



EERC



UNIVERSITY OF
NORTH DAKOTA



Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

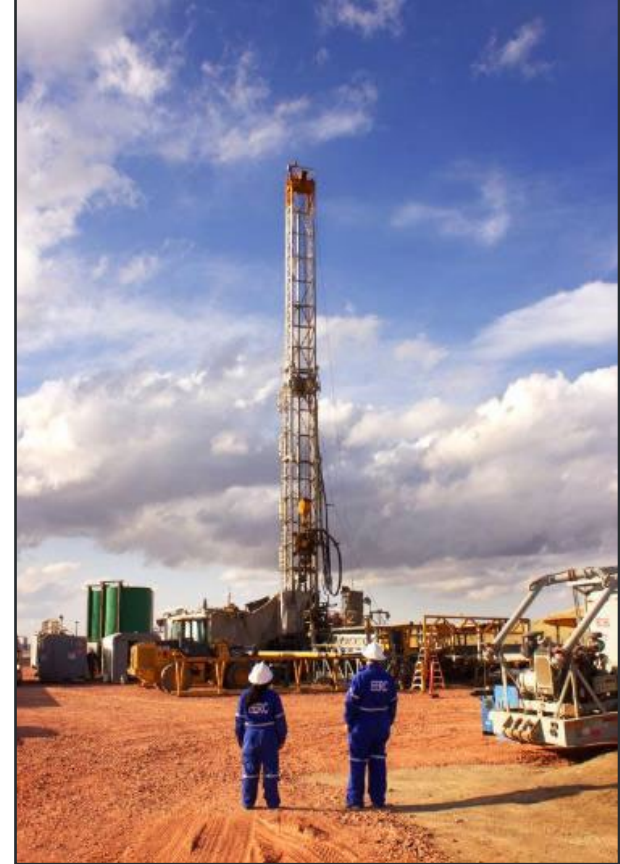
PCOR Partnership A Catalyst for Commercial CCUS Deployment

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.



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

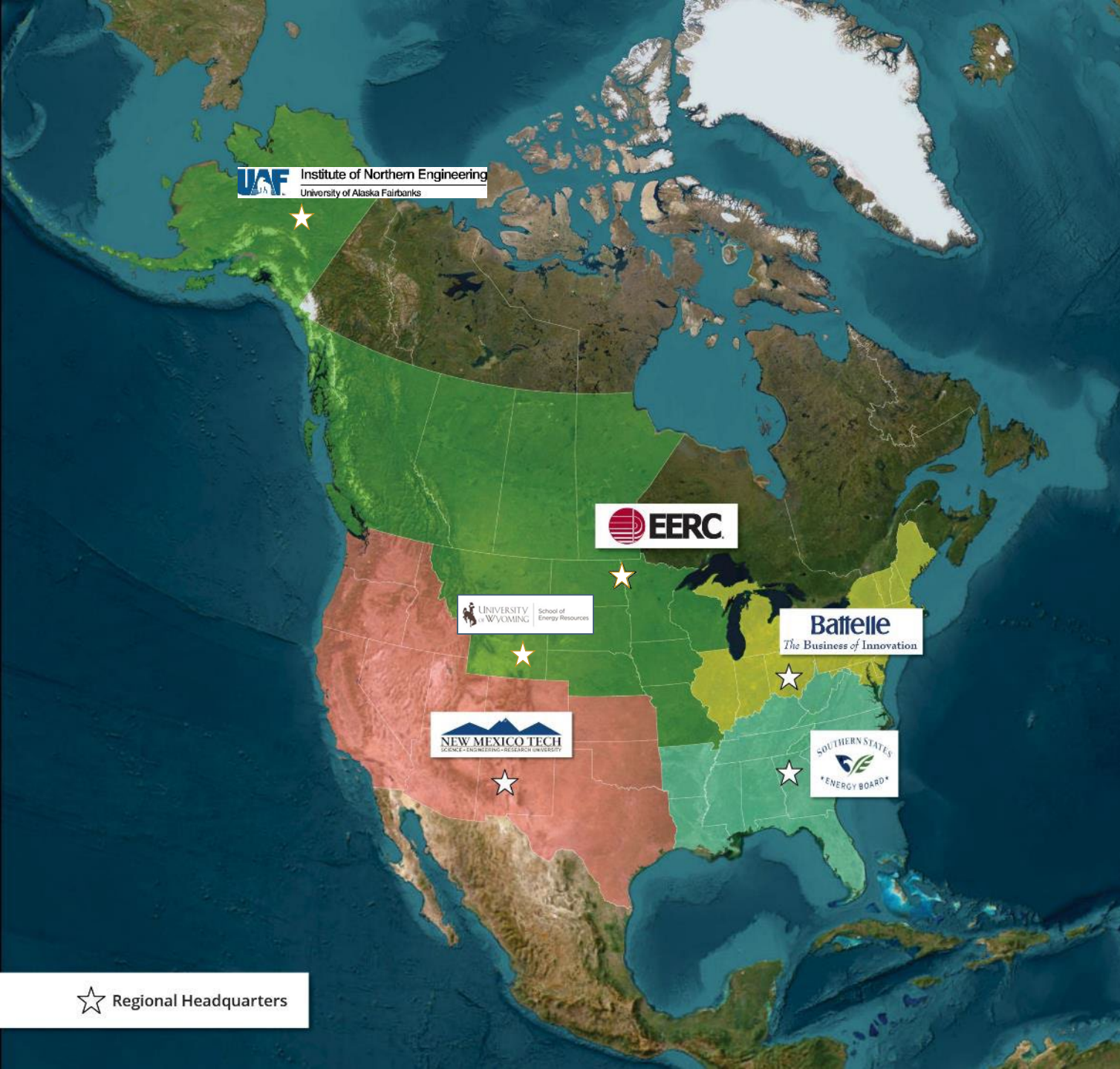
TECHNOLOGY
DEMONSTRATION

OUR FACILITIES

254,000 SQ FT OF FACILITIES

DISCOVERY HALL
MEETING AREA

PCOR PARTNERSHIP AND THE REGIONAL INITIATIVE PROGRAM



In 2002, President Bush committed the United States to a “comprehensive strategy to reduce the greenhouse gas emission intensity of the American economy by **18 percent** by **2012**.”

