



**EERC**<sup>®</sup>



U N I V E R S I T Y O F  
**NORTH DAKOTA**<sup>®</sup>



Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

# EERC OVERVIEW

Presented to the North Dakota House 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





**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**

# 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.

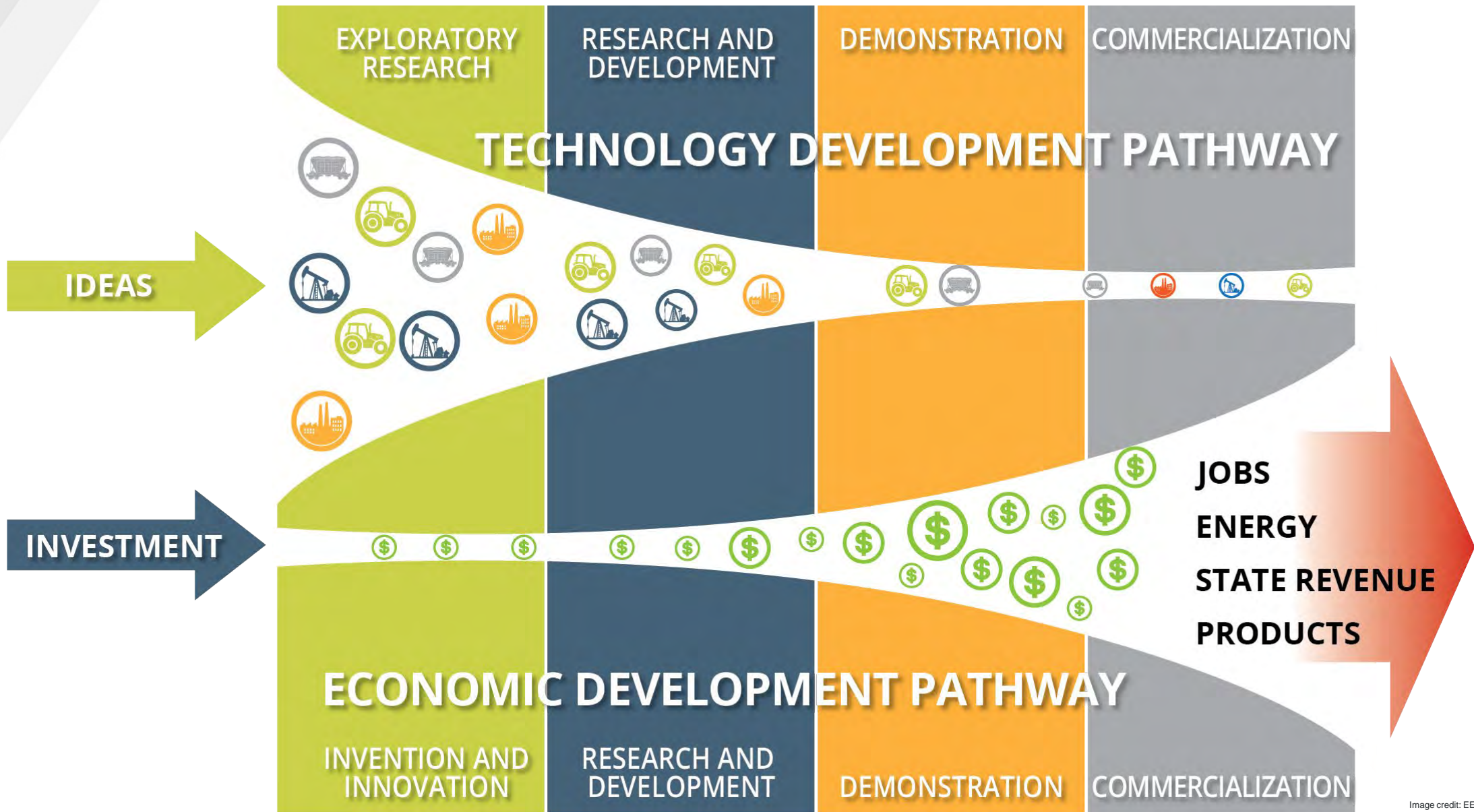
**It takes energy to feed and power the world.**



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



# RESEARCH

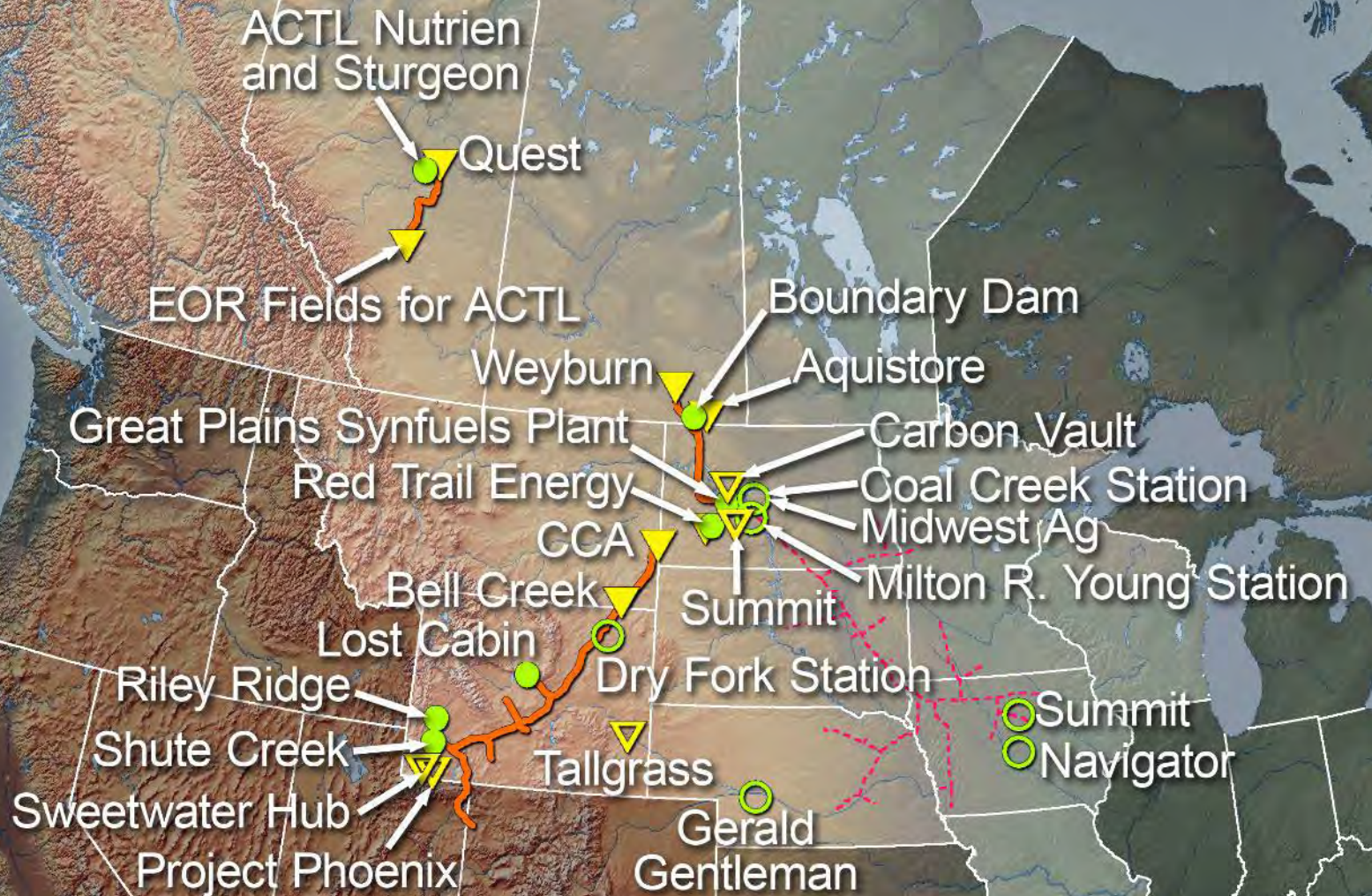


# CO<sub>2</sub> CAN BE MANAGED



## Active and Developing CCUS Projects in the PCOR Partnership Region

- Active Capture
- ▼ Active Injection
- Developing Capture
- ▽ Developing Injection
- CO<sub>2</sub> Pipeline
- - - Proposed CO<sub>2</sub> Pipeline



