Southeast Regional Carbon Sequestration Partnership

Evaluating CO_2 Storage Options in the Southeast

United States Energy Association
CCS Briefing Series

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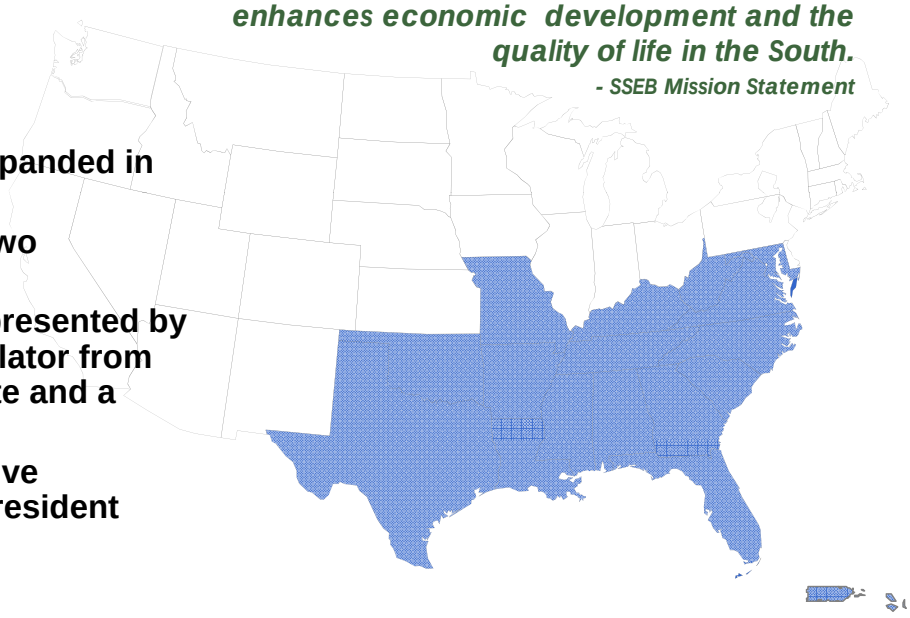
SOUTHERN STATES ENERGY BOARD

Through innovations in energy and environmental policies, programs and technologies, the Southern States Energy Board enhances economic development and the quality of life in the South.

- SSEB Mission Statement



- Established 1960, expanded in 1978
- 16 U.S. States and Two Territories
- Each jurisdiction represented by the governor, a legislator from the House and Senate and a governor's alternate
- Federal Representative Appointed by U.S. President

SSEB Carbon Management Program

- Established in 2003 (Chairman's Initiative)
- Southeast Regional Carbon Sequestration Partnership (SECARB)
- Southeast CO_2 Sequestration Technology Training Program (SECARB-Ed)
- SSEB's Carbon Management Partners: Involved in Demonstration Projects; Monitoring Federal Climate and Energy Policy
- Recovery Act: DOE/NETL Funding Opportunity Announcements – Several responses from the SSEB region

Acknowledgements

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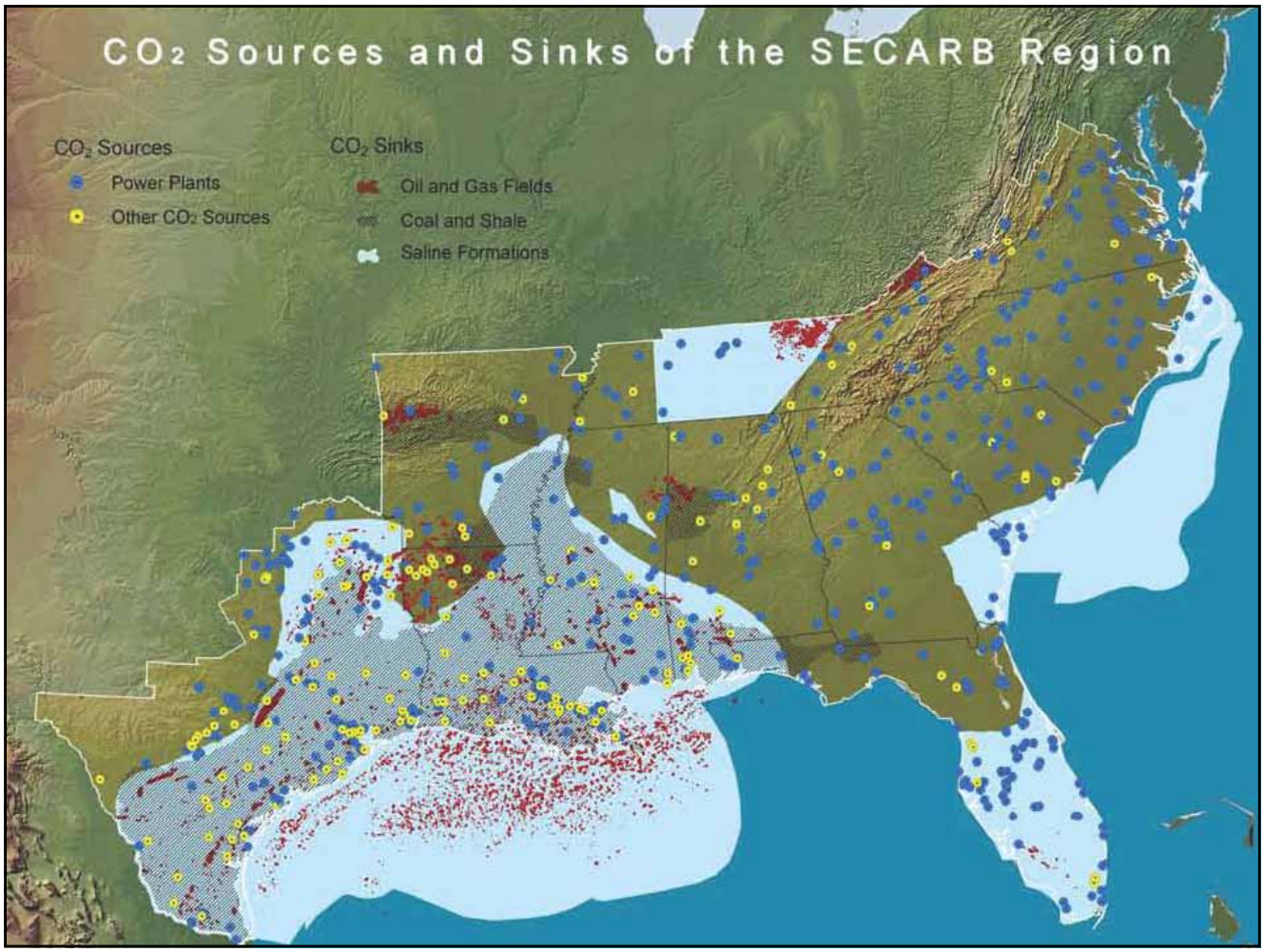
- Cost share and research support provided by SECARB/SSEB Carbon Management Partners

