Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

Large-Scale CCS Projects and the Role of Research and Development in CCS Commercialization in North Dakota, U.S.A.

CCS Technical Workshop 2026

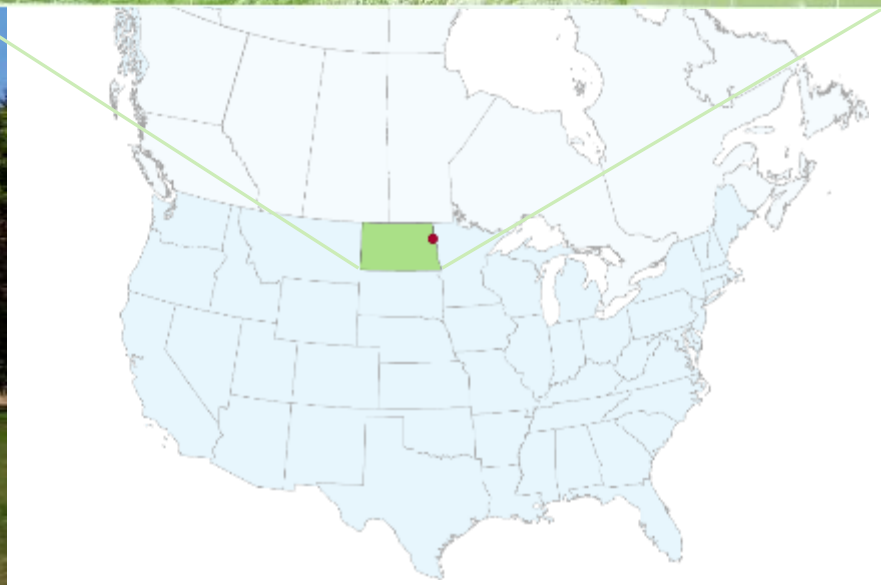
Tokyo, Japan

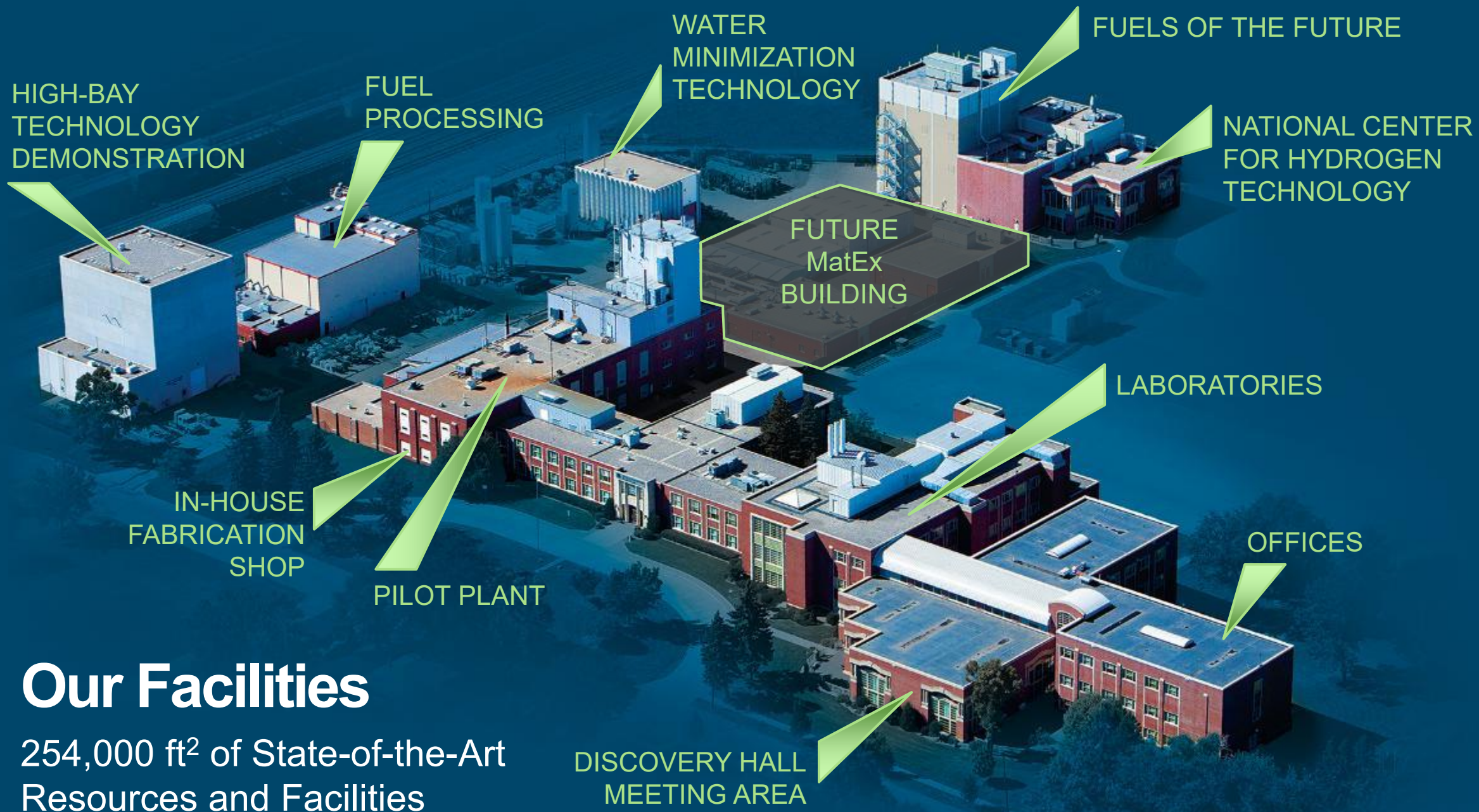
January 21, 2026

Kevin C. Connors

Assistant Director for Regulatory Compliance and Energy Policy

Energy & Environmental Research Center (EERC)





Our Facilities

254,000 ft^2 of State-of-the-Art Resources and Facilities

COLLABORATIVE APPROACH

TRUSTED, DYNAMIC, WORKING RELATIONSHIPS WITH INDUSTRY, GOVERNMENT, AND RESEARCH ENTITIES WORLDWIDE.

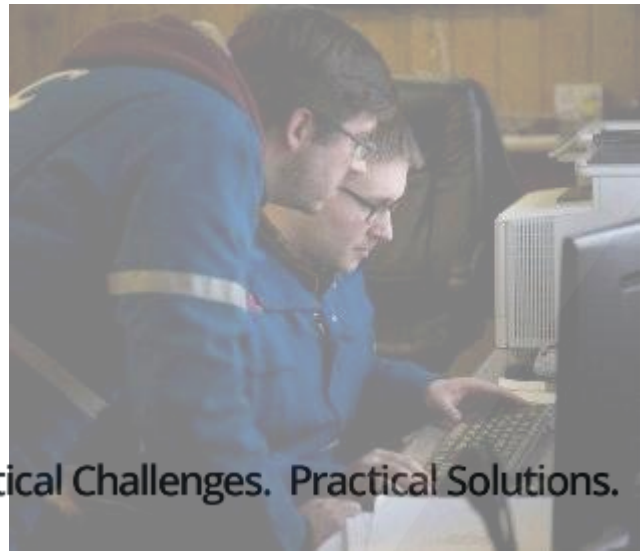



CORE RESEARCH PRIORITIES

- Coal Utilization & Emissions
- Carbon Management
- Oil & Gas
- Alternative Fuels & Renewable Energy
- Energy–Water


EERC | UND UNIVERSITY OF NORTH DAKOTA | PCOR Partnership

ADVANCING CCS THROUGH INDUSTRY GOVERNMENT COLLABORATION



Critical Challenges. Practical Solutions.

EERC | UND UNIVERSITY OF NORTH DAKOTA | PCOR Partnership

U.S. DEPARTMENT OF ENERGY (DOE)

REGIONAL CARBON SEQUESTRATION PARTNERSHIP (RCSP) PROGRAM

EERC | UND UNIVERSITY OF NORTH DAKOTA | PCOR Partnership

PCOR PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

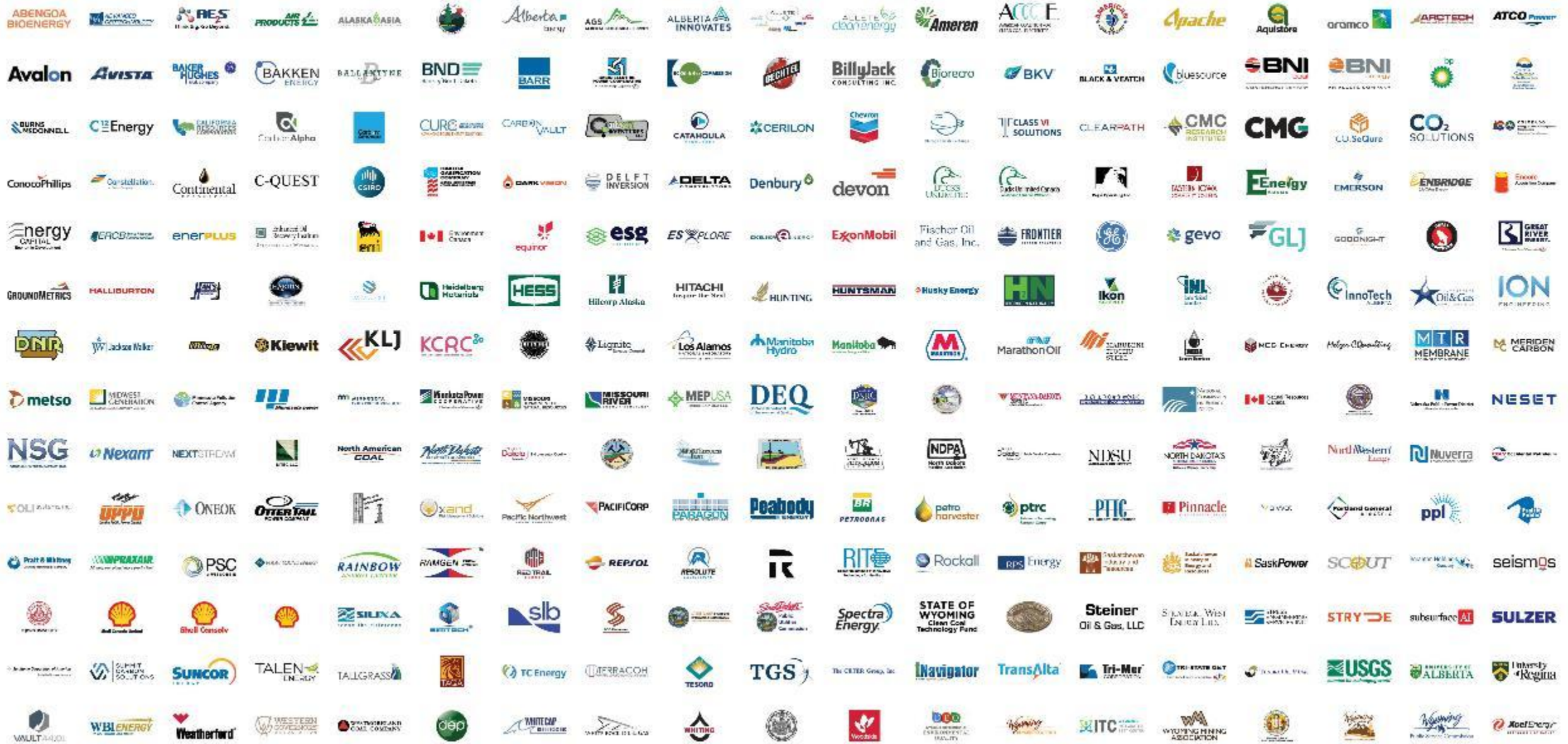
2019+ – PCOR Partnership: Commercial Deployment

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

EERC | UND UNIVERSITY OF NORTH DAKOTA | PCOR Partnership

PCO2R Partnership — PARTNERSHIP MEMBERS

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY | EERC UNIVERSITY OF NORTH DAKOTA | North Dakota Industrial Commission | UAF Institute of Northern Engineering, University of Alaska Fairbanks | University of Wyoming, School of Energy Resources



The logos displayed represent current and prior member organizations to recognize their contribution to building the technical foundation of the PCOR Partnership Program.

09/25

PARTNERSHIP MEMBERS

The logos displayed represent current and prior member organizations to recognize their contribution to building the technical foundation of the PCOR Partnership Program.

PCO2R Partnership

MAKING SAFE, PRACTICAL CCUS PROJECTS A REALITY


Industry-Government Partnership that shares a common goal: Accelerate commercial deployment of CCUS.
infor
PCO2R Partnership
MAKING SAFE, PRACTICAL CCUS PROJECTS A REALITY

PCOR PARTNERSHIP

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

- Strengthening the technical foundation for geologic CO_2 storage and enhanced oil recovery (EOR).
- Advancing capture technology.
- Improving application of monitoring technologies.
- Promoting integration between capture, transportation, use, and storage industries.
- Facilitating development of regulatory frameworks.
- Providing scientific support to policy makers.
- Engaging the public through outreach and education.