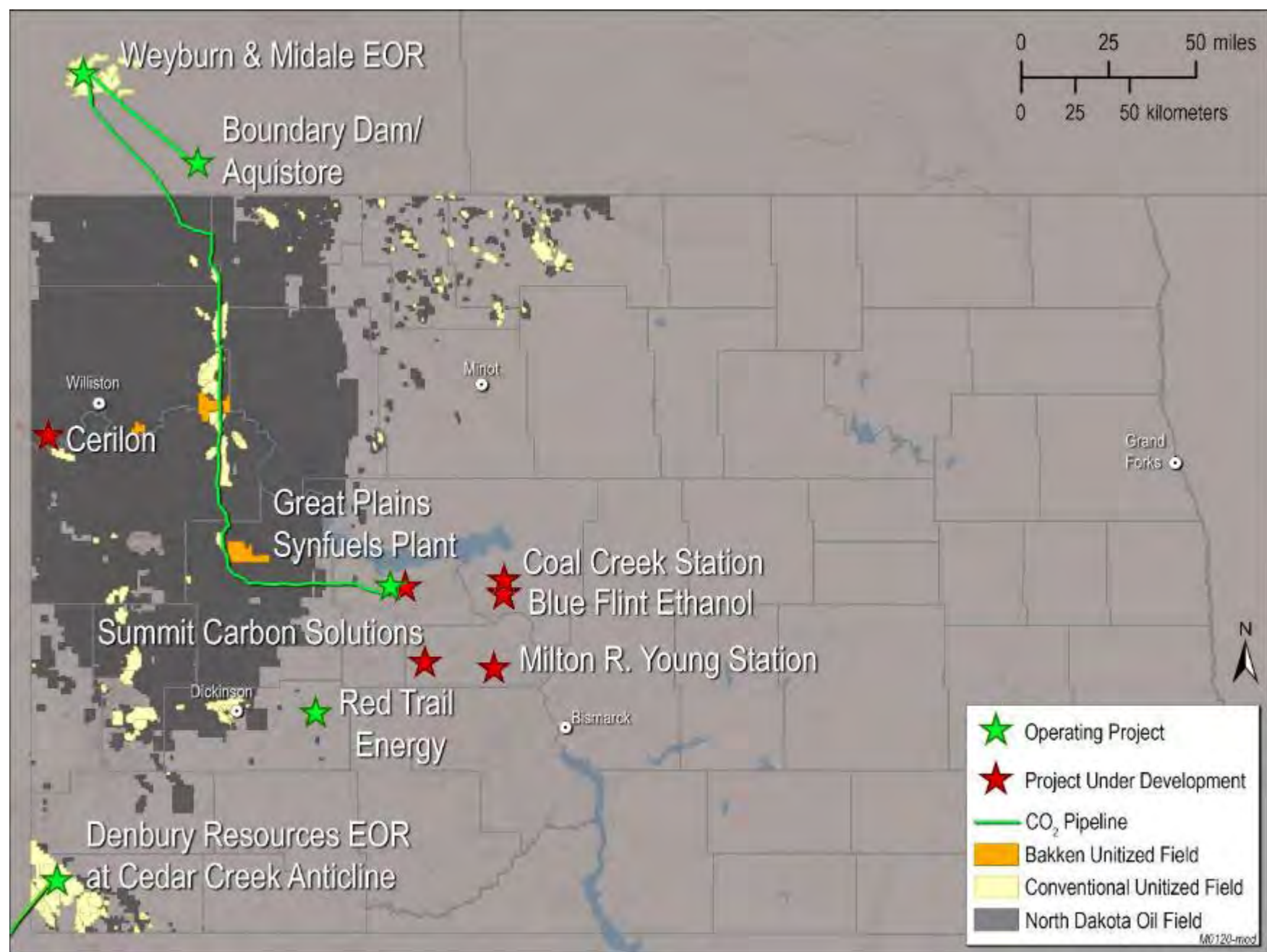
# NORTH DAKOTA CCUS ACTIVITY

## 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 CO<sub>2</sub> from the fermentation process and is injecting approximately 500 metric tons of CO<sub>2</sub> per day into the Broom Creek Formation.



*Images Credit: Red Trail Energy*



# PROJECT TUNDRA



# COAL CREEK STATION



  
**RAINBOW**  
*ENERGY CENTER*

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

Identified

201

Conventional Oil Fields

Requiring

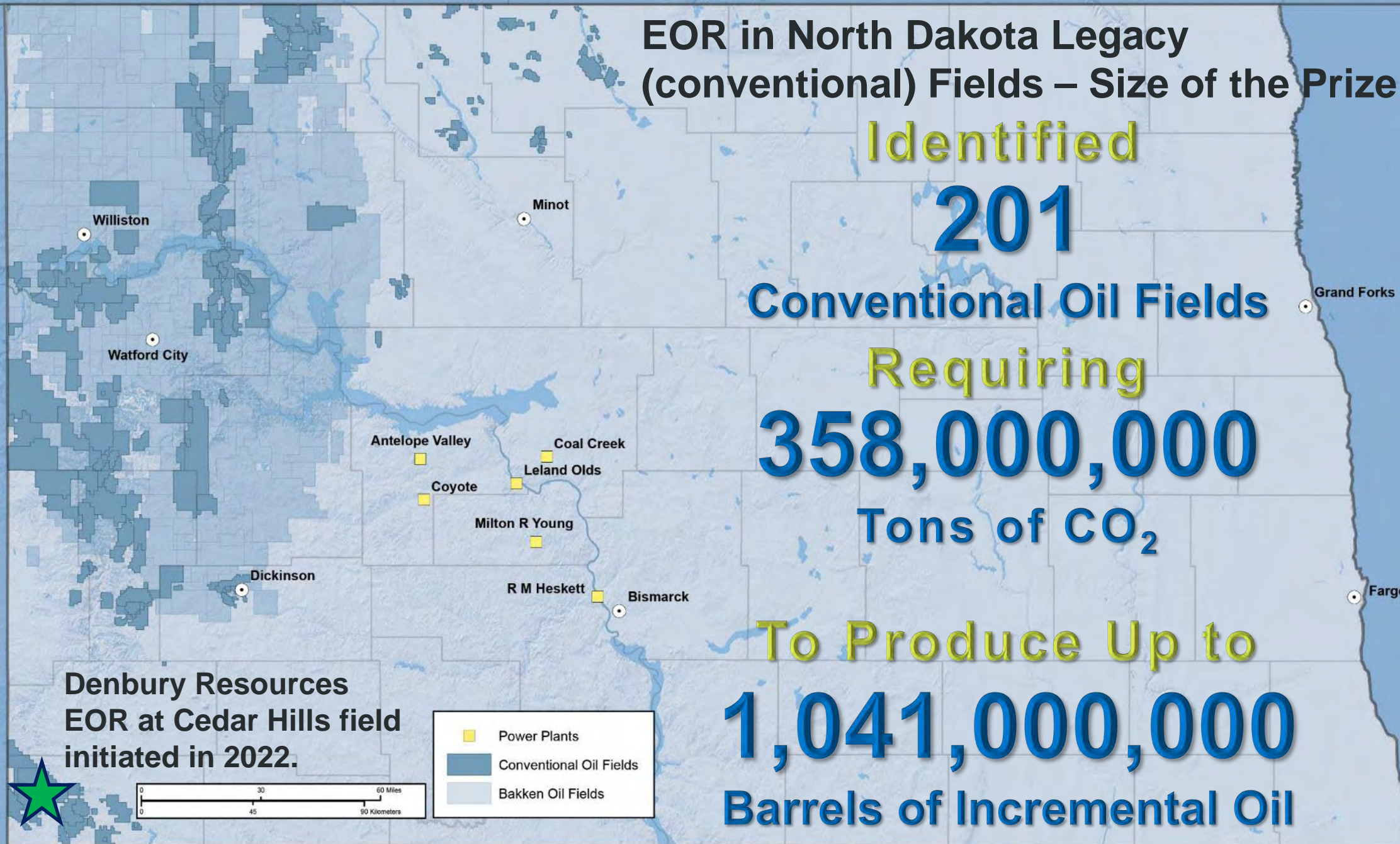
358,000,000

Tons of CO<sub>2</sub>

To Produce Up to

1,041,000,000

Barrels of Incremental Oil

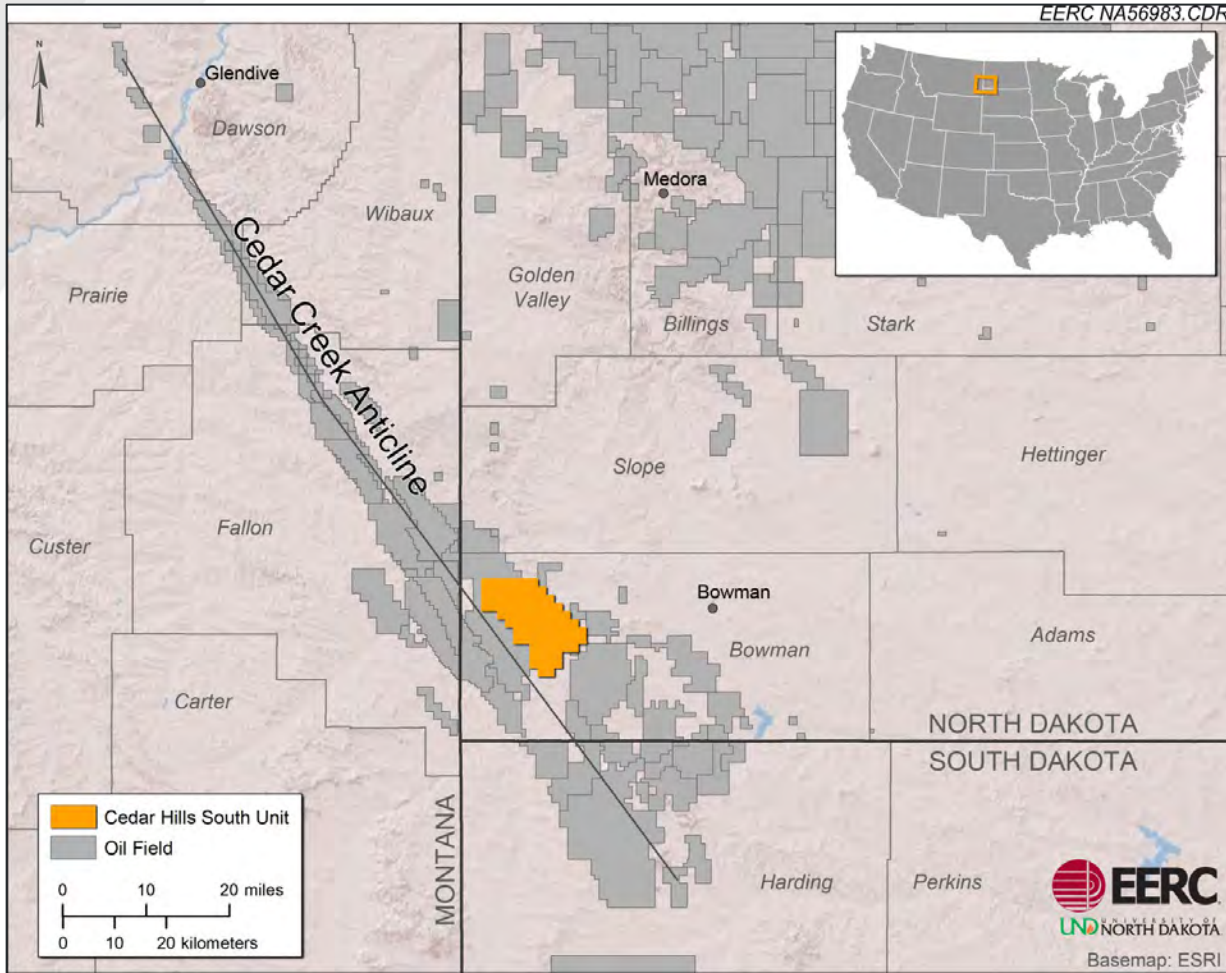


Denbury Resources  
EOR at Cedar Hills field  
initiated in 2022.

