SCALING UP TO INDUSTRIAL CCUS

A Regional Perspective
North Dakota, USA

Ground Water Protection Council
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John Hamling
Assistant Director, Integrated Projects
A STATE OF ENERGY

Population – ~760,000 (~70,000 square miles)
CO\textsubscript{2} emissions – 34th – ~56 million tonnes per year

Total Energy Production 6\textsuperscript{th}

- Oil – 2nd
- Natural gas – 10th
- Coal – 8th
- Wind – 10th
- Ethanol – 10th

Agricultural products

- 19 – top three
A Prolific Oil-Producing Region in North America

- Conventional
- Unconventional
- Stacked horizons
- Residual oil zones (ROZs)?

Abundant Anthropogenic CO₂ Sources Proximal to Enhanced Oil Recovery (EOR) and Storage Opportunities

Growing CO₂ Transportation Network

Massive CO₂ Storage Potential in Deep Saline Formations
GEOLOGY

21 hydrocarbon-bearing formations; several contain multiple producing horizons.

Multiple potential unconventional source rock formations.
ENORMOUS EOR OPPORTUNITY

86 conventional unitized fields:
- 280 million to 630 million bbl of incremental oil
- 47 million to 283 million metric tons of CO₂ needed

200+ conventional fields
- >1 Bbbl of incremental oil
- >358 million metric tons of CO₂ needed

Conventional + Bakken Petroleum System:
- 4 Bbbl–7.6 Bbbl of incremental oil
- 2 Btons–3.8 Btons of CO₂ needed
...or more
ENORMOUS DEDICATED STORAGE POTENTIAL IN DEEP SALINE FORMATIONS

More than 330 GT of storage potential,

100+ billion tonnes in ND alone.

ENGAGED PARTNERS
Commercial Industrial CCUS Projects

- Basin Electric Power Cooperative, Dakota Gasification Company Great Plains Synfuels (commercial)
- Basin Electric Power Cooperative Urea Process Liquefaction Plant (commercial)
- SaskPower Boundary Dam Carbon Capture Project (commercial)
- Exxon Mobil Shute Creek Natural Gas Processing (commercial)
- ConocoPhillips Lost Cabin Natural Gas Processing (commercial)
- Shell Quest CCS Facility* (commercial) – Alberta, Canada

*not pictured.
Announced Industrial CCUS Projects

- Red Trail Energy – Richardton Ethanol Facility (precommercial/FEED)
- Minnkota Power Cooperative Project Tundra – Milton R. Young Station (precommercial/FEED)
- Basin Electric Power Cooperative Dry Fork Station (precommercialization/FEED)
- Great River Energy CCS² - Coal Creek Station (feasibility)
- Midwest AgEnergy – Blue Flint Ethanol Facility (feasibility)
- SaskPower Shand Power Station (feasibility)
CO₂ Transportation Network

DGC line (commercial)
- 205-mile 14” - 12”

Greencore Pipeline (commercial)
- 232-mile long 20”
- (725 MMscf/day)
- Anadarko CO₂ pipeline interconnect

Greencore Pipeline Expansion (sanctioned)
- 110-mile expansion to Baker, MT, and Cedar Creek Anticline

North Dakota Industrial Sources Line(s) (conceptual)

DGC Food-Grade Truck Facility (commercial)
INCENTIVES

West Coast LCFS Markets
- Credits trading up to $213 per ton.
- Stacked with 45Q

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)

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

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).

Tax credits trading up to $213 per ton.
- Stacked with 45Q West Coast LCFS Markets
A RESOURCE MANAGEMENT PHILOSOPHY

Mission to promote and prudently develop North Dakota’s oil, gas, fossil, and renewable energy resources.

“Public interest to promote geologic storage of carbon dioxide...”

Carbon capture, utilization, and storage (CCUS) is a key to leveraging a tremendous endowment of fossil energy to provide secure, reliable, affordable, safe, clean energy.

