



EERC[®]



U N I V E R S I T Y O F
NORTH DAKOTA[®]



Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

EERC OVERVIEW

Presented to the North Dakota Senate Energy &
Natural Resources Committee

January 5, 2023

Charles D. Gorecki
CEO

EERC VISION

TO LEAD THE WORLD IN
DEVELOPING SOLUTIONS
TO ENERGY AND ENVIRONMENTAL
CHALLENGES.

EERC QUICK FACTS FY22



FISCAL YEAR FUNDING
\$76 MILLION

TOTAL ACTIVE
CONTRACTS



179

77%
OF CONTRACTS
WERE WITH

PRIVATE
INDUSTRY



ECONOMIC
IMPACT
IN THE GRAND
FORKS REGION



\$108.3
MILLION

DIVERSE EXPERTISE

AND CAPABILITIES TO IMPACT THE WORLD





**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**

OUR FACILITIES

254,000 SQ FT OF FACILITIES

A STATE OF AG AND ENERGY



Image Credit – Steve Shook

In 2019, North Dakota energy consumption was 0.67 quads (39th).

Energy consumption per capita that same year was 0.0009 quads (3rd).

Industrial energy consumption that same year was 0.36 quads.

But...North Dakota is 6th in overall U.S. energy production.

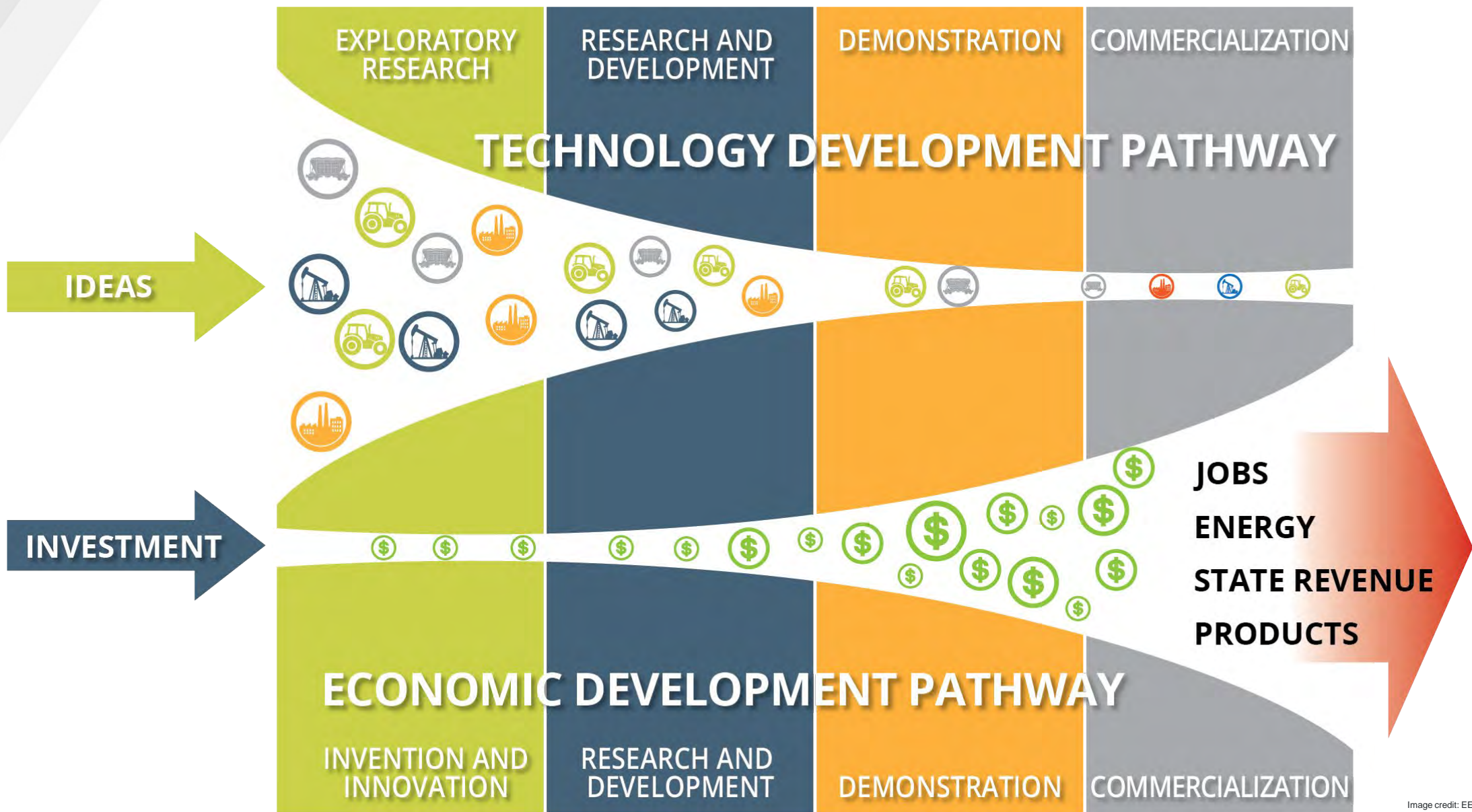
And a leader in agricultural products.

It takes energy to feed and power the world.

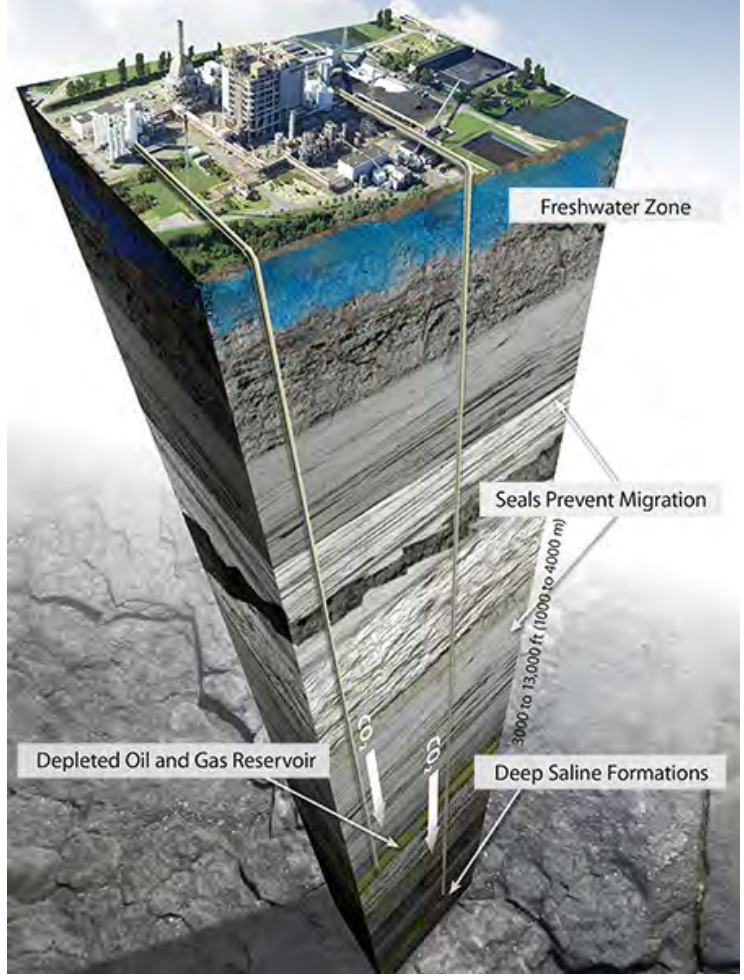


Data sourced from U.S. Energy
Information Administration
Image credit: EERC

RESEARCH



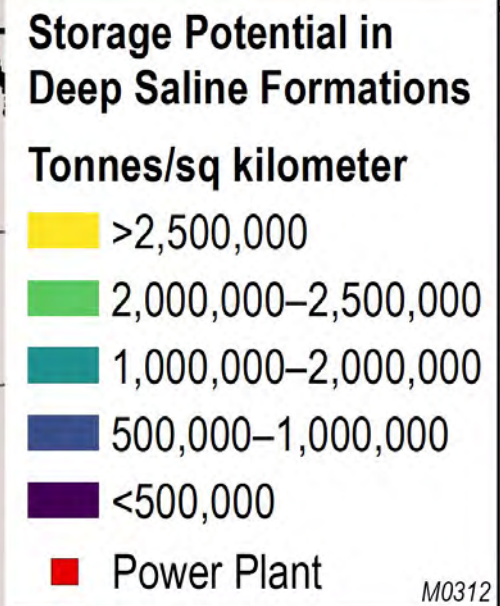
CO₂ CAN BE MANAGED



Active and Developing CCUS Projects in the PCOR Partnership Region

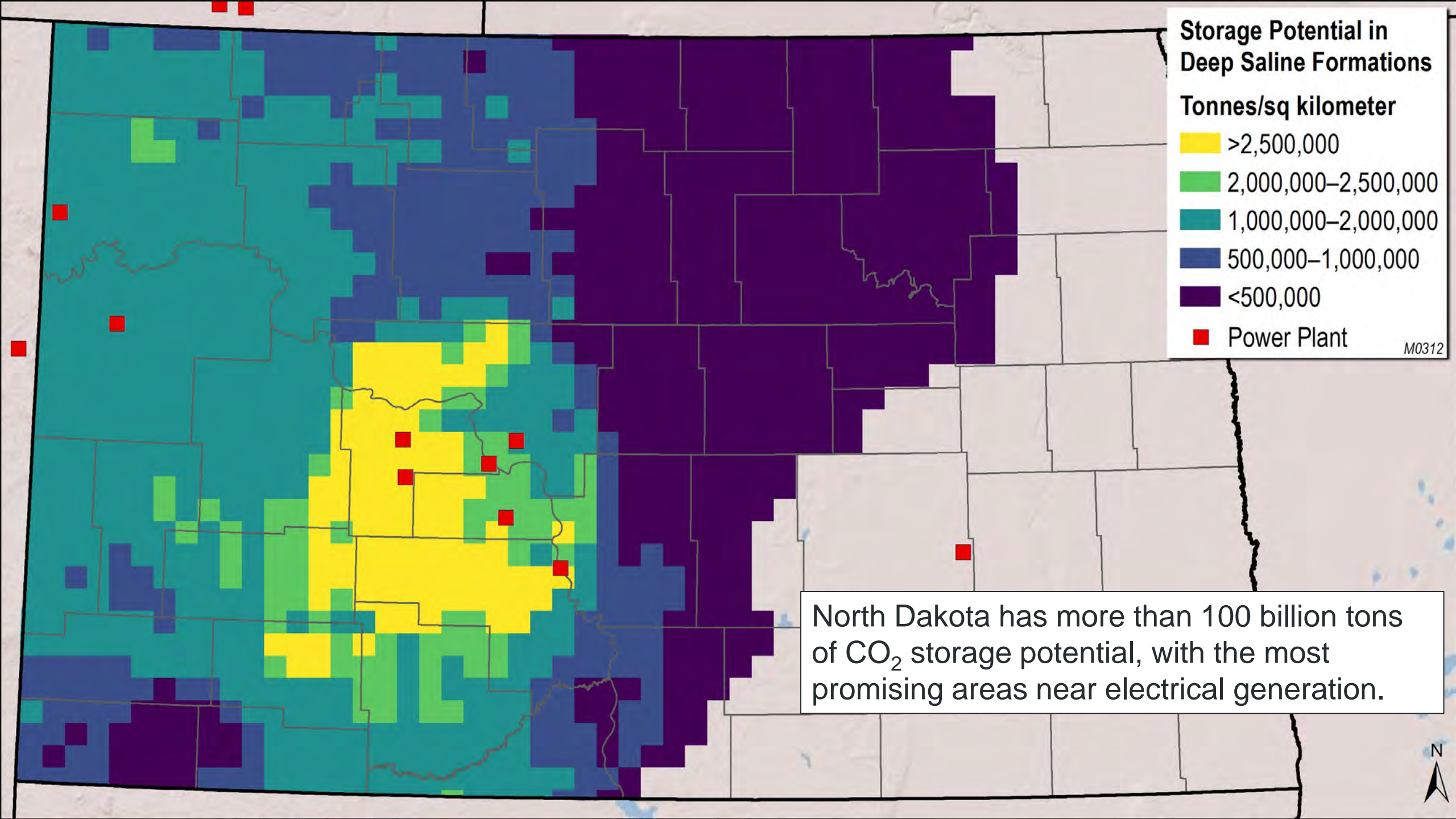
- Active Capture
- ▼ Active Injection
- Developing Capture
- ▽ Developing Injection
- CO₂ Pipeline
- - - Proposed CO₂ Pipeline





