Clean Coal Energy Policies and Technologies Meeting - Technological Solutions to a Robust Coal Future

Southern Company CCUS
Research, Development, Deployment

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Southern Company

May 20, 2015
Introduction to Southern Company
Regulated Utility Franchises

Regulated Utilities
- Alabama Power
- Georgia Power
- Gulf Power
- Mississippi Power
- Southern Nuclear

Competitive Power
- Southern Power
- Southern Generation Technology

Core Service Area
- 120,000 sq. miles in four states
- 4.4 million retail customers
- 26,000 employees
- 46 GW generation capacity
Southern Company Generation Mix 2005 and 2014

Source: Southern Company Form 10K filings
All of the Below Energy Strategy

New Natural Gas

21st Century Coal

New Nuclear

Energy Efficiency

Biomass

Wind

PV Solar
Southern Company R&D

- Only U.S. electric power company with internal R&D organization
- Approximately 150 engineers and scientists in laboratories and facilities dispersed across operating assets
- Active collaboration with other power companies; domestic and international
- Primary goal of research is to provide technology options to power operating business
Carbon Capture & Storage R&D Program

“Efforts key to our long-term program success”

Pilot Scale

Demonstration Scale

Carbon Capture Utilization Storage

Capture

Transportation

Storage

Commercial Demonstration

Widespread Commercial Deployment

Laboratory Testing

Applied Science

6
Plant Barry PC-CCS Demonstration
“largest capture facility on a fossil-fueled power plant in the U.S.”

- Carbon capture from Plant Barry (equivalent to 25MW of electricity).
- 12 mile CO$_2$ pipeline linking captured CO$_2$ with the injection site.
- CO$_2$ permitting/injection into ~9,400 ft. deep saline formation at the Citronelle Oil Field.
- Monitoring of CO$_2$ storage during injection and three years post-injection.
Aerial Photograph with Labels

- Flue gas demister and outlet
- CO₂ absorber (lower) and Water wash (upper) column
- Solvent regeneration ("CO₂ stripper") column
- CO₂ compression and dehydration unit
- Flue gas quench column
Directional drilled 18 sections of the pipeline under roads, utilities, railroad tracks, tortoise colonies, and wetlands (some up to 3,000 feet long and up to 60 ft deep).

DOT 29 CFR 195 liquid pipeline; buried 5 feet with surface vegetation maintenance.
**CO₂ Capture Plant Performance**

- Gas In for CO₂ Capture Plant: June, 2011
- Commissioning of CO₂ Compressor: August, 2011
- Commissioning of CO₂ Pipeline: March, 2012
- CO₂ Injection: August, 2012

<table>
<thead>
<tr>
<th>Items</th>
<th>Units</th>
<th>Results*</th>
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</thead>
<tbody>
<tr>
<td>Total Operation Time</td>
<td>hrs</td>
<td>13,090</td>
</tr>
<tr>
<td>Total Amount of Captured CO₂</td>
<td>metric tons</td>
<td>240,900</td>
</tr>
<tr>
<td>Total Amount of Injected CO₂</td>
<td>metric tons</td>
<td>114,104</td>
</tr>
<tr>
<td>CO₂ Capture Rate</td>
<td>metric tons per day</td>
<td>&gt; 500</td>
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<tr>
<td>CO₂ Removal Efficiency</td>
<td>%</td>
<td>&gt; 90</td>
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<tr>
<td>CO₂ Stream Purity</td>
<td>%</td>
<td>99.9+/N₂</td>
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<tr>
<td>Steam Consumption</td>
<td>ton-steam/ton-CO₂</td>
<td>0.98</td>
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*As of 04/16/2015*
Geologic Characterization
“to advance site certification for commercial storage”

Alabama Power William Crawford
Gorgas Stratigraphic Test Well

Mississippi Power Victor J. Daniel
CO₂ Pilot Injection Study

Alabama Power James M. Barry
CO₂ Injection Demonstration

Georgia Power Plant Bowen
Deep Site Geology Investigation
Estimated years of onshore geologic storage per state for all CO$_2$ emission sources

Source: National Carbon Sequestration Database and Geographic Information System (NATCARB)

- Alabama – 1,249 yrs
- Florida – 744 yrs
- Georgia – 1,614 yrs
- Mississippi – 3,820 yrs

Years of Storage (low estimate)

