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Critical Challenges. Practical Solutions.



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Energy & Environmental Research Center (EERC)

PCOR Partnership A Catalyst for Commercial CCUS Deployment

Fuel Ethanol Workshop & Expo
Carbon Capture & Storage Summit

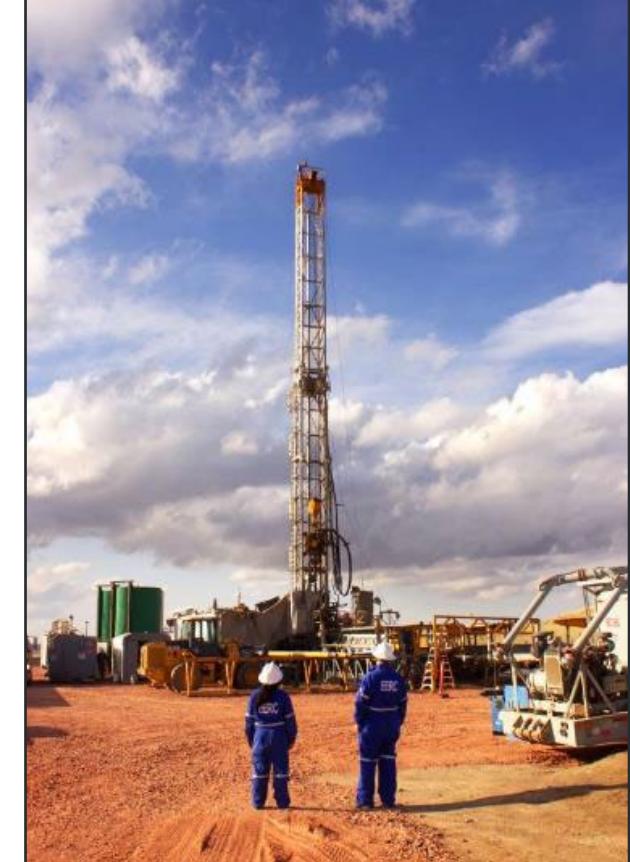
Minneapolis, MN

June 11, 2024

Michael Hillix, PG
Principal Geoscientist and Energy Advisor

AGENDA

- EERC background
- Introduction to the Plains CO₂ Reduction (PCOR) Partnership
- PCOR through the years
 - Phases of PCOR
- CCUS in the PCOR region today
- The road ahead





CRITICAL CHALLENGES. PRACTICAL SOLUTIONS.

The EERC is a leader in developing new technologies and practical solutions to critical energy challenges.





