



Building a New Carbon Economy: How Carbon Capture and Use Can Accelerate Decarbonization and Deliver Economic Growth

Overview of Federal and State/Regional Policy Initiatives

2019 NASEO Annual Meeting

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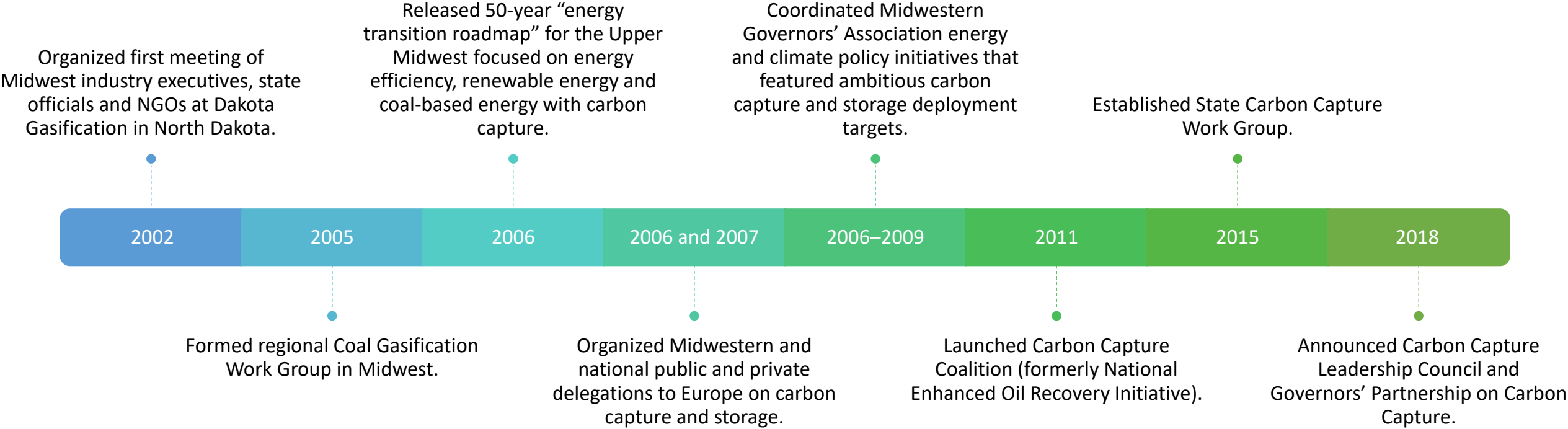
Great Plains Institute




**GREAT PLAINS
INSTITUTE**

Better Energy.
Better World.

Great Plains Institute: Nearly Two Decades of Work on Carbon Capture, Utilization & Storage




Coordinated Federal and State/Regional Initiatives Underway to Advance U.S. Carbon Capture Policy and Project Deployment



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.



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.



Carbon Capture Leadership Council

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



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.



