PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

04/2008

SOUTHEAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP—DEPLOYMENT PHASE

Background

As part of a comprehensive effort to assess options for sustainable energy systems, the U.S. Department of Energy has selected seven Regional Partnerships, through its Regional Carbon Sequestration Partnership (RCSP) Program, to determine the best approaches for capturing and permanently storing carbon dioxide (CO_2), a greenhouse gas (GHG) which can contribute to global climate change. The RCSPs are made up of state agencies, universities, private companies, national laboratories, and nonprofit organizations that form the core of a nationwide network helping to establish the most suitable technologies, regulations, and infrastructure needs for carbon sequestration. Altogether, the Partnerships include more than 350 organizations, spanning 41 states, two Indian nations, and four Canadian provinces.

The Regional Partnership initiative is being implemented in three phases. The Characterization Phase began in September 2003 with the seven Partnerships working to develop the necessary framework to validate and potentially deploy carbon sequestration technologies. In June 2005, work transitioned to the Validation Phase, a four-year effort focused on validating promising CO_2 sequestration opportunities through a series of field tests in the seven regions. Presently, activities in the Deployment Phase (2008-2017) are proceeding and will demonstrate that CO_2 capture, transportation, injection, and storage can be achieved safely, permanently, and economically at a large scale. These tests will promote understanding of injectivity, capacity, and storability of CO_2 in the various geologic formations identified by the Partnerships. Results and assessments from these efforts will assist commercialization efforts for future sequestration projects in North America.

The Southeast Regional Carbon Sequestration Partnership (SECARB), led by the Southern States Energy Board (SSEB), represents the 11 southeastern states of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia, plus counties in Kentucky and West Virginia. SECARB is comprised of more than 100 partners and stakeholders. The Partnership estimates that 31 percent of the nation's CO_2 stationary source emissions come from states in the SECARB region. SECARB's deep saline formations offer potential capacity for safe and permanent storage of those emissions. Moreover, SECARB, along with the other Regional Partnerships, continue to develop an assemblage of best practices to support the transfer and wide-scale deployment of information and technology developed from their projects.

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-4867
sean.plasynski@netl.doe.gov

Bruce Lani
Project Manager
National EnergyTechnology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-5819
bruce.lani@netl.doe.gov

Ken Nemeth
Executive Director
Southern States Energy Board
6325 Amherst Court
Norcross, GA 30092
770-242-7712
nemeth@sseb.org

PARTNERS AND STAKEHOLDERS

- Advanced Resources International
- AGL Resources
- Alabama Oil & Gas Board
- Alawest
- Alpha Natural Resources
- American Electric Power
- Amvest Gas Resources
- Applied Geo Technologies
- Arch Coal
- Arkansas Oil and Gas Commission
- Association of American Railroads
- Augusta Systems, Incorporated
- Big Rivers Electric Corporation
- BP America
- Buchanan Energy Company of Virginia, LLC
- Buckhorn Coal Company
- CDX Gas, LLC
- CEMEX
- Center for Energy & Economic Development (CEED)
- ChevronTexaco Corporation
- Clean Coal Technology Foundation of Texas
- Clean Energy Systems, Inc.
- CNX Gas
- CO_2 Capture Project
- Composite Technology Corporation
- CONSOL Energy, Inc.
- Core Laboratories
- Dart Oil & Gas Corporation
- Denbury Resources, Inc.
- Dominion
- Duke Energy
- Eastern Coal Council
- Edison Electric Institute
- Electric Power Research Institute (EPRI)
- Entergy Services, Inc.
- Equitable Resources
- Florida Municipal Electric Association
- Florida Power & Light Company
- Geological Survey of Alabama