M0312

North Dakota has more than 100 billion tons of CO₂ storage potential, with the most promising areas near electrical generation.



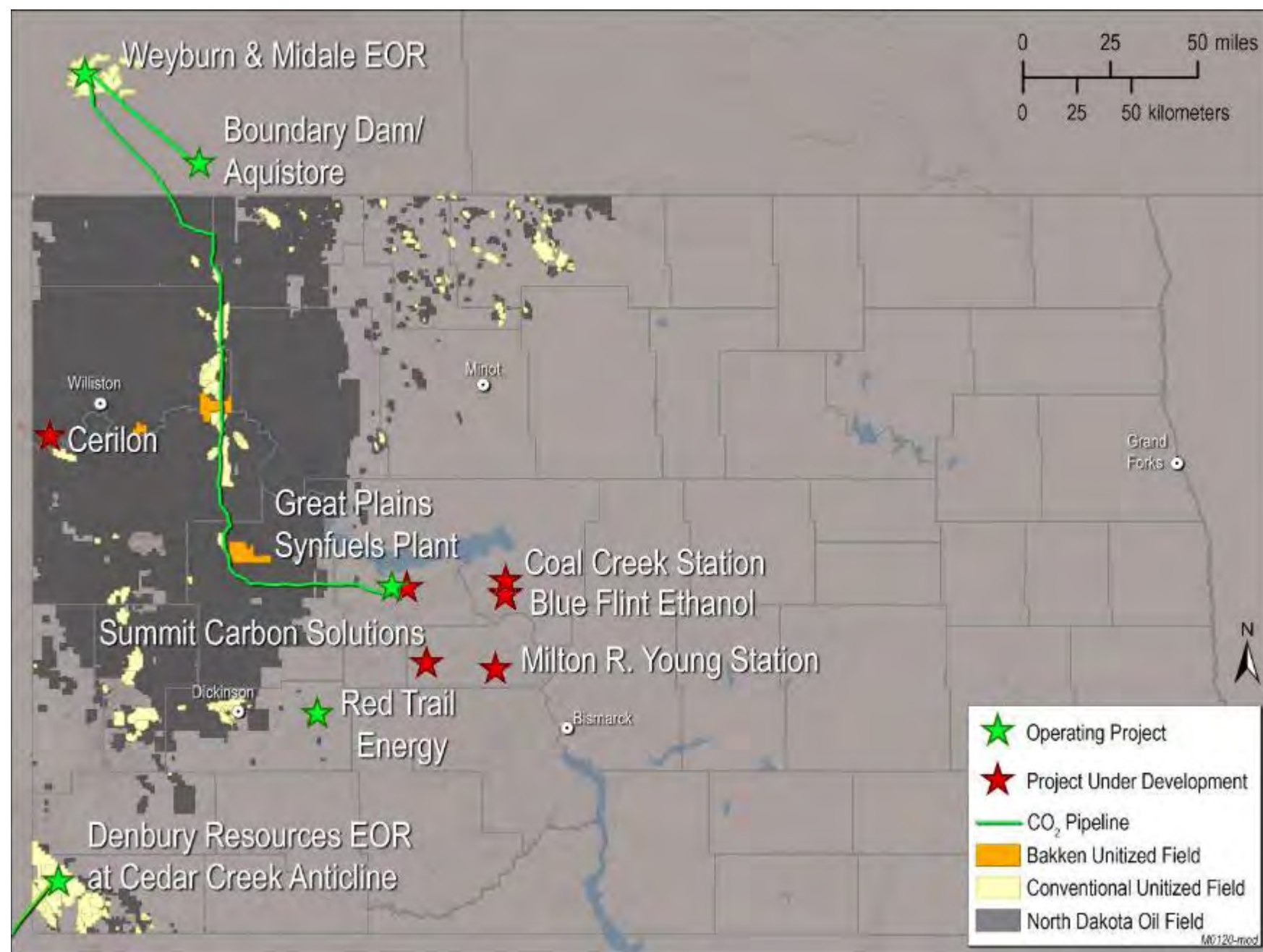
NORTH DAKOTA CCUS ACTIVITY

Approved permits:

- Red Trail Energy
- Minnkota (Milton R. Young Station)

Pending permits:

- Great Plains Synfuels Plant
- Blue Flint Ethanol



Red Trail Energy

- RTE announced June 16, 2022 as the official start date of CCS operations.
- RTE is capturing 100% of CO₂ from the fermentation process and is injecting approximately 500 metric tons of CO₂ per day into the Broom Creek Formation.



RTE



Images Credit: Red Trail Energy



IS.

PROJECT TUNDRA

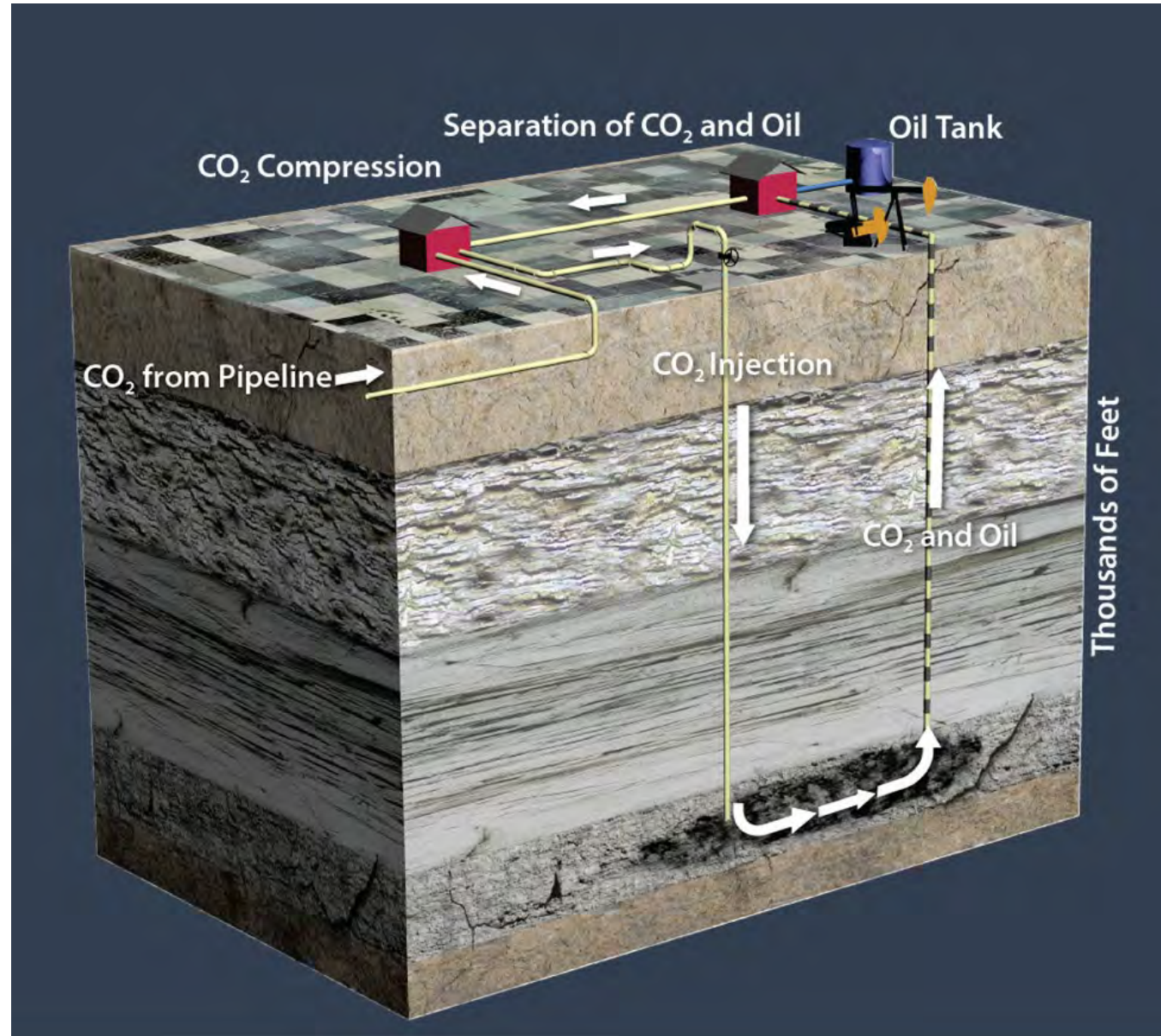


COAL CREEK STATION




RAINBOW
ENERGY CENTER

ENHANCED OIL RECOVERY (EOR)