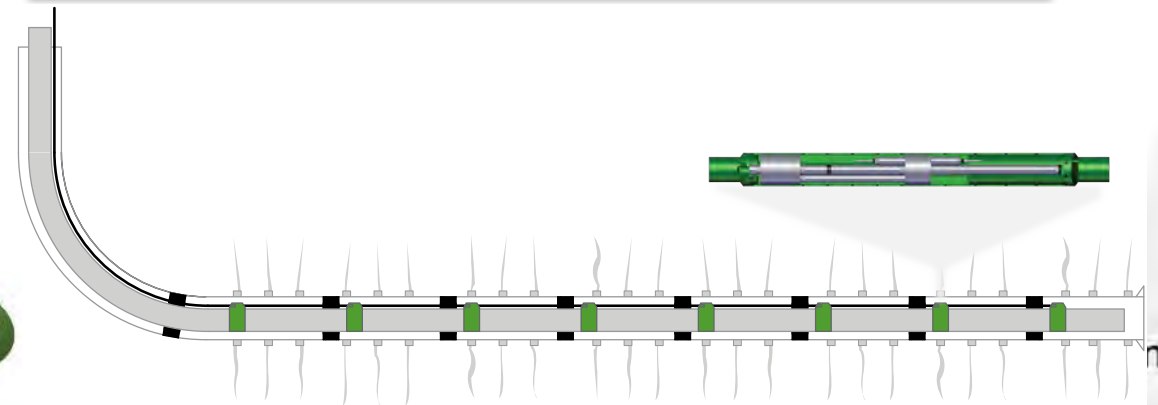
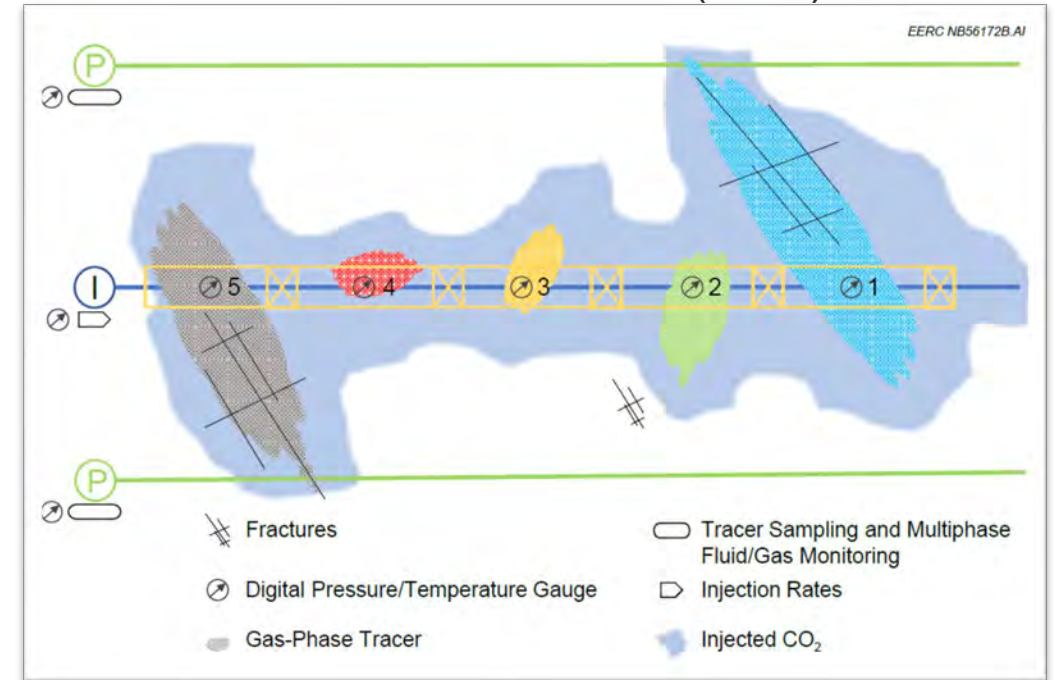




# CEDAR CREEK ANTICLINE CO<sub>2</sub> EOR PILOT

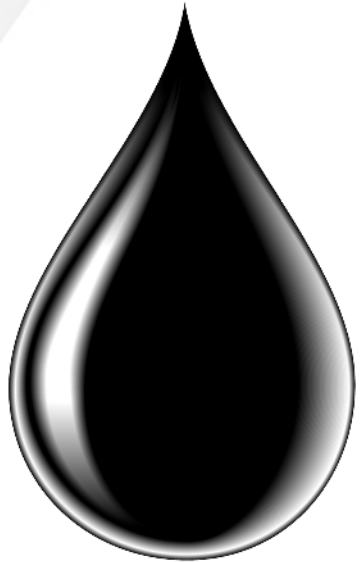


## Interval Control Valves (ICVs)



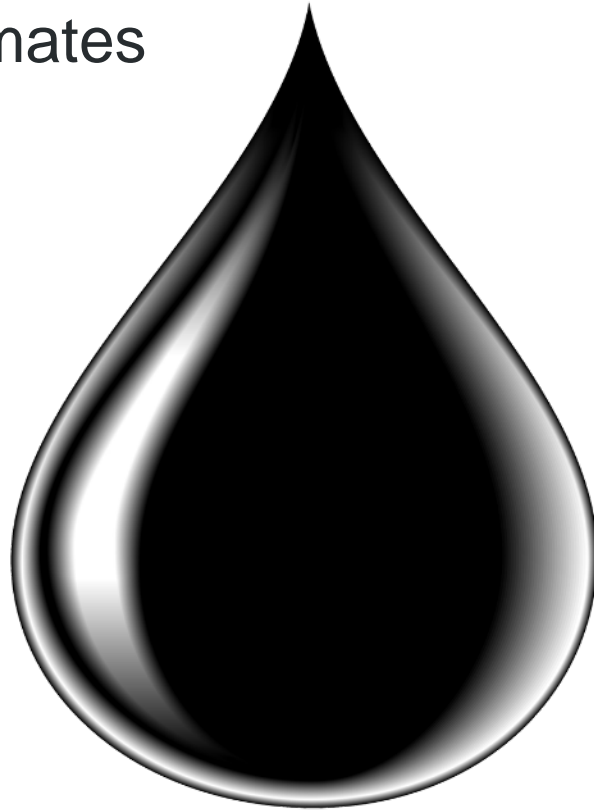
# BAKKEN EOR SIZE OF THE PRIZE

## 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)

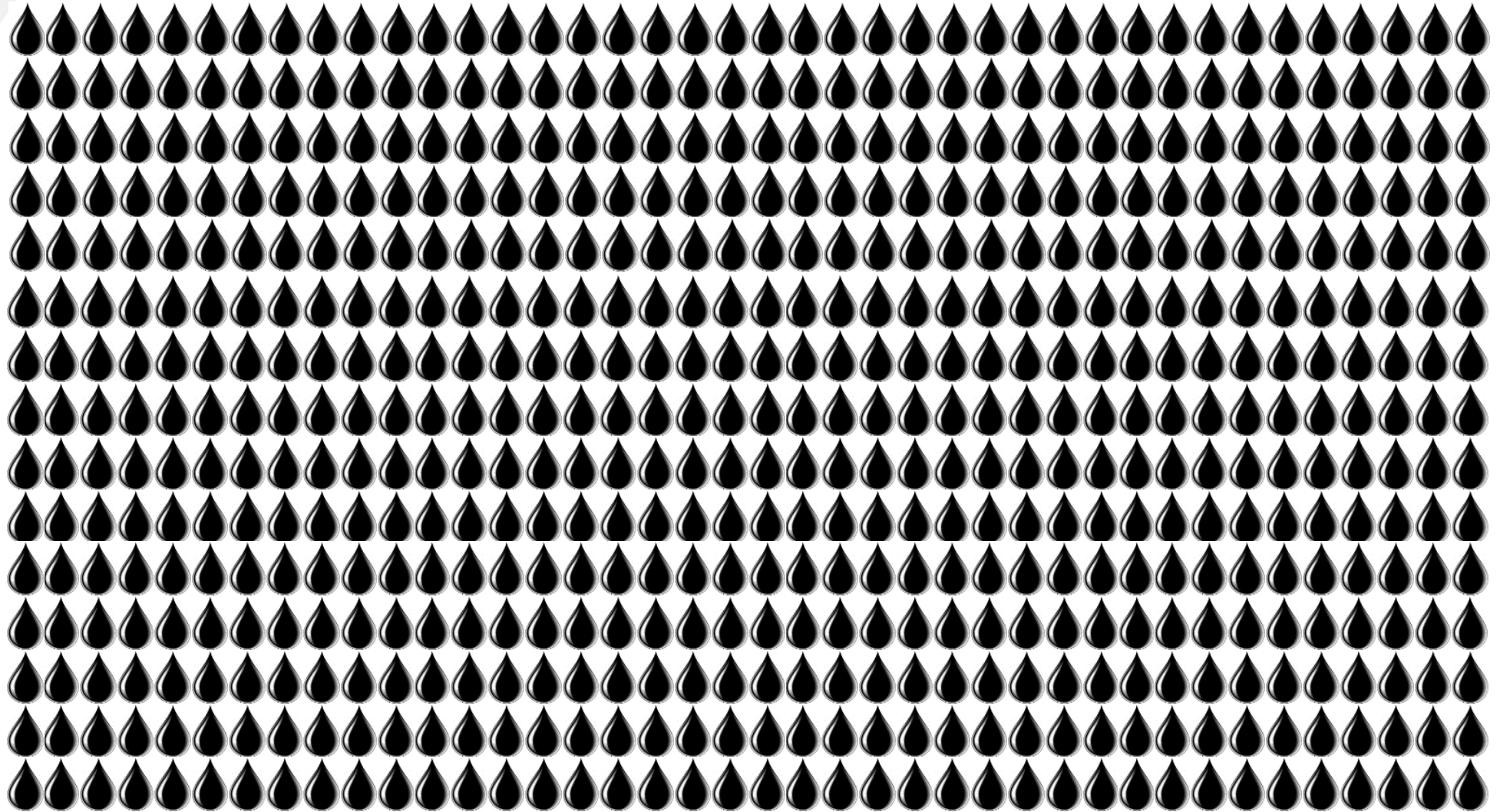
## Bakken and Three Forks Production to Date



