Establishing an Early CO_2 Storage Complex in Kemper County, Mississippi: Project ECO_2S (Phase III) DE-FE0031888

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U.S. Department of Energy

National Energy Technology Laboratory

Carbon Management and Oil and Gas Research Project Review Meeting – Carbon Storage

August 2 - 11, 2021

Presentation Outline

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

ECO_2S Phase III Partners

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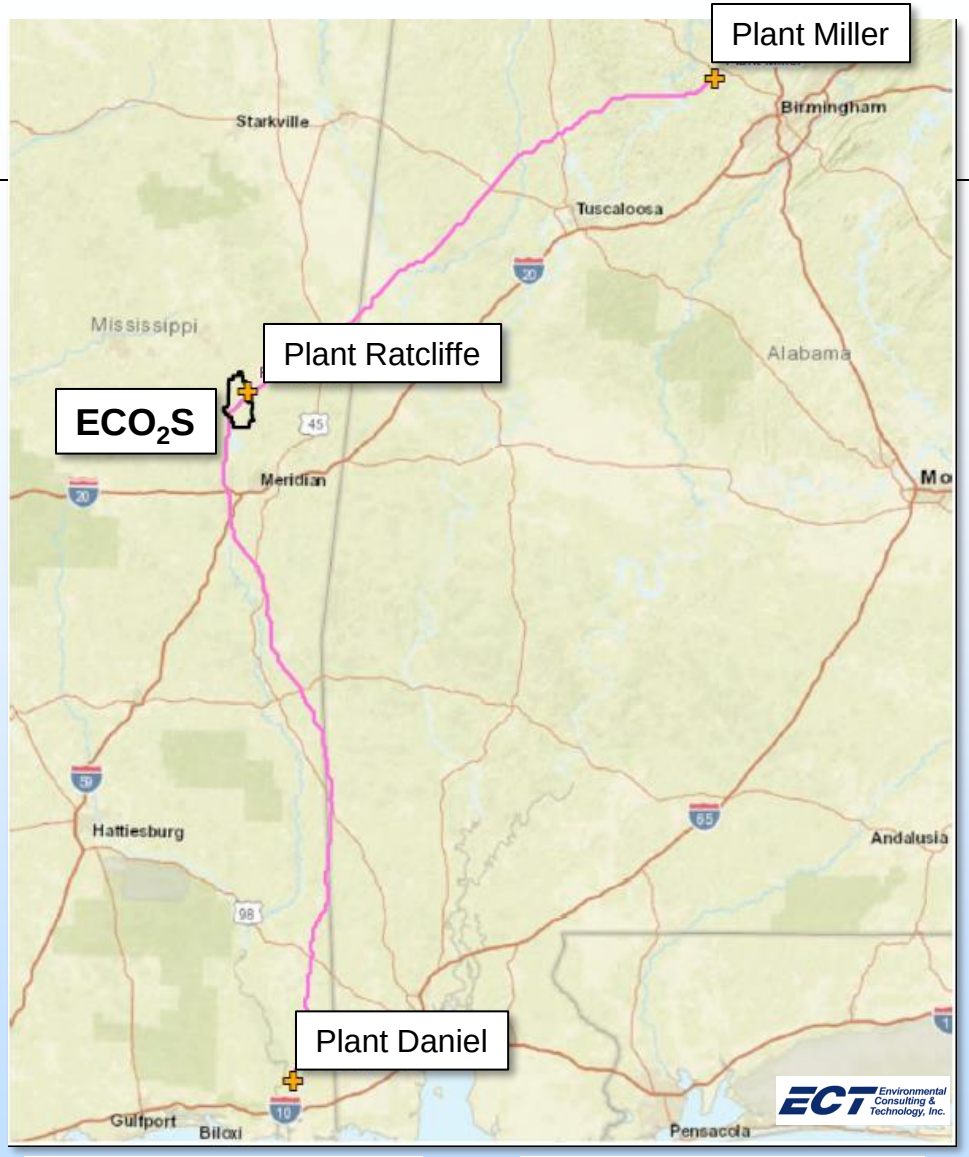
Technical Status