EOR in North Dakota Legacy (conventional) Fields – Size of the Prize

Identified

201

Conventional Oil Fields

Requiring

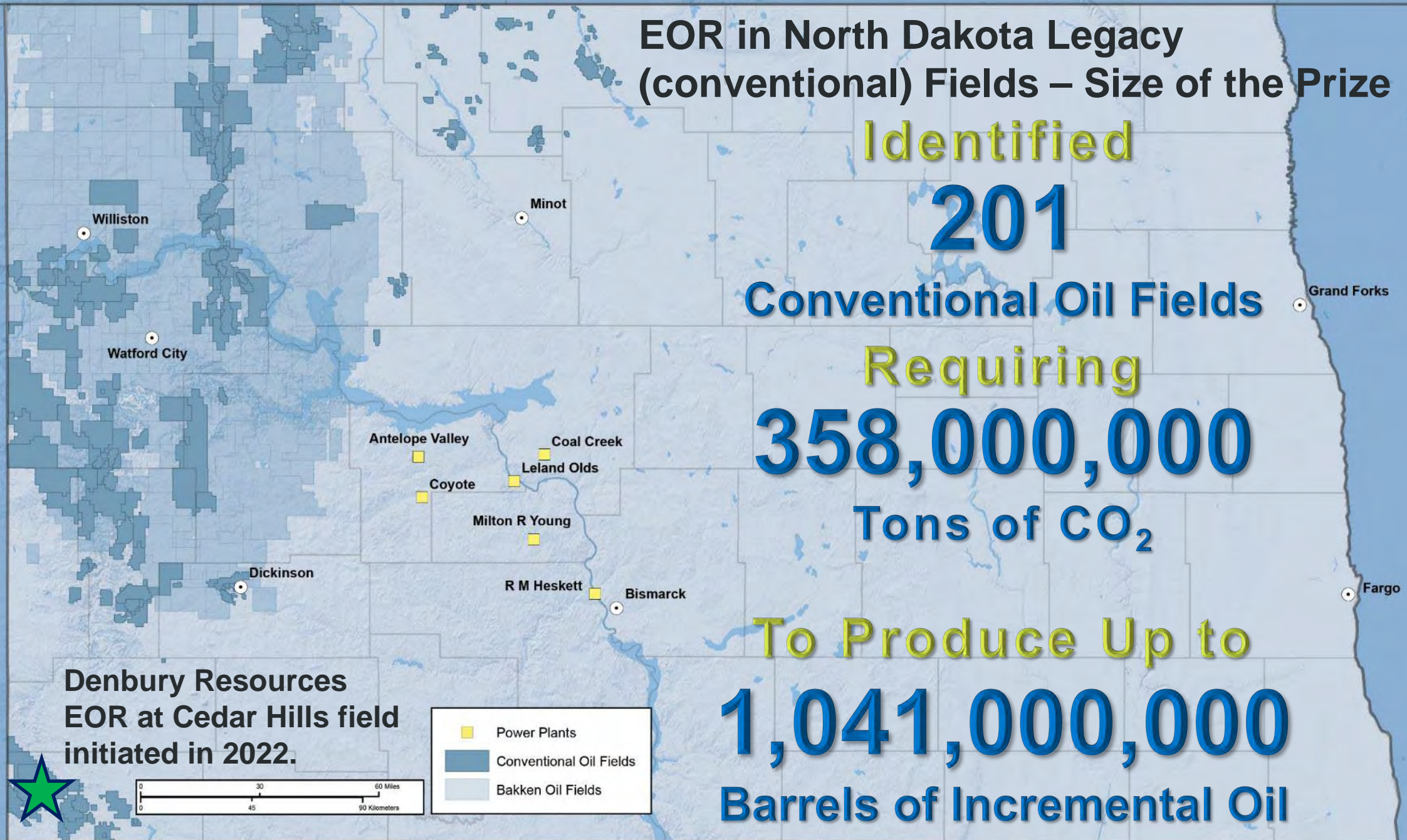
358,000,000

Tons of CO₂

To Produce Up to

1,041,000,000

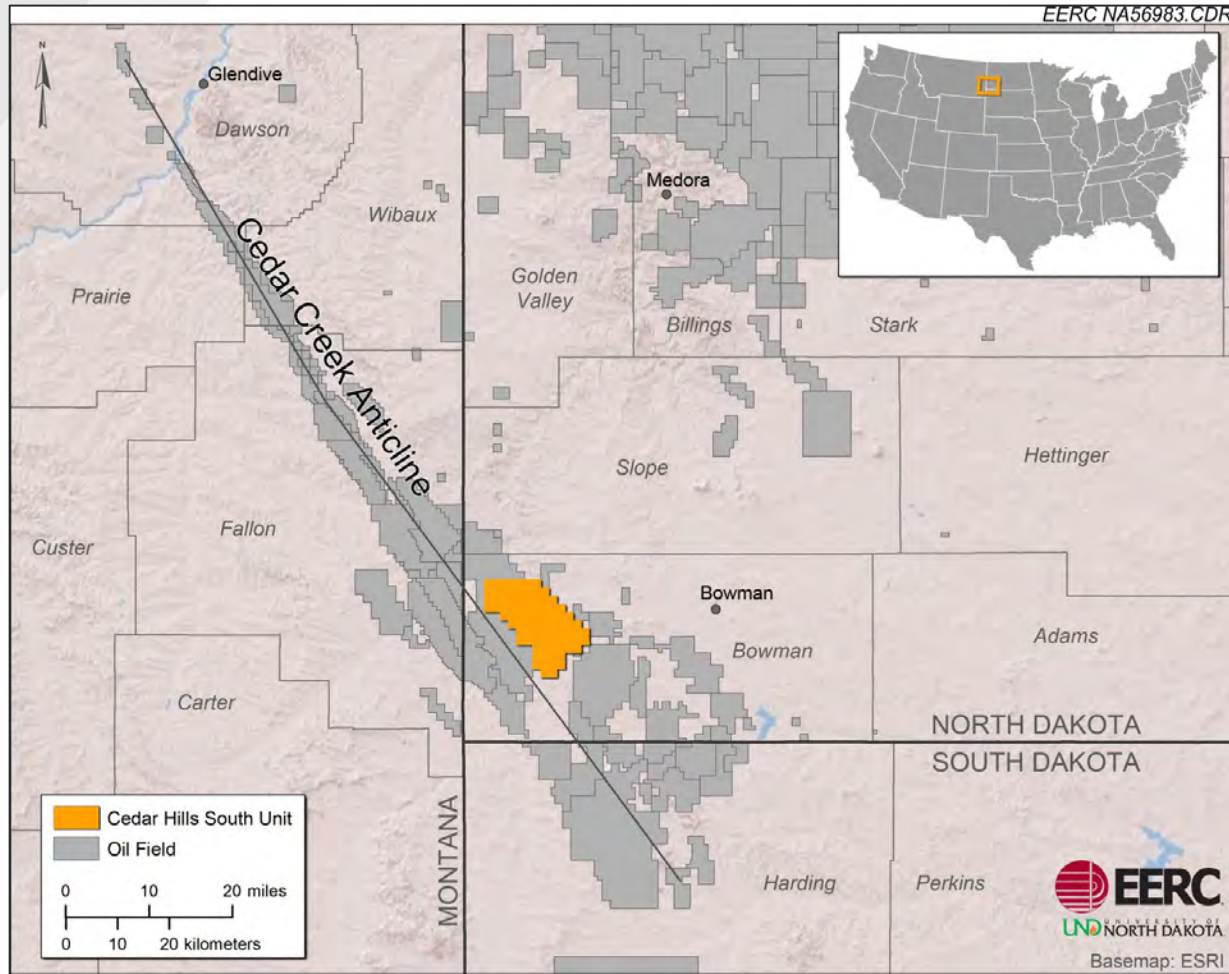
Barrels of Incremental Oil



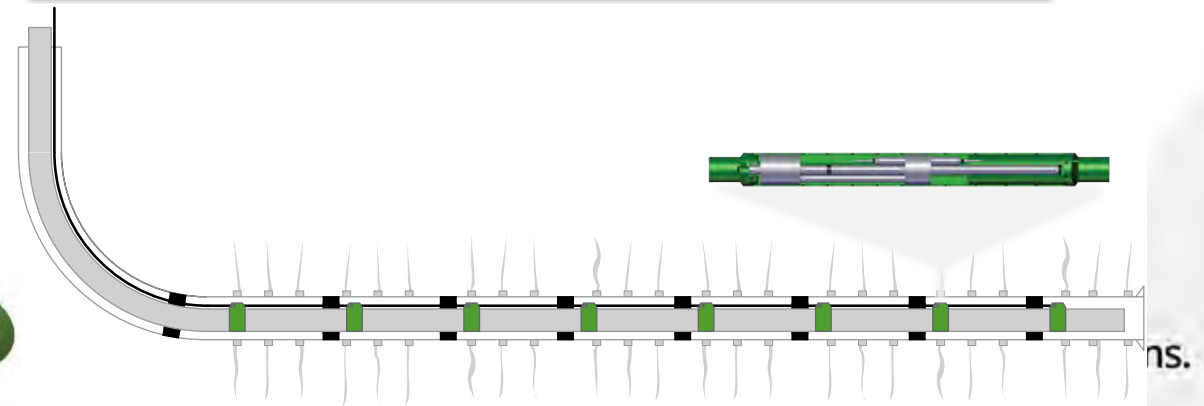
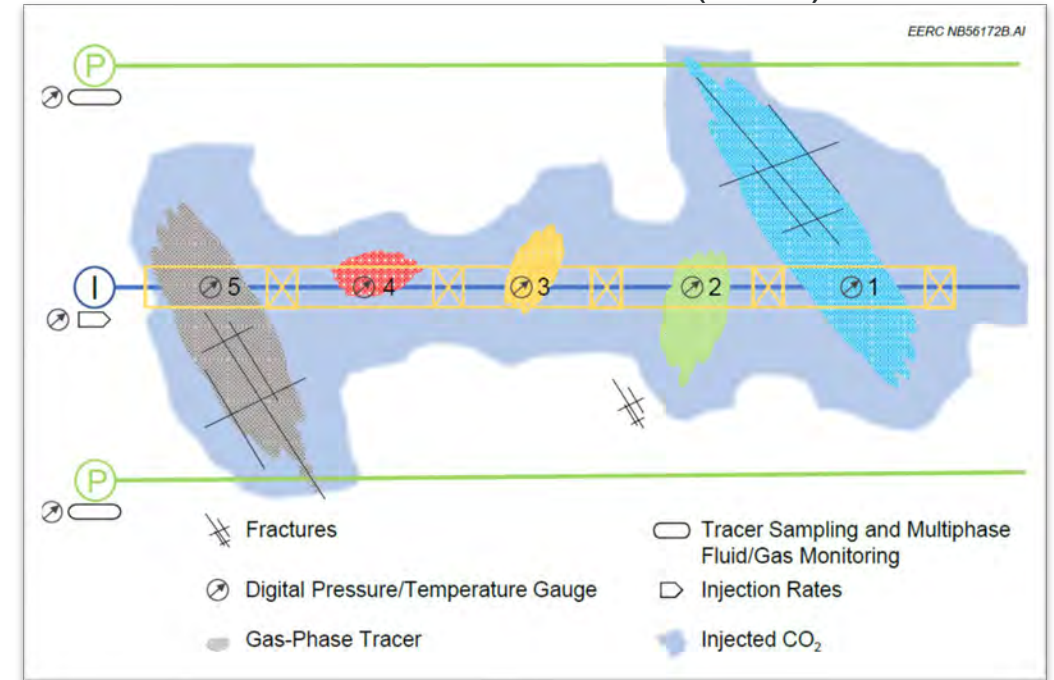
Denbury Resources
EOR at Cedar Hills field
initiated in 2022.