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.



School of
Energy Resources

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



Image credit – EERC

0 500 1,000 kilometers



PHASE I: CHARACTERIZATION 2003-2005



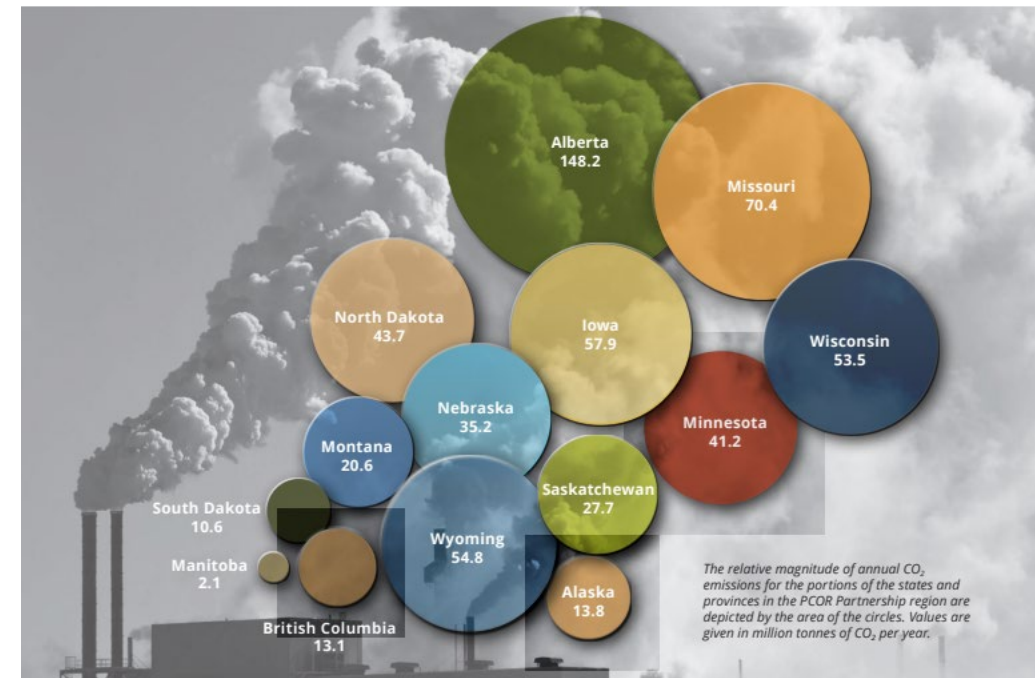
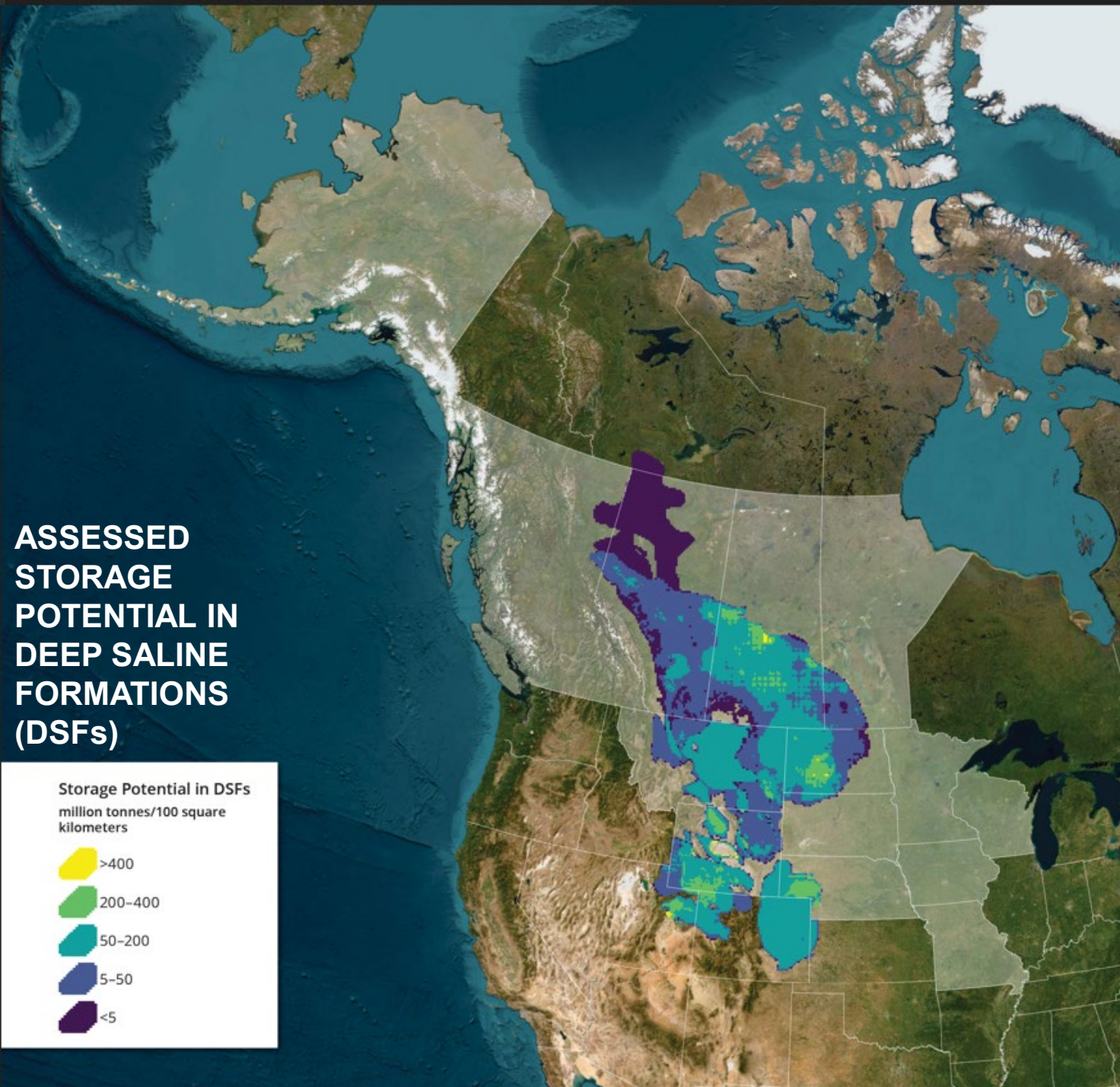
Phase 1 Results: Lots of CO₂ and potentially plenty of places to put it!