Our partners inform our priorities.

REGIONAL SOURCES AND SEDIMENTARY BASINS

PROJECTS IN THE PCOR PARTNERSHIP REGION

Critical Challenges. Practical Solutions.

REGIONAL ACTIVITY

40 years of CCUS Operations
>1600 miles of CO_2 Pipeline
~ 180 million tonnes of CO_2 Stored**

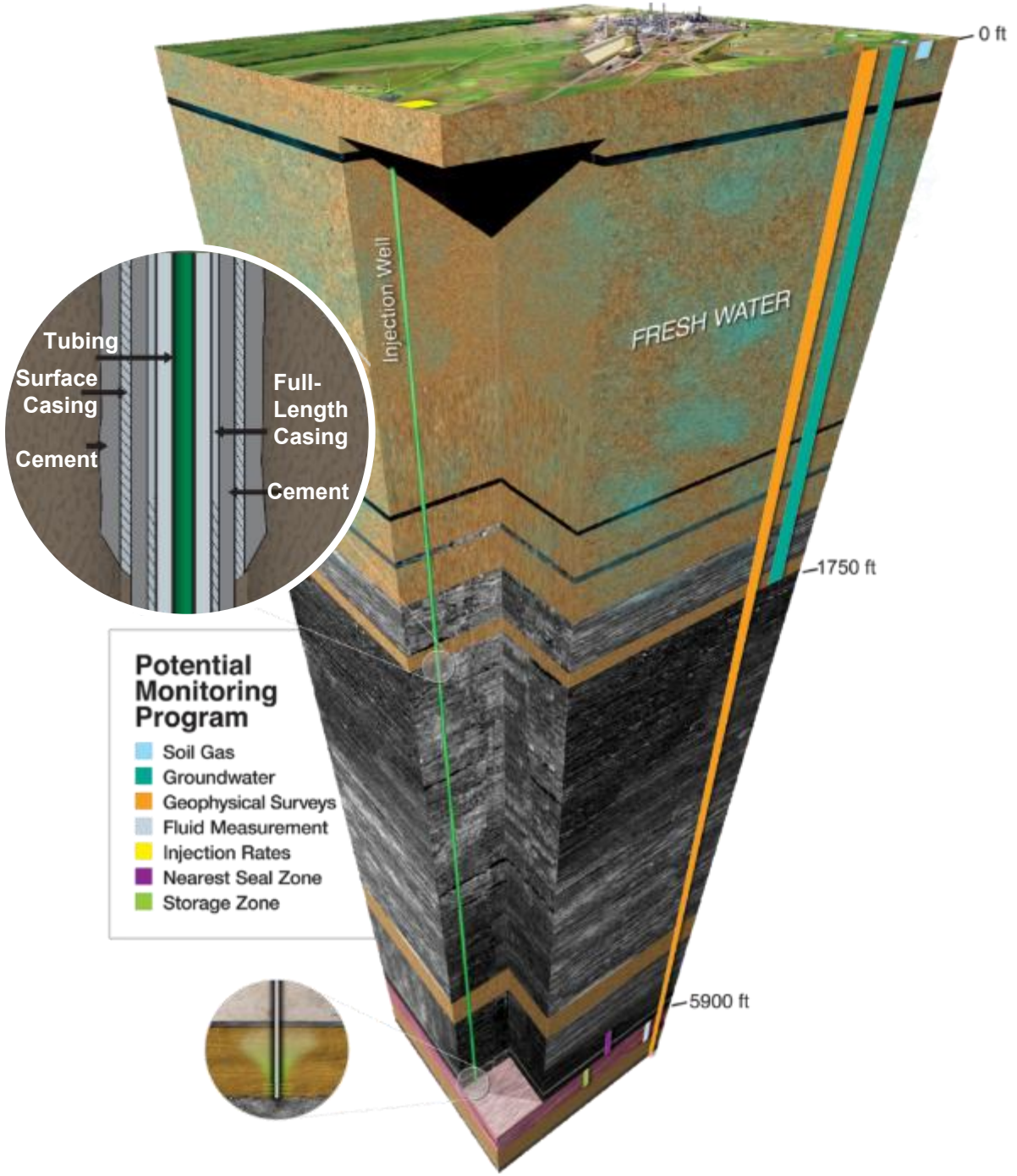
Project	Net CO_2 Stored,* tonnes
Bell Creek EOR	11,900,000*
Blue Flint	383,933**
Cedar Creek Anticline EOR	4,000,000*
DGC Beulah	2,629,068**
U.S. Regional Pilots and Field Tests	> 2,000*
Aquistore	585,000*
Quest	> 9,000,000*
Gevo Richardton CCS	577,485**
Weyburn	> 40,000,000*
Wyoming EOR	97,000,000*
Shute Creek Class II AGI	6,100,000*
Canadian Pilots and other EOR	7,024,000*

US UIC Class VI Projects

* Calculated estimate.
**Tonnes stored as of Dec. 2025.

CARBON CAPTURE, UTILIZATION AND STORAGE POLICY AND REGULATIONS

ENSURING HUMAN SAFETY AND PROTECTING GROUNDWATER



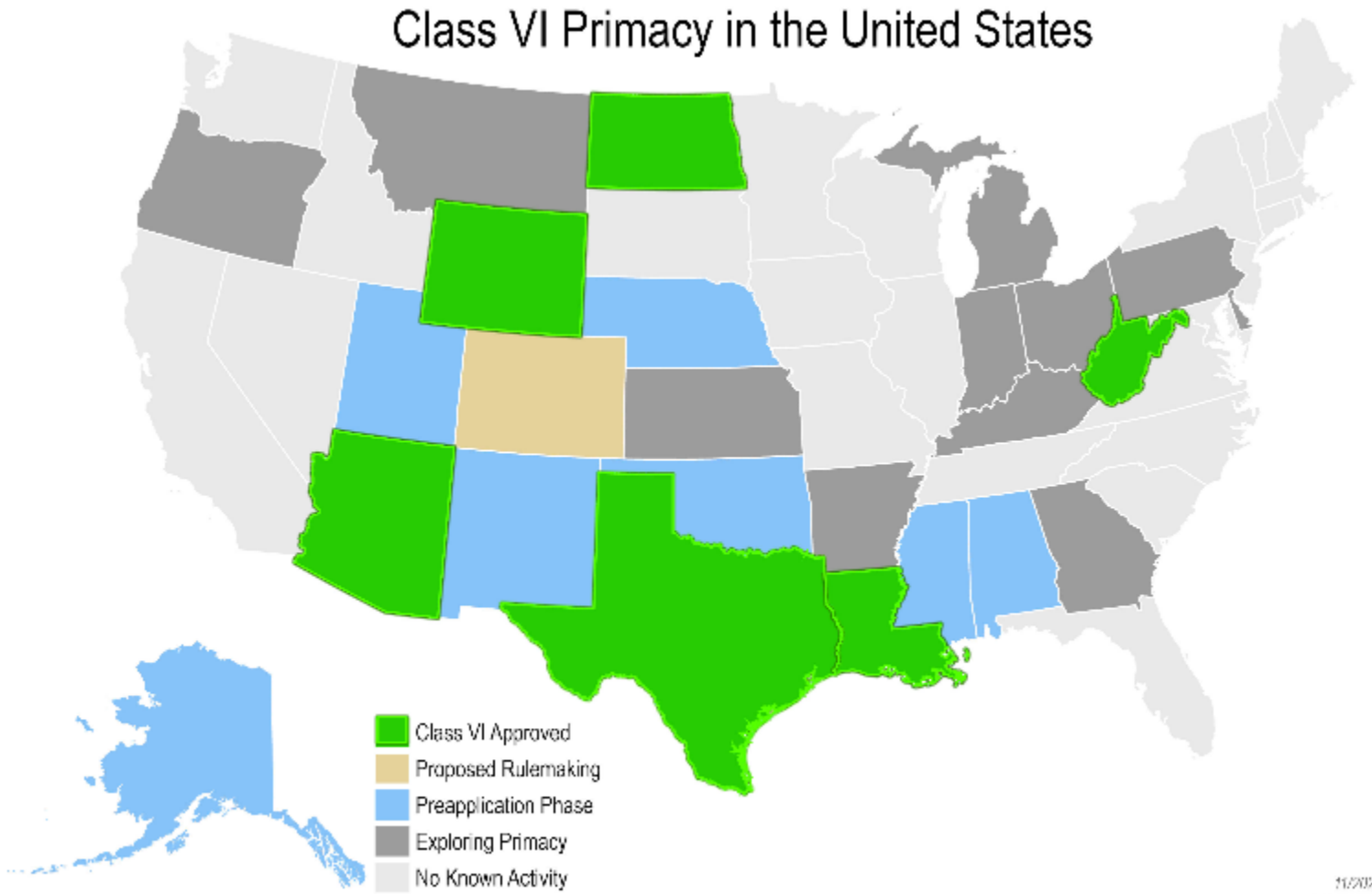
REGULATORY ENGAGEMENT

The Regulatory Roundup is a forum for sharing and coordinating regulatory strategies to accelerate commercial deployment of CCUS.

The goal of the meeting is to facilitate the development of prudent regulatory frameworks.

STATES WITH PRIMARY REGULATORY AUTHORITY

- North Dakota (2018)
- Wyoming (2020)
- Louisiana (2024)
- West Virginia (2025)
- Arizona (2025)
- Texas (2025)



STATE AND FEDERAL INCENTIVES

45Q Tax Credits

- Projects beginning construction before January 1, 2033, can claim credits for 12 years after operations begin.
- Provides for direct payment for 45Q credits.
- Tax credit for CO_2 stored in a qualified EOR project: $85/tonne.
  - Tax credit from direct air capture (DAC): $180/tonne.
- Tax credit for CO_2 stored in a saline formation: $85/tonne.
  - Tax credit from DAC: $180/tonne.

West Coast LCFS Markets

- Credits trading up to $54 per ton (Jan. 2026).
- Stacked with 45Q.

North Dakota Incentives

- No sales tax on capture-related infrastructure.
- No sales tax on CO_2 sold for EOR.
- No sales tax on construction of pipeline.
- Property tax-exempt for 10 years (equipment).
- Coal conversion tax: tax reduction with CO_2 capture (up to 50%).
- No sales tax on CO_2 EOR infrastructure.
- 0% extraction tax for 20 years for CO_2 EOR.

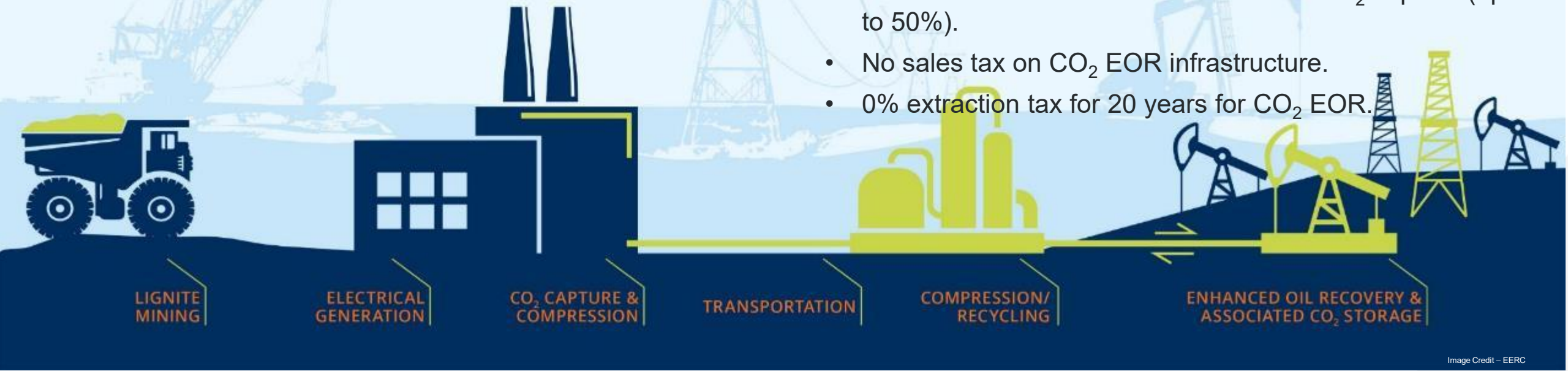


Image Credit – EERC

Carbon Storage Assurance Facility Enterprise (CarbonSAFE)

