



**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)

# IMPROVING NORTH DAKOTA OIL PRODUCTION

Presented to the North Dakota Senate Appropriations  
Education and Environment Division

January 28, 2025

Charles D. Gorecki  
CEO

In 2022, North Dakota was 8<sup>th</sup> in total energy production, 4.114 quads.

Energy consumption was 0.671 quads (40<sup>th</sup>).

In 2023, North Dakota had a per capita GDP of \$74,005 (3<sup>rd</sup>).

As of September 2024, North Dakota's average retail price of electricity was 12.78 cents/kWh (8<sup>th</sup> lowest).

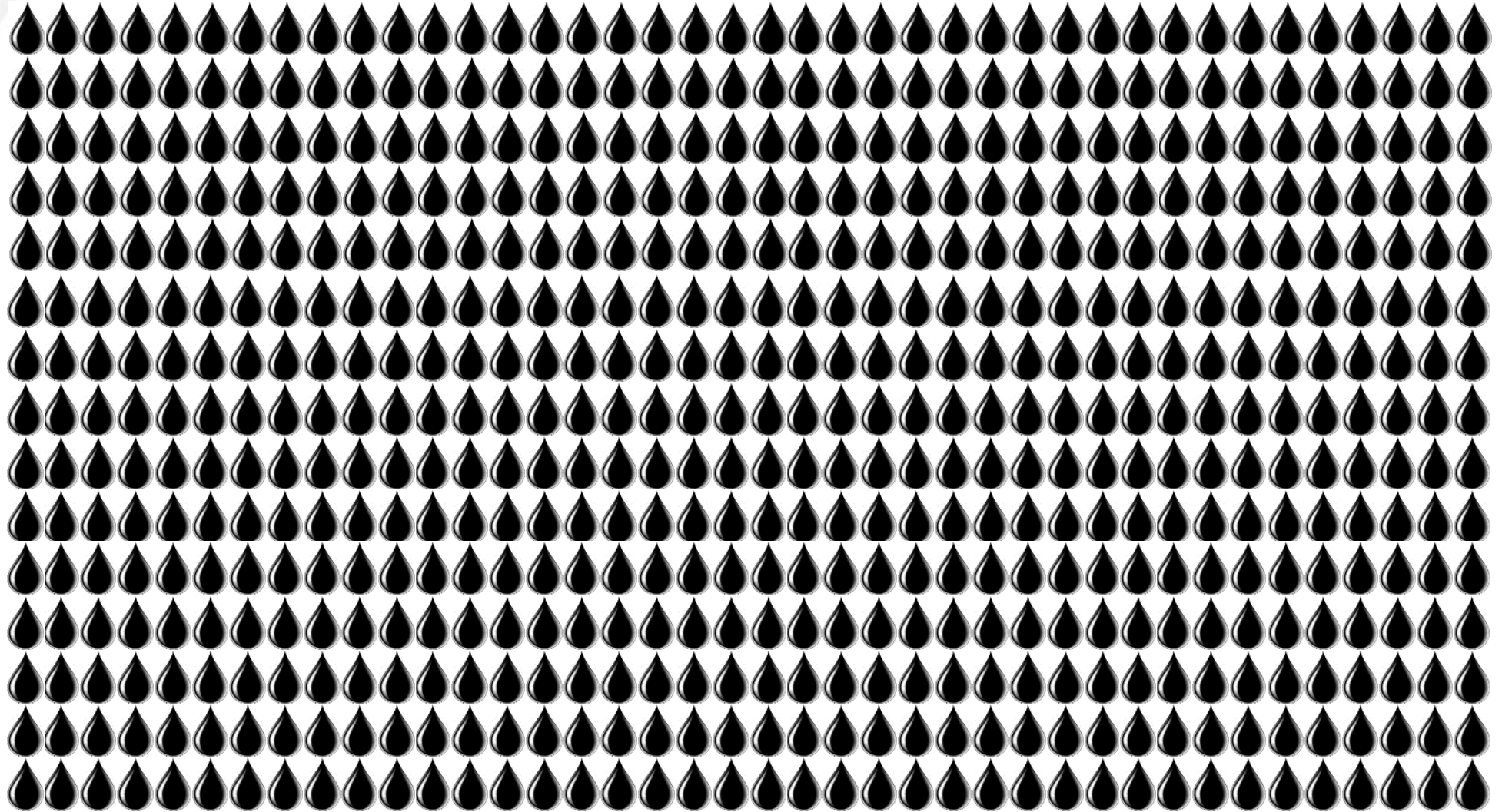
And North Dakota's a leader in agricultural products.

