Southern Company R&D Program Review: Strategy and Reasons for Future Optimism with CCS

Southeast Regional Carbon Sequestration Partnership
13th Annual Stakeholders Briefing, February 7, 2018

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R&D Program Manager – Geosciences and Carbon Management
America’s Premier Energy Company

Southern Company

- Approximately 46,000 mw of Generating Capacity
- Nearly 200,000 Miles of Power lines
- More than 80,000 Miles of Natural Gas Pipelines
- 190 Bcf of Natural Gas Storage Capacity

Operations in 19 States
- 11 Electric & Natural Gas Utilities
- 32,500 Total Employees
- 9 Million Utility Customers
- More than 1 Million Retail Customers
• Revolutionizing the future of energy
• Technology development for the **production**, **delivery** and **end-use** of energy
• Diverse research portfolio
• Collaboration with governments, utilities, universities and technology developers
• Innovative solutions to meet customers’ current and future energy needs
CCUS R&D Technology Research Drivers

Are these drivers valid/or and moving targets?

- GHG environmental regulations
- Voluntary carbon footprint reduction
- Abundant domestic fossil-fuel resources coupled with stable fuel pricing
- Depreciated fossil-fuel generation assets with state-of-the-art environmental controls
- Maintain a balanced fuels portfolio
- Energy independence on the national level
- Challenging regional renewable portfolio in the Southeast, USA
- World class storage geology with demand for CO₂-EOR
- Federal & State incentives
# Pre-Act 45Q Projects v. Post-Act 45Q Projects

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<thead>
<tr>
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<th>Pre-Act Projects</th>
<th>Post-Act Projects</th>
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</table>
| **Non-EOR**    | • $20/T + inflation  
• 75 million ton limit for EOR and non-EOR combined*  
• All projects | • $22.66/T → $50/T over 10 years** + inflation after 10 year period  
• 12-year credit |
| **EOR**        | • $10/T + inflation  
• 75 million ton limit for EOR and non-EOR combined* | • $12.83/T → $35/T over 10 years** + inflation after 10 year period  
• 12-year credit  
• Applies to: EOR, EGR, photosynthesis, chemosynthesis, chemical conversion, & other commercial use |

*Credit expires when 75 million total load claimed  **10 year linear progression from 2017 to 2026
Overview of New 45Q Tax Credit

• **Limitations** - New Credit includes the following limitations:
  - Small facilities - If emitting $\leq 500,000$ tpy COx, must capture $\geq 25,000$ tpy.
  - Electric generating facilities - Must capture $\geq 500,000$ tpy.
  - Direct air capture facilities - Must capture $\geq 100,000$ tpy.
  - NOTE: No apparent limit for other facilities (e.g., gas processing, refining).

• **Definition** - Secretary of Treasury required to define “secure geological storage” in consultation with EPA, DOE, and DOI.
  - This is already in the current law, but provides a new impetus for Treasury to act. It implicates UU v. RR GHG reporting issue.

• **Recapture** - Treasury must issue regulations regarding recapture of stored credit for COx that is reused.
Overview of New 45Q Tax Credit

• **Carbon oxide** - Covers carbon oxide (hereinafter “COx”) sequestered, not just CO₂.

• **Incremental capacity increases** - New higher credit applies to COx captured beyond pre-Act capacity. Credit ramps up over time from $22.66 (2018) and caps at $50 (2026) with rate of inflation added each year after that. If starting in 2017, it would average at around $37 over the 12 years.

• **Otherwise released** - Applies to COx that “would otherwise be released into the atmosphere as industrial emission.”

• **Deadline** - Facility must be under construction before January 1, 2024 and either
  • (1) the carbon capture equipment must also be under construction; or
  • (2) the original planning and design of facility must include carbon capture equipment.

• **Qualifying Facilities** - Includes industrial facilities and direct air capture facilities.
Is the new tax credit a driver for CCS deployment?

• By Federal law, tax credits can only offset tax liability by 75%.

• With our tax rate decrease to 21% from 35%, there is a potential “reduced value” of 45Q going forward.

• Interest deduction is now limited to 30% of earnings before interest, taxes and amortization (EBITA) (for most companies). However, there is a “Carve-out” for the regulated business. Many questions yet to be answered by the IRS regarding what gets “Carved-out” as part of the regulated business.

• Accelerated tax depreciation will be allowed but no bonus depreciation. On the non-regulated side of the business, capital investments can be expensed immediately.

• Future net operating income could increase appetite for projects with 45Q tax credits, but it is difficult to predict without passed regulations. Models are being built to evaluate the various impacts of tax reform.

• High capital investments should have stand alone ROI and not depend on tax credits?