- Began in 2016
- Build upon the knowledge and experience of the Regional Carbon Sequestration Partnerships' (RCSPs)
- Address key gaps toward carbon capture and storage (CCS) deployment.
- Understand the development of a CCS storage complex, from feasibility study to injection, through the 4 phases.
- Reduce technical risk, uncertainty, and the cost of commercial-scale saline storage projects.
- Improve understanding of project screening; site selection; characterization; baseline monitoring, verification and accounting (MVA) procedures

CARBONSAFE: FOUR MAIN PHASES

Phase I: Integrated CCS Prefeasibility

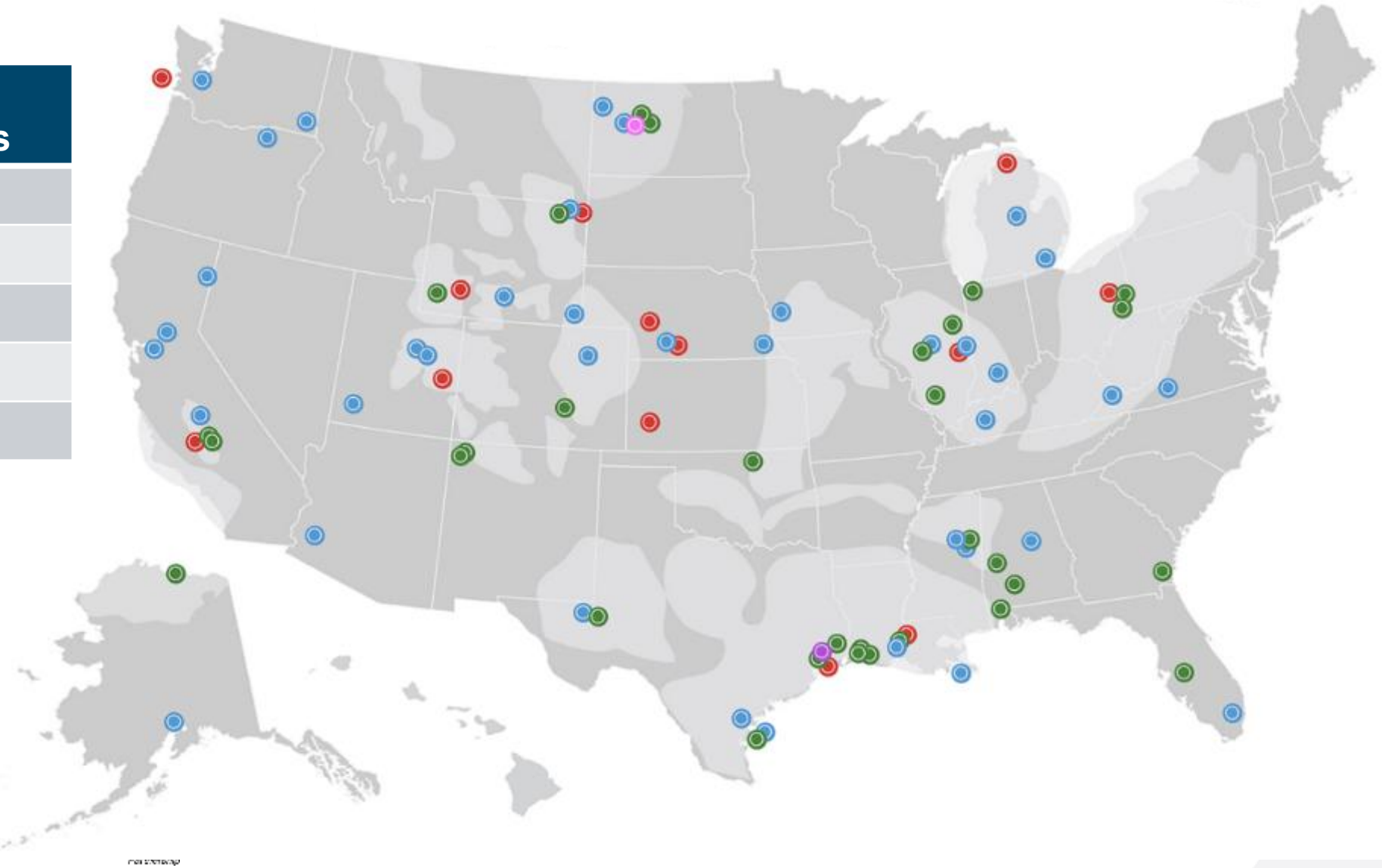
Phase III: Site Characterization and Permitting

Phase II: Storage Complex Feasibility

Phase IV: Construction

U.S. DOE CARBONSAFE TOTAL PROJECTS: 83

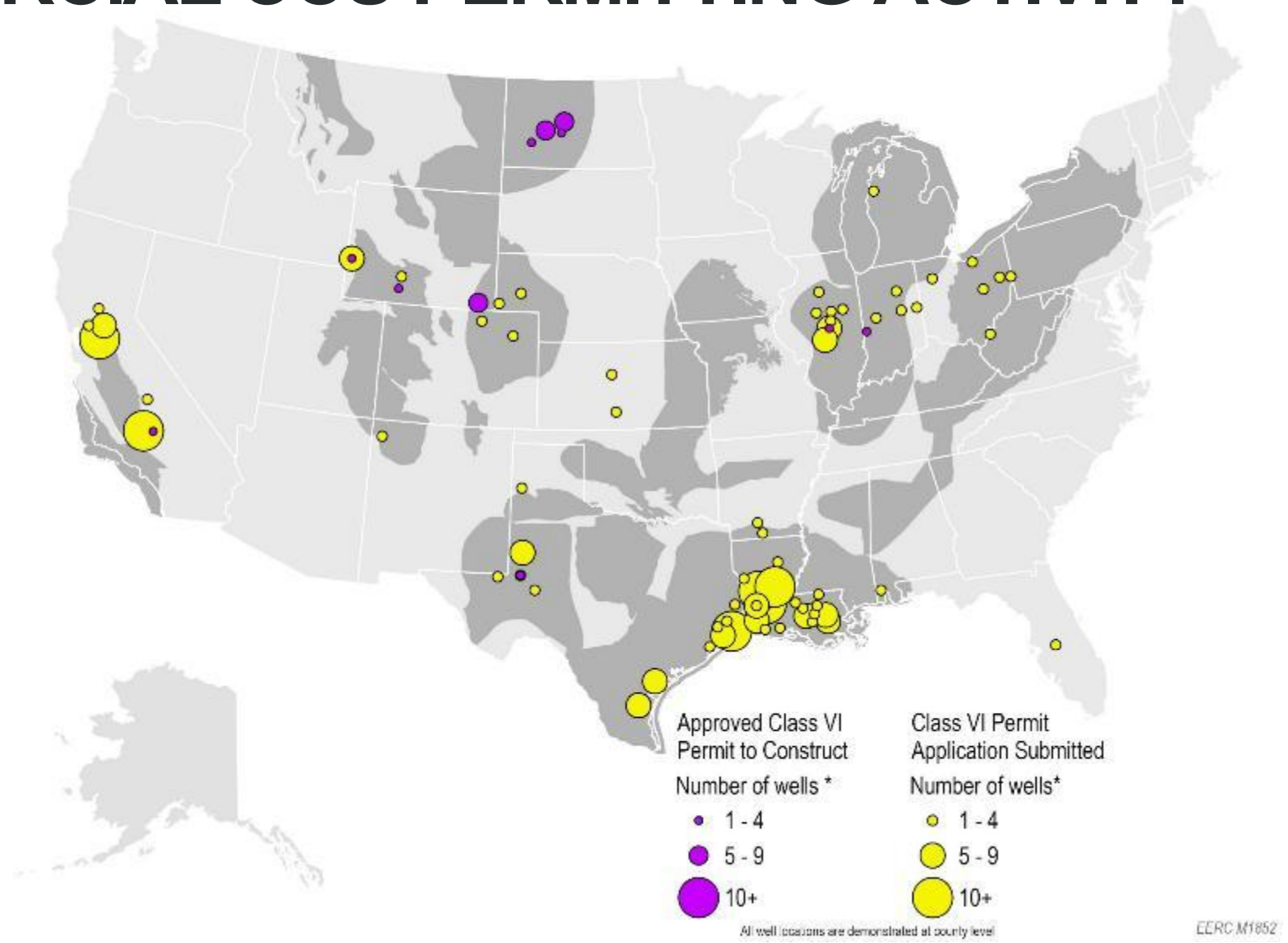
CarbonSAFE Phase	No. of Projects
I	13
II	38
III	30
III.5*	1
IV	1