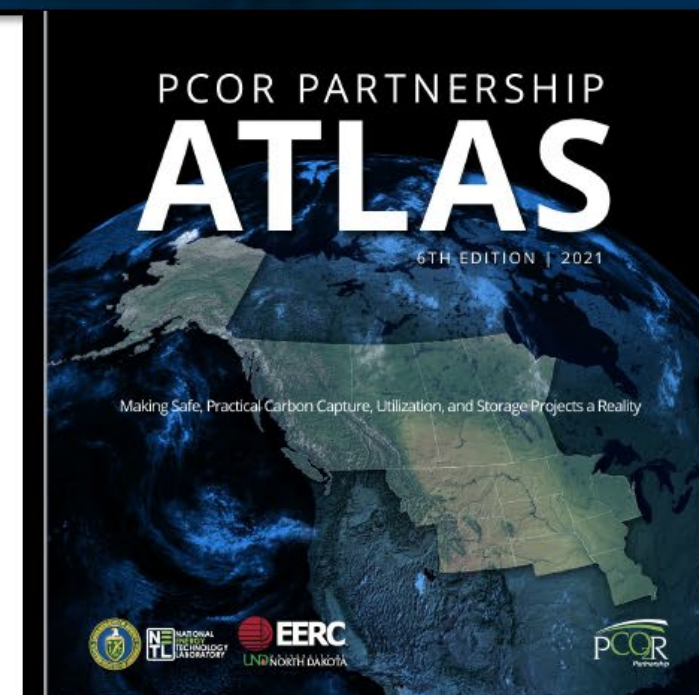
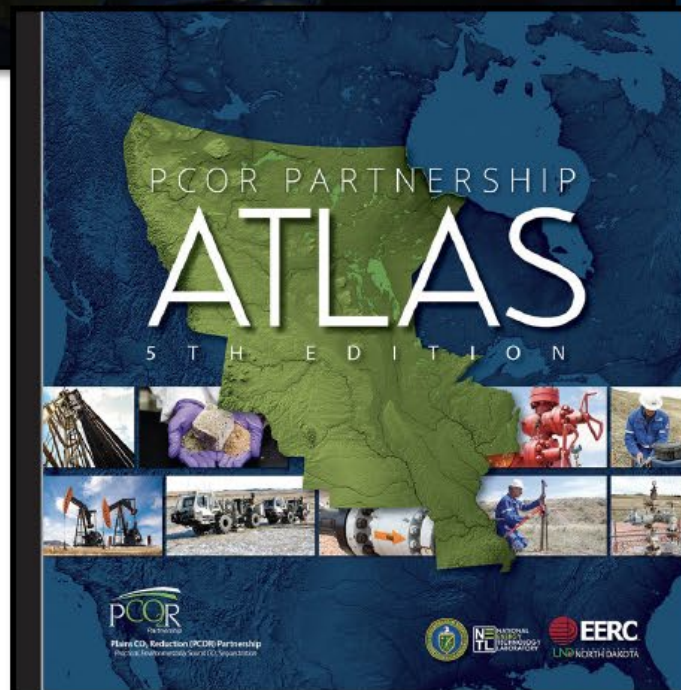
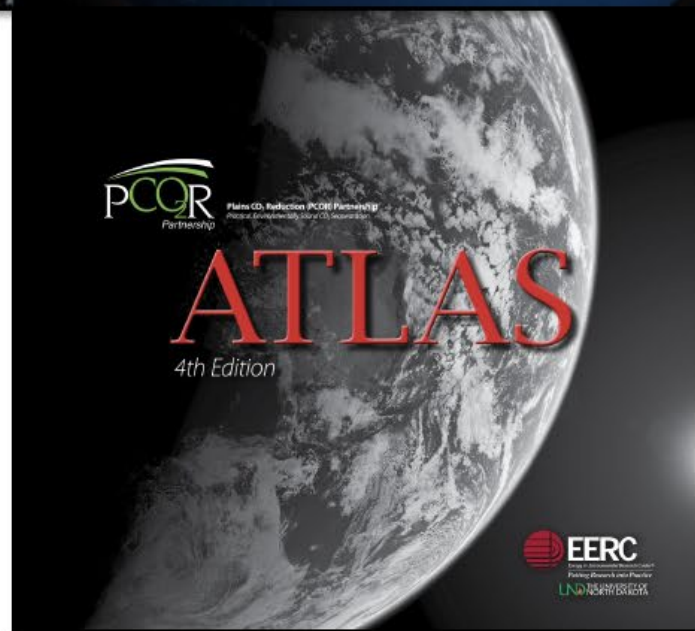
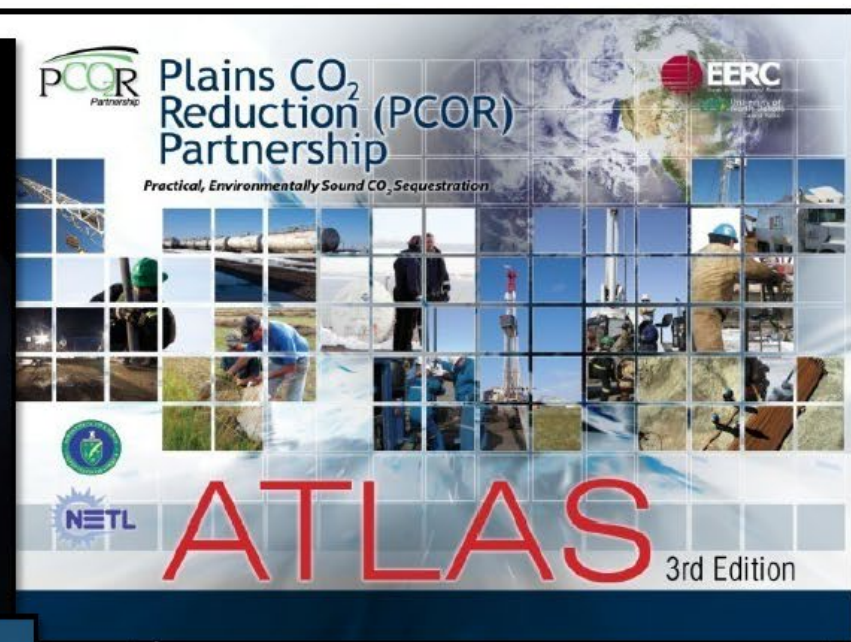


