Establishing an Early CO$_2$ Storage Complex in Kemper County, Mississippi: Project ECO$_2$S (Phase III) DE-FE0031888

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National Energy Technology Laboratory
Carbon Management and Oil and Gas Research Project Review Meeting – Carbon Storage
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Presentation Outline

• Project ECO$_2$S Phase III technical status
• Accomplishments to date
• Lessons learned
• Summary and Next steps
ECO$_2$S Phase III Partners

**Research Partners**
- U.S. Department of Energy
- Battelle
- CCUS Consult
- International CCS Knowledge Centre
- IOM Law
- London Technical Services LLC
- Advanced Resources International, Inc.
- Southern Company
- Trimeric Corporation
- The University of Alabama at Birmingham
- Enhanced Oil Recovery Institute
- U.S. Geological Survey

**Specialized Partners & Vendors**
- DNV-GL
- ECT Environmental Consulting & Technology, Inc.
- Linde
- Mitsubishi Heavy Industries
- Schlumberger
- Spectrum
- Stantec
Technical Status

- Project ECO₂S is in Kemper County Mississippi near Mississippi Power Company’s Plant Ratcliffe NGCC facility
- Potential regional CO₂ storage hub capable of storage CO₂ from multiple large sources
- Overall objectives are to:
  - Demonstrate that the subsurface at Kemper can safely and securely store commercial volumes of CO₂
  - Evaluate commercial prospects post combustion coal- and gas-fired capture, transportation and storage in the southeastern U.S.
Technical Status

- Six characterization/monitoring wells drilled in Phase II and III to test and characterize geologic properties
- 290 ft of hole core was taken from the Paluxy and Washita-Fredericksburg reservoirs the Tuscaloosa Marine shale primary confining unit and other secondary confining units
- Extensive well logging
- Reservoir fluid sampling and injection tests
Technical Status

- Large portfolio of potential sinks and seals in east-central Mississippi.
- Main storage targets in Paluxy-Tuscaloosa section.
- Main reservoir rock is fluvial sandstone; seals include mudrock and chalk.
- Sandstone is subarkose with significant dissolution porosity.
- Porosity of sandstone in target zones averages 28.5%.
- Permeability averages 3.6 Darcies
- Major stacked storage potential with >1,300 net feet of sandstone.
- Preliminary $P_{50}$ storage resource estimate: ~22 Mt/mi$^2$; 1.2 Gt in storage complex.
Technical Status

Stratigraphic Cross Section

Upper Tuscaloosa
Marine shale Tuscaloosa Group
Massive sand
Dantzler sand

Big Fred sand Washita-Fredericksburg interval

Paluxy Fm.
Mooringsport Fm.
Paleozoic rocks

Legend:
- Yellow: Sandstone
- Blue: Limestone
- Green: Mudrock sealing strata
- Pink: Mudrock baffles and barriers
- Orange: Conglomeratic baffles and barriers
Technical Status

- Acquisition of 92 mile 2D seismic survey in June-July 2021
- Goal is to identify geologic storage structural risks across storage complex
- All receiver lines live during acquisition resulting in a pseudo 3D design
- Image to the right shows the pseudo 3D fold plot at 7,500 ft depth (warmer colors indicate increased fold)
- Interpretation ongoing (Geological Survey of Alabama)
Technical Status

- Preparation of two Class VI UIC permit applications
  - Each well has the capacity for 1.45 million metric tons per year
  - AoR model will be finalized after full integration of geologic data from 2021 wells
- Target is to submit permit applications to EPA Region IV in Q3/Q4 of CY 2021

Preliminary Simulation (30 year injection)
Technical Status

Regional Topseal and USDW

Deep USDW characterization well

- Deep USDW?
- Drinking Water Reservoir
- Regional Seal
- Naheola Formation
- Porters Creek Clay
- Clayton Formation
- Selma Group (chalk)
- Eutaw Formation
- Palaeogene Paleocene System Series
- GR, SP Resistivity
- Depth in ft
- 0 ft
- 500
- 1000
- 1500
- 2000