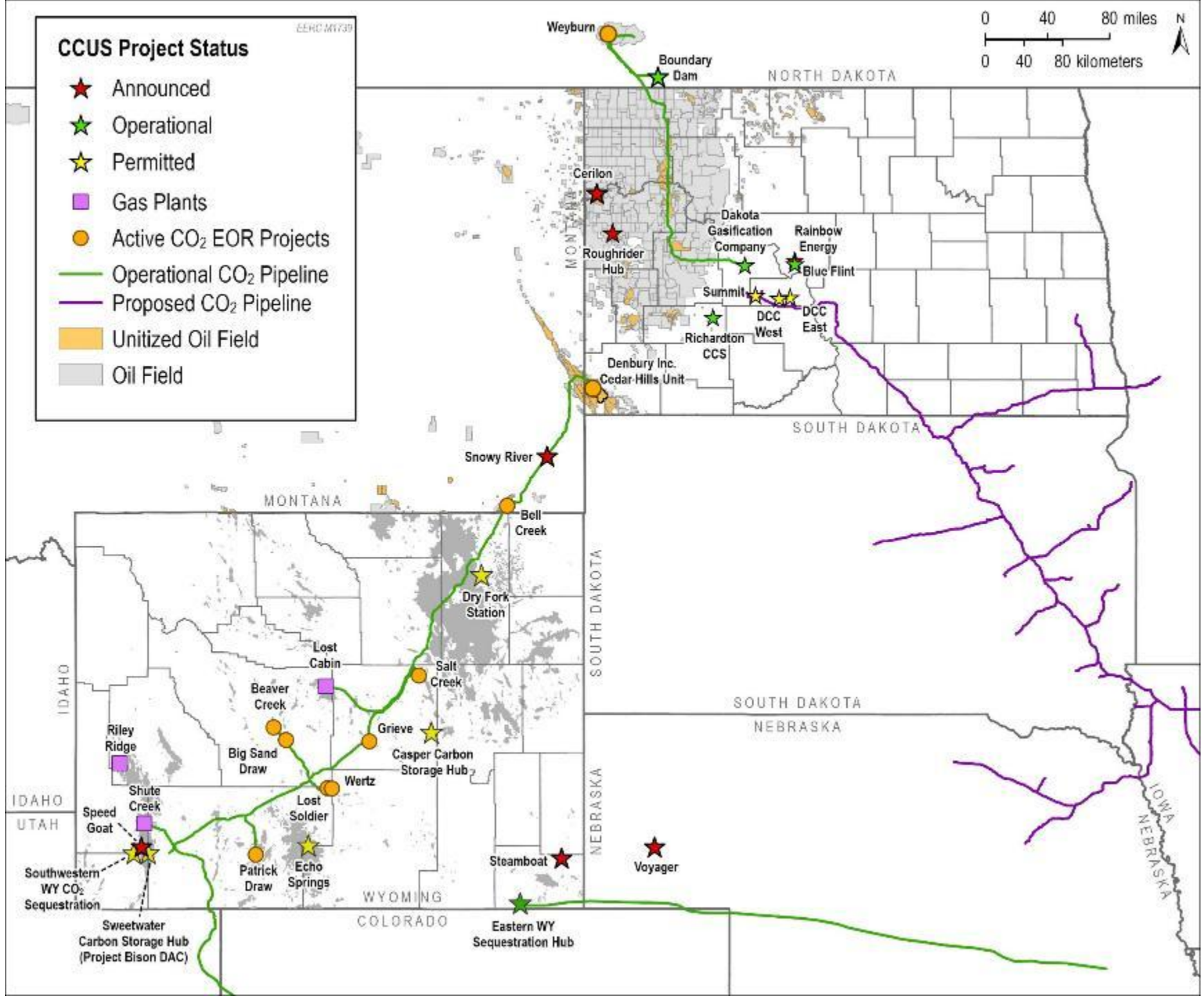


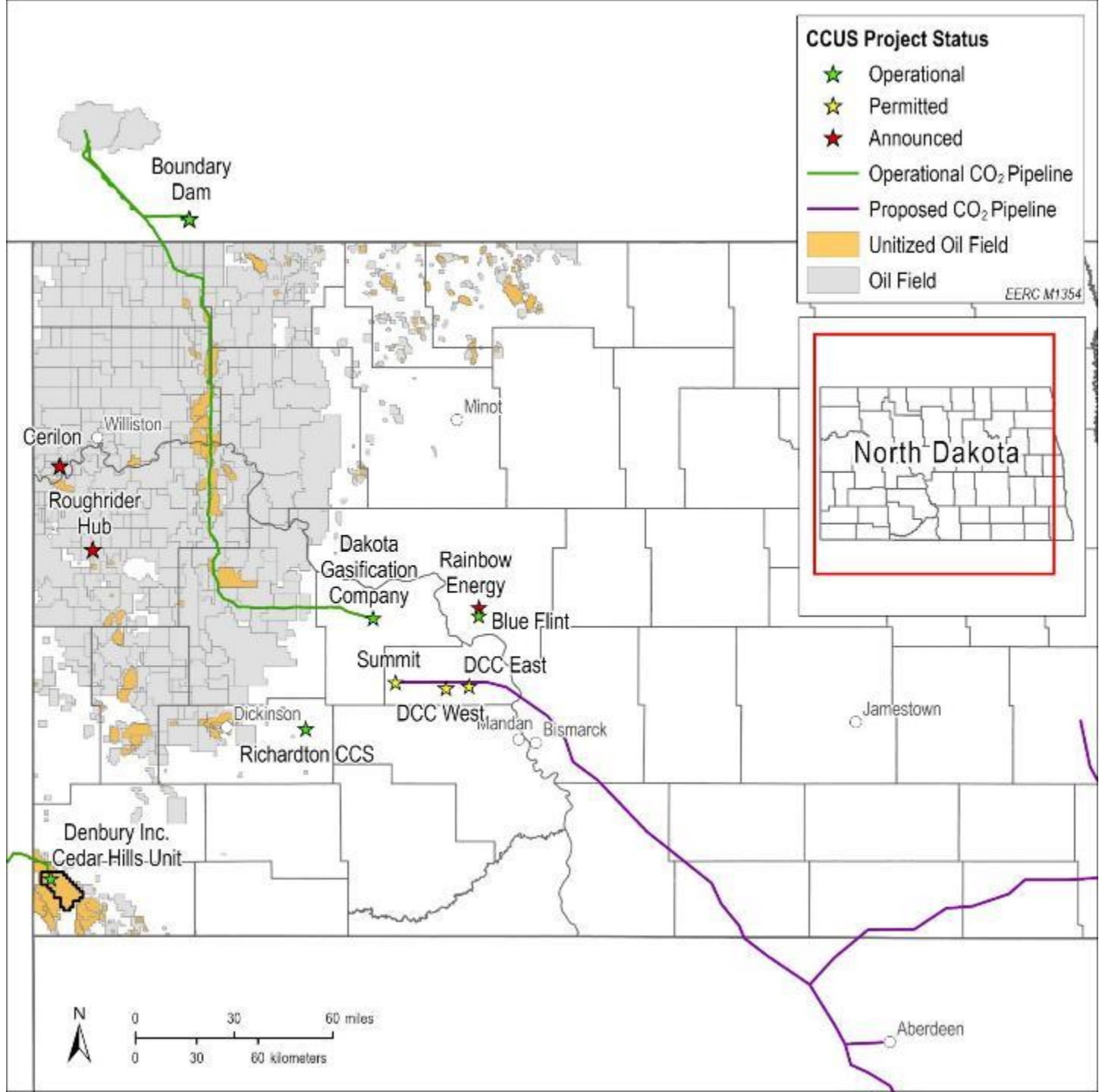
*Storage Development Plan and Front-End Engineering Design Study

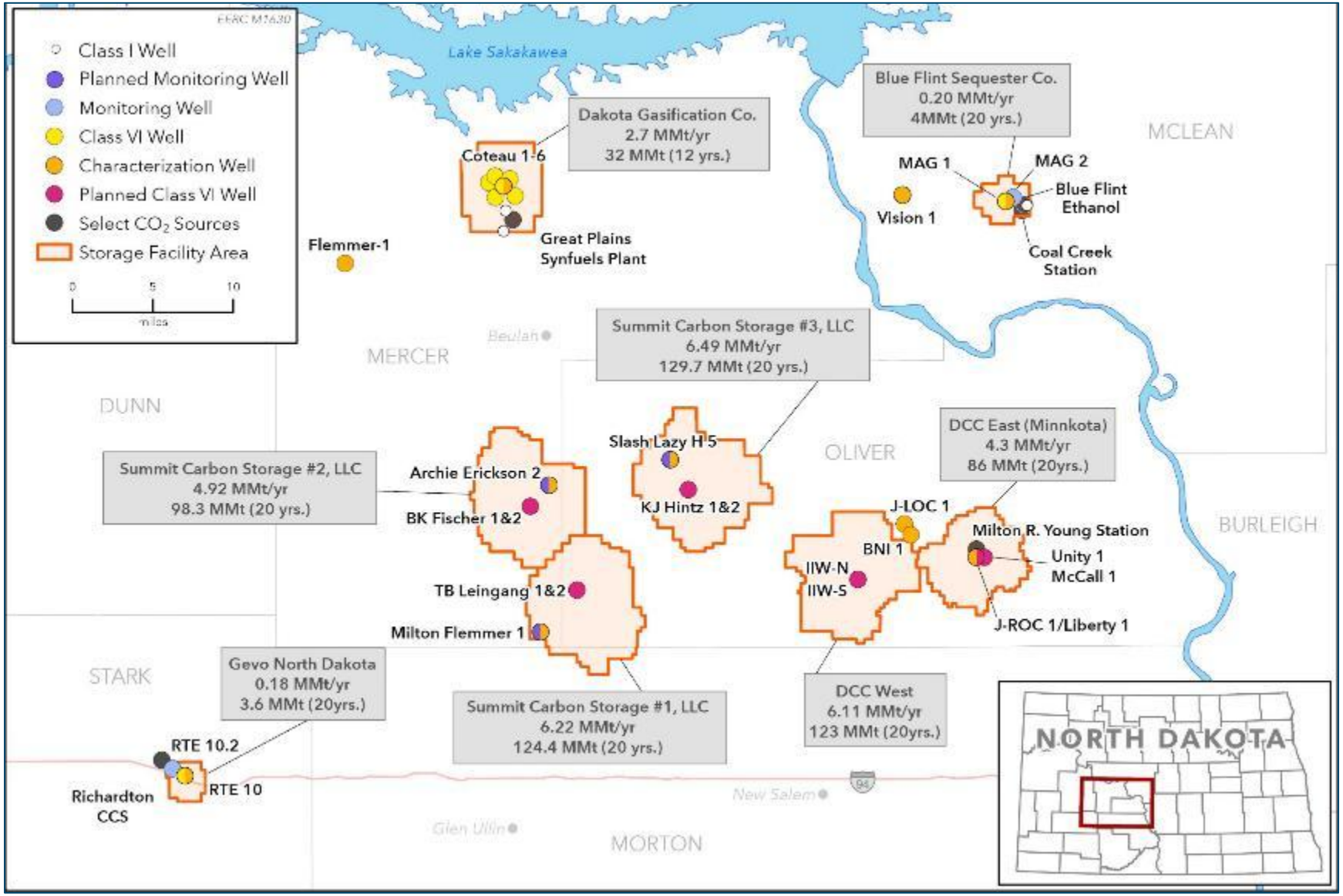
EERC | UND UNIVERSITY OF NORTH DAKOTA

COMMERCIAL CCS PERMITTING ACTIVITY




CCUS Project Status
Announced
Operational
Permitted
Gas Plants
Active CO_2 EOR Projects
Operational CO_2 Pipeline
Proposed CO_2 Pipeline
Unitized Oil Field
Oil Field
0 40 80 miles
0 40 80 kilometers
N
Weyburn
Boundary Dam
NORTH DAKOTA
Cerilon
Roughrider Hub
Dakota Gasification Company
Rainbow Energy
Blue Flint
Summit
DCC West
DCC East
Richardton CCS
Denbury Inc. Cedar Hills Unit
SOUTH DAKOTA
Snowy River
MONTANA
Bell Creek
Dry Fork Station
Lost Cabin
Salt Creek
Beaver Creek
Grieve
Riley Ridge
Big Sand Draw
Casper Carbon Storage Hub
Wertz
Shute Creek
Lost Soldier
Speed Goat
Southwestern WY CO_2 Sequestration
Patrick Draw
Echo Springs
Steamboat
Voyager
Sweetwater Carbon Storage Hub (Project Bison DAC)
WYOMING
COLORADO
Eastern WY Sequestration Hub
IDAHO
UTAH
NEBRASKA
IOWA


CCUS Project Status
Operational
Permitted
Announced
Operational CO_2 Pipeline
Proposed CO_2 Pipeline
Unitized Oil Field
Oil Field
EERC M1354
North Dakota
Boundary Dam
Minot
Williston
Cerilon
Roughrider Hub
Dakota Gasification Company
Rainbow Energy
Blue Flint
Summit
DCC East
DCC West
Dickinson
Mandan
Bismarck
Jamestown
Richardton CCS
Denbury Inc. Cedar Hills Unit
Aberdeen
N
0 30 60 miles
0 30 60 kilometers

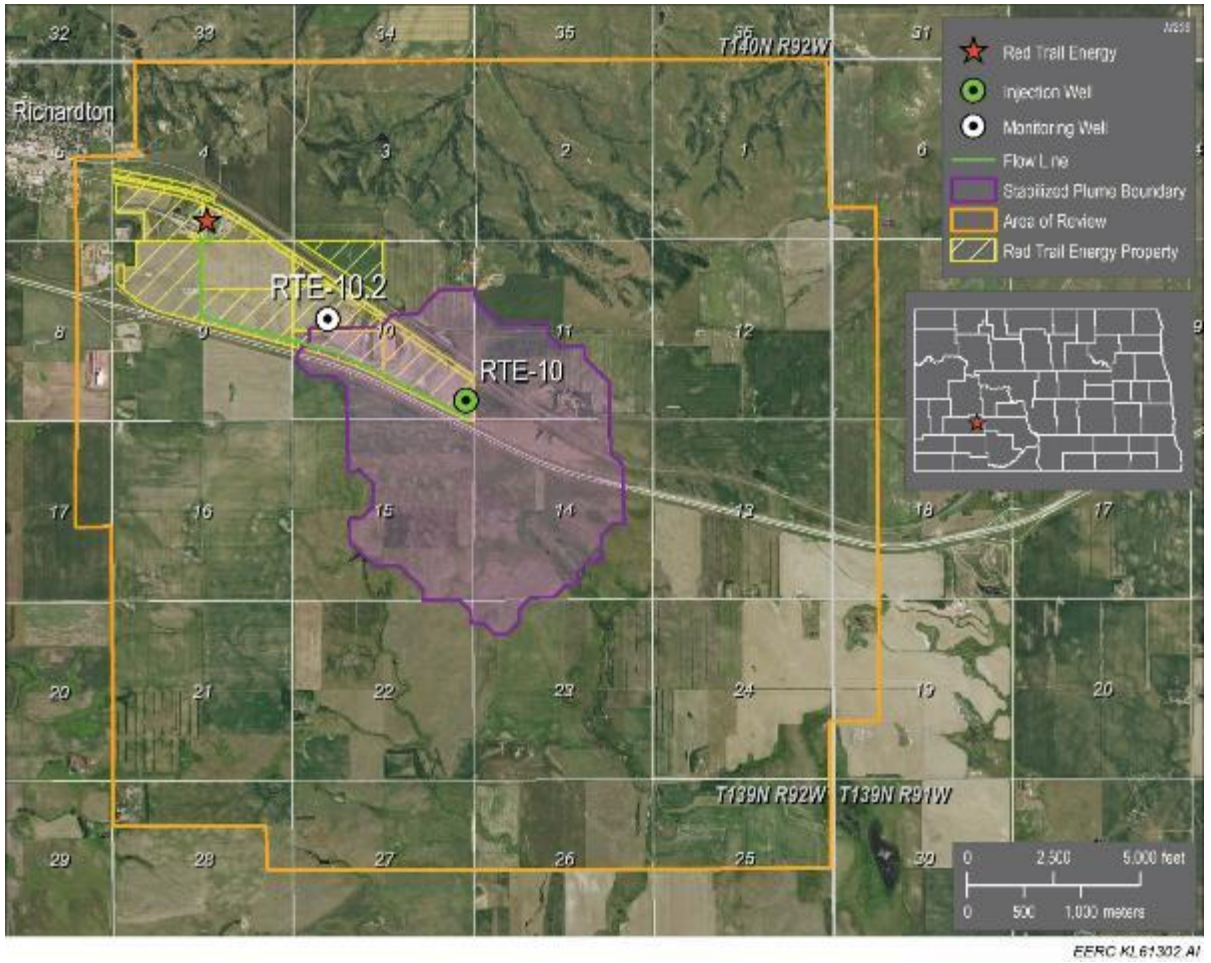

EERC M1630
Class I Well
Planned Monitoring Well
Monitoring Well
Class VI Well
Characterization Well
Planned Class VI Well
Select CO_2 Sources
Storage Facility Area
0 5 10
miles
Lake Sakakawea
Dakota Gasification Co.
2.7 MMt/yr
32 MMt (12 yrs.)
Coteau 1-6
Great Plains Synfuels Plant
Flemmer-1
Blue Flint Sequester Co.
0.20 MMt/yr
4MMt (20 yrs.)
MAG 1
MAG 2
Blue Flint Ethanol
Vision 1
Coal Creek Station
MCLEAN
Summit Carbon Storage #3, LLC
6.49 MMt/yr
129.7 MMt (20 yrs.)
Beulah
MERCER
DUNN
Summit Carbon Storage #2, LLC
4.92 MMt/yr
98.3 MMt (20 yrs.)
Archie Erickson 2
BK Fischer 1&2
Slash Lazy H 5
KJ Hintz 1&2
OLIVER
DCC East (Minnkota)
4.3 MMt/yr
86 MMt (20yrs.)
J-LOC 1
BNI 1
IIW-N
IIW-S
Milton R. Young Station
Unity 1
McCall 1
J-ROC 1/Liberty 1
BURLEIGH
TB Leingang 1&2
Milton Flemmer 1
Gevo North Dakota
0.18 MMt/yr
3.6 MMt (20yrs.)
STARK
Summit Carbon Storage #1, LLC
6.22 MMt/yr
124.4 MMt (20 yrs.)
DCC West
6.11 MMt/yr
123 MMt (20yrs.)
RTE 10.2
RTE 10
Richardton CCS
New Salem
94
Glen Ullin
MORTON
NORTH DAKOTA


gevo®
Capture Facility: Ethanol Plant
Annual Injection Volume: 180,000 metric tons
Injection Permit Approved: 2022
Injected Volume: 577,485*
*Through 12/2025