DOE's Regional Carbon Sequestration Partnerships

"Developing the Infrastructure for Wide Scale Deployment"

- 350 Organizations
- 41 States
- 4 Canadian Provinces
- 3 Indian Nations
- Total of 34% cost share


CO2 Sources and Sinks of the SECARB Region
CO2 Sources
Power Plants
Other CO2 Sources
CO2 Sinks
Oil and Gas Fields
Coal and Shale
Saline Formations

Phase II Geographic Region & Field Test Site Locations

Coal Seam Project
Host Company: CNX Gas
Russell County, Virginia

Coal Seam Project
Host Company: El Paso
near Tuscaloosa, Alabama

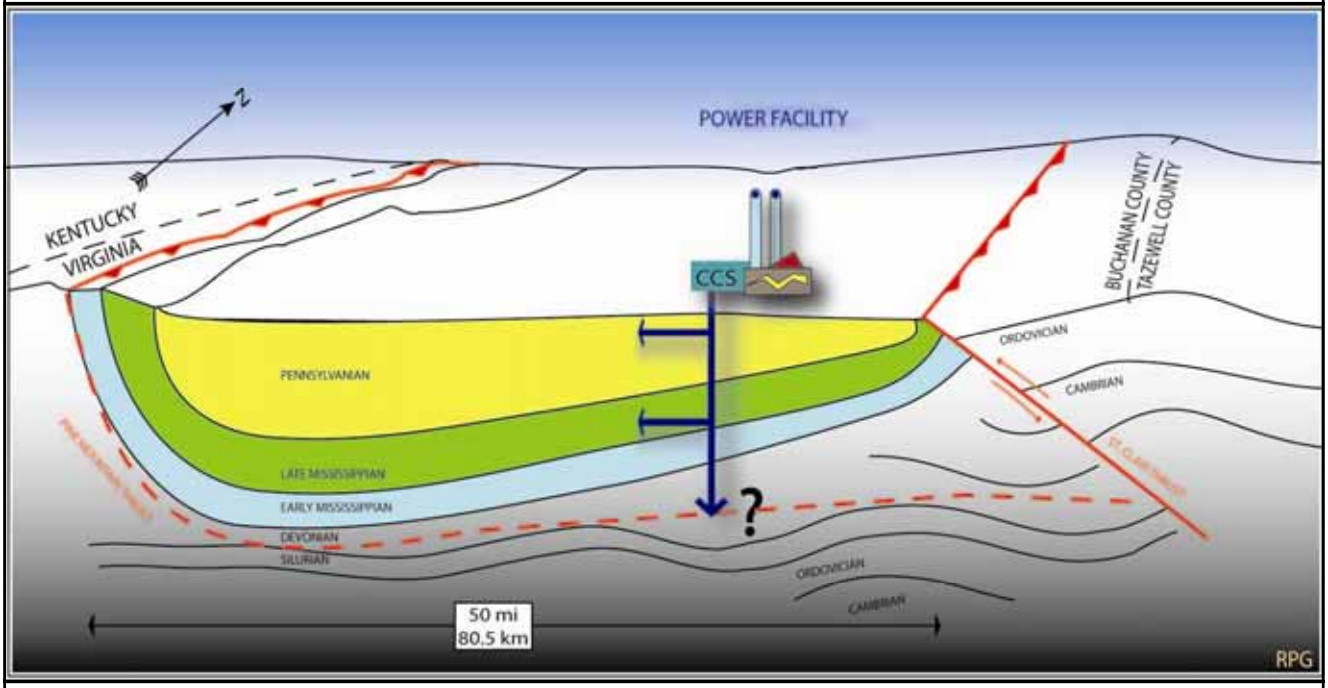
Stacked Storage Project
Cranfield Test Site
Host Company: Denbury Resources, Inc.
Southwest Mississippi