OUR FACILITIES

254,000 SQ FT OF FACILITIES

HIGH-BAY
TECHNOLOGY
DEMONSTRATION

FUEL
PROCESSING

MOBILE
LABORATORIES

WATER USE
MINIMIZATION
TECHNOLOGY

FUELS OF THE FUTURE

NATIONAL CENTER
FOR HYDROGEN
TECHNOLOGY

CHEMICAL STORAGE

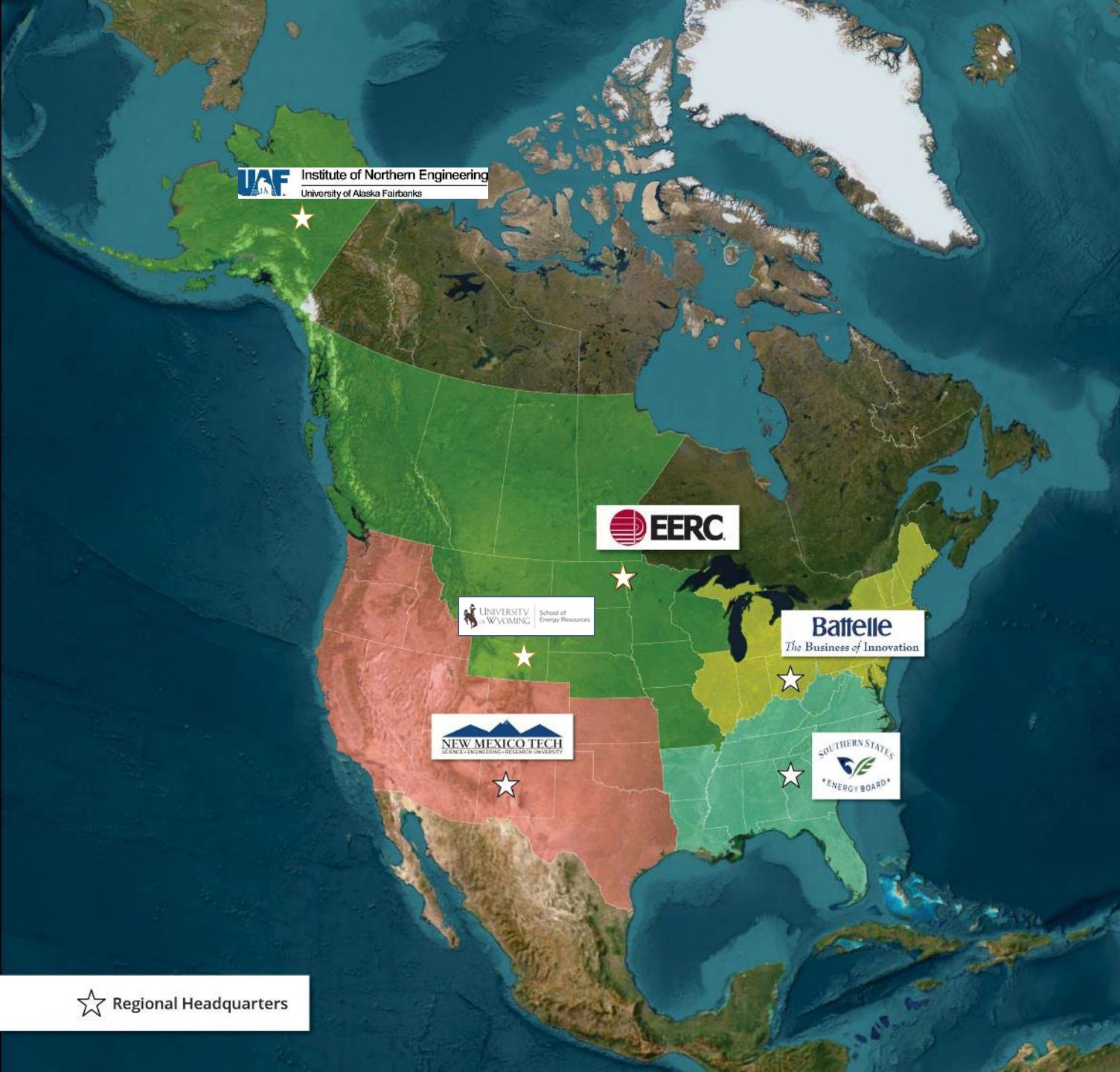
LABORATORIES

OFFICES

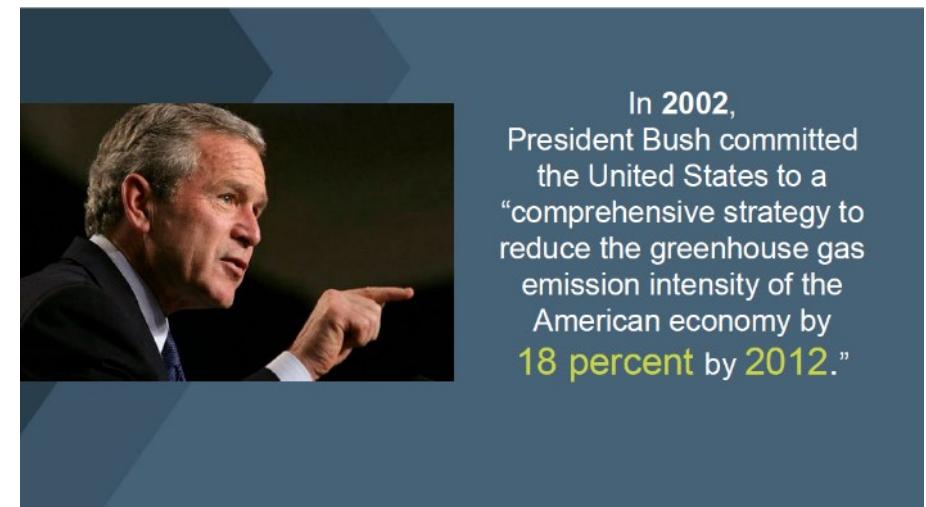
IN-HOUSE
FABRICATION SHOP

TECHNOLOGY
DEMONSTRATION

DISCOVERY HALL
MEETING AREA



PCOR PARTNERSHIP AND THE REGIONAL INITIATIVE PROGRAM



PCOR PARTNERSHIP

2003 – PRESENT

The PCOR Partnership addresses regional capture, transport, use, and storage challenges facing commercial CCUS deployment. The Partnership focuses on the following:

- Strengthening the technical foundation for geologic CO₂ storage and enhanced oil recovery (EOR)
- Regional characterization
- Advancing capture technology
- Improving application of monitoring technologies
- Promoting integration among capture, transportation, use, and storage industries
- Facilitating development of regulatory frameworks
- Providing scientific support to policymakers
- Enabling and advancing deployment of CCUS

The partners inform our priorities.





PCOR PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

2019–2024 – PCOR Partnership Initiative: Commercial Deployment

2024-2034 – PCOR Partnership: Sustained Commercial Deployment



UAF Institute of Northern Engineering
University of Alaska Fairbanks



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A wide-angle landscape photograph of a rugged, arid region. In the foreground, there are large, light-colored, layered rock formations with distinct horizontal sedimentary structures. A dry, light-colored riverbed or wash cuts through the center of the image, leading towards a more densely forested area in the background. The background features rolling hills and mountains covered in green vegetation under a bright blue sky with scattered white clouds.