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

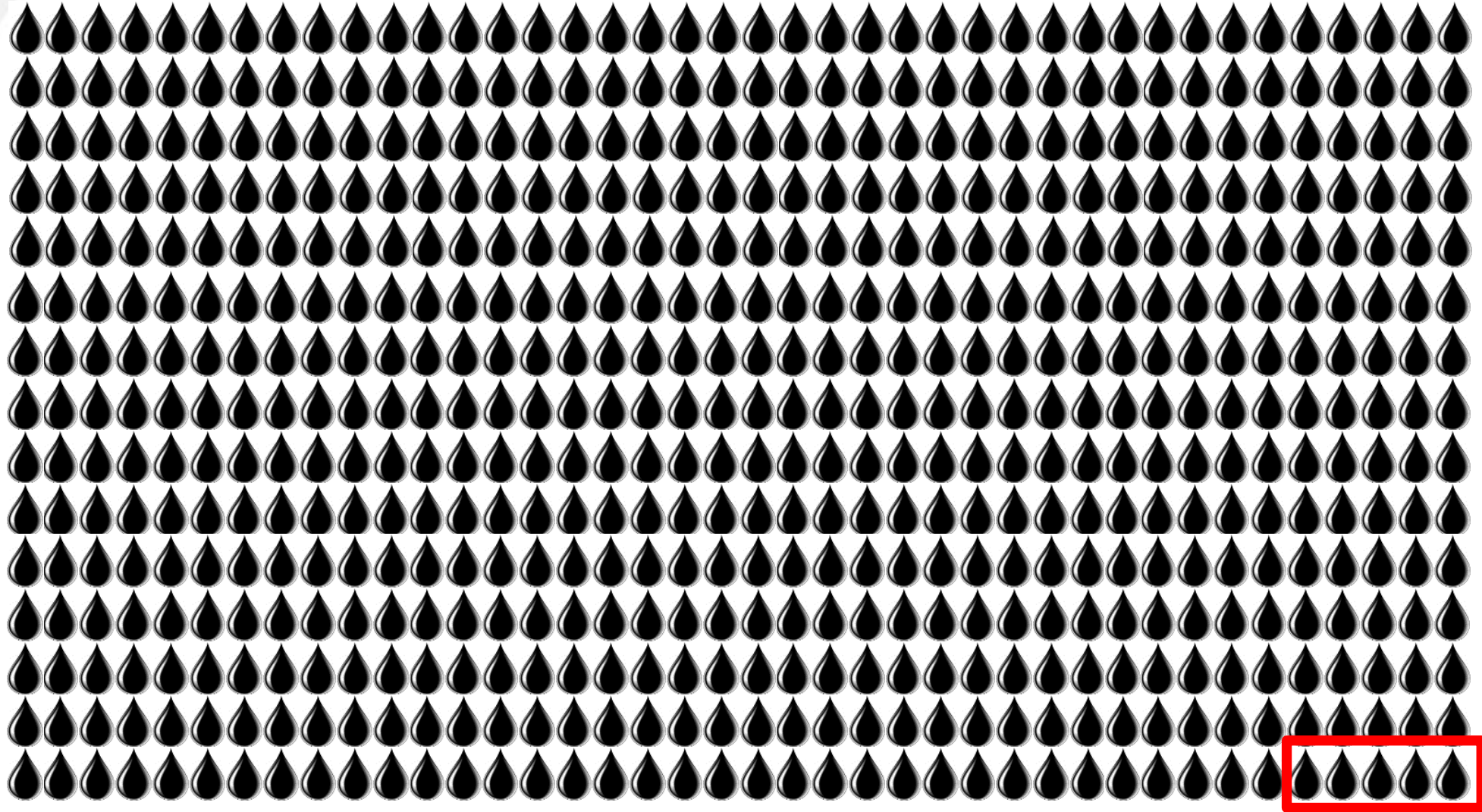


Data sourced from U.S. Energy  
Information Administration  
Image credit: EERC

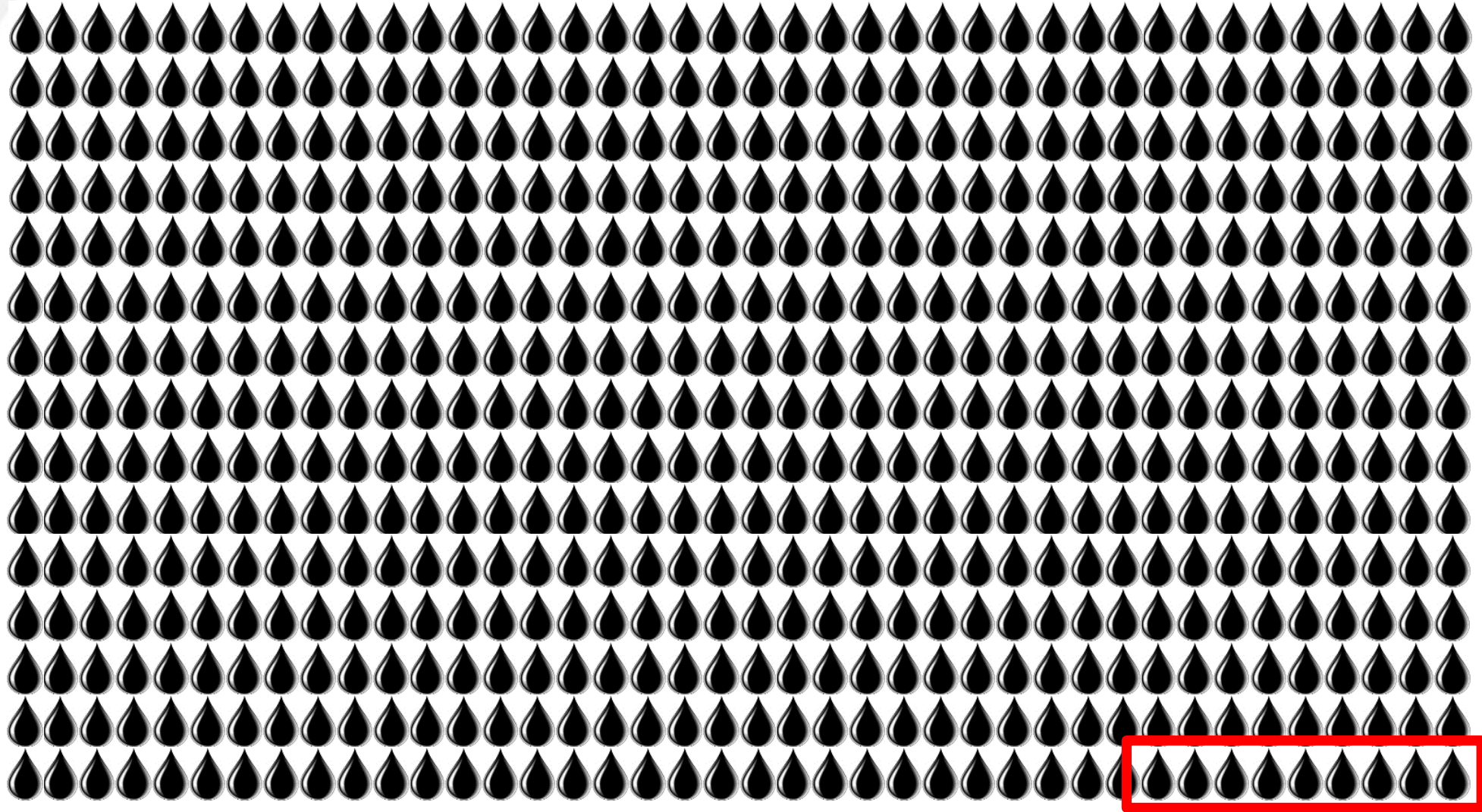