MAJOR STATIONARY CO₂ SOURCES



Deep Saline Formations: Largest opportunity for CO₂ Storage



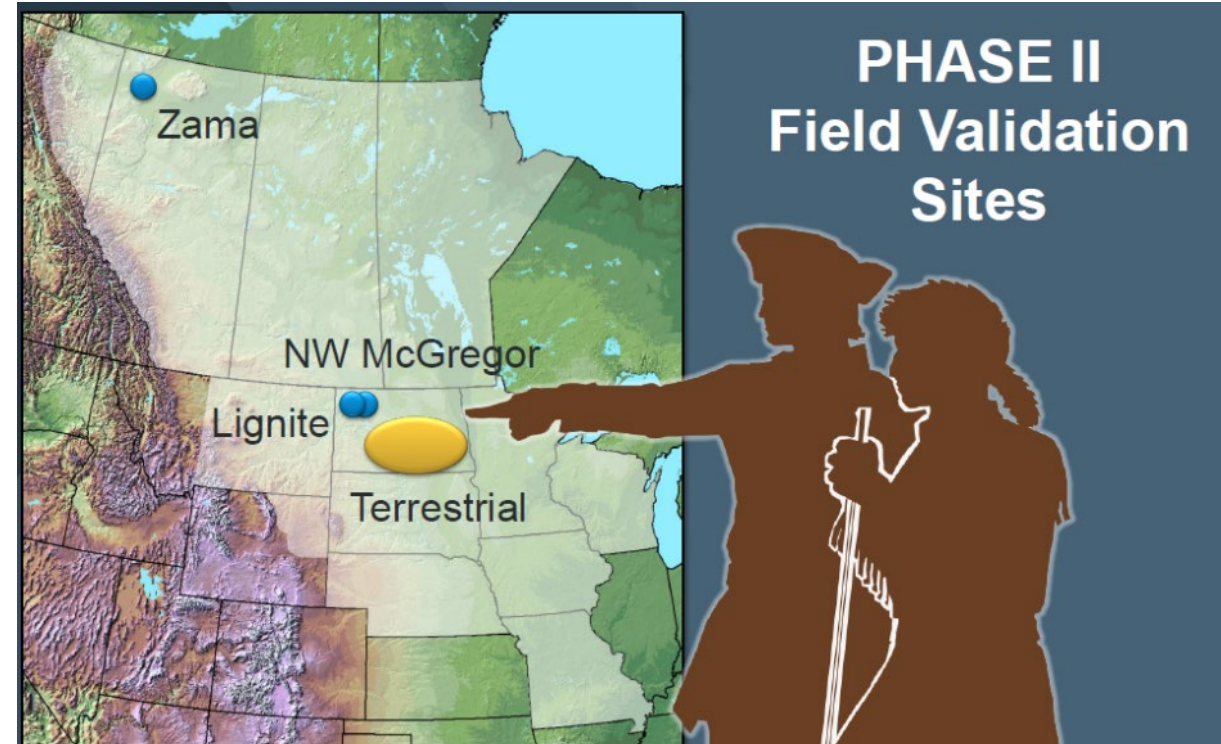


PHASE 2: FIELD VALIDATION 2005-2008



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

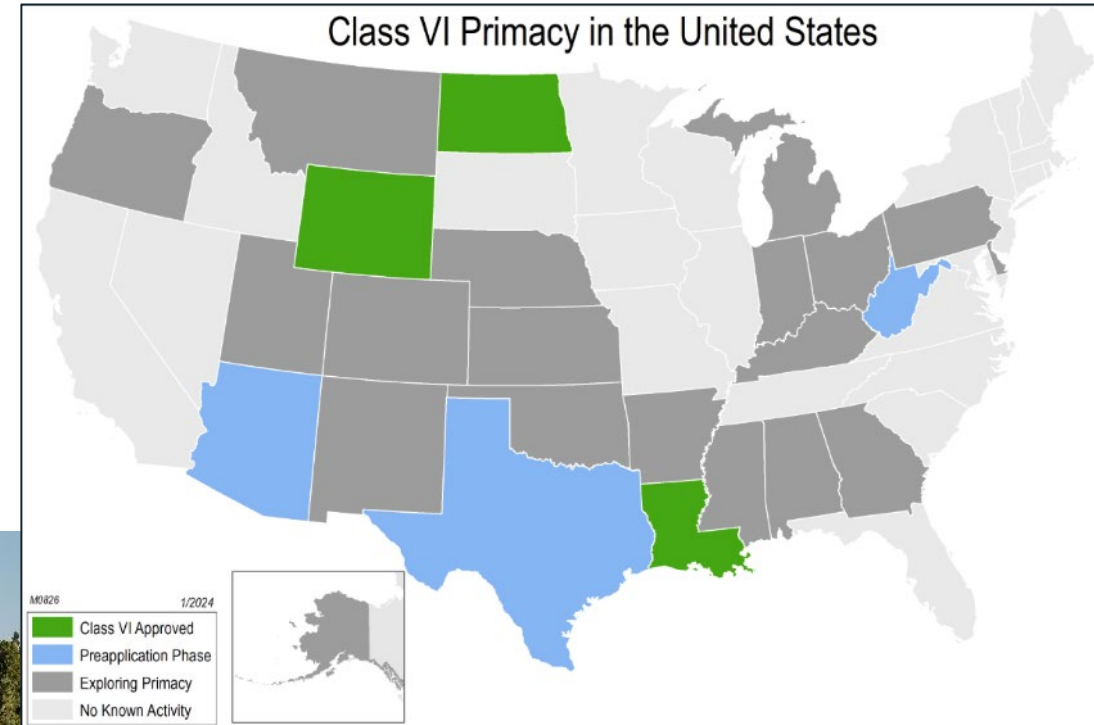


Key to Success: Active Participation of PCOR Partners

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

Regulatory Roundup Meeting
Deadwood, South Dakota
July 2023



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



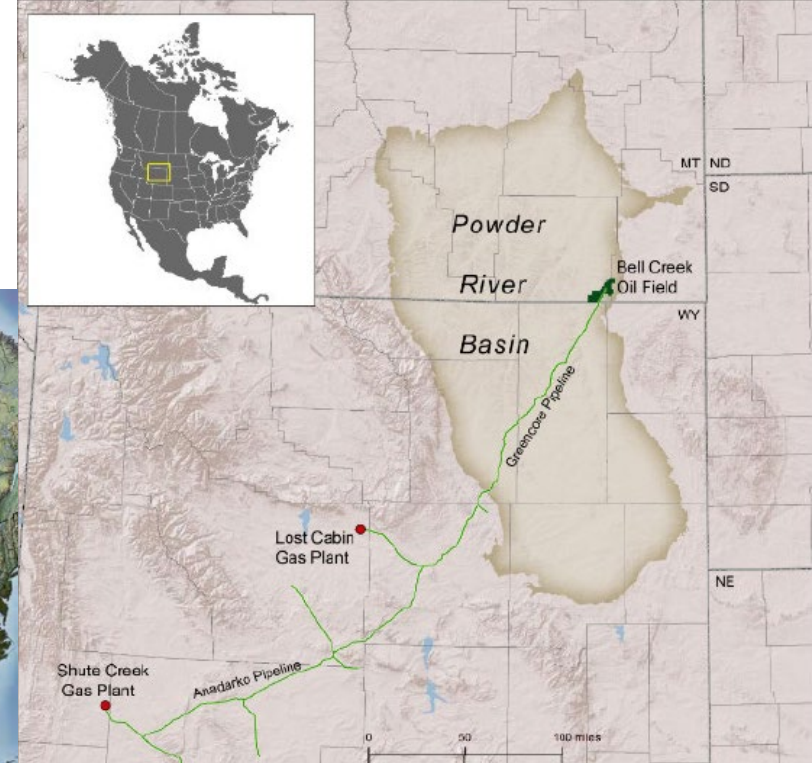
Aurora Award
Gold Winner
2009

PHASE III: COMMERCIAL DEMONSTRATION 2007-2019



COMMERCIAL DEMONSTRATION 1 MILLION TONNES OR BUST!

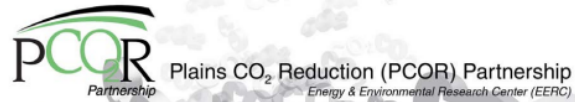
- Worked with industrial partners to develop two commercial-scale CCUS demonstrations.
 - Fort Nelson Demonstration
