



EERC



UNIVERSITY OF
NORTH DAKOTA



Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

CCS DEVELOPMENT IN THE NORTHERN PLAINS

CO₂ EOR Carbon Management Workshop

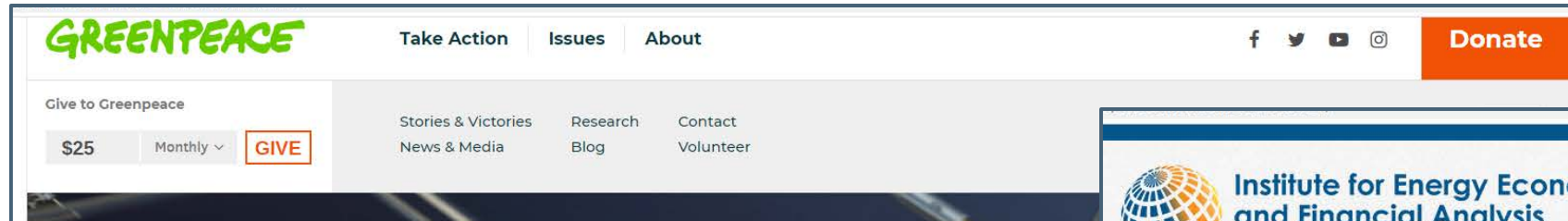
December 8, 2020

James Sorensen

Director of Subsurface R&D

Energy & Environmental Research Center

HEADWINDS FOR FOSSIL ENERGY AND CCUS



GREENPEACE Take Action Issues About

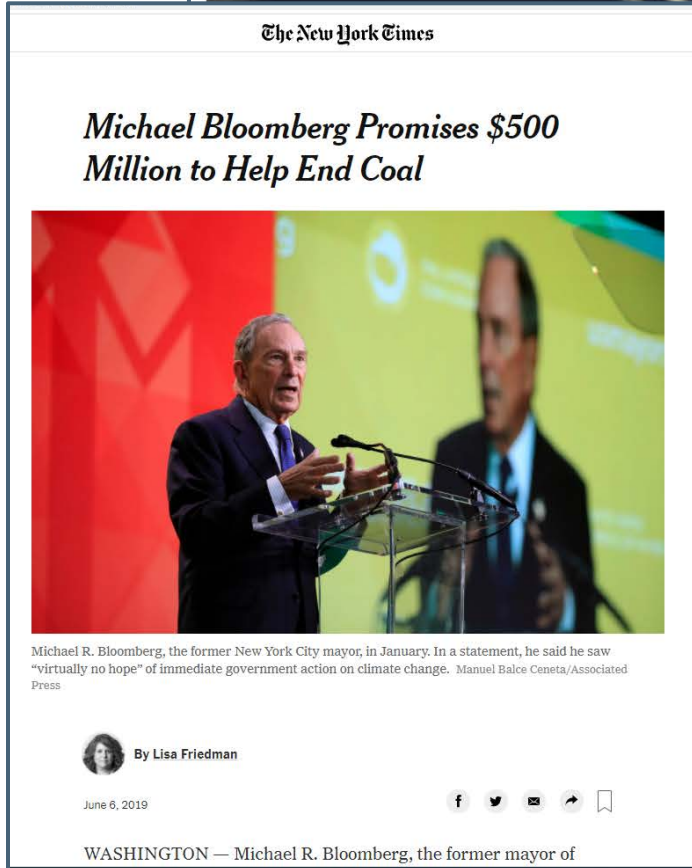
f t y i

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Give to Greenpeace


\$25 Monthly GIVE

Stories & Victories Research Contact
News & Media Blog Volunteer



The New York Times

Michael Bloomberg Promises \$500 Million to Help End Coal


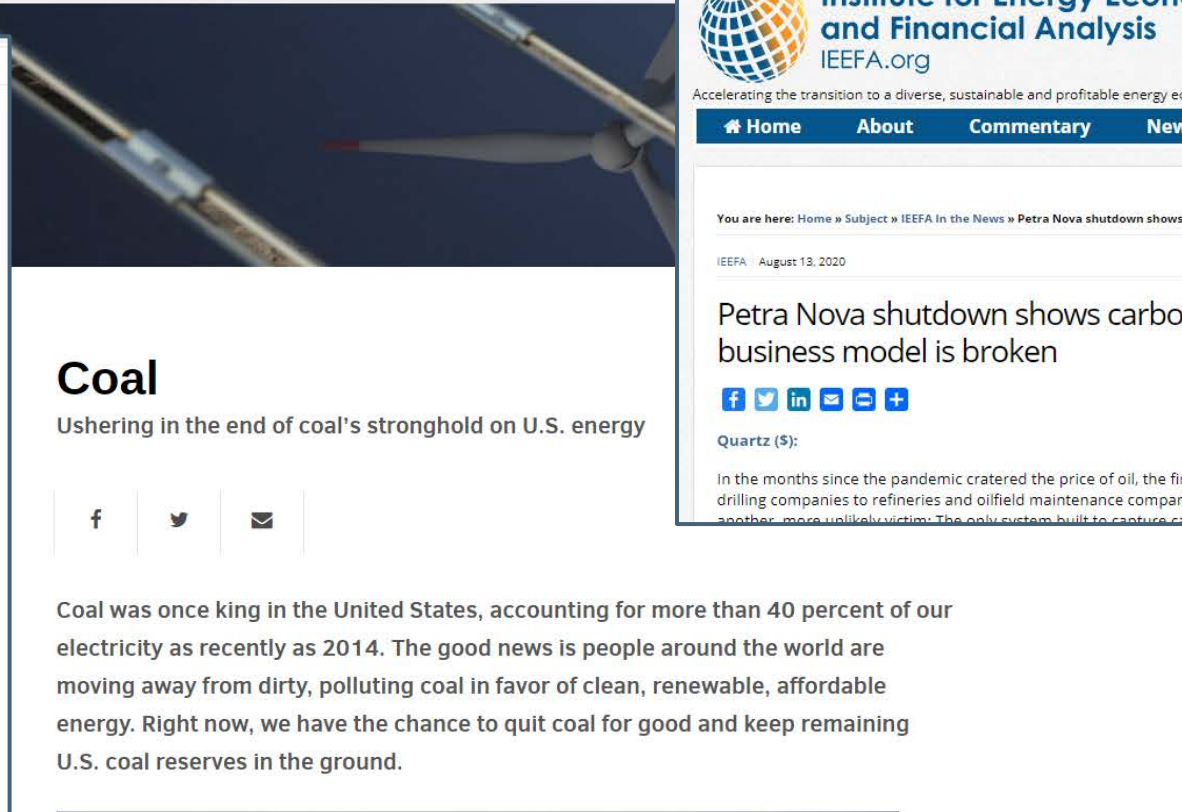


Michael R. Bloomberg, the former New York City mayor, in January. In a statement, he said he saw "virtually no hope" of immediate government action on climate change. Manuel Balce Ceneta/Associated Press

By Lisa Friedman

June 6, 2019

WASHINGTON — Michael R. Bloomberg, the former mayor of



Institute for Energy Economics and Financial Analysis
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Accelerating the transition to a diverse, sustainable and profitable energy economy

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IEEFA August 18, 2020

Petra Nova shutdown shows carbon capture business model is broken

f t in e +

Quartz (\$):

In the months since the pandemic cratered the price of oil, the financial fallout has spread from drilling companies to refineries and oilfield maintenance companies. Now the crash has claimed another, more unlikely victim: The only system built to capture carbon emissions from a coal plant

Coal

Ushering in the end of coal's stronghold on U.S. energy

f t e

Coal was once king in the United States, accounting for more than 40 percent of our electricity as recently as 2014. The good news is people around the world are moving away from dirty, polluting coal in favor of clean, renewable, affordable energy. Right now, we have the chance to quit coal for good and keep remaining U.S. coal reserves in the ground.