# BAKKEN OIL IN PLACE



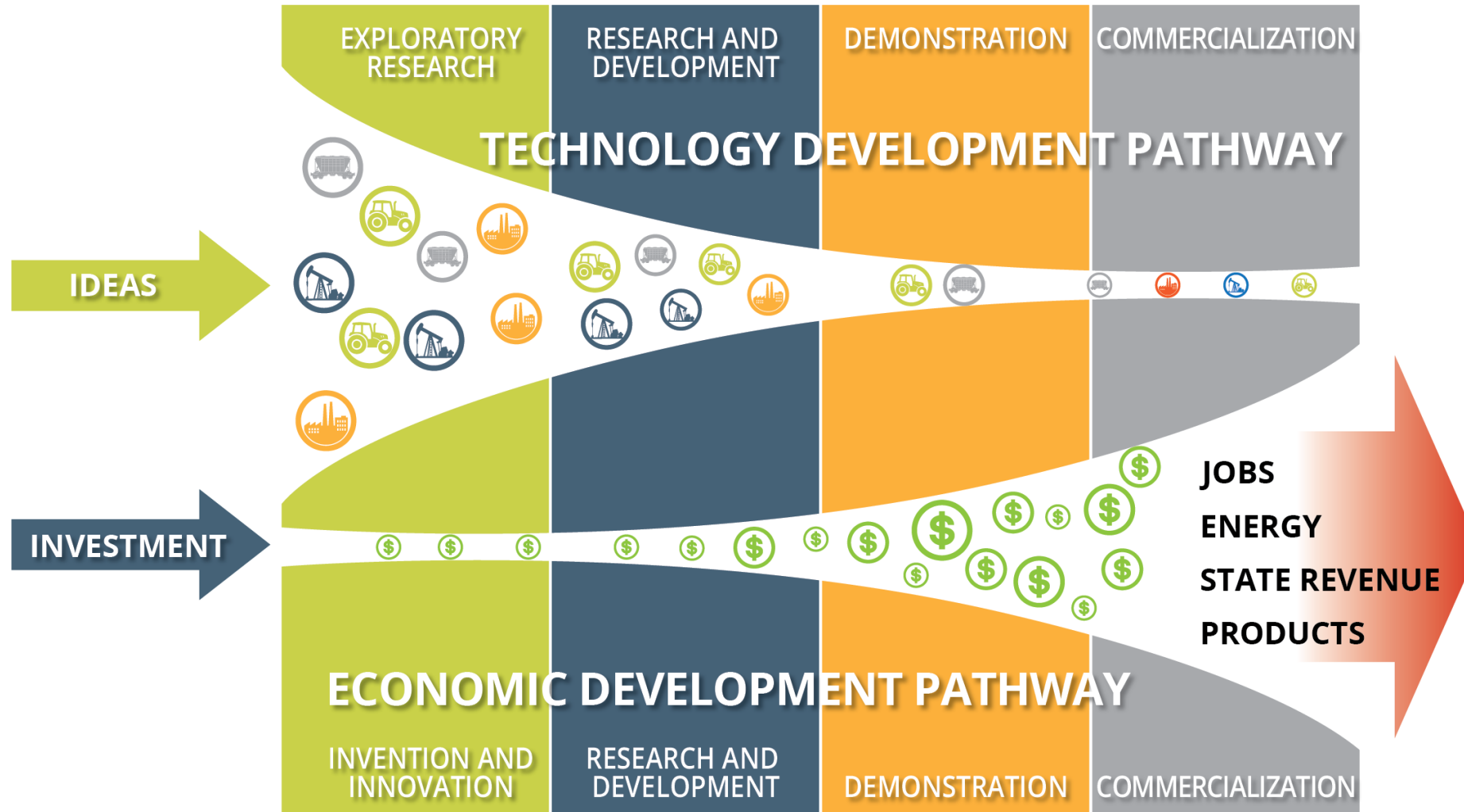
# BAKKEN OIL RECOVERY THROUGH 2024



# BAKKEN OIL RECOVERY BY 2035

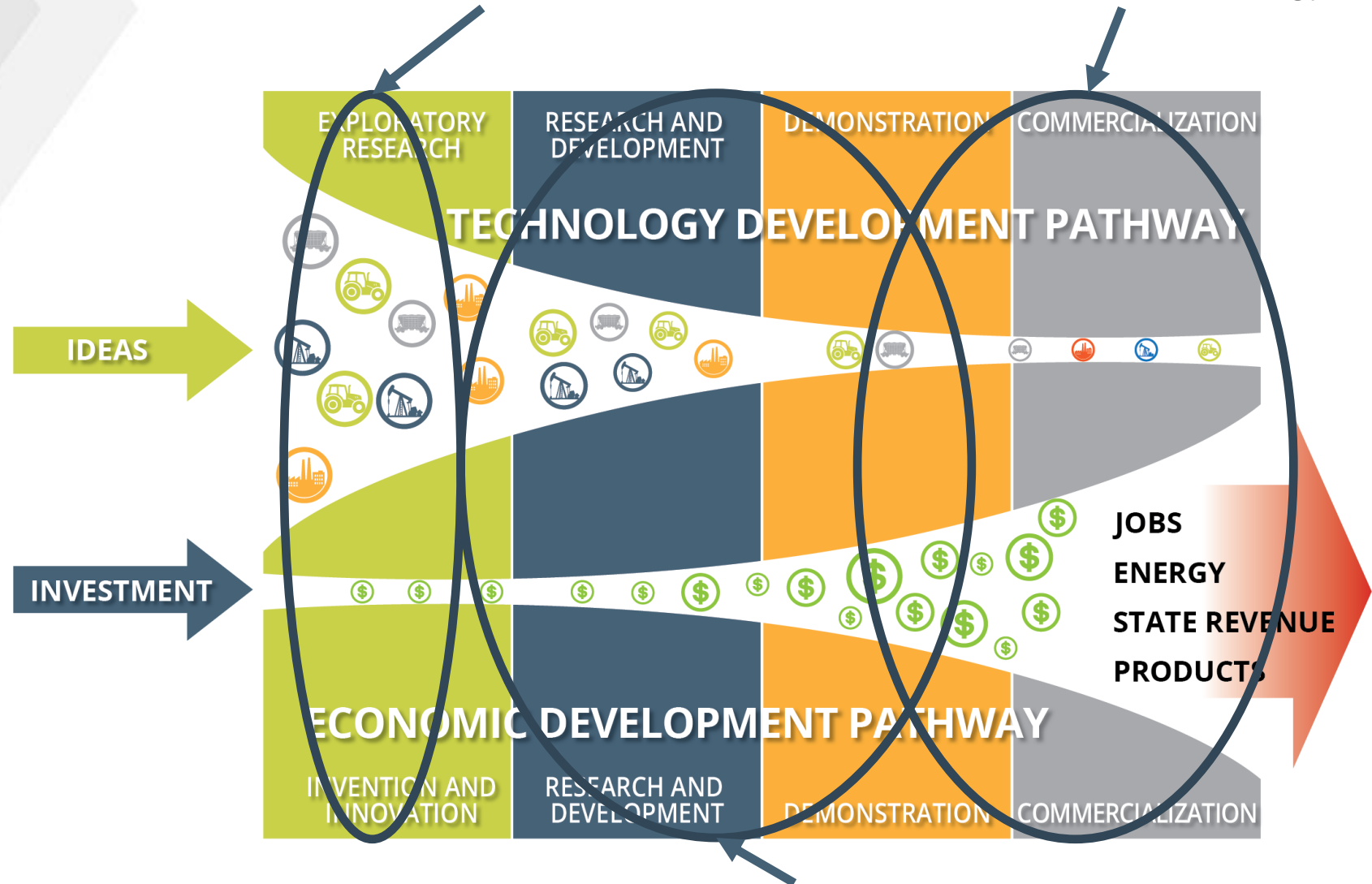


# TECHNOLOGY DEVELOPMENT



State Energy Research Center (SERC)

