Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S

DE-FE0031888

David Riestenberg, Advanced Resources International, Inc. Richard Esposito, Southern Company

> U.S. Department of Energy National Energy Technology Laboratory Carbon Management Project Review Meeting August 15 - 19, 2022

Introduction

- 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 gasfired capture, transportation and storage in the southeastern U.S.



ECO₂S Phase III Partners

RESEARCH PARTNERS



SPECIALIZED PARTNERS & VENDORS













Stantec

Technical Status – Data Acquisition

- Six characterization/monitoring wells drilled in Phase II and III to test and characterize geologic properties
- 290 ft of hole core from the Paluxy and Washita-Fredericksburg reservoirs, the Tuscaloosa Marine shale, and other secondary confining units
- Extensive well logging
- Reservoir fluid sampling and injection tests
- 92 line-miles of 2D seismic







Technical Status - Geology

- Main reservoir rock interpreted as bedload-dominated fluvial sandstone; seals include mudrock and chalk
- Reservoirs occur between 3,500 ft and 5,500 ft bgs
- Porosity of sandstone in target zones averages 28.5%
- Reservoir permeability averages 3.6 D; maximum measured permeability is 16 D
- Mudstone confining units typically 1-64 nD
- Major stacked storage potential with >1,300 net feet of Cretaceous sandstone
- Static P₅₀ storage resource estimate: ~26 Mt/mi²; 1.4 Gt in 30,000 acre storage complex



Pashin et al., 2020

Technical Status - Geology



Technical Status – USDW Characterization



science for a changing world

Aquifers below the Eutaw-McShan have TDS concentrations of > 10,000 mg/L

Technical Status 2D Seismic

The interpretation of the new 2D seismic shows near-horizontal formations above the Paleozoic unconformity with little internal heterogeneity. no cross-cutting faults or fractures

Depth (ft)			A
0.1000 5000 10000 15000 20000 25000 25000	Porters Creek Clay Selma Group	n Tuscaloosa	
3000-1- 3500-1- 4000-1- 4500-1- 5500-1- 5500-1- 5500-1- 6000-1- 6500-1- 7500-1- 7500-1- 7500-1- 8000-1- 8500-1- 9000-1- 9500-1- 9500-1- 9000-1- 10000-1-		Lower Cretaceous Paluxy Sub-Mesozoic Unconformity	Imposite Imposite

Technical Status – UIC Permitting

- CarbonSAFE Phase III scope requires Class VI well construction permits capable of 50MMt of storage in 30 years
- UIC program designed with two wells, each capable of 4,000 t/d (2.9 MMt/y)
 - Plant Ratcliffe's annual CO₂ emissions are 1.7 to 2.2 MMt/y
- First permit application uploaded to GSDT site in August 2022





Technical Status – UIC Permitting

- CO₂ remains confined to the Paluxy formation
 - Internal baffles reduce vertical migration
- Plume growth is to the northeast (updip)
 - Essentially stabilized 20 years after injection stops





CO2 plume is the projection of all the layers to show the maximum extent

Technical Status – Storage Resources Management System

Paluxy reservoir at ECO₂S progresses from *Prospective Storage Resource* at the beginning of CarbonSAFE support to *Capacity* at the beginning of Phase IV





Technical Status – CO₂ Capture Assessments

- The project involves two CO₂ capture assessments, one at Plant Miller (coal) and one at Plant Ratcliffe (gas) with MHIA as the engineering contractor
 - The Plant Miller pre-feasibility assessment is being completed now. The capture technology developer completed the Inside Boundary Limit (ISBL) and CCSKC is completing the overall roll-up
 - The Plant Ratcliffe pre-feasibility assessment is being completed as well
- The Plant Daniel FEED under a separate DOE award (FE0031847) was completed in June 2022, and information will be available for the Ratcliffe assessment

Technical Status – Surface Facilities

- Pipeline network and injection facility designed to accommodate single source and multi-source hub options
- Preliminary hydraulic modeling by Trimeric estimates that without any booster stations, a 20-inch pipeline for Plant Daniel and a 36-inch pipeline for Plant Miller would be required