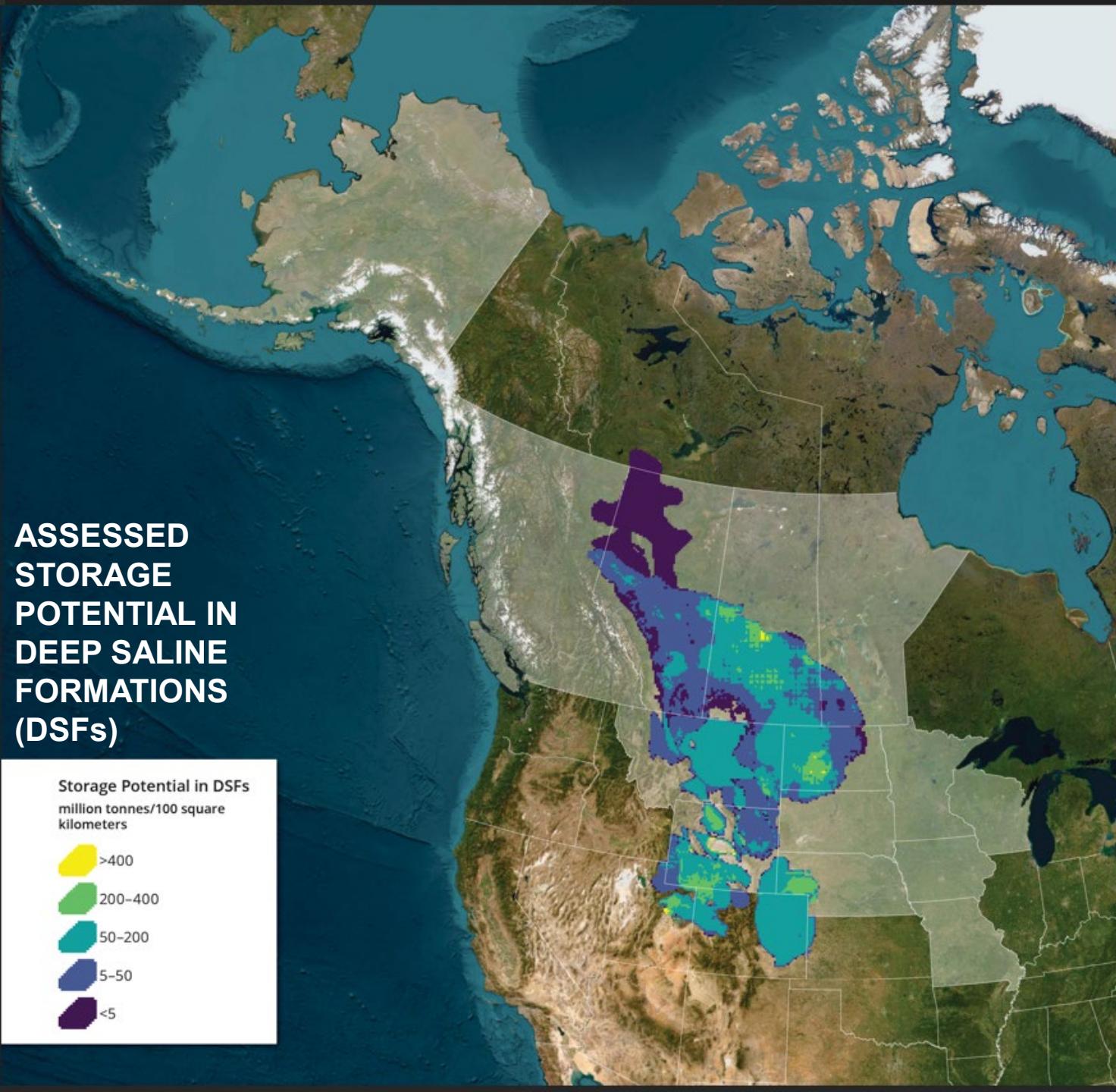
PHASE I: CHARACTERIZATION

2003-2005

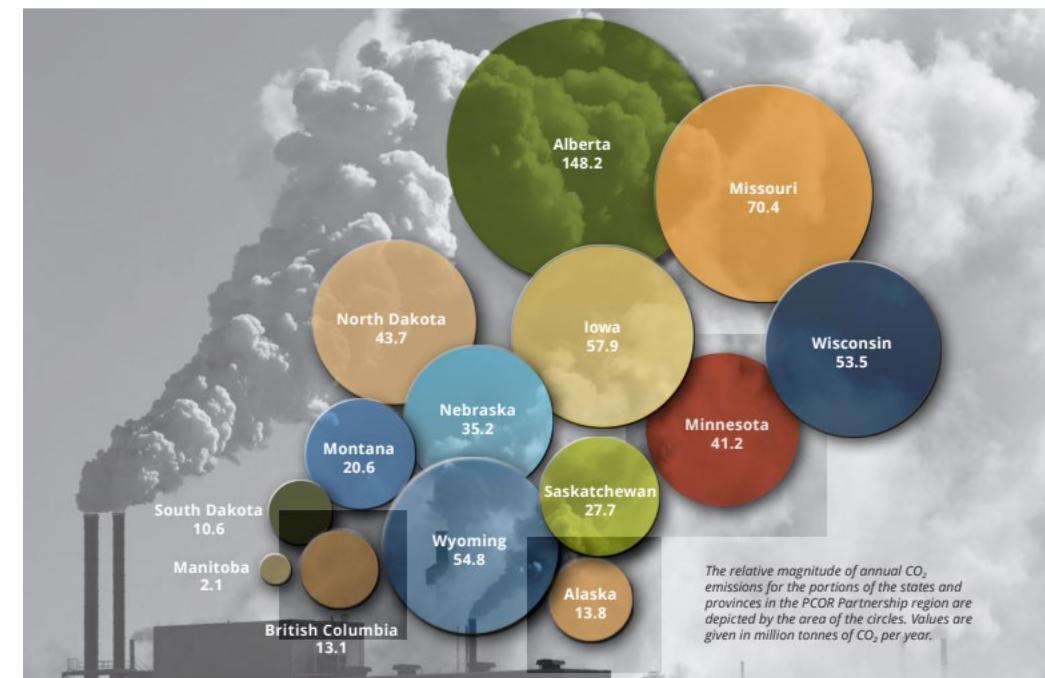


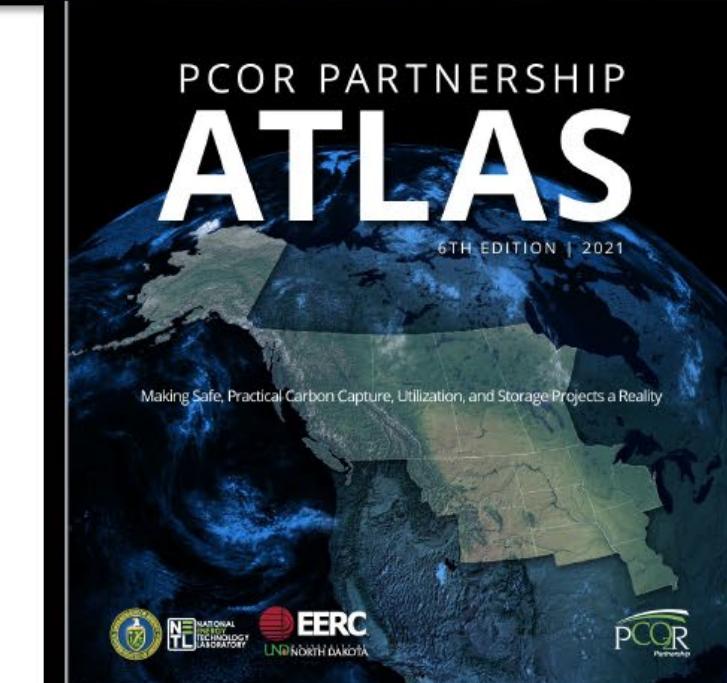
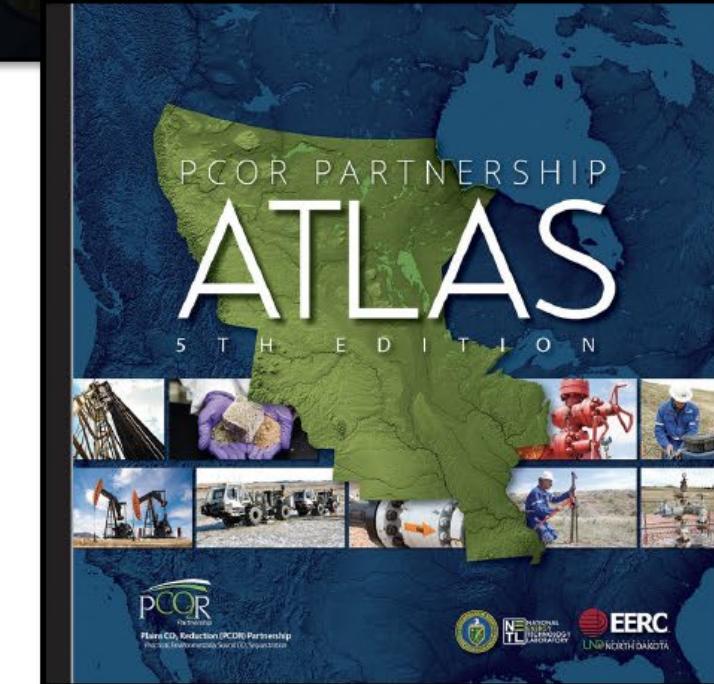
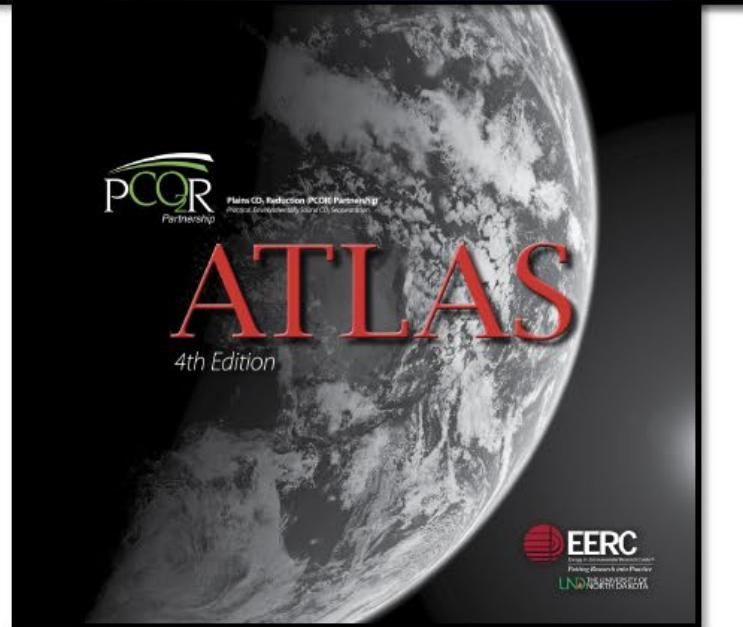
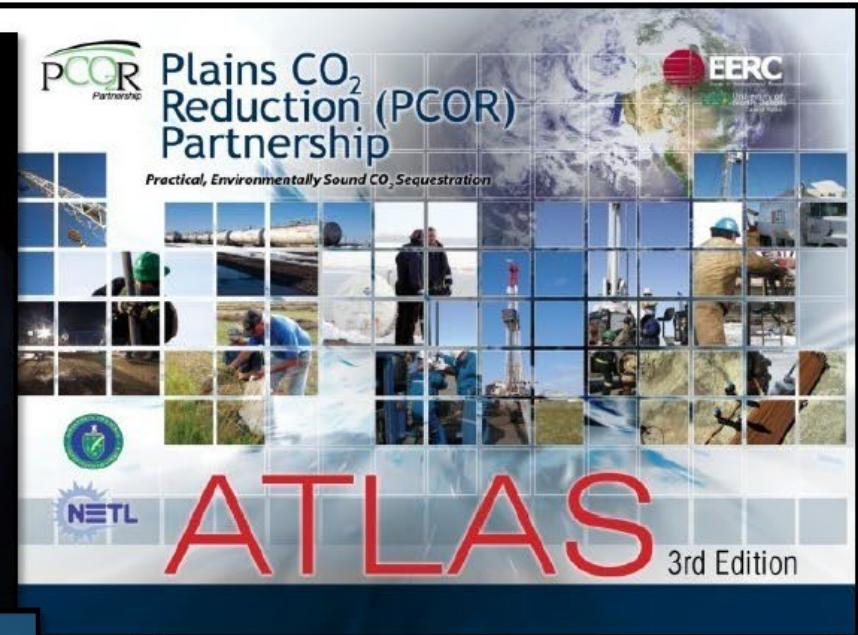
**Phase 1 Results:
Lots of CO₂ and
potentially plenty of
places to put it!**





