

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

***Southern Company CCUS
Research, Development, Deployment***

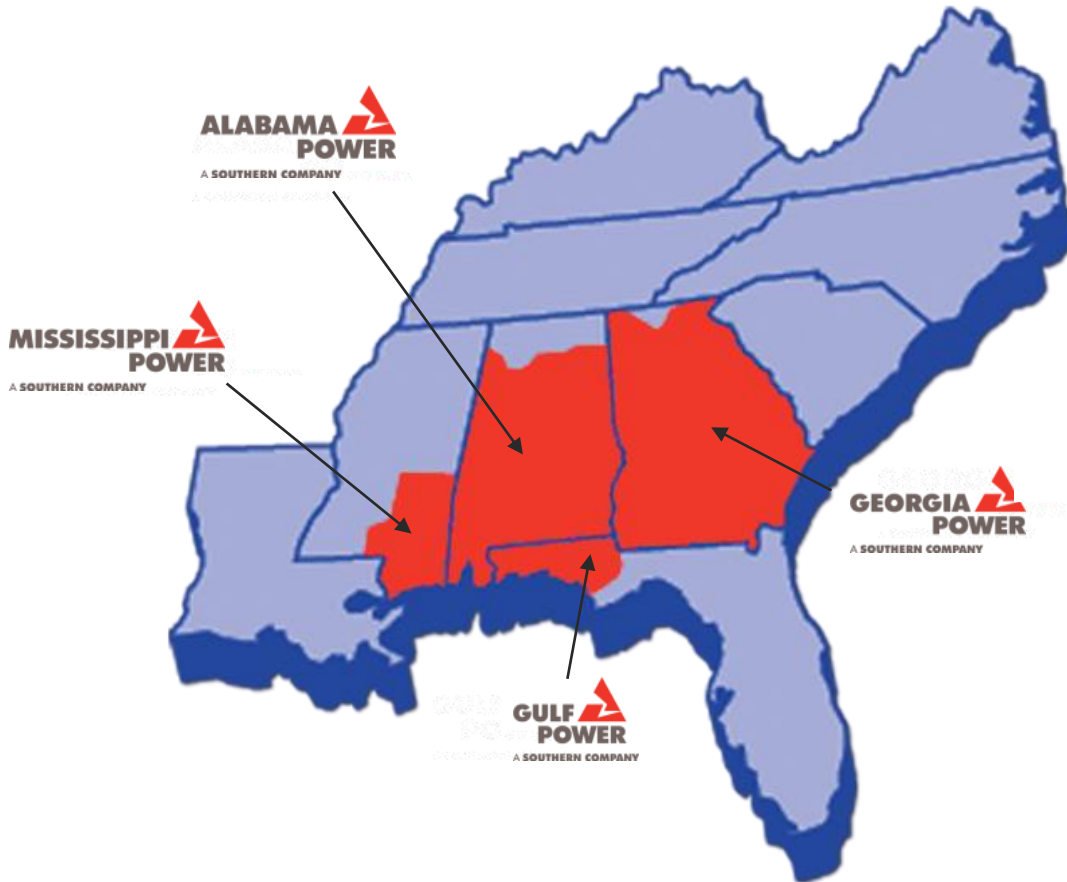
*Dr. Richard A. Esposito
Southern Company*