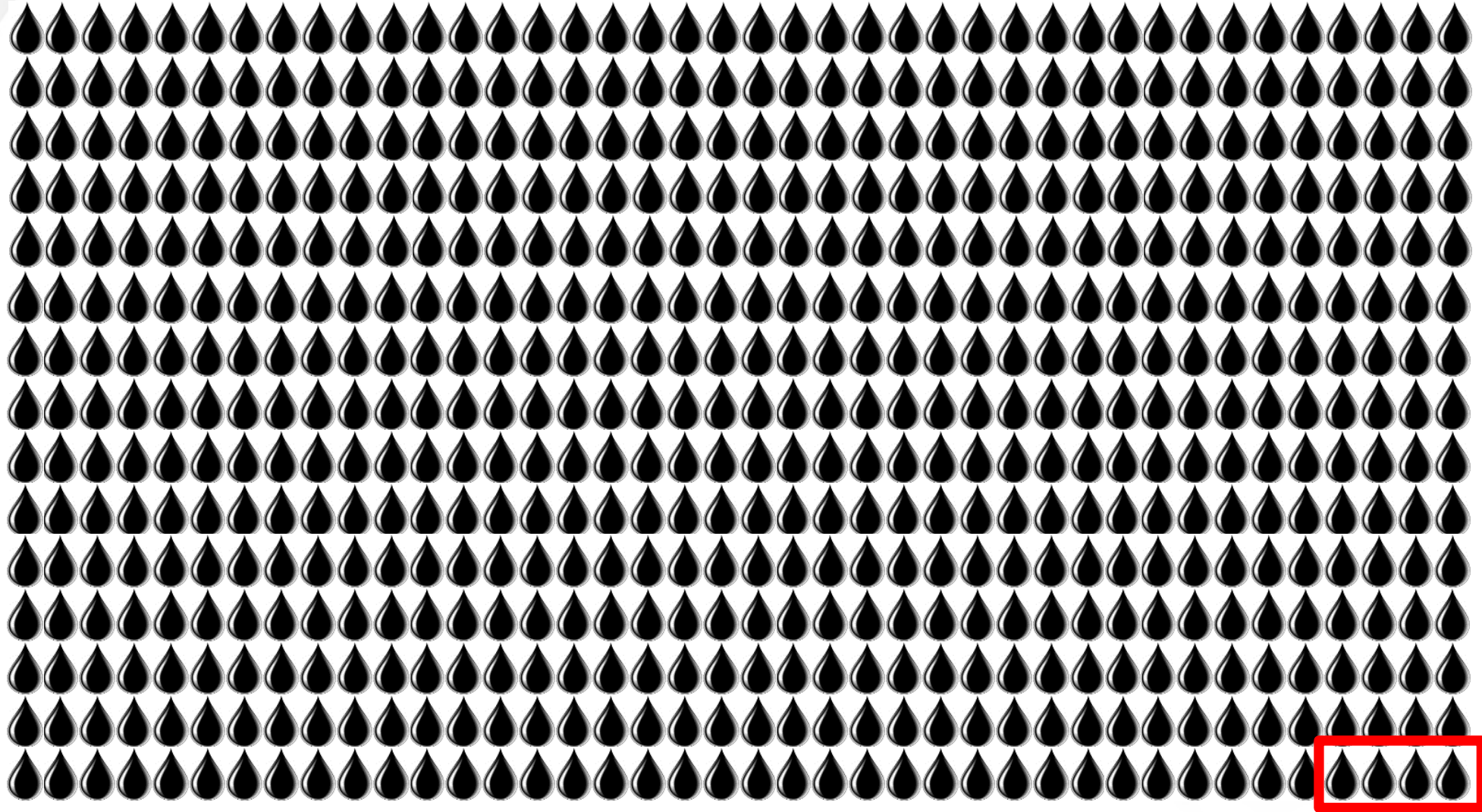
~4 Bbbl

(NDIC, 2022)

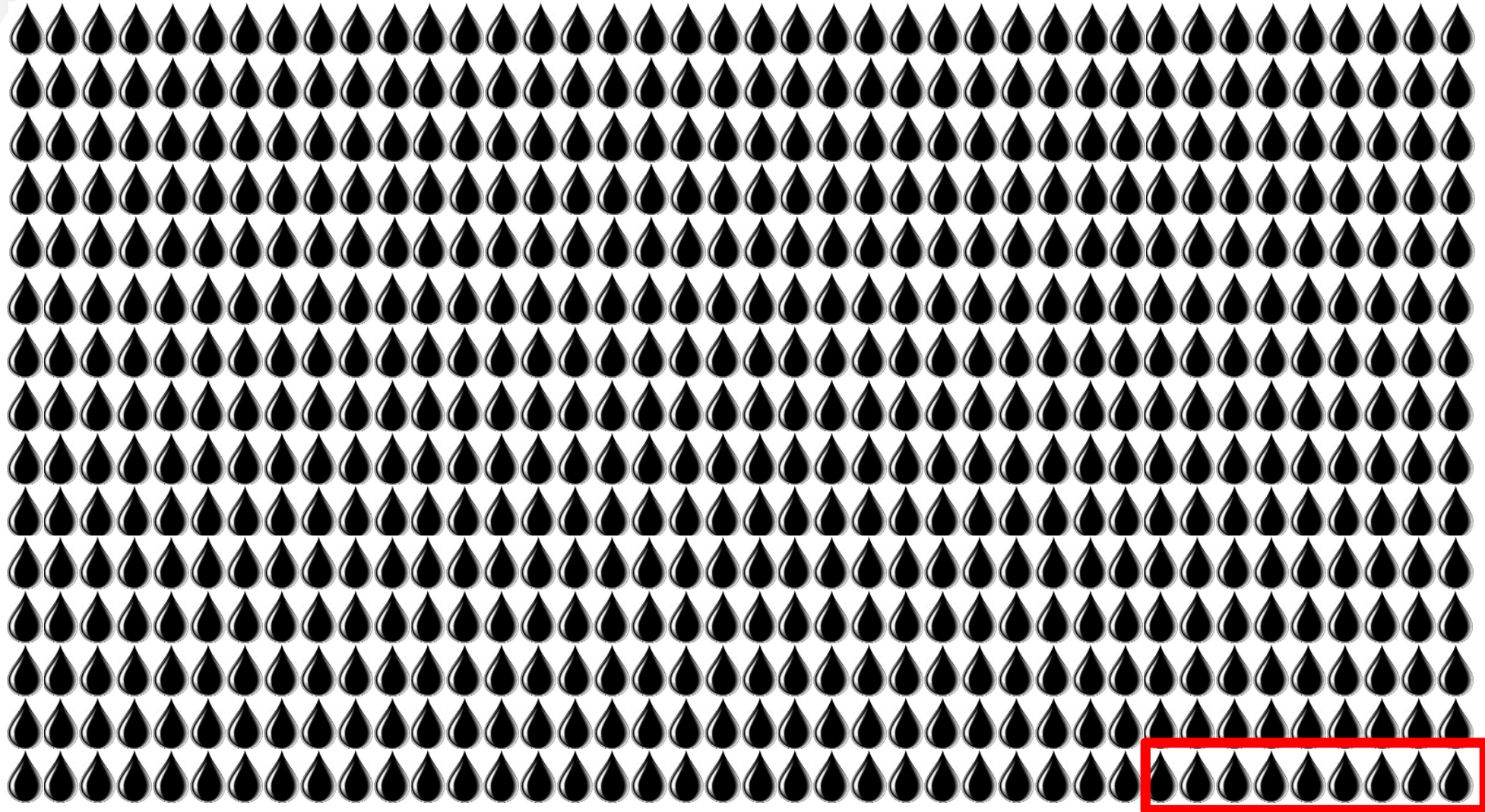
# BAKKEN OIL IN PLACE



# BAKKEN OIL RECOVERY



# BAKKEN OIL RECOVERY BY 2033



# EOR in Bakken and Three Forks – Size of the Prize

EOR in the  
Bakken Using

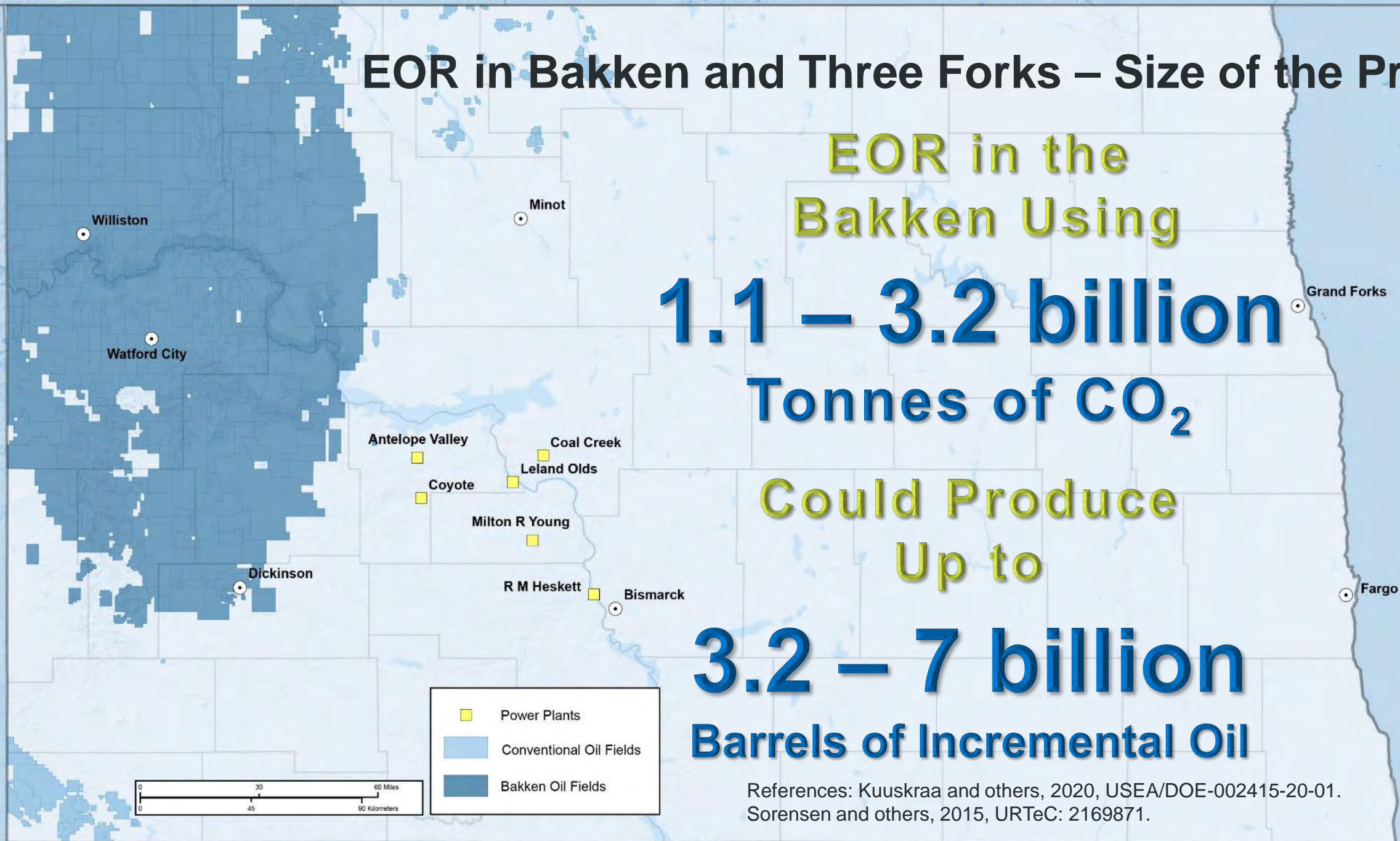
**1.1 – 3.2 billion**

**Tonnes of CO<sub>2</sub>**

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 CO<sub>2</sub> injection test demonstrated **ability of CO<sub>2</sub> 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.**