GOVERNORS' PARTNERSHIP FOR CARBON CAPTURE

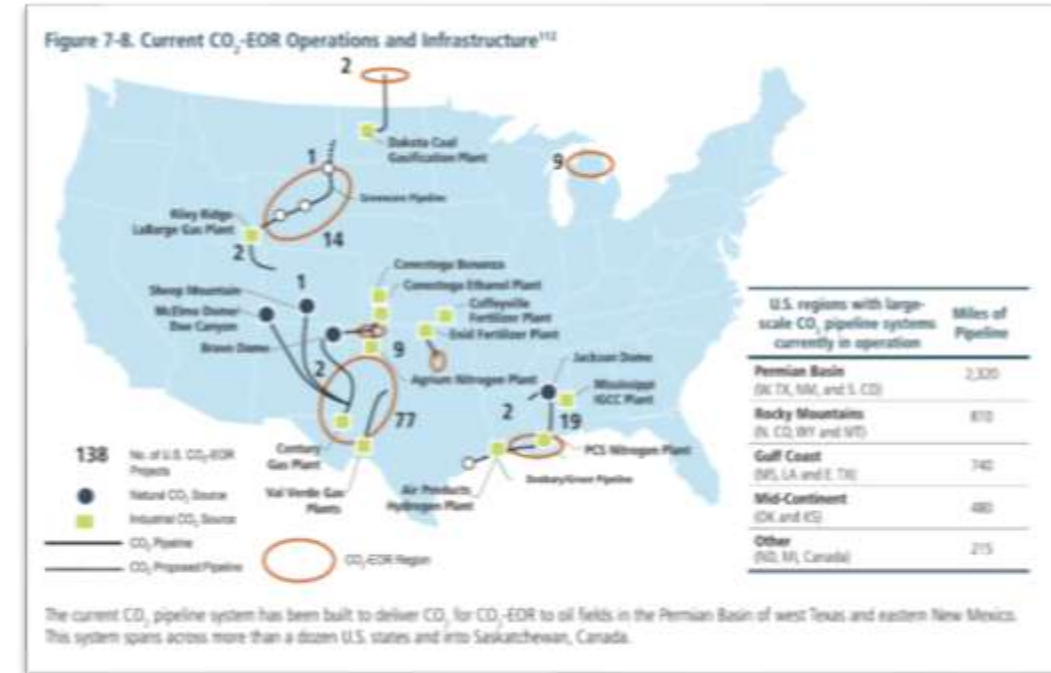
Bipartisan initiative of governors to provide leadership, focus and a stronger state voice for mutual carbon capture policy and deployment priorities.

Industrial Carbon Capture: Area of Increasing Focus

- Steel delegation to UAE, Belgium & Netherlands (Sep 2019)
- Prospective cement delegation to Europe (Q1 2020)
- Industrial focus at CO₂ NNECT 2019 and 2020 national carbon capture events.

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 Emissions
Reduction, Energy
Production & Jobs
Benefits

- **U.S. oil industry has purchased, transported and injected well over 1 billion tons of CO₂ over the past half century** with no fatalities, serious injuries, or major environmental incidents (~65 million tons of CO₂).
- **~37% net lifecycle emissions reductions achieved through geologically storing industrial and power plant CO₂ through enhanced oil recovery (EOR), 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 enabling atmospheric carbon removal for negative emissions.
- **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 protects and creates good-paying, highly-skilled jobs** across value chain of capture, transport, use and storage.

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

- Under IEA's scenario to limit warming to 2° C, carbon capture contributes 14% of cumulative 2015-2050 reductions and 20% annually by 2050.
- An essential strategy for industry, not just coal and gas power generation: In IEA's 2° scenario, 45% of captured CO₂ from industrial sectors.
- The IPCC's 5th Assessment finds that mitigation under the 2 degree C scenario costs 138% more, if carbon capture is excluded from solution set.

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 and bioenergy with carbon capture.

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 US\$
Pure CO2 emissions	Compression & Dehydration	Ethanol, Natural Gas Processing, Ammonia	\$15-20/metric ton
CO2 emissions @ 16-50% concentration	Amine CO2 separation equipment plus Compression and Dehydration	Hydrogen Plants, Cement, Fluidized Catalytic Crackers (Refineries), Blast Furnace Gas Combustion (Steel)	\$40-60
CO2 emissions @ ~ 13-15% concentration		Pulverized Coal Power Plants	\$50-65
CO2 emissions @ ~ 4%		Natural Gas Combined Cycle Power Plants	\$65-75

Source: Jeff Brown, Stanford University. These figures are preliminary based on work currently underway.

Carbon Capture Coalition: 70+ Industry, Labor & NGO Membership Unites Diverse Interests

- Accelergy
- 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
- Center for Climate & Energy Solutions
- Citizens for Responsible Energy Solutions Forum
- Clean Air Task Force
- ClearPath Foundation
- Cloud Peak Energy
- Conestoga Energy Partners
- Core Energy LLC
- DTE Energy
- 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
- Pacific Ethanol
- Peabody
- 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
- Biomass Power Association
- Carbon Engineering
- Carbon Utilization Research Council
- Cornerpost CO₂, LLC
- Enhanced Oil Recovery Institute, University of Wyoming
- Environmental Defense Fund
- Institute for Clean Air Companies
- Melzer Consulting
- Tellus Operating Group
- World Resources Institute

- S. 1535, the FUTURE Act (**F**urthering carbon capture, **U**tilization, **T**echnology, **U**nderground storage, and **R**educed **E**missions), 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
Political 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.