CEDAR CREEK ANTICLINE CO₂ EOR PILOT

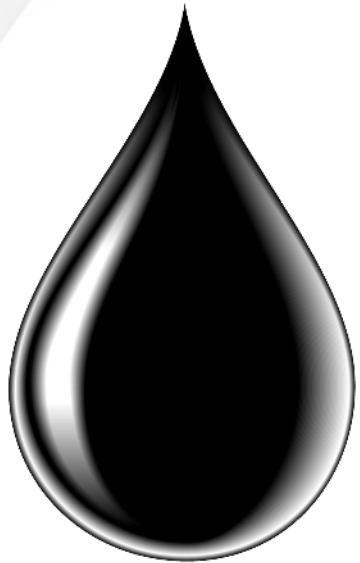


Interval Control Valves (ICVs)



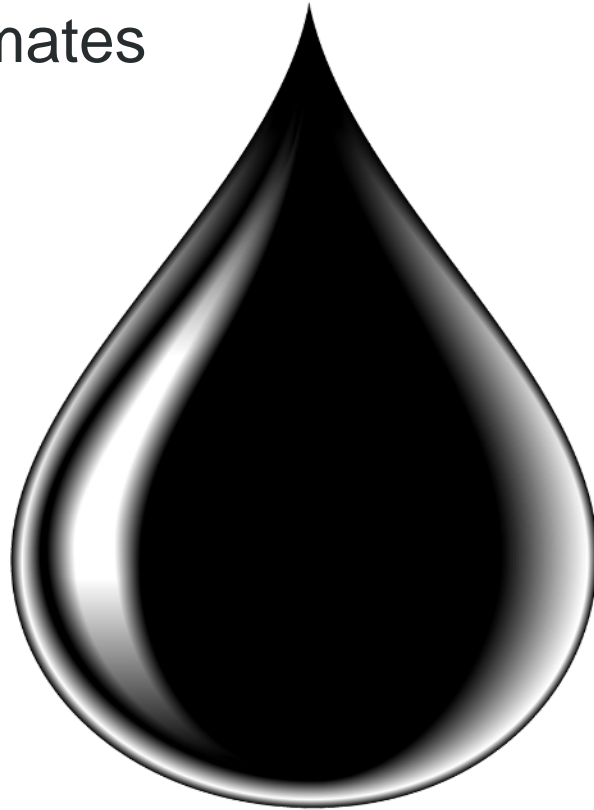
BAKKEN EOR SIZE OF THE PRIZE

OOIP Estimates



300 Bbbl

(Flannery and Kraus, 2006)



900 Bbbl

(Continental Resources, 2011)

Technically Recoverable Reserve Estimates



24 Bbbl

(Continental Resource, 2011)



7.4 Bbbl

(USGS, 2013)



4.3 Bbbl

(USGS, 2021)

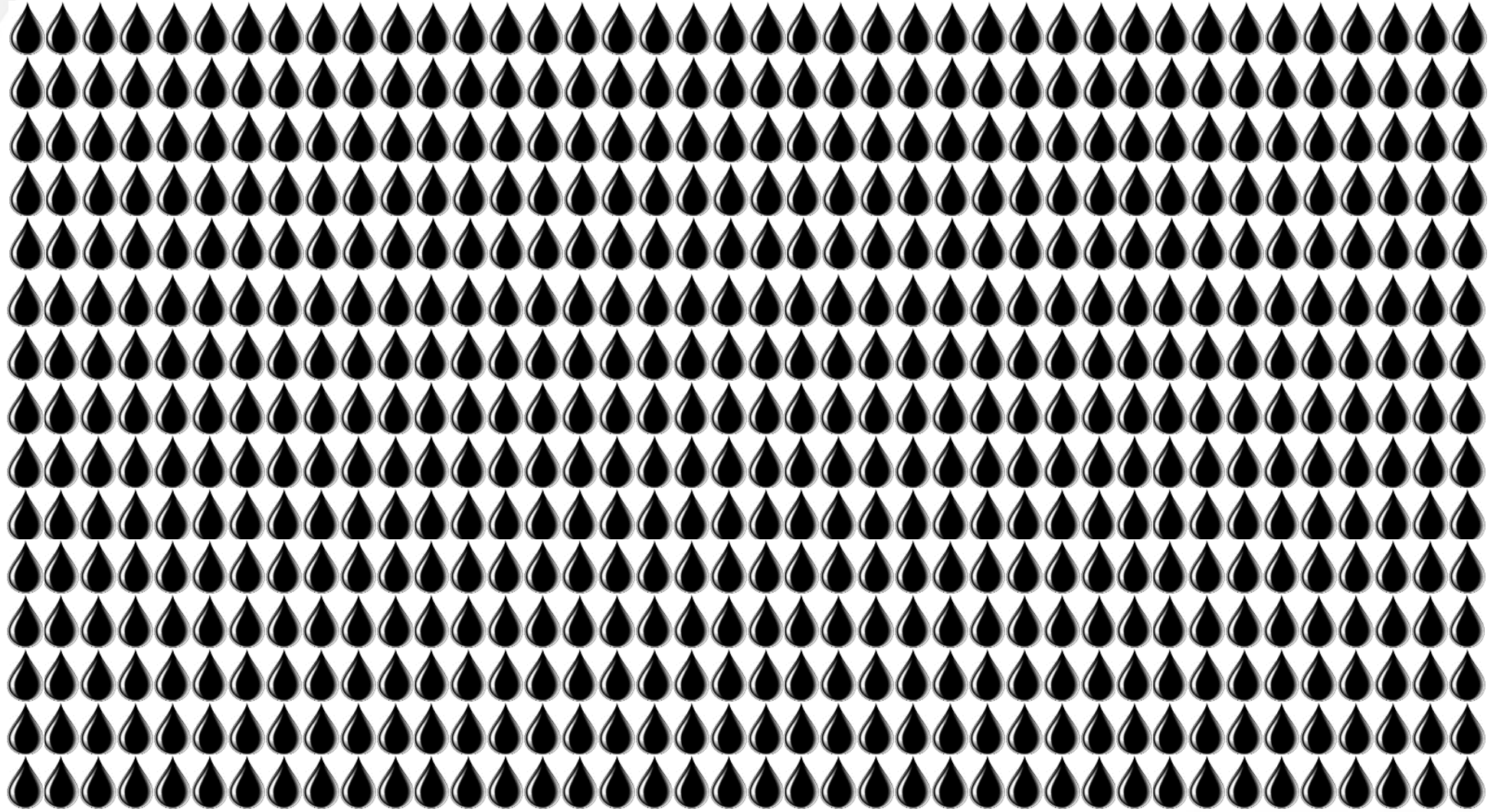
Bakken and Three Forks Production to Date



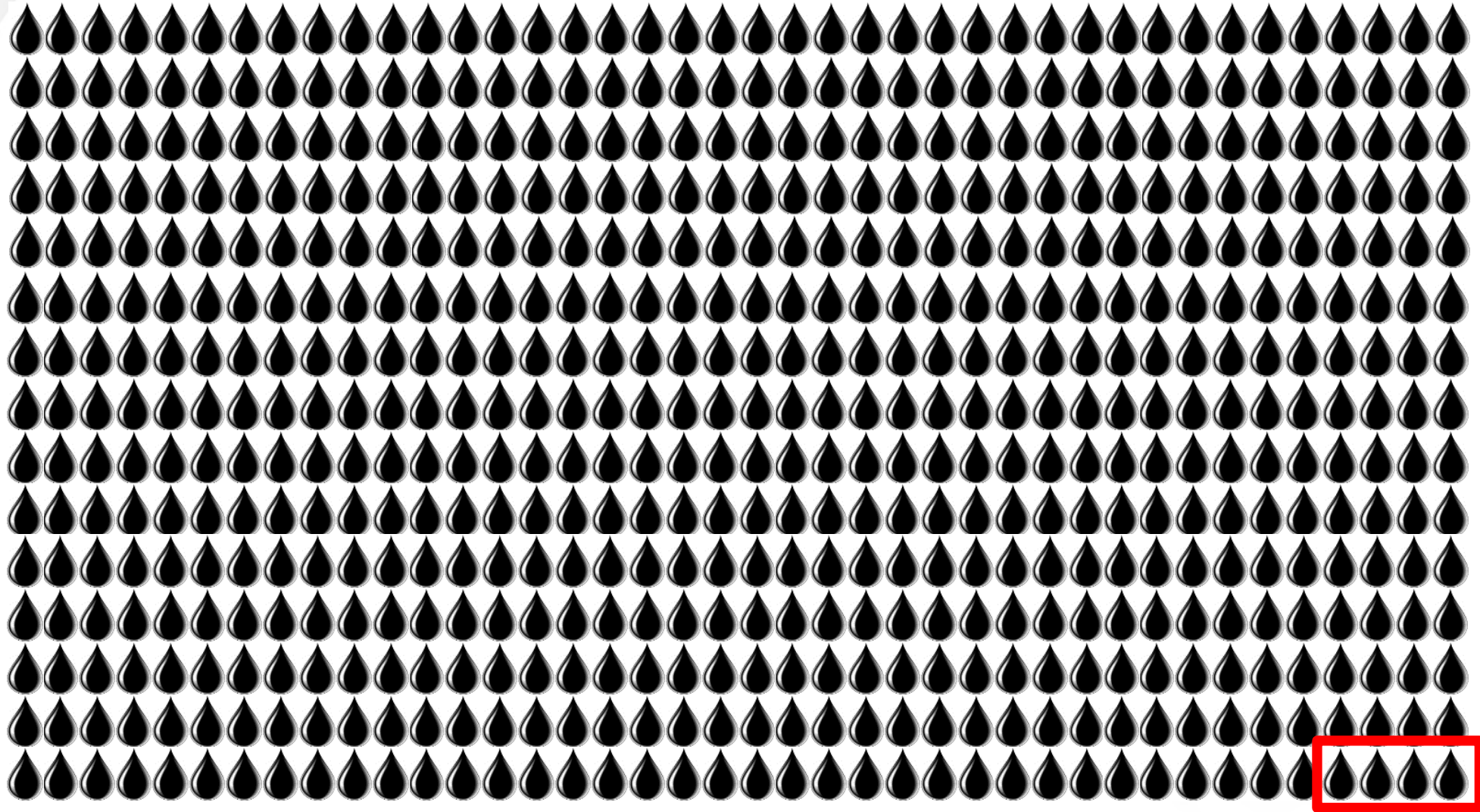
~4 Bbbl

(NDIC, 2022)