LEANING IN TO CCUS - PCOR PARTNERSHIP INITIATIVE

Building on over 17 years of applied research in CCUS

Active region developing commercial CCUS projects

Engaged and motivated partners

Well-equipped project team



PLAINS CO₂ REDUCTION (PCOR) PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

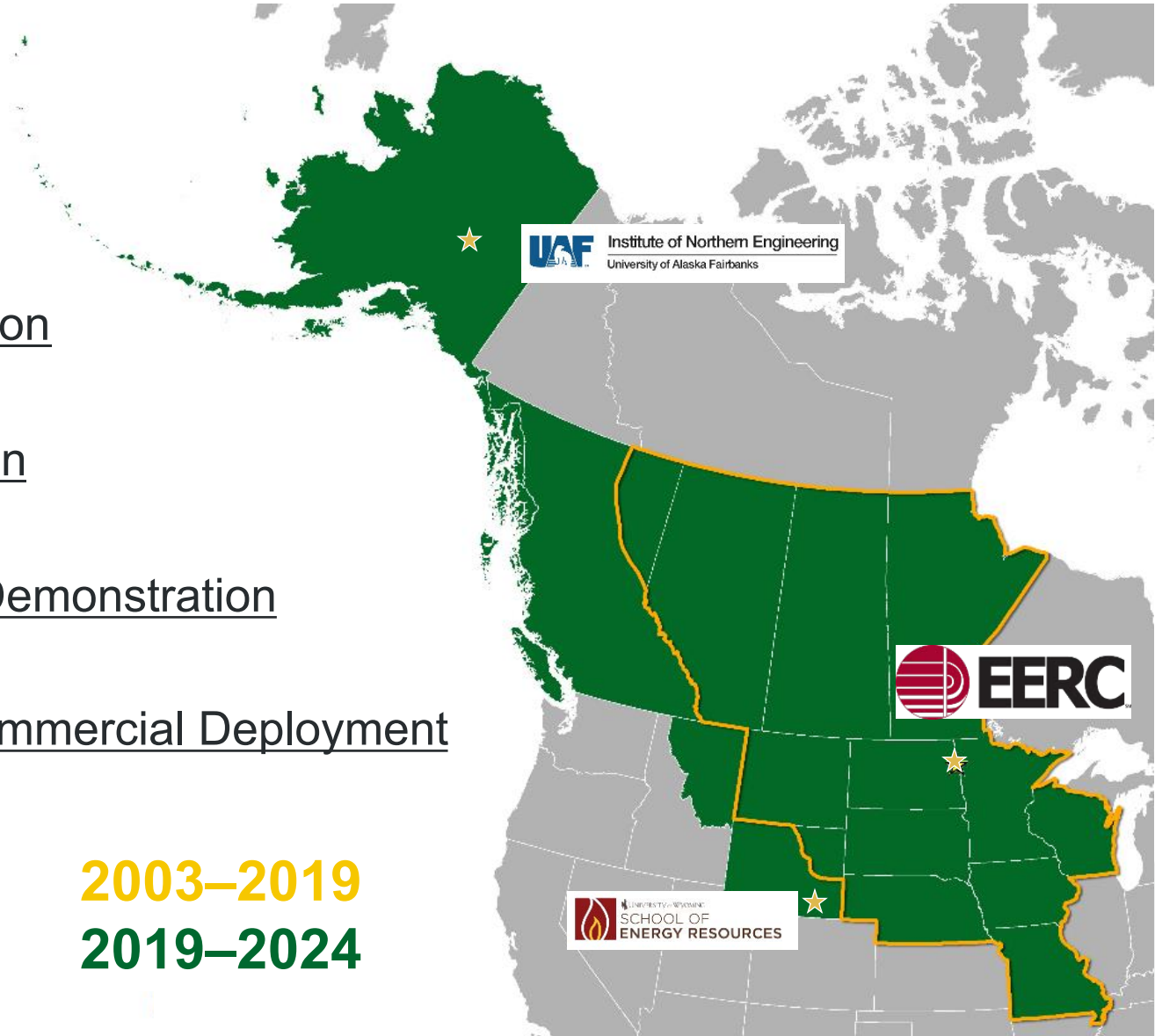
2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

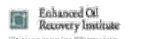
2019–2024 – *PCOR Partnership Initiative*: Commercial Deployment

2003–2019

2019–2024



Critical Challenges. Practical Solutions.

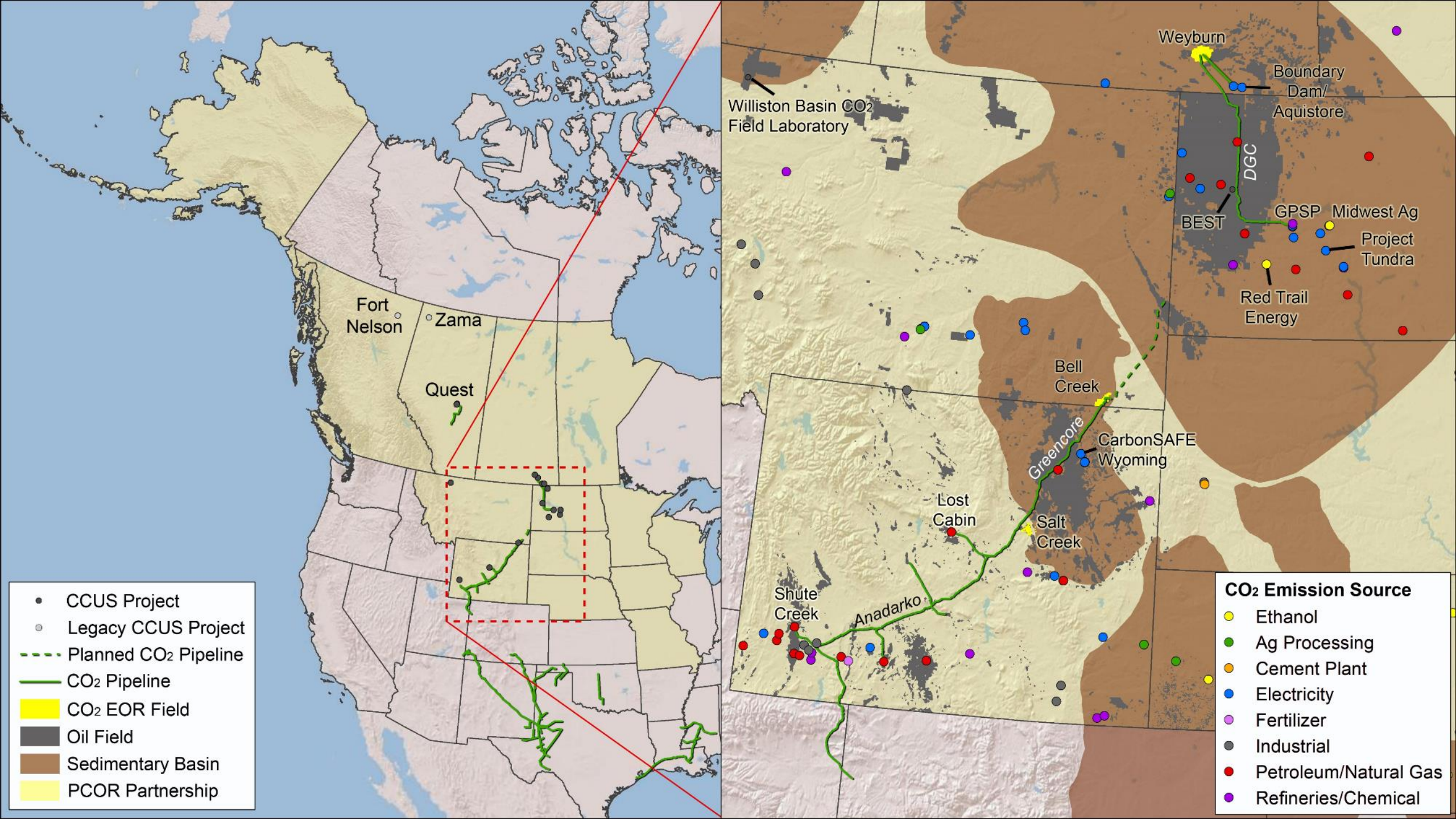


PCOR PARTNERSHIP INITIATIVE

The PCOR Partnership Initiative is addressing regional capture, transport, use, and storage challenges facing commercial CCUS deployment. The Initiative is focusing on:

- Strengthening the technical foundation for geologic CO₂ storage and enhanced oil recovery.
- Advancing capture technology.
- Improving application of monitoring technologies.
- Promoting integration between capture, transportation, use, and storage industries.
- Facilitating regulatory frameworks.
- Providing scientific support to policy makers.





- CCUS Project
- Legacy CCUS Project
- - - Planned CO₂ Pipeline
- CO₂ Pipeline
- CO₂ EOR Field
- Oil Field
- Sedimentary Basin
- PCOR Partnership

- CO₂ Emission Source**
- Ethanol
 - Ag Processing
 - Cement Plant
 - Electricity
 - Fertilizer
 - Industrial
 - Petroleum/Natural Gas
 - Refineries/Chemical

**NORTH DAKOTA'S ACTIVE CCS PROJECTS AND THE
FUTURE OF CARBON MANAGEMENT IN THE
WILLISTON BASIN**

FUTURE OF NORTH DAKOTA'S ECONOMY IS TIED TO CCUS




International CCS Knowledge Centre: Let's Be Clear, Petra Nova's Carbon Capture System Works

f t in G+ p @ Email Print-Friendly Share

August 18, 2020 16:45 ET | Source: International CCS Knowledge Centre

THE CONVERSATION
Academic rigor. Journalistic flair.

COVID-19 Arts + Culture Economy + Business Education Environment + Energy Ethics + Religion Health Politics/Election '20 Science + Technology



The end of coal: good riddance or dangerous gamble?

March 24, 2016 2:11pm EDT

Scotland has become the first part of the UK to stop burning coal to supply electricity following the closure of Longannet, its largest power station, on March 24. It is a sign of the times, with the rest of the UK's coal-fired power stations on death row after energy secretary Amber Rudd announced late last year that they will all be forced to close by 2025.

Author: Paul Younger, Professor of Energy Engineering, University of Glasgow

ENERGY AND MINING

Workers, communities fear closing North Dakota's largest coal plant will destroy their way of life

The Minnesota-based Great River Energy announced this month it plans to shutter Coal Creek Station in North Dakota, which turns lignite from Falkirk Mine into electricity, in 2022.

Written By: April Baumgarten | May 17th 2020 - 6am.



Fourth-generation coal miner Grace Kerzmann stands Wednesday, May 13, near the Coal Creek Station power plant south of Underwood, N.D. Michael Vosburg / Forum Photo Editor

UNDERWOOD, N.D. — For the past five years, fourth-generation lignite coal miner Grace Kerzmann could be found driving giant trucks, the ones with wheels roughly double her height, around Falkirk Mine near Underwood.

CCS REQUIRES UNDERGROUND INJECTION CONTROL (UIC) CLASS VI WELL PERMITS

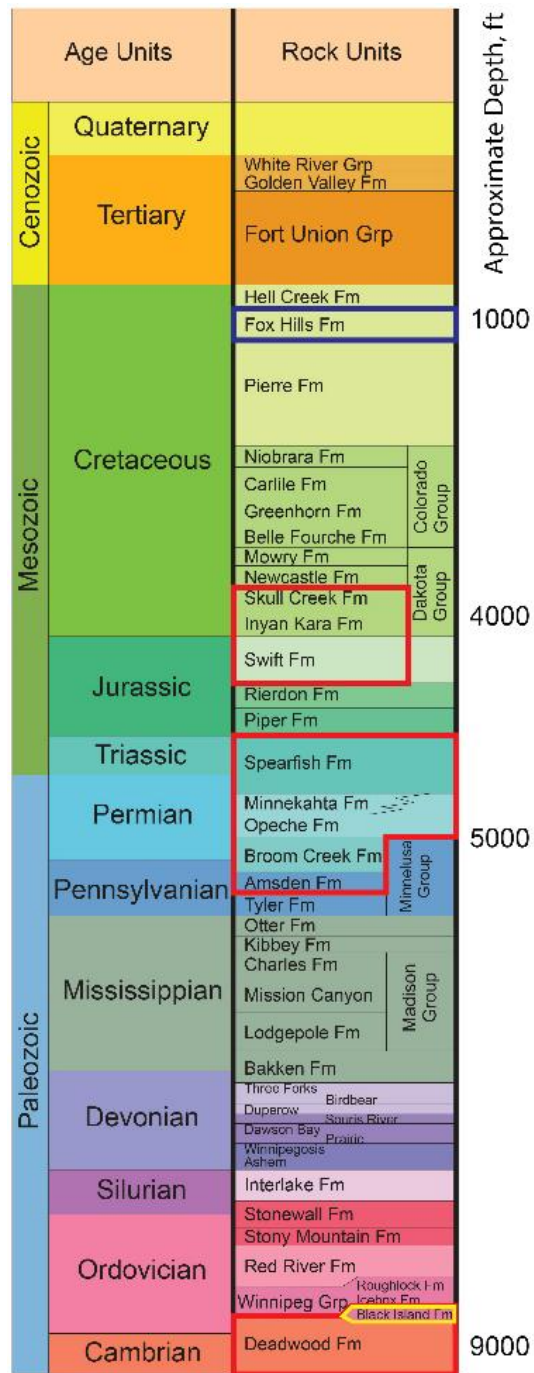
- **2018 US EPA Approved North Dakota Class VI Primacy**

ND Class VI Program Key Components

- The North Dakota Industrial Commission – Department of Mineral Resources is the regulatory authority for Class VI wells.
- Rules for pore space ownership and amalgamation of pore space for the purposes of CCS have been established.
- A clear and straightforward process for obtaining the necessary permits has been established.



NORTH DAKOTA GEOLOGY OFFERS MULTIPLE OPTIONS FOR CCS & CCUS



Inyan Kara Fm – Saline Storage

Broom Creek Fm – Saline Storage

Madison conventional reservoirs – EOR

Bakken & Three Forks unconventional reservoirs – EOR

Duperow conventional reservoirs – EOR

Red River conventional reservoirs – EOR

Deadwood Fm – Saline Storage

CURRENT INCENTIVES

West Coast LCFS Markets

- Credits trading up to \$218 per tonne, with 2019 average = \$197/tonne
- Stacked with 45Q

US Federal 45Q Tax Credits

- Projects beginning construction before January 1, 2024, can claim credits for 12 years after operations begin.
- Tax credits claimed by the taxpayer capturing the emissions or transferred to operators of CO₂ EOR projects.
- Tax credit for CO₂ stored in a qualified **EOR project** (10-year ramp-up to a maximum of **\$35/tonne in 2026**).
- Tax credit for CO₂ stored in a **saline formation** (10-year ramp-up to a maximum of **\$50/tonne in 2026**).