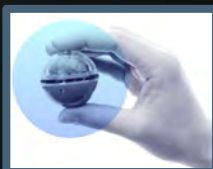
### 2021–2022 – East Nesson

Operator = Liberty Resources

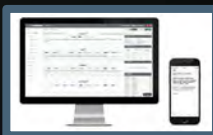
Location = Mountrail County

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

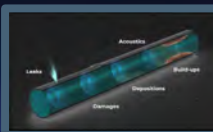
## Leak Detection Innovation



In-line inspection  
“small diameter”



Artificial intelligence  
monitoring



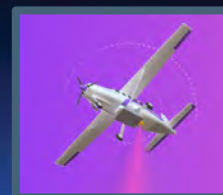
Advanced acoustics



Subsurface polymer  
absorption monitoring



Intelligent sensors  
for early detection  
anywhere



Advanced aerial  
sensor technology

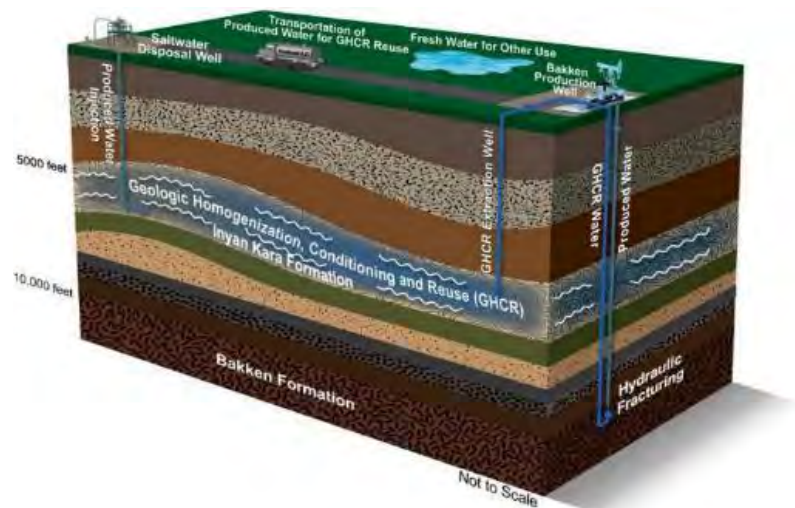


New generation  
monitoring from  
space



# 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 CO<sub>2</sub> 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 Bear<sup>SM</sup>

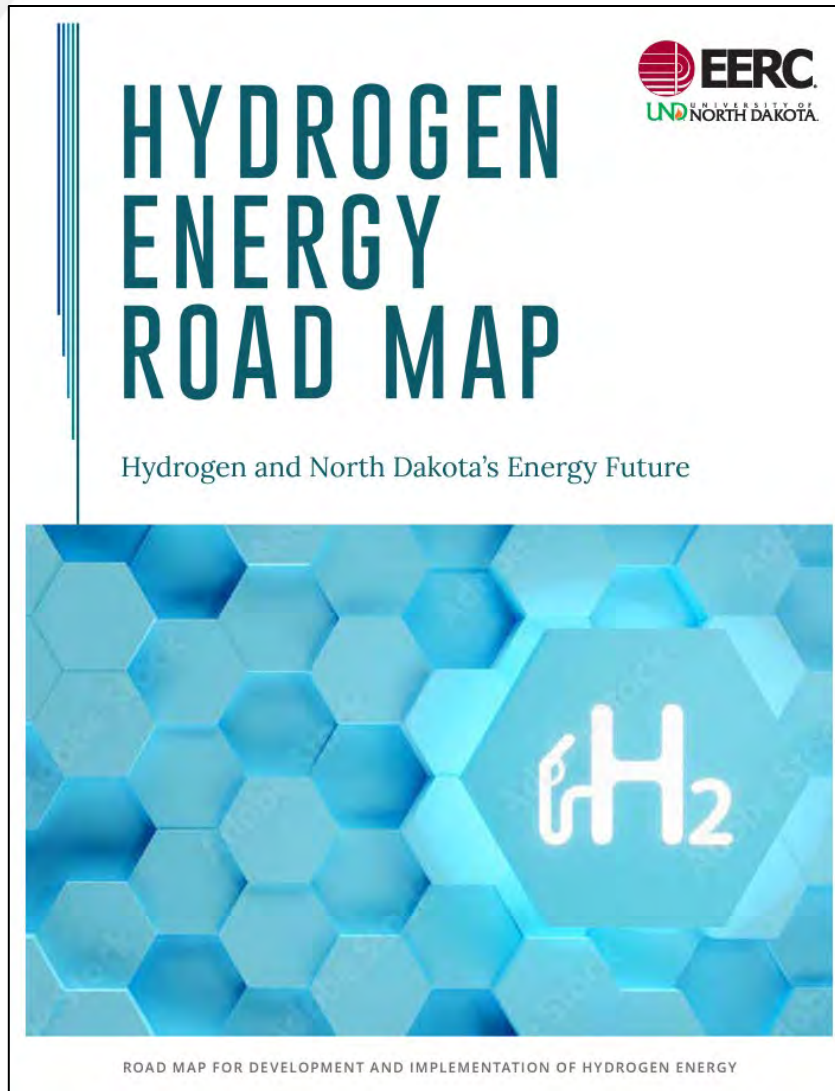
- Robust
- Adaptive
- Environmentally Sensitive



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# HYDROGEN ENERGY ROAD MAP UPDATE

Senate Bill 2014 of the 2020 North Dakota Legislature



## Interim Report Topics

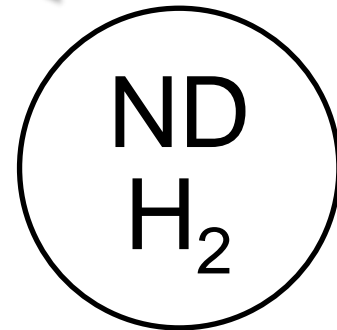
- Basis for Hydrogen
- Producing Low-Carbon Hydrogen
- Working with Hydrogen
- Opportunities for North Dakota
- Hydrogen Policy

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**



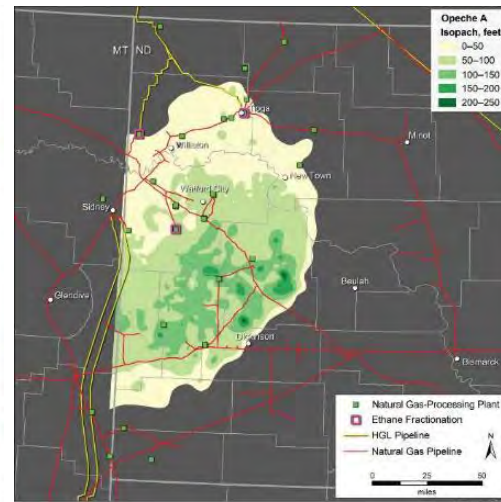
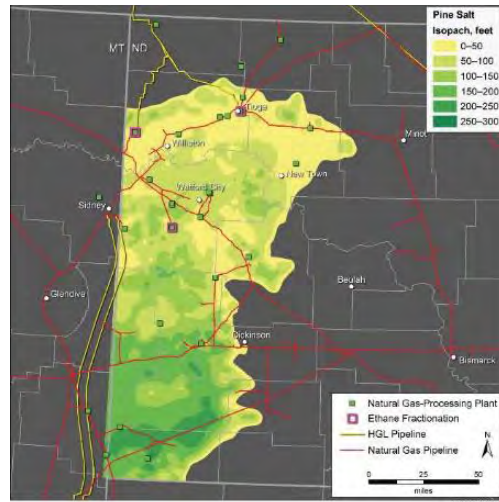
**Natural Gas  
Pipeline Blending**