Mississippi Test Site
Mississippi Power's Plant Daniel
near Escatawpa, Mississippi

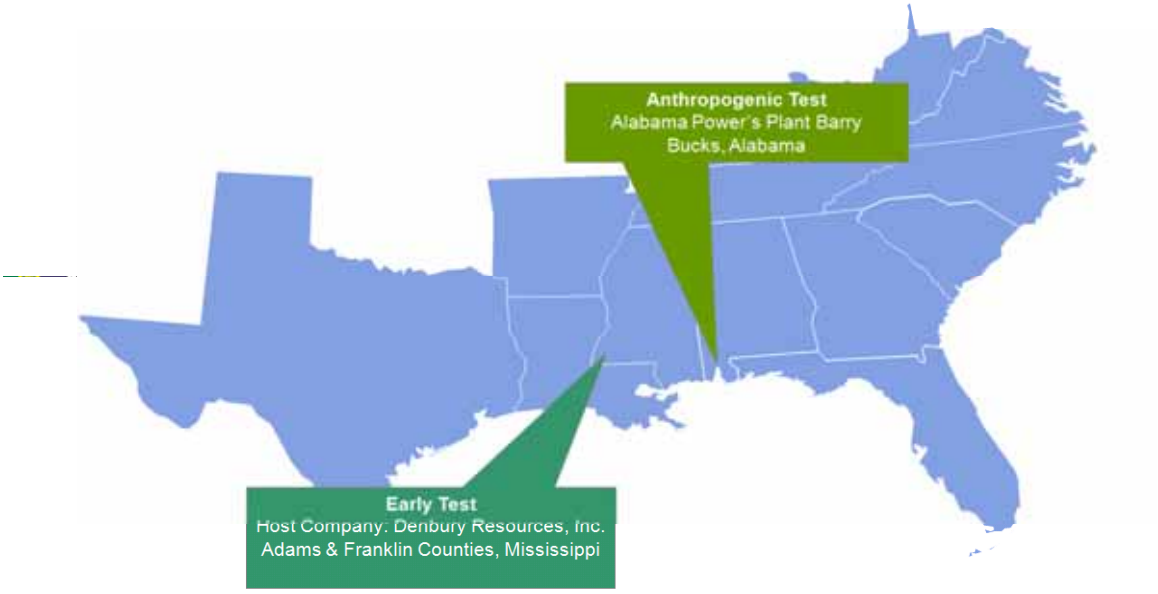
Phase II Central Appalachia Coal Seam Project: Groundbreaking Ceremony

CO_2 Injection: January & February 2009

Phase II Central Appalachian Characterization
Conceptual Model - Large Scale CO_2 Injection Opportunities



Phase III Geographic Region & Field Test Site Locations



SECARB Phase III Projects - Overview

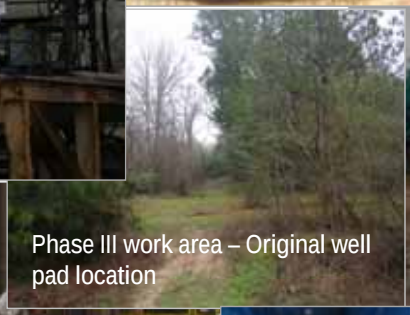
- Phase III Early Test: Large volume saline injection “down-dip” of EOR activity at Cranfield Unit – 1.5 million ton injection started in April 2009
  - SECARB Early Test was recognized by DOE for furthering CCS technology and meeting G-8 goals for deployment of 20 similar projects by 2010. The Early Test is the fifth project worldwide to reach the CO_2 injection volume of one million tonnes and the first in the U.S. (DOE Techline, 11/05/2009)
- Phase III Anthropogenic Test: Large volume saline injection with power plant capture & separation source – 100,000 to 250,000 ton per year injection starting FY2011

SECARB Phases II & III – April 2010 – 2 million tonnes CO_2 Injected

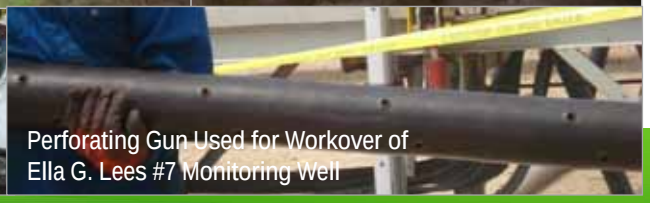
Workover Rig on
Ella G. Lees #7 Well
Phase II Monitoring Well