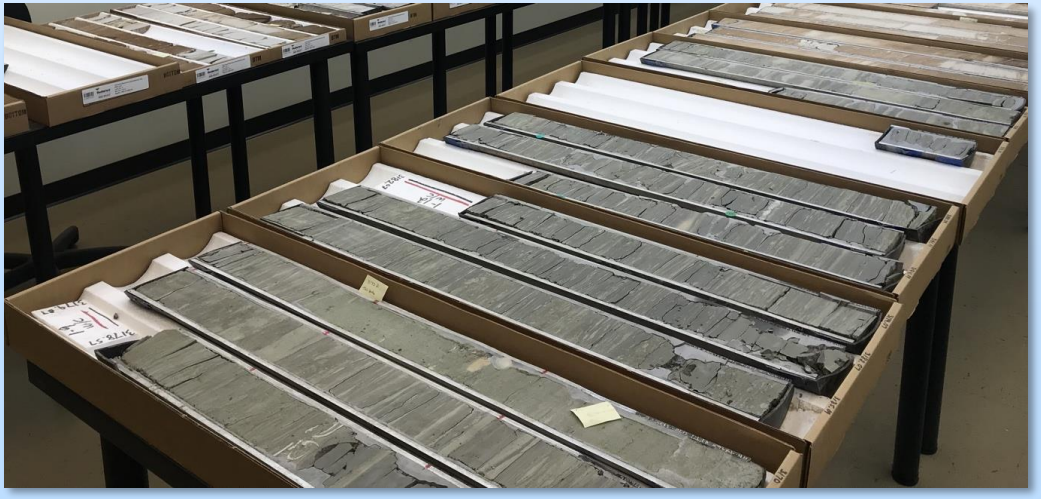
- Project ECO_2S is in Kemper County Mississippi near Mississippi Power Company's Plant Ratcliffe NGCC facility
- Potential regional CO_2 storage hub capable of storage CO_2 from multiple large sources
- Overall objectives are to:
  - Demonstrate that the subsurface at Kemper can safely and securely store commercial volumes of CO_2
  - Evaluate commercial prospects post combustion coal- and gas-fired capture, transportation and storage in the southeastern U.S.