Other Accomplishments to Date

- Environmental Information Volume submitted in July 2021, revised in April 2022 — currently under evaluation for a single source (Ratcliffe) scope
- Risk workshop in May 2022, final risk report to be issued in August 2022
- UAB examining the NRAP Seal Flux and Open-IAM tools to evaluate caprock leakage risk

Building on the Project ECO₂S Experience for Future Development

The ECO₂S CarbonSAFE Phase III Project in Kemper County (Plant Ratcliffe) has provided significant value:

- Established a "world class" CO₂ storage hub that could serve additional CO₂ sources in the region.
- Built a foundation for continued positive community outreach and education.
- Provided improved understanding of carbon capture costs for NGCC at Plant Ratcliffe from adaptation of the FEED study conducted at Mississippi Power's Plant Daniel and Alabama Power — Plant Barry for storage site development.
- Highlighted the importance of retaining access to pore space and surface easements in future property transactions.

Building on the Project ECO₂S Experience for Future Development (Cont'd)

Project ECO₂S has also contributed significantly to Southern Company's and Mississippi Power's plans for future CCUS development:

- Provided a catalyst for evaluating large-scale future Infrastructure Bill funded DOE/NETL projects such as Direct Air Capture (DAC), Hydrogen Hubs, and Integrated Capture and Storage Pilots and Demonstrations.
- Helped clarify future power generation and decarbonization strategies in the Southeast with CCUS related source-sink matching driven by regulatory/policy changes or enhanced 45Q tax credits.
- Motivated continued discussions with large landowners for access to pore space and surface property.
- Provided motivation for evaluating CarbonSAFE Phases 3.5 and 4 proposals for addressing internal (regulated power assets) and external (industrial) CO₂ sources.