Deep Saline Formations: Largest opportunity for CO₂ Storage





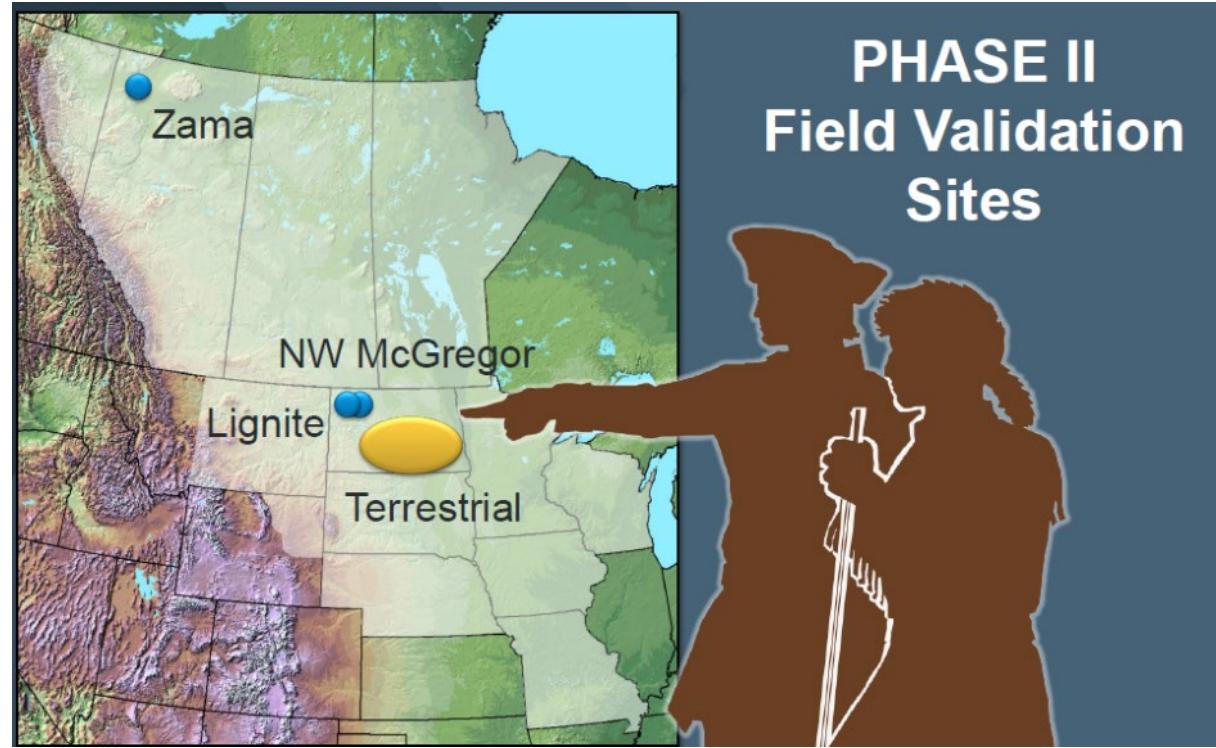
A wide-angle landscape photograph of a rugged, layered rock formation, likely the Badlands. The foreground shows a rocky outcrop with distinct horizontal sedimentary layers. A winding river or stream bed cuts through a valley filled with green grass and scattered trees. In the background, more of the same layered rock formations stretch towards a distant horizon under a bright blue sky with scattered white clouds.

PHASE 2: FIELD VALIDATION

2005-2008

PHASE II HIGHLIGHTS

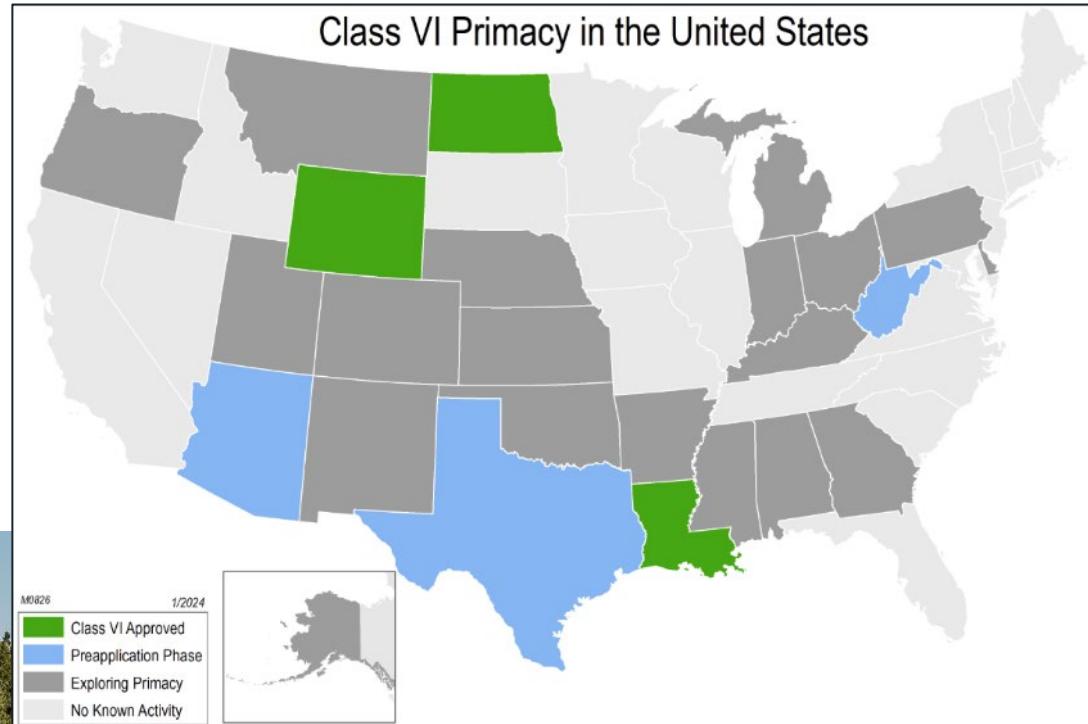
- Validation of four scenarios for CO₂ storage
 - CO₂ storage in a deep oil reservoir (NW McGregor)
 - CO₂ storage in unminable lignite coal seams
 - CO₂-rich gas storage in pinnacle reef structure (Zama)
 - Terrestrial CO₂ storage within a managed wetland
- First experiences with CO₂ storage project permitting
 - Creation of annual PCOR Regulatory Roundup