May 20, 2015



Introduction to Southern Company

Regulated Utility Franchises



Regulated Utilities

Alabama Power
Georgia Power
Gulf Power
Mississippi Power
Southern Nuclear

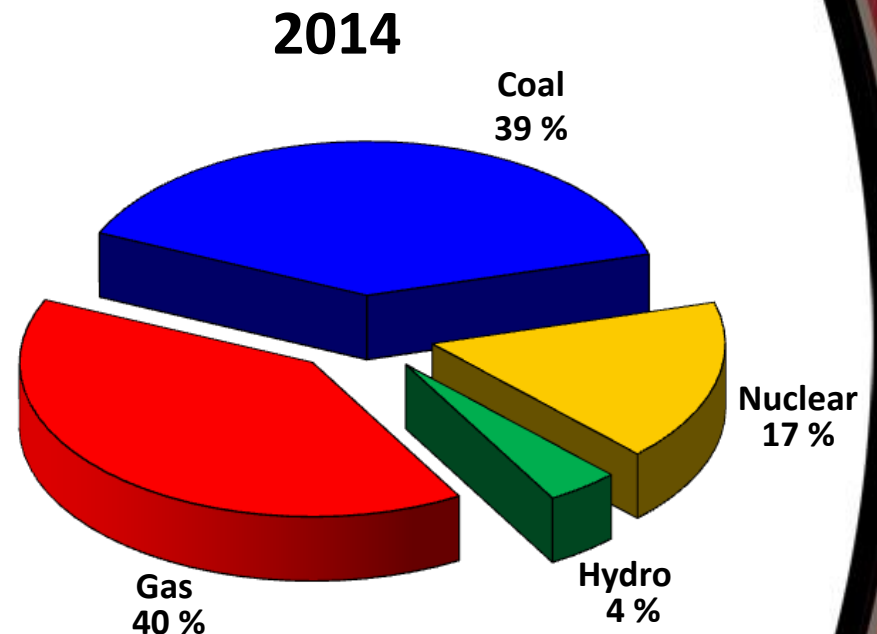
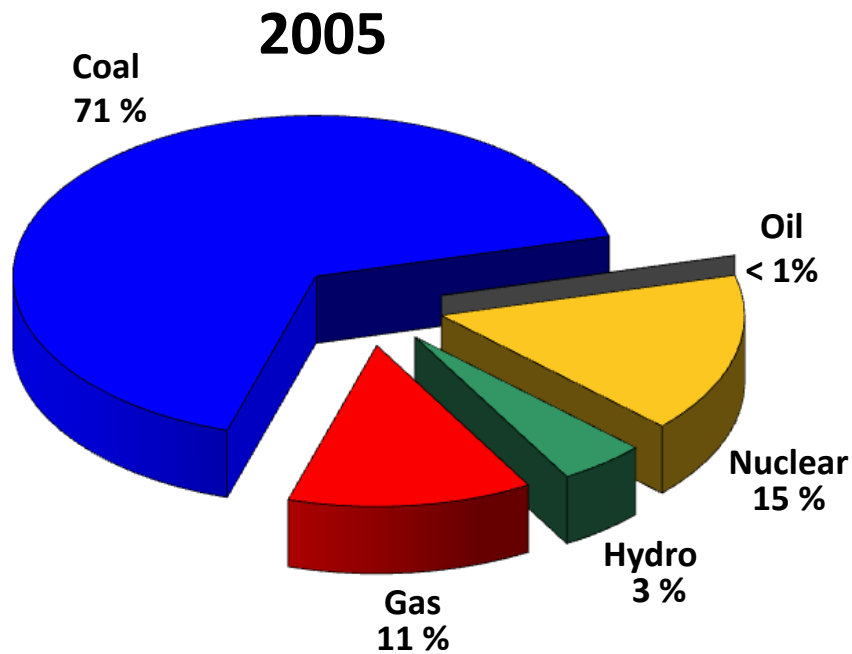
Competitive Power

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

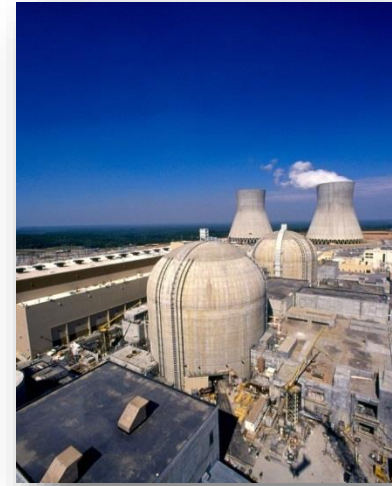
All of the Below Energy Strategy



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



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE



U.S. DEPARTMENT OF

ENERGY