Mississippi Power Alabama Power

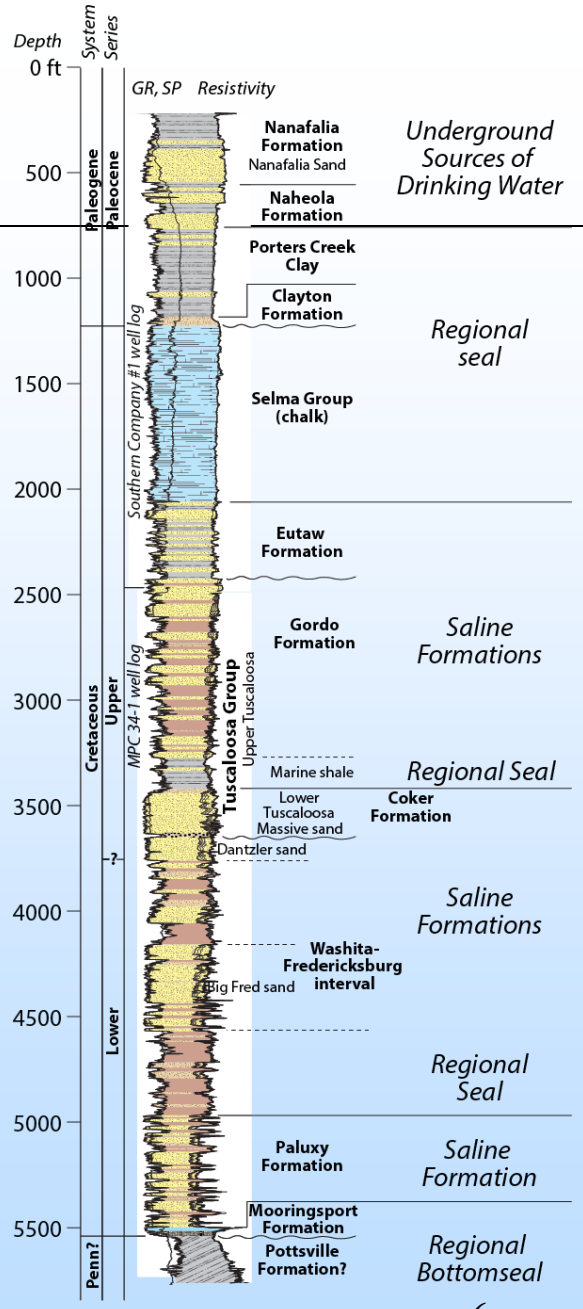
Technical Status

- 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



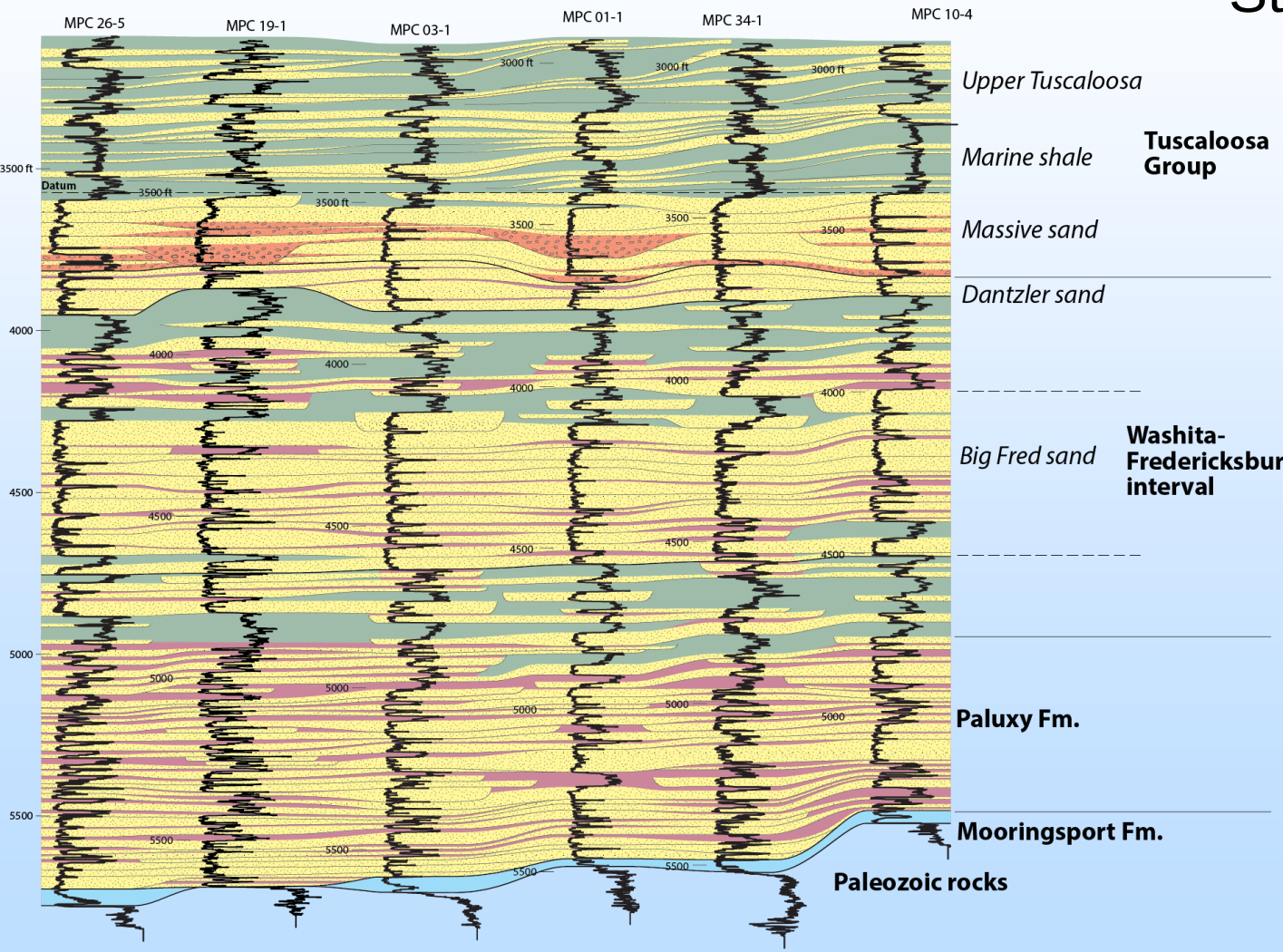
Technical Status

- 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.