Clean Sustainable Energy Authority



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



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

Identified

201

Conventional Oil Fields

Requiring

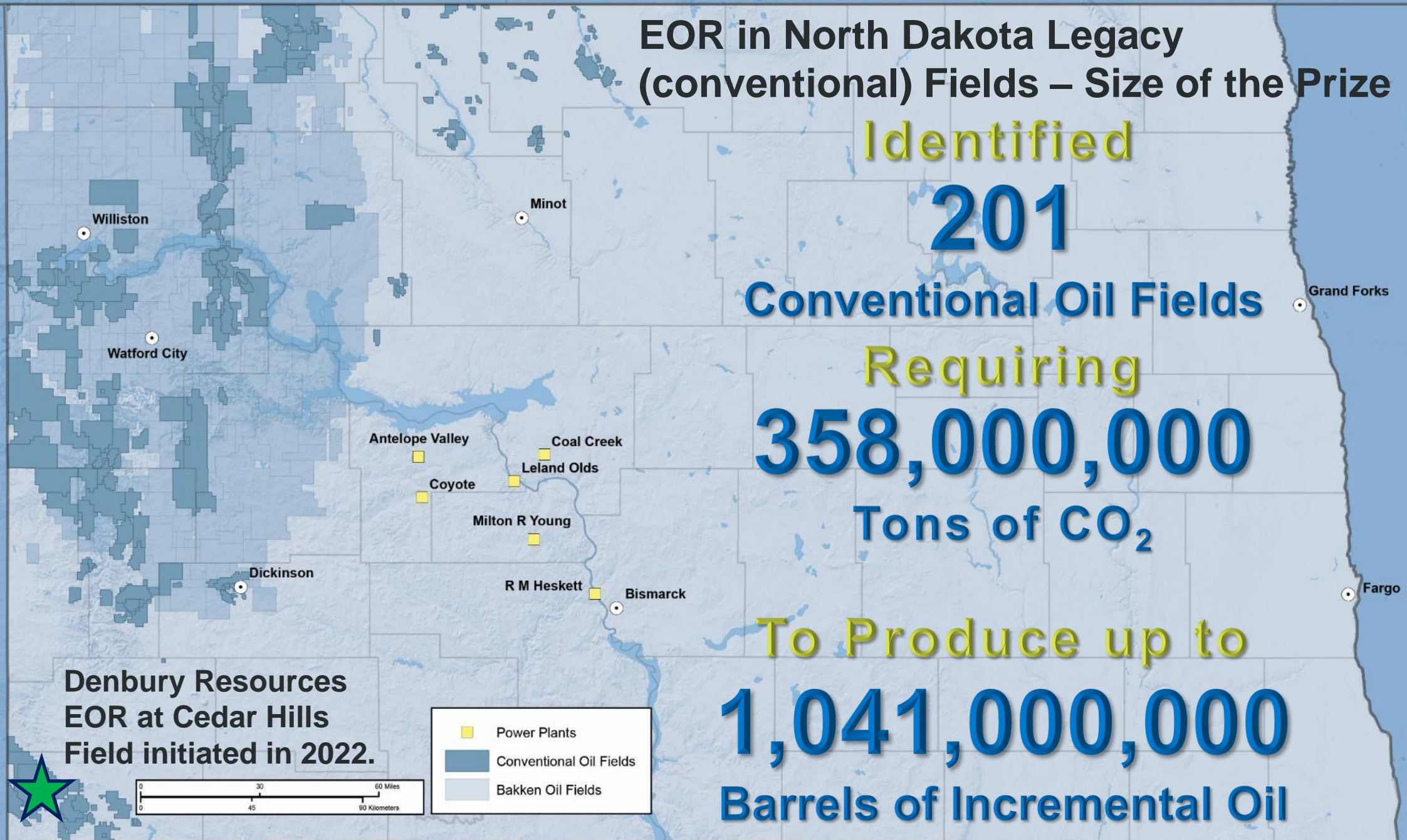
358,000,000

Tons of CO<sub>2</sub>

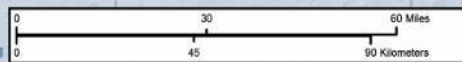
To Produce up to




1,041,000,000

Barrels of Incremental Oil



Denbury Resources  
EOR at Cedar Hills  
Field initiated in 2022.



	Power Plants
	Conventional Oil Fields
	Bakken Oil Fields

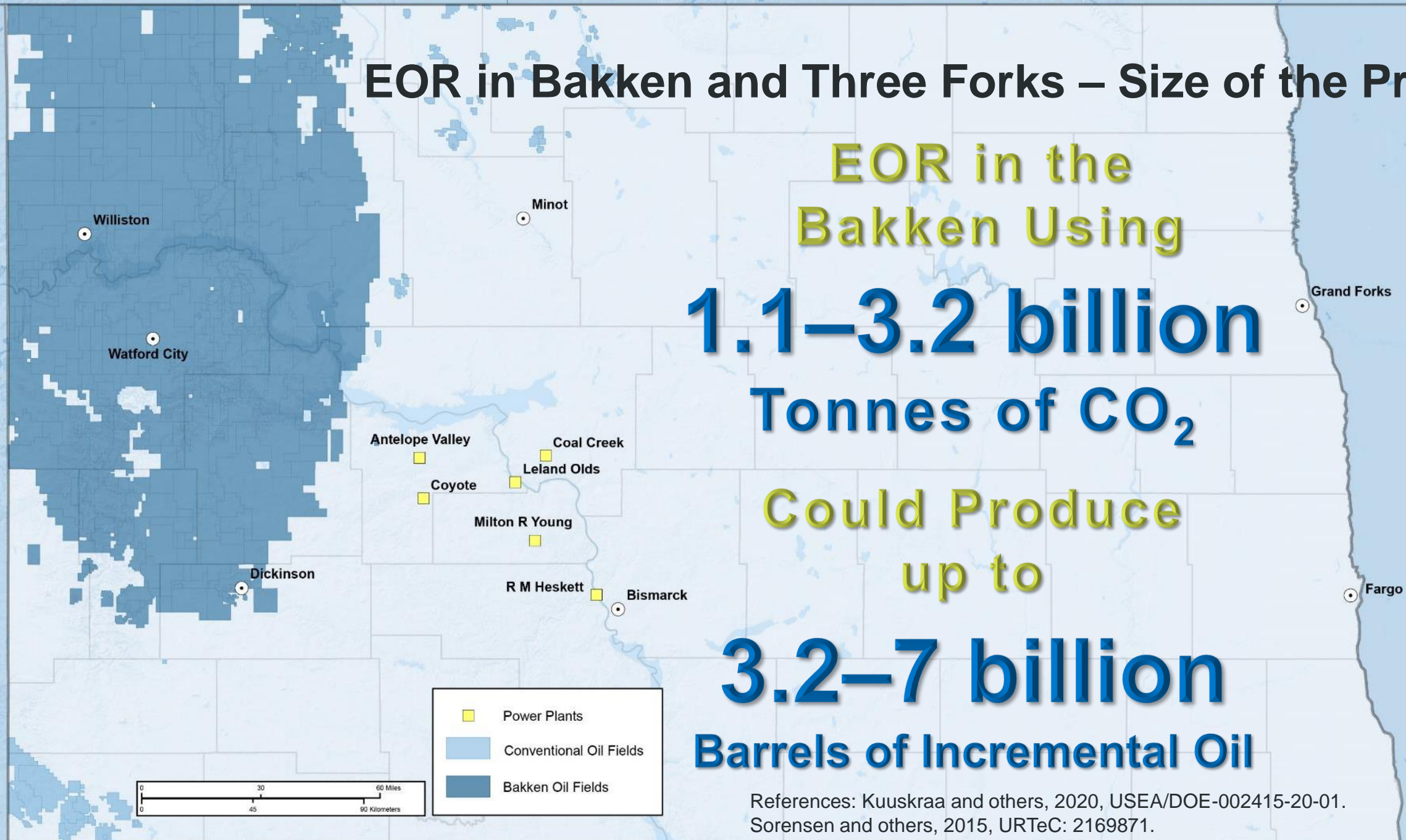
# EOR in Bakken and Three Forks – Size of the Prize