Key to Success: Active Participation of PCOR Partners

PCOR REGULATORY ROUNDUP

- Engagement with CCUS regulators across the PCOR region and beyond.
 - Open forum for discussion of technical and regulatory policy
 - Lessons learned and best practices
 - Regulatory, legislative, and policy updates



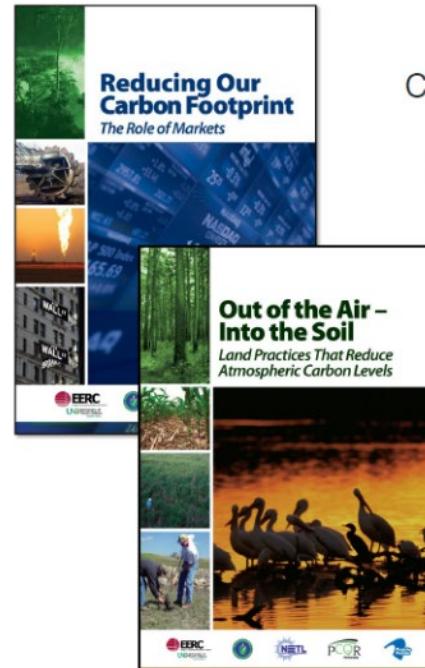
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ENERGY



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PHASE II: PUBLIC OUTREACH

- Produced five documentaries with Prairie Public Broadcasting.
 - Two of them Award Winners!
- Outreach and Education continues to be important component of PCOR mission.
 - Factsheets
 - PCOR Atlases
 - Nontechnical posters



Communicator
Award of
Excellence
2009



Aurora Award
Gold Winner
2009

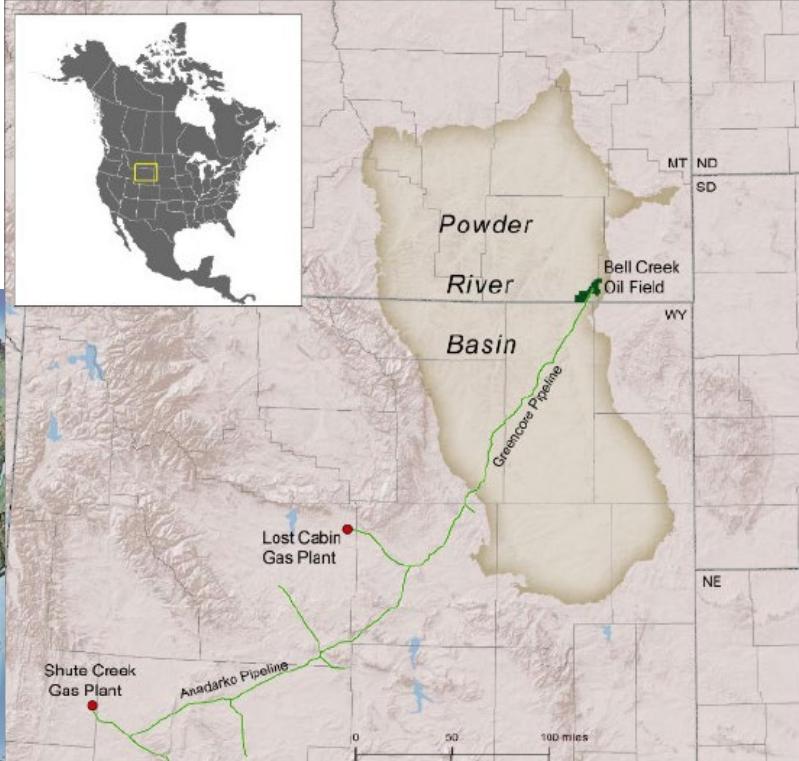
PHASE III: COMMERCIAL DEMONSTRATION

2007-2019



COMMERCIAL DEMONSTRATION 1 MILLION TONNES OR BUST!

- Worked with industrial partners to develop two commercial-scale CCUS demonstrations.
 - Fort Nelson Demonstration
 - ◆ Storage of CO₂ from a natural-gas processing facility within a deep carbonate saline formation
 - Bell Creek Field Demonstration
 - ◆ Associated CO₂ storage from commercial EOR operations



Monitoring, Verification, and Accounting (MVA) of stored CO₂ a Critical Component of these demonstrations.

CCUS BEST PRACTICE MANUALS



Plains CO₂ Reduction (PCOR) Partnership
Energy & Environmental Research Center (EERC)

BEST PRACTICES MANUAL (BPM) FOR SITE CHARACTERIZATION

Plains CO₂ Reduction (PCOR) Partnership Phase III
Task 4 – Deliverable D35

Prepared for:

Andrea M. Dunn

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PO Box 10940
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Cooperative Agreement No. DE-FC26-05NT42592

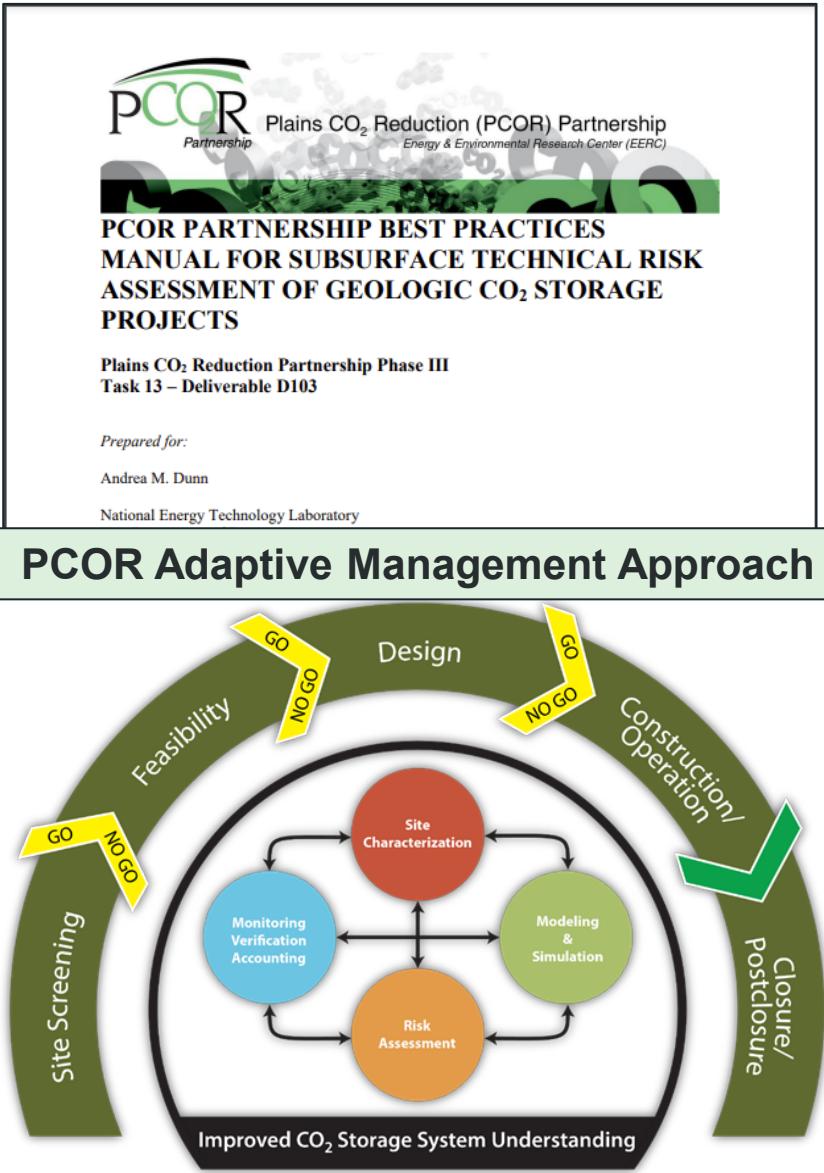
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March 2017
Approved