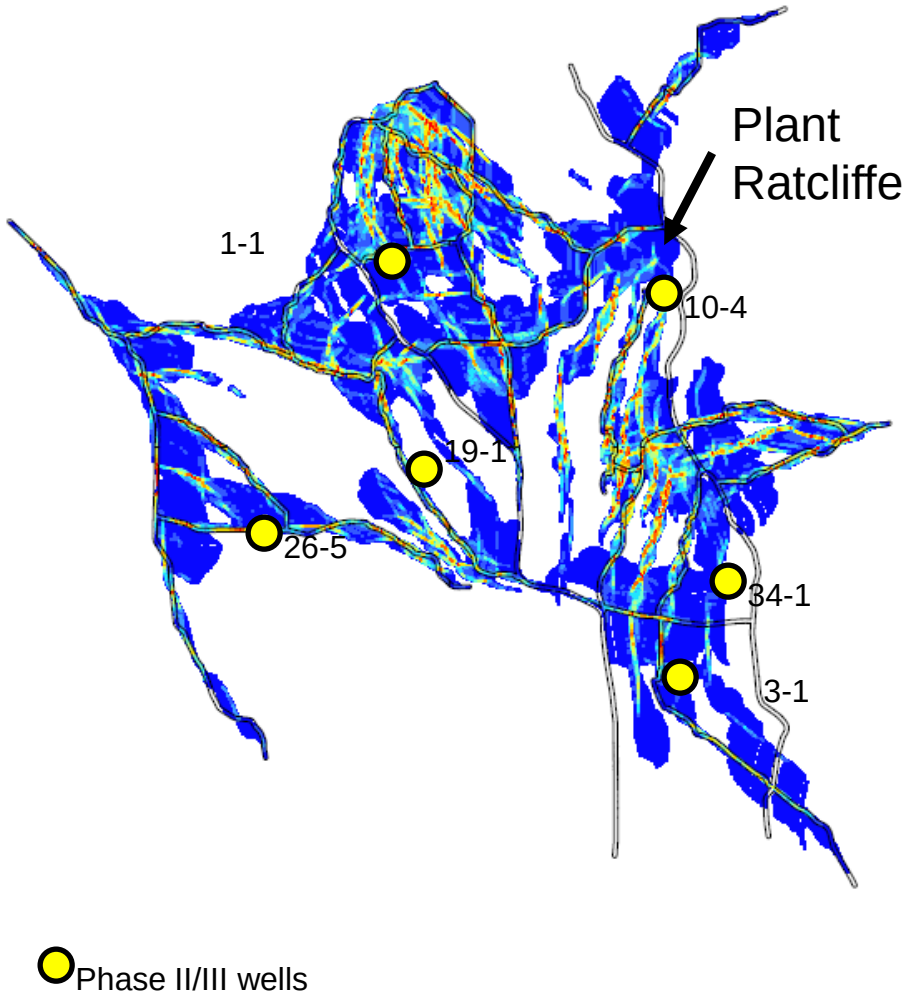
Technical Status

Stratigraphic Cross Section



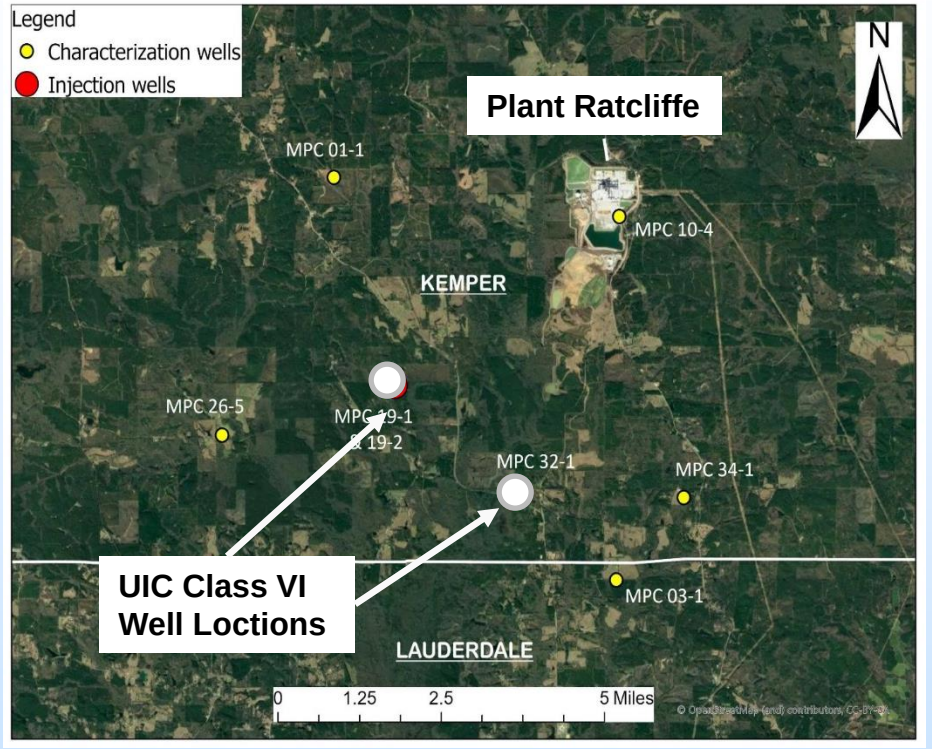
Technical Status

- 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

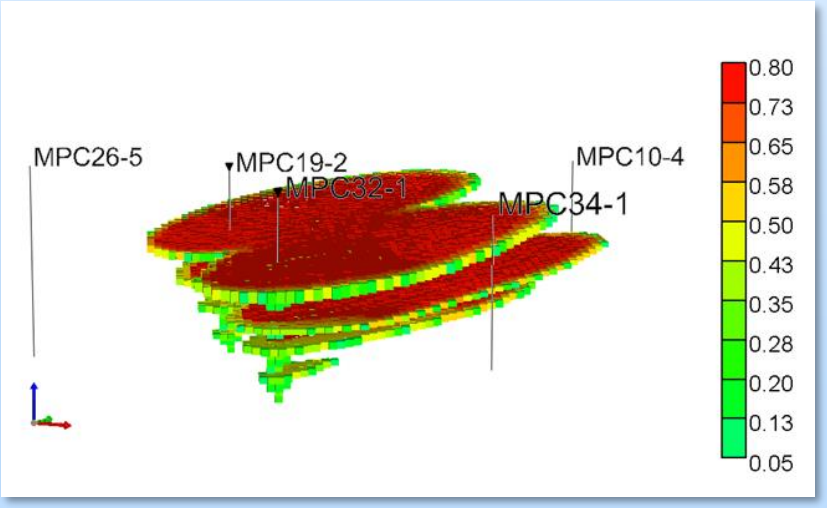


Technical Status

- 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

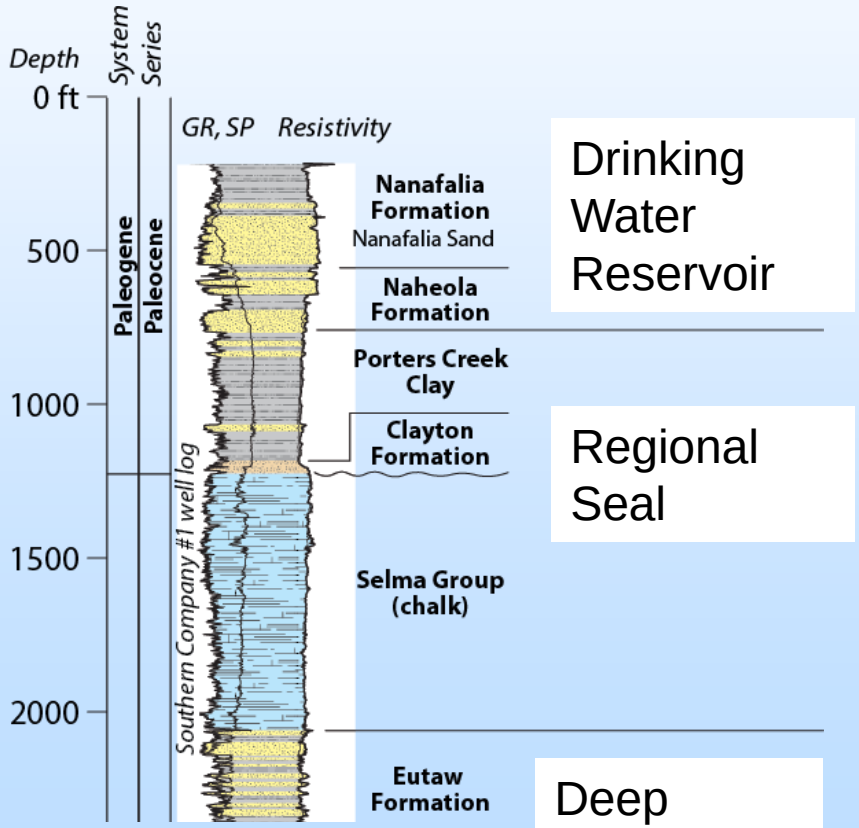


Preliminary Simulation (30 year injection)



Technical Status

Regional Topseal and USDW



Deep USDW characterization well

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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
- CO_2 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 ECO_2S
  - 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_2S 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_2S
  - NRAP tool evaluation(s)
  - Artificial Neural Networks (ANN) will be used for advanced seismic signal processing

Thank You


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Appendix

– These slides will not be discussed during the presentation, but are mandatory.