EOR in the  
Bakken Using

**1.1–3.2 billion  
Tonnes of CO<sub>2</sub>**

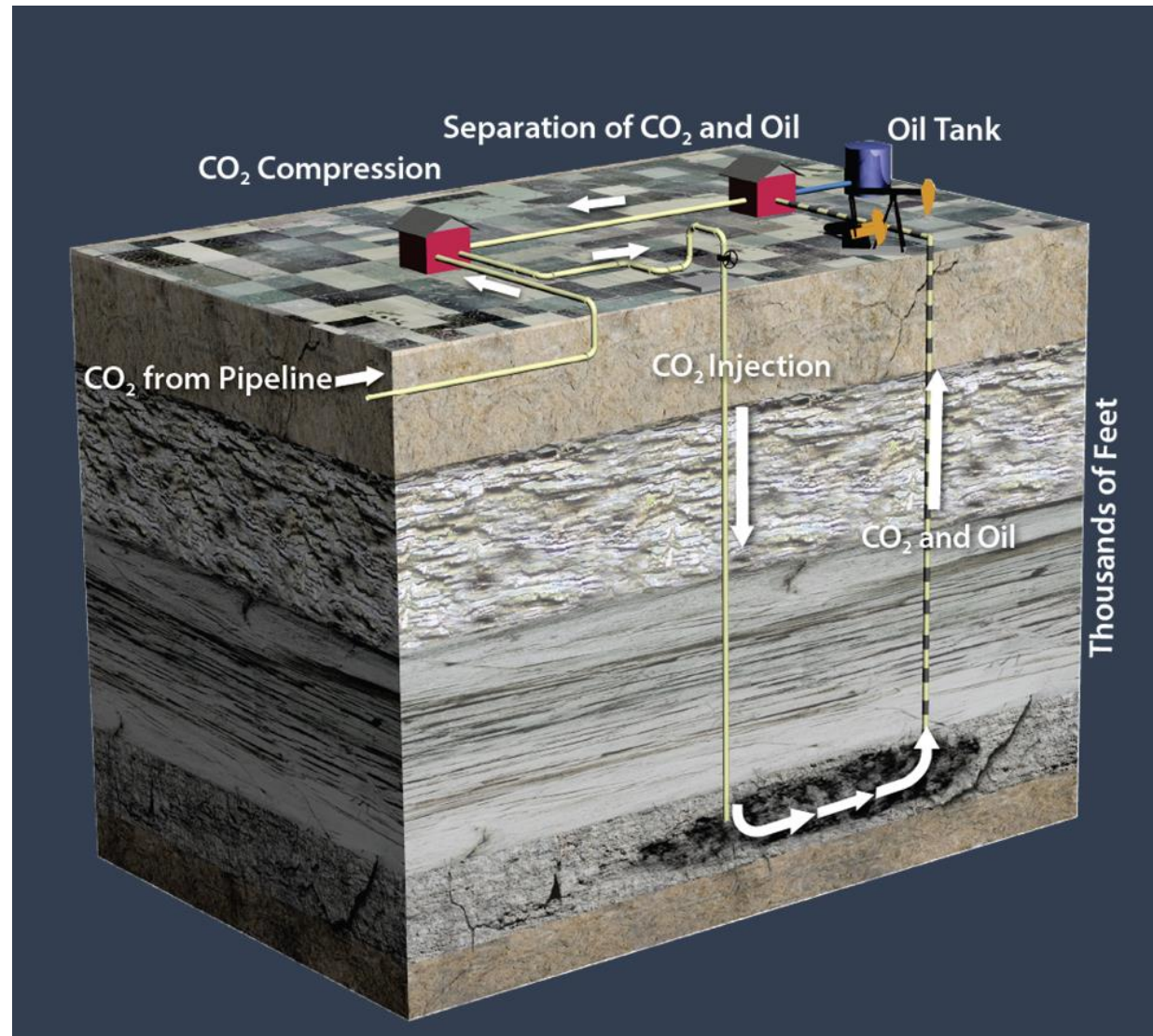
Could Produce  
up to

**3.2–7 billion  
Barrels of Incremental Oil**



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

# HOW DOES EOR WORK?



# CO<sub>2</sub> EOR Study Goals and Outcomes

- **Goal:** Forecast plausible CO<sub>2</sub> EOR development scenarios (5–20 million tons CO<sub>2</sub>/year) in North Dakota's unconventional and conventional reservoirs over 20 years.

## Bakken

- Incremental oil recoveries ranged from 337 million barrels (MMbbl) to 1 billion barrels (Bbbl) under low- and high-CO<sub>2</sub>-availability scenarios, with an average of 694 MMbbl under the baseline CO<sub>2</sub> scenario of 10 million tonnes (MMt) CO<sub>2</sub>/year.
- CO<sub>2</sub> supply demands ranged from 93 to 294 MMt, depending on the scenario.
- If EOR were operated to maintain higher CO<sub>2</sub>-utilization rates or we achieved greater IOR ratios, greater than 20 MMt CO<sub>2</sub>/year would be needed (CO<sub>2</sub> supply constrained).

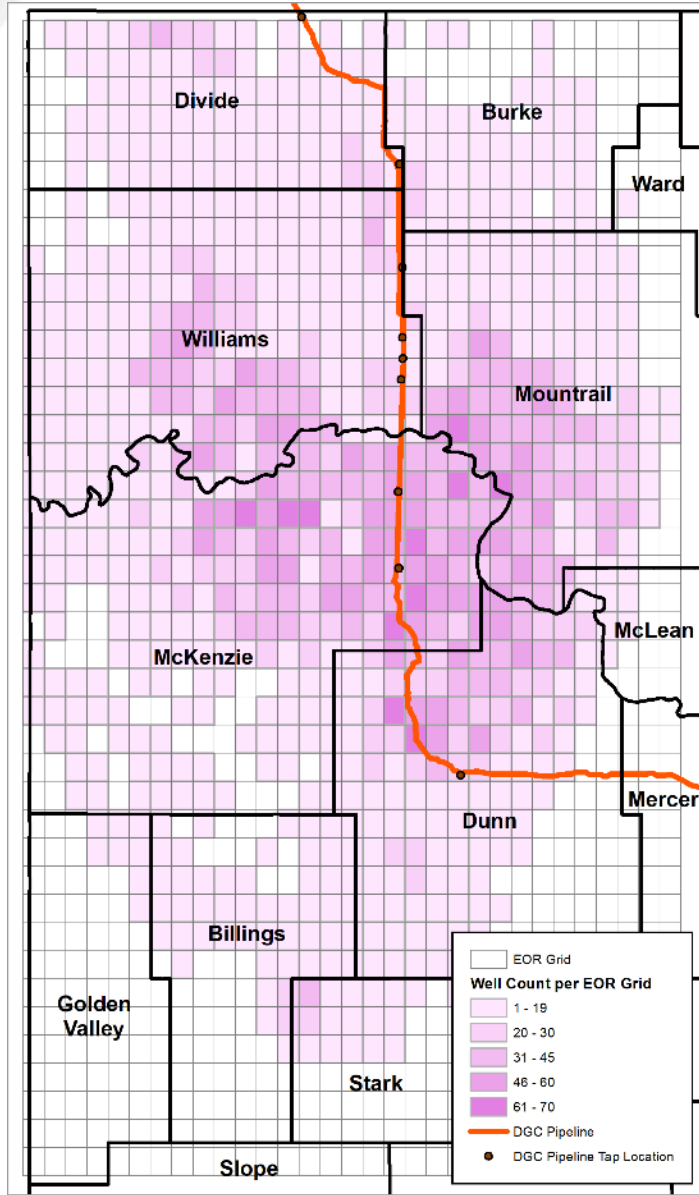
## Conventional Reservoirs

- Incremental oil recoveries were 105 MMbbl, and CO<sub>2</sub> supply demand was 88 MMt.