2017-EERC-06-08



PCOR PARTNERSHIP BEST PRACTICES MANUAL FOR SUBSURFACE TECHNICAL RISK ASSESSMENT OF GEOLOGIC CO₂ STORAGE PROJECTS

Plains CO₂ Reduction Partnership Phase III
Task 13 – Deliverable D103

Prepared for:

Andrea M. Dunn

National Energy Technology Laboratory



BEST PRACTICES MANUAL – MONITORING FOR CO₂ STORAGE

Plains CO₂ Reduction (PCOR) Partnership Phase III
Task 9 – Deliverable D51

Prepared for:

William W. Aljoe

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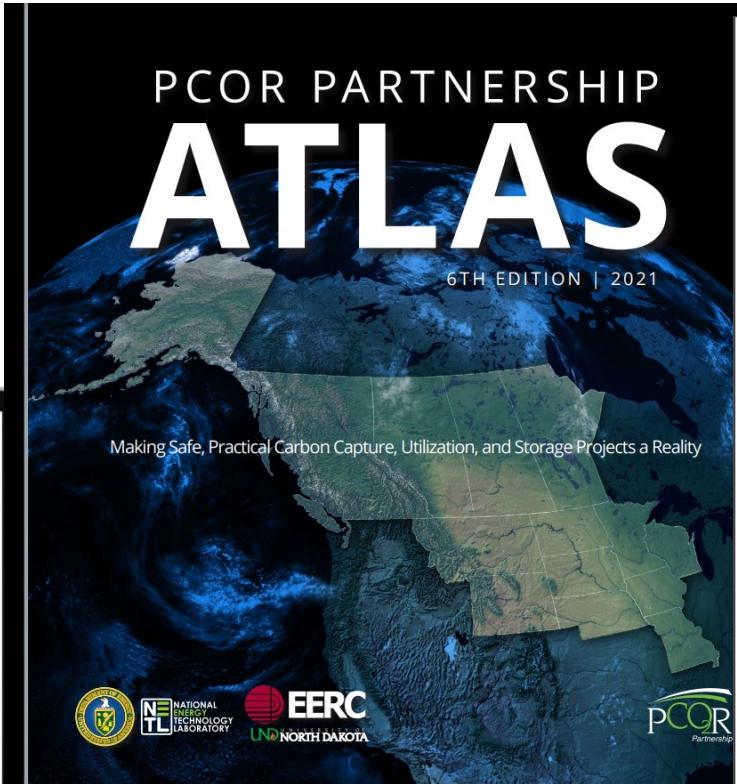
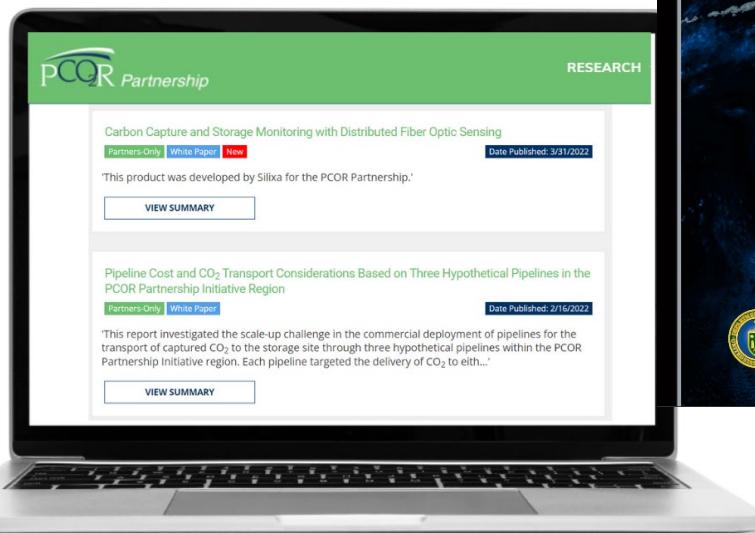
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PCOR PARTNERSHIP PRODUCTS



Available online to all
partners at
undeerc.org/PCORPartners



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Section 45Q of the U.S. Internal Revenue Code was

What Is the Tax Credit?

45Q tax credits are available based on where the CO₂ is sourced and how it is stored:

- \$85/tonne for dedicated storage from carbon capture on power or industrial facilities
- \$60/tonne for associated storage from carbon capture on power or industrial facilities
- \$180/tonne for dedicated storage from direct air capture
- \$130/tonne for associated storage from direct air capture

When Is the Tax Credit Available?

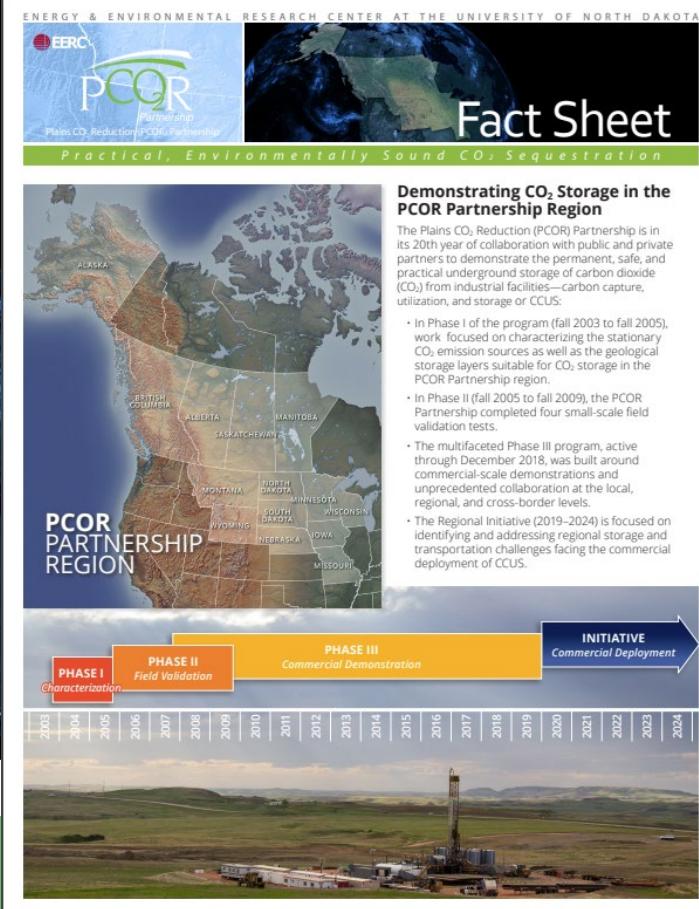
Projects that have entered the construction phase by January 1, 2033, are eligible for 45Q tax credits. The credit is available to qualified facilities for 12 years once equipment is placed in service.

