

SECARB 10th Annual Stakeholders' Briefing

Southern Company CCS R&D: Plant Barry CCS Demo

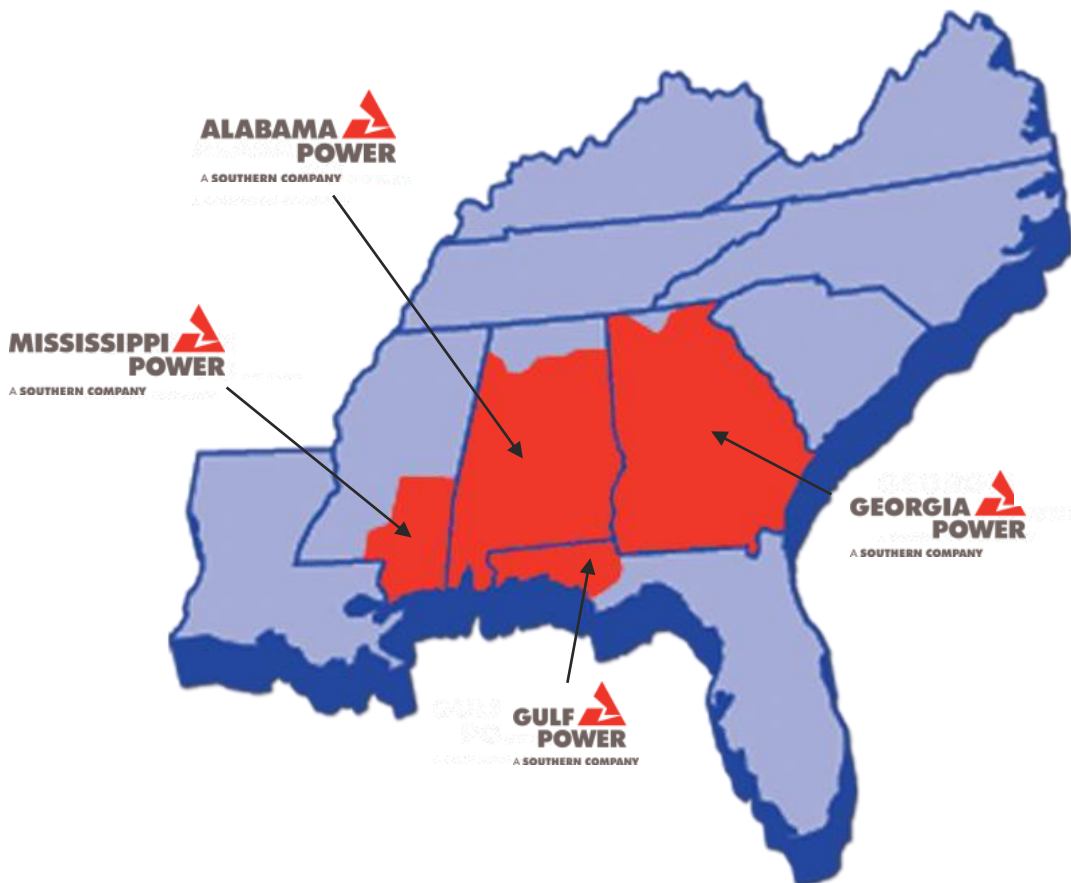
***Dr. Richard A. Esposito
Southern Company***

