Establishing an Early Carbon Dioxide Storage Complex in Kemper County, Mississippi: Project ECO$_2$S

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Disclaimer

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Phase II Accomplishments

- Overall objective was to demonstrate that the subsurface at Kemper can safely and permanently store commercial volumes of CO$_2$
- Established a 30,000 acre area of interest which contains gigatonne CO$_2$ storage potential
- Drilled 3 characterization wells (MPC 10-4, MPC 26-5, MPC 34-1)
- Identification and characterization of three storage reservoirs (Massive Sand/Dantzler, Washita-Fredericksburg, and Paluxy)
- Model of CO$_2$ plume and stabilization
- Regional storage complex commercialization plan
ECO$_2$S Data Collection

- Three characterization/monitoring wells were drilled in 2017 to test and characterize geologic properties
- 200 ft of hole core was taken from the Paluxy and Washita-Fredericksburg reservoirs and the Marine Tuscaloosa shale confining unit
- Reservoir fluid sampling and injection tests
ECO$_2$S Geologic Characterization

- Major stacked storage potential with >1,300 net feet of sandstone
- Logs and core show sandstone mean porosity of 29%
- Mean permeability of 3.6 Darcies
- No faults in or above the storage interval
- Moderate formation dip (less than one degree)
- Seals include mudrock and chalk with nanoDarcy permeability
ECO$_2$S Storage Complex Capacity

- Each of the three potential storage zones have commercial capacity
- Together the three storage zones result in a gigatonne capacity storage complex that has the potential to act as a regional hub

<table>
<thead>
<tr>
<th>CO$_2$ Storage Reservoir</th>
<th>$P_{10}$ Capacity (MMmt)</th>
<th>$P_{50}$ Capacity (MMmt)</th>
<th>$P_{90}$ Capacity (MMmt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive/Dantzler</td>
<td>85</td>
<td>160</td>
<td>280</td>
</tr>
<tr>
<td>Wash.-Fred.</td>
<td>350</td>
<td>660</td>
<td>1,130</td>
</tr>
<tr>
<td>Paluxy</td>
<td>200</td>
<td>380</td>
<td>650</td>
</tr>
<tr>
<td>TOTAL</td>
<td>635</td>
<td>1,200</td>
<td>2,060</td>
</tr>
</tbody>
</table>

DOE methodology for site-specific saline storage efficiency calculation based on fluid displacement factors for clastic reservoirs where net pay, net thickness and net porosity are known of 7.4% ($P_{10}$), 14% ($P_{50}$) and 24% ($P_{90}$) (Goodman et al., 2011)
Project ECO₂S Phase III

SPECIALIZED PARTNERS & VENDORS
Project ECO$_2$S Phase III Objectives

- Demonstrate that the Subsurface Saline Formations at the Storage Complex Can Store Commercial Volumes of CO$_2$ Safely and Permanently.
- Conduct Pre-Feasibility Studies to Establish the Technology, Design and Costs of CO$_2$ Capture at Three Southern Company Power Plants
- Optimize the CO$_2$ Storage Capacity of the Storage Complex Including Establish the Areal Extent of the CO$_2$ Plume and Pressure Front.
- Confirm the Viability of Each of the Reservoir Seals to Serve as a Long-Term, Reliable Confining System for the CO$_2$ Storage Site
- Conduct a Comprehensive Risk Assessment Utilizing Reservoir Modeling and the NETL-Sponsored Integrated Assessment Model
Project ECO$_2$S Phase III Objectives

• Baseline Characterization of USDWs
• Develop a Methodology for Refining/Sharpening the Characterization/Monitoring Protocols Employing Machine Learning/Artificial Intelligence Protocols
• Define a Comprehensive CO$_2$ MVA System and a Quick-Response Contingency Plan
• Conduct Additional Public Outreach
• Apply and Obtain Approval for An Underground Injection Control (UIC) Class VI Permit to Construct
• Evaluation of Project Commerciality
CO\textsubscript{2} Sources

- **Pipeline #1.** A 5-mile main CO\textsubscript{2} pipeline plus short distance CO\textsubscript{2} distribution lines would transport 0.7 MMmt of CO\textsubscript{2} per year from the Kemper County Energy Facility to the ECO\textsubscript{2}S Regional CO\textsubscript{2} Storage Complex.

