Southeast Regional Carbon Sequestration Partnership (SECARB)

Saline Reservoir Field Test

secarb.org

Field Test Location

Escatawpa, Mississippi

Amount and Sources of CO_2

3,000 Tons (short) of Natural CO_2 (donation)

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Field Test Partners

Primary Sponsors
DOE/NETL
SSEB

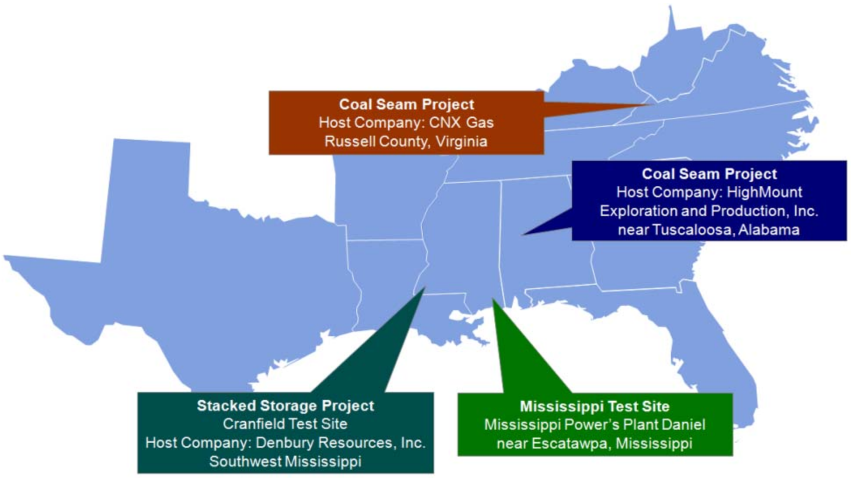
Industrial Partners
Advanced Resources, International
Denbury Resources, Incorporated
Duke Energy
Tennessee Valley Authority

Summary of Field Test Site and Operations

The Southeast Regional Carbon Sequestration Partnership's (SECARB) Saline Reservoir Field Test will be conducted at Mississippi Power Company's Plant Daniel, a power generation facility capable of delivering over 1,000 megawatts of coal-fired electricity into the Jackson County power grid. Situated near the town of Escatawpa, the power plant covers about 1,600 acres of surface area in southeast Mississippi (Figure 1).

One injection well and one observation well have been drilled, to depths of 9,500 feet, to access the Massive Sand Unit of the Lower Tuscaloosa Formation, for a carbon dioxide (CO_2) pilot injection study.. A Class 5 UIC permit was issued from the Mississippi Department of Environmental Quality (MDEQ) for the pilot injection.

The observation well was drilled first to provide site-specific subsurface data from coring, geophysical well logging and stress testing. This data has been collected and analyzed and confirms the viability of the test site. A robust monitoring and verification program has been developed for environmental safety and to monitor the movement of the injected CO2 in the target formation. Monitoring protocols include, soil flux, tracers, isotopes, groundwater quality, and seismic profiling. Extensive outreach and education has been performed at each phase of site activities.