March 12, 2015



Introduction to Southern Company

Regulated Utility Franchises



Regulated Utilities

Alabama Power
Georgia Power
Gulf Power
Mississippi Power
Southern Nuclear

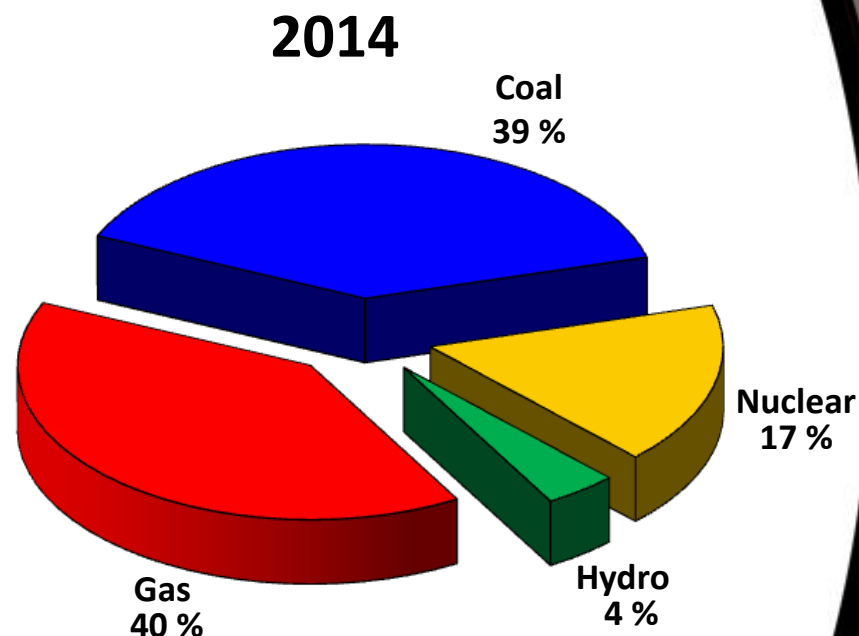
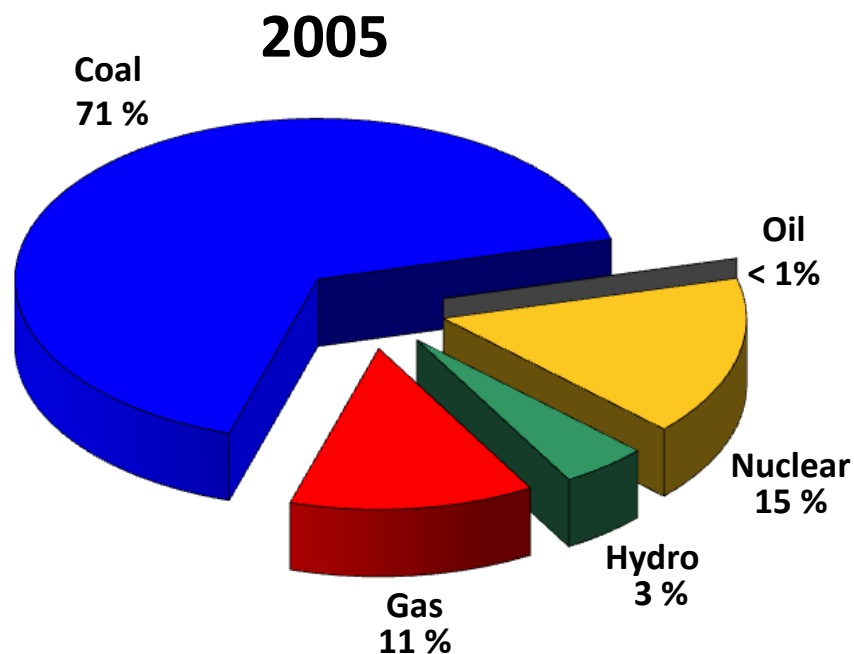
Competitive Power