Injection Well


Lone Wolf Drilling Rig
CO_2 Injector

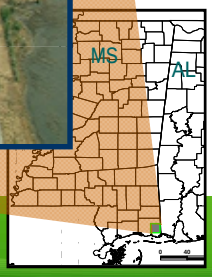

Phase III work area – Original well
pad location


During Perforation of Ella G. Lees #7 Monitoring Well


Perforating Gun Used for Workover of
Ella G. Lees #7 Monitoring Well

Phase II Saline Injection
Mississippi Test Site/Plant Daniel

Image Source: Google Earth



- 3000 metric ton injection at Mississippi Power's Plant Daniel
- Field Team: Mississippi Power Company; Southern Company; Electric Power Research Institute; and Advanced Resources International

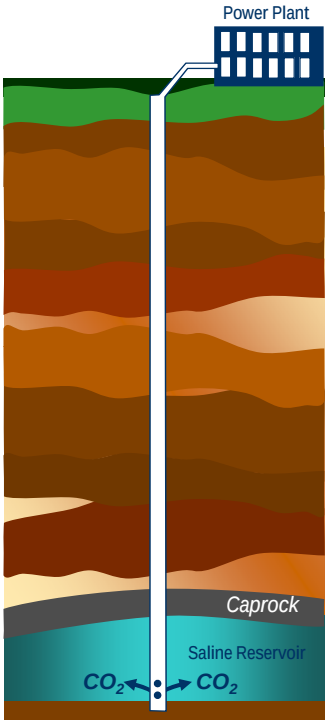
SECARB Phase II – Plant Daniel (MS Power)

CO_2 Storage Tanks

Plant Daniel Open House During Injection Operations, October 15, 2008

Phase III Anthropogenic Test

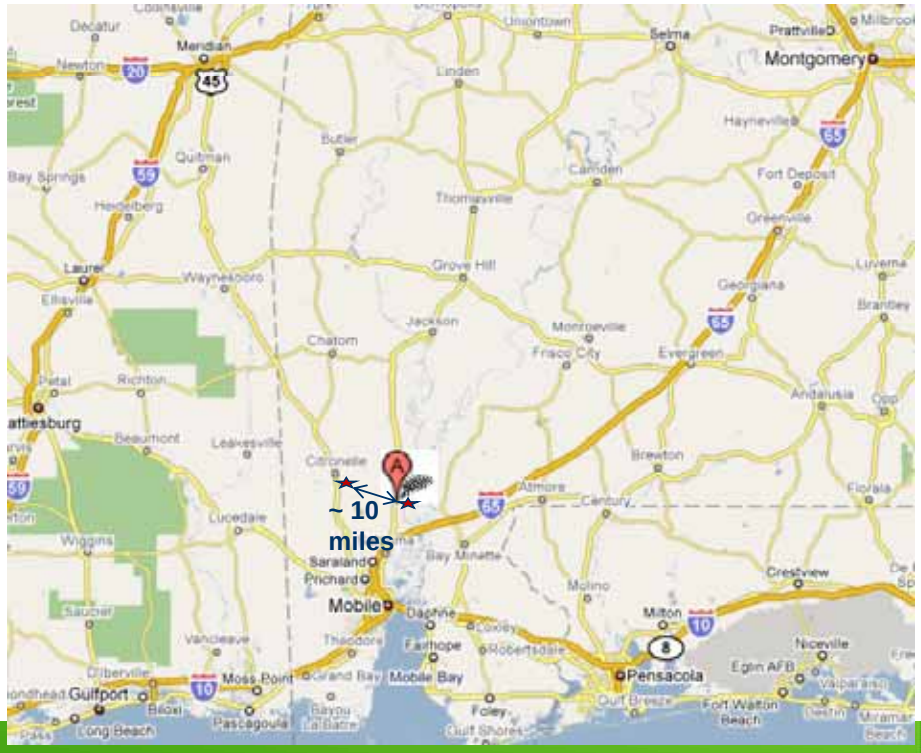
- **Purpose:** Locate suitable geological sequestration sites in proximity to the 25 MW MHI post-combustion CO_2 capture pilot at Plant Barry and inject CO_2
  - One of the first demonstrations of integrated capture, transport and storage in U.S.
- **Initial Target:** Lower Cretaceous Gulf Coast saline reservoirs with high CO_2 storage capacity and injectivity



Phase III Anthropogenic Test

Integrating Capture, Transportation and Storage of CO_2

- CO_2 Capture Unit at Alabama Power's Plant Barry
- 10-mile CO_2 pipeline constructed by Denbury Resources
- Injection and monitoring at Denbury's Citronelle Field