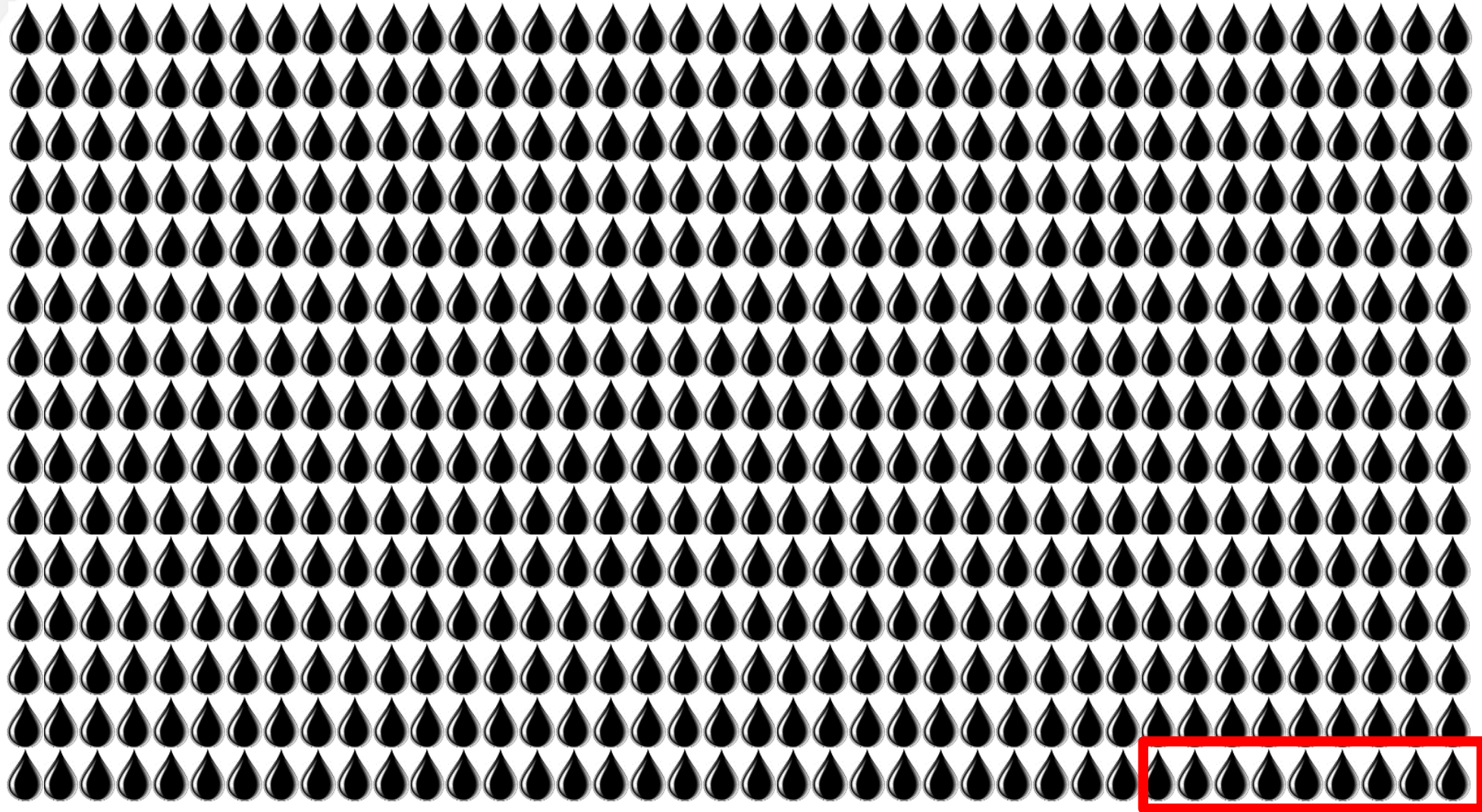
BAKKEN OIL IN PLACE



BAKKEN OIL RECOVERY



BAKKEN OIL RECOVERY BY 2033



EOR in Bakken and Three Forks – Size of the Prize

EOR in the
Bakken Using

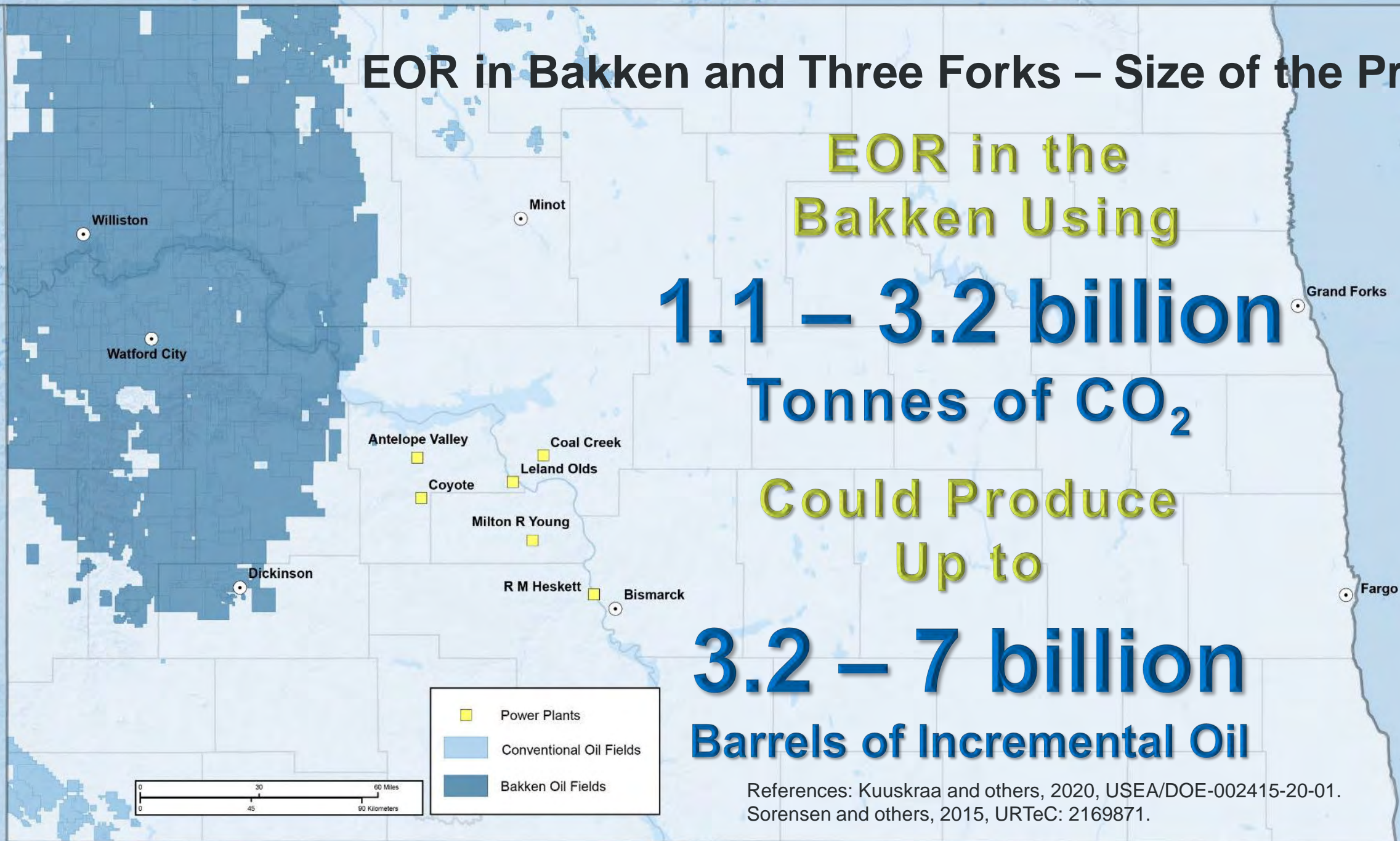
1.1 – 3.2 billion

Tonnes of CO₂

Could Produce
Up to

3.2 – 7 billion

Barrels of Incremental Oil



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



2017 – Bear Creek

Operator = XTO

Location = Dunn County

Small-scale CO₂ injection test demonstrated **ability of CO₂ to mobilize stranded oil in the Bakken.**



2018–2019 – Stomping Horse

Operator = Liberty Resources

Location = Williams County

Multi-well rich gas EOR pilot demonstrated ability to **build reservoir pressure and keep the injected gas in the drill spacing unit.**



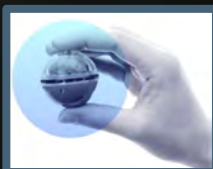
2021–2022 – East Nesson

Operator = Liberty Resources

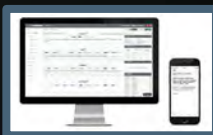
Location = Mountrail County

EOR pilot test using injection of rich gas pulsed with water and surfactant yielded **>4000 barrels of incremental oil over 9 months.**

Leak Detection Innovation



In-line inspection
“small diameter”



Artificial intelligence
monitoring



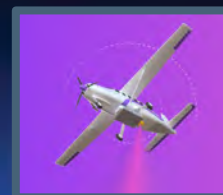
Advanced acoustics



Subsurface polymer
absorption monitoring



Intelligent sensors
for early detection
anywhere



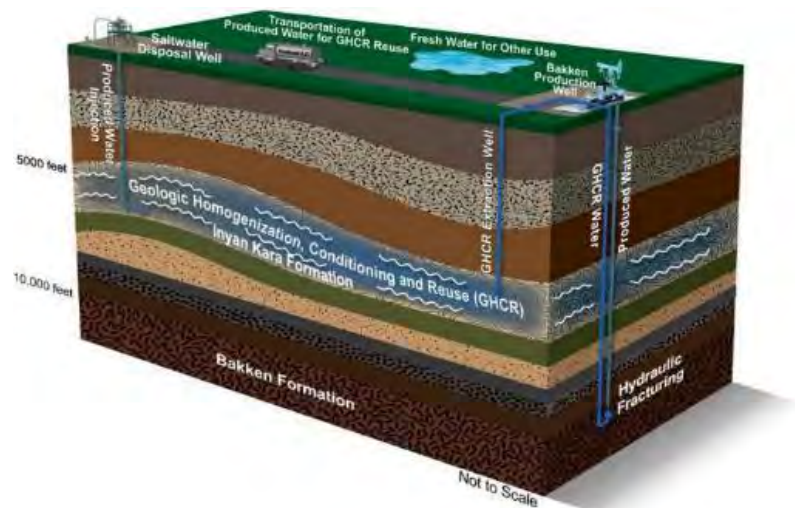
Advanced aerial
sensor technology



New generation
monitoring from
space

Brine Extraction and Storage Test, Johnsons Corner, ND

- Demonstrated active reservoir management
- Developed a brine treatment testbed
- Demonstrated geologic homogenization, conditioning, and reuse of produced water
- Reduces rate and magnitude of pressurization of formation as a result of SWD
- Potential to integrate CO₂ storage through carbonated brine injection