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

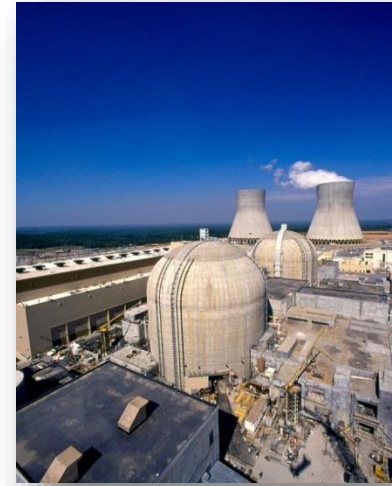
All of the Below Energy Strategy



New Natural Gas



21st Century Coal



New Nuclear



Energy Efficiency



Biomass



Wind



PV Solar

Recent and Planned Additions

Plant McDonough-Atkinson

2,520 MW Natural Gas CC

Among of the most efficient in the nation



Utility Scale Solar
at Southern Power
and initiatives at
Georgia Power



Multiple
Wind Energy
PPAs



One of the
Largest Biomass
Facilities in
North America



Vogtle Units 3 & 4

~1,005MW Ownership
AP1000 technology

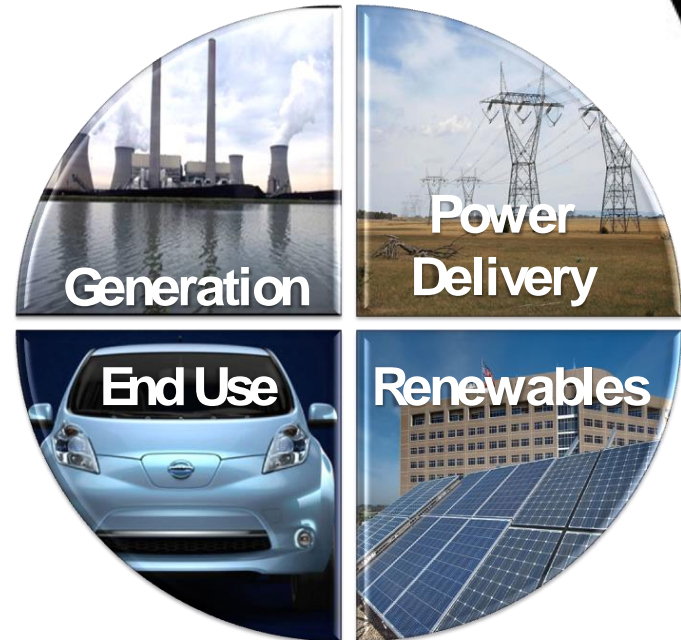


Kemper County IGCC

~495MW Ownership
Proprietary TRIG technology

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 portfolio is to provide technology options to power operating business



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE



U.S. DEPARTMENT OF

ENERGY



**SOUTHERN
COMPANY**

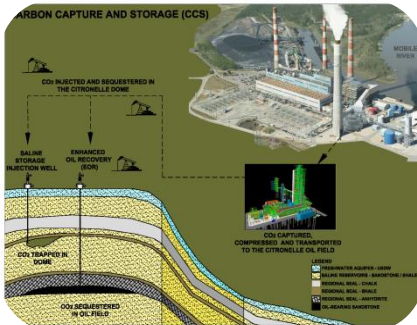
Carbon Capture & Storage R&D Program

"Efforts key to our long-term program success"