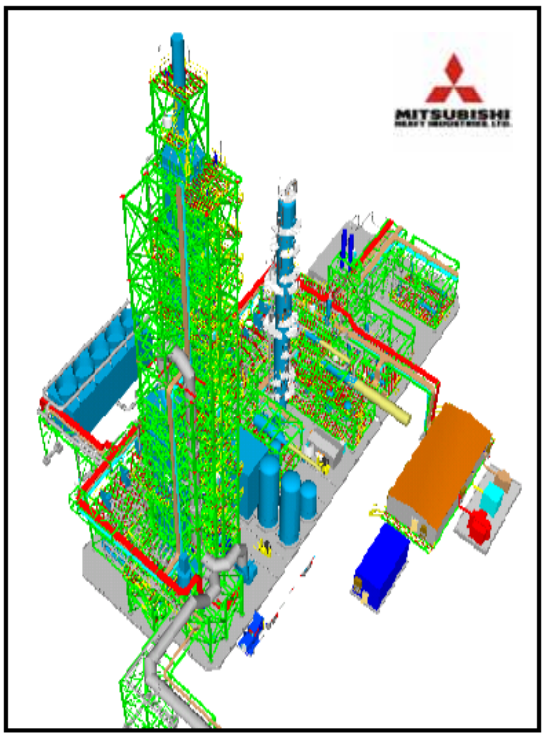
Integration of CO_2 Capture, Transportation and Injection

- Southern Company and EPRI lead the capture demonstration and will provide CO_2 to SECARB as project cost share
- Denbury will construct a CO_2 pipeline from Plant Barry to Citronelle and operate for a fee during the 3-year injection
- Denbury has unitized mineral rights and will secure pore space at the Citronelle saline injection site
- SECARB will monitor CO_2 injection into Denbury's pore space

Plant Barry CO_2 Capture Unit

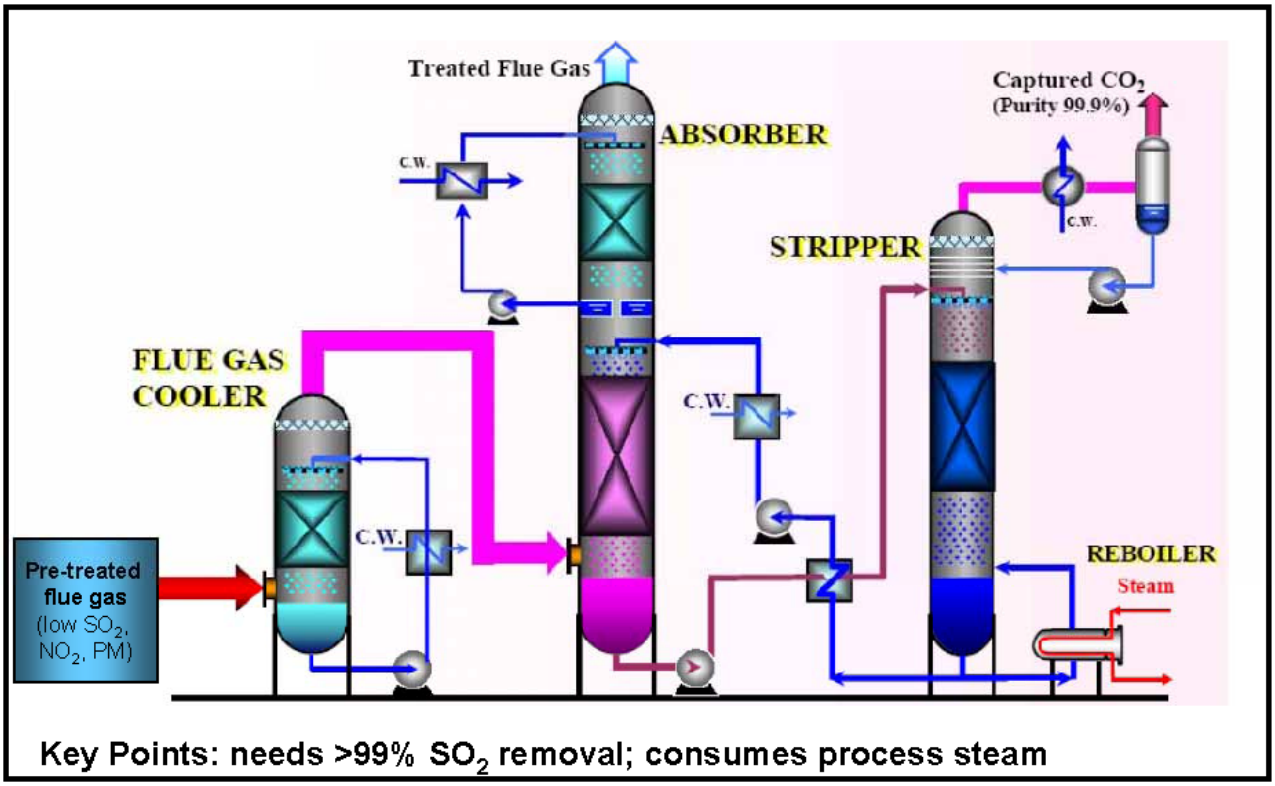
MHI advanced amine capture unit

- 25 MW post combustion slip stream
- Fabricate off-site and barge to Plant Barry
- Compress CO_2 to 1500 psi
- Scheduled start up First Quarter, FY2011
- Separately funded; CO_2 provided to SECARB for sequestration at Citronelle Field