North Dakota CCUS Incentives

- Coal conversion tax: tax reduction with CO₂ capture (up to 50%)

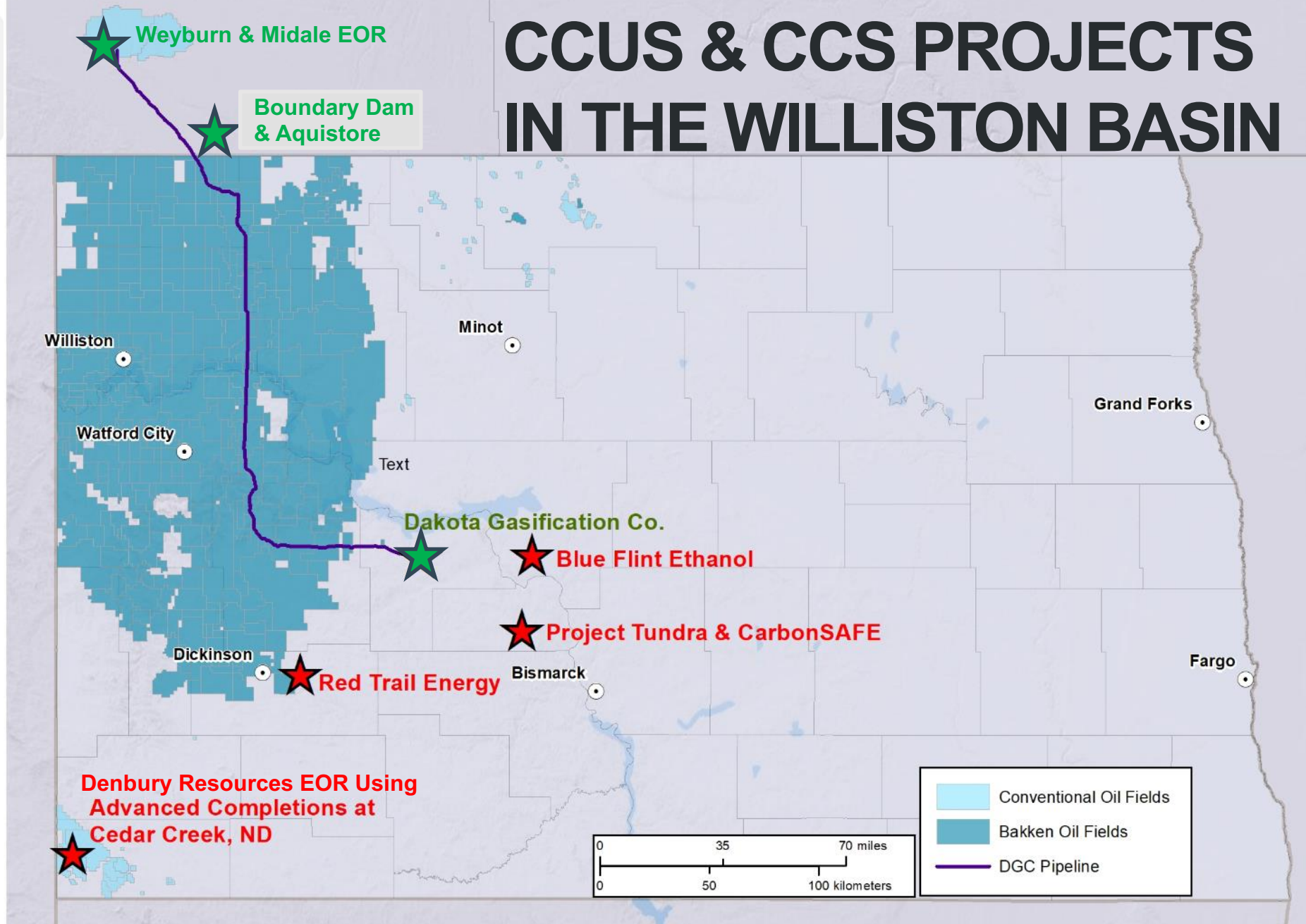
- No sales tax on capture-related infrastructure
- No sales tax on CO₂ sold for EOR

- No sales tax on construction of pipeline
- Property tax-exempt for 10 years (equipment)

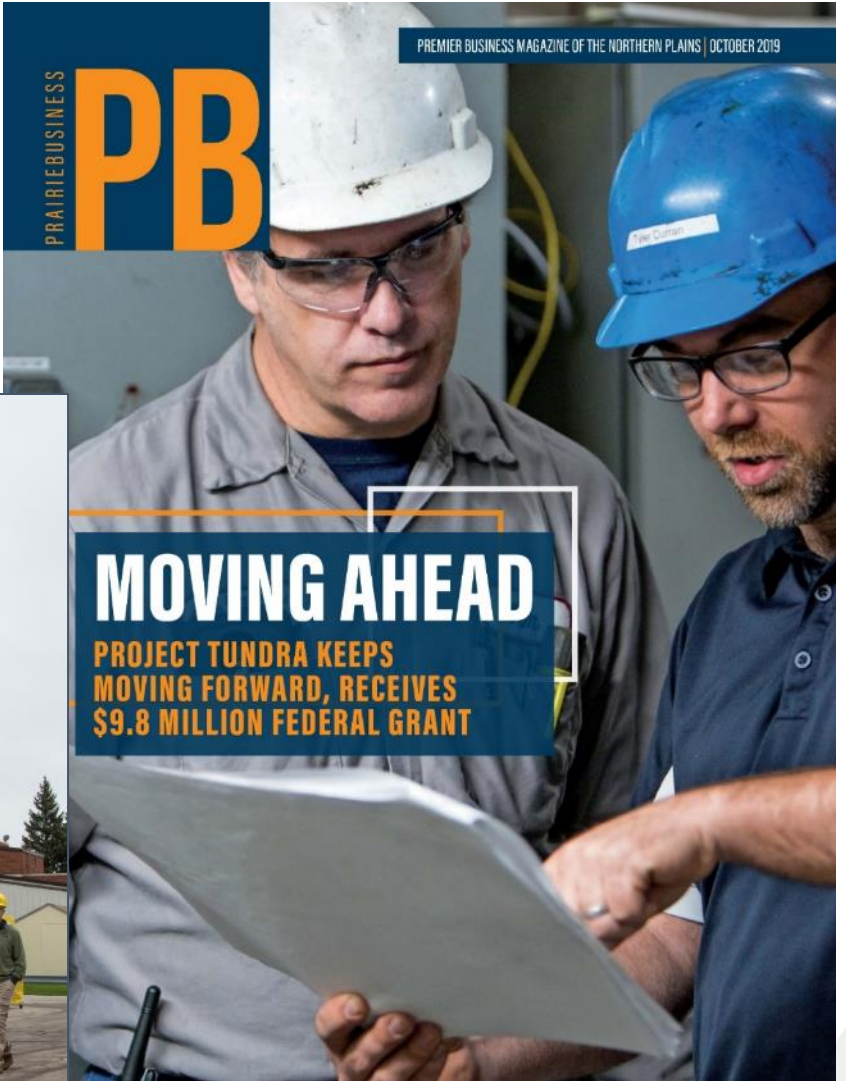
- No sales tax on CO₂ EOR infrastructure
- **0% extraction tax for 20 years for tertiary incremental recovery**
- Production tax still applies



