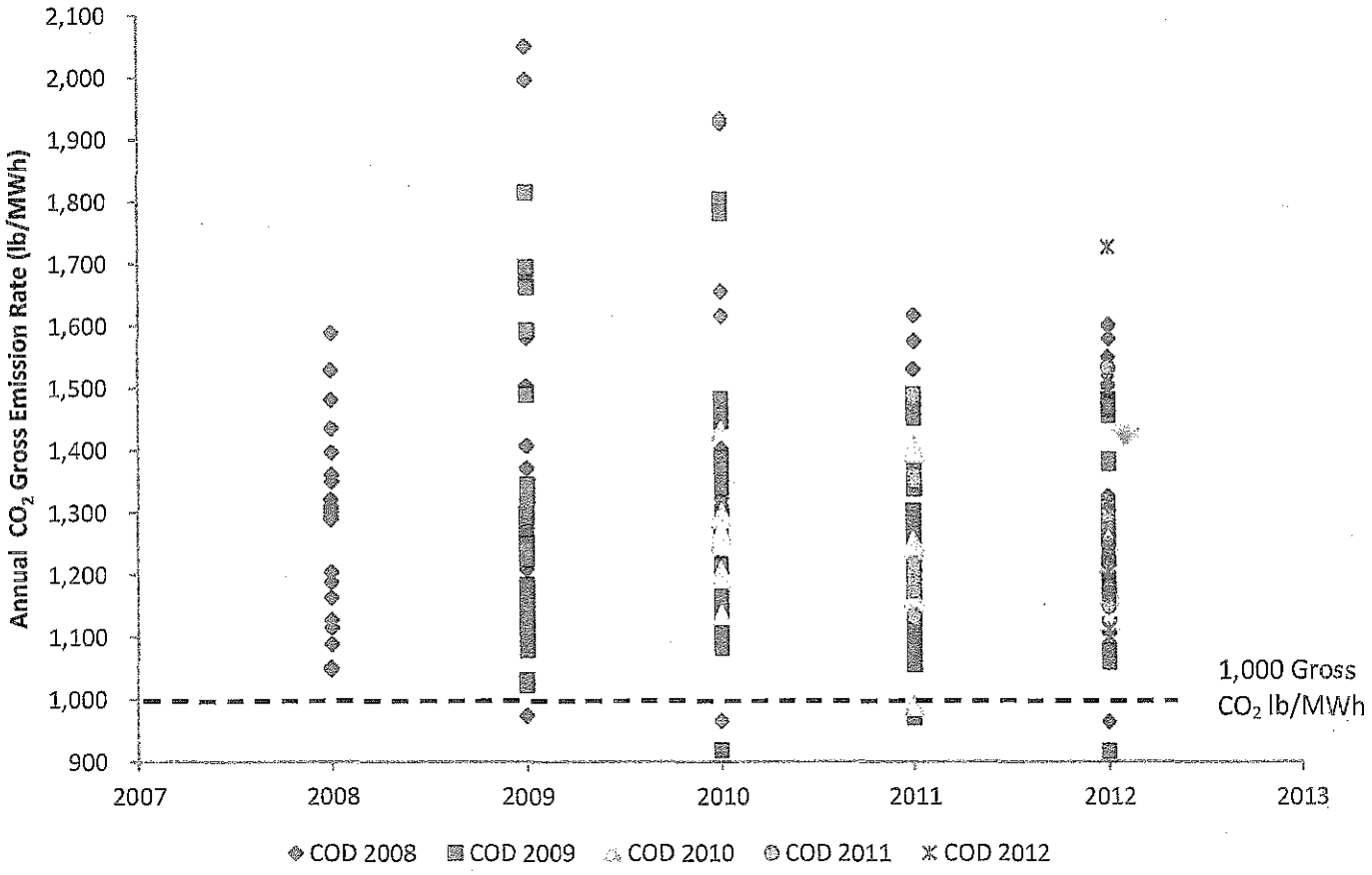
National NGCT, Units Built in Last 5 Years