SOUTHERN COMPANY

Simplified CO_2 Scrubbing Process (Amine)



Key Points: needs >99% SO_2 removal; consumes process steam

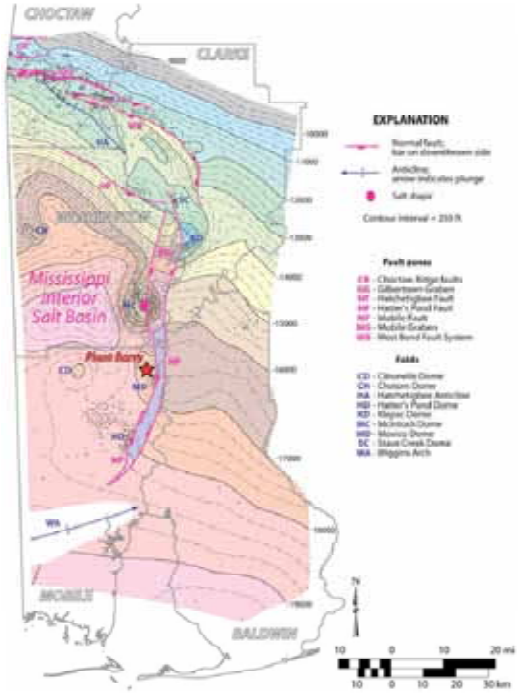
Plant Barry CO_2 Capture Unit Fabrication

This structure will contain the cooler and absorber.

Geologic Overview for Plant Barry and Citronelle Field

Proposed sequestration site is on the southeast flank of the Citronelle Dome

- Proven four-way closure
- No evidence of faulting or fracturing
- Multiple confining units between potential injection targets and base of USDW
- However, historic oil and gas wells and a lack of local characterization of saline reservoirs presents challenges

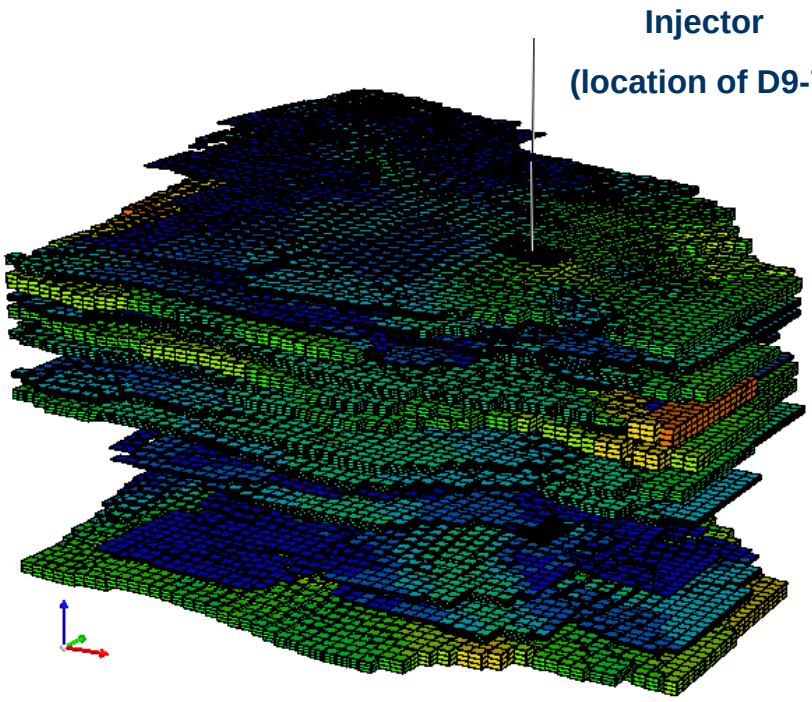


Structural contour map of the top of the Smackover Formation (Upper Jurassic) in southwest Alabama (GSA 2008)