CCUS & CCS PROJECTS IN THE WILLISTON BASIN



PROJECT TUNDRA



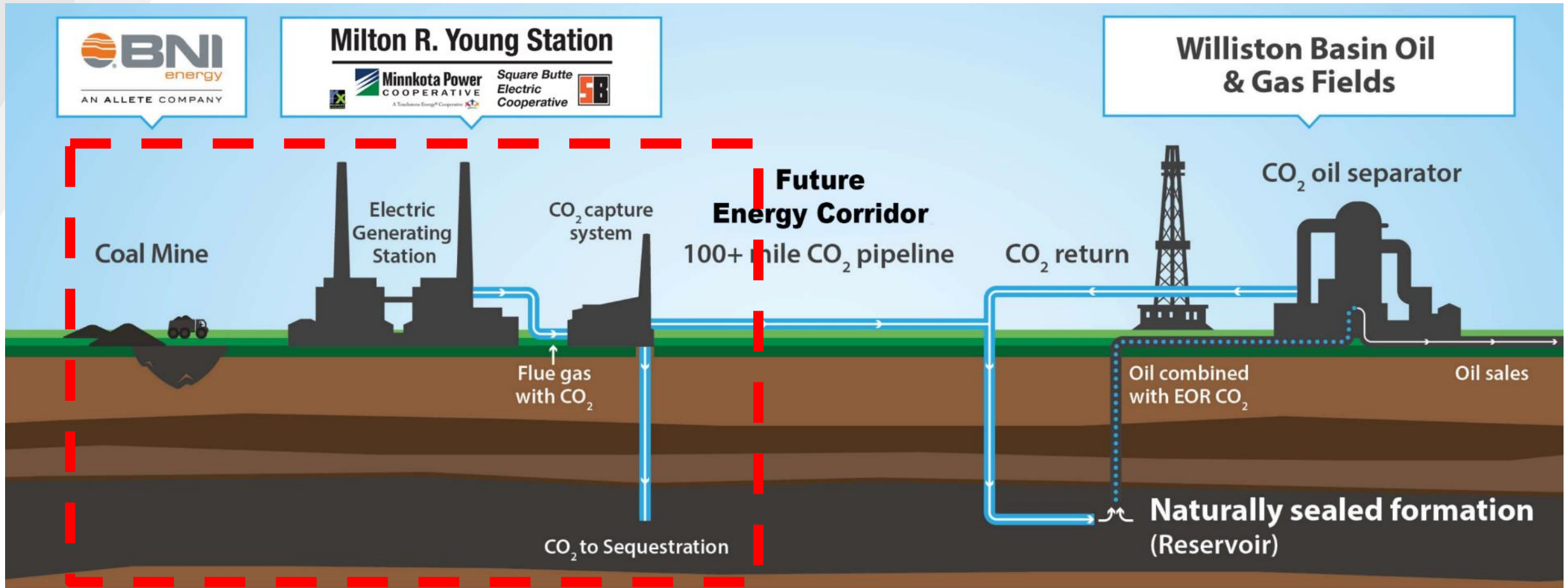
PREMIER BUSINESS MAGAZINE OF THE NORTHERN PLAINS | OCTOBER 2019

PRAIRIEBUSINESS
PB

MOVING AHEAD

**PROJECT TUNDRA KEEPS
MOVING FORWARD, RECEIVES
\$9.8 MILLION FEDERAL GRANT**

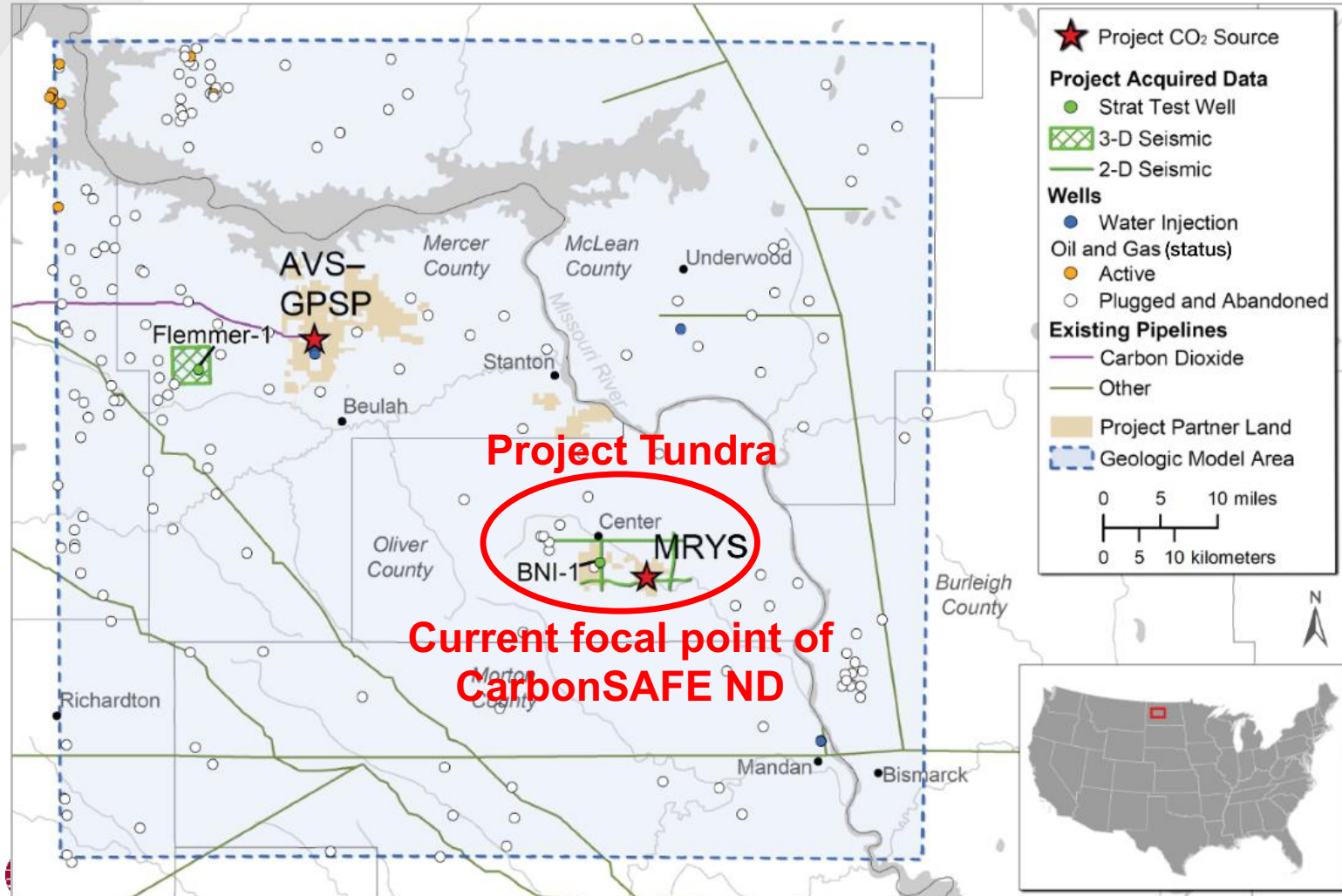
PROJECT TUNDRA – UP TO 4 MTONNES CO₂/YEAR



Current Paradigm – CCS Focused

Visionary Paradigm Could Include CCUS

CARBONSAFE NORTH DAKOTA



- In support of Project Tundra, identify and characterize multiple commercial-scale CO₂ stacked storage targets
 - Inyan Kara Fm
 - Broom Creek Fm
 - Deadwood Fm
- Apply for, and obtain approval of multiple North Dakota CO₂ Storage Facility Permits

Critical Challenges. Practical Solutions.

2020 CARBONSAFE ACCOMPLISHMENTS & NEXT STEPS

- Two stratigraphic test wells drilled to the Precambrian basement (10,300 feet).
- Collected core and logs from three reservoir/seal intervals from each well.
- 6-mi² seismic survey complete.
- Core, log, and seismic data being integrated into models & simulations.
- CCS Storage Complex Permit application package is being prepared for submission to ND Department of Mineral Resources in 2021.