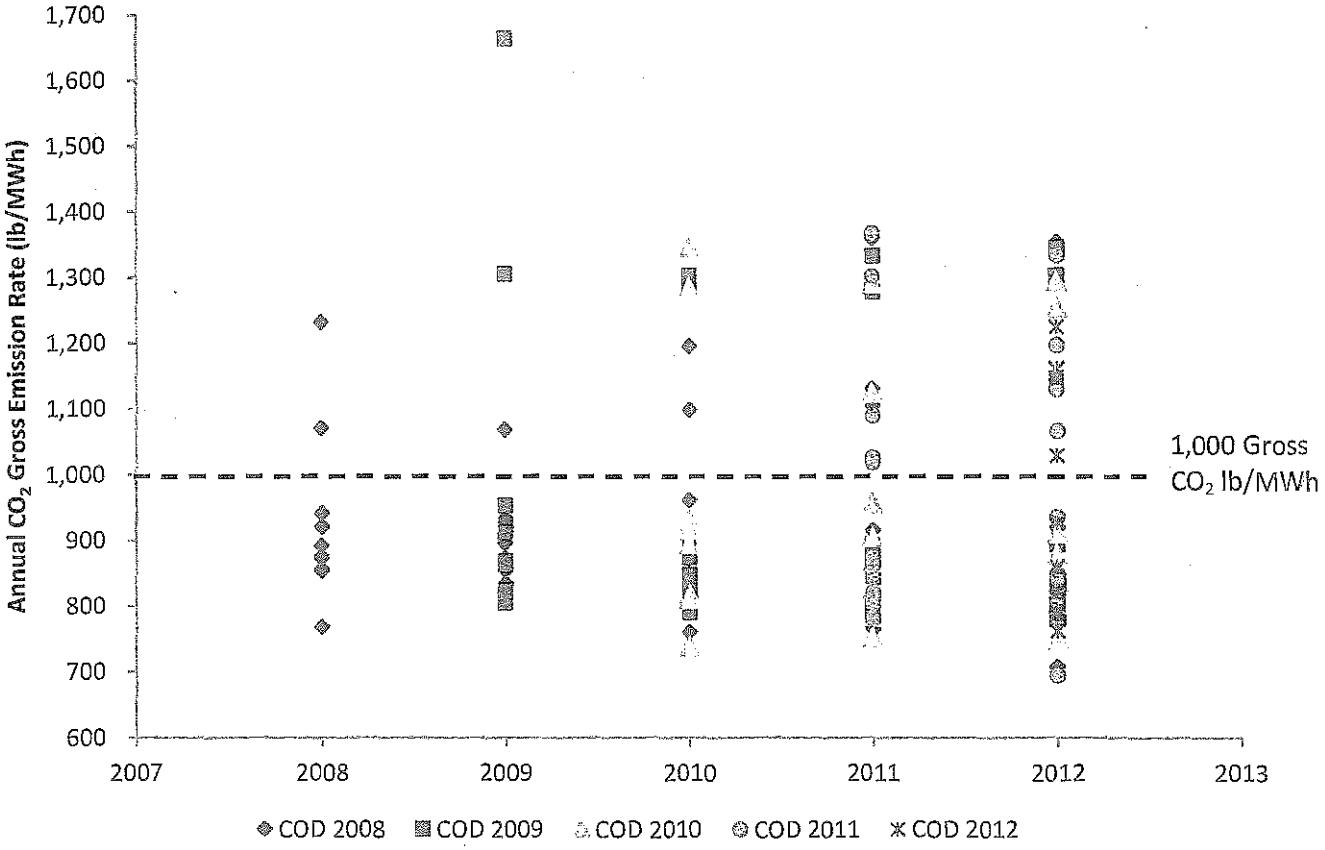


	2008	2009	2010	2011	2012		
New Units in Respective Year	28	33	12	11	17	Total # of Potential Annual Compliance Periods from 2008-12	343
New Units Above 1,000 lb/MWh (%)	28 (100)	33 (100)	12 (100)	11 (100)	17 (100)		
Total Units*	28	61	73	83	98	Total # of Potential Annual Compliance Periods above 1,000 lb/MWh from 2008-12 (% of 343)	336 (98)
Total Units Above 1,000 lb/MWh (%)	28 (100)	60 (98)	71 (97)	82 (99)	96 (98)		

*shown cumulatively after 2008

Data Source: Ventyx Velocity Suite

National NGCC, Units Built in Last 5 Years



	2008	2009	2010	2011	2012			
New Units in Respective Year	11	12	9	14	13		Total # of Potential Annual Compliance Periods from 2008-12	171
New Units Above 1,000 lb/MWh (%)	2 (18)	2 (17)	3 (33)	7 (50)	5 (38)			
Total Units*	11	23	32	46	59		Total # of Potential Annual Compliance Periods above 1,000 lb/MWh from 2008-12 (% of 171)	40 (23)
Total Units Above 1,000 lb/MWh (%)	2 (18)	3 (13)	6 (19)	14 (30)	15 (25)			