 - ◆ Storage of CO₂ from a natural-gas processing facility within a deep carbonate saline formation
 - Bell Creek Field Demonstration
 - ◆ Associated CO₂ storage from commercial EOR operations



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



CCUS BEST PRACTICE MANUALS



BEST PRACTICES MANUAL (BPM) FOR SITE CHARACTERIZATION

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

Prepared for:

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Cooperative Agreement No. DE-FC26-05NT42592

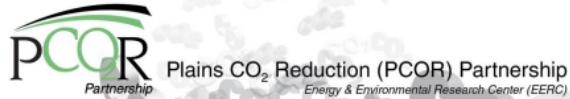
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March 2017
Approved

2017-EERC-06-08



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

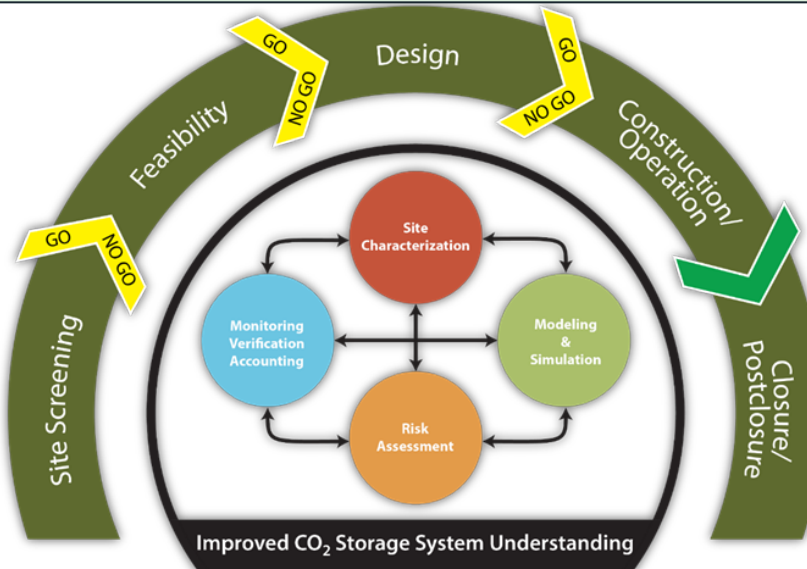
Plains CO₂ Reduction Partnership Phase III
Task 13 – Deliverable D103