SECARB Phase II Geographic Region and Field Test Site Locations

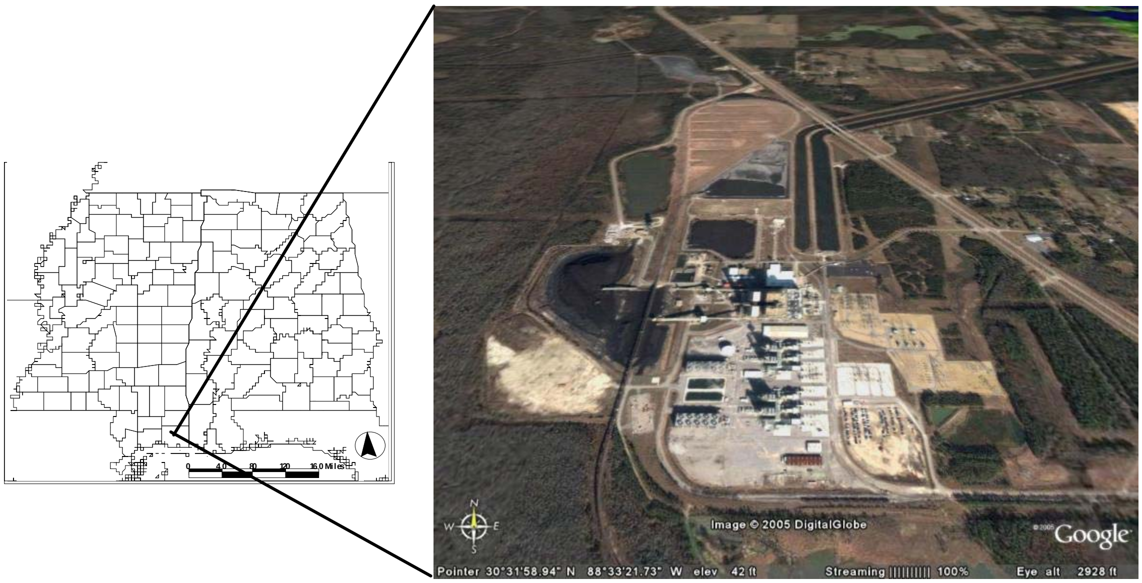


Figure 1. Plant Daniel Location Map

Research Objectives

The purpose of this project is to test the deep saline reservoirs located near the large coal-fired power plants along the Mississippi Gulf Coast for geological storage of CO_2. In this area, the Lower Tuscaloosa Massive Sand Unit has been identified as a promising, high capacity, CO_2 storage option.

To assure a safe, secure and publicly accepted storage site, the project team is in the process of building the essential foundation of knowledge and science. This includes: (1) constructing geological and reservoir maps to further assess the test site; (2) conducting reservoir simulations to estimate CO_2 injection rate, storage capacity, and the long-term fate of injected CO_2; (3) addressing state/local regulatory issues for permitting this site; (4) fostering public education and outreach to build acceptance; (5) injecting 3,000 tons of CO_2; and (6) conducting longer-term monitoring to establish the location and security of the CO_2 plume.

Summary of Modeling and MMV Efforts

Preliminary geophysical reservoir modeling indicates that the 3,000 tons of CO_2 to be injected will be confined to a very small volume of reservoir pore space. The plume is expected to flow about 250 feet radially and 50 feet vertically, becoming essentially immobile within 5 years. The CO_2 will remain confined within the Massive Sand Unit. Geochemical modeling will be conducted using subsurface data (core and fluid sampling) collected during the drilling of the observation well.

Prior to, during, and following CO_2 injection, subsurface and surface monitoring techniques will be employed to track the flow, trapping and confinement of the CO_2.

In addition to time-lapse vertical seismic profililing (VSP) for areal migration and pulsed-neutron logging for vertical saturation of the CO_2, numerous surface time-lapse monitoring protocols will be performed to ensure the safety of this sequestration project. These will include: (1) monitoring the shallow subsurface CO_2 flux and comparing those to historical baseline and background sampling; (2) tagging the CO_2 with perfluorocarbon (PFT) tracers and detecting for their presence at the surface; and (3) using wellhead and down hole pressure probes to ensure well integrity. A listing of MMV protocols is shown in Table 1.

Table 1. MMV Objectives, Parameters and Procedures

Monitoring Objective	Measurement Parameter(s)	Monitoring Topic Addressed	MMV Procedure(s) and Tools
Surface and Subsurface CO_2 Pressure	• Operating pressure • Formation pressure • Formation temperature	• Leakage out of the storage formation • Basic data to calibrate reservoir modeling	Down hole gauges in CO_2 injection well to collect continuous pressure and temperature data; Wellhead pressure gauges in CO_2 injection well to monitor for leakage.
Vertical Location of CO_2 Plume	• CO_2 saturation profile	• Tracking CO_2 movement in and above storage formation	Time-lapse (pre-, during, and post-injection) pulsed-neutron surveys of the storage formation and overlying seals and formations.
Areal and Vertical Location of CO_2 Plume	• P and S wave seismic velocity • Reflection horizons	• Detect distribution of CO_2 in the storage formation • Detect leakage of CO_2 through faults and fractures	Time-lapse (pre- and post-injection) VSP surveys of the storage formation and overlying seals and formations.
Wellbore Integrity	• CO_2 levels and isotopic ratio near wellhead • Wellhead pressure • Cement and formation bond quality	• Detect vertical leakage of CO_2 through the wellbore • Control of formation pressure below fracture gradient • Monitor packer, tubing, and casing integrity	Tracer monitoring using Praxair's portable CO_2 tracer detector. Continue monitoring of pressure inside and outside injection string. Ultra-sonic cement bond logs for annual test of cement bond/quality.
Near-Surface Accumulations of CO_2	• Soil gas composition • Surface evidence of CO_2 tracers • Groundwater Quality	• Leakage or seepage of CO_2 to surface	A suite of surface monitoring stations and wells located around the well site, sampled at 1-yr pre-and 2-yr post-injection for baseline and elevated soil CO_2 concentrations.