*shown cumulatively after 2008

Data Source: Ventyx Velocity Suite

secarbon.org

SECARB

Southeast Regional Carbon Sequestration Partnership (SECARB)

Phase III Anthropogenic CO_2 Injection Field Test

Field Test Location and Amount/Sources of CO_2

Anthropogenic Test

Alabama Power's Plant Barry

- *100,000 to 150,000 tonnes of CO_2 per year*
- *Coal-Fired Power Plant (Commercial/Anthropogenic Source)*

Primary Contacts

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Southern States Energy Board

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Field Test Partners

Primary Sponsors

U.S. Department of Energy

National Energy Technology Laboratory

Southern States Energy Board

Industrial Partners

(In alphabetical order)

Advanced Resources International

Alabama Power

Denbury Resources, Inc.

Electric Power Research Institute

Geological Survey of Alabama

Southern Company

Southern Natural Gas

About SECARB

SECARB is one of seven Regional Carbon Sequestration Partnerships (RCSP) established by the U.S. Department of Energy (DOE) in 2003. The seven partnerships form a national network of more than 400 organizations covering 43 states and four Canadian provinces. The SECARB program spans 13 states in the southeastern United States and is funded by DOE and cost-sharing partners.

Summary of Field Test Site and Operations

Past work by Southeast Regional Carbon Sequestration Partnership's (SECARB) has identified that a series of thick, regionally extensive saline formations with high-quality seals exist within the Gulf Coastal Region. These saline formations have the potential to hold large volumes of carbon dioxide (CO_2). One such formation, the Cretaceous-age Paluxy Formation sandstone, is the target for the SECARB Anthropogenic CO_2 storage test, **Figure 1**.

The Anthropogenic CO_2 storage field test is being performed in southwest Alabama near the town of Citronelle in northern Mobile County. The CO_2 source for the test is a newly constructed post-combustion CO_2 capture facility at Alabama Power's existing 2,657 MW Barry Electric Generating Plant (Plant Barry). A small amount of flue gas from Plant Barry (equivalent to the amount produced when generating 25 MW of electricity) will be diverted from the plant and captured using a process developed by Mitsubishi Heavy Industries to produce highly pure CO_2. Plant Barry is a coal- and natural gas-fired electrical generation facility located in Bucks, Mobile County, Alabama, **Figure 2**. (Alabama Power is a subsidiary of Southern Company.)

The CO_2 storage site is located within the Citronelle Dome geologic structure. The Citronelle Dome, which provides secure four-way closure free of faults or fracture zones, is located approximately 15 kilometers west of Plant Barry. A pipeline was constructed in 2011 to link the CO_2 capture system with the Paluxy Formation, a major reservoir containing saline water (i.e. water that is too deep and salty to serve as a drinking water supply). The Paluxy occurs at a depth of 3,000 to 3,400 meters. The Paluxy is overlain by multiple geologic confining units that serve as vertical flow barriers and will prevent CO_2 from escaping from the storage reservoir, **Figure 1**.

Three new wells will be drilled during the test; a reservoir characterization well, an observation/backup injection well, and a dedicated CO_2 injection well. The characterization well, the first deep well drilled at Citronelle since the 1980's, was completed in January 2011 **(Figure 3)**. Modern characterization data were collected on the injection zone, confining zones and the oil reservoir. The primary injection well was drilled in December 2011 and the backup injector was drilled in January 2012. In addition to the new wells, the project will utilize several existing idle oilfield wells surrounding the CO_2 injection site to monitor injection operations and to ensure public safety.

Beginning in 2012, between 100,000 and 150,000 metric tons per year of CO_2 captured from the pilot facility at Plant Barry will be transported to the storage site. CO_2 injection will continue for a period of two to three years.

During the injection period, multiple CO_2 monitoring technologies will be deployed to track the CO_2 plume, to measure the pressure front, to understand CO_2 trapping mechanisms of the Paluxy saline formation, and to monitor for potential leakage. Three years of post-injection monitoring are planned. Site closure is expected to occur in 2017. The wells will either be plugged and abandoned per state regulations or re-permitted for CO_2-enhanced oil recovery operations in a deeper mineral formation.