Prepared for:

Andrea M. Dunn

National Energy Technology Laboratory

PCOR Adaptive Management Approach



BEST PRACTICES MANUAL – MONITORING FOR CO₂ STORAGE

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

Prepared for:

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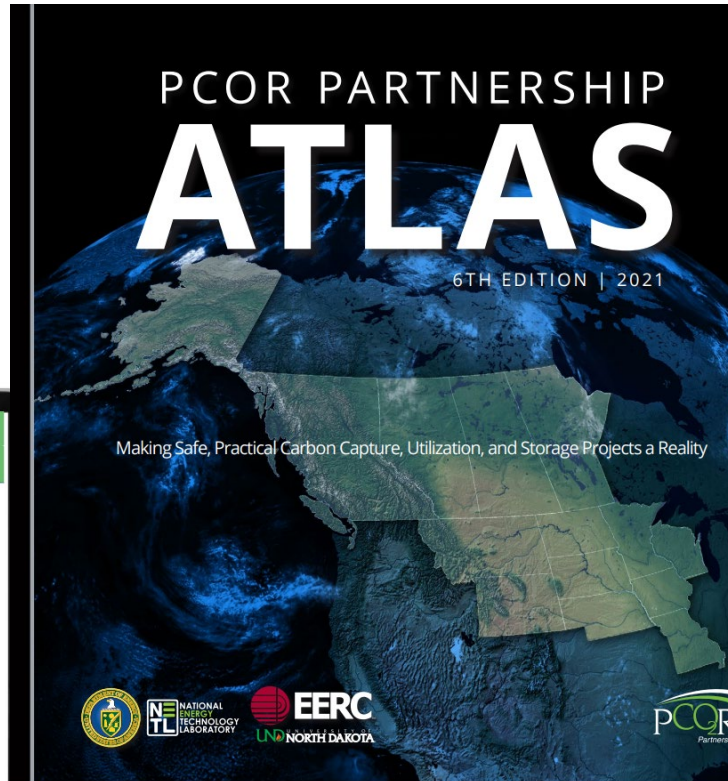
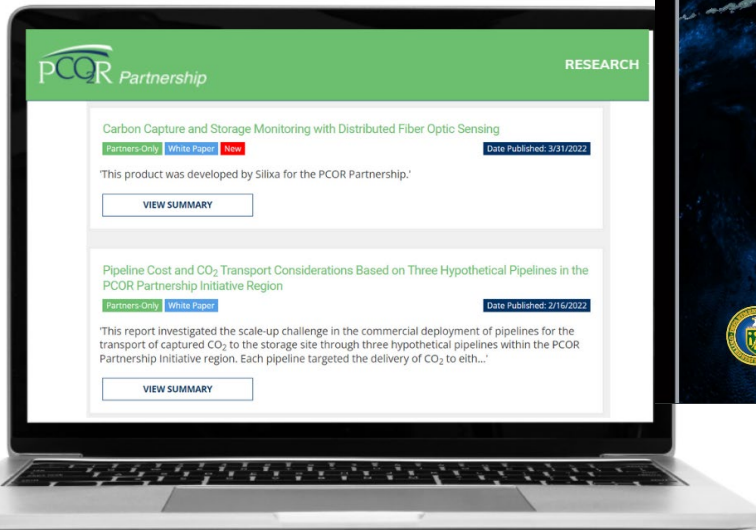
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2018-EERC-03-15

PCOR PARTNERSHIP PRODUCTS



Available online to all
partners at
undeerc.org/PCORPartners



Critical Challenges. Practical Solutions.