RED TRAIL ENERGY – ETHANOL

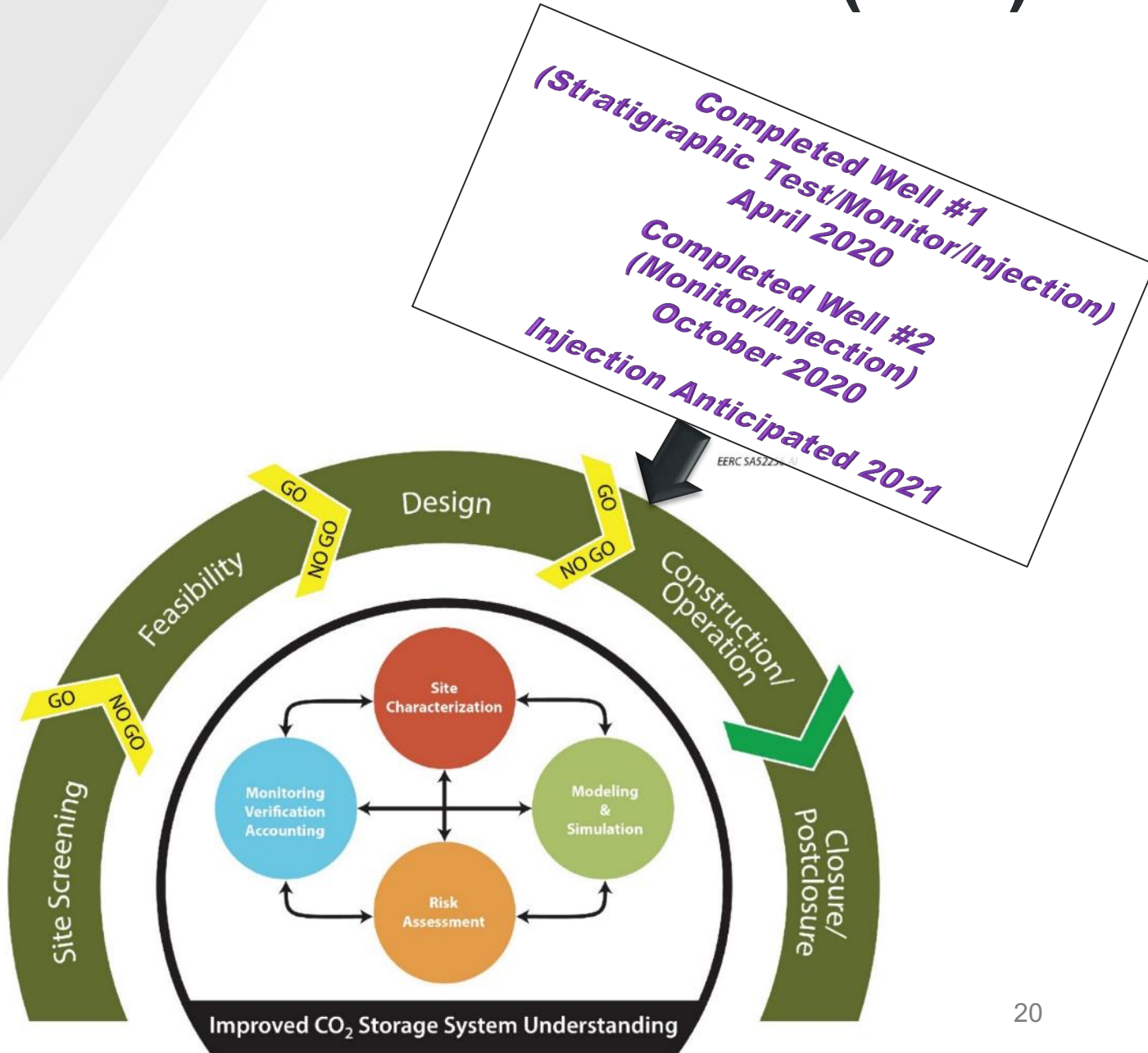


~ 200,000 tons of CO₂ annually.

LOW CARBON
FUEL STANDARD



RED TRAIL ENERGY (RTE)



Corn Ethanol Production Facility

- ~**200,000 tons of CO₂ per year** (biofermentation)
- ~ 40% net reduction in CO₂ emissions
- Incentive-driven carbon storage
 - Tax credit: U.S. 45Q up to ~US\$50 per ton
 - Low Carbon Fuel Programs: CARB LCFS up to ~US\$218 per ton

Injection target

- Broom Creek Formation
- ~6400 ft (1950 meters) in depth
- ~ 300 ft (90 meters) thick

RED TRAIL ENERGY - ACCOMPLISHMENTS AND NEXT STEPS

- ✓ **Validated the Broom Creek Formation** as a suitable target for CCS.
- ✓ **Determined the full carbon life cycle** of an industrial fuel production facility with CCS.
- ✓ **Determined the validity and pathway** of using CCS to meet California LCFS program.
- ✓ **Capture and compression equipment ordered.**
- ✓ **Installed advanced monitoring equipment**, in collaboration with RITE.

Next Steps

- Finalize & submit CCS Storage Complex Permit application package in early 2021.
- Acquire permit & start injection in late 2021.



MIDWEST AG ENERGY – BLUE FLINT – ETHANOL



- ~ 200,000 tons of CO₂ annually from fermentation.
- Strat test well, core & logs collected.