Kemper USDW 06/23/2021
Accomplishments to Date

- Drilled three characterization wells during Phase II and an additional three during Phase III
- Identification and characterization of three storage reservoirs (Massive Sand/Dantzler, Washita-Fredericksburg, and Paluxy)
- 92-mile 2D seismic survey completed July 25, 2021
- USDW characterization well completed July 26, 2021
- Class VI UIC permit applications in preparation
Accomplishments to Date

• NEPA Environmental Information Volume submitted to NETL on July 13, 2021
  – Project team will proceed with EA or EIS pending NEPA determination

• Initial Phase III Risk Registry prepared within 45 days of award prior to the commencement of the well drilling activities
  – A more comprehensive risk assessment is underway for the fully integrated project

• Preliminary modeling of pipelines

• CO₂ capture assessment underway at Plant Miller (coal) and Plant Ratcliffe (natural gas)
  – For the third source, Plant Daniel, a separately funded FEED study is underway (FE0031847)
Lessons Learned

– Scope change from a modest 3D seismic survey to a large area 2D survey due to the size of our storage complex was discussed extensively
  • If EPA requires a 3D survey of the injection site(s) prior to giving permission to operate we will include in a Phase IV scope

– Meaningful well tests to determine fracture pressures are difficult in the subsurface at ECO₂S
  • Openhole MDT fracture test on confining interval failed due to borehole rugosity and exceptional permeability
  • Reservoir step rate tests cannot achieve sufficient rates through tubing
  • Use laboratory and petrophysical approaches to model geomechanical response
Project Summary

- Continued geologic characterization confirms that the ECO$_2$S site has the potential to serve as a regional CO$_2$ storage hub

- Currently completing 2D seismic survey processing and interpretation and USDW characterization

- Next Steps
  - Submit Class VI permit applications in the next few months
  - Tie pipeline models and capture assessments to site storage evaluation to determine commercial feasibility of large-scale storage at ECO$_2$S
  - NRAP tool evaluation(s)
  - Artificial Neural Networks (ANN) will be used for advanced seismic signal processing
Thank You
Appendix

- These slides will not be discussed during the presentation, but are mandatory.
Benefit to the Program

• The southeastern U.S. is a CCUS nexus with a confluence of large industrial CO₂ sources and world-class storage geology providing the perfect opportunity for a regional mega-scale carbon capture and storage hub. The Kemper Regional CO₂ Storage Facility is perfectly positioned within relatively short transportation distances from three major Southern Company Power Plants capable of providing 22.5 MMmt per year of CO₂ to the Storage Facility for 30 years. Successful capture, transport, and secure storage of this volume of CO₂ would result in a considerable reduction in annual emissions for Southern Company and the southeastern U.S.

• Project ECO₂S will deliver pre-feasibility studies to establish the technology, design, and costs of CO₂ capture at three Southern Company power plants (1 coal and 2 gas), including a pre-feasibility study of the transportation infrastructure requirements to the Kemper Regional CO₂ Storage Facility. This mega-scale CO₂ storage project will result in the finalization of plans to safely and securely store these volumes through the development of monitoring and operational plans for the site, including those to actively manage the plume through brine extraction/re-injection in order to mitigate plume movement and encourage immobilization. These activities provide a critical advancement in testing and scaling up CCUS to significant regional storage hubs.
Project Overview

Goals and Objectives

• The primary objective of *Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S (Phase III)* is to establish the foundation for a commercial-scale regional geologic storage complex for CO₂ captured from three Southern Company facilities; Plant Ratcliffe (the Kemper County Energy Facility), Plant Daniel, and Plant Miller, and potentially CO₂ captured from other industrial and/or power plants in the region. Through the Project ECO₂S CarbonSAFE Phase II work, our Partners identified a geologic setting in east-central Kemper County, Mississippi, adjacent to the Kemper County Energy Facility, as a “world class” geologic area capable of securely storing over 900 million metric tons (MMmt) of CO₂. The Partners also identified follow-on work essential for acquiring a UIC Class VI Permit to construct the Kemper Regional CO₂ Storage Complex, including drilling additional site characterization wells, conducting a substantial 3D seismic acquisition, and undertaking risk assessment, public outreach, and other tasks. A major additional feature of Project ECO₂S is preparing pre-feasibility design and cost studies for CO₂ capture at three Southern Company plants involving both coal and gas-fueled generation units.
Organization Chart