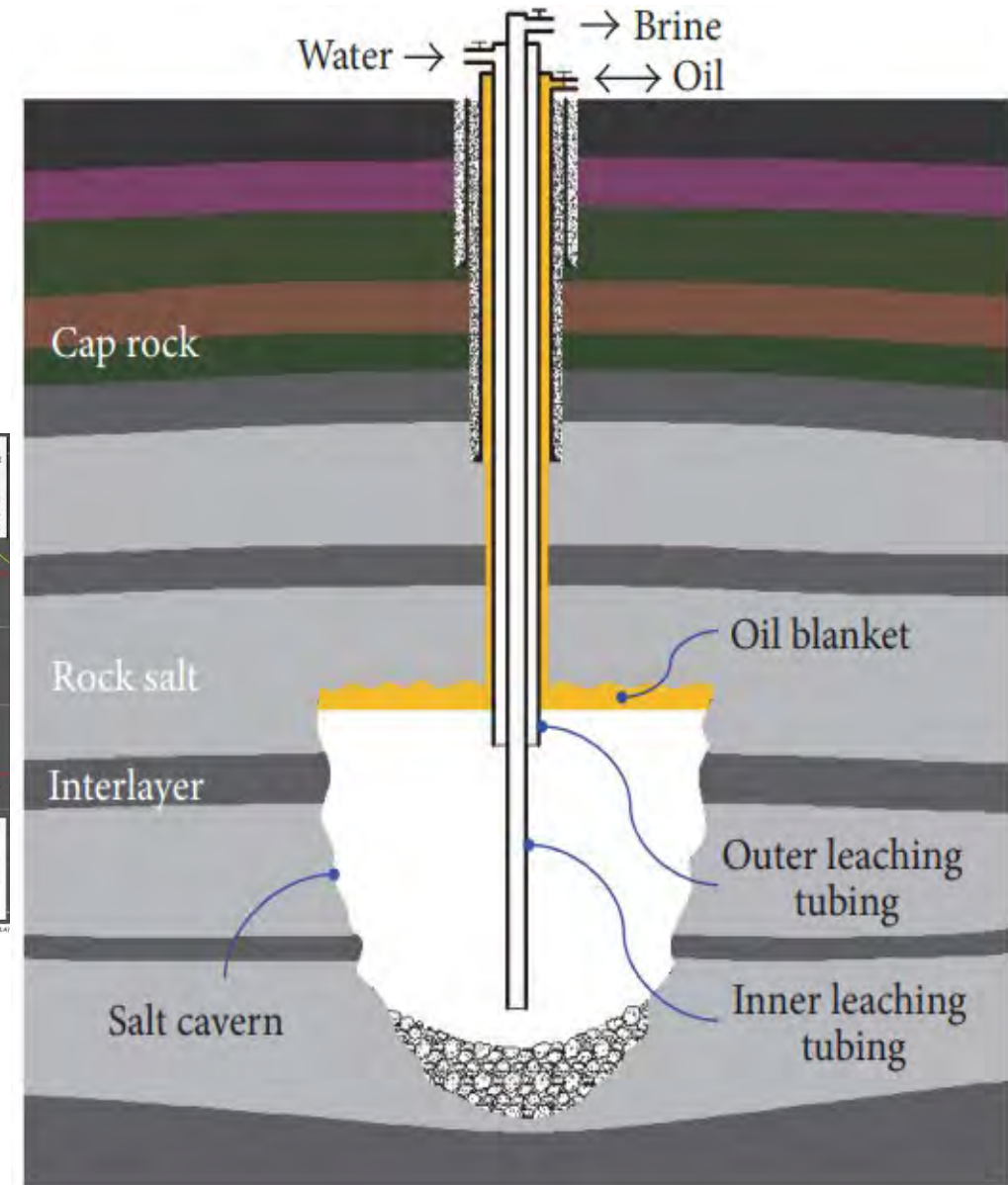
**Low-Carbon  
Ammonia**

Critical Challenges. Practical Solutions.

# CHARACTERIZATION OF SALT FORMATIONS



Salt cavern storage could support petrochemical and energy industries.



# NEXT STEPS

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

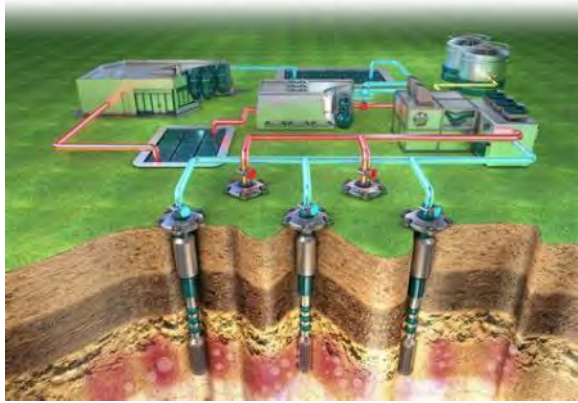


*Preliminary results are promising and indicate that N.D. salt members may be thick enough and have the right composition to develop subsurface caverns.*

# 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



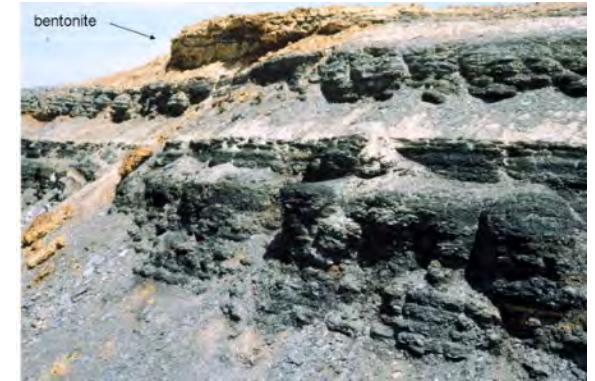
Existing Lignite Coal Mines



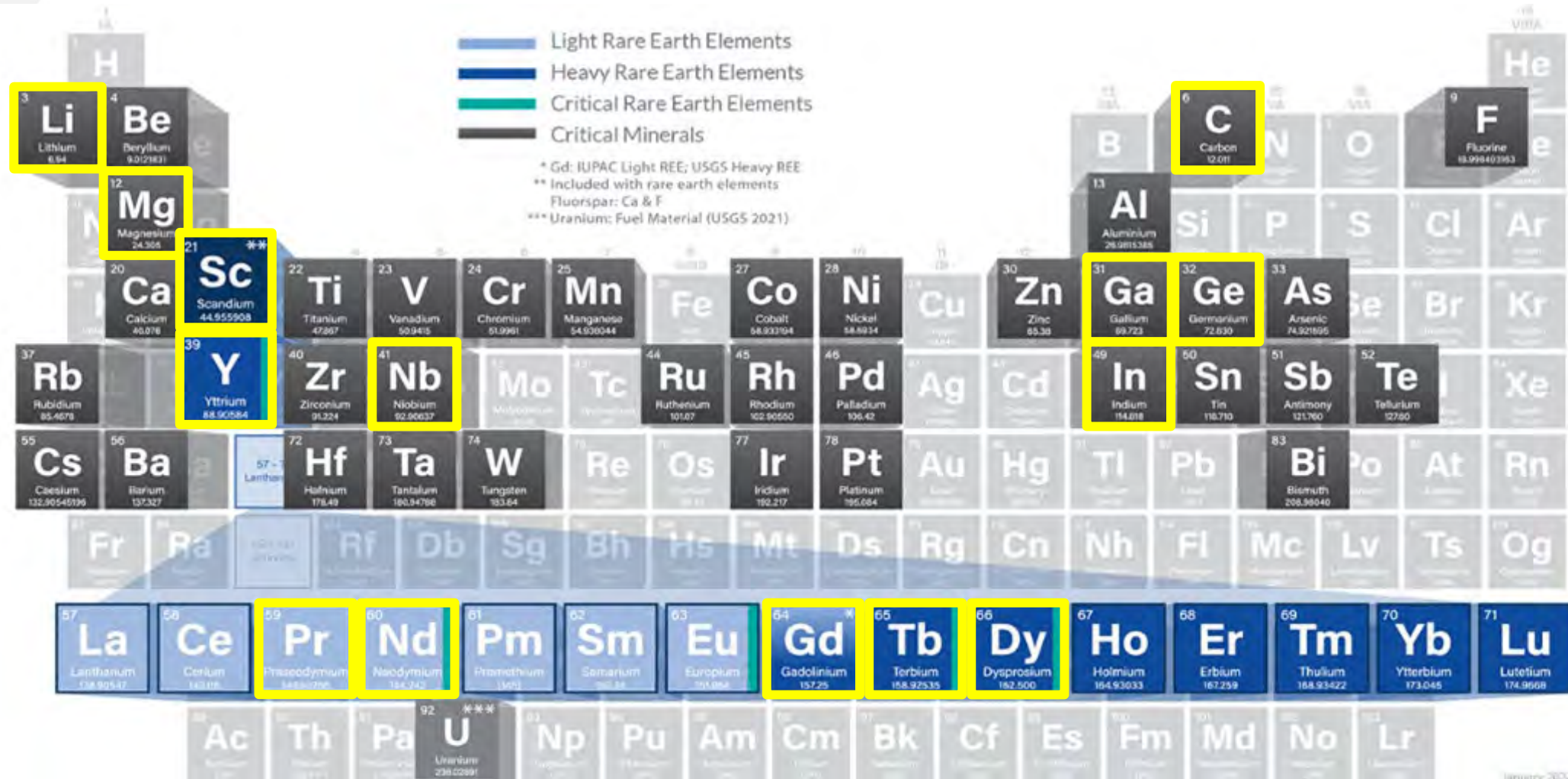
Coal Ash



ND Shales – Pierre, Niobrara, Upper and Lower Bakken



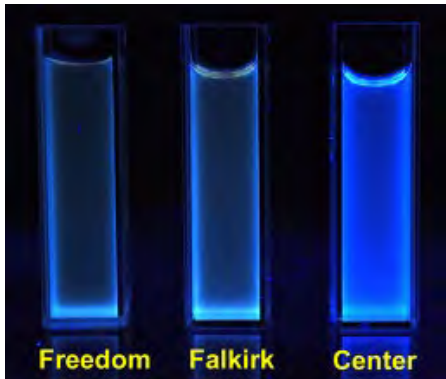
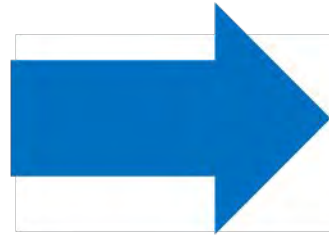
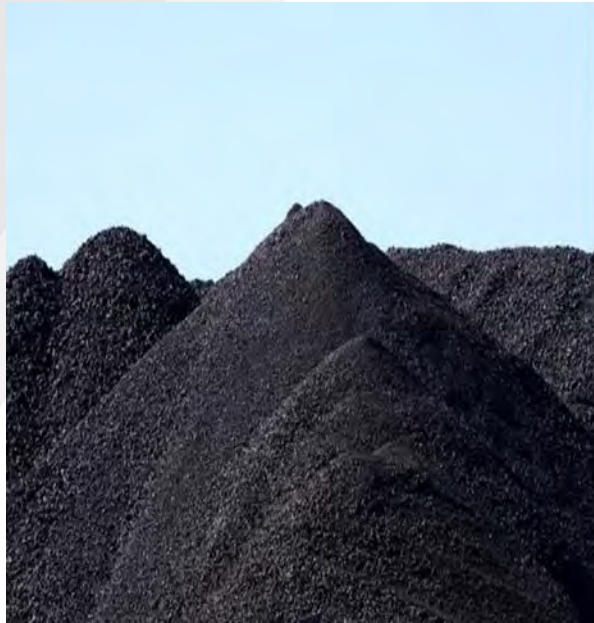
# Elements with Greatest Potential to Contribute to the Williston Basin Market