Thank You



Appendix

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

Organization Chart



Gantt Chart

Project ECO ₂ S Phase III		 Milestone 		Phase I/Budget Period 1														Phase II/Budget Period 2						
r toject Ecozo r nase m	 Decis 	sion Point	9/1/2020 to 8/31/22												_	9/1/22 to 8/31/23								
TASK DESCRIPTIONS	Start Date	End Date	slo	DN I	J	FN	A	LN	J	۱s	ON	D.	IF	M,	AM	J J	A	slo	N	L D	FN	A	A J	JA
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										П												
Milestone: Implement Project Management Plan	9/30/20	9/30/20	٠									П										\square		
Decision Point 1: Negotiation/Implementation of PMP	9/30/20	9/30/20	٠	Ш			Ш		Ш	Ш		Ш		Ц			\square		Ш		Ц	Ш	Ш	Ш
Decision Point 3: Negotiation /Implementation of Phase II/BP2	8/31/22	8/31/22	Ц	11		4	Ц	+	Ц	11	_	Щ	+	Ц	\square		•		Ц		4	44	11	\square
Subtask 1.2: Data Management Plan	9/1/20	8/31/23	\vdash	++	+	\square	\square	+	\square	++	+	Ш	+	Н	+		+		\square			+++	++	
Subtask 1.3: Technology Maturation Plan	9/1/20	8/31/22	\vdash	++			\square		\square	++	+	₩	+	\square				-	₩	+	\square	₩	++	++
Subtask 1.4: Contractual	9/1/20	12/1/20	\vdash	╈		\vdash	⊢	+	\square	++	+	₩	+	\vdash	+		+		┉		\vdash	╈	++	++
TASK 2.0: NATIONAL ENVIDOMENTAL DOLICY ACT/NEDAL	9/1/20	8/31/23																						
Subtack 2.1: Preparation and Submission of NEPA Documentation for Site	9/1/20	0/31/23	=																					
Characterization and CO2 Capture Assessment	9/1/20	12/31/20																						
Subtack 2.2: Bransention and Submission of an EIV for Dotantial Subura	-,-,		H	Ħ		+	H	+	H	Ħ	+	Ħ	+	H	Н		Η	+	Ħ		H	Ħ	++	++
Construction and Operation	9/1/20	3/3/21					ш																	
Milestone: Complete Environmental Information Volume	3/3/21	3/3/21					-	+	H	++	+	H	+	H	+	+	+	+	╈	+	H	++	++	++
Subtask 2.3: Preparation and Submission of NEPA Documentation for			H	++	+	Ť		+	H	++	+	Ħ	+	H	Η		Н		Ħ		H	Ħ	++	+
Potential Future Construction and Operation	3/4/21	8/31/23																						
TASK 3.0: RISK MANAGEMENT	9/1/20	8/31/23																						
Decision Point 2: Complete Initial Risk Register	3/3/21	3/3/21	•				Π		μŢ	Π	T	Π	Γ	I			Γ		Π	T		П	П	
Subtask 3.1: Commercial Scale Integrated Risk Assessment	9/1/20	8/31/23	\square	\prod			\square		H	\square		H		ЦÍ					H			4	11	
Subtask 3.2: Risk Assessment Tools	9/1/20	8/31/23																				44	44	
TASK 4.0: SITE SELECTION AND WELL DRILLING	9/1/20	12/31/22																			\square	++	++	++
Subtask 4.1: Well Site Selection	9/1/20	12/1/20	\square	++		4	H	+	\square	11	+	Ш	╇	\square	+		+	4	++	+	\square	++	++	++
Subtask 4.2: Permitting and Site Surveys	9/1/20	3/3/21	\vdash	++			Н	+	\square	++	+	11	+	\square	-+		+	-	++	+	\square	₩	++	
Subtask 4.3: Well Design	9/1/20	12/1/20		++			++	+	\square	++	+	++	+	\square	+		+		┿		\vdash	++	++	-+
Subtask 4.4: Well Drilling and Geologic Data Collection	11/1/20	12/31/22																			\vdash	++	++	++
TASK 5.0: COMPLETE GEOLOGIC CHARACTERIZATION	9/1/20	12/1/22																			\vdash	++	++	++
Subtask 5.1: Underground Sources of Uninking Water	9/1/20	2/2/22		++		+	⊢	+	\mathbb{H}	++	+	₩	+	\vdash	+	+	+	+		+	\vdash	++	++	++
Subtask 5.2. 50 Seranic Survey Subtask 5.3: Surface Characterization for LIIC Injection Well Drilling	12/2/21	12/1/22	\vdash	++	+		++	+	\mathbb{H}	+	+	₩	+	\vdash	+		+		╈		\vdash	++	++	++
TASK 5.0: CEOLOCIC DATA ANALYSIS	2/2/21	9/21/22	\vdash	++	+																	-		
Milettone: Complete Geologic Characterization	8/31/23	8/31/23	\vdash	╈	+														П					
Subtask 6 1: Core and Fluid Analysis	3/4/21	3/3/22	\vdash	++	+	H	H	+	H	+	+	H	+	H	Н	+	Н	+	Ħ	+	H	++	++	Ť
Subtask 6.2: Refined Geologic Model	9/1/21	3/3/22	H	++	+		H		H	Ħ	+	Ħ	+	H	Н	+	Н	+	Ħ	+	H	++	++	++