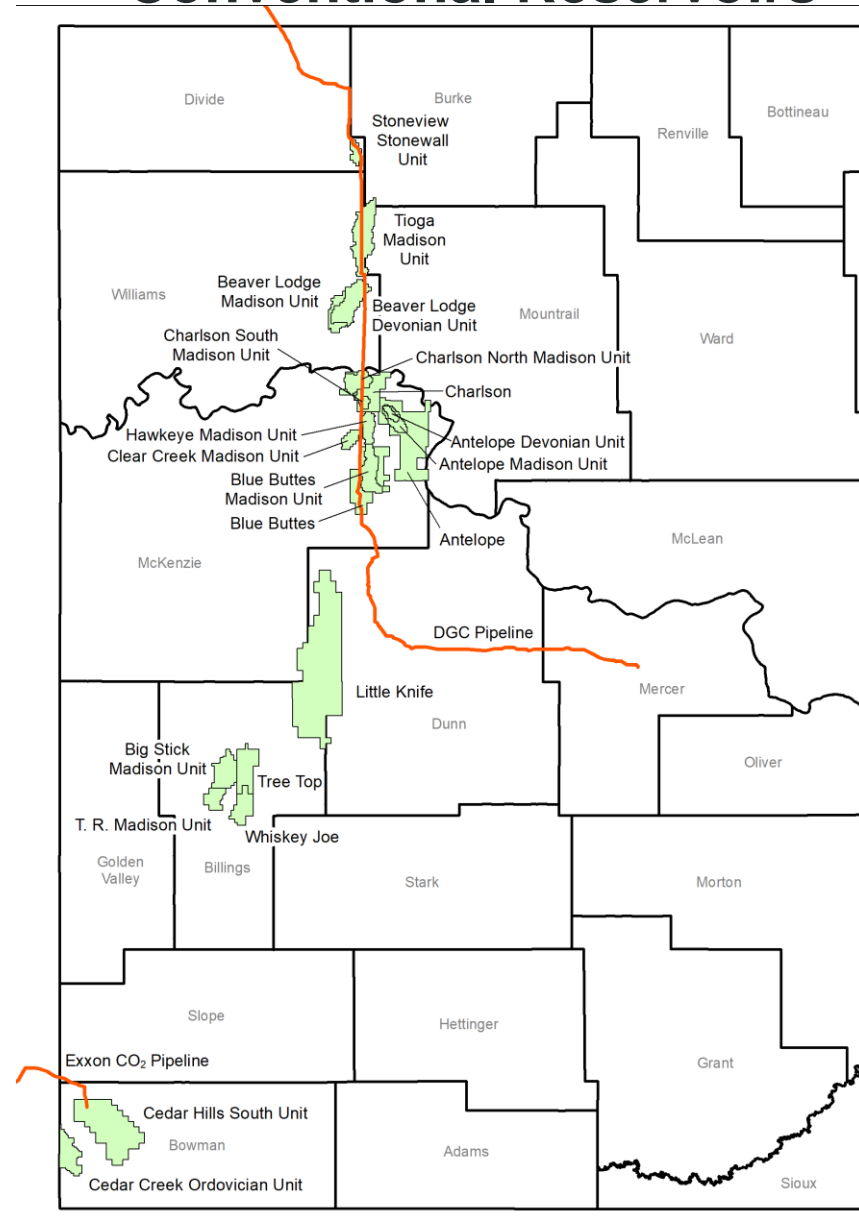
# Bakken CO<sub>2</sub> EOR Development Assumptions

- **Baseline case:** CO<sub>2</sub> was limited to 10 MMt of CO<sub>2</sub>/year. The baseline case assumed 6 thousand cubic feet (Mcf)/bbl (0.3 tonnes/bbl) and an increased oil recovery (IOR) ratio of 1.3.
- **Low-/high-CO<sub>2</sub>-availability cases:** Two additional sensitivity cases were considered using 50% less (5 MMt CO<sub>2</sub>/year) and 50% more (15 MMt CO<sub>2</sub>/year).
- **High-CO<sub>2</sub>-utilization case:** The high-CO<sub>2</sub>-utilization case used 3x more CO<sub>2</sub> per incremental barrel than the baseline case (17.3 Mcf/bbl, or 0.9 tonnes/bbl) to explore a scenario where operators were incentivized to store CO<sub>2</sub>.
- **High-IOR case:** The high-IOR case increased the IOR from 1.3 to 1.6, and CO<sub>2</sub> utilization was 9.6 Mcf/bbl (0.5 tonnes/bbl).

