North Dakota CarbonSAFE Phase III: Site Characterization and Permitting (FE0031889)

U.S. Department of Energy
National Energy Technology Laboratory
Carbon Management and Natural Gas & Oil Research Project Review Meeting
August 2022

Wes Peck
Energy & Environmental Research Center
Project Overview

GOAL:
• Perform commercial-scale site characterization and permitting for the geologic storage of nearly 4 million metric tons (Mt) of CO$_2$ per year.
Objective: Accelerate wide-scale deployment of CCUS by assessing and permitting the geologic storage of CO$_2$ emissions captured from the Milton R. Young Power station.
Two Projects in One

1. **Divert flue gas then separate CO$_2$** in a carbon capture system that strips out the CO$_2$ then liquifies under pressure.

2. **Inject CO$_2$ into storage formation** over a mile below lignite mine.

No impact on the power plant and no impact on its costs
How Did We Get Here?

• CarbonSAFE Jump Start—Leveraged existing:
  – Partnerships
  – Expertise
  – Methods
  – Regional characterization
Phase III:

- CSND Phase II—ended March 31, 2020
- CSND Phase III—started one month later!

Bridging Activity:
- Pre-award: 5/1/2020
- J-LOC1: 5/14/2020
- J-ROC1: 9/8/2020
- Award - BP1: 10/1/2020
**Black Island/Deadwood**
**Measured Values**
- Depth: ~9400 ft
- Porosity (%): 3.4–15
- Permeability (mD): 0.03–2060

**Broom Creek Measured Values**
- Depth: ~4900 ft
- Porosity (%): 2–27
- Permeability (mD): 0.06–2690

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**Project Location**

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Phase III Technical Approach: Address the Needs of the Permit!

<table>
<thead>
<tr>
<th>Major NDIC Permitting Requirements</th>
<th>Core</th>
<th>Logging</th>
<th>Downhole</th>
<th>Testing</th>
<th>Lab Testing</th>
<th>Modeling</th>
<th>Simulation</th>
<th>Seismic Collection</th>
<th>Baseline Sampling</th>
<th>New Fox Hills Wells</th>
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</thead>
<tbody>
<tr>
<td>Determine Plume Extent</td>
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<td>Determine Pore Space Amalgamation</td>
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<td>Geologic Properties of Injection and Confining Zones</td>
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<td>Regional Faulting Assessment</td>
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<td>Potential for Seismic Activity</td>
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<td>Geologic Maps and Cross Sections</td>
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<td>Geomechanics of Confining Zones(s)</td>
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<td>Determine Area of Review</td>
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<td>Baseline Geochemical Data</td>
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<td>Baseline Water and Soil Data</td>
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Data Collection

Step rate injection test

2551 feet of core collected

18 square miles of seismic collection

Critical Challenges. Practical Solutions.
Pore Space and Area of Review

• Pore Space Access:
  – ~50 parcels of land
  – ~60 different landowners
  – >95% voluntary enrollment

• Area of Review (AOR)—risk-based approach for over-pressured formations (Broom Creek Formation)
Public Hearing

Combined applications were 1200+ pages

Over 7 hours of testimony and responding to public comments
First coal-fired power plant permitted to store CO$_2$
MRV Plan Development and Approval

- Develop an EPA-compliant MRV plan to meet the requirements of the IRS 45Q tax incentive program.
- The MRV plan is founded on the storage facility permit application “testing and monitoring plan” and complements the ND Class VI UIC reporting requirements.

MRV plan submitted November 2021.
MRV plan approved April 2022.
EIV Submitted

- Verbal approval
- Preparing to begin the Environmental Assessment (EA)
Timeline

Jan-May 2021
Create SFP

May 2021
SFP Submitted

November 2021
SFP Hearing
MRV Submitted

January 2022
SFP Approved
MRV Approved

April 2022
EIV Submitted

June 2022
DOE Comments Received
Lessons Learned

• Injection tests are worth it.
• Scenario iteration takes time—every answer generates more questions.
• Pore space acquisition takes more time than you think.
• Working in a state with Class VI primacy—priceless.
• Great partners make a difference!
Where Are We Today

- NDIC administrative orders signed for two SFPs
- Received approval for Class VI injection wells
- MRV plan approved
- EIV document verbal approval

Future activity:
- Install injection wells and monitoring well
- File for permit to inject when CO$_2$ is available.
For More Information

www.dmr.nd.gov/dmr/oilgas/ClassVI

CO2 Storage Facility Permit Requests:

- **Applicant:** Dakota Gasification Company
  - NDIC Case No. 29450 - Draft permit, fact sheet, and storage facility permit application

CO2 Storage Facility Permits Issued:

- **Applicant:** Minnkota Power Cooperative, Inc.
  - Order 31583 – Minnkota Power Cooperative – Geologic storage of carbon dioxide, Broom Creek Formation, Oliver County
  - Order 31584 – Minnkota Power Cooperative – Amalgamation of storage reservoir pore spacing, Broom Creek Formation, Oliver County
  - Order 31585 – Minnkota Power Cooperative – Determination of financial responsibility for geologic storage of carbon dioxide, Broom Creek Formation, Oliver County
  - Order 31586 – Minnkota Power Cooperative – Geologic storage of carbon dioxide, Deadwood Formation, Oliver County
  - Order 31587 – Minnkota Power Cooperative – Amalgamation of storage reservoir pore spacing, Deadwood Formation, Oliver County
  - NDIC Case No. 29029 - Draft permit, fact sheet, and storage facility permit application
  - NDIC Case No. 29032 - Draft permit, fact sheet, and storage facility permit application

- **Applicant:** Red Trail Energy LLC
  - Order 31453 – Geological storage of carbon dioxide from Red Trail Energy
  - Order 31454 – Amalgamation of the storage reservoir pore space/Red Trail Energy
  - Order 31455 – Determination of financial responsibility/Red Trail Energy
  - NDIC Case No. 28848 - Draft Permit, fact sheet, and storage facility permit application
Project Overview

Objective:
• Perform commercial-scale site characterization and permitting for the geologic storage of nearly 4 million metric tons (Mt) of CO₂ per year.

<table>
<thead>
<tr>
<th>Funding</th>
<th>DOE</th>
<th>Cost Share</th>
<th>Project Total</th>
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</thead>
<tbody>
<tr>
<td>Dollars (MM)</td>
<td>$16.97</td>
<td>$7.96</td>
<td>$24.93</td>
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<tr>
<td>Contribution</td>
<td>68%</td>
<td>32%</td>
<td>100%</td>
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• Performance dates:
  – BP1: October 2020 - September 2022
  – BP2: October 2022 - September 2023
Project Overview – Goals and Objectives

• The goal of the proposed effort is to accelerate wide-scale deployment of CCUS by assessing and permitting two safe, cost-effective, commercial-scale storage sites within a storage complex for CO₂ emissions captured from MRYS in central North Dakota. Achieving the goal of Phase III will require acquisition, analysis, and development of geologic information to fully characterize a storage complex in the region around MRYS to demonstrate storage resources for commercial volumes of CO₂.

• Through the proposed effort, the following key activities will be performed: 1) identify and characterize two commercial-scale CO₂ stacked storage sites; 2) apply and obtain approval for an UIC Class VI permit to construct each proposed injection well; and 3) prepare an Environmental Information Volume (EIV) to assess any NEPA (National Environmental Protection Act)-related issues for the identified capture, transport, and storage sites.
Success Criteria

BP1

Subtask 3.1 – Submit Permit to Drill (M1). By November 30, 2020, a stratigraphic test well permit will be submitted to drill the well. The activity is necessary to collect core from each reservoir of interest and perform a suite of laboratory analyses and logging suites to supplement existing knowledge of the storage complex from CarbonSAFE Phase II. Completed August 14, 2021

Subtask 3.2 – Geophysical Data Acquisition Complete (M2). By July 31, 2021, 3-D seismic survey data acquisition will be complete. The data will serve to update geocellular modeling efforts in the storage complex and are a critical component for establishing the storage facility permits for each reservoir (M6). Completed June 19, 2021

Subtask 4.3 – Area of Review Determined (M5). By September 30, 2021, the area of review will be determined for the proposed CO₂ storage program which is required to satisfy storage facility permit applications (M6). Completed June 19, 2021

Subtask 5.1 – Storage Facility Permit Application Complete (M6). By September 30, 2021, the storage facility permit application will be completed and submitted to the North Dakota Industrial Commission. Completed May 28, 2021
Success Criteria Continued

BP2

Subtask 8.1 – NRAP Supplemental Testing Complete (M7). By January 31, 2023, work would expand upon the initial testing done for North Dakota CarbonSAFE Phase 2 and either a) test new versions of existing NRAP tools or b) test existing NRAP tools using newly generated simulation outputs. The results of the testing would be included in the final report and would not be a standalone deliverable. Completed

Subtask 8.2 – ML Algorithm Testing and Evaluation (M8). By April 30, 2023, ML algorithms developed through the SMART Initiative Task 4 would be applied to North Dakota CarbonSAFE. Phase III data to test and evaluate the performance of one or more ML algorithms against numerical reservoir simulations. The results of the testing would be included in the final report and would not be a standalone deliverable.