Achieve Near-Zero Flaring

Increase the environmental competitiveness of North Dakota oil

Continue to attract investment and jobs

Generate additional revenue

Polar BearSM

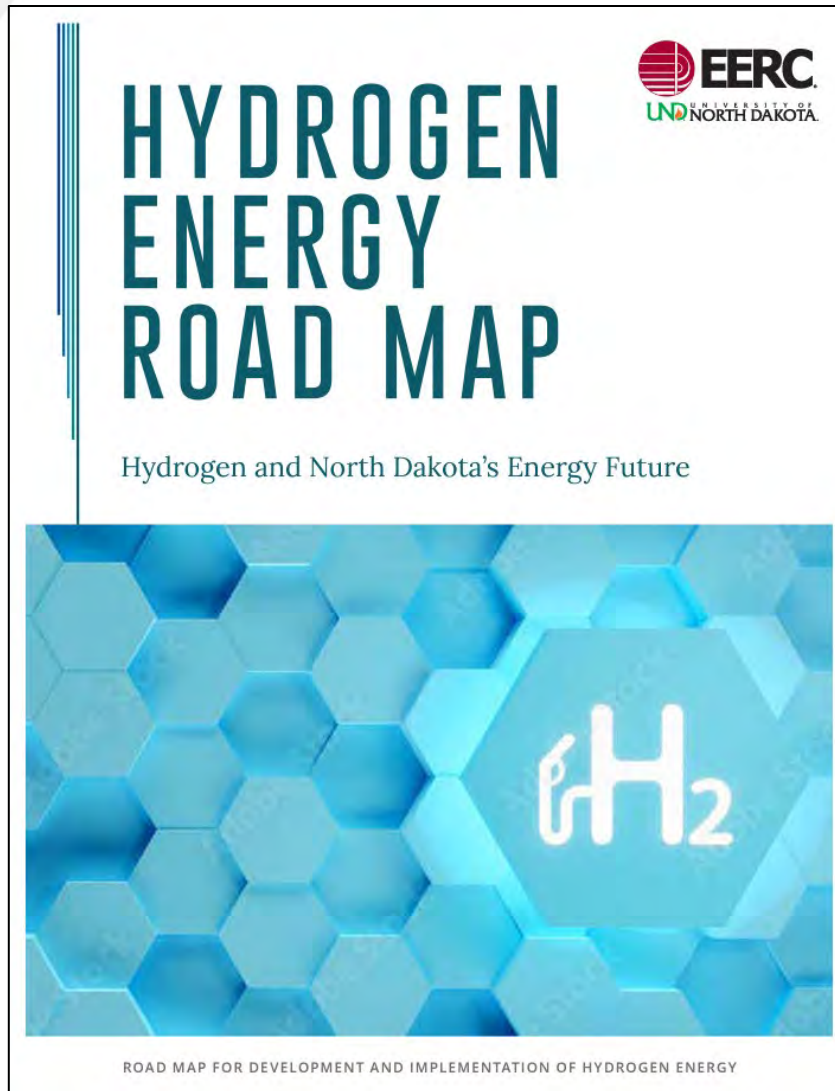
- Robust
- Adaptive
- Environmentally Sensitive



Critical Challenges. Practical Solutions.

HYDROGEN ENERGY ROAD MAP UPDATE

Senate Bill 2014 of the 2020 North Dakota Legislature



Interim Report Topics

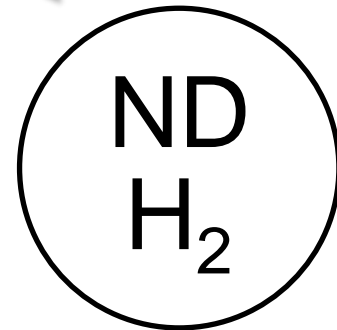
- Basis for Hydrogen
- Producing Low-Carbon Hydrogen
- Working with Hydrogen
- Opportunities for North Dakota
- Hydrogen Policy

Critical Challenges. Practical Solutions.

OPPORTUNITIES FOR NORTH DAKOTA

Hydrogen produced from:

- Natural gas reforming with carbon sequestration
- Water electrolysis using low-carbon electricity



**Petroleum and
Crop Oil Refining**



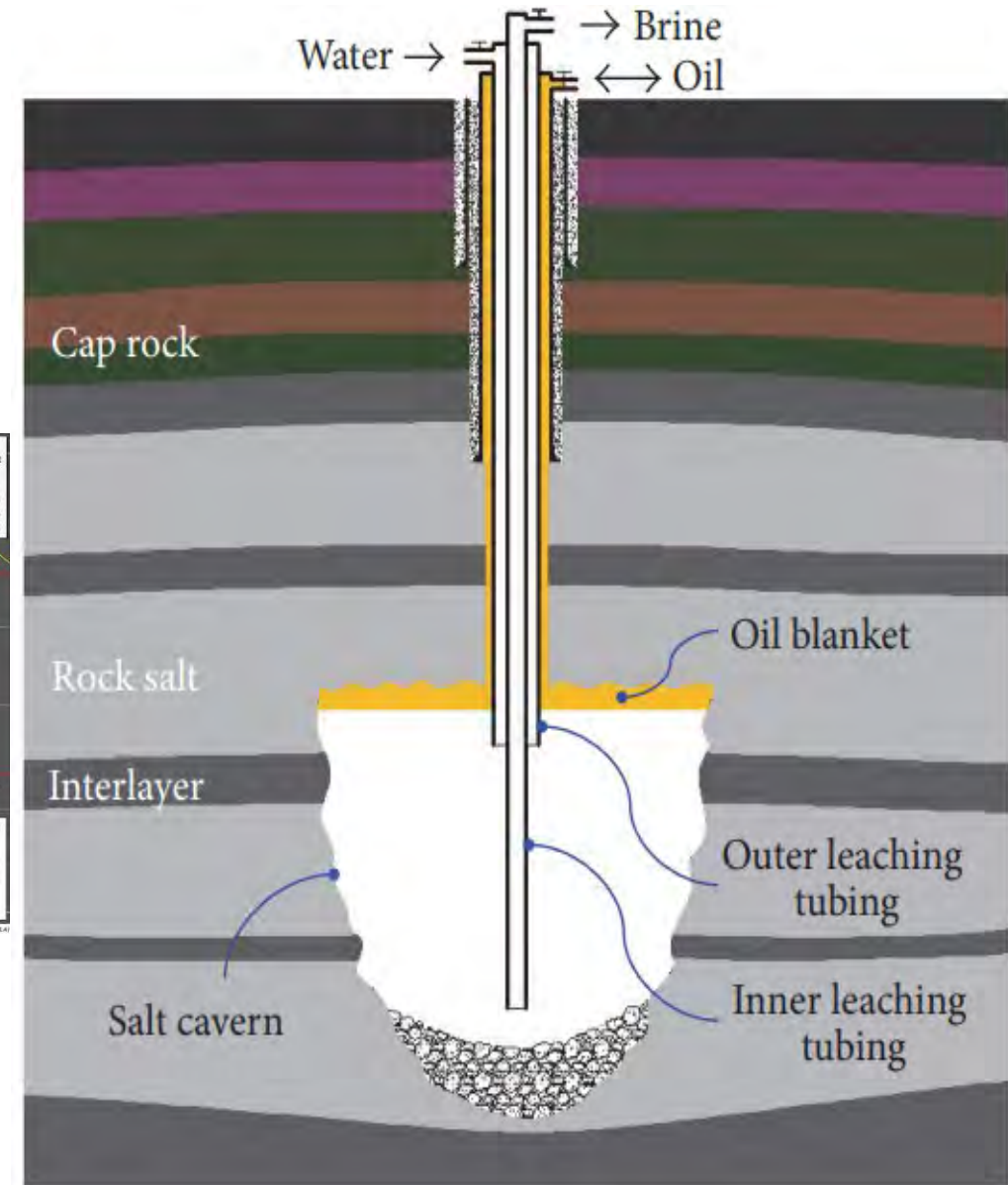
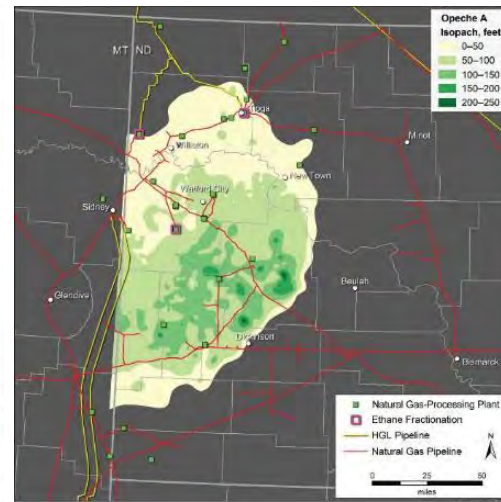
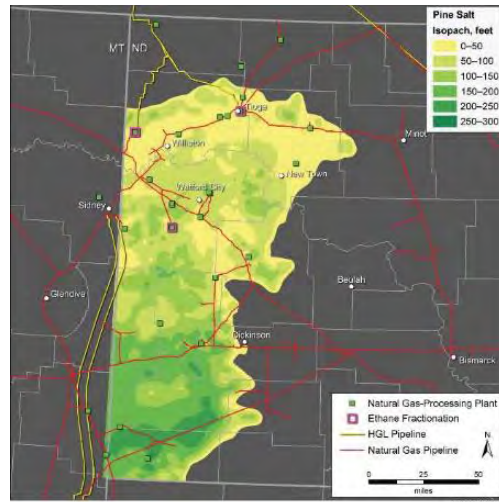
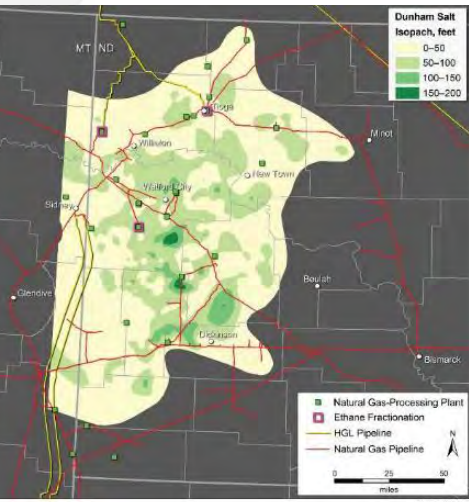
**Natural Gas
Pipeline Blending**



**Low-Carbon
Ammonia**

Critical Challenges. Practical Solutions.

CHARACTERIZATION OF SALT FORMATIONS



Salt cavern storage could support petrochemical and energy industries.

CHARACTERIZATION OF NORTH DAKOTA'S SALT FORMATIONS

- A primary goal of the project was to drill a characterization well to investigate North Dakota's subsurface salt beds.
- Core and logs were collected from target salt formations.
- Preliminary results indicate that N.D. salts have thicknesses and compositions similar to other areas in North America where caverns have been developed in bedded salts.

Salt caverns can be used to store hydrogen and natural gas liquids (i.e., propane, ethane), thereby helping to grow N.D.'s energy and petrochemical industries.