Accomplishments to Date

To date, the project has performed several successful outreach & education, regulatory compliance, contractual, and field activities. Key accomplishments include:

- Developed a plan to conduct the sequestration experiment on the grounds of the Plant Daniel Electric Generating Facility, approved in April 2006 by Mississippi Power Company.
- Participated in a Mississippi Power sponsored "neighbor meeting" to discuss the project and inform the public. The technical team participated in the interactive discussion with the public, using various visual aids (posters, rock samples, etc.) to convey our message.
- A Class 5 UIC permit application was submitted and was issued by the Mississippi Department of Environmental Quality (MDEQ) a Class V Experimental Well Application. At the request of MDEQ, all Class I non-hazardous standards were met in the Application.
- In August, 2007, MDEQ held a public meeting to complete the regulatory requirements for the Class V Experimental Well Application. No additional questions were brought to the Board and the Well Permit was issued.
- Baseline soil flux and groundwater monitoring was initiated in September 2007
- Drilling permits for the planned injection and observation wells were submitted and issued by the Mississippi Oil and Gas Board.. The injection well permit entailed a thorough technical application; the observation well

required only an application for an administrative permit.

- In February 2008 drilling of the monitoring and injection wells was initiated. Both wells were successfully drilled, cased, and cemented by early April. Geopyisical logs, cores, and fluid samples were taken for reservoir analysis.
- A baseline VSP survey was conducted in late April 2008.
- The pilot injection is scheduled and on track to be performed in October of 2008.

Target Sink Storage Opportunities and Benefits to the Region

The target formation for the SECARB Phase II project is the Massive Sandstone Unit of the Lower Tuscaloosa Formation, a Cretaceous age sandstone saline reservoir that occurs in the subsurface along the Gulf of Mexico Coastal Plain from western Florida to Texas (where it is defined as the Woodbine Formation). A type stratigraphic column of the Gulf Coast Region is shown in Figure 2. The Lower Tuscaloosa contains an upper section of alternating shale and sand and a basal section, the Massive Sand Unit, which contains a thick package of clean, medium- to coarse-grained predominantly quartz sand. The Formation was deposited during a major period of global sea-level rise and its deposition has been interpreted as an upward gradation from fluvial and deltaic sedimentation (the Massive Sand) to marine shelf deposition (alternating sand and shale).

The target formation is representative of the geology that could be used to store 50 percent of the CO_2 produced in the SECARB region during the next 100 years.

System	Series	Stratigraphic Unit	Sub-Units	Hydrology
Tertiary	Miocene	Misc. Miocene Units	Pascagoula Fm.	Freshwater Aquifers
			Hattiesburg Fm.	
			Catahoula Fm.	
	Oligo-cene	Vicksburg		SalineReservoir
			Red Bluff Fm.	Minor confining unit
	Eocene	Jackson		SalineReservoir
		Claiborne		SalineReservoir
		Wilcox		SalineReservoir
	Paleo-cene	Midway Shale		Confining unit
Cretaceous	Upper	Selma Chalk	Navarro Fm.	Confining unit
			Taylor Fm.	
		Eutaw	Austin Fm.	Confining unit
			Eagle Ford Fm.	Saline Reservoir
		Tuscaloosa Group	Upper Tusc.	Minor Reservoir
			Marine Tusc.	Confining unit
			Lower Tusc.	Saline Reservoir
	Lower	Washita-Fredricksburg	Dantzler Fm.	Saline Reservoir
			"Limestone Unit"	

Figure 2. Type Stratigraphic Column of the Gulf Coast Region

The Lower Tuscaloosa Formation is a key component of a larger, regional group of similar formations, in terms of deposition and character, called the Gulf Coast Wedge. This wedge of sediments spans the entire region (from the Gulf of Mexico, through Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina and Virginia) and includes some of the largest saline sinks (in terms of areal extent and capacity) for the SECARB region as well as the United States.