How Do Taxpayers Receive the Credit?

In order to qualify for the tax credit, project operators of dedicated storage projects must report CO₂ volumes under the U.S. Environmental Protection Agency (EPA) Greenhouse Gas Reporting Program (GHGRP) Subpart RR. Subpart RR requires EPA-approved monitoring, reporting, and verification (MRV) plan and outlines methods for calculating stored CO₂ (<https://www.epa.gov/current-title-40/chapter-1/section-209a/phase-rr>).

Who Receives the Tax Credit?

The annual carbon dioxide sequestration credit provided by 45Q is generally granted to the taxpayer that owns the capture equipment and physically or contractually ensures secure geologic storage, which is formally defined in Subpart RR.



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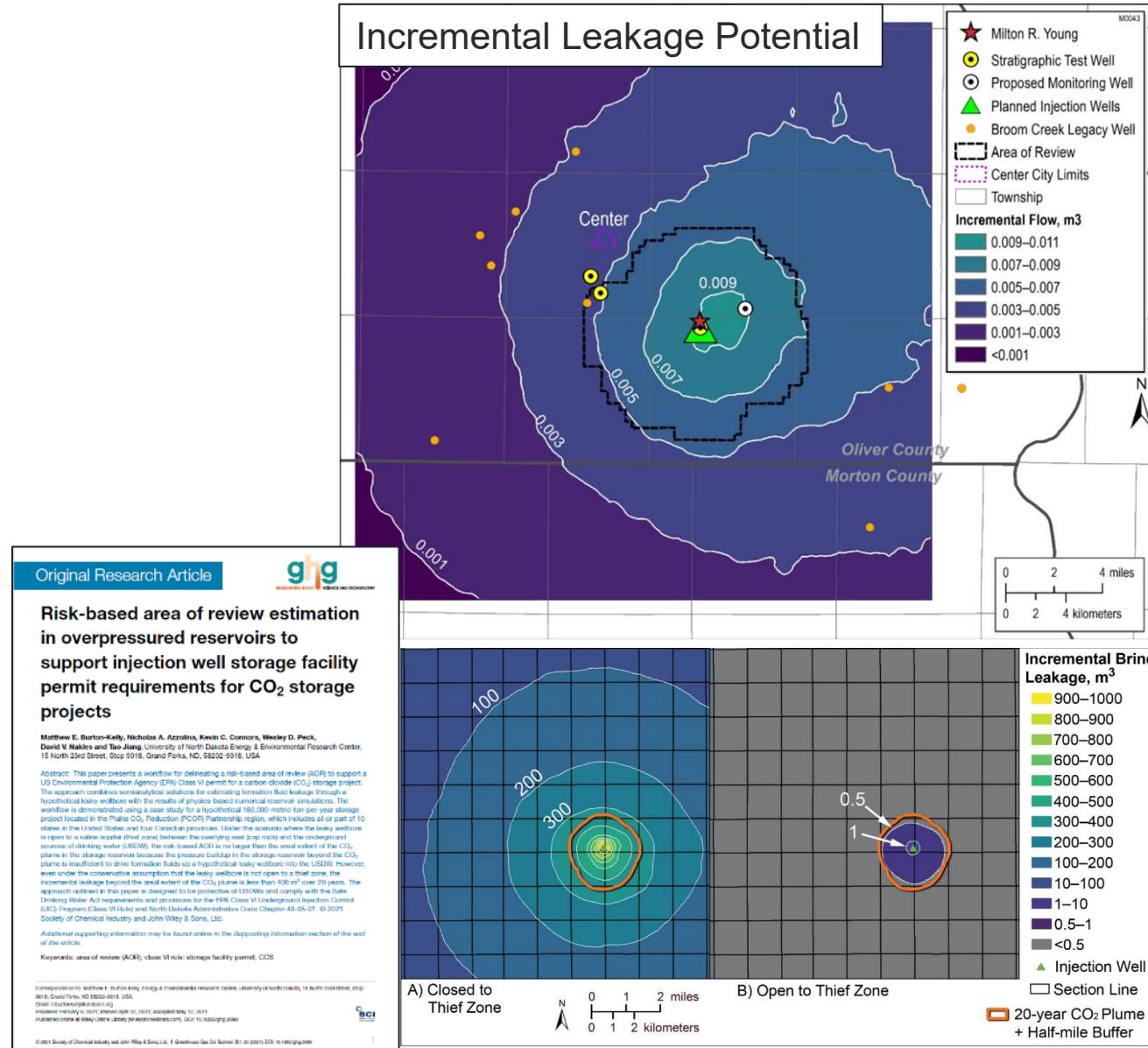


COMMERCIAL DEPLOYMENT

CCUS IN THE PCOR REGION TODAY

CCUS PERMITTING – AREA OF REVIEW (AOR)

- The AOR is the region surrounding the storage project where injection activity may endanger USDWs.
- An AOR must be defined as part of Class VI permitting requirements.
- EPA methods for AOR determination unsuitable for naturally overpressured storage formations.
 - Result in infinitely large AORs.
- Methodology developed through PCOR allows for AOR determination of overpressured formations.
 - Ensures protection of drinking water resources.
 - Unlocks millions of tonnes of potential CO₂ storage capacity.