LOW CARBON
FUEL STANDARD



IDEAL CCUS OPPORTUNITIES IN NORTH DAKOTA

Image Credit – EERC



Image Credit – EERC



Image Credit – EERC



Image Credit – NACCO Industries

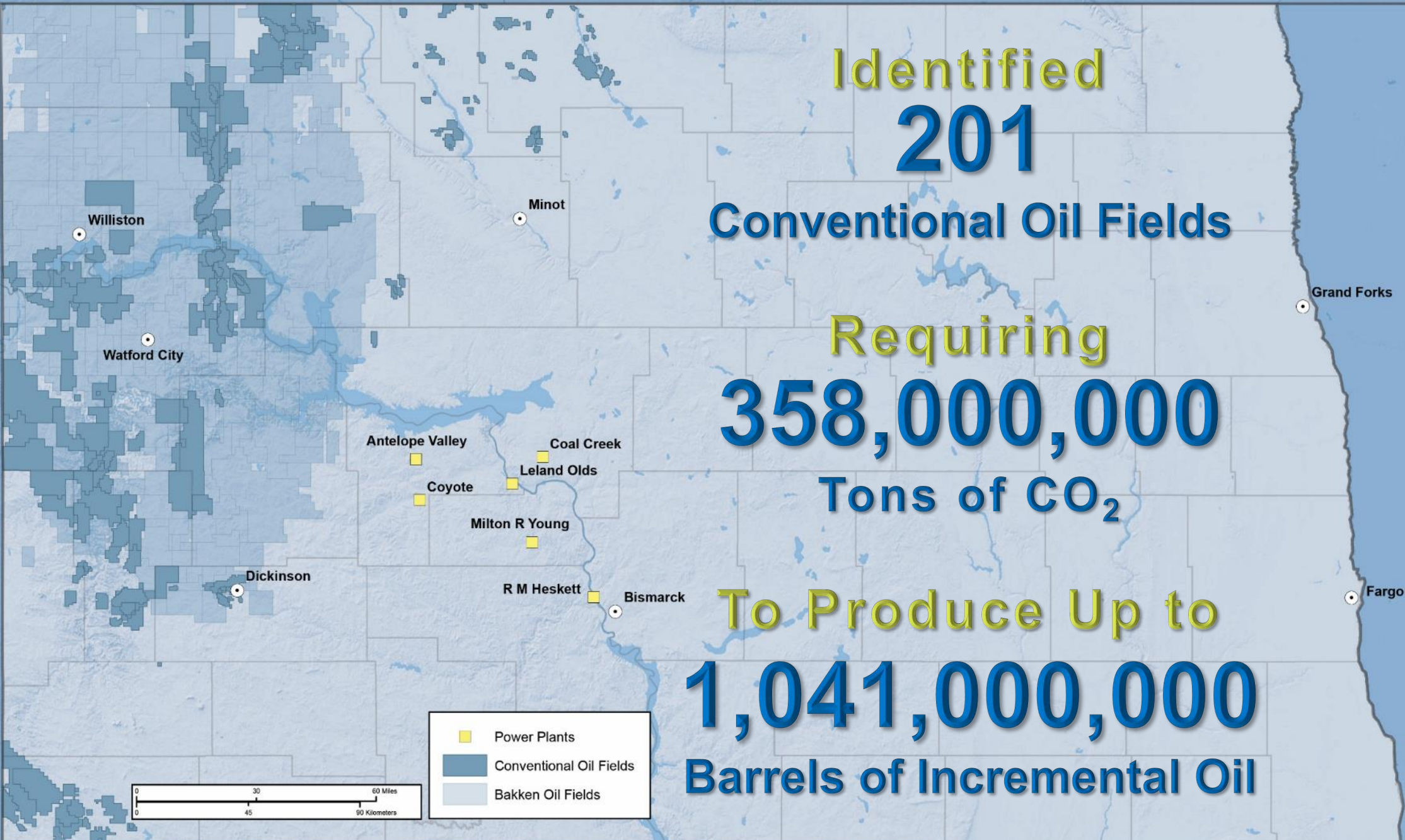


Image Credit – EERC

Identified
201
Conventional Oil Fields

Requiring
358,000,000
Tons of CO₂

To Produce Up to
1,041,000,000
Barrels of Incremental Oil

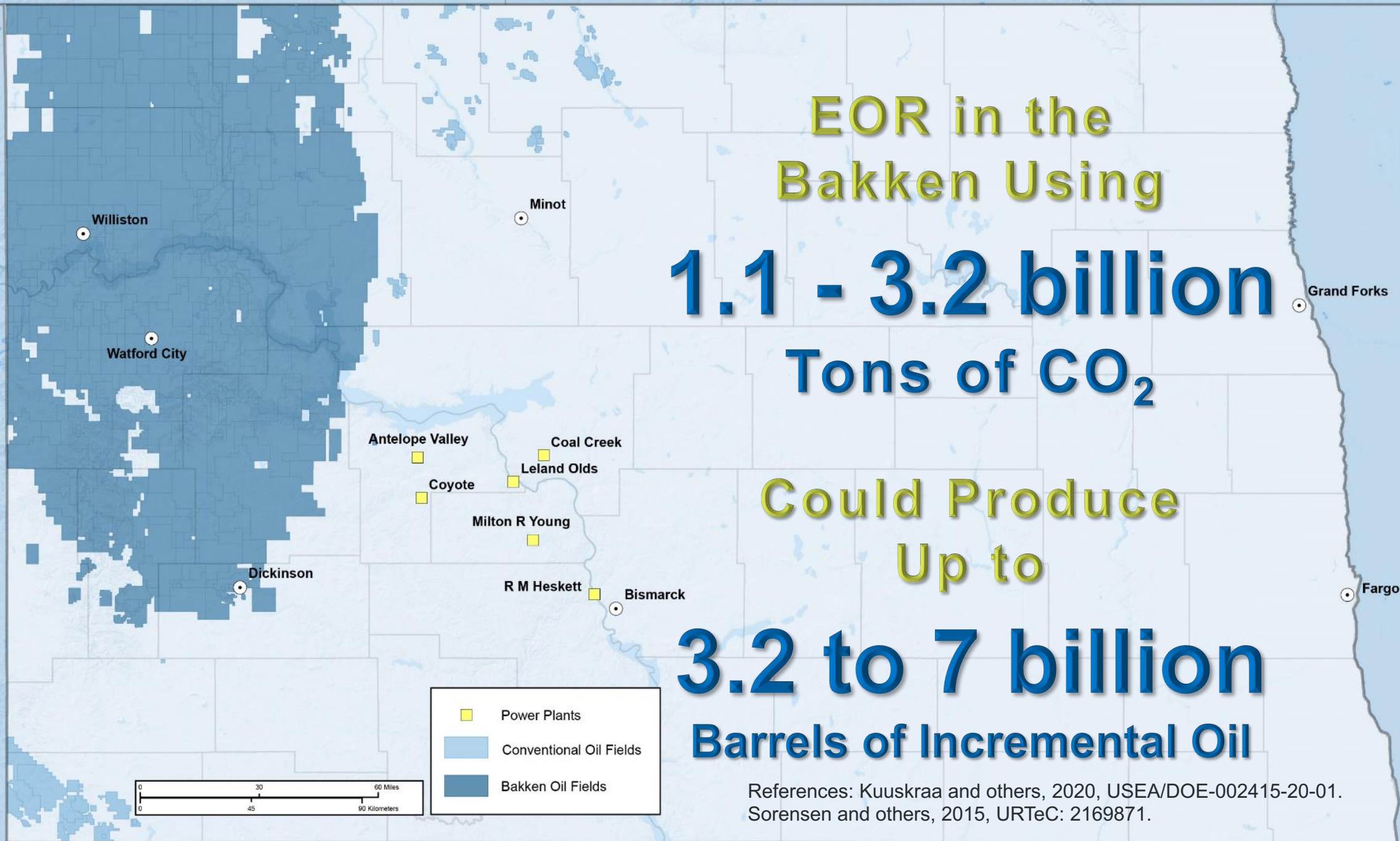


EOR in the
Bakken Using

1.1 - 3.2 billion
Tons of CO₂

Could Produce
Up to

3.2 to 7 billion
Barrels of Incremental Oil



References: Kuuskraa and others, 2020, USEA/DOE-002415-20-01.
Sorensen and others, 2015, URTeC: 2169871.

BAKKEN EOR TESTS



2017 Pilot showed CO₂ can mobilize oil from the Bakken.



Image Credit - EERC

Image Credit - EERC



2018-19 Pilot used rich hydrocarbon gas to test multiwell cyclic EOR scheme.



Image Credit - EERC

KEY LESSONS FOR FUTURE PILOTS IN THE BAKKEN

- Larger injection rates and volumes are necessary in future pilot tests to more rapidly build reservoir pressure and mobilize stranded oil.
- Innovative compression and injection technologies may improve the performance and economics of injection.
- Even in current low price environment, multiple Bakken operators are planning new pilot EOR tests.