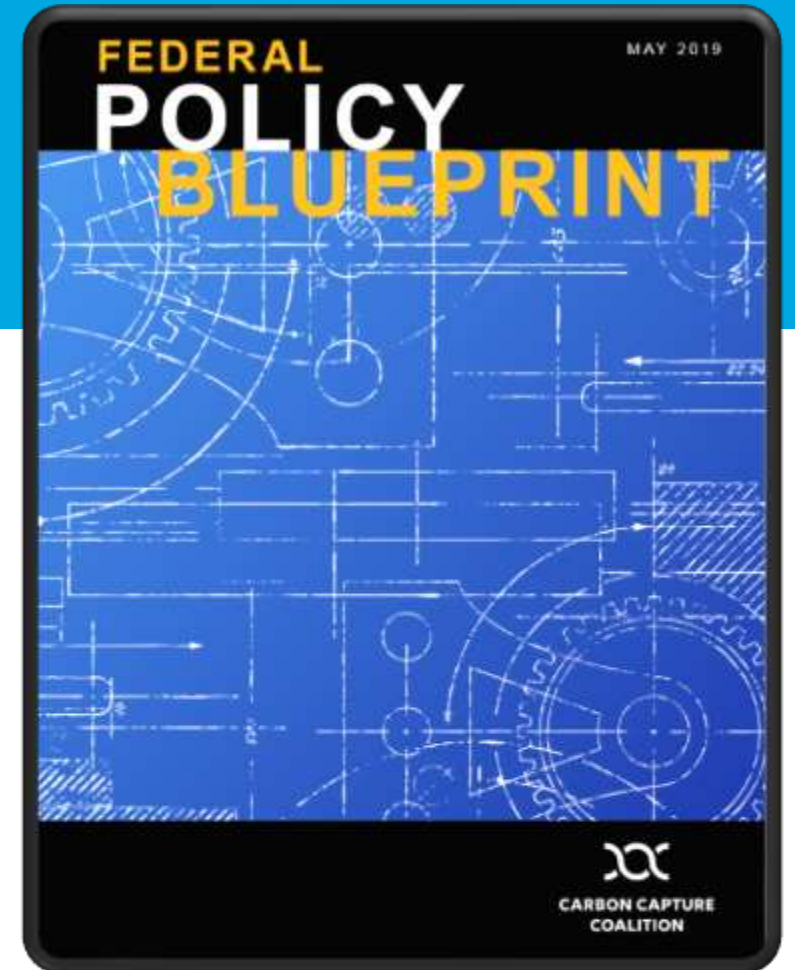
Federal Policy Agenda Going Forward



- Ensure effective implementation of 45Q by Treasury to provide financial certainty and business model flexibility to advance commercial-scale industrial carbon capture and utilization projects by the end of 2023 (current authorization of 45Q);
- Provide additional incentives to complement, expand and build upon 45Q in financing projects;
- Incorporate carbon capture, transport, utilization, removal and storage into broader national infrastructure policy;
- Expand, retool and prioritize federal funding for research, development, demonstration and deployment of the next generation of carbon capture, utilization, removal and geologic storage technologies and practices.
- Ensure inclusion of all industrial sectors in federal carbon capture policy and eligibility of both CO₂ and CO emissions, where applicable.

