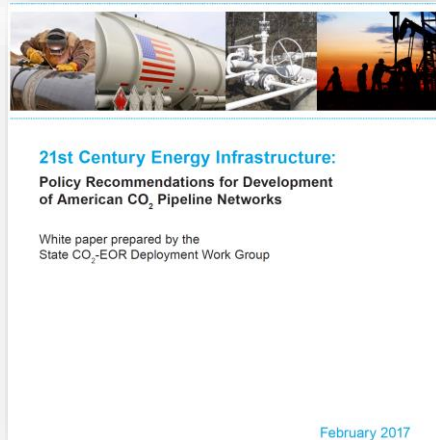
STATE CARBON CAPTURE WORK GROUP

*State participation varies and includes governors' staff, cabinet secretaries, utility commissioners and agency and commission staff.

Four Major Work Group Deliverables To Date



- ***Putting the Puzzle Together: State and Federal Policy Drivers for Growing America's Carbon Capture and CO₂-EOR Industry***
- ***21st Century Energy Infrastructure: Policy Recommendations for Development of American CO₂ Pipeline Networks***
- ***Electricity Market Design and Carbon Capture Technology: The Opportunities and the Challenges***
- ***Capturing and Utilizing CO₂ from Ethanol: Adding Economic Value and Jobs to Rural Economies and Communities While Reducing Emissions***



Regional Cooperation to Support Carbon Capture & CO₂ Pipeline Infrastructure Deployment

- Two cooperative regional efforts to harness the federal 45Q tax credit for deployment:
 - Western and Midwestern regions.
 - Former Governor Mead invited 17 governors to have their states participate.
 - Governors Mead and Bullock announced Regional Deployment Initiative in Jackson Hole, WY in June 2018, together with officials from other states.
 - State Carbon Capture Work Group coordinating effort.

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Three-Phased Approach to Fostering Project Deployment

Phase I (complete)

- Baseline mapping of sources and sinks;
- Preliminary cost analysis; and
- Pipeline modeling.

Phase II (complete)

- Convened state officials and stakeholders to launch Initiative in Midwestern and Western regions.

Phase III (underway)

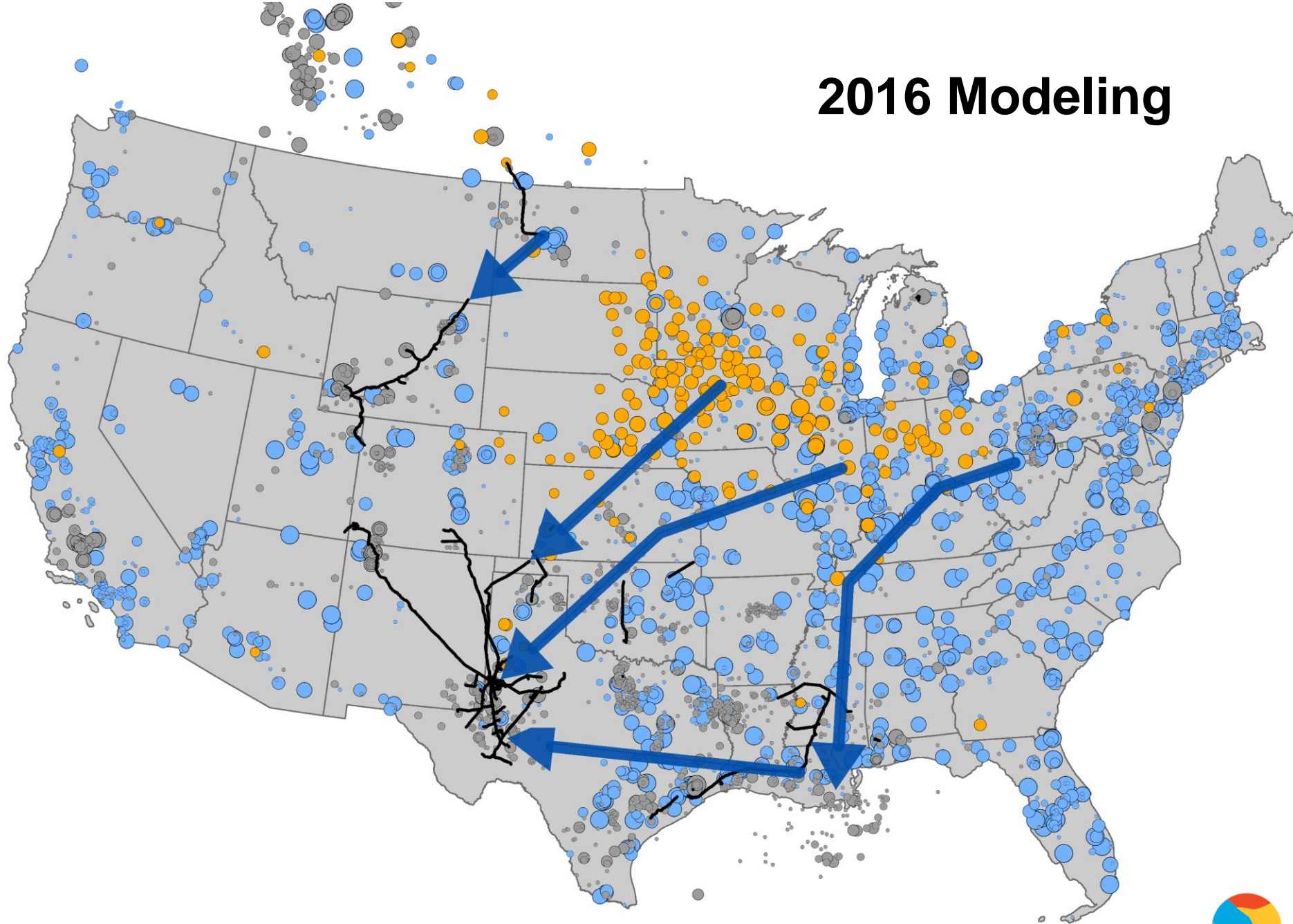
- Modeling and planning to support project deployment.
- Identification of additional state and federal policies to close remaining cost gaps for projects.
- Engage stakeholders, policymakers and media to marshal support for projects to meet 45Q timeline of beginning construction by end of 2023.
- Prepare for 2020 state legislative sessions.