NEXT STEPS

- Core analysis interpretation
- Geologic modeling
- Geomechanical simulation to determine cavern geometry and stability
- Engineering assessment of infrastructure and facility needs

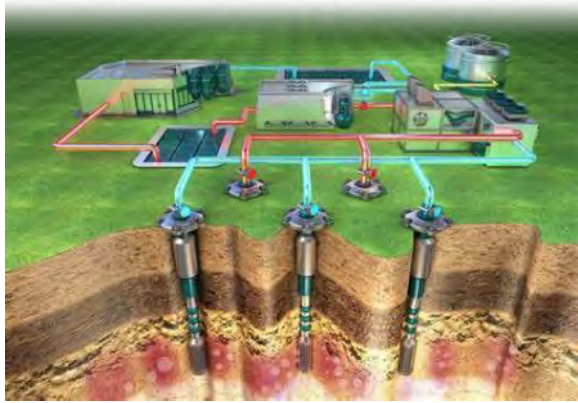


Preliminary results are promising and indicate that N.D. salt members may be thick enough and have the right composition to develop subsurface caverns.

RARE-EARTH ELEMENTS AND CRITICAL MINERALS

The EERC is developing new and innovative ways to extract REEs and CMs from:

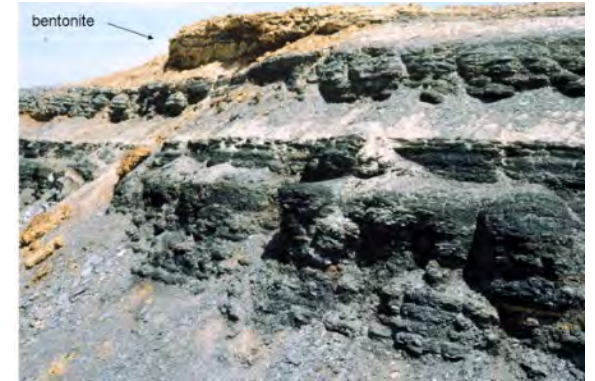
Deep, Unminable Coal Seams by In Situ Extraction



Existing Lignite Coal Mines



ND Shales – Pierre, Niobrara, Upper and Lower Bakken

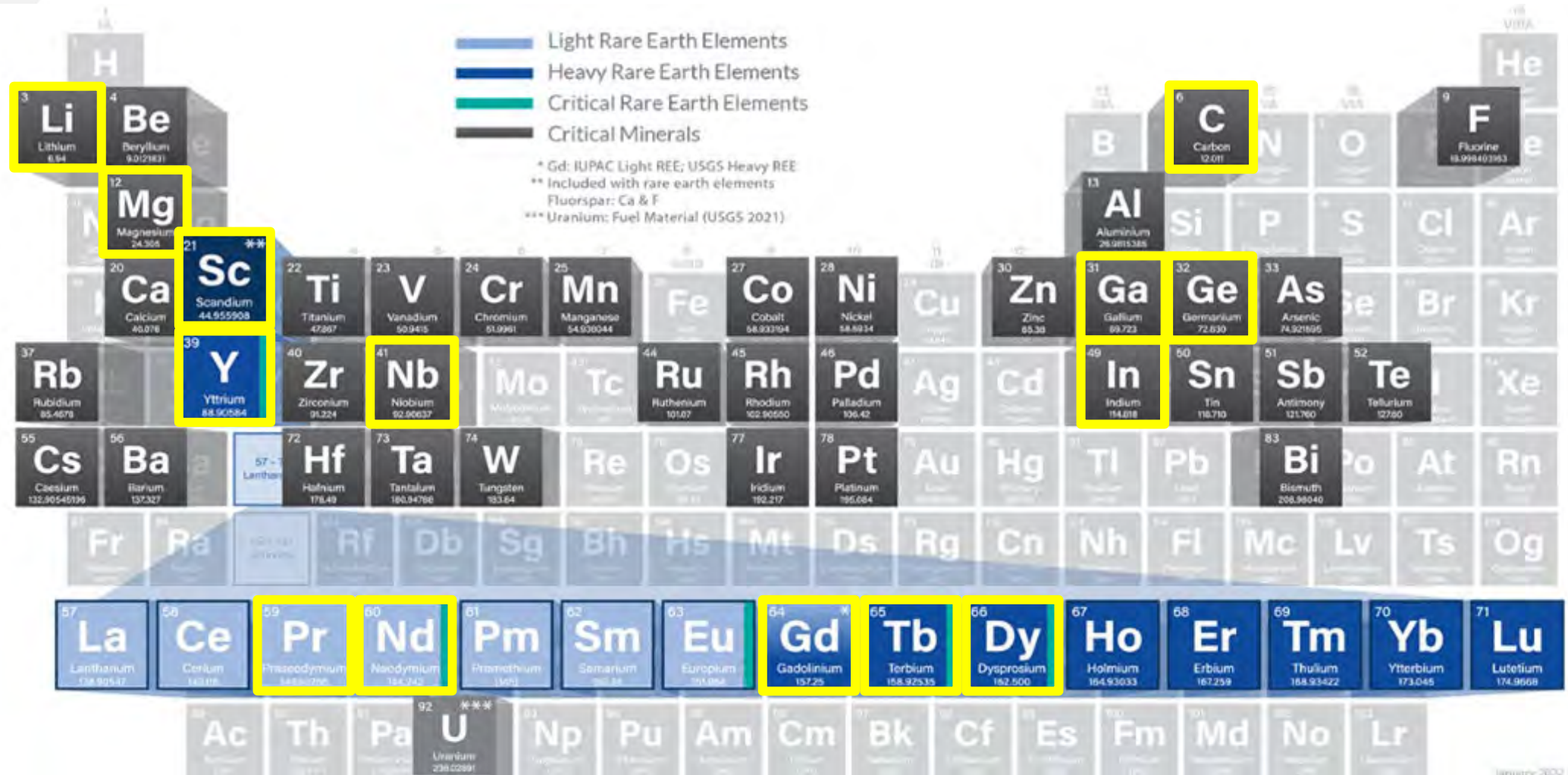


Coal Ash



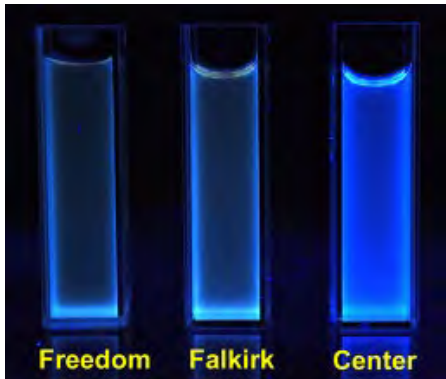
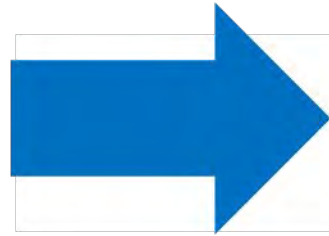
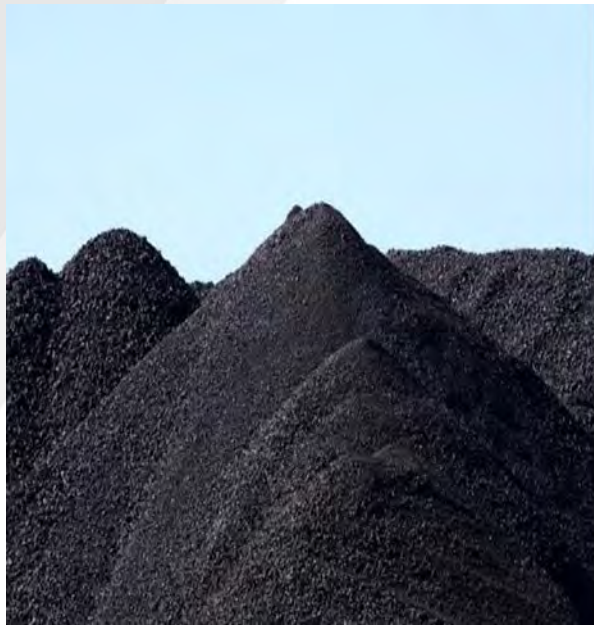
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Elements with Greatest Potential to Contribute to the Williston Basin Market



January 2022

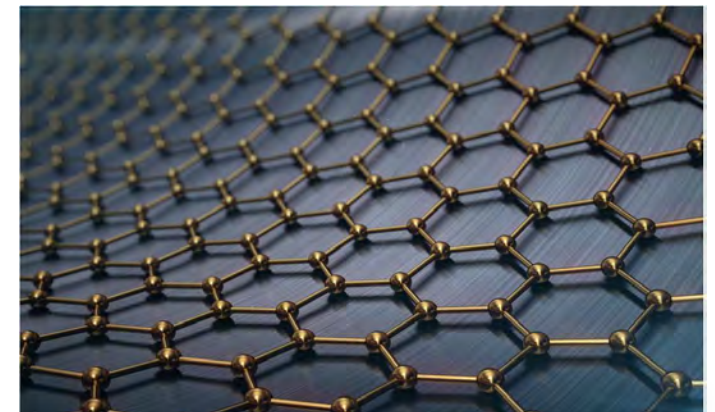
GRAPHITE AND GRAPHENE FROM N.D. LIGNITE



Graphene Quantum Dots



N.D. Lignite-Derived Graphite



Graphene Sheet

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LOW-WEIGHT, HIGH-STRENGTH COAL-BASED BUILDING MATERIALS FOR INFRASTRUCTURE PRODUCTS



ROOFING MATERIALS

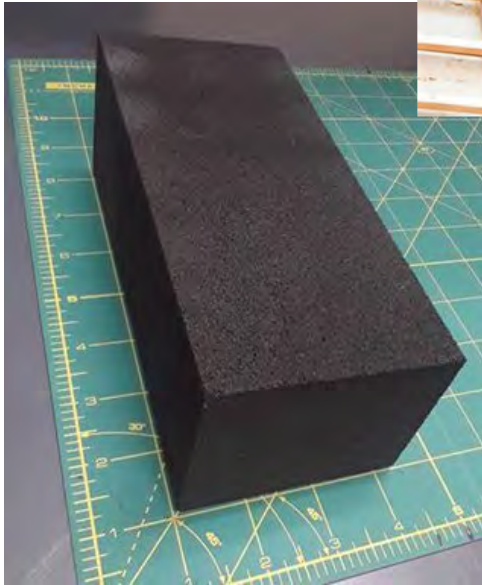
Coal-core composites provide light weight, low cost, and high-volume roofing materials.

DECKING AND SIDING

Coal plastic composite (CPC) decking boards reduce manufacturing costs compared to commercial wood plastic composite (WPC) decking boards and meet all applicable ASTM and International Building Code (IBC) performance specifications.

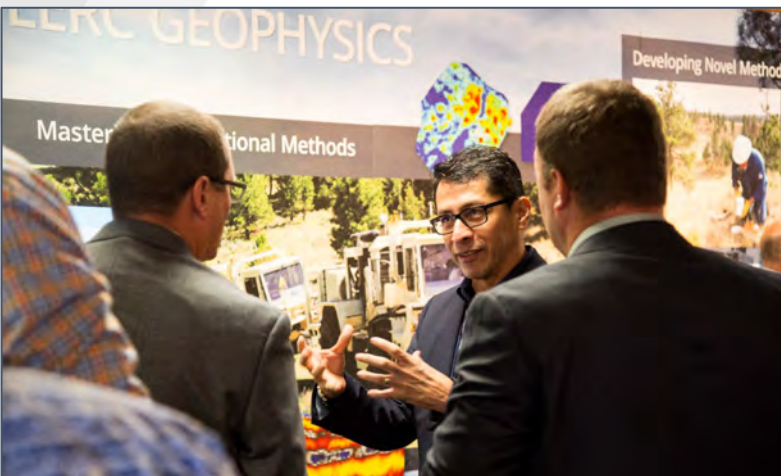
ARCHITECTURAL BLOCK AND BRICK

Coal-derived materials added to block and brick formations enable improved structural and thermal insulation properties.