- < 100 Yrs
- 101-500 Yrs
- 501-1,000 Yrs
- 1,001-2,000 Yrs
- > 2,001 Yrs
- unassessed
Offering a world-class neutral test facility and a highly specialized staff, the National Carbon Capture Center accelerates the commercialization of advanced technologies and enables coal-based power plants to achieve near-zero emissions.
R&D Role of the NCCC/PC4

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- **Fundamental R&D**
- **Tech transfer to power plant slip-stream unit e.g. Plant Barry**
- **Full deployment**
Kemper County IGCC

• First of a kind gasification technology developed by SO and KBR with U.S. DOE support

• Carbon footprint equivalent to a combined cycle natural gas unit
  – 65% CO₂ capture for enhanced oil recovery
  – CO₂ sold to oil companies for EOR

• Affordable, abundant, low-rank coal resource
  – Mine mouth lignite coal

• Technology platform for the future of coal
Gasifier as Installed
Kemper Energy Facility

582-MW TRIG™ IGCC with 65% CO$_2$ Capture
Job creation and economic impact

Nearly 12,000 direct and indirect jobs have been created during construction. Peak construction employment will be approximately 6,000, and more than 1,000 direct and indirect permanent positions will be in place once the facility opens.

More than 500 companies in our state have a significant role in the construction of the project.

During construction the project will create nearly $75 million in state and local taxes. Once operational the project will create $30 million annually in state and local taxes during the life of the plant.

Using carbon dioxide from Kemper will increase U.S. oil output by 2 million barrels per year, playing an important role in reducing Mississippi’s and America’s use of foreign oil and keeps oil revenue at home rather than sending it overseas.

The oil recovery operation also results in jobs and tax revenue for the State of Mississippi.
Other collaborative initiatives

- **Outreach & Education:**
  - DOE Research Experience in Carbon Sequestration (RECS)
  - DOE CCS Training & Education/SECARB Ed

- **Standards:**
  - CSA US-Canada Standards for Geologic Storage of CO₂
  - ANSI ISO TC-265 International Standards for Carbon Capture and Geologic Storage

- **Infrastructure Assessment:**
  - CCS Technology and Pipeline Infrastructure Study (LANL)
  - Florida Panhandle Pipeline Infrastructure Model (University of North Florida)

- **University Collaborations:**
  - Carbon Sequestration Simulation Center (University of Alabama at Birmingham)
  - Geologic Cap Rock Integrity Lab (University of Alabama at Birmingham)
  - Geological assessment of the South Georgia Rift Basin (University of South Carolina)
  - Membership in MIT Carbon Sequestration Initiative and GCCSI

- **Risk Management:**
  - Well bore leakage mitigation study for biomineralization remediation of legacy well bores (Montana State University)
  - *Valuation of Human Health and Environmental Damages* from CCS operations (Industrial Economics Incorporated)
Future commercial deployment

• **Deployment has been a niche opportunity involving:**
  – Mine mouth fuel sources
  – Long-term off-take agreements with CO$_2$-EOR
  – Proximity to pipeline infrastructure

• **Barriers to wide-spread deployment:**
  – Cost of CO$_2$ capture technologies/diminishing R&D funding
  – Low natural gas prices
  – Pipeline infrastructure especially with existing EGUs

• **Positive process being made:**
  – Technology choices and costs
  – Acceptance of environmental risks
  – Certification of storage
  – New business models
  – Incentives?
CO₂-EOR Storage Update

- Following Texas’ lead, Montana and Wyoming adopted CO₂-EOR storage certification laws in 2015.
- On April 24, 2015, EPA issued guidance that diminishes threat of EOR UIC Class II operations being converted into Class VI.
- On April 27, 2015, American Carbon Registry issued voluntary methodology for CO₂ storage via CO₂-EOR.
- ISO making progress on standard for CO₂ storage via CO₂-EOR.
- Sen. Enzi (R-WY) has signaled future introduction of CCUS bill.
- Challenges remaining –
  - Draft UIC Class II to VI transition guidance remains outstanding.
  - Section 111(b) final rule may require EOR to opt into Subpart RR/MRV.
  - GHG PSD permitting remains a concern (CO₂-EOR as BACT).
Southern Company
R&D for the Future of Clean Energy

Thank You!

Southern States Energy Board
Technological Solutions to a Robust Coal Future