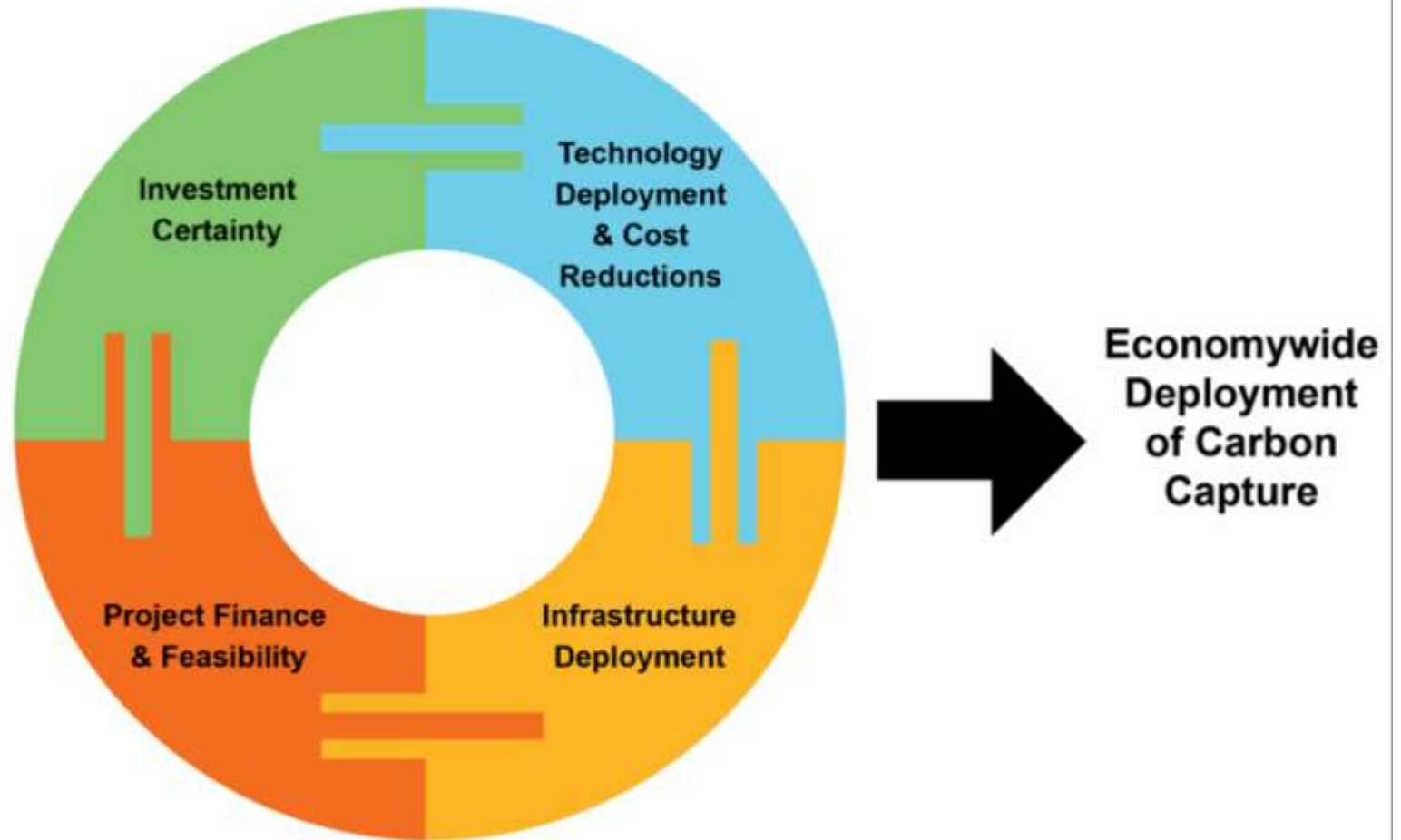
Carbon Capture Coalition Federal Policy Blueprint

- ✓ **First-ever policy blueprint on federal carbon capture policies**
- ✓ **Promotes economywide deployment of carbon capture technologies**
- ✓ **Represents consensus of more than 60 energy, industrial and technology companies, labor unions, and conservation, environmental, clean energy and agricultural organizations**