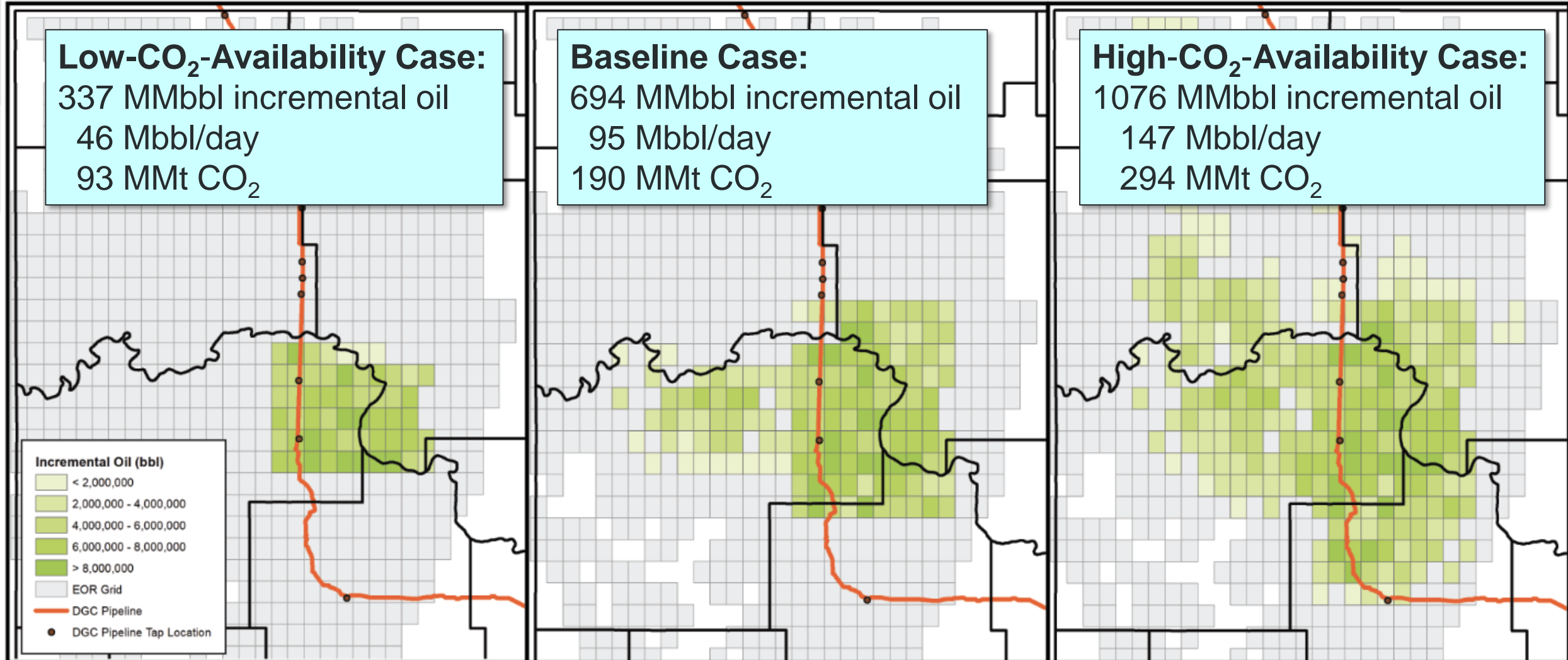
# Bakken



# Conventional Reservoirs



# Bakken 20-Year CO<sub>2</sub> EOR Performance

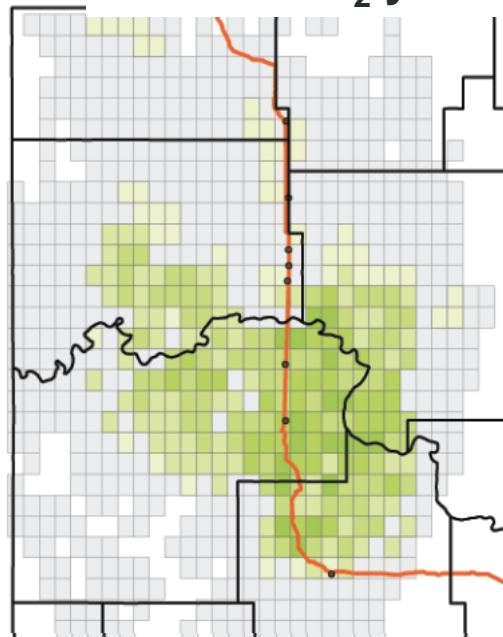
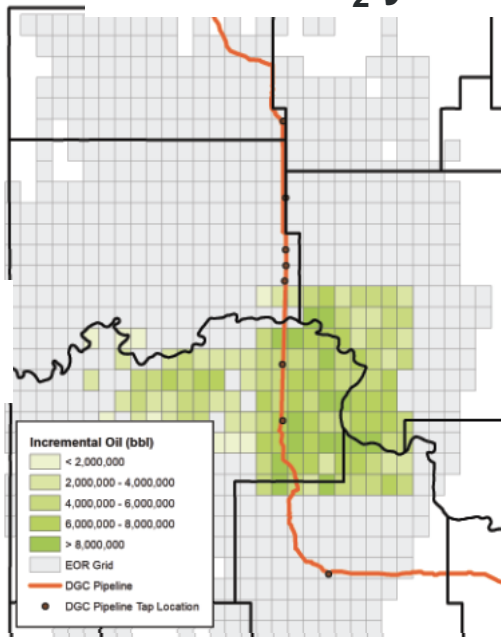


# Bakken CO<sub>2</sub> EOR Performance – Sensitivity

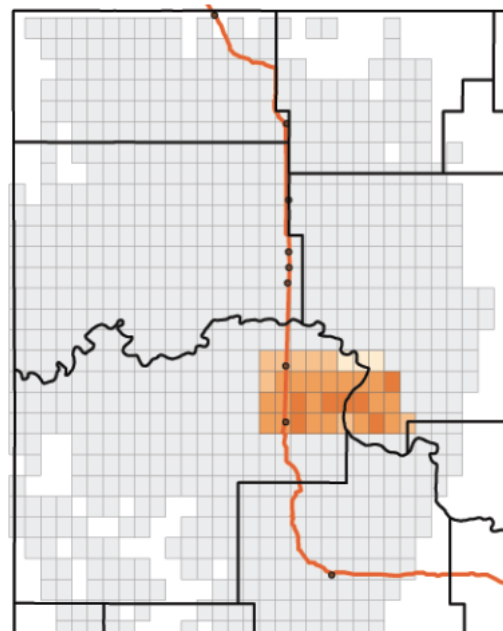
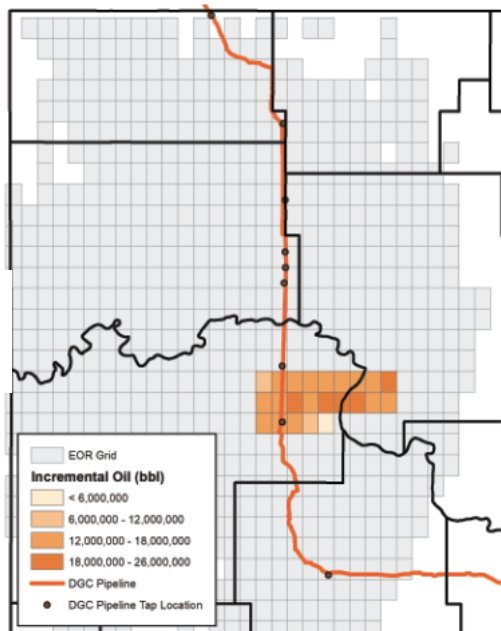
Baseline Case

10 MMt CO<sub>2</sub>/year

15 MMt CO<sub>2</sub>/year



High-IOR Case



- High IOR/baseline:
  - 42 grids (69% decrease)
  - 295 MMbbl (58% decrease)
  - 172 MMt CO<sub>2</sub> (19% decrease)
- High IOR/high CO<sub>2</sub> availability:
  - 36 grids (86% decrease)
  - 513 MMbbl (52% decrease)
  - 269 MMt CO<sub>2</sub> (3% decrease)
- Similar results for the high-CO<sub>2</sub>-utilization cases





### 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

Multiwell rich gas EOR pilot demonstrated ability to **build reservoir pressure and keep the injected gas in the drill spacing unit (DSU).**



### 2021–2022 – East Nesson

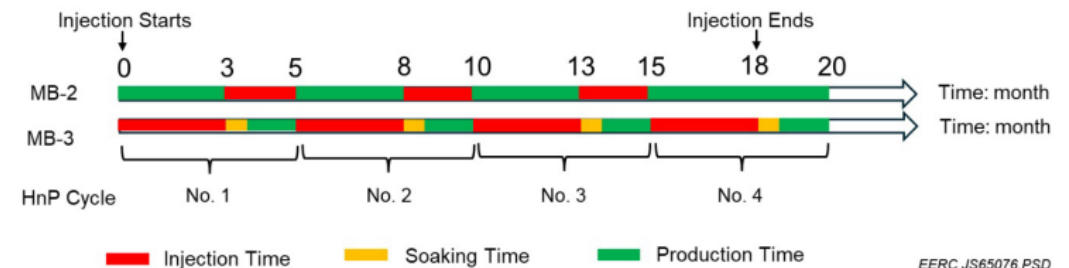
Operator = Liberty Resources

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.**

# BAKKEN EOR LARGE-SCALE PILOT

- EERC received \$11.6 million DOE award in October 2024.
- Field requirements:
  - Injection of up to 500,000 tons CO<sub>2</sub> into Bakken reservoir over 18 months
- Project objectives:
  - Demonstrate incremental recovery from unconventional reservoirs through CO<sub>2</sub> injection and storage.
  - Advance North Dakota energy goals of Bakken optimization and CCUS.
  - Deployment in McKenzie County DSU
    - ◆ *Heart of the Basin – proven here, proven everywhere*



EERC JS65076.PSD

# BAKKEN EOR LARGE-SCALE PILOT

- Success = Demonstrated pathway to commercialization
- Continues building on results of previous pilots
- Moving by orders of magnitude – 10X
  - Previous pilots – 1000s/10,000s tons injected
  - **Current pilot – 100,000s**
  - Commercialization – 1,000,000s

## East Nesson Bakken Enhanced Oil Recovery Pilot: Coinjection of Produced Gas and a Water-Surfactant Mixture

Gordon Pospisil; Larry Griffin; Tappan Souther; Stacy Strickland; Jeremy McChesney; C. Mark Pearson; Chantsalmaa Dalkhaa; James Sorensen; John Hamling; Bethany Kurz; Nicholas Bosshart; Michael Warmack; Ailin Assady; Jin Zhao; Brian Schwantiz; Adrian Williams; David Schechter; Abhishek Sarmah

Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, USA, June 2022.