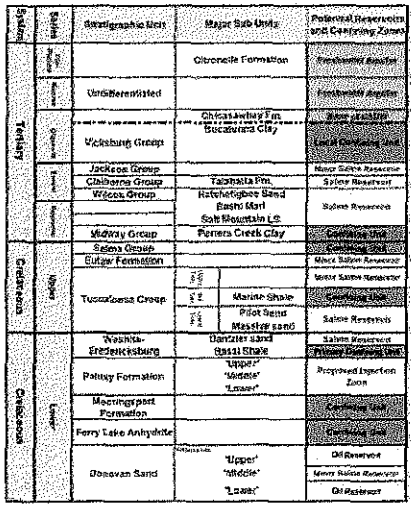

Figure 1. Citronelle Dome Stratigraphy.

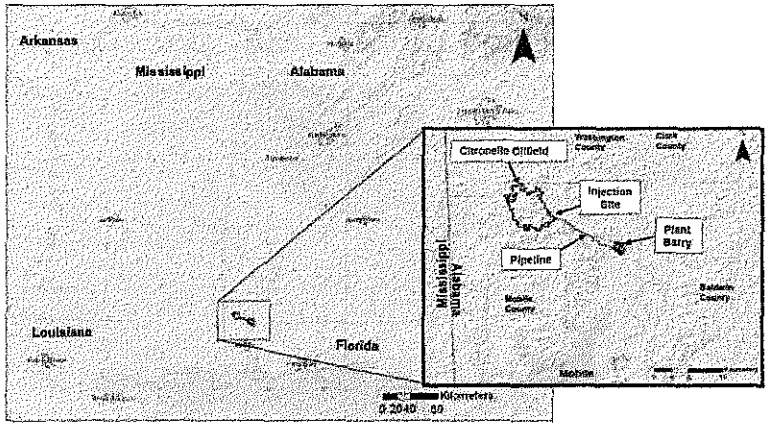

Figure 2. Geographic Location of the SECARB Phase III Anthropogenic Test.

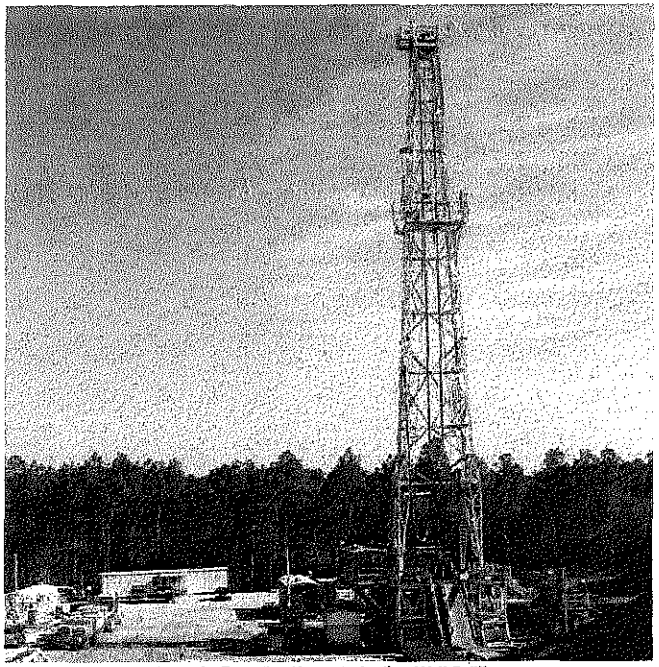

Figure 3. D-9-8#2, Characterization Well Drilling

Research Objectives

The purpose of the SECARB Phase III project is to test and demonstrate safe, secure CO_2 injection and storage in significant, regionally extensive saline reservoirs. Phase III will draw from and build on the Phase II sequestration "lessons learned" and will work to validate sequestration technologies of well design and integrity, monitoring protocols, injection operations as well as regulatory, permitting and outreach. The multi-partner collaborations developed during Phase I and II continued in Phase III.

In the Anthropogenic Test, the R&D objectives are to: 1) test the CO_2 flow, storage and CO_2 trapping mechanisms of the Paluxy Formation; 2) evaluate injection and storage capacity of a major saline reservoir in the Gulf Coast; 3) evaluate the integration of power plant CO_2 capture, transportation, injection and long-term geologic storage; 4) understand how the saline reservoir's internal architecture (the interplay between the reservoir flow units, seals and baffles) can be effectively used to maximize available CO_2 storage capacity and minimize the areal extent of the CO_2 plume; 5) test commercially available, but not yet utilized, "off-the-shelf" and experimental CO_2 monitoring technologies; and 6) evaluate the effect of anthropogenic CO_2 captured from a coal-fired power plant on the geochemistry of a saline reservoir.