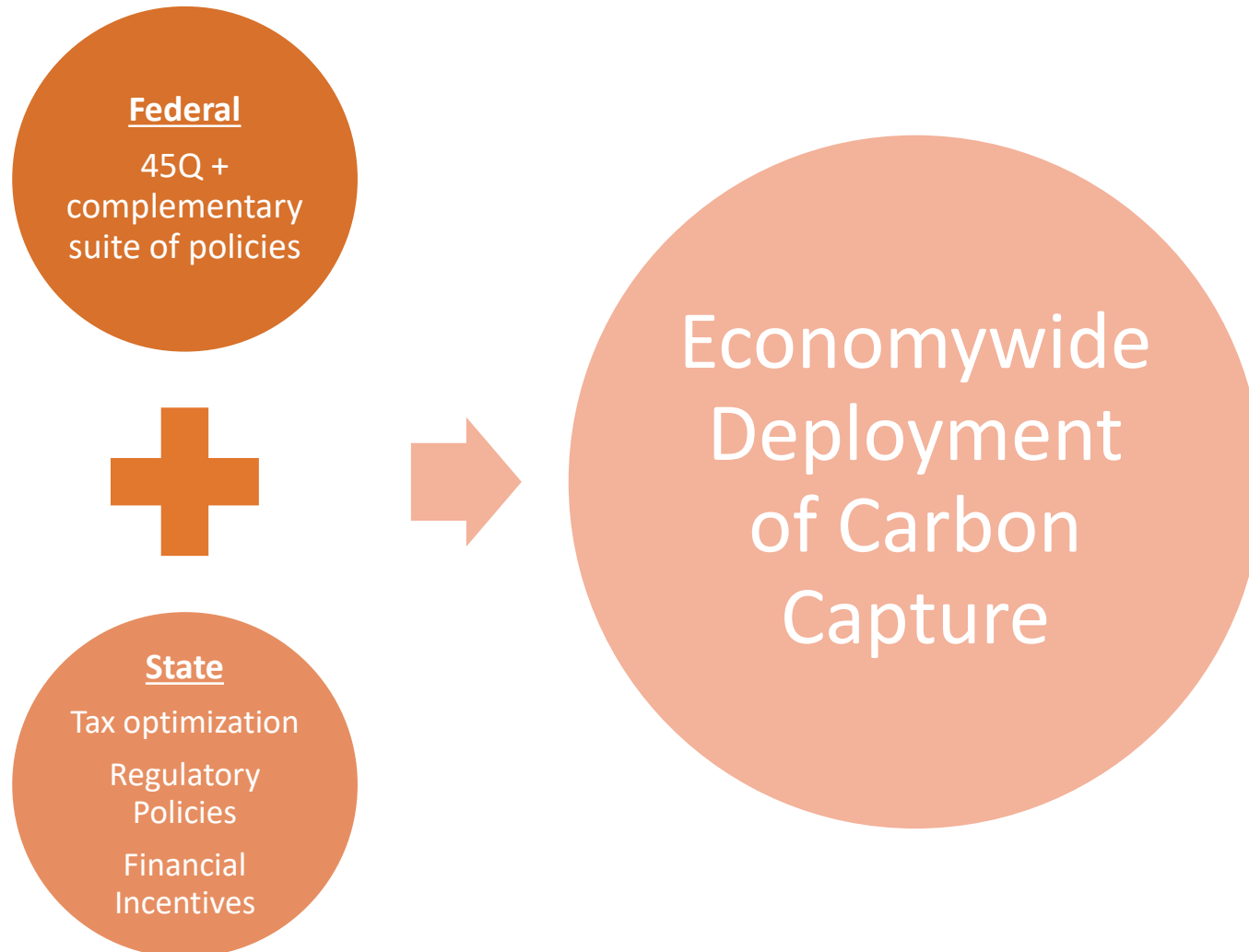


Next Ten Years for Carbon Capture: How do we reach critical mass for economywide deployment?

Reform of the 45Q tax credit is a significant accomplishment and provides a foundation for the broader suite of policies needed to scale commercial deployment of carbon capture, similar to what has benefitted other low and zero-carbon technologies.