RICHARDTON CCS PROJECT OVERVIEW

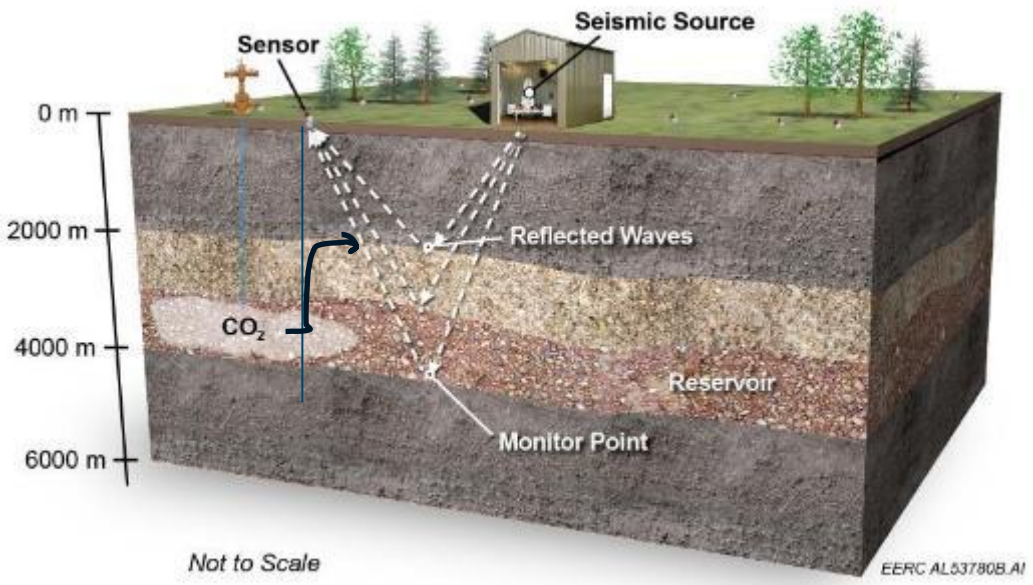
- Gevo owns and operates an ethanol plant near Richardton, ND that captures 180,000 tonnes of CO_2 annually.

- Gevo complies with several permits and incentive programs, including:
  - North Dakota's Class VI permit;
  - U.S. Environmental Protection Agency's (EPA) Subpart RR monitoring, reporting, and verification (MRV) plan; and
  - Oregon's Clean Fuels Program.
  - Puro registry on the voluntary carbon market.

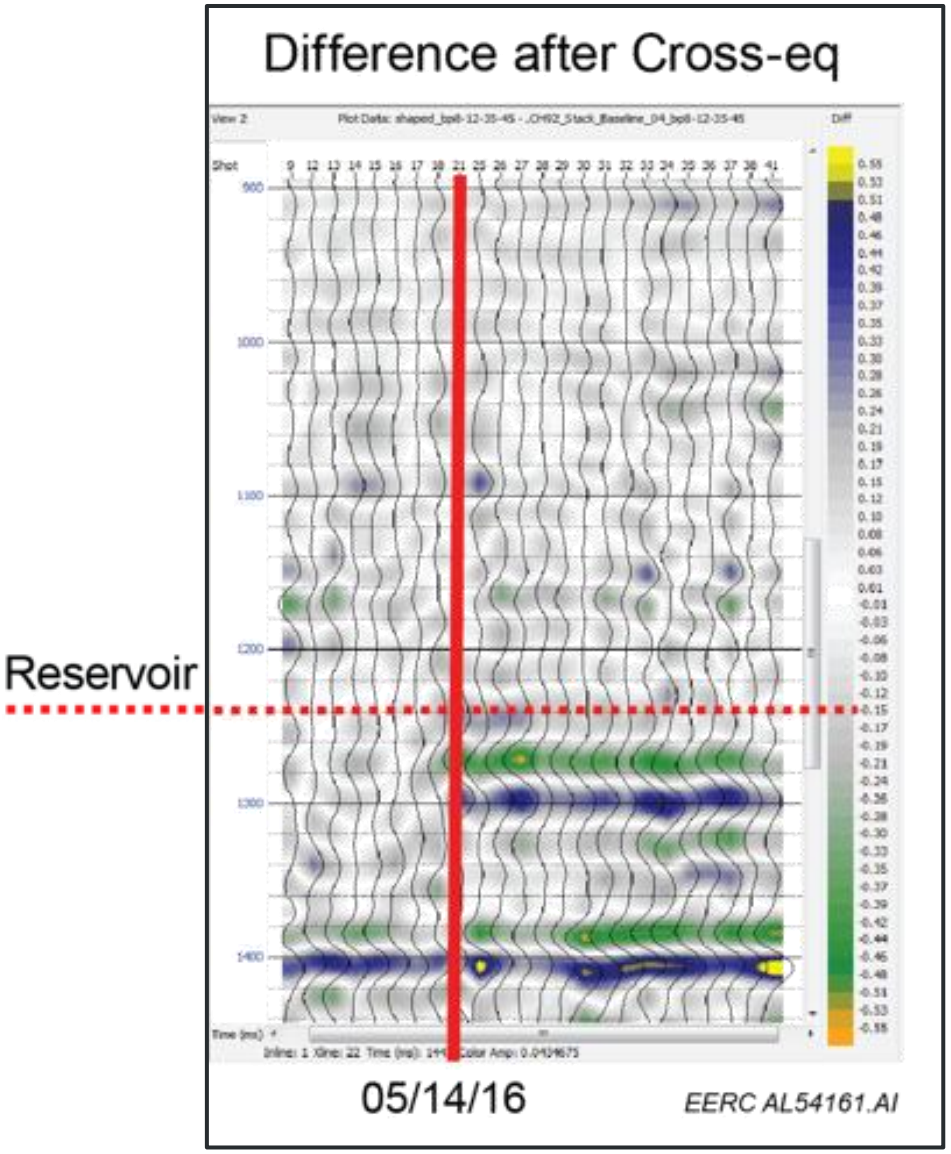


Source: RTE's approved North Dakota storage facility permit application

SCALABLE, AUTOMATED, SPARSE SEISMIC ARRAY (SASSA)



- Monitoring of strategically located subsurface discrete locations for understanding plume extents.
- Low-fold weekly reflection changes indicate change in CO_2 saturation.
- Integrate with dynamic reservoir simulations.
- **EERC team continued the development of SASSA in partnership with Red Trail Energy (GEVO) and Research for Innovative Technology of the Earth (RITE) to perform additional research at the Richardton CCS site in North Dakota.**



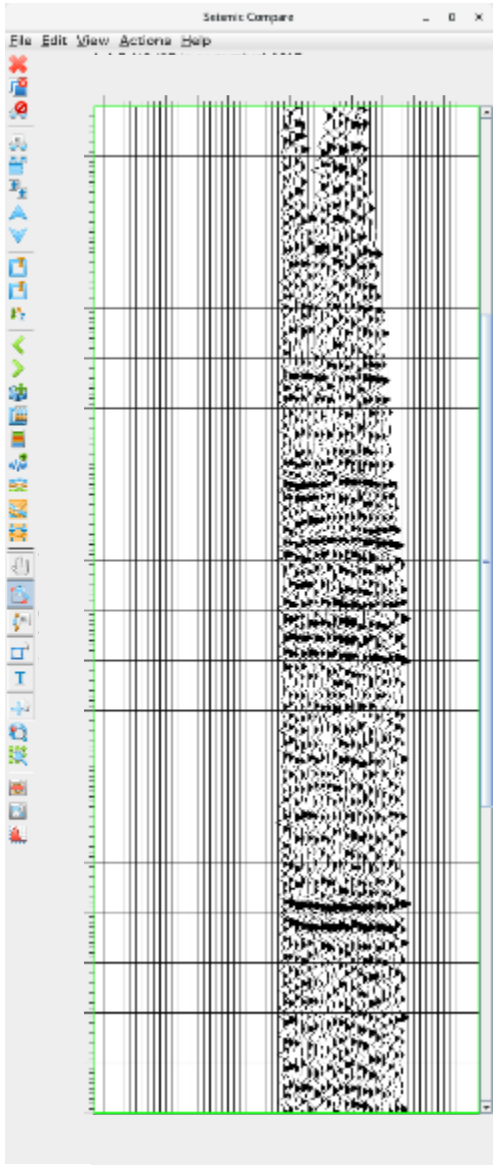
Bell Creek Oil Field, MT – SASSA Example

SASSA

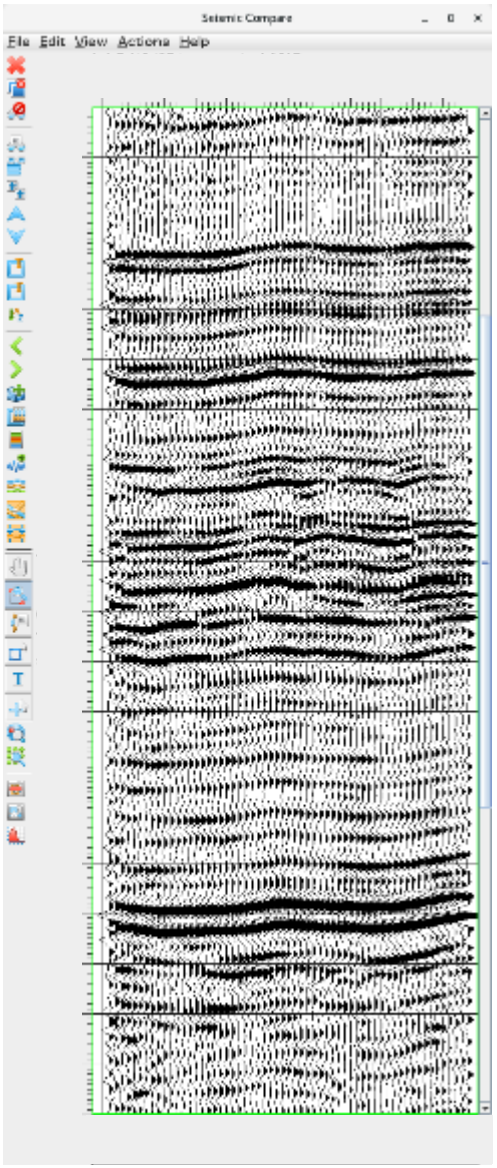
Collected with 2 sources provided by PCOR member Research Institute of Technology for the Earth (RITE) and 200 receivers (provided and deployed by PCOR member Paragon Geophysical).