Benefit to the Program

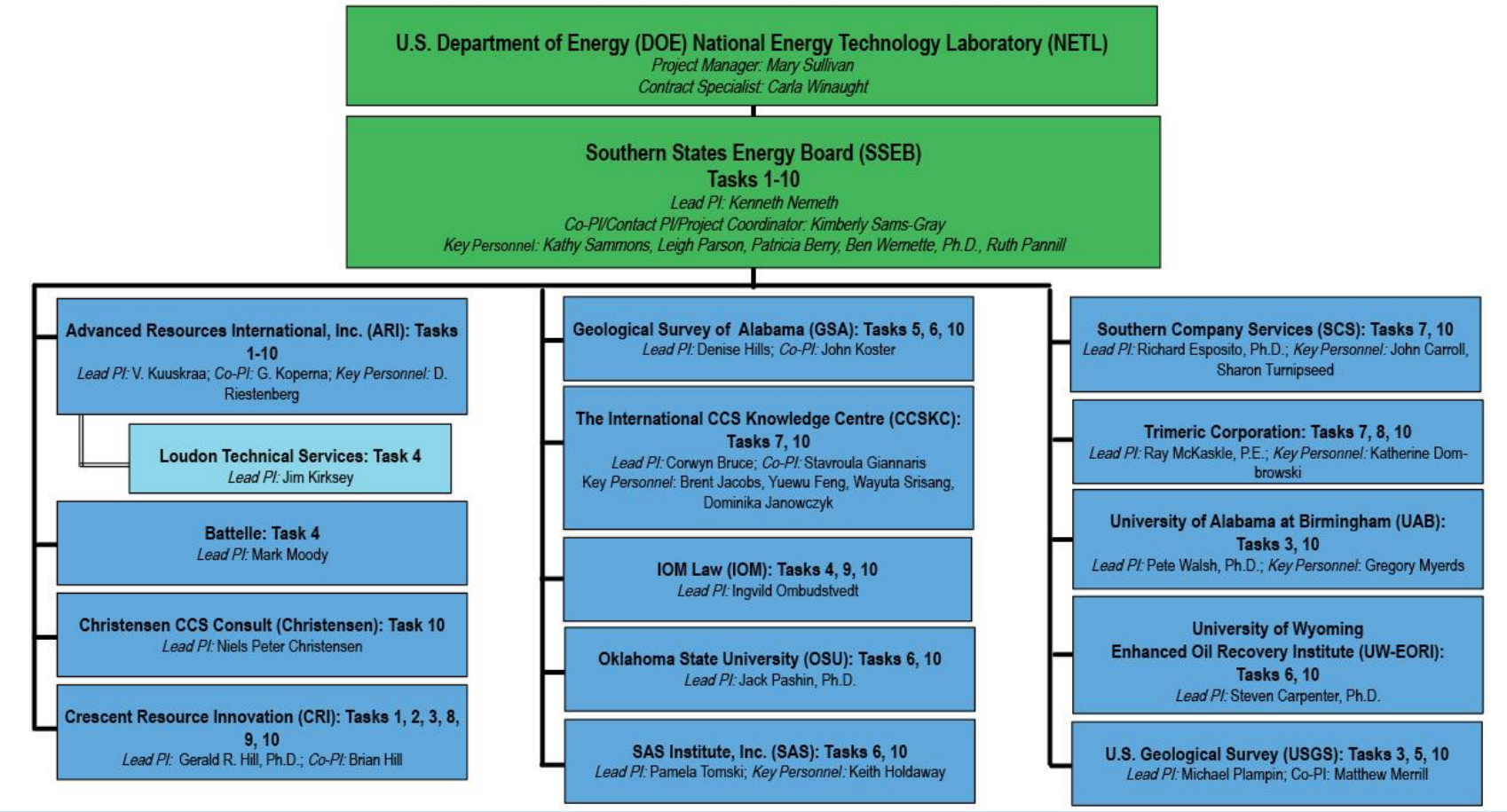
- The southeastern U.S. is a CCUS nexus with a confluence of large industrial CO_2 sources and world-class storage geology providing the perfect opportunity for a regional mega-scale carbon capture and storage hub. The Kemper Regional CO_2 Storage Facility is perfectly positioned within relatively short transportation distances from three major Southern Company Power Plants capable of providing 22.5 MMmt per year of CO_2 to the Storage Facility for 30 years. Successful capture, transport, and secure storage of this volume of CO_2 would result in a considerable reduction in annual emissions for Southern Company and the southeastern U.S.
- Project ECO_2S will deliver pre-feasibility studies to establish the technology, design, and costs of CO_2 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 CO_2 Storage Facility. This mega-scale CO_2 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 CO_2 Storage Complex in Kemper County, Mississippi: Project ECO_2S (Phase III)* is to establish the foundation for a commercial-scale regional geologic storage complex for CO_2 captured from three Southern Company facilities; Plant Ratcliffe (the Kemper County Energy Facility), Plant Daniel, and Plant Miller, and potentially CO_2 captured from other industrial and/or power plants in the region. Through the Project ECO_2S 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 CO_2. The Partners also identified follow-on work essential for acquiring a UIC Class VI Permit to construct the Kemper Regional CO_2 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 ECO_2S is preparing pre-feasibility design and cost studies for CO_2 capture at three Southern Company plants involving both coal and gas-fueled generation units.

