Wyoming CarbonSAFE: Accelerating CCUS Commercialization and Deployment at Dry Fork Station and the Wyoming Integrated Test Center

PROJECT AWARD #: DE-FE0031891
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Project Overview
Project Overview: Wyoming CarbonSAFE Phase III

- Dry Fork Station (Basin Electric Power Coop)
- Wyoming Integrated Test Center (WY-ITC)

**Dry Fork Station**
- Built in 2007
- Operating life to 2072
- 385 MW
- 3.3 million tons of CO₂/year

**WY-Integrated Test Center (ITC)**
- Completed fall 2017
- Test CO₂ capture/CCUS technologies
- $20M public/private investment
- $65M Membrane Technology Research (MTR) Large-scale pilot
Full-Scale FEED of MTR’s Capture Process at Dry Fork Station
Project Participants

ACADEMIC PARTNERS
- University of Wyoming
- Advanced Resources International
- Energy and Environmental Research Center
- Los Alamos National Laboratory

CARBON CAPTURE
- Membrane technology and Research, Inc. (MTR)
- Wyoming Integrated Test Center

INDUSTRIAL PARTNERS
- Schlumberger Carbon Services
- Denbury Resources
- Oxy Low Carbon Ventures
- Carbon GeoCapture
- Western Fuels Association

PERMITTING, ENVIRONMENTAL AND REGULATORY EXPERTS
- Long Reimer Winegar Beppler, LLP
- TriHydro Corporation
- Wyoming Energy Authority
- Wyoming Department of Environmental Quality (DEQ)
- Wyoming Municipal Power Agency
Major Objectives

1. Finalize surface and subsurface characterization activities at DFS
2. Conduct NEPA and environmental analysis
3. Integrate MTR’s CO₂ FEED capture assessment
4. Complete Class VI permits to construct for the storage hub
5. Advance commerciality within the Wyoming CarbonSAFE storage hub

Project funding:
• $15,526,325 (Federal)
• $3,941,389 (Cost share)
• $19,467,714 (Total)

Site selection and characterization
Rational for site selection

- CO₂ source with 50 year operational life-span
- Modern coal plant
- Located within Carbon Valley, the site of:
  - Existing intrastate CO₂ transportation network
  - Multiple utilization industries
    - Carbon to products industry
    - CO₂-EOR for carbon utilization
  - Experienced carbon workforce
  - Multiple CO₂ point sources
  - Transportation infrastructure
- Wyoming has
  - CO₂ management legislative framework
  - Class VI primacy
  - Educated and supportive public
  - Known geologic targets
Site Characterization to-date

- One stratigraphic test well completed, one well designed and in-review
- Assessment of core, formation fluid and logs from target injection formations and sealing lithology
- Environmental (EIV) and monitoring assessments (Soil, GW)
- 3D seismic survey
- Storage hub property models and injection feasibility simulations
- Regulatory assessment
- Economic/business case assessments
- Initial risk and MVA assessments

<table>
<thead>
<tr>
<th>Location</th>
<th>Sundance Stored CO₂, MT</th>
<th>Minnelusa Stored CO₂, MT</th>
<th>Total Stored CO₂, MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.9</td>
<td>5.4</td>
<td>8.3</td>
</tr>
<tr>
<td>2 (UW PRB)</td>
<td>0.9</td>
<td>6.8</td>
<td>7.7</td>
</tr>
<tr>
<td>3</td>
<td>8.5</td>
<td>9.1</td>
<td>17.6</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>0.6</td>
<td>7.5</td>
<td>8.1</td>
</tr>
<tr>
<td>6</td>
<td>5.2</td>
<td>6.8</td>
<td>12.0</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>18.1</td>
<td>35.6</td>
<td>53.7</td>
</tr>
</tbody>
</table>
Site Characterization to-date

**Figure 2:** Schematic cross section of the study area from a 2D seismic line with log-facies interpretation of the... UW PRB #1 and surrounding wells show lateral continuity, though sand bodies are intrinsically variable with respect to...
Site Characterization to-date

Legal, public and regulatory analysis

- Class VI permitting analysis
- Preliminary title abstract for pore space ownership
- Impacts of anticipated Federal and State regulations
- Model project and business agreements
- Potential business agreements
- Integrated pipeline networks
- Initiated public outreach
Advantages