3D seismic was collected with over 1000 sources and 1000 receivers

Surface Orbital Vibe (SOV)



3D Seismic Vibroseis

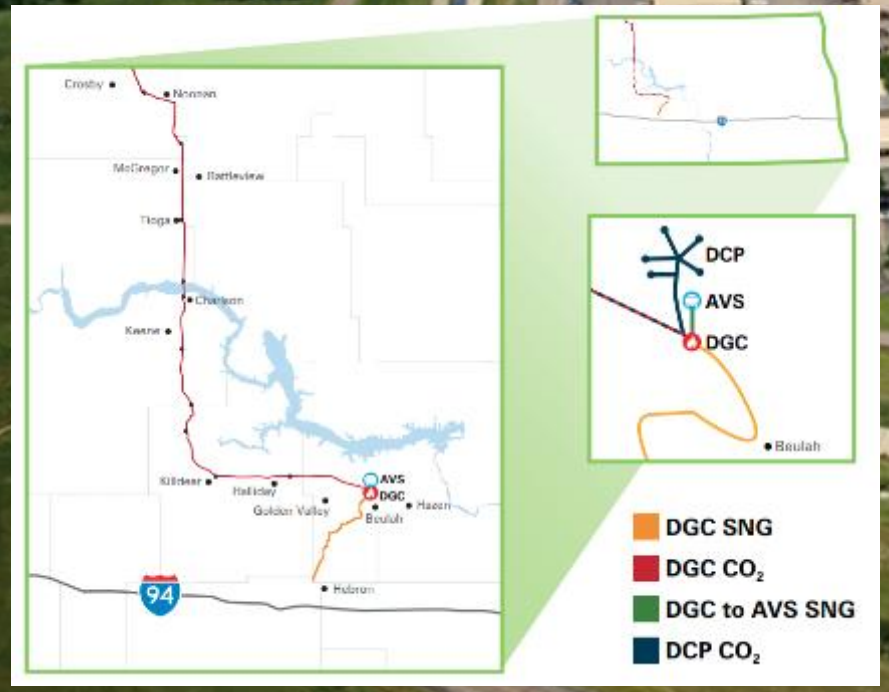


Injection Zone

Precambrian Basement

DAKOTA GASIFICATION COMPANY
A BASIN ELECTRIC POWER COOPERATIVE SUBSIDIARY

Dakota Gasification, Active CCS and CCUS
Beulah, North Dakota
EOR: 42 million metric tons to Canada
Dedicated Storage: 2.7 million metric tons per year



DAKOTA GASIFICATION COMPANY

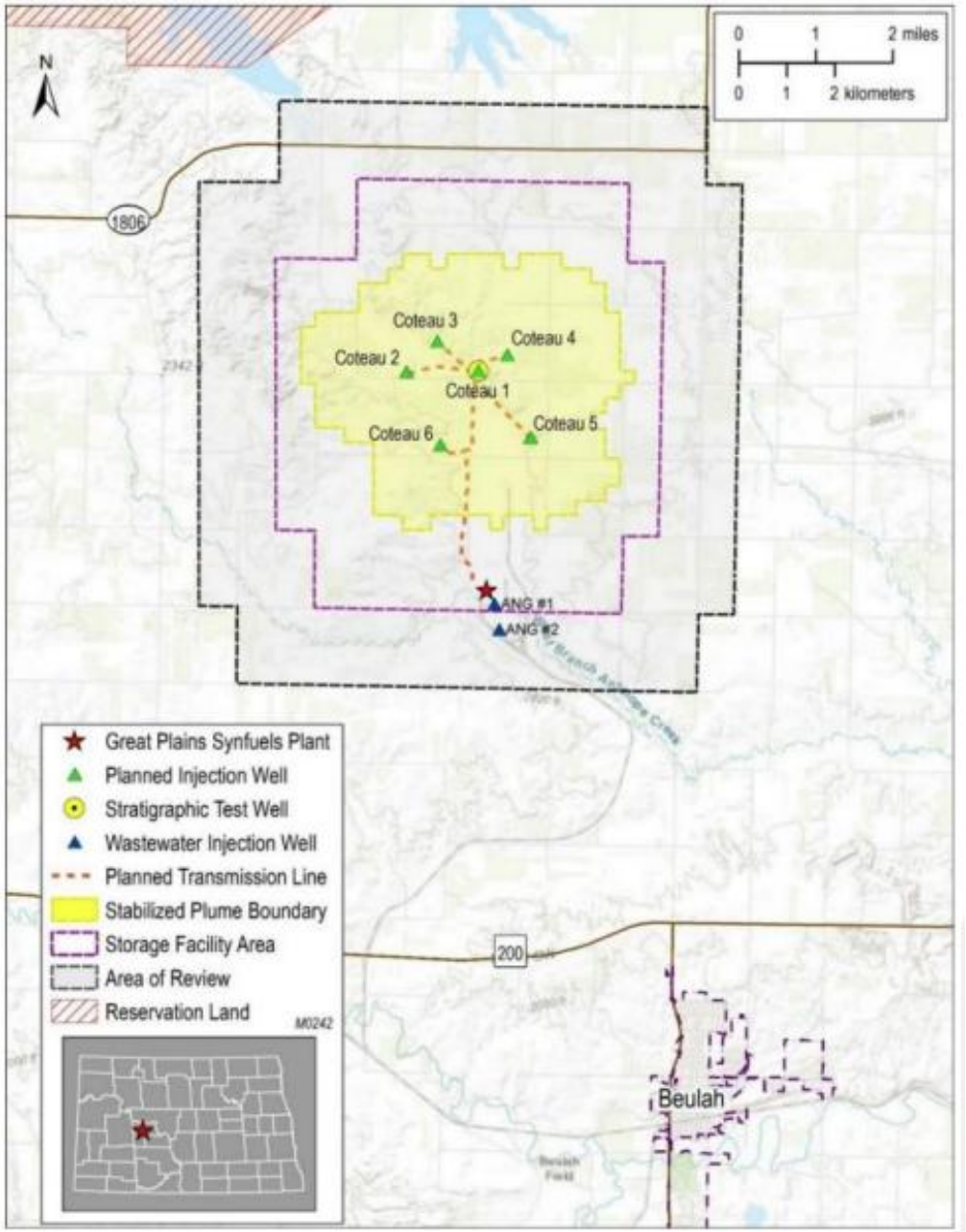
Capture Facility: Coal Gasification Plant

Annual Injection Volume: 2.7 million metric tons

Injection Permit Approved: 2023

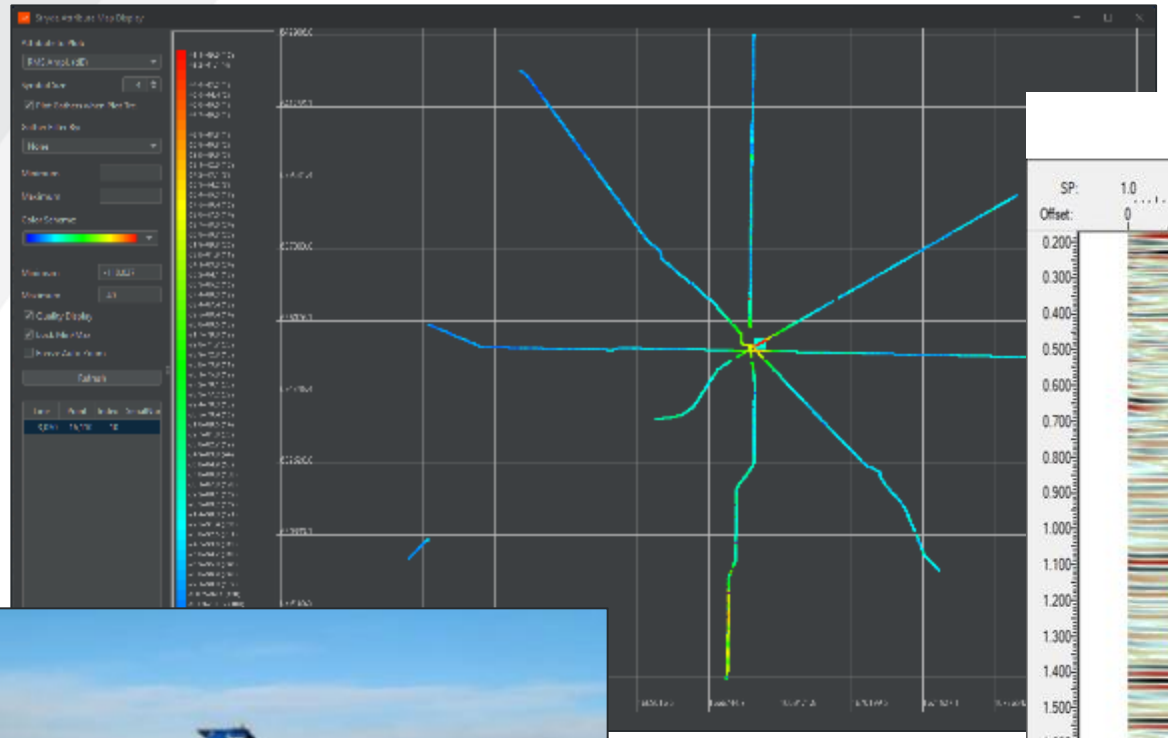
Injected Volume: 2,629,068*

*Through 11/2025

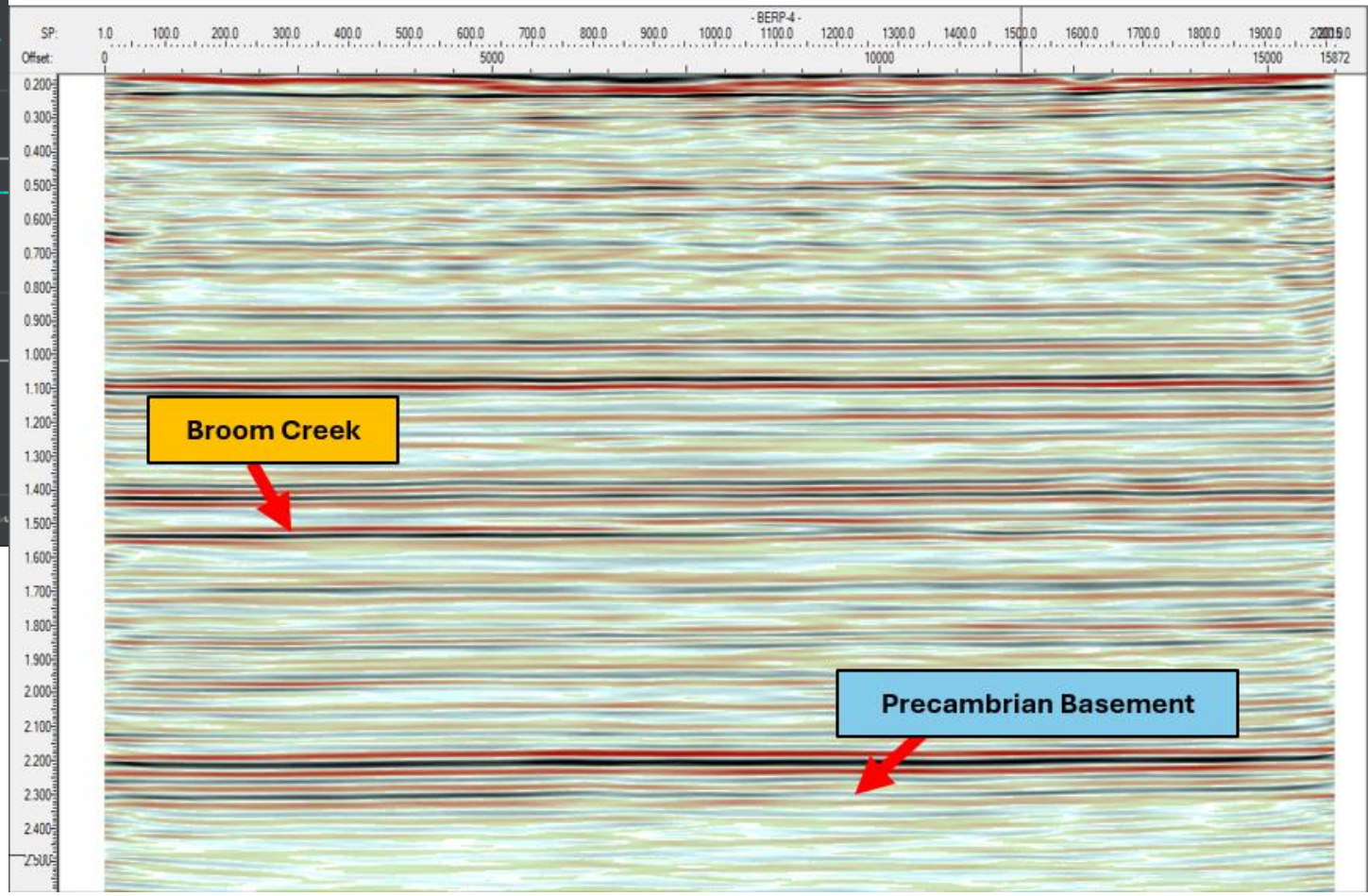


Critical Challenges. Practical Solutions.