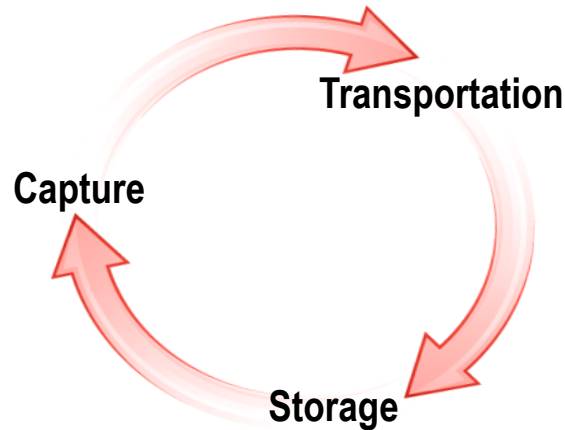
Pilot Scale



Demonstration Scale



Carbon Capture Utilization Storage

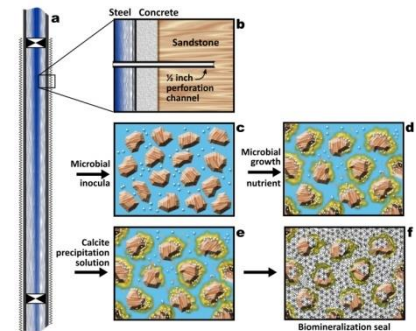


Commercial Demonstration

Laboratory Testing



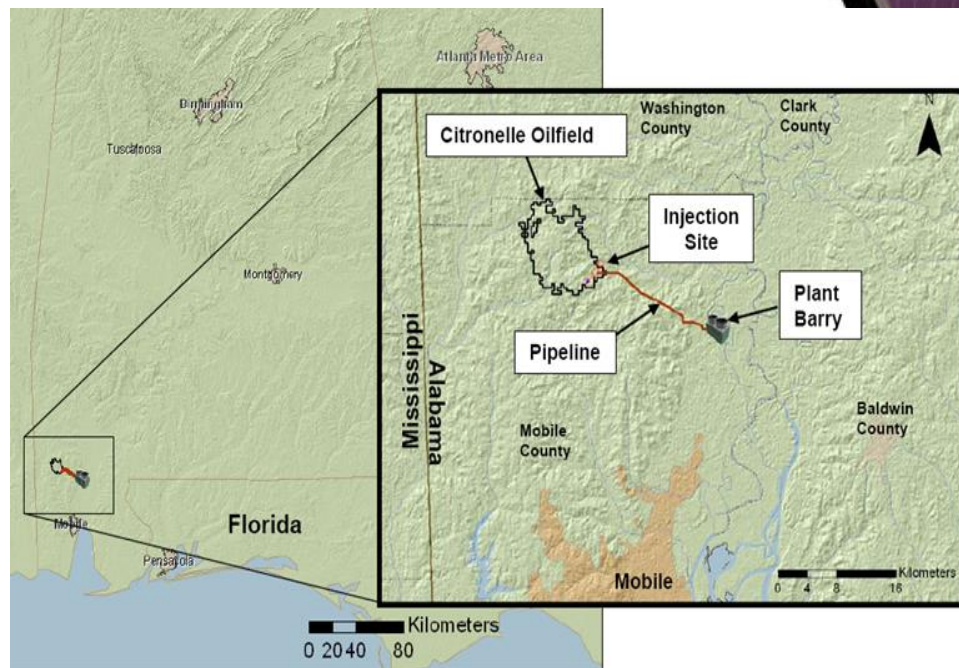
Applied Science



Plant Barry 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 CO₂ pipeline linking captured CO₂ with the injection site.
- CO₂ permitting/injection into ~9,400 ft. deep saline formation at the Citronelle Oil Field.
- Monitoring of CO₂ storage during injection and three years post-injection.