Organization Chart



Gantt Chart

Project ECO2S Phase III	◆ Milestone ● Decision Point		Phase I/Budget Period 1																						Phase II/Budget Period 2											
			9/1/2020 to 8/31/22																						9/1/22 to 8/31/23											
TASK DESCRIPTIONS	Start Date	End Date	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
TASK 1.0: PROJECT MANAGEMENT AND PLANNING	9/1/20	8/31/23																																			
Subtask 1.1: Project Management Plan	9/1/20	8/31/23																																			
Milestone: Implement Project Management Plan	9/30/20	9/30/20	◆																																		
Decision Point 1: Negotiation/Implementation of PMP	9/30/20	9/30/20	●																																		
Decision Point 3: Negotiation /Implementation of Phase II/BP2	8/31/22	8/31/22												●																							
Subtask 1.2: Data Management Plan	9/1/20	8/31/23																																			
Subtask 1.3: Technology Maturation Plan	9/1/20	8/31/22																																			
Subtask 1.4: Contractual	9/1/20	12/1/20																																			
Subtask 1.5: Project Coordination	9/1/20	8/31/23																																			
TASK 2.0: NATIONAL ENVIROMENTAL POLICY ACT (NEPA)	9/1/20	8/31/23																																			
Subtask 2.1: Preparation and Submission of NEPA Documentation for Site Characterization and CO2 Capture Assessment	9/1/20	12/31/20																																			
Subtask 2.2: Preparation and Submission of an EIV for Potential Future Construction and Operation	9/1/20	9/30/21																																			
Milestone: Complete Environmental Information Volume	9/30/21	9/30/21												◆																							
Subtask 2.3: Preparation and Submission of NEPA Documentation for Potential Future Construction and Operation	7/1/21	8/31/23																																			
TASK 3.0: RISK MANAGEMENT	9/1/20	8/31/23																																			
Decision Point 2: Complete Initial Risk Register	10/16/20	10/16/20		●																																	
Subtask 3.1: Commercial Scale Integrated Risk Assessment	9/1/20	8/31/23																																			
Subtask 3.2: Risk Assessment Tools	9/1/20	8/31/23																																			
TASK 4.0: SITE SELECTION AND WELL DRILLING	9/1/20	12/31/22																																			
Subtask 4.1: Well Site Selection	9/1/20	12/1/20																																			
Subtask 4.2: Permitting and Site Surveys	9/1/20	3/3/21																																			
Subtask 4.3: Well Design	9/1/20	12/1/20																																			
Subtask 4.4: Well Drilling and Geologic Data Collection	11/1/20	12/31/22																																			
TASK 5.0: COMPLETE GEOLOGIC CHARACTERIZATION	9/1/20	12/1/22																																			
Subtask 5.1: Underground Sources of Drinking Water	9/1/20	12/1/22																																			
Subtask 5.2: 3D Seismic Survey	3/4/21	3/3/22																																			
Subtask 5.3: Surface Characterization for UIC Injection Well Drilling	12/2/21	12/1/22																																			
TASK 6.0: GEOLOGIC DATA ANALYSIS	3/4/21	8/31/23																																			
Milestone: Complete Geologic Characterization	8/31/23	8/31/23																																			◆
Subtask 6.1: Core and Fluid Analysis	3/4/21	3/3/22																																			
Subtask 6.2: Refined Geologic Model	9/1/21	3/3/22																																			
Subtask 6.3: Reservoir Modeling	12/2/21	8/31/22																																			
Subtask 6.4: Seismic Processing and Interpretation	9/1/21	3/3/23																																			
Subtask 6.5: *DeepLook* STUDY	3/4/21	8/31/23																																			