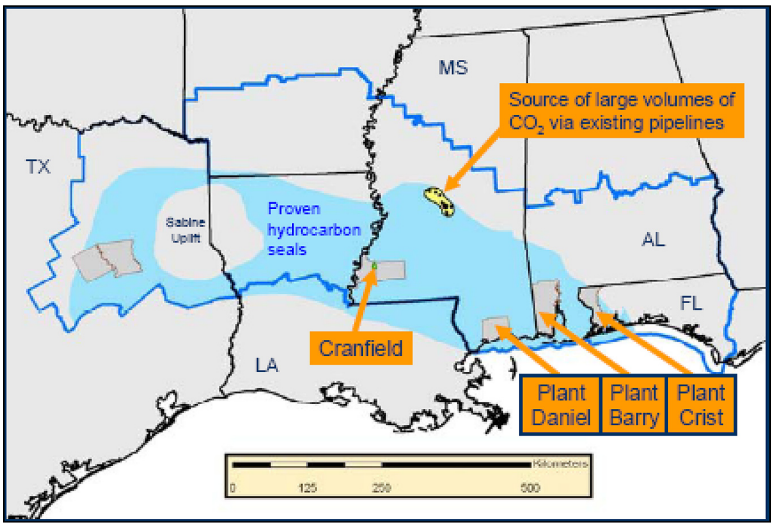
Project Description

Project Summary

SECARB will conduct a two-step, large-volume injection test in the lower Tuscaloosa Formation, a key component of a larger, regional group of similar formations, in terms of deposition and character, called the Gulf Coast Wedge. The first step, or "Early Test," will inject 1.4 million tonnes (1.5 million U.S. tons) of CO_2 per year for 18 months. The CO_2 will come from a naturally occurring source from the Jackson Dome and will be delivered by Denbury Resources' CO_2 pipeline. The second step, or "Anthropogenic Test," will inject 100,000 to 250,000 tonnes (110,000 to 275,000 U.S. tons) of CO_2 per year for three to seven years. The CO_2 will be supplied from a pilot unit capturing CO_2 from flue gas produced from a Southern Company power plant located near the injection site.

Injection Site Description

The Early Test will focus on the down dip "water leg" of the Cranfield unit, operated by Denbury Resources, Inc. in Adams and Franklin Counties, Mississippi, about 15 miles east of Natchez, Mississippi, and one and a half miles north of the unincorporated village of Cranfield. The area selected for the Early Test is immediately north of the SECARB Validation Phase "Stacked Storage" study underway in the oil rim field. The Anthropogenic Test will be conducted on or in proximity to a Southern Company plant site on the Gulf Coast.

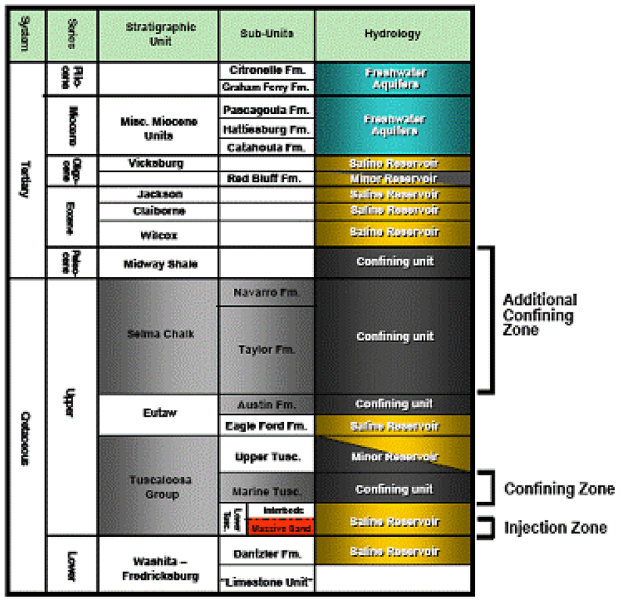


Geographic location of SECARB's Deployment Phase activities

Description of Geology

The lower Tuscaloosa Formation is one of the named stacked sandstone formations of the Gulf Coast Wedge. It is a Cretaceous age sandstone saline formation 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). The Tuscaloosa contains an upper section of alternating shales and sands and a basal section, the Massive Sand Unit, which contains a thick layer of clean, coarse-grained 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 shelf deposition (alternating sands and shales). The Massive Sand was deposited in a wave-dominated shallow coastal barrier environment. The well-sorted, clean, coarse-grained nature of the Massive Sand, a result of this environment, makes it an ideal candidate for CO_2 injection due to its high-permeability and porosity. As the sea level continued to rise, the shelf depositional environment gave way to a deep marine environment, during which the overlying middle (Marine) Tuscaloosa Formation was deposited. This formation consists of about 500 feet of low-permeability shale, providing an excellent cap rock and primary seal to CO_2 injection into the lower Tuscaloosa Formation.



General southeastern Mississippi stratigraphic column

Source of CO_2

The CO_2 for the Early Test will be provided by Denbury Resources. The source is commercially available, of high purity, highly reliable, and low cost. The CO_2 for the Anthropogenic Test will be supplied from a pilot unit capturing CO_2 from flue gas produced from a Southern Company power plant at a location near the injection site. The expectation is that this unit will be capable of producing 100,000 to 250,000 tonnes (110,000 to 275,000 U.S. tons) of CO_2 per year for a period of four years.

Injection Operations

Injections will occur at a scale sufficient to successfully address issues of injection rate and cumulative injection impacts that may be factors in the design of future large-scale, commercial sequestration deployments. During the Early Test, 1 to 1.5 million tonnes (1.1 to 1.65 million U.S. tons) of CO_2 will be transported through the commercial Denbury Sonat pipeline (a former gas pipeline that Denbury retrofitted for CO_2 transport in 2007) from a natural source at Jackson Dome (near Jackson, Mississippi) to Cranfield, Mississippi. Distribution lines and compression will be developed by Denbury to bring CO_2 from the pipeline head to the injection wells. For the Anthropogenic Test, the CO_2, once captured, will be dehydrated and compressed to approximately 2,000 psig. It will be transported over a short distance via carbon steel pipe to the injection site.