January 2022



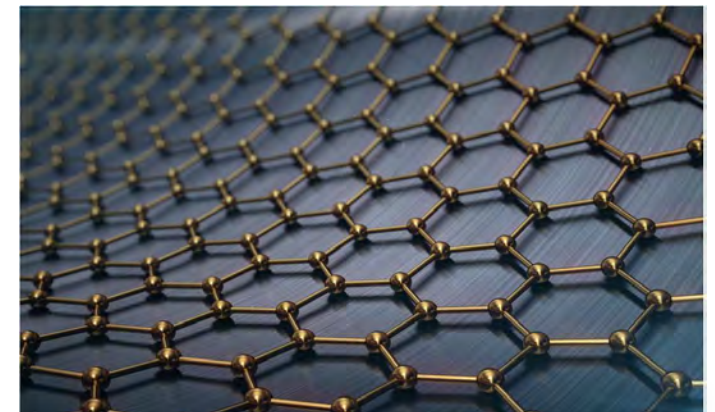
# GRAPHITE AND GRAPHENE FROM N.D. LIGNITE



**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

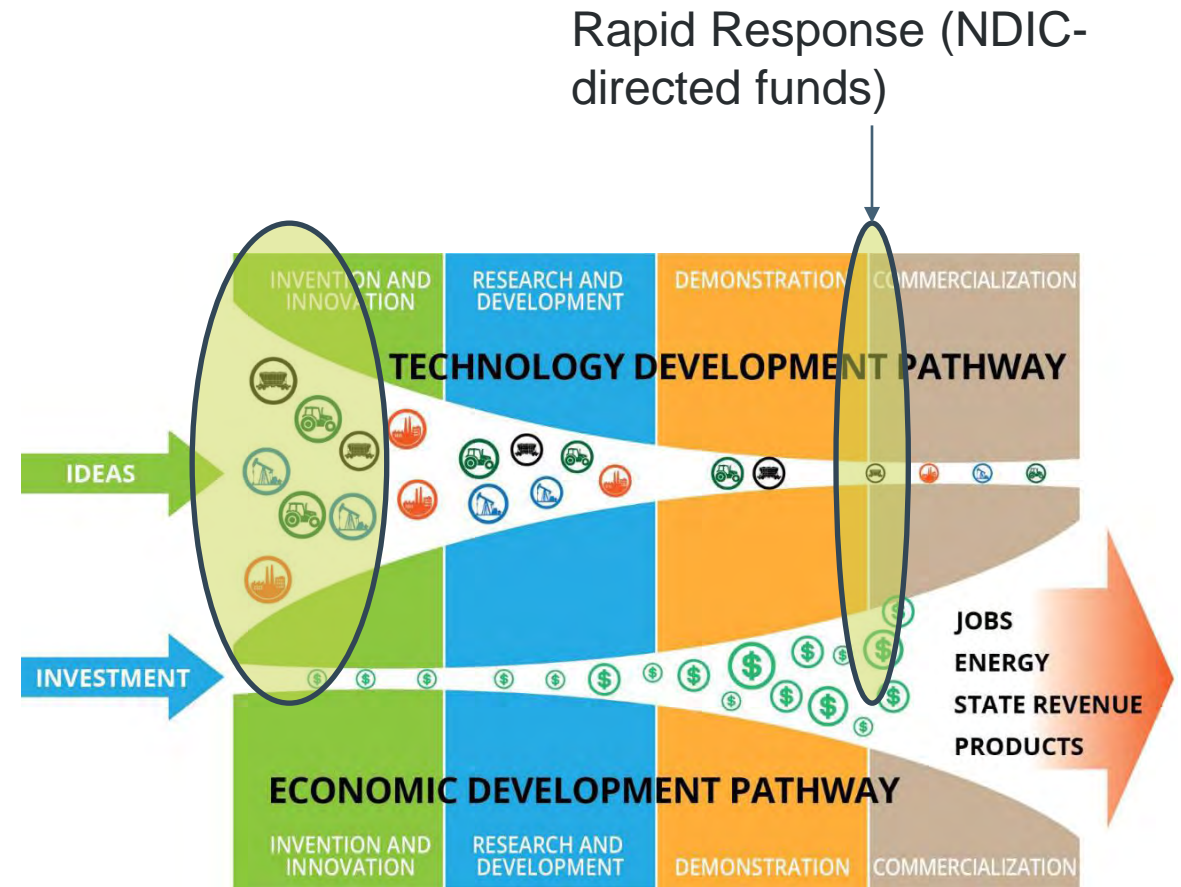
Coal-derived materials added to block and brick formations enable improved structural and thermal insulation properties.



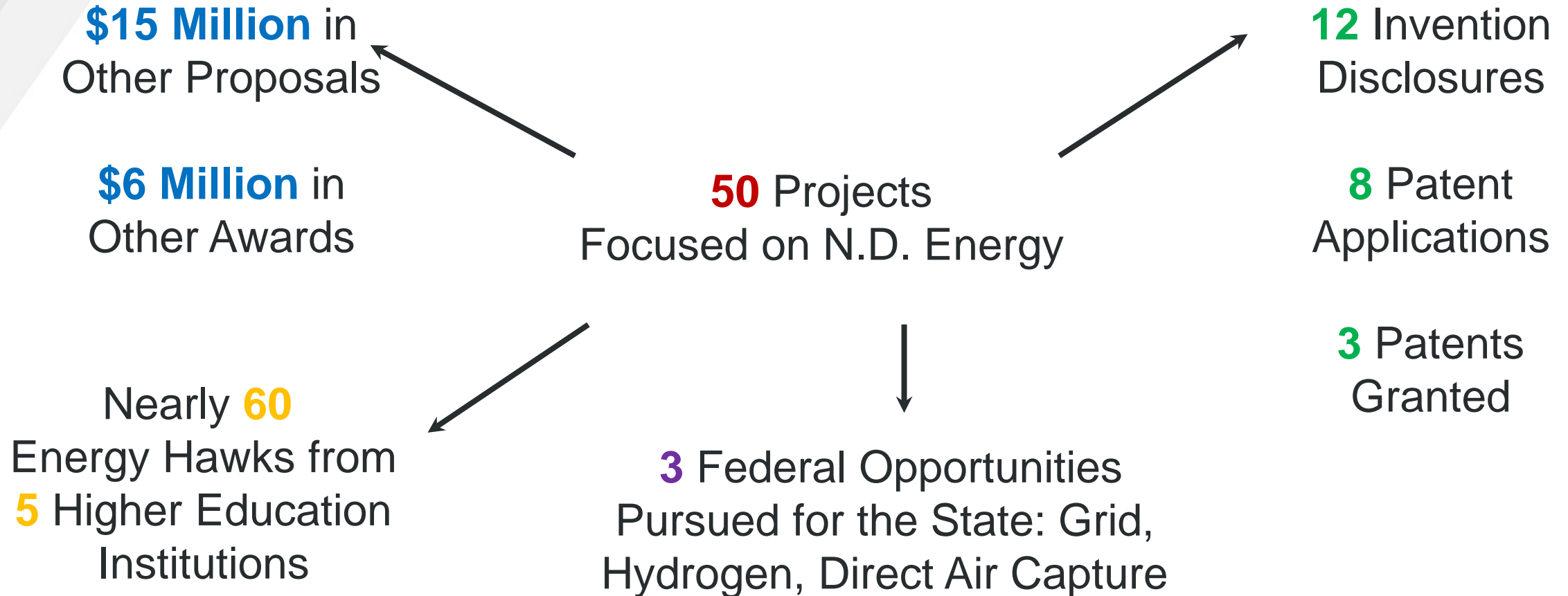
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# STATE ENERGY RESEARCH CENTER

- \$5 million per biennium from oil and gas taxes
  - Exploratory research
  - NDIC-directed projects
  - Energy Hawks
- Current sunset in 2027
- Goal to get sunset clause removed (or at least extended)



# SUMMARY OF SERC TO DATE

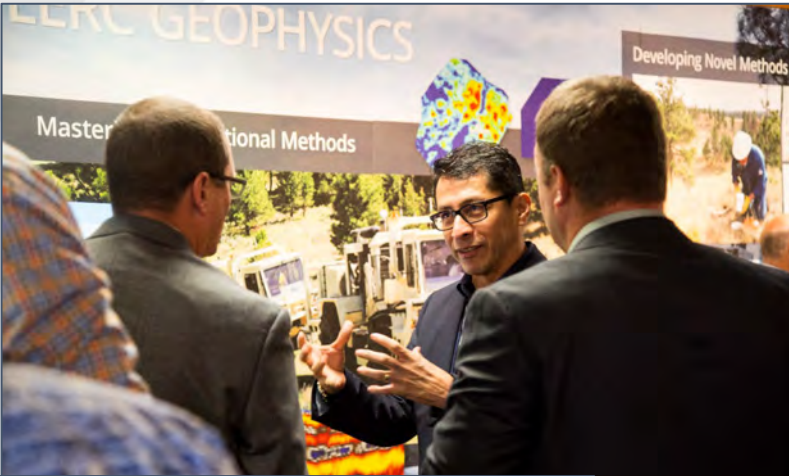


# ENERGY HAWKS

- 2021
  - Thirteen students (ten UND and one each from NDSU, MSU, NHS College)
- 2022
  - Thirteen students (ten UND and one each from NDSU, MSU, BSC)
- Immersed in all things North Dakota energy, including a full week “out west.”
- Students developed a series of collaborative research white papers on topics of their choice.



# EDUCATE THE WORLD!



**FLARING**  
Nearly 30% of the associated gas produced in North Dakota is vented to the atmosphere. There is a pressing need for a cost-effective and safe means to capture and utilize this gas.

**WATER**  
Water is a finite resource that is essential for life and industry. In the Bakken region, water is used for a variety of purposes, including hydraulic fracturing, steam generation, and process water. It is important to understand how water is used and how it can be conserved.

**How Is Water Used in Oil and Gas Production?**  
Development of one of the largest accumulations of oil and gas in North America is occurring in North Dakota and Montana, with oil from the Bakken and Three Forks Formations being produced at over 100,000 barrels a day. It is important to understand how water is used in the production of these resources.

**How Much Water Are We Talking?**  
Hydraulic fracturing is a process that creates a network of small fractures in the rock to allow oil and gas to flow more easily to the well. This process uses a large amount of water, and it is important to understand how much water is used and how it can be conserved.

