EERC VISION

TO LEAD THE WORLD IN DEVELOPING SOLUTIONS TO ENERGY AND ENVIRONMENTAL CHALLENGES.
EERC Quick Facts FY22

- Total Active Contracts: 179
- Fiscal Year Funding: $76 Million
- 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
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.
RESEARCH

TECHNOLOGY DEVELOPMENT PATHWAY

IDEOAS

INVESTMENT

ECONOMIC DEVELOPMENT PATHWAY

JOBS
ENERGY
STATE REVENUE
PRODUCTS

Image credit: EERC
CO₂ CAN BE MANAGED
Active and Developing CCUS Projects in the PCOR Partnership Region

- Green circle: Active Capture
- Yellow triangle: Active Injection
- Green circle with a line through it: Developing Capture
- Yellow triangle with a line through it: Developing Injection

- Orange line: CO₂ Pipeline
- Dashed orange line: Proposed CO₂ Pipeline

Projects and Stations:

- ACTL Nutrient and Sturgeon
- Quest
- EOR Fields for ACTL
- Weyburn
- Great Plains Synfuels Plant
- Red Trail Energy
- CCA
- Bell Creek
- Lost Cabin
- Sumit
- Dry Fork Station
- Sweetwater Hub
- Project Phoenix
- Riley Ridge
- Shute Creek
- Tallgrass
- Gerald Gentleman
- Summit
- Aquistore
- Carbon Vault
- Coal Creek Station
- Midwest Ag
- Milton R. Young Station
- Navigator
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$_2$ from the fermentation process and is injecting approximately 500 metric tons of CO$_2$ per day into the Broom Creek Formation.
Denbury Resources EOR at Cedar Hills field initiated in 2022.

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
CEDAR CREEK ANTICLINE CO$_2$ EOR PILOT

Interval Control Valves (ICVs)

- Tracer Sampling and Multiphase Fluid/Gas Monitoring
- Digital Pressure/Temperature Gauge
- Gas-Phase Tracer
- Injection Rates
- Injected CO$_2$
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)
<table>
<thead>
<tr>
<th>Bakken Oil In Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of oil drops]</td>
</tr>
</tbody>
</table>
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
Interim Report Topics

- Basis for Hydrogen
- Producing Low-Carbon Hydrogen
- Working with Hydrogen
- Opportunities for North Dakota
- Hydrogen Policy
OPPORTUNITIES FOR NORTH DAKOTA

Hydrogen produced from:
- Natural gas reforming with carbon sequestration
- Water electrolysis using low-carbon electricity
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.
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
GRAPHITE AND GRAPHENE FROM N.D. LIGNITE

Graphene Quantum Dots

N.D. Lignite-Derived Graphite

Graphene Sheet

Critical Challenges. Practical Solutions.
LOW-WEIGHT, HIGH-STRENGTH COAL-BASED BUILDING MATERIALS FOR INFRASTRUCTURE PRODUCTS

**ROOFING MATERIALS**
Coal-core composites provide lightweight, 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.
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)
$15 Million in Other Proposals

$6 Million in Other Awards

Nearly 60 Energy Hawks from 5 Higher Education Institutions

50 Projects Focused on N.D. Energy

3 Federal Opportunities Pursued for the State: Grid, Hydrogen, Direct Air Capture

12 Invention Disclosures

8 Patent Applications

3 Patents Granted
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.
State Energy Research Center

Clean Sustainable Energy Authority

Lignite, Oil and Gas, Renewable Research Programs, and Legislatively Directed Projects
IDEAL OPPORTUNITIES IN NORTH DAKOTA