• Tax credits will spur technology advancement with R&D!
National Carbon Capture Center

- **Sponsors:** U.S. Department of Energy and its National Energy Technology Laboratory
- **Partners:** Electric Power Research Institute, power and energy industry leaders
- **Managed and operated by:** Southern Company
- **Location:** Wilsonville, Alabama
A world-class neutral test facility and highly specialized staff to accelerate the commercialization of advanced technologies and enable fossil fuel-based power plants to achieve near-zero emissions (low-cost CO₂)
Successful Testing and Partnerships
Technology Development Process

1. Evaluate and Screen Technology
2. Define Scope of Work with Developer
3. Design and Construct
4. Operate According to Test Matrix
5. Analyze Data and Report
Major Accomplishments

• More than **100,000 test hours** for post- and pre-combustion carbon capture and gasification projects

• Post-combustion operation about **50,000 hours** and over **6,000 hours** under natural gas conditions

• 30+ post-combustion projects: enzymes, membranes, sorbents, solvents and associated systems

• Supported commercial developers to scale-up and **DOE’s Carbon Capture Simulation Initiative**

• Technology developers from the U.S. and six countries
# Carbon Storage Initiatives

<table>
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<tr>
<th>Site Certification for Commercial Storage</th>
<th>CO₂ Capture, Transportation and Storage Demonstration</th>
<th>Brine Extraction and Storage Test (BEST)</th>
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<tbody>
<tr>
<td>Geologic resource assessment in saline reservoirs</td>
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<tr>
<td>- Plant Gorgas stratigraphic test well</td>
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<tr>
<td>- Plant Daniel CO₂ pilot injection study</td>
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<tr>
<td>- Plant Barry CO₂ injection demonstration</td>
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<tr>
<td>- Kemper County CarbonSAFE storage complex feasibility study</td>
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<tr>
<td>Integrated CCS at 25-MW scale</td>
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<tr>
<td>- 12-mile pipeline to injection site</td>
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<tr>
<td>- 250,000+ metric tons captured</td>
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<td>- 115,000+ metric tons transported and injected into 9,400-foot deep formation</td>
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<td>- Site characterization, permitting, injection, monitoring and closure</td>
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<td>Test wells at Plant Smith in Florida Panhandle</td>
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<td>- Focused on managing CO₂ subsurface injection pressures to facilitate commercial storage</td>
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<td>- Includes beneficial reuse of extracted brine associated with commercial-scale CO₂ injection operations</td>
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CCS Demonstration at Alabama Power’s Plant Barry

**Integrated CO₂ capture, transportation and storage at a fossil-fueled power plant**

- CO₂ capture equivalent to 25-megawatts
- 12-mile pipeline linking captured CO₂ with injection site in Citronelle Dome
- 211,000 metric tons CO₂ captured with 115,000 metric tons injected into ~9,400-foot deep saline formation
- Site characterization, UIC permitting, injection and monitoring of CO₂ for geologic storage, and closure
Project ECO$_2$S is a storage complex “feasibility study” of $11.2$ million DOE funds / $3.6$ million industry cost-share for a total of $14.8$ million total budget awarded for work at the Kemper County Energy Facility.

Scope is to perform detailed site-characterization of a storage complex having high potential for commercial storage (50+ million tonnes CO$_2$).

Three deep wells have drilled in 2017 for site characterization.
MPC-25-6 CarbonSAFE Project ECO$_2$S
## DOE Coal, CCS & Power Systems Budgets

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<tr>
<th><strong>Coal, CCS &amp; Power Systems</strong> (All figures in $ Thousands)</th>
<th><strong>FY 17 Omnibus</strong></th>
<th><strong>FY18 Request</strong></th>
<th><strong>FY18 House</strong></th>
<th><strong>FY18 Senate</strong></th>
<th><strong>FY19 Request</strong></th>
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<tbody>
<tr>
<td>Carbon Capture</td>
<td>101,000</td>
<td>16,000</td>
<td>95,000</td>
<td>93,930</td>
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<td>Carbon Storage</td>
<td>95,300</td>
<td>15,000</td>
<td>89,073</td>
<td>88,269</td>
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<td>Advanced Energy Systems</td>
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<td>46,000</td>
<td>103,000</td>
<td>97,650</td>
<td>58,000</td>
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<td>Cross-Cutting Research</td>
<td>45,500</td>
<td>37,800</td>
<td>51,550</td>
<td>42,315</td>
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<td>Supercritical CO2 Technology (STEP) Program</td>
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<td>19,530</td>
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<td>Transformational Pilot Plant Solicitation</td>
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<td>25,000</td>
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<tr>
<td>Carbon Capture, Utilization and Storage</td>
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<td>23,000</td>
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<td>Subtotal Before NETL R&amp;D</td>
<td>370,800</td>
<td>114,800</td>
<td>387,623</td>
<td>341,694</td>
<td>117,000</td>
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<tr>
<td>NETL R&amp;D</td>
<td>53,000</td>
<td>68,100</td>
<td>53,000</td>
<td>72,663</td>
<td>35,000</td>
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<tr>
<td>CCS &amp; Power Systems R&amp;D Subtotal</td>
<td>423,800</td>
<td>114,800</td>
<td>440,623</td>
<td>341,694</td>
<td>117,000</td>
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<tr>
<td>Transformational Pilot Plant Solicitation</td>
<td>50,000</td>
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<td>Natural Gas Advanced Power Systems R&amp;D</td>
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<td><strong>Total for FE R&amp;D Programs</strong></td>
<td>473,800</td>
<td>182,900</td>
<td>440,623</td>
<td>414,357</td>
<td>152,000</td>
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Generation Planning and CCS

Resource Planning

- Generation Mix Optimization & Expansion Plan
- Regulatory Approvals
- Load Forecasts*
- Fuel Forecasts*
- Existing Generating Units Cost & Performance
- Environmental Compliance Costs**
- New Generating Technologies Cost & Performance
- Lowest Cost to Customers $$

Generation Development

- Technology Costs
  - Capex
  - O&M
  - Performance
- Site Specific Costs
  - Transmission
  - Delivered Fuel
  - Environmental+

Site Selection Based on Total Life-Cycle Cost

- varies by scenario + may include CCS

For Illustration Only
Thank You!