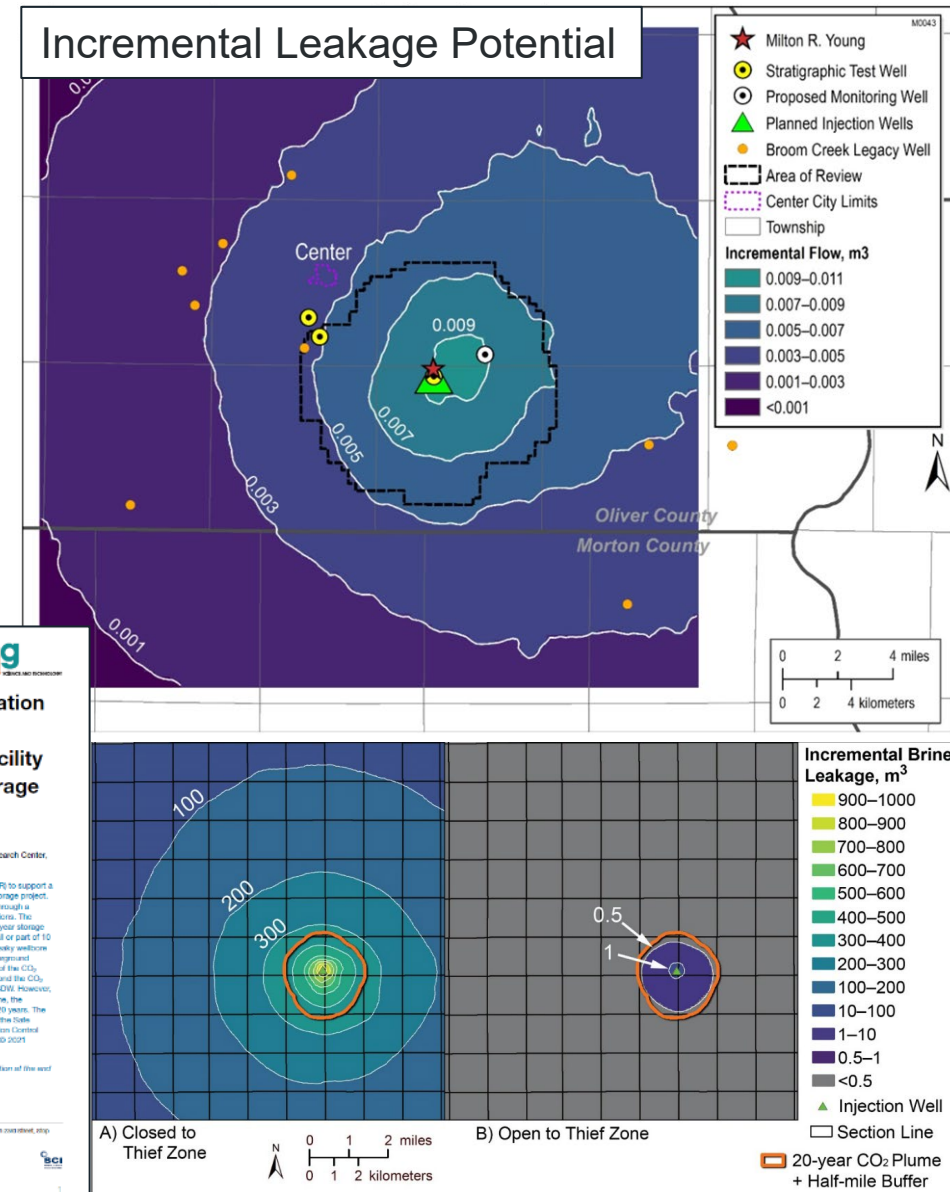
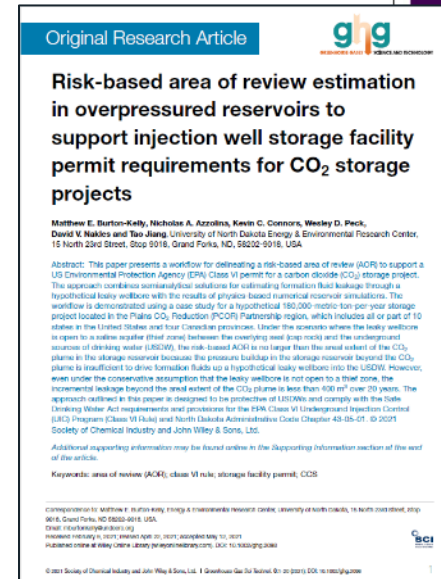
COMMERCIAL DEPLOYMENT CCUS IN THE PCOR REGION TODAY



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.