Summary of Monitoring and Modeling, Verification and Accounting (MVA) Efforts

The MVA strategy at the Anthropogenic Test is designed to test commercially available "off-the-shelf" technologies in a manner not utilized before to better understand their performance and future application as listed in the table below.

Table 1. Measurement Technologies to be Deployed at the Anthropogenic Test.

Measurement Technique	Measurement Parameters	Application
Bottom-hole pressure	Pressure transducers deployed down hole near the injection interval	Key measurement for assessing the reservoir's, injectivity, capacity and pressure field.
Cased-hole logging (pulsed neutron capture)	CO_2 and water saturations	CO_2 saturation buildup near new and existing wellbores to monitor for leakage along wellbores and to confirm models.
Time-lapse crosswell and vertical seismic imaging	Change from baseline sonic velocity and amplitude	Distribution of CO_2 plume vertically and horizontally to monitor for migration out of zone and to confirm reservoir models.
Above-zone pressure and fluid geochemical monitoring	Monitor for changes in pressure and deep saline water geochemistry (i.e., pH, metal concentrations)	Monitoring for CO_2 buildup above the primary confining unit.
Tracers introduced in the CO_2 stream	Measure tracer levels around area oilfield wells	Monitor for the presence of tracer buildup near new and existing wellbores which would suggest leakage of vertical CO_2 along the well annuli.
Drinking water aquifer monitoring	Monitor for changes in a wide suite of parameters (i.e. pH, alkalinity, cations and anions).	Monitoring of area freshwater aquifers for geochemical changes related to shallow CO_2 leakage.

Accomplishments to Date

- A major geologic characterization effort was conducted on the injection reservoir and confining units using existing well and seismic data. Detailed maps of the Paluxy Reservoir sand units and multiple overlying confining units were created.
- The Environmental Impact Statement prepared by the project to fulfill the requirements of the National Environmental Protection Act resulted in a Finding of No Significant Impact.
- The project team has secured minerals and surface rights for the CO_2 storage test.
- The project's first characterization/observation well was drilled in December 2010-January 2011. Data from this well will be used to refine the geologic model.
- The Underground Injection Control permit application was submitted to the Alabama Department of Environmental Management for the two injection wells in December 2010. Permits were issued in November 2011.
- In 2011, Denbury completed construction of a 12-mile pipeline to transport the CO_2 from Plant Barry to the injection well in the Citronelle oilfield.
- Injection well drilling began in December 2011, and the observation/backup injection well is being drilled in January 2012.
- Currently finalizing the Test Site risk assessment and evaluating mitigation strategies.

Target Sink Storage Opportunities and Benefits to the Region

Gulf Coast Cretaceous-age formations are key components of a larger, regional group of similar formations, in terms of deposition and character, called the Gulf Coast Wedge. The wedge of sediments spans the entire SECARB region and includes the largest capacity saline sinks in the United States. CO_2 storage capacity estimates for the SECARB Gulf Coast Wedge range from 850-11,700 billion metric gigatons (Gt). In comparison, annual stationary point-source emissions of CO_2 for the region have been estimated to be 1.085 Gt. Using the range of reported CO_2 storage capacities, the saline formations in the Gulf Coast Wedge may have the capacity to accommodate these emissions for over 800 years.

Project Cost and Key Dates

PHASE III PROJECT COST*			KEY PROJECT DATES	
	Dollars	Percent	ANTHROPOGENIC TEST	
DOE Share	$76,981,260	69.10%	Drilling Operations Begin	12/2010 (characterization well) 12/2011 (injection wells)
Non-DOE Share	$34,432,171	30.90%	Pre-Injection MVA Begins	8/2011
Total Value	$111,413,431 (includes $2,444,000 for Federal Laboratories)		Injection Operations Begin	3/2012
			Injection Operations End	2014
*Includes all Tasks for the Phase III Program			Post-injection MVA Ends	2017

This material is based upon work supported by the U.S. Department of Energy National Energy Technology Laboratory under DE-FC26-04NT42590.

the ENERGY lab

PROJECT FACTS

Clean Coal Power Initiative (CCPI 2)

Demonstration of a Coal-Based Transport Gasifier

Background

Coal is an abundant and indigenous energy resource and currently supplies almost 38 percent of the United States' electric power. Demand for electricity, vital to the nation's economy and global competitiveness, is projected to increase by almost 28 percent by 2040. The continued use of coal is essential for providing an energy supply that supports sustainable economic growth. Unfortunately, nearly half of the nation's electric power generating infrastructure is more than 30 years old and in need of substantial refurbishment or replacement. Additional capacity must also be put in service to keep pace with the nation's ever-growing demand for electricity. It is in the public interest to upgrade the nation's energy infrastructure with the latest and most advanced viable technologies to achieve greater efficiencies, environmental performance, and cost-competitiveness.