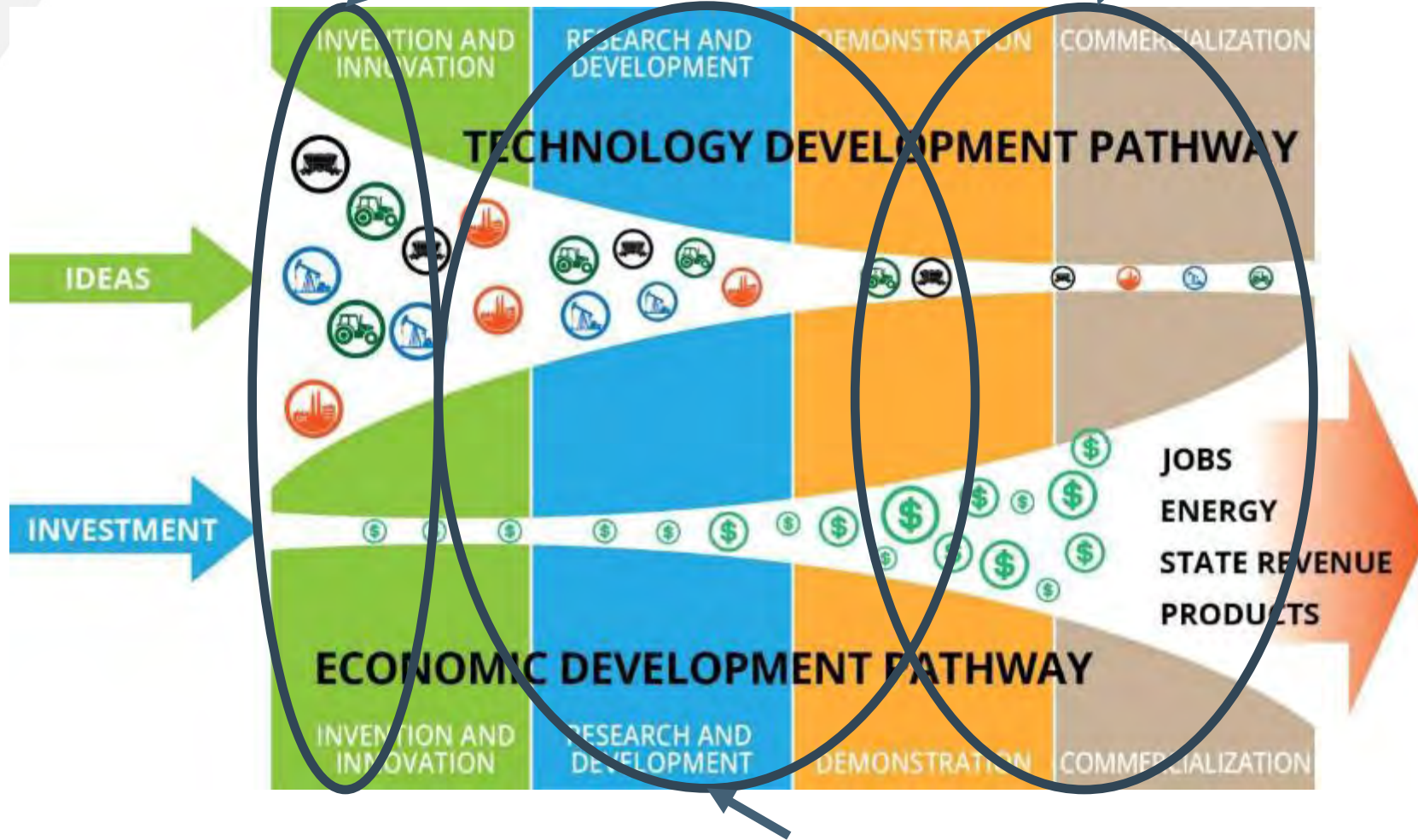
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EDUCATE THE WORLD!

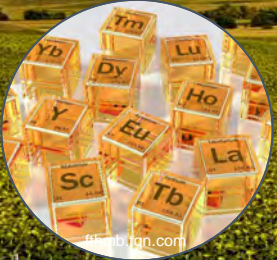
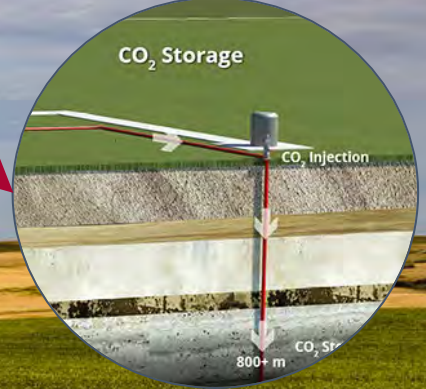
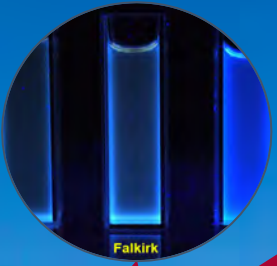
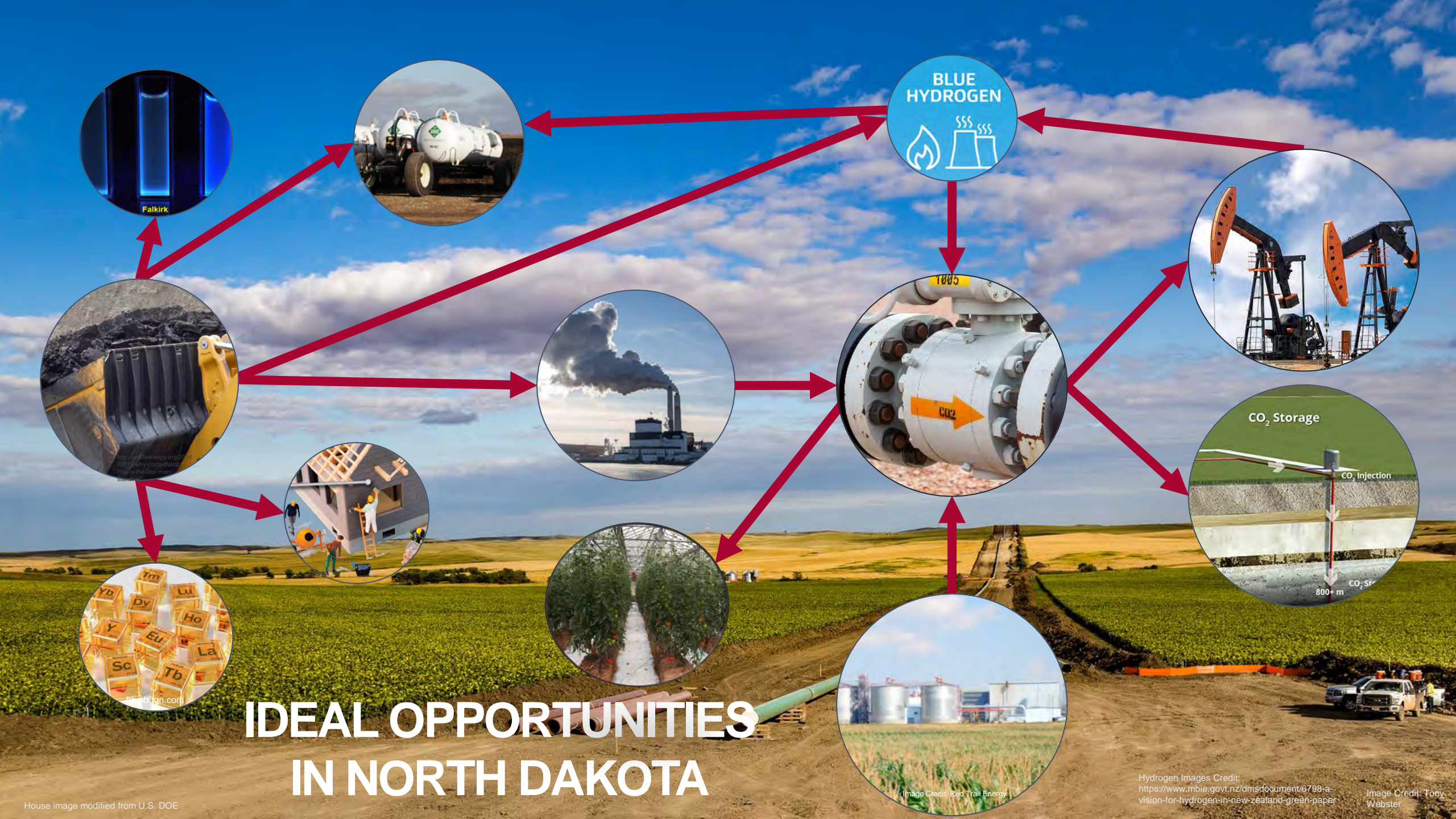


State Energy Research Center

Clean Sustainable Energy Authority



Lignite, Oil and Gas, Renewable
Research Programs, and Legislatively Directed Projects



IDEAL OPPORTUNITIES IN NORTH DAKOTA



Charles Gorecki
CEO

cgorecki@undeerc.org

701.777.5355 (phone)

**Energy & Environmental
Research Center**

University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

www.undeerc.org

701.777.5000 (phone)

701.777.5181 (fax)

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 is a green lawn. In the middle ground, there are several red brick buildings and a parking lot filled with cars. In the background, there are more buildings and a tall white tower. The sky is a mix of orange, yellow, and blue.

THANK YOU

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EERC[®]



U N I V E R S I T Y O F
NORTH DAKOTA[®]



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THE FUTURE: A CARBON-CONSTRAINED WORLD



INDUSTRY SEGMENTS DEPARTMENTS PROJECTS & EXPANSIONS RESOURCES MEDIA EVEN

Low-carbon hydrogen key to net-zero transition

BY NANCY FORD, CONTRIBUTING WRITER | JANUARY 4, 2023 | 9:07 AM

Offshore Energy

[Home](#) > [Fossil Energy](#)

Two oil & gas firms to develop CCS project that connects Germany & Norway

[CARBON CAPTURE USAGE & STORAGE](#)

August 30, 2022, by Nermina Kulovic

REFINING & PROCESSING

Global refiners prepare for low-carbon future

Global refiners in 2022 maintained investments in projects aimed at preparing their conventional oil refining operations for a low-carbon future in line with the global energy transition.

Dec. 5, 2022

Oil & Gas Journal, 1/4/2023

Reuters – 2/23/2022