- **Pipeline #2.** A 180-mile CO\textsubscript{2} pipeline with five booster stations would connect Plant Daniel and its 3 MMmt per year of captured CO\textsubscript{2} emissions (160 MMcfd) with the Storage Complex.

- **Pipeline #3.** A 150-mile, CO\textsubscript{2} pipeline with four booster stations would connect Plant Miller and its 18.8 MMmt per year of captured CO\textsubscript{2} emissions (1 Bcfd) to the Storage Complex.
Funding & Schedule

Funding
- Federal: $17,479,430
- Non-Federal: $6,113,380
- Cost Share Percentage: 26%

Performance Period: 3 Years
(Official Start Date Pending Award)
- Budget Period 1: 2 Years
- Budget Period 2: 1 Year
Project ECO$_2$S – Southern Company Host-Site Update

• All site activities in CarbonSAFE Phase II were accomplished with Target Zero corporate safety goals
  – Drilling and well testing are inherently safe operations if done responsibly

• Corporate support for the CarbonSAFE program is strong with Southern
  – Host-site access (Phase II and Phase III)
  – Cost-share of 4M in cash for Phase II & Phase III combined
  – Commitment to Class VI UIC permit application

• CarbonSAFE program provides synergy with corporate GHG reduction goals and system planning for deployment of CCUS

• Results to date fit well with commercialization strategy to leverage the Section 45Q tax credits

• Strong synergy with FEED study awarded to Southern Company on Plant Daniel NGCC units
Kemper County - Site Attributes

- Significant legal - pore space ownership and site access for drilling
- Staked formations provide for large storage capacity
- Site characterization/monitoring well Infrastructure provides not only site certification and reduces risk, but cost offsets for commercial storage consideration
- Class VI UIC permit (TBD) in-hand presents the site as being storage ready
- Low-cost storage option in SE USA (Esposito et al 2019)

# Capital Costs for Establishing Storage Site

<table>
<thead>
<tr>
<th></th>
<th>Total Cost (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Site Design</strong></td>
<td></td>
</tr>
<tr>
<td>1. Site Characterization and Modeling</td>
<td>$8.4</td>
</tr>
<tr>
<td>▪ Drill Characterization Wells</td>
<td></td>
</tr>
<tr>
<td>▪ Purchase and Interpret 2-D Seismic</td>
<td></td>
</tr>
<tr>
<td>▪ Build Geologic Model</td>
<td></td>
</tr>
<tr>
<td>▪ Conduct Reservoir/Geophysical Modeling</td>
<td></td>
</tr>
<tr>
<td>2. Class VI Permit Application</td>
<td>$0.6</td>
</tr>
<tr>
<td>3. MRV Plan for Subpart RR</td>
<td>$0.1</td>
</tr>
<tr>
<td>4. Financial Bonds</td>
<td>$0.2</td>
</tr>
<tr>
<td>5. Site Preparation (included in well costs)</td>
<td>-</td>
</tr>
<tr>
<td>6. Acquisition of Pore Space Rights (assumed available)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>$9.3</strong></td>
</tr>
<tr>
<td><strong>B. Site Installation</strong></td>
<td></td>
</tr>
<tr>
<td>1. CO2 Injection Wells</td>
<td>$14.3</td>
</tr>
<tr>
<td>2. Monitoring Wells</td>
<td>$20.0</td>
</tr>
<tr>
<td>3. Seismic/Microseismic</td>
<td>$2.1</td>
</tr>
<tr>
<td>4. Transportation</td>
<td>$7.4</td>
</tr>
<tr>
<td>5. Other Costs/Contingency</td>
<td>$7.4</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>$51.2</strong></td>
</tr>
<tr>
<td><strong>C. Total</strong></td>
<td><strong>$60.5</strong></td>
</tr>
</tbody>
</table>

- The overall capital costs for the regional CO\(_2\) storage facility for 3 million metric tons/year is $60.6 million.
- With annual storage site transportation and operating costs of $2 million (for 12 years) and annual post-injection operating and closure costs of $1.3 million (for 10 years), the NPV of these costs is about $20 million (at a 7% discount rate).
- This storage complex results in CO\(_2\) storage costs of less then $3 metric ton.
- Approximately 25% of these costs would be covered by the CarbonSAFE Program through Phase III.