TASK 7.0: CO2 CAPTURE ASSESSMENT	9/1/20	8/31/22																																			
Subtask 7.1: Potential CO2 Source Screening and Selection	9/1/20	3/3/21																																			
Subtask 7.2: Selecting Engineering Contractor for Engineering Services	9/1/20	12/1/21																																			
Subtask 7.3: Establish Basis of Design	12/2/20	12/1/21																																			
Subtask 7.4: Permitting Considerations	12/2/20	4/30/22																																			
Subtask 7.5: Flue Gas Supply System	3/4/21	8/31/22																																			
Subtask 7.6: Flue Gas Pre-Treatment Process	3/4/21	8/31/22																																			
Subtask 7.7: Regeneration Energy Source Evaluation	3/4/21	8/31/22																																			
Subtask 7.8. Additional Cooling Capacity	3/4/21	8/31/22																																			
Subtask 7.9. CO2 Compression and Dehydration	3/4/21	8/31/22																																			
Subtask 7.10. CO2 Pipeline Infrastructure	3/4/21	8/31/22																																			
Subtask 7.11. Balance of Plant	9/1/21	8/31/22																																			
Milestone: Complete CO2 Capture Pre-Feasibility Studies	8/31/22	8/31/22												◆																							
TASK 8.0: PROJECT INTEGRATION	3/4/21	3/3/23																																			
Subtask 8.1: CO2 Delivery and Well Infrastructure Needs	3/4/21	3/3/23																																			
Subtask 8.2: Pore/Surface Rights and Right of Way Requirements	3/4/21	3/3/23																																			
Subtask 8.3: Financial and Contractual Model(s)	9/1/21	8/31/22																																			
TASK 9.0: UIC PERMITTING	1/1/21	8/31/23																																			
Subtask 9.1: Project Description and Site Characterization	1/1/21	8/31/22																																			
Subtask 9.2: Construction and Operational Plans	3/1/21	8/31/22																																			
Subtask 9.3: Site Closure Demonstration	3/1/21	8/31/22																																			
Milestone: Submit UIC Class VI Permit to Construct Application	8/31/22	8/31/22												◆																							
Subtask 9.4: Public Outreach and Engagement	2/2/21	3/3/23																																			
Subtask 9.5: Address U.S. EPA Comments on Class VI Permit Application	9/1/22	8/31/23																																			
Milestone: Receive Permission to Construct UIC Class VI Well	8/31/23	8/31/23																																			◆
TASK 10.0: KNOWLEDGE DISSEMINATION AND TECHNOLOGY TRANSFER	9/1/20	8/31/23																																			
Subtask 10.1: Community Outreach and Education	9/1/20	8/31/23																																			
Subtask 10.2: Regulatory Outreach	9/1/20	8/31/23																																			
Subtask 10.3. Knowledge Sharing through Conferences, Workshop & Tech Papers	9/1/20	8/31/23																																			
Milestone: Participate in Project Kickoff Meeting	11/30/20	11/30/20			◆																																
Subtask 10.4. International Collaboration	9/1/20	8/31/23																																			

Bibliography

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

- Journal, one author:
  - Gaus, I., 2010, Role and impact of CO_2-rock interactions during CO_2 storage in sedimentary rocks: International Journal of Greenhouse Gas Control, v. 4, p. 73-89, available at: XXXXXXX.com.
- Journal, multiple authors:
  - MacQuarrie, K., and Mayer, K.U., 2005, Reactive transport modeling in fractured rock: A state-of-the-science review. Earth Science Reviews, v. 72, p. 189-227, available at: XXXXXXX.com.
- Publication:
  - Bethke, C.M., 1996, Geochemical reaction modeling, concepts and applications: New York, Oxford University Press, 397 p.