- Modern, relatively-young CO₂ source
- Supportive industry partners
- Existing capture technology programs/projects
- Proximity to CO₂ infrastructure
- Existing CO₂ management industry
- Robust regional subsurface data (proven injection targets and confining potential)
- Stacked storage lessons footprint
- Minimal surface structures/large land holdings
- Supportive regulatory framework
Technical Approach
Technical Approach for Site Characterization and Commercialization of the Wyoming CarbonSAFE Storage Hub

- Characterize seven sites within the storage hub
- Full injection/permitting completion of the DFS site
  - 2 wells for optimal stacked storage, reservoir testing, interference tests, subsurface data gap completion
  - Wells completed to Class VI standards
- Develop and complete Class VI permits for all sites
- Develop business and commercial strategies for the storage hub
- Environmental assessment (NEPA demands and baseline conditions)
- Integrate MTR’s capture assessment into commercial plan
- Finalize site risk and MVA
- Develop greater regional capacity than the program requires
### Key milestones

<table>
<thead>
<tr>
<th>Milestone Title &amp; Description</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finalize initial environmental assessment</td>
<td>3/30/2021</td>
</tr>
<tr>
<td>Initiate drilling of UW PRB#2</td>
<td>9/30/2021</td>
</tr>
<tr>
<td>Update models with seismic and field data</td>
<td>1/1/2022</td>
</tr>
<tr>
<td>Initiate Class VI applications</td>
<td>11/1/2020</td>
</tr>
<tr>
<td>Submittal of Class VI permits</td>
<td>9/30/2022</td>
</tr>
<tr>
<td>Complete risk assessment</td>
<td>1/31/2023</td>
</tr>
<tr>
<td>Public Outreach meeting</td>
<td>9/1/2021</td>
</tr>
<tr>
<td>Identification of potential business partners</td>
<td>1/31/2023</td>
</tr>
</tbody>
</table>

### Success criteria

- EIV identifies site(s) issues
- CO₂ capture study is not completed
- Submitting and receiving applications to initiate drilling
- Obtaining access agreements
- Drilling UW PRB#2
- Complete subsurface field testing and monitoring

### Project risks and mitigation strategies

<table>
<thead>
<tr>
<th>Perceived Risk</th>
<th>Mitigation/Response Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>Drilling expenses</td>
<td>Rates are subject to the market price of oil. If rates increase, the co-PIs will look for ways to absorb costs in other areas of the project.</td>
</tr>
<tr>
<td><strong>Cost/Schedule Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>Project timeline</td>
<td>The Project timeline was developed based on the experienced gained from previous projects of this scale and will communicate regularly with the DOE program Manager.</td>
</tr>
<tr>
<td><strong>Technical/Scope Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>NEPA assessments</td>
<td>UW will select an environmental consultant with a proven record of accomplishment of EIVs.</td>
</tr>
<tr>
<td>Drilling and field operations</td>
<td>Challenges will be addressed through the team’s prior experience with drilling operations and the selection of experienced contractors and commercial technologies.</td>
</tr>
<tr>
<td>Data collection</td>
<td>The team has extensive experience performing fieldwork in the PRB and has successfully collected the necessary data</td>
</tr>
<tr>
<td>Subsurface modeling</td>
<td>CEGR, EERC and ARI have extensive experience with the industry-standard software packages that will be used</td>
</tr>
<tr>
<td>Class VI well permitting</td>
<td>WYDEQ has received Class VI primacy and the Project team has collaborated closely with WYDEQ on permitting strategies</td>
</tr>
<tr>
<td>CO₂ source commitment</td>
<td>As demonstrated by the CO₂ source commitment letters, BEPC (source) and MTR (capture) can provide the CO₂ for successful implementation of future phases.</td>
</tr>
<tr>
<td><strong>Management, Planning and Oversight Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>Project Management</td>
<td>Risks are negligible due to the team’s collective experience in projects of this type.</td>
</tr>
<tr>
<td><strong>ES&amp;H Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>All physical activities, including drilling, will be overseen in compliance with applicable laws.</td>
</tr>
<tr>
<td><strong>External Factor Risks:</strong></td>
<td></td>
</tr>
<tr>
<td>Site access</td>
<td>The drilling site is on land owned by partner BEPC, which mitigates these concerns.</td>
</tr>
<tr>
<td>Pore space ownership</td>
<td>Risk will be addressed by WY law, which defines pore space ownership; minimization of project impacts; and project siting to focus impacts on land owned by team members. Risks are at medium due to the first-of-its-kind program.</td>
</tr>
<tr>
<td>Public acceptance</td>
<td>The Project team will continue to implement the outreach strategy deployed during Phases I &amp; II.</td>
</tr>
<tr>
<td>Resource availability</td>
<td>Resource availability risks include access to a drilling site, equipment and skilled labor. These are negligible as BEPC will construct the drilling site and the PRB has a skilled workforce.</td>
</tr>
</tbody>
</table>
Status Update
Progress and Current Status