U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL)
Project Manager: Mary Sullivan
Contract Specialist: Carla Winneagle

Southern States Energy Board (SSEB)
Tasks 1-10
Lead PI: Kenneth Nemeth
Co-PI/Contact PI/Project Coordinator: Kimberly Sams-Gray
Key Personnel: Kathy Sammons, Leigh Parson, Patricia Berry, Ben Werneft, Ph.D., Ruth Fantini

Advanced Resources International, Inc. (ARI): Tasks 1-10
Lead PI: V. Kuuskraa; Co-PI: G. Koperna; Key Personnel: D. Riestenburg

Loudon Technical Services: Task 4
Lead PI: Jim Kirksey

Battelle: Task 4
Lead PI: Mark Moody

Christensen CCS Consult (Christensen): Task 10
Lead PI: Niels Peter Christensen

Geological Survey of Alabama (GSA): Tasks 5, 6, 10
Lead PI: Denise Hila, Co-PI: John Košlar

The International CCS Knowledge Centre (CCSKC):
Tasks 7, 10
Lead PI: Corwin Bruce; Co-PI: Stavroula Giannamis
Key Personnel: Brent Jacobs, Yuewu Feng, Wayul Srsung, Dominika Janowicz

IOM Law (IOM): Tasks 4, 9, 10
Lead PI: Inguldr Omdalstvedt

Oklahoma State University (OSU): Tasks 6, 10
Lead PI: Jack Fashin, Ph.D.

SAS Institute, Inc. (SAS): Tasks 6, 10
Lead PI: Pamela Tomski; Key Personnel: Keith Holdaway

Southern Company Services (SCS): Tasks 7, 10
Lead PI: Richard Esposito, Ph.D.; Key Personnel: John Carroll, Sharon Turnipseed

Trimeric Corporation: Tasks 7, 8, 10
Lead PI: Ray McKaske, P.E.; Key Personnel: Katherine Dom- browski

University of Alabama at Birmingham (UAB):
Tasks 3, 10
Lead PI: Pete Walsh, Ph.D.; Key Personnel: Gregory Myerds

University of Wyoming Enhanced Oil Recovery Institute (UW-EORI):
Tasks 6, 10
Lead PI: Steven Carpenter, Ph.D.

U.S. Geological Survey (USGS): Tasks 3, 5, 10
Lead PI: Michael Plampin, Co-PI: Matthew Memil
<table>
<thead>
<tr>
<th>Project ID: ECO S Phase III</th>
<th>Milestone</th>
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<th>Phase II/Budget Period 2</th>
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<td>Start Date</td>
<td>End Date</td>
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<td><strong>TASK 1.0: PROJECT MANAGEMENT AND PLANNING</strong></td>
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<td>9/7/20</td>
<td>8/31/23</td>
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<td>9/7/20</td>
<td>8/31/23</td>
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<td>9/7/20</td>
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<td>9/7/20</td>
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<td>9/7/20</td>
<td>9/30/23</td>
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<td>9/7/20</td>
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<td>8/31/23</td>
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<td>6/30/22</td>
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<td>9/7/20</td>
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<td>6/30/22</td>
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<td>9/7/20</td>
<td>6/30/22</td>
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<td>9/7/20</td>
<td>6/30/22</td>
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<td>9/7/20</td>
<td>6/30/22</td>
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<td>6/30/22</td>
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<tr>
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<td>6/30/22</td>
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<td>9/7/20</td>
<td>6/30/22</td>
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Note: The table and diagram represent the Gantt Chart for the project, detailing milestones, phases, and tasks with corresponding start and end dates.
Bibliography

– List peer reviewed publications generated from the project per the format of the examples below.

• **Journal, one author:**

• **Journal, multiple authors:**

• **Publication:**