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2016 Modeling

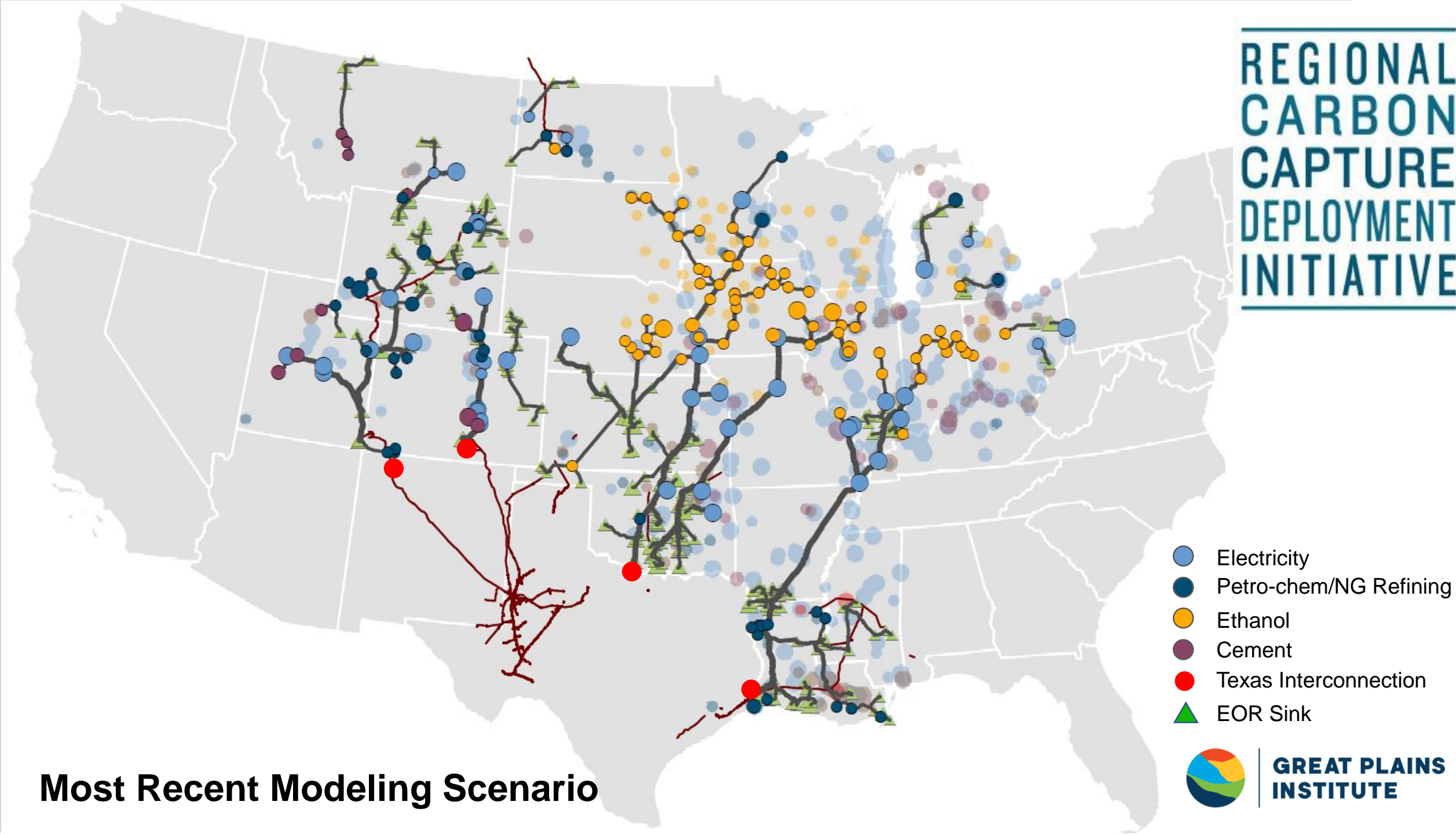
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CO₂ Pipeline Infrastructure Corridors

REGIONAL CARBON CAPTURE DEPLOYMENT INITIATIVE



Most Recent Modeling Scenario



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Thank You

Brad Crabtree
Vice President, Carbon Management
Great Plains Institute
(701) 647-2041 work | (701) 830-0302 mobile
bcrabtree@gpisd.net



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