Integrating Federal & State Policy is Key to Success in the U.S. Context

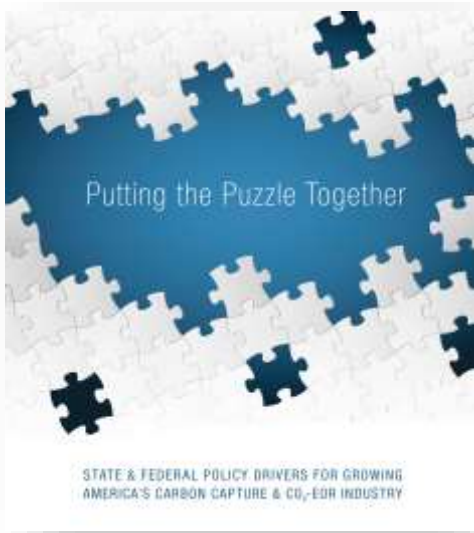


- Co-convened by former Gov. Mead (R-WY) and Gov. Bullock (R-MT) in 2015, with staffing from Great Plains Institute.
- Officials from 15 states* with stakeholders and experts.
- Objectives:
 - Help policymakers understand states' potential for carbon capture, transport, use and storage;
 - Recommend state and federal policies; and
 - Support implementation of policy and carbon capture and CO₂ pipeline deployment.
- **We would welcome your state's participation.**



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

Four Major State 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*](#)



21st Century Energy Infrastructure:
Policy Recommendations for Development
of American CO₂ Pipeline Networks

White paper prepared by the
State CO₂-EOR Deployment Work Group

February 2017



Electricity Market Design
and Carbon Capture Technology:
The Opportunities and the Challenges

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Capturing and Utilizing
CO₂ from Ethanol:
Adding Economic Value and Jobs to
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While Reducing Emissions

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December 2017

Harnessing 45Q for State and Regional Carbon Capture and CO₂ Pipeline Infrastructure Deployment

- Governor Mead invited 17 governors to work together to capitalize on the 45Q tax credit.
- Governors Mead and Bullock announced the Regional Deployment Initiative in Jackson Hole, WY in June 2018.
- State Carbon Capture Work Group now coordinating Midwestern and Western regional efforts.
- Modeling and policy development underway for 2020 state legislative sessions.