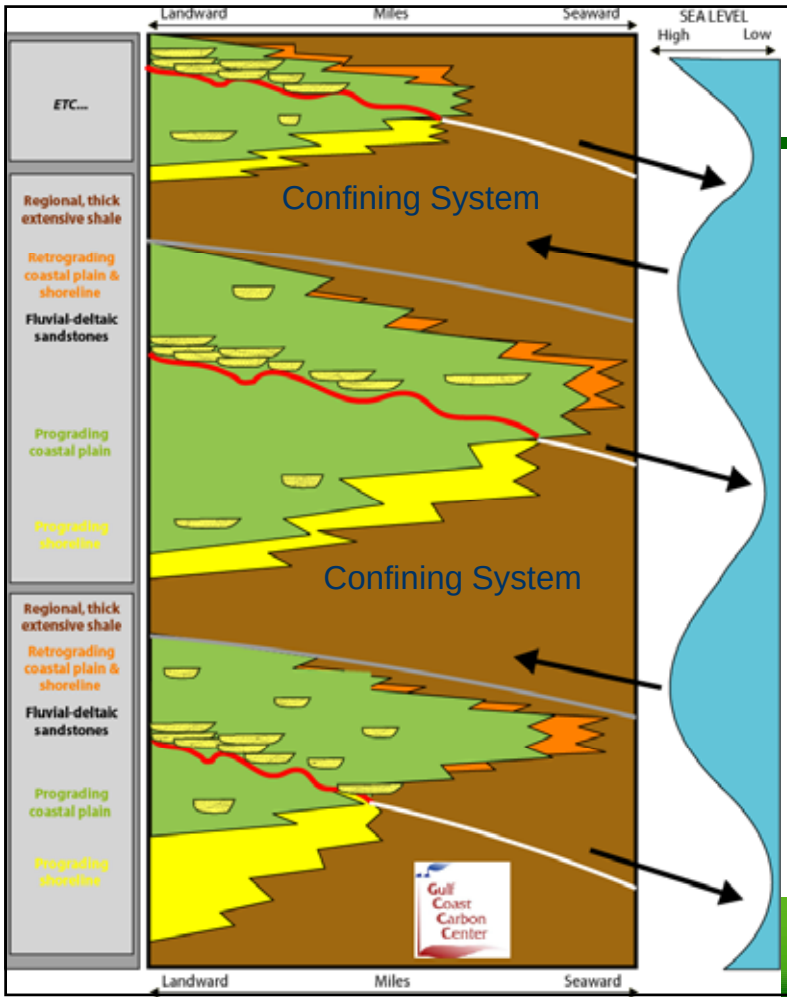
Expected Reservoir Intersection Depths at Citronelle

Formation Tops	Anticipated Depth Feet	Interval Thickness Feet
Bottom of Fresh Water (<1,000 mg/l)	~ 1,000	1,000
Bottom of Potable Water (<10,000 mg/l)	Max ~ 2,000	1,000
Selma Chalk Group	4,550	1,150
Eutaw Group	5,700	300
Upper Tuscaloosa Formation	6,000	700
Marine Tuscaloosa Formation	6,700	250
Lower Tuscaloosa Formation	6,950	300
Washita-Fredericksburg Undifferentiated	7,250	2,150
Paluxy Formation	**9,400**	**1,100**
Mooringsport Formation	10,500	250
Ferry Lake Anhydrite	10,750	200
Rodessa Formation (oil reservoir)	10,950	-

Model 3-D View of Citronelle Injection Site



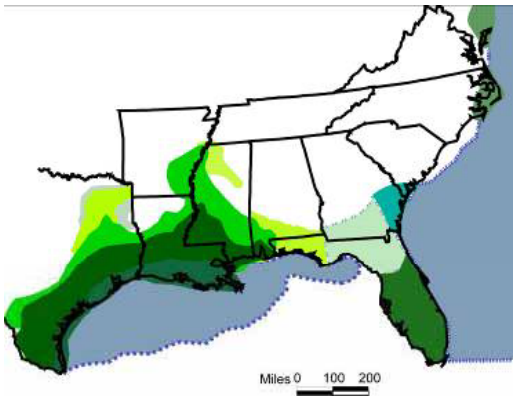
- 17 sand bodies from geological model
- Average permeability of 88 mD
- Average porosity of 19.3%
- Identical permeability and porosity in all layers