Paper Number: URTEC-3722974-MS

<https://doi.org/10.15530/urtec-2022-3722974>

Published: June 20 2022.



Cite

Share

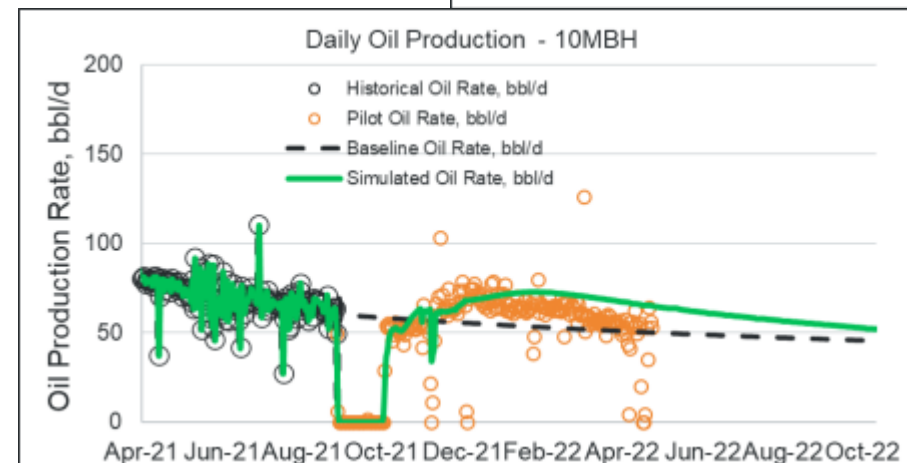
### Abstract

Objectives/Scope: In 2021, Liberty (EOR) pilot via a single huff 'n' puff County, North Dakota. The primary produced gas with water and surfactant. Liberty in partnership with the Ene. The objectives were to 1) repressurize



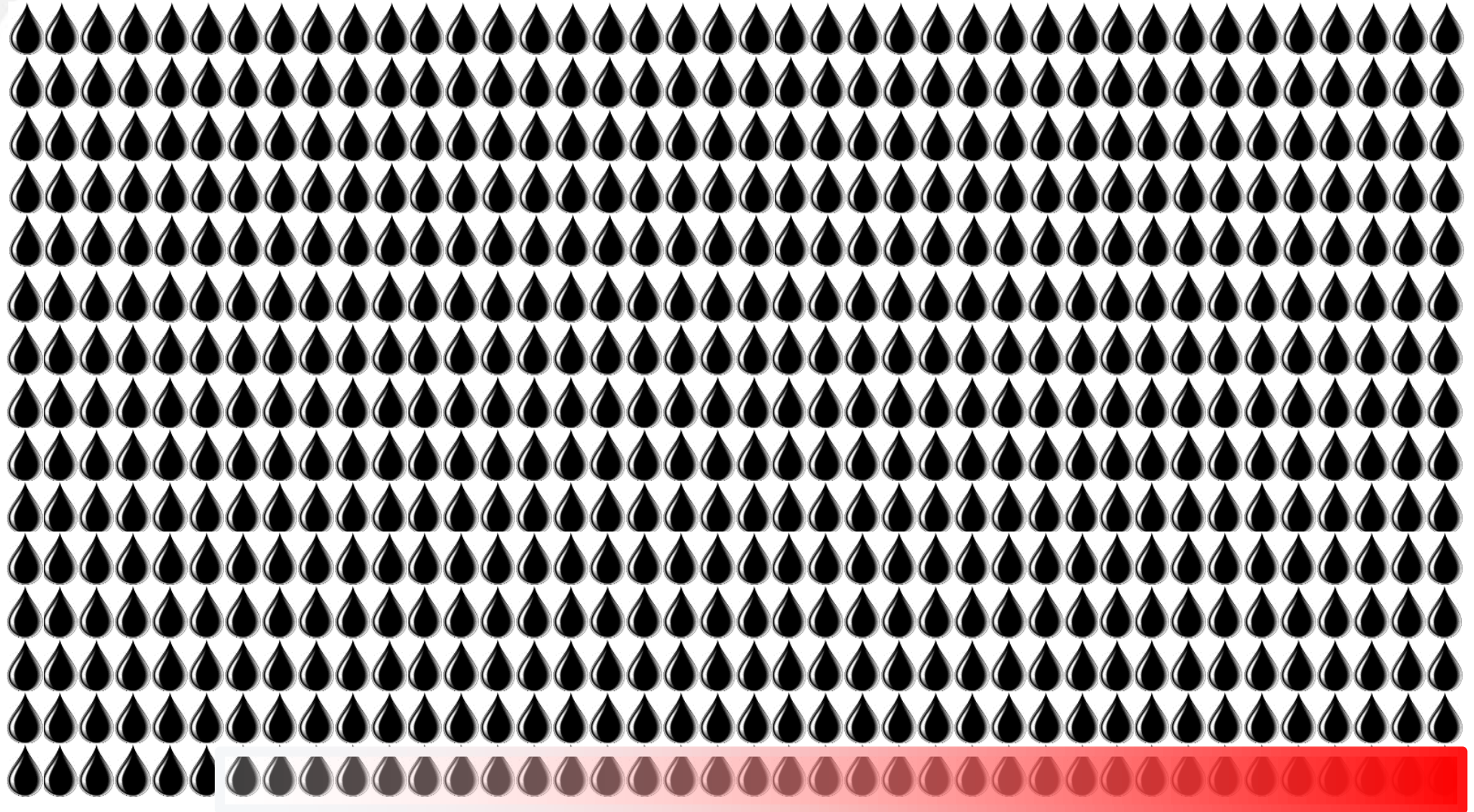
SPE-201471-MS

Report on the First Rich Gas EOR Cyclic Multiwell Huff N Puff Pilot in the Bakken Tight Oil Play



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# BAKKEN OIL RECOVERY BEYOND 2035





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

**THANK YOU**

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# Conventional 20-Year CO<sub>2</sub> EOR Performance

- Maximum daily oil rate: 23 Mbbbl/day
- Average daily oil rate: 14 Mbbbl/day
- Cumulative incremental oil production over 20 years: 105 MMbbl
- Maximum and average CO<sub>2</sub> utilization were 17,000 and 12,000 tonnes of CO<sub>2</sub>/day, respectively
- Cumulative purchased CO<sub>2</sub> over 20 years: 88 MMt CO<sub>2</sub>