Power Plant



Capture



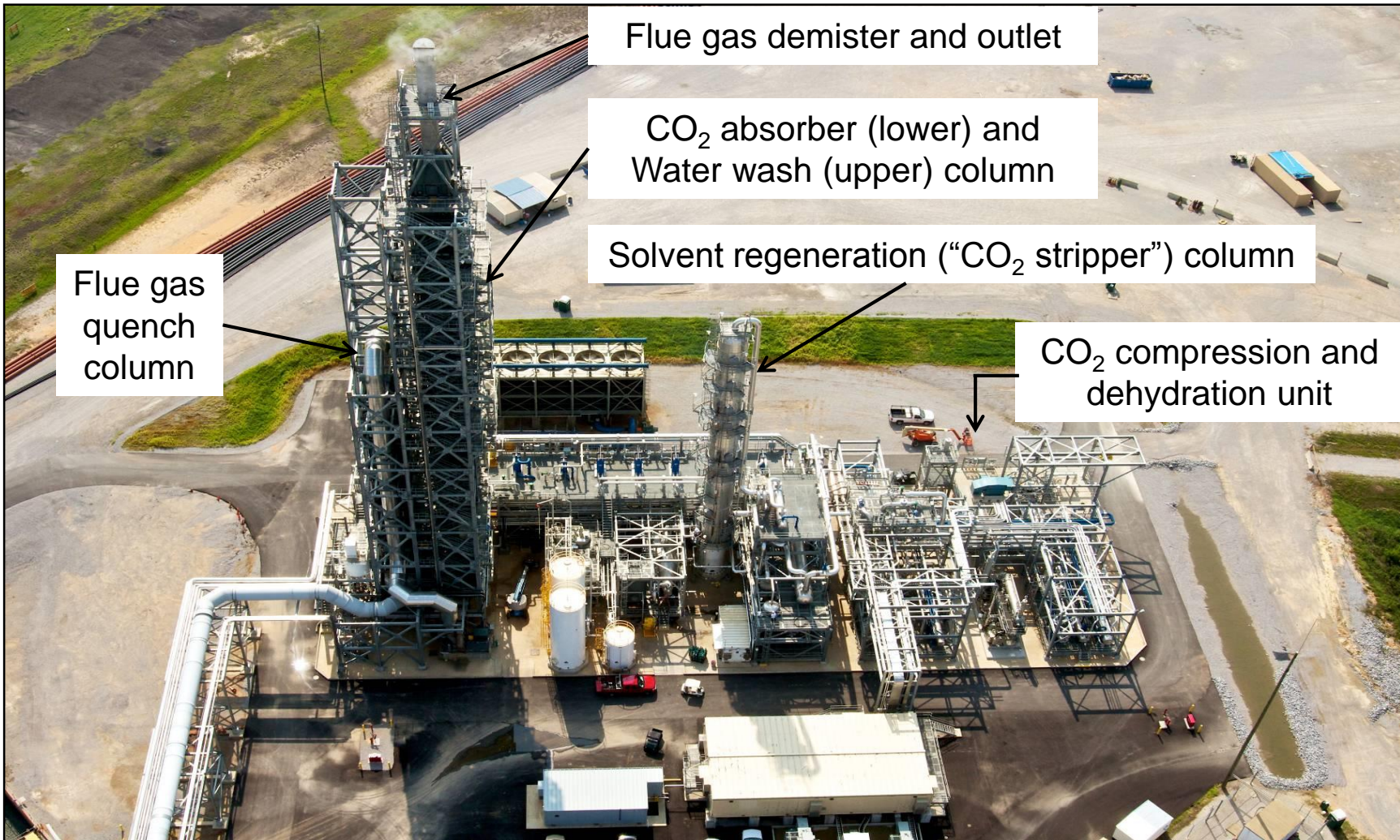
Transport



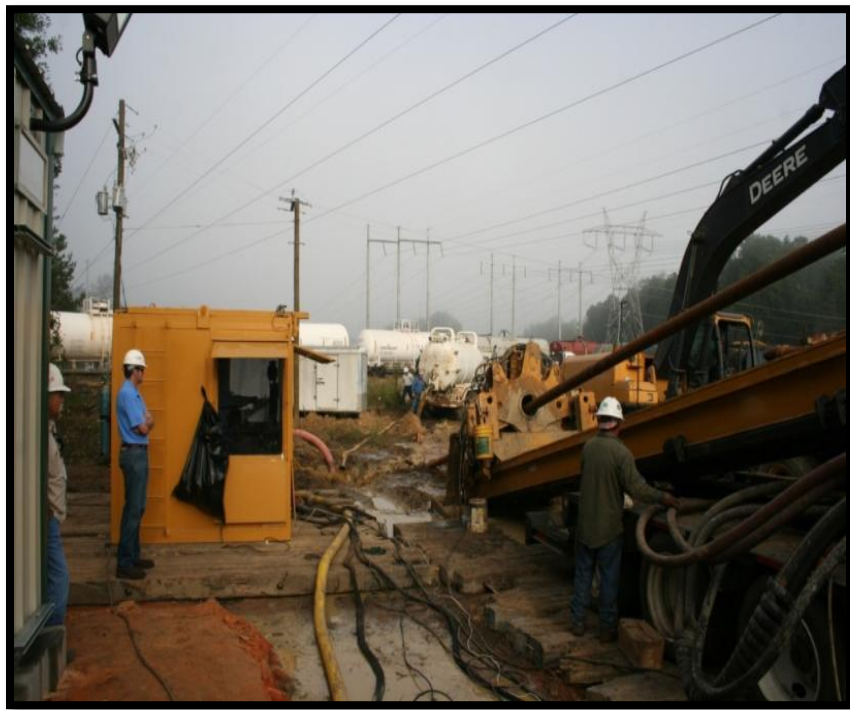
Storage

**SOUTHERN
COMPANY**

Aerial Photograph with Labels







DOT 29 CFR 195
liquid pipeline;
buried 5 feet with
surface vegetation
maintenance.

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).



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

Items		Results*
Total Operation Time	hrs	13,090
Total Amount of Captured CO ₂	metric tons	240,900
Total Amount of Injected CO ₂	metric tons	114,104
CO ₂ Capture Rate	metric tons per day	> 500
CO ₂ Removal Efficiency	%	> 90
CO ₂ Stream Purity	%	99.9+/N ₂
Steam Consumption	ton-steam/ton-CO ₂	0.98

*As of 12/16/2014

Improved Technology Applications

- Proprietary spray type distributor developed by MHI to reduce weight of tower internals
- Keeping the same performance as the trough type distributor approximately 50% cost reduction of tower internals was achieved

Fig. Trough Type Distributer



Fig. Spray Type Distributer
(MHI Proprietary)