**What Is Associated Gas?**  
Associated gas is a natural gas that is produced along with oil. It is important to understand how this gas is produced and how it can be captured and utilized.

**Why Does Flaring Occur?**  
Flaring is the process of burning off excess gas. It is important to understand why flaring occurs and how it can be reduced.

**What Is NORM?**  
NORM is a type of radioactive material that is produced during the production of oil and gas. It is important to understand how NORM is produced and how it can be managed.

**Some Radiation Fundamentals:**  
Radiation is energy emitted from the nucleus of an atom. It is important to understand the different types of radiation and how they can be measured and managed.



PCOR PARTNERSHIP  
**ATLAS**  
6TH EDITION | 2021  
Making Safe, Practical Carbon Capture, Utilization, and Storage Projects a Reality

**Installing a Casing-Conveyed Permanent Downhole Monitoring System**

**Reducing Our Carbon Footprint: The Role of Markets**

**Nature in the Balance: CO2 Sequestration**

**Out of the Air - Into the Soil: Land Practices That Reduce Atmospheric Carbon Levels**

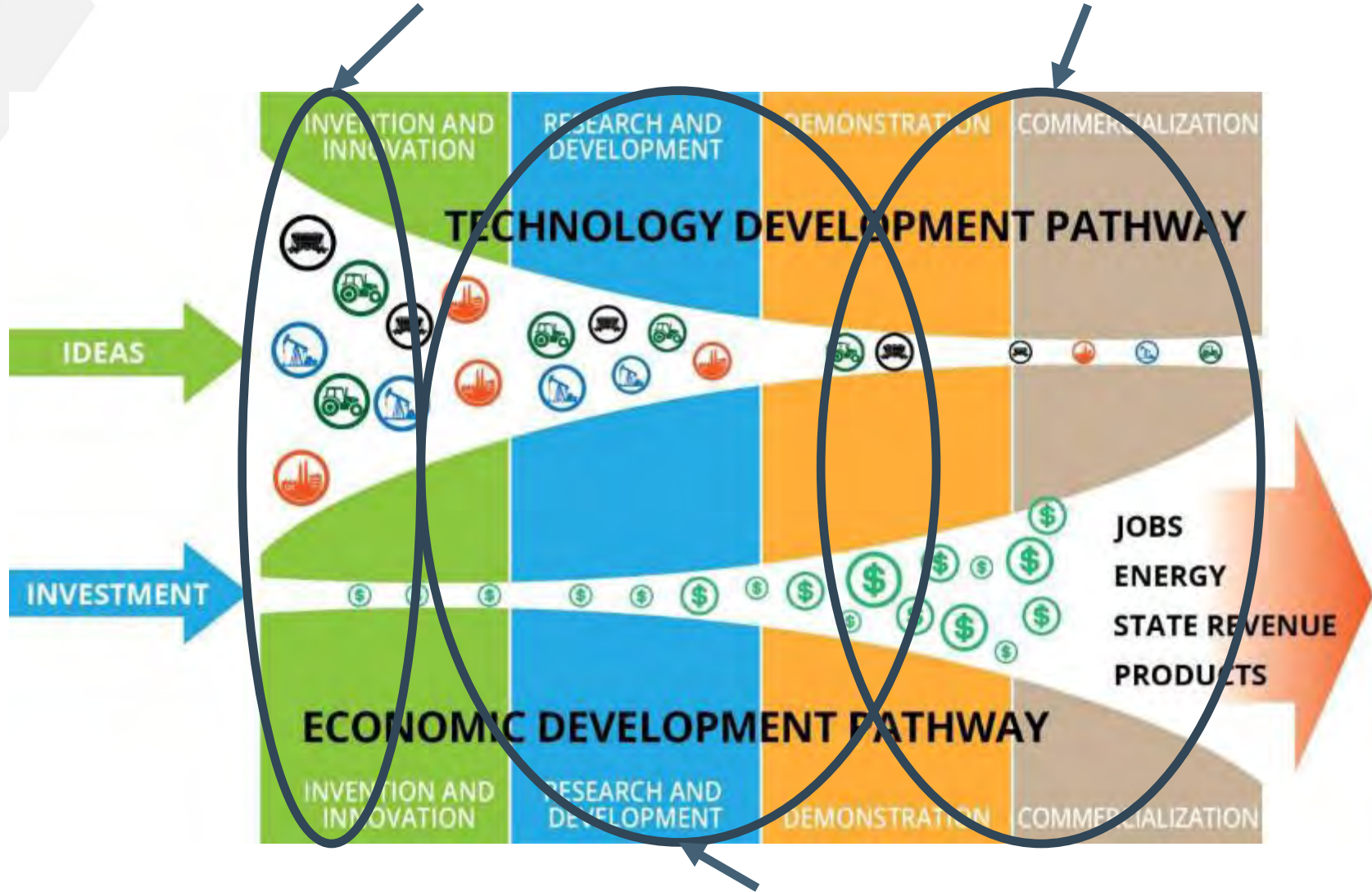
**Global Energy and Carbon: Tracking Our Footprint**

**Managing Carbon Dioxide: The Geologic Solution**

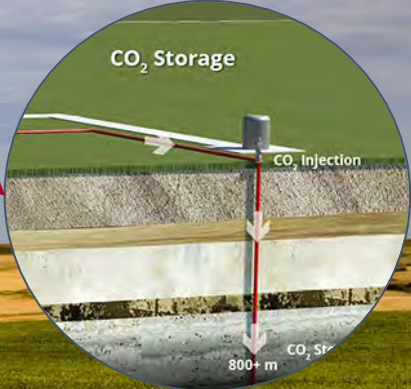
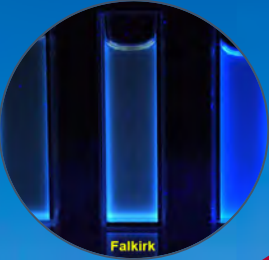
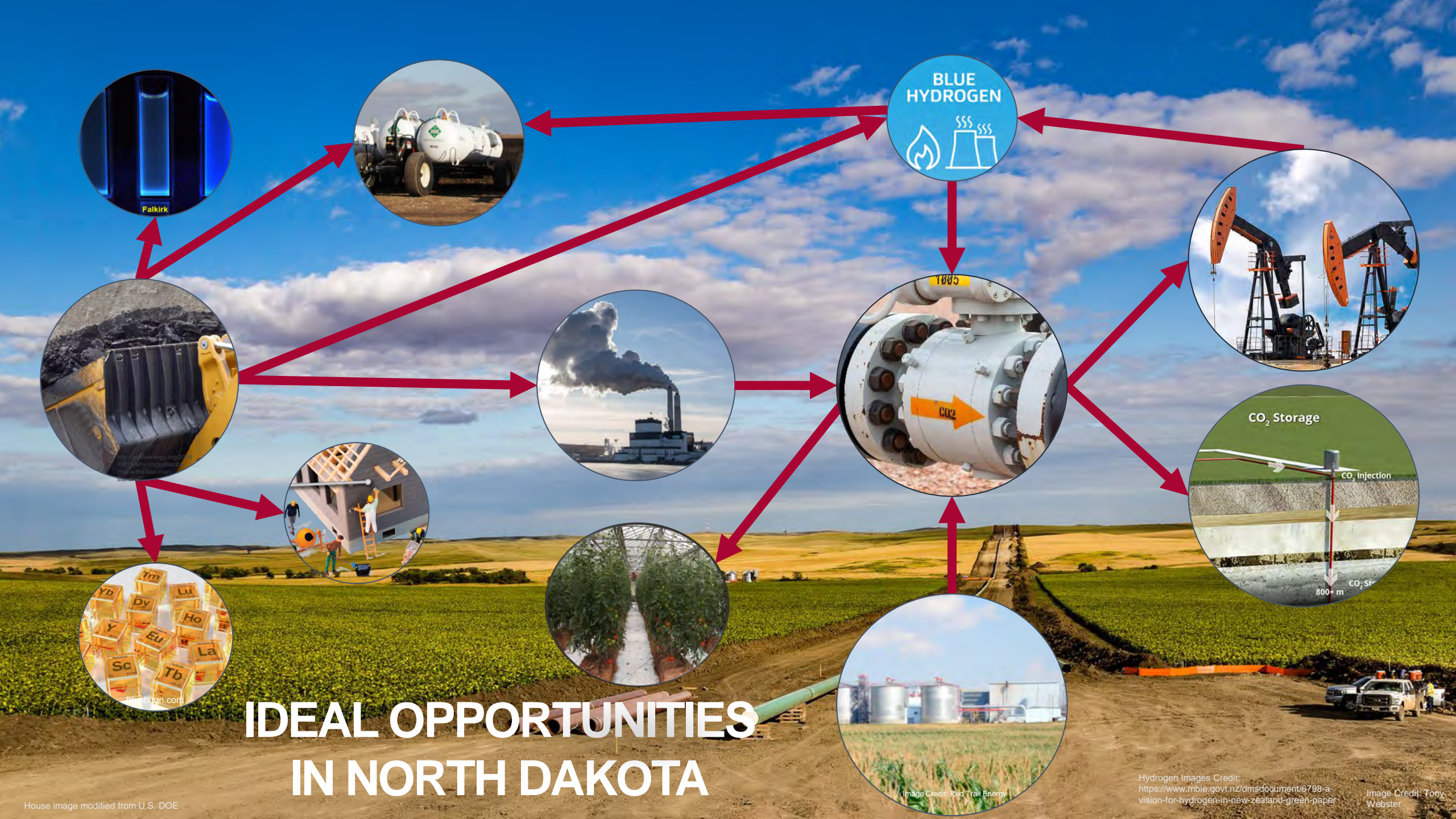


State Energy Research Center

Clean Sustainable Energy Authority



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



# IDEAL OPPORTUNITIES IN NORTH DAKOTA

House image modified from U.S. DOE

Image Credit: Red Trail Energy

Hydrogen Images Credit:  
<https://www.mbie.govt.nz/dmsdocument/6798-a-vision-for-hydrogen-in-new-zealand-green-paper>

Image Credit: Tony Webster





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A wide-angle photograph of a university campus at sunset. The sun is low on the horizon, creating a warm glow and long shadows. 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 trees with some yellow autumn foliage.

**THANK YOU**

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