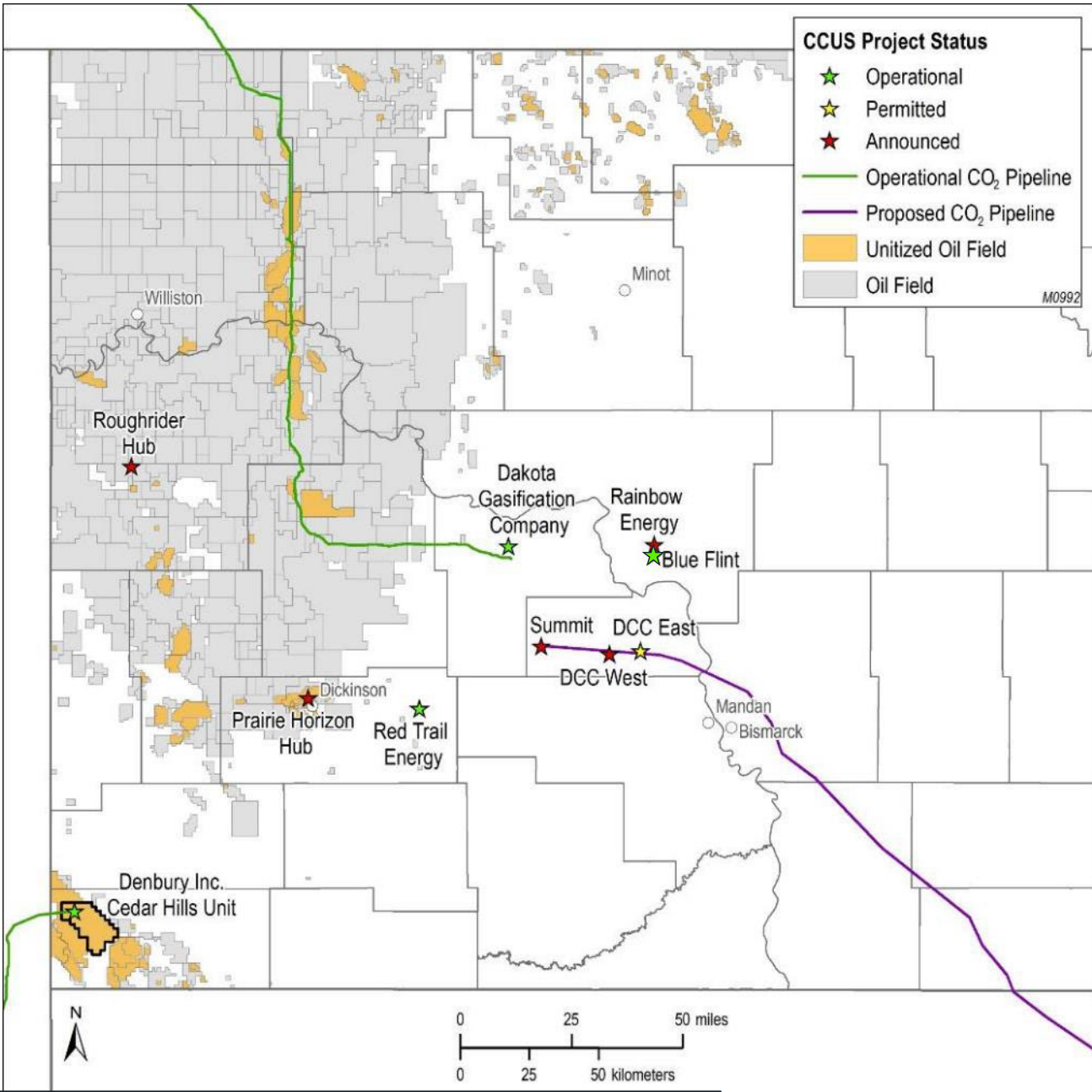
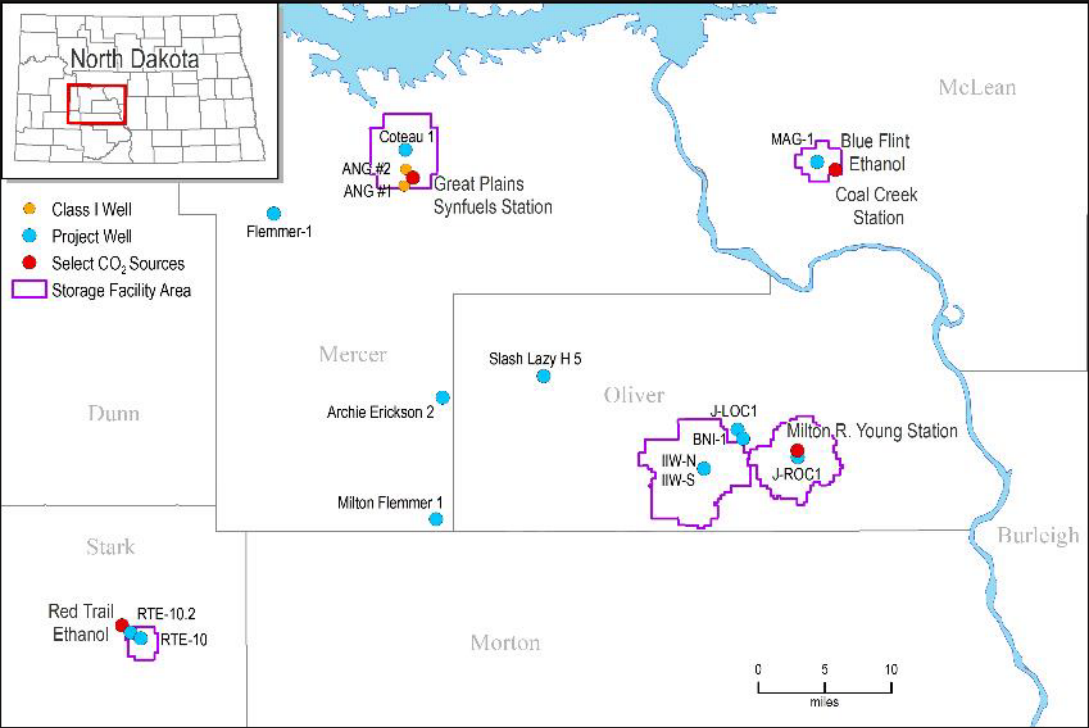
Burton-Kelly, M.E., Azzolina, N.A., Connors, K.C., Peck, W.D., Nakles, D.V., and Jiang, T., 2021, Risk-based area of review estimation in overpressured reservoirs to support injection well storage facility permit requirements for CO₂ storage projects: Greenhouse Gases: Science and Technology, v. 11, 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

Active and Developing CCUS Projects in the PCOR Partnership Region

- Active Capture
- ▲ Active Injection
- Developing Capture*
- ▼ Developing Injection**
- CO₂ Pipeline
- Active
- Planned

ACTL = Alberta Carbon Trunk Line
CCA = Cedar Creek Anticline (ND/MT border)
EWSH = Eastern Wyoming Sequestration Hub
* Not all Developing Capture are shown on map
** May also be partially permitted

Proposed Alberta CCUS Hubs

- | | |
|----------------------------|--------------------------------|
| 1. Grande Prairie Net Zero | 14. Alberta Carbon Grid |
| 2. Greenview Region | 15. Atlas Carbon Sequestration |
| 3. Grande Prairie CCS | 16. Wolf Midstream |
| 4. Maskwa | 17. Battle River |
| 5. Athabasca Banks | 18. Central Alberta |
| 6. Opal Carbon | 19. Ram River |
| 7. Rocky Mountain | 20. Bow River |
| 8. Tourmaline Clearwater | 21. Rolling Hills |
| 9. Brazeau | 22. North Drumheller |
| 10. Oil Sands Pathways | 23. Pincher Creek |
| 11. Meadowbrook | 24. Clear Horizon |
| 12. Open Access Wabamun | 25. East Calgary Region |
| 13. Origins | Carbon Sequestration |

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.**



Critical Challenges. Practical Solutions.

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



Institute of Northern Engineering
University of Alaska Fairbanks



School of Energy Resources

August 27–28, 2024, BISMARCK, NORTH DAKOTA



ACKNOWLEDGMENT

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A wide-angle photograph of a university campus at sunset. The sun is low on the left, casting a warm glow over the scene. In the foreground, there are trees with yellowing leaves. In the background, there are several large, multi-story brick buildings, likely university halls or administrative buildings, and a parking lot filled with cars.

THANK YOU!

Critical Challenges. Practical Solutions.