Recent Barry 25 MW CCS Testing

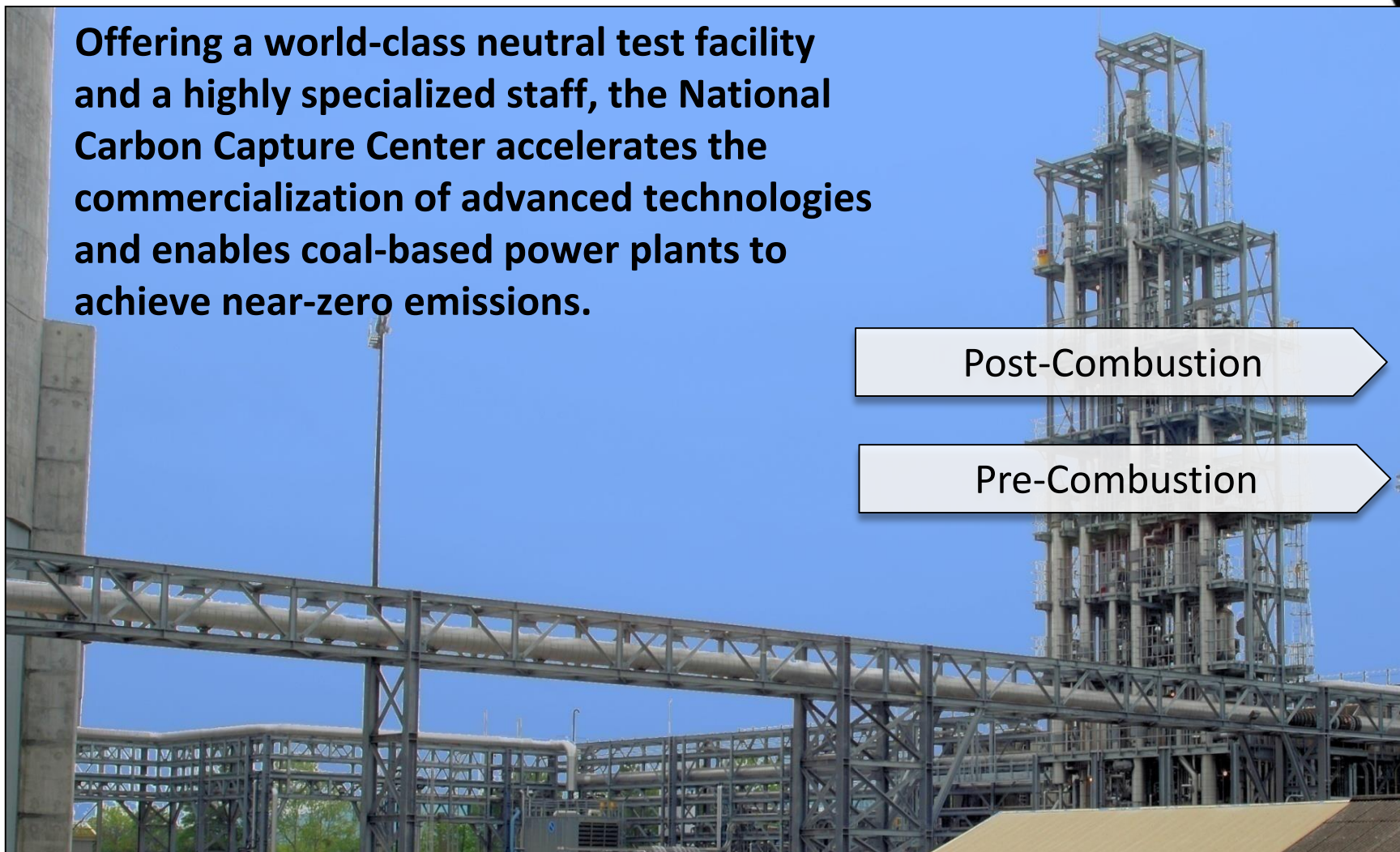
- Built-in Reboiler
 - Evaluating a new built-in reboiler design to replace the shell and tube reboiler in solvent regeneration (better heat transfer)
- Dehydration Glycol Consumption
 - Glycol consumption slightly higher than the design case (looking at different additives (O₂ scavenger)
- Caustic Scrubbing
 - Deep flue gas desulfurization was substituted with 20% caustic instead of the traditional limestone scrubbing.



The National Carbon Capture Center

“at the Power Systems Development Facility”

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.