PARTNERS AND STAKEHOLDERS (cont.)

- GeoMet, Inc.
- Georgia Environmental Facilities Authority
- Georgia Forestry Commission
- Georgia Power Company
- Halliburton
- Integrated Utility Services, Inc.
- International Coal Group
- Interstate Oil and Gas Compact Commission
- Kentucky Geological Survey
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Louisiana Department of Environmental Quality
- Louisiana Geological Survey
- Marshall Miller & Associates
- Massachusetts Institute of Technology
- McJunkin Appalachian Oil Field Supply Company
- Mississippi Power Company
- Mississippi State University
- National Coal Council
- National Mining Association
- Natural Resource Partners
- Norfolk Southern
- North American Coal Corporation
- North Carolina State Energy Office
- Nuclear Energy Institute
- Oak Ridge National Laboratory
- Old Dominion Electric Cooperative
- Peabody Energy
- Penn Virginia Corporation
- Phillips Group, The
- Pine Mountain Oil & Gas, Inc.
- Pocahontas Land Corporation
- Powell River Project
- Praxair
- Progress Energy
- QEA, LLC
- Rentech, Inc.

PARTNERS AND STAKEHOLDERS (cont.)

- RMB Earth Science Consultants
- RMS Strategies
- SCANA Energy
- Schlumberger
- Shell Oil Company
- Smith Energy
- South Carolina Department of Agriculture
- South Carolina Electric & Gas Company
- South Carolina Public Service Authority/Santee Cooper
- Southern Company
- Southern States Energy Board
- Susan Rice and Associates, Inc.
- Tampa Electric Company
- Tennessee Valley Authority
- Texas Bureau of Economic Geology
- TXU Corporation (Luminant Energy)
- United Company, The
- University of Alabama
- University of British Columbia
- Virginia Center for Coal and Energy Research
- Virginia Department of Mines, Minerals and Enegy
- Walden Consulting
- Winrock International

COST

Total Project Value

$98,689,241

DOE/Non-DOE Share

$66,949,078/ $28,740,163

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Simulation and Monitoring of CO_2

SECARB will adhere to a vigorous monitoring, measurement, and verification (MMV) program during the 10-year Deployment Phase project. Each site will be well instrumented with multiple sensor arrays. In the "Early Test," sweep efficiency will be monitored by saturation measurements along well bores, cross well measurements, and vertical seismic profiling (VSP) and/or surface seismic methods. Proposed monitoring activities for the "Anthropogenic Test" will include: (1) well bore integrity assessed through Ultrasonic Imaging Tool (USIT) logging, annular pressure monitoring, and tracer injection; (2) assessment of areal extent of the plume through drilling and monitoring up-gradient wells, seismic surveys (3-D and VSP), and Reservoir Saturation Tool (RST) logs in observation wells; (3) monitoring for formation leakage through RST logging and using the VSP geophones to map and trace CO_2 leakage; and (4) CO_2 seepage through shallow subsurface monitoring for CO_2, carbon isotopes, and tracers. To help predict plume movement and assess the ultimate fate of the injected CO_2, the project team will utilize two types of simulation models: GEM simulation software and TOUGHREACT.

Goals and Objectives

SECARB's overall goal is to validate the efforts of the public outreach, research, and field activities implemented under the Characterization and Validation Phases. Specific objectives include:

- Conducting a large-volume, high pressure injection test that benefits from existing CO_2 infrastructure and reasonable CO_2 costs
- Assessing the viability and logistics of injecting a million tonnes (1.1 million U.S. tons) of CO_2 per year into a regionally significant saline formation in the Gulf Coast
- Achieving a more thorough understanding of the science, technology, regulatory framework, risk factors, and public opinion issues associated with large-scale injection operations
- Executing a sequestration test that covers all aspects of capture, separation, and storage, while fulfilling technical, regulatory, social and economic considerations
- Refining capacity estimates of the formation using results of the test

Benefits to the Region

The lower Tuscaloosa Formation is representative of the Gulf Coast geology, which could be used to store 50 percent of the CO_2 produced in the SECARB region, estimated at 50 billion tonnes (55 billion U.S. tons), during the next 100 years. The Gulf Coast Wedge includes the largest saline sinks (in terms of areal extent and capacity) for the SECARB region, as well as the United States. Annual stationary point-source emissions of CO_2 have been estimated to be 1 billion tonnes (1.1 billion U.S. tons). Using the range of reported capacity, the Gulf Coast Wedge can accommodate these emissions for approximately 300 to nearly 1,200 years, using capture and storage technologies. These volumes are sufficient to support commercialization of this CO_2 sink and demonstrate that CO_2 capture and sequestration can be a viable option for mitigating GHG emissions from the region.