EPA GHGRP & eGRID
US DOE EIA
ABB / Energy Velocity

CO2 Supply
Industrial & Power

Stanford
NETL, IEA
National Petroleum Council

Capture Costs

Advanced Resources
International

**EOR
Potential Demand**

NETL & USGS
Los Alamos National Lab
Indiana University
Ohio State

**Saline
Storage Potential**
SCO2T

NETL
Los Alamos
Princeton
Industry Consulting

Pipeline Costs

**REGIONAL
CARBON
CAPTURE
DEPLOYMENT
INITIATIVE**

SimCCS
Los Alamos

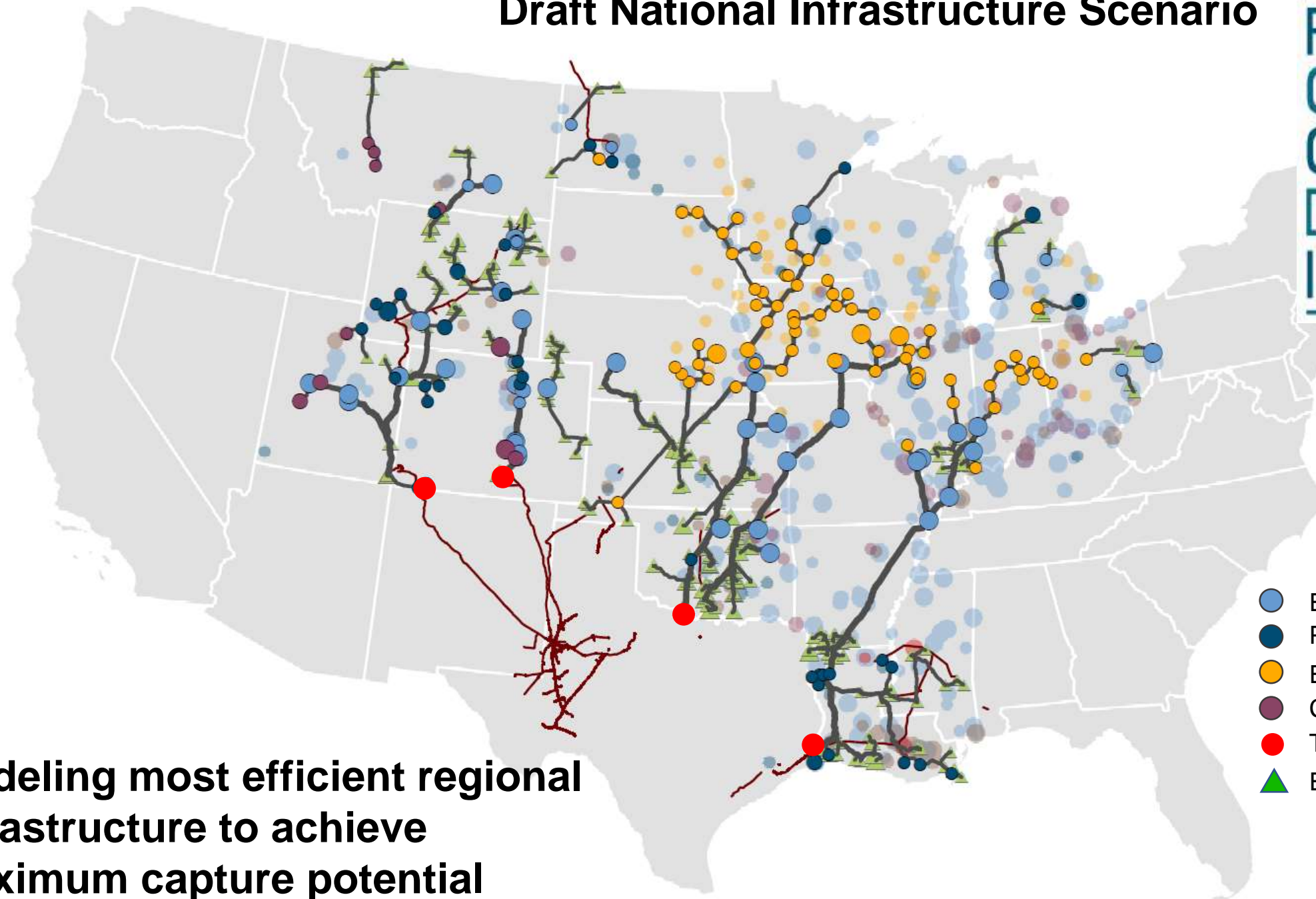
**GPI-Coordinated
National Modeling
Team**

**Identify potential
early mover
capture projects
by state.**

**Model optimized
regional CO₂
transport
infrastructure to
maximize feasible
capture, use and
storage.**

Draft National Infrastructure Scenario

REGIONAL CARBON CAPTURE DEPLOYMENT INITIATIVE



- Electricity
- Petro-chem/NG Refining
- Ethanol
- Cement
- Texas Interconnection
- ▲ EOR Sink

Modeling most efficient regional infrastructure to achieve maximum capture potential

Where We are in the Process

Phase I – Preliminary Analysis (January-September 2018)

- Mapping of industrial facilities and power plants and CO₂ storage opportunities, initial cost analysis, and preliminary pipeline modeling.

Phase II – Convening State Officials and Stakeholders (October 2018)

- Launched Initiative in Columbus, OH and Salt Lake City, UT.

Phase III – Supporting State Policy Development and Projects (Underway)

- Identify priority feasible projects and state policies to complement 45Q tax.
- Prepare for 2020 state legislative sessions.

Goals for 2019

- In preparation for 2020 state legislative sessions:
 - Complete modeling and analysis,
 - Identify potential candidate carbon capture projects by state; and
 - Recommend state policies to complement the federal 45Q tax credit to achieve project feasibility.
- Build state, industry, labor, and NGO support for carbon capture projects to meet 45Q deadline of beginning construction by the end of 2023 and to advance multi-state CO₂ pipeline projects.
- **Additional states and stakeholders encouraged to participate!**

REGIONAL
CARBON
CAPTURE
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INITIATIVE

Thank You

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