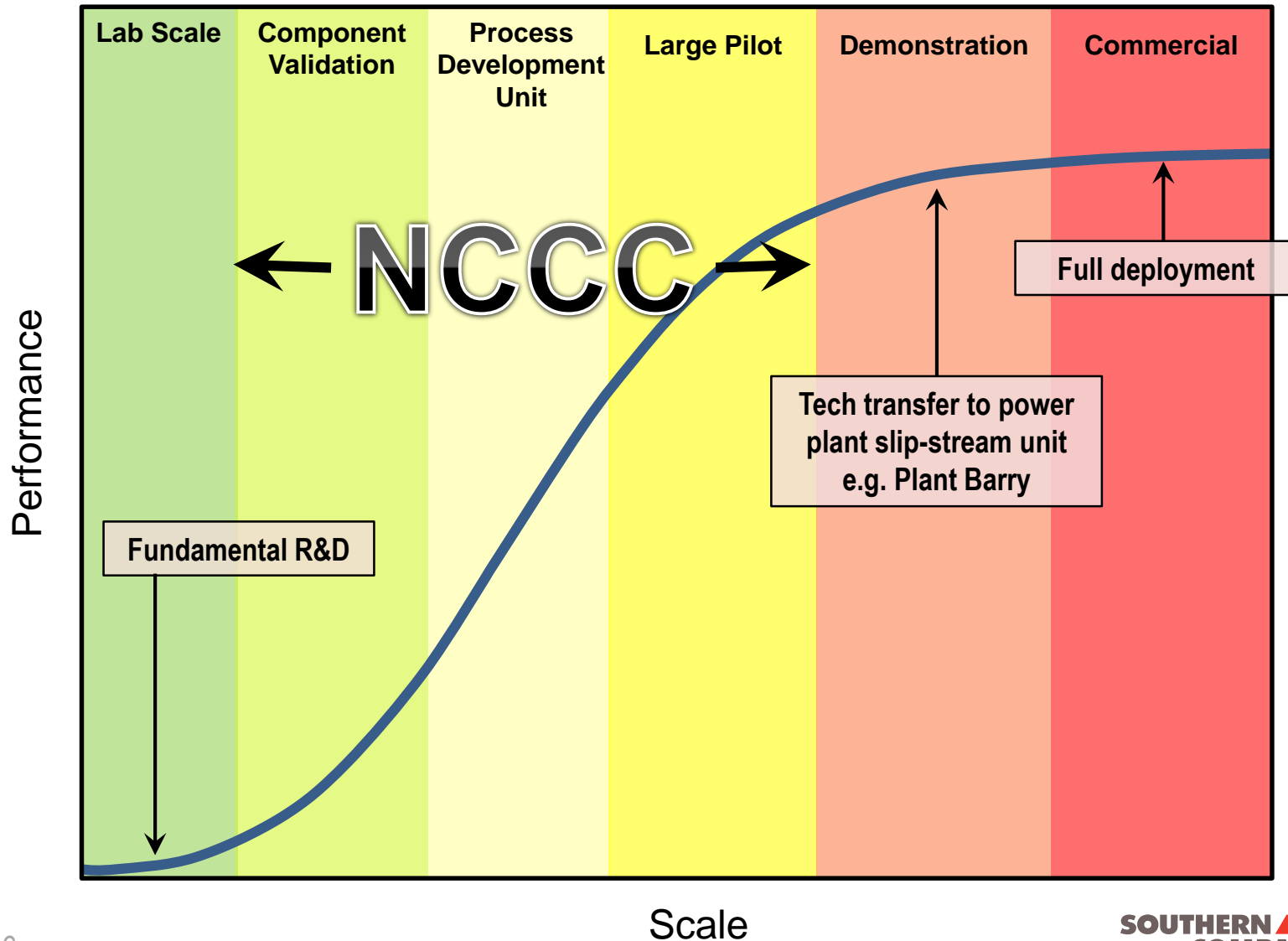


Post-Combustion

Pre-Combustion



R&D Role of the NCCC/PC4



Kemper Energy Facility

582-MW TRIG™ IGCC with 65% CO₂ Capture



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



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



Other supported/collaborative efforts

- **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 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)

Concluding thoughts on CCS

- The Barry project represents a significant understanding and improvements in post combustion CCS and is a stepping stone to commercial deployment
- CCS will be a niche market with Southern Company in the Southeast
- Early project development benefits from long-term CO₂ off-take agreements for EOR to support financial investment
- Pipeline infrastructure for EOR and saline storage could be a limiting factor with existing generating units
- Environmental risks are not as large as we one thought
- Low natural gas prices will continue to limit commercial CCS deployment

Southern Company

R&D for the Future of Clean Energy

Thank You!

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