LOW-IMPACT SEISMIC DATA ACQUISITION

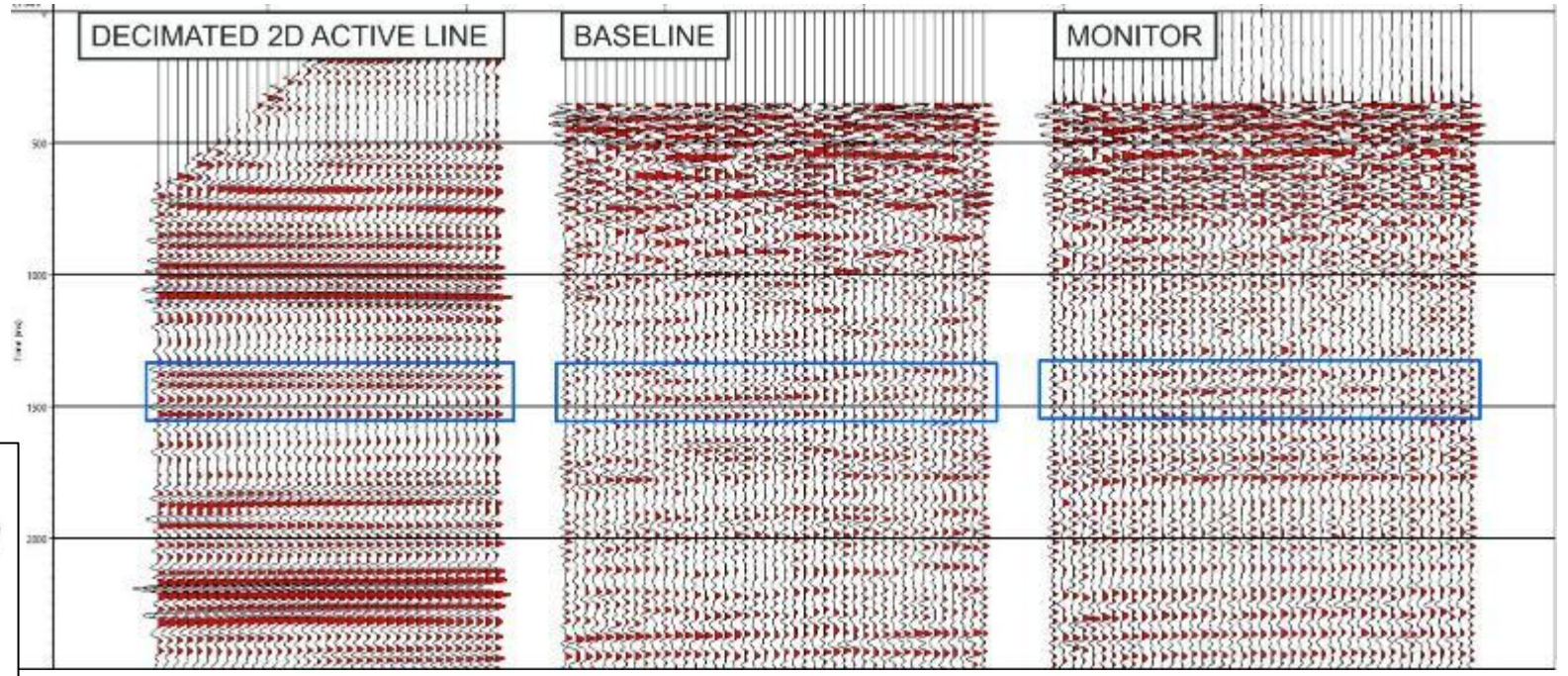


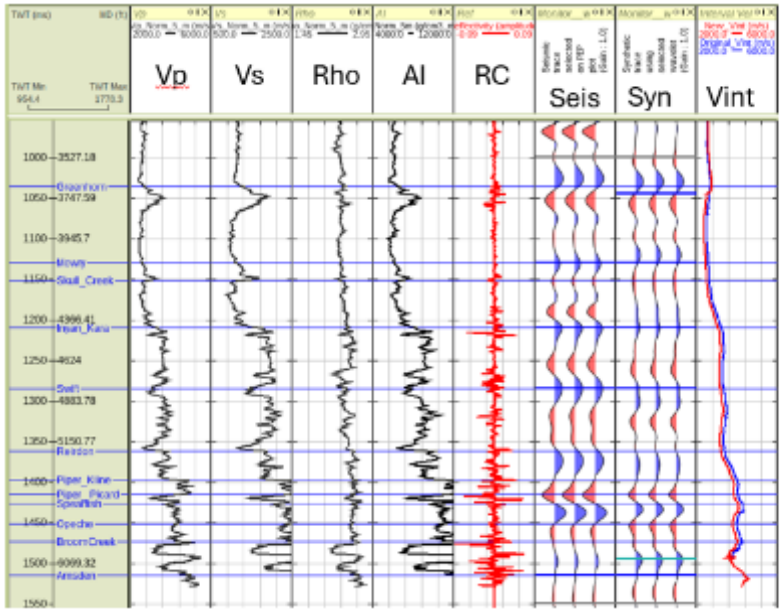
Sept/Oct 2024 10 Drops

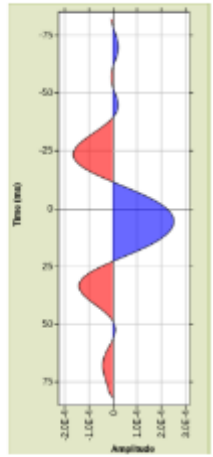


PCGR Partnership

PASSIVE SEISMIC ACQUISITION







BLUE FLINT SEQUESTER COMPANY

Capture Facility: Ethanol Plant

Annual Injection Volume: 200,000 metric tons

Injection Permit Approved: 2023

Injected Volume: 383,933*

*Through 12/2025

Coal Creek Station, Developing CCS
Underwood, North Dakota
Two Units: 1200 MW
Two Units: Approx. 9 million metric tons per year

RAINBOW
ENERGY CENTER

UNDERWOOD 3D SEISMIC SURVEY: BY THE NUMBERS

120 Days Working in the Field

40 Days of Weather Delays

236 Square Miles of Proposed Survey Area

194 Square Miles Accessed

45,106 Sensor Locations

35,290 Source Truck Points

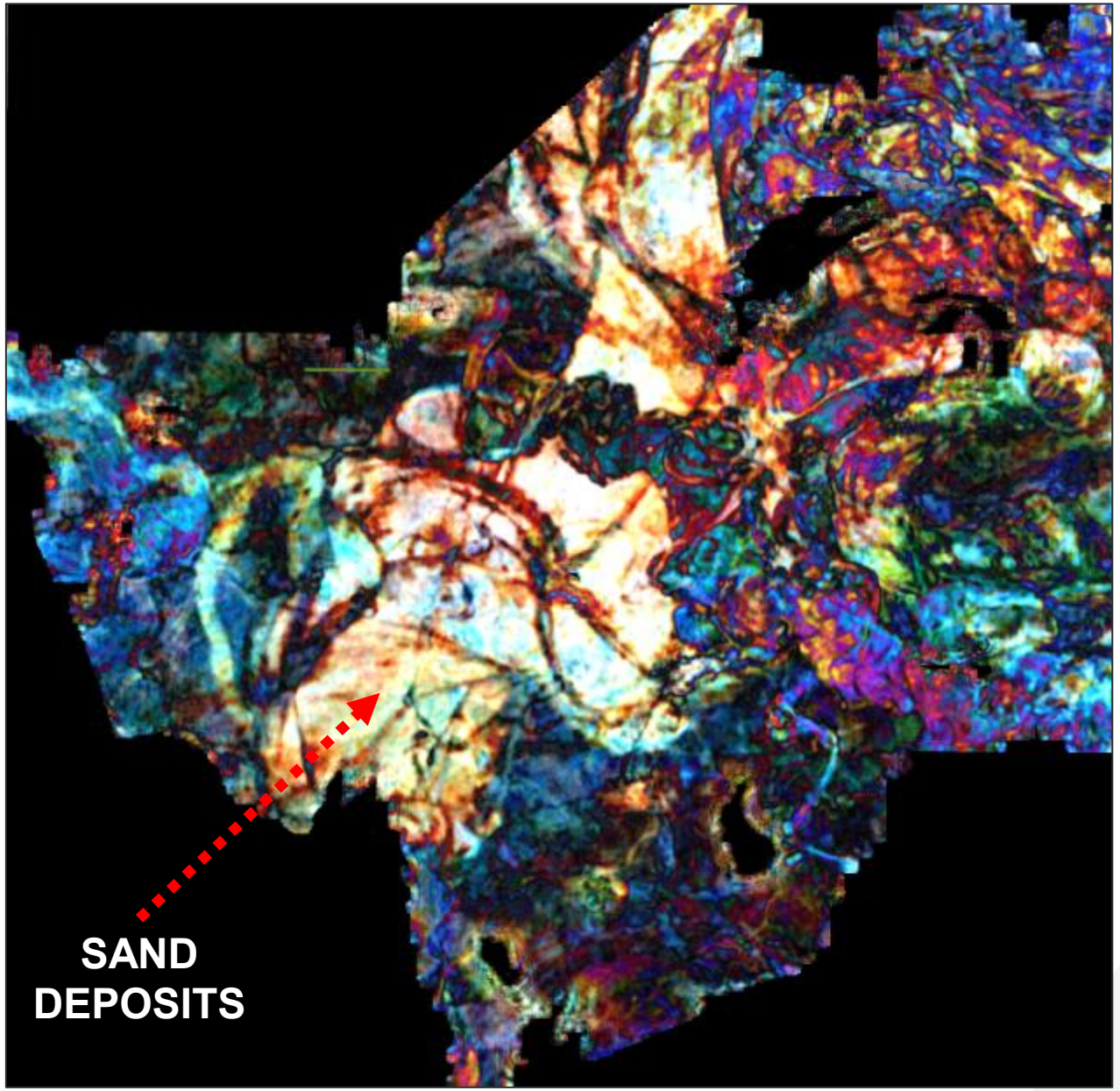
EERC | UND UNIVERSITY OF NORTH DAKOTA | PCOR Partnership

Critical Challenges. Practical Solutions.

INYAN KARA

In the Inyan Kara, the survey reveals ancient river channels similar to the modern-day Mississippi River valley.

Photo Credit: Image captured from Google Earth showing the Mississippi river valley in northwestern Mississippi.

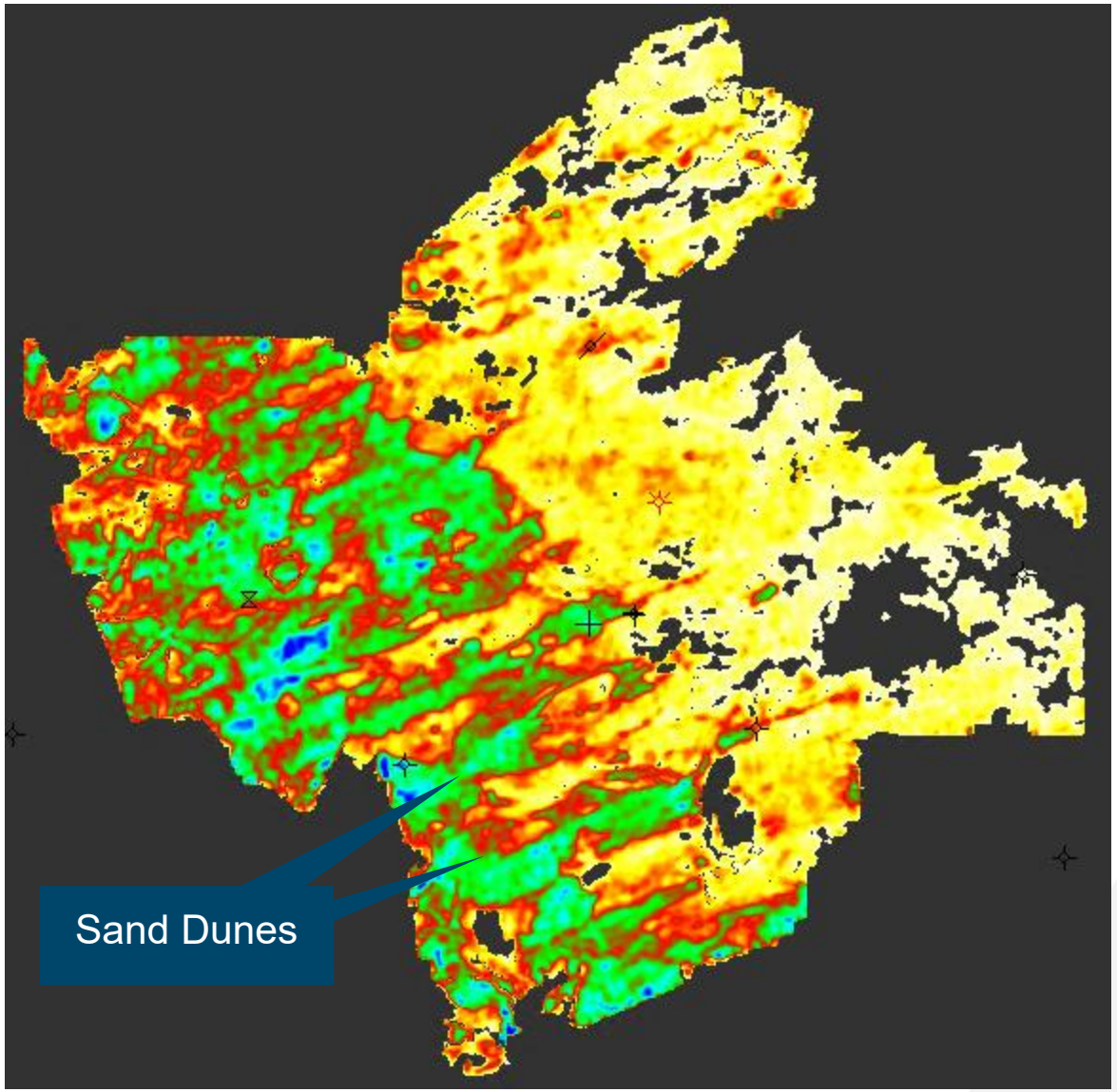


BROOM CREEK

The Broom Creek sand dunes pinch out when moving to the east across the survey area.