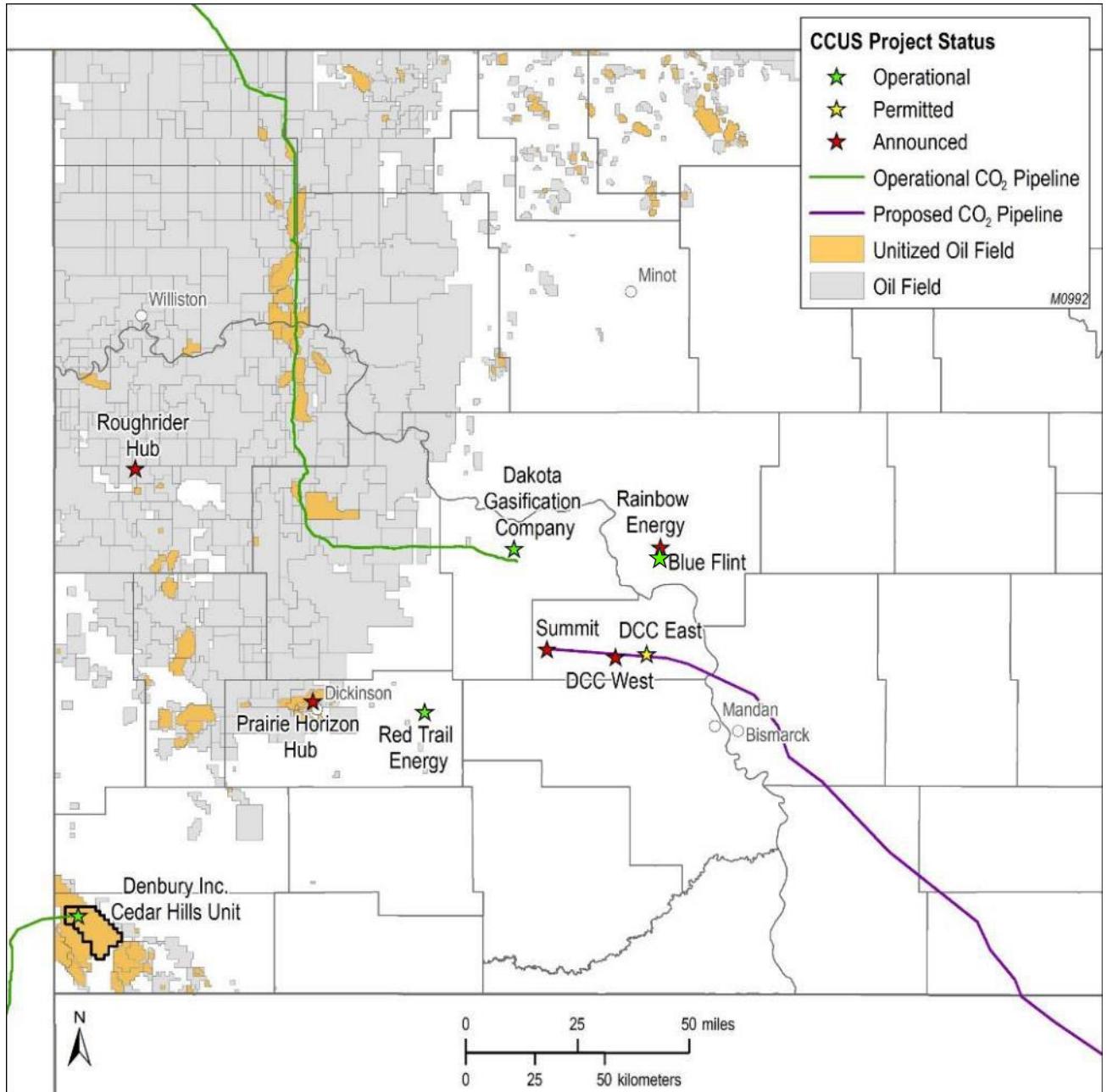
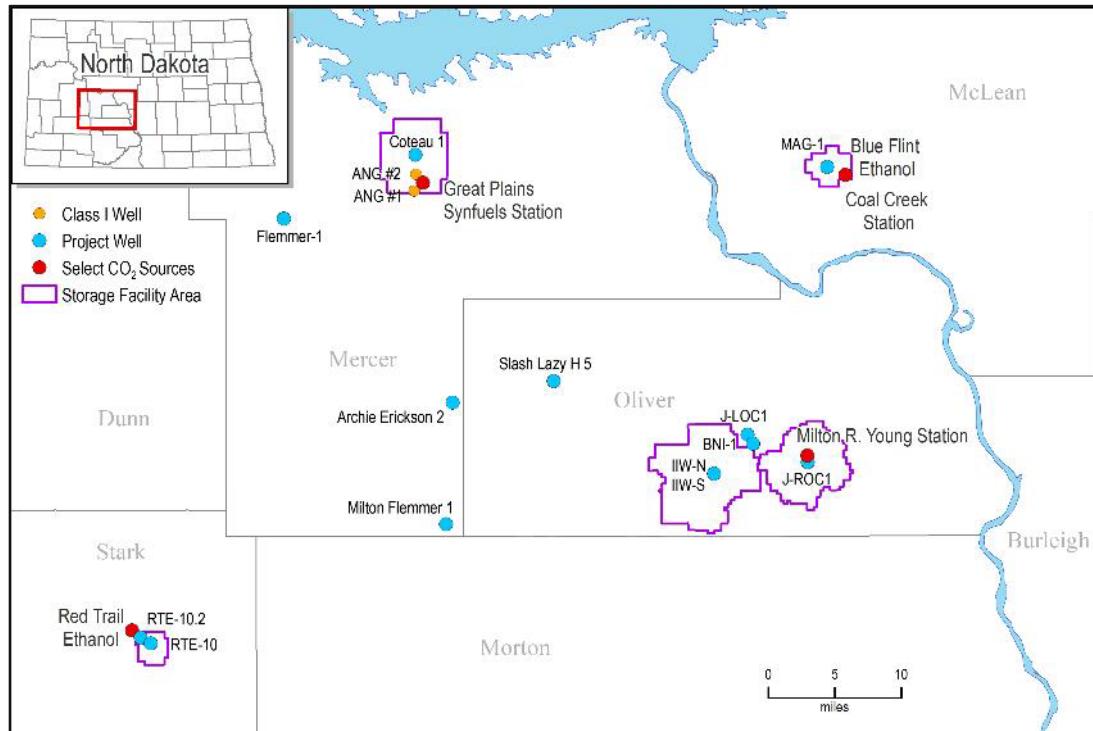


Burton-Kelly, M.E., Azzolina, N.A., Connors, K.C., Peck, W.D., Nakles, D.V., and Jiang, T., 2021, Risk-based area of review estimation in overpressured reservoirs to support injection well storage facility permit requirements for CO₂ storage projects: *Greenhouse Gases: Science and Technology*, v. 11, p. 887–906. <https://doi.org/10.1002/ghg.2098>.

NORTH DAKOTA CCUS PROJECTS

Announced, Permitted, and Operational

~250 million tonnes of CO₂ Storage Permitted



Majority of the permitted CO₂ Storage in North Dakota utilizes Risk-Based Area of Review Methodology developed through the PCOR Partnership.



PROJECTS IN PCOR PARTNERSHIP REGION

- 17 active projects
- 4 partially permitted
- 35 announced/developing

SUSTAINED COMMERCIAL DEPLOYMENT OF CCUS PCOR AND THE ROAD AHEAD

- 1) Build upon prior assessments to verify the ability of target formations to store CO₂.
- 2) Continue to facilitate the development of CO₂ transportation infrastructure.
- 3) Continue to facilitate development of regulatory and permitting frameworks for CO₂ storage.
- 4) Identify opportunities for CCUS, and support development of projects by PCOR partners.
- 5) Provide outreach and education for CO₂ storage stakeholders and the general public.



THE PCOR PARTNERSHIP

- Active region developing commercial CCUS projects.
- Building on over 20 years of applied research in CCUS.
- Engaged and motivated partners.
- Development of Best Practices and Solutions to Challenges.

A catalyst for commercial CCUS development in the region.



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PCOR PARTNERSHIP ANNUAL MEETING

Bismarck, North Dakota, August 26–28, 2024.

Schedule of Events:

- Monday, August 26: Evening networking Social
- Tuesday, August 27: PCOR Partnership Annual Meeting
- Wednesday, August 28: Field trip to an active carbon capture facility



PCOR
PARTNERSHIP
ANNUAL MEETING



UAF
Institute of Northern Engineering
University of Alaska Fairbanks

UNIVERSITY of WYOMING
School of Energy Resources

August 27–28, 2024, BISMARCK, NORTH DAKOTA

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THANK YOU!

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