CO_2 Injection tests into the Lower Tuscaloosa Formation will yield confidence in the storage ability of these other Cretaceous and Tertiary basins due to the similar lithologic characteristics, analogous depositional environments, proven seals, and moderately complex structural settings exhibited by all of the six Mesozoic and Cenozoic formations in the region.

The CO_2 storage capacity of the SECARB region has been recently assessed using conservative methodology set forth by the Geological Working Group's subcommittee on storage capacity. Annual stationary point-source emissions of CO_2 have been estimated to be 1,047 Mt (MIT 2007). Using the range of reported capacity, the Gulf Coast Wedge has the capacity to accommodate these emissions for 300 to 1,200 years, should one hundred percent of this CO_2 in the region need to be captured and stored.

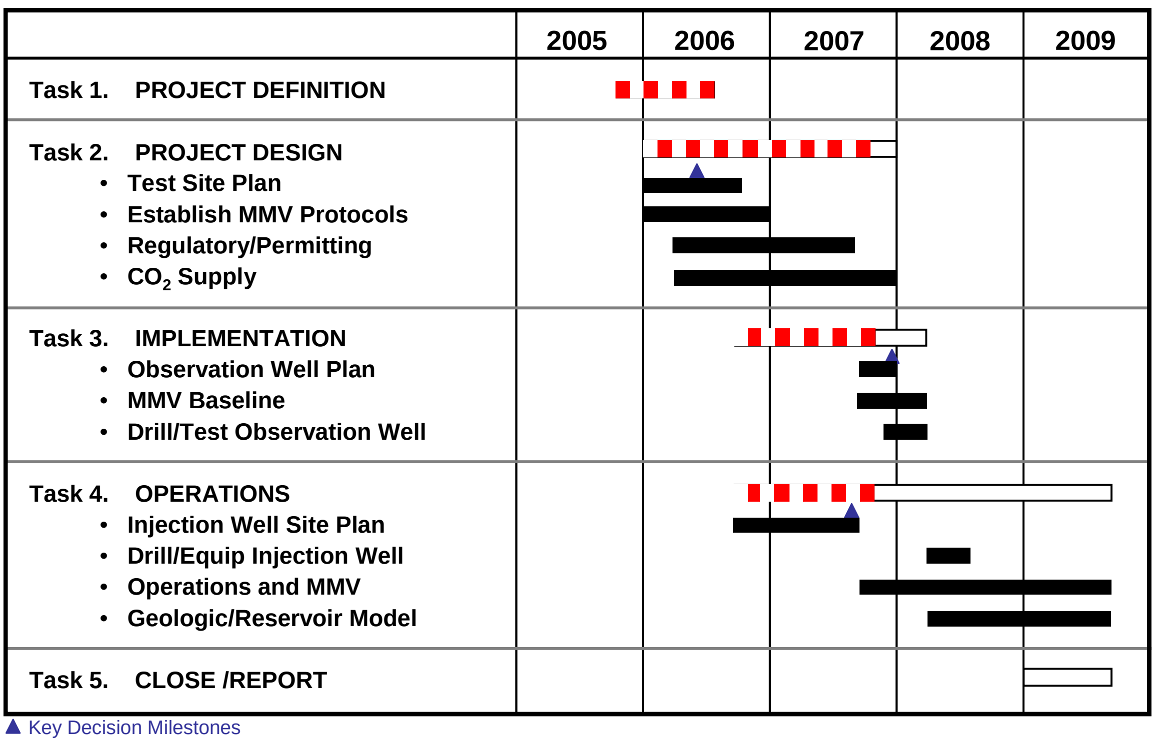
Cost

Total Field Project Cost (Years 1-4):	$6,755,245	
DOE Share:	$5,112,799	75.7%
Non-DOE Share:	$1,642,446	24.3%

Field Project Key Dates

Baseline Completed:	12/2007
Drilling Operations Begin:	02/2008
Injection Operations Begin:	10//2008

Field Test Schedule and Milestones (Gantt Chart):



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