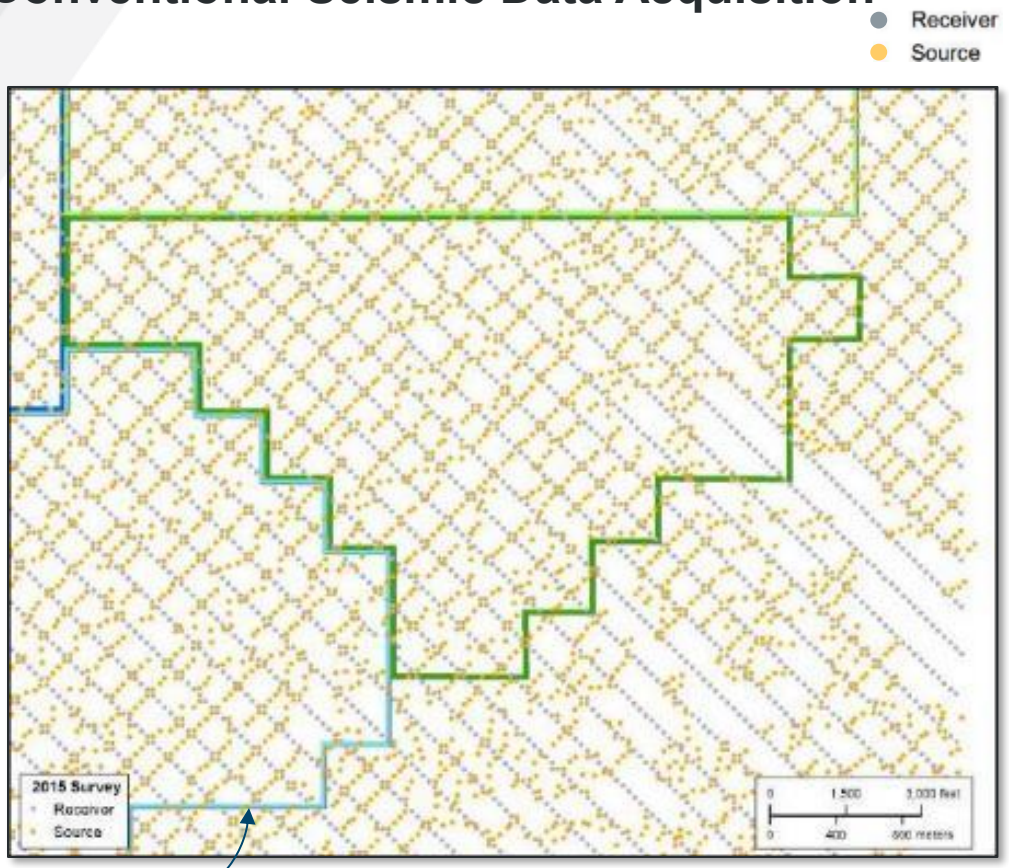
Photo credit: https://www.freepik.com/premium-photo/sand-dunes-with-ripples-mesquite-flats-death-valley-california-usa_62482812.htm.

Aerial View of Coastal Dunes, Namib by Martin Harvey.



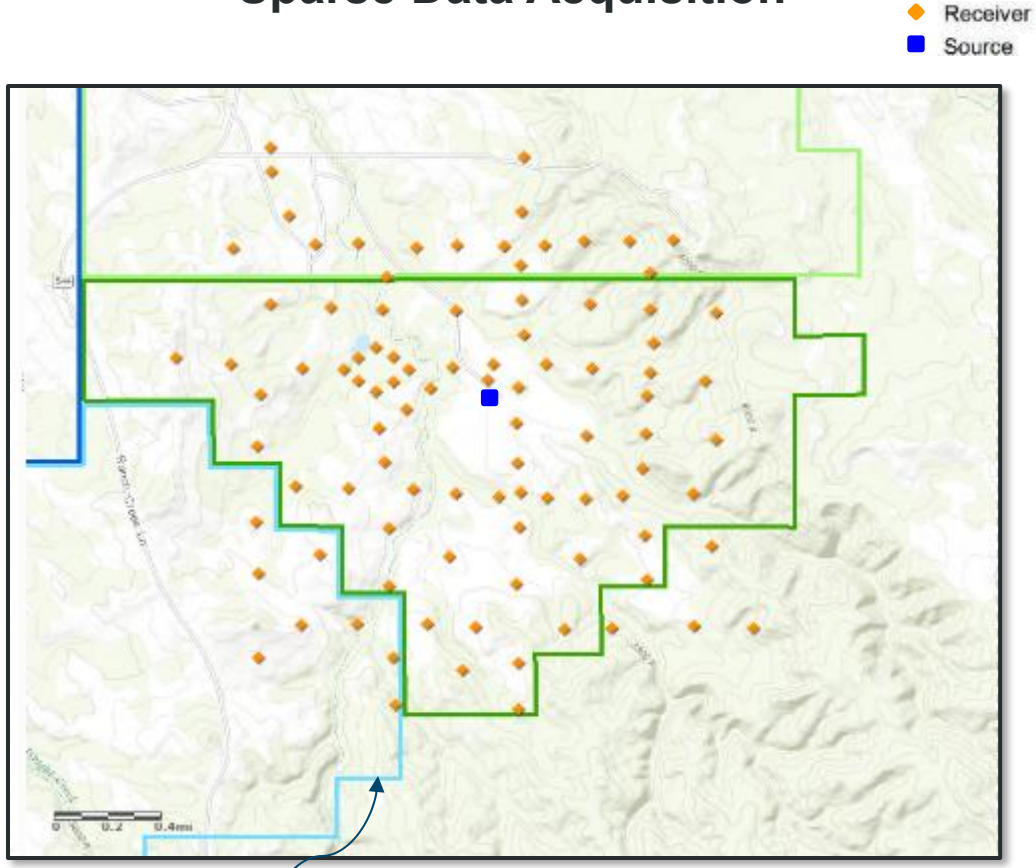
CONVENTIONAL VERSUS SPARSE ACQUISITION

Conventional Seismic Data Acquisition



Development regions

Sparse Data Acquisition



Development regions

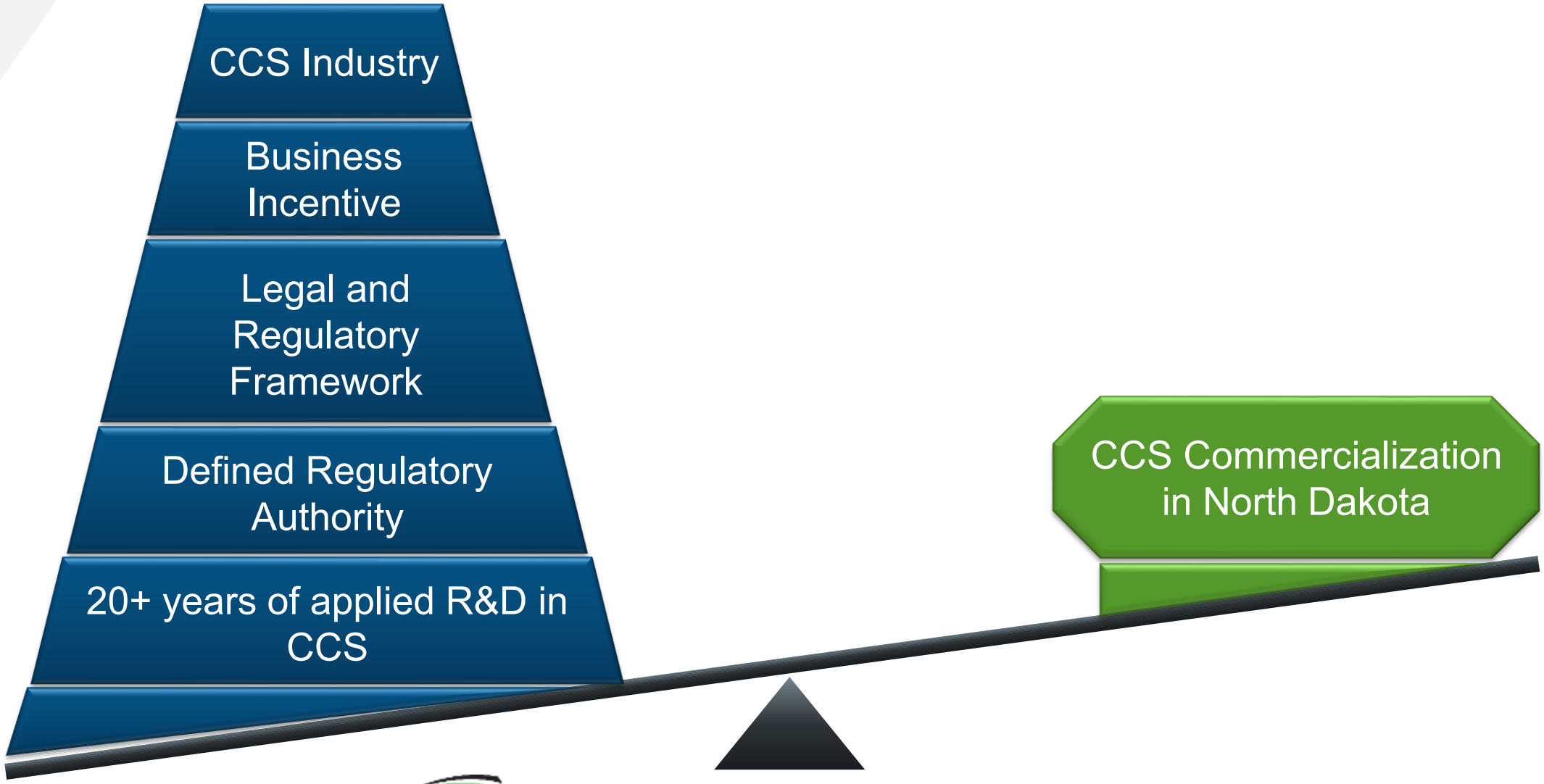
DRIVING INNOVATION IN CO_2 INJECTION MONITORING

- **To advance practical, scalable, and cost-effective monitoring technologies for CO_2 storage and EOR projects, ensuring environmental integrity and operational efficiency.**
  - Integration of advanced technologies for improved reservoir characterization.
  - Lower-impact, lower-cost monitoring solutions.
  - Enhanced reservoir management through dynamic simulations.
  - Collaboration with regulators and industry partners.
  - Commitment to sustainability and safe CO_2 storage.

SUMMARY

- **Industry-government collaboration** and regional characterization helped establish the technical foundation for the CCS activity today.
- **R&D demonstration projects** improved understanding on site screening; site selection; characterization; collection of baseline MVA, improved understanding of technical risk, and reduced uncertainty.
- Comprehensive **legal and regulatory framework** and defined regulatory authority provide critical project development certainty.
- As CCS commercialization continues, R&D programs are crucial to ensure operational learnings are shared to improve next generation project design, development timelines, and understanding of site-based risks.

NORTH DAKOTA'S LEVERAGE



THANK YOU

Kevin C. Connors
Assistant Director for Regulatory Compliance
and Energy Policy
kconnors@undeerc.org

Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018
701.777.5000
www.undeerc.org

THANK YOU

Critical Challenges. Practical Solutions.

Critical Challenges. Practical Solutions.

NDIC Disclaimer

DISCLAIMER

This presentation was prepared by the EERC pursuant to an agreement partially funded by the Industrial Commission of North Dakota, and neither the EERC nor any of its subcontractors nor the North Dakota Industrial Commission nor any person acting on behalf of either:

Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this presentation, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

Assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this presentation.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the North Dakota Industrial Commission. The views and opinions of authors expressed herein do not necessarily state or reflect those of the North Dakota Industrial Commission.