Subtask 6.3: Reservoir Modeling	12/2/21	8/31/22	H	++		H	Ħ	+	H	Ħ	+	Ħ	+	H	Η		Н		Ħ		H	Ħ	++	++
Subtask 6.4: Seismic Processing and Interpretation	9/1/21	3/3/23	H	Ħ		H	Ħ	+	H	Н	+	Ħ	+	H	+		\top		Ħ		H	Ħ	Ħ	++
Subtask 6.5: DeepLook STUDY	3/4/21	8/31/23	H	++	Н		Ħ	+	H	Ħ	+	Ħ	+	H	Н		Н		Ħ	+	H	Ħ	++	+
TASK 7.0: CO2 CAPTURE ASSESSMENT	9/1/20	8/31/22																	П			T	\mathbf{T}	П
Subtask 7.1: Potential CO2 Source Screening and Selection	9/1/20	3/3/21		Π						Π		Π							П			П	П	П
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				\square	Ш		Ш	\square	_	Ш		Ц			\square		Ш		Ц	Ш	\square	Ш
Subtask 7.4: Permitting Considerations	12/2/20	4/30/22		\square			Ш		Ц	Ш		Ш		Ц					Ш			Ш	\square	Ш
Subtask 7.5: Flue Gas Supply System	3/4/21	8/31/22	\square	11			Ш	+	Ц	11	+	Щ	╇	Щ	+		\perp		\square		\square	\square		
Subtask 7.6: Flue Gas Pre-Treatment Process	3/4/21	8/31/22	\vdash	++	+		11	+	\square	++	+	11	+	Н	+		+	4	++	+	\square	₩	++	++
Subtask 7.7: Regeneration Energy Source Evaluation	3/4/21	8/31/22	\vdash	++	+		++	+	\square	++	+	₩	+	\square	+	+	+	+	++	+	\vdash	++	++	++
Subtask 7.8. Additional Cooling Capacity	3/4/21	8/31/22	\vdash	++	+		⊢	+	\square	++	+	₩	╋	\vdash	+	+	+	+	₩	+	\vdash	++	++	++
Subtask 7.9, CO2 Compression and Denyaration	3/4/21	8/31/22	\vdash	++	+		H	+	H	++	+	₩	╋	H	+	+	+	+	↔	+	+	++	++	++
Subtask 7.10. CO2 Pipeline initiastructure	0/1/21	0/31/22	\vdash	++	+		+		\mathbf{H}	╉	+	₩	╋	H	+	+	+	+	++	+	+	++	++	++
Milatona: Complete CO2 Canture Pro-Fearibility Studier	8/31/22	8/31/22	\vdash	╈	+	+	H	+	H			╉					-	╋	₩	+	H	₩	++	++
TASK 8.0: PROJECT INTEGRATION	3/4/21	3/3/23	\vdash	╈	+												÷					+	++	++
Subtask 8.1: CO2 Delivery and Well Infrastructure Needs	3/4/21	3/3/23	H	++	+					Π												H	++	++
Subtask 8.2: Pore/Surface Rights and Right of Way Requirements	3/4/21	3/3/23	H	++			Ħ	+	H	Ħ	+	Ħ	+	H	+		\top		Ħ	+	H	H	++	++
Subtask 8.3: Financial and Contractual Model(s)	9/1/21	8/31/22		\mathbf{T}			П		П	Π		Π	\top	П	Τ		Π		TT			T	\mathbf{T}	П
TASK 9.0: UIC PERMITTING	9/1/21	8/31/23		\mathbf{T}			П		П															
Subtask 9.1: Project Description and Site Characterization	9/1/21	8/31/22		П			Π		Π			Π										П	Π	\Box
Subtask 9.2: Construction and Operational Plans	9/1/21	8/31/22										Ш										П		
Subtask 9.3: Site Closure Demonstration	9/1/21	8/31/22	\square	μT		Ц	ЦĪ		Ц			Щ		Ц					μŢ		Ц	Ц	11	
Milestone: Submit UIC Class VI Permit to Construct Application	8/31/22	8/31/22	\square	\prod		\square	Ц		\square	\square		П		Ц			٠		ЦĪ			11	44	\square
Subtask 9.4: Public Outreach and Engagement	3/4/22	3/3/23	\vdash	\square	+	\square	\square	_	\square	$\downarrow \downarrow$		\square	+	\square					\square			\downarrow	11	+
Subtask 9.5: Address U.S. EPA Comments on Class VI Permit Application	9/1/22	8/31/23	\vdash	++	+	\square	\square	+	\square	+	+	\square	+	\square	+	\square	+		\prod			44	41	
Milestone: Receive Permission to Construct UIC Class VI Well	8/31/23	8/31/23																				Ш	Ш	٠
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	+	++		+	+	+	\square	+	+	\mathbf{H}	+	H	+	+	+		++	+	+	+	++	+
Subtask 10.2: Regulatory Outreach	9/1/20	8/51/23	+	++	+	+	\mathbf{H}	+	++	+	+	\mathbf{H}	+	\mathbb{H}	+	+	+		++	+	+	++	++	+
Subtask 10.5. Knowledge Sharing through Conferences, Workshop & Tech	0/1/20	9/21/22		11			11												11			\prod		
Papers	9/1/20	8/31/23	\mathbb{H}	-			\mathbf{H}	+	\square	+		\mathbf{H}	+	\mathbb{H}			+		++	Ŧ		++	41	-
witestone: Participate in Project Kickoff Meeting	11/30/20	2/21/22	\vdash	*			++		\mathbf{H}	+	+	\mathbf{H}		\square			+		++			++	++	+
Subtask 10.4. International Collaboration	9/1/20	8/51/25		\square			11		\square	\square		11		\square					\square			44	+	