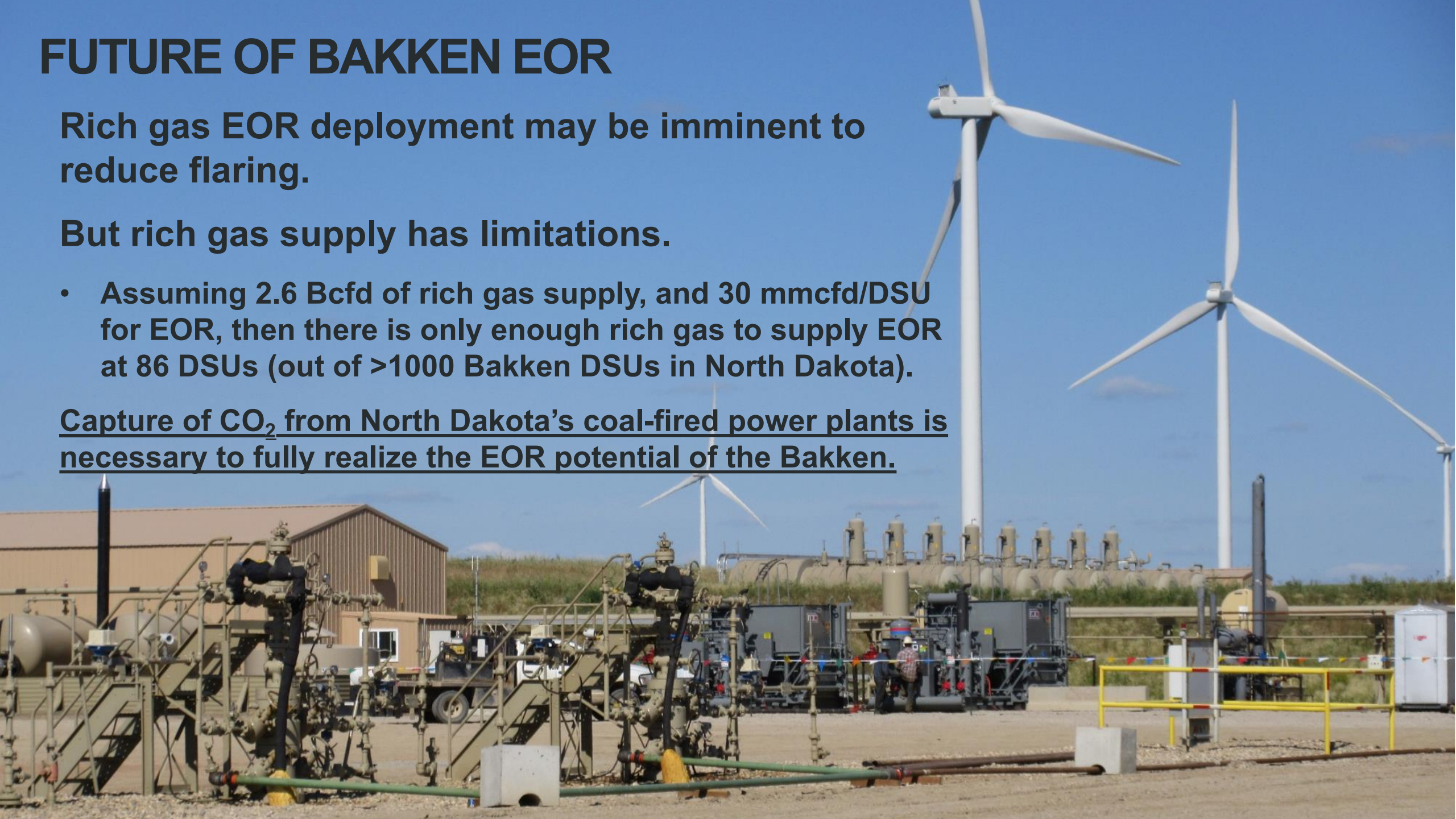
FUTURE OF BAKKEN EOR

Rich gas EOR deployment may be imminent to reduce flaring.

But rich gas supply has limitations.

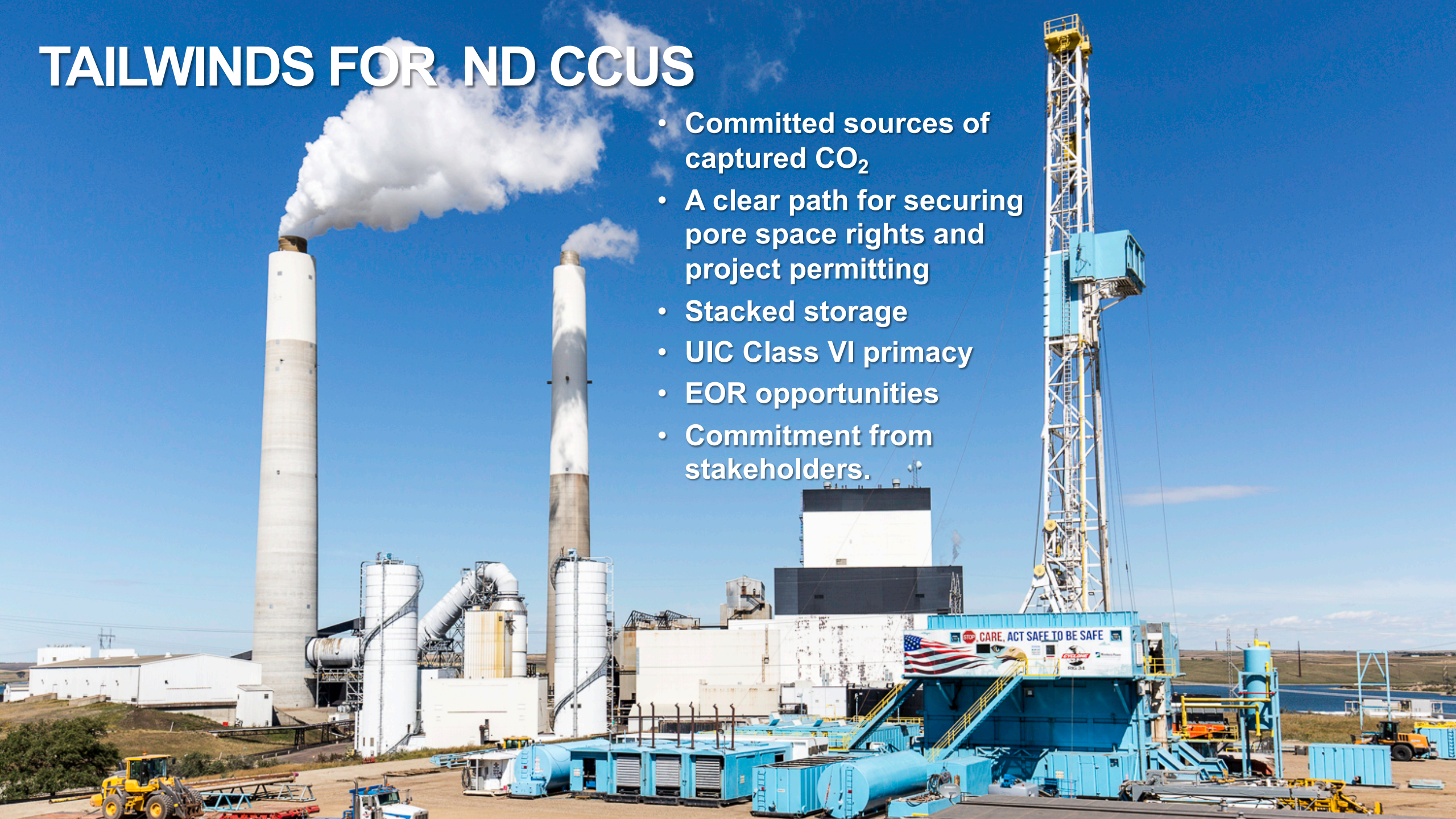
- Assuming 2.6 Bcfd of rich gas supply, and 30 mmcfd/DSU for EOR, then there is only enough rich gas to supply EOR at 86 DSUs (out of >1000 Bakken DSUs in North Dakota).

Capture of CO₂ from North Dakota's coal-fired power plants is necessary to fully realize the EOR potential of the Bakken.



TAILWINDS FOR ND CCUS

- Committed sources of captured CO₂
- A clear path for securing pore space rights and project permitting
- Stacked storage
- UIC Class VI primacy
- EOR opportunities
- Commitment from stakeholders.



THANK YOU





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NORTH DAKOTA

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A wide-angle photograph of a university campus during sunset. The sun is low on the horizon, casting a warm glow over the scene. In the foreground, there are large trees with some yellowing leaves. In the background, several multi-story brick buildings and a parking lot with many cars are visible under a clear sky.

THANK YOU

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