Finalize surface and subsurface characterization activities

• One well drilled, sampled and analyzed
• 3D seismic survey acquired
• Second well designed, testing and completion programs verified
• Initial permits acquired for completion of both wells
• Feasibility models (full scale and site specific) completed and tested, populated with Phase II data
• Formation fluid characterized and modeled for reactivity
• Data incorporation for Machine Learning
• NRAP IAM being built
Progress and Current Status

Conduct NEPA and environmental analysis

- A Environmental Information Volume has been completed and reviewed
  - Incorporated MTR’s capture design, and potential storage sites
  - Evaluated ownership, mineral estates, wetlands, vegetation and wildlife resources, atmospheric impacts, existing structures, soils/surficial geology, historic and cultural resources, potential wastes, land cover, health and safety factors, and compliance issues
- Baseline environmental monitoring stations/sampling is underway
  - Set eight soil gas sensors within the DFS storage site
  - Sampling local/regional groundwater monitoring wells
  - Designed a passive seismic study (acquisition Fall 2021)
DOE Awards Approximately $65 Million for Demonstration of Large-Scale Pilot Carbon Capture Technology

Integrate MTR’s CO$_2$ FEED capture assessment
Progress and Current Status

Complete Class VI permits for the storage hub

- Initial permit applications (Class I) for both wells have been submitted and reviewed by the DEQ
- Class VI standard well completion diagrams submitted and reviewed
- Wyoming CarbonSAFE Risk Register has been drafted, research/data gaps identified
- Awaiting data, interpretations and updated modeling post completion and testing of UW PRB#2
Progress and Current Status

Advance commerciality within the Wyoming CarbonSAFE storage hub

- Initiated public outreach strategy
- Finalized sight access agreements
- Developed infrastructure right-of-ways and working with commercial CO₂ transportation partners
- Developed model business agreements to assess operational models
- Developed utilization business models
- Developed an economic model that incorporates tax credits, operational lifecycle, capex/opex, etc. and assesses the impact to local communities
- Advancing synergistic opportunities with capture, utilization and governmental industries
Progress and Current Status

Gaps/challenges/hurdles

- Finalizing site risk characterization
- Risk register assessment using Wyoming’s matrix
- Class VI well completion materials
- Scale of boundaries/compartmentalization (if existent) within reservoirs
- “First” of its kind project
Wyoming CarbonSAFE envisions the successful and timely completion of all Phase 3 objectives, and is on track to deliver the same.

Site Selection & Characterization: (1) the site possesses numerous favorable technical, infrastructure and geologic attributes based on existing conditions/data and work conducted in prior project phases; (2) additional site characterization work will be conducted in Phase III, with additional subsurface data from a new well (UW PRB#2) and well testing between it and the existing well (UW PRB #1); and (3) existing legal, regulatory and public acceptance analyses will be advanced in Phase III.

Technical Approach for Phase III: (1) characterize 7 sites within the storage hub; (2) drill/re-enter two test wells, both completed/re-completed to Class VI construction standards; (3) prepare Class VI permits to construct for a full project; (4) further advance business and commercial strategies for the storage hub; (5) satisfy all NEPA requirements of Phase III; (6) integrate MTR’s capture assessment into the commercial plan; (7) finalize site risk and MVA; and (8) develop greater regional capacity than the CarbonSAFE program requires.

Project on track to satisfy milestones and success criteria, and is assessing/managing project risks and mitigation strategies.
Questions?
Appendix