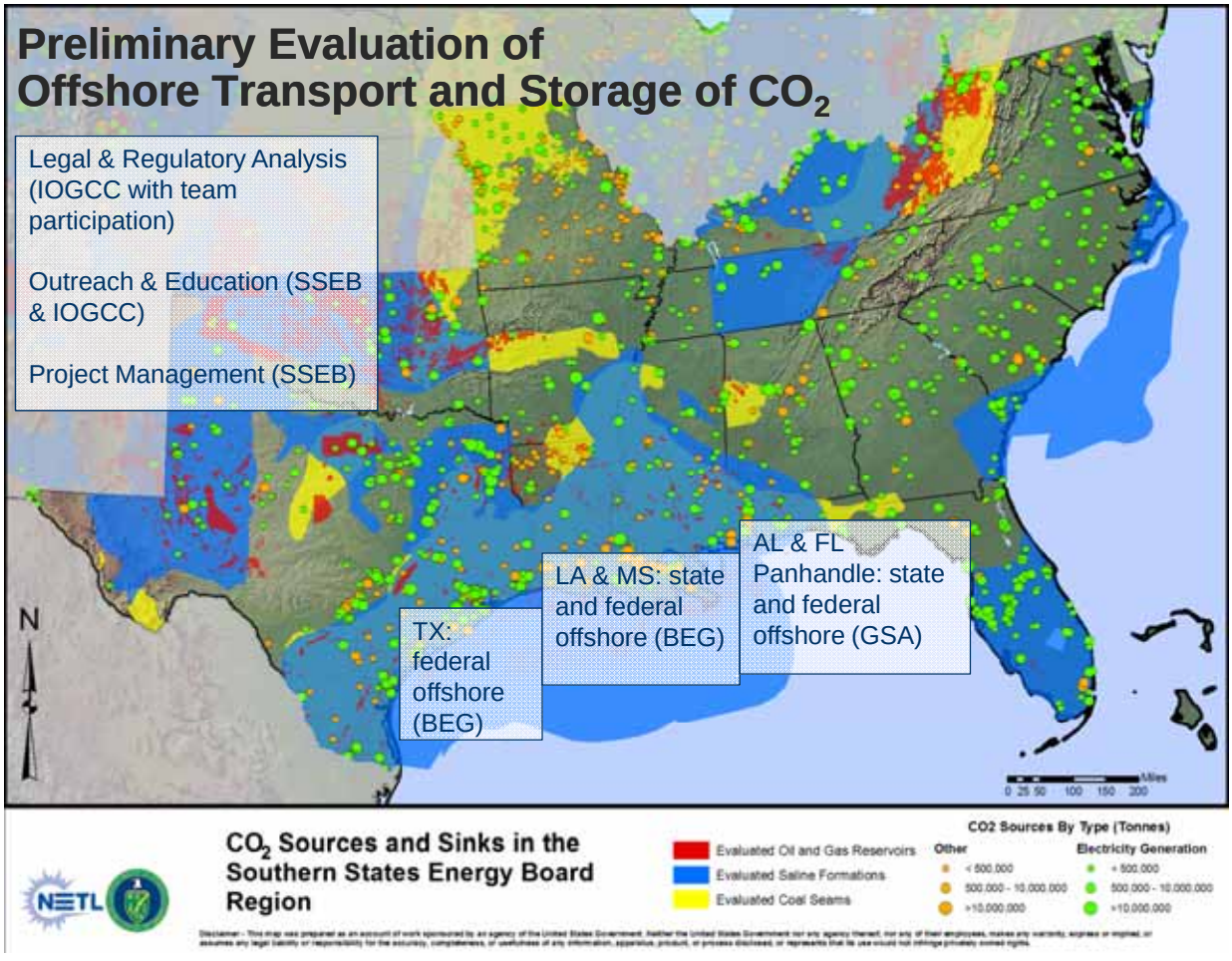
Other SECARB Activity

Continued Characterization During 2010 and 2011

Assessments will be conducted in the Gulf of Mexico, South Georgia Basin and along the Carolina coast.



Preliminary Evaluation of Offshore Transport and Storage of CO_2



SECARB-Ed

GHG Fundamentals
Legal, Regulatory, Institutional
CO_2 Capture, Treatment, Compression, and Transportation
Produced Water Treatment
Monitoring, Verification, and Accounting
Storage: Saline, Oil and Gas, Coal, and Shale

- **Purpose**
  - Develop a self-sustaining regional CO_2 sequestration training program to facilitate the transfer of knowledge and technologies required for site development, operations and monitoring of commercial CCS projects.
- **Objectives**
  - Implement sponsorship development program
  - Develop short courses on CCS technologies
  - Conduct regional training and other activities through outreach and networking
  - Perform region/basin technology transfer services

International Activity in Carbon Management and CCS

- **Carbon Sequestration Leadership Forum (CSLF)**
  - SSEB is a member of the CSLF Stakeholders and is working with CSLF's "CCS Financing Roundtable" which met on April 6th in Washington, DC.
- **US-Australia**
  - SSEB is a "Founding Member" of the Global CCS Institute. The Institute was set up by the Australian government with $500 million Australian to facilitate the deployment of CCS. SSEB is assisting the Institute in setting up its next members meeting in Pittsburgh on May 13-14, 2010.
  - SSEB will present on behalf of the seven regional partnerships at the Carbon Capture and Storage World Conference in Melbourn, June 22-23, 2010.
- **International Energy Agency (IEA)**
  - SSEB works with IEA's Greenhouse Gas Programme and has presented on behalf of the seven regional partnerships at international meetings.

International Activity in Carbon Management and CCS

- **World Energy Council: Cleaner Fossil Fuels Systems**
  - SSEB has participated in forums on Carbon Capture and Storage, CCS Financing, and the Rountable on Water & Energy – Sustainable Together?
- **US-China Dialogue**
  - SSEB participated in 2009 US-China workshop on CCS hosted by West Virginia University.
- **US-Canada Clean Energy Dialogue**
  - SSEB will participate in the first bilateral National Conference on Carbon Capture and Storage, May 10, 2010 in Pittsburgh, PA.
- **US-Mexico**
  - SSEB has been assisting DOE's Bob Wright with the North America Carbon Atlas Project.

SECARB Annual Stakeholder Briefing

- 2010 – Fifth Stakeholder Briefing
- 119 Participants (Over 500 in 5 years!)
  - Legislators, Regulators, Industry, Academics, Legal, Utility, Non-profits, Government, National Labs
- Highlights
  - West Virginia Governor & SSEB Chair Joe Manchin
  - SECARB Phase II & III Project Updates
  - SECARB Support
    - Outreach and Education
    - Regulatory and Accounting Protocols
    - CO_2 Transportation Infrastructure
    - SECARB-Ed
  - Capture, Transport, and Storage Project Integration