Public accustomed to energy industry and the role it plays.
**UNDERGROUND INJECTION CONTROL**

**NORTH DAKOTA’S GOT CLASS! I, II, III, IV, V, AND VI**

<table>
<thead>
<tr>
<th>Class</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
<th>Class V</th>
<th>Class VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>ND Dept of Health</td>
<td>ND Geological Survey</td>
<td>ND Dept of Health</td>
<td>ND Dept of Health</td>
<td>NDIC Oil &amp; Gas Division</td>
</tr>
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<td></td>
<td>Hazardous and nonhazardous fluids (industrial and municipal wastes).</td>
<td>Brines and other fluids associated with oil and gas production.</td>
<td>Fluids associated with solution mining of minerals.</td>
<td>Hazardous or radioactive wastes. This class is banned by EPA.</td>
<td>Injection of carbon dioxide for long-term storage.</td>
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</tbody>
</table>

* EPA retains direct implementation authority for class II wells in Florida and Idaho.
CHAPTER 38-22 CARBON DIOXIDE UNDERGROUND STORAGE

38-22-01. Policy. It is in the public interest to promote the geologic storage of carbon dioxide. Doing so will benefit the state and the global environment by reducing greenhouse gas emissions. Doing so will help ensure the viability of the state's coal and power industries, to the economic benefit of North Dakota and its citizens. Further, geologic storage of carbon dioxide, a potentially valuable commodity, may allow for its ready availability if needed for commercial, industrial, or other uses, including enhanced recovery of oil, gas, and other minerals. Geologic storage, however, to be practical and effective requires cooperative use of surface and subsurface property interests and the collaboration of property owners. Obtaining consent from all owners may not be feasible, requiring procedures that promote, in a manner fair to all interests, cooperative management, thereby ensuring the maximum use of natural resources.
Carbon dioxide storage facility administrative fund ($0.01/ton): administrative costs associated with regulating storage facilities.

Carbon dioxide storage facility trust fund ($0.07/ton): cost of long-term monitoring.

Certificate of Project Completion – Release of Bond – Transfer of Title and Custody

ANCILLARY

State issues certificate of project completion (all criteria met – at least 10 years postinjection)

REGULATORY
• Releases responsibility, regulatory requirements, and bonds
• Transfer of title and custody to storage facility and stored CO₂ state
• State oversees/responsible for monitoring and managing the storage facility until such time as federal government assumes responsibility (assures site access/confidence)

MECHANISMS

FACILITATE
• State retains all authority to regulate future mineral and UIC activities
  • protection from recapture of incentives.

INDUSTRIAL

CCUS

State issued determination of storage (facilitate trading and incentive programs)
INTEGRATED ADAPTIVE MANAGEMENT APPROACH TO PROJECT IMPLEMENTATION

• Staged approach to manage uncertainty and inform investment strategy

• Implementation can be accelerated
  – More investment needed at lower levels of confidence
  – Balance financial and technical risk
    ♦ Site qualification
    ♦ Permitting
    ♦ Investment
    ♦ 45Q start of construction
GENERALIZED TIMELINE AND MAJOR MILESTONES

**Operations**
- Drill and construct injection and monitoring wells; Install infrastructure; Update permits

**Investment & Construction**
- 45Q Start Construction by 01/01/2024

**Design & Permitting**
- Permit Review & Approval
- Receive Permit Approvals
- File Permits
- Storage Facility Permit Defined
  - # Injection Wells
  - # Monitoring Wells
- Storage Facility Permit Development
- Baseline Monitoring
- AOR (legacy wells)
- Additional Data Collection

**Feasibility**
- Go-No-Go

**Screening**
- Go-No-Go

Acquire pore space and negotiate access agreements

# Injection Wells
# Monitoring Wells

Critical Challenges. Practical Solutions.
DRIVERS FOR INDUSTRIAL CCUS
OBSTACLES FOR INDUSTRIAL CCUS
John Hamling
Assistant Director for Integrated Projects
jhamling@undeerc.org
701.777.5472 (phone)