The U.S. Department of Energy (DOE) Office of Fossil Energy, through the National Energy Technology Laboratory, is charged with the implementation of the DOE's Clean Coal Power Initiative (CCPI). The intent behind the CCPI is to leverage public and private investment to secure low-cost energy production and protect the environment. The goal of this program is to demonstrate a new generation of innovative coal-utilization technologies in a series of projects carried out across the country. These demonstrations are conducted on a commercial scale to prove the technical feasibility of the technologies and to provide technical and financial information for future applications. The U.S. Department of Energy awarded Southern Company Services a cooperative agreement under the CCPI Round 2 Program to provide direct financial support for the development and deployment of the Transport Integrated Gasification (TRIG™) technology that is being utilized by the project.

Project Description

The Kemper County Project (Kemper County Energy Facility) is a lignite-fueled integrated gasification combined-cycle (IGCC) facility being constructed in Kemper County, Mississippi. The plant design incorporates the air-blown TRIG™ technology jointly developed by Southern Company, KBR, and DOE at the Power Systems Development Facility in Wilsonville, Alabama. Mississippi Power Company (MPC), a Southern Company subsidiary, will own and operate the plant. The facility will employ state-of-the-art emission controls to produce electricity from lignite in an efficient and environmentally friendly manner and will also assist MPC in achieving key strategic objectives of fuel and geographical diversity, and cost stability, while providing a reliable economic resource to meet customer needs.

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PARTNERS

Mississippi Power Company
KBR, LLC

PROJECT DURATION

Start Date	End Date
01/30/2006	05/01/2018

COST

Total Project Value
~ $3,000,000,000*

DOE/Non-DOE Share
$270,000,000 / $2,800,000,000

*Note: The cost above includes scope in which DOE is not participating in cost sharing under the CCPI.

U.S. DEPARTMENT OF ENERGY

Lignite reserves near the plant site owned by Mississippi Power Company and developed and mined by Liberty Fuels, a subsidiary of North American Coal Corporation, will supply the feedstock for the IGCC plant. The estimated nameplate capacity of the plant will be 830 MW with a peak net output capability of 582 MW. The peak capacity of 582 MW occurs when using syngas in the combustion turbine coupled with natural gas firing in the heat recovery steam generator duct burners. During syngas-only operations, the plant will achieve a net generating capacity of 524 MW and a heat rate of 12,150 Btu/kWh. The facility will employ advanced emissions control equipment to produce marketable byproducts of ammonia, sulfuric acid, and carbon dioxide. Over 65 percent of the carbon dioxide will be captured, making the Kemper County Energy Facility's carbon emissions comparable to a natural gas-fired combined cycle power plant. The commercial operation date of the Kemper County IGCC plant will be May 2014.

The estimated 3 million metric tons of CO_2 per year captured from the Kemper County Energy Facility gasification process will be transported via pipeline to two off takers for use in enhanced oil recovery operations at depleted oil production fields in Mississippi.

Goals/Objectives

The primary objective of this project is to demonstrate the operation of a commercial-scale, air-blown transport gasifier technology and integrate it with a combined-cycle island. Other objectives of the project include (1) operating an advanced syngas cleanup system that includes sulfur removal and recovery; high temperature, high-pressure particulate filtration; and ammonia recovery and mercury removal; (2) demonstrating high availability, high thermal efficiency, low cost, and low emissions of the IGCC in commercial operating mode; and (3) operating an integrated CO_2 capture and compression system with the intent to capture and geologically sequester 65 percent of the CO_2 via enhanced oil recovery.

Benefits

The TRIG™ technology offers a simpler and more robust method for generating power from low-rank coal than other alternatives. It is unique among coal gasification technologies in that it is cost-effective when using both low rank coals and coals with high moisture or ash content. These coals make up half of the proved reserves in the U.S. and throughout the world. Moreover, the transport gasifier is capable of both air- and oxygen-blown operation. This inherent flexibility will allow future applications of this technology to be readily adapted to other applications beyond power generation, such as the production of chemicals used in industrial operations.

Moreover, the inclusion of CO_2 control as part of the project is critical to the future deployment of coal-based power generation in both the United States and the world. Installation of advanced power generation facilities is an important part of the strategy to become energy independent.

Aerial View of Kemper County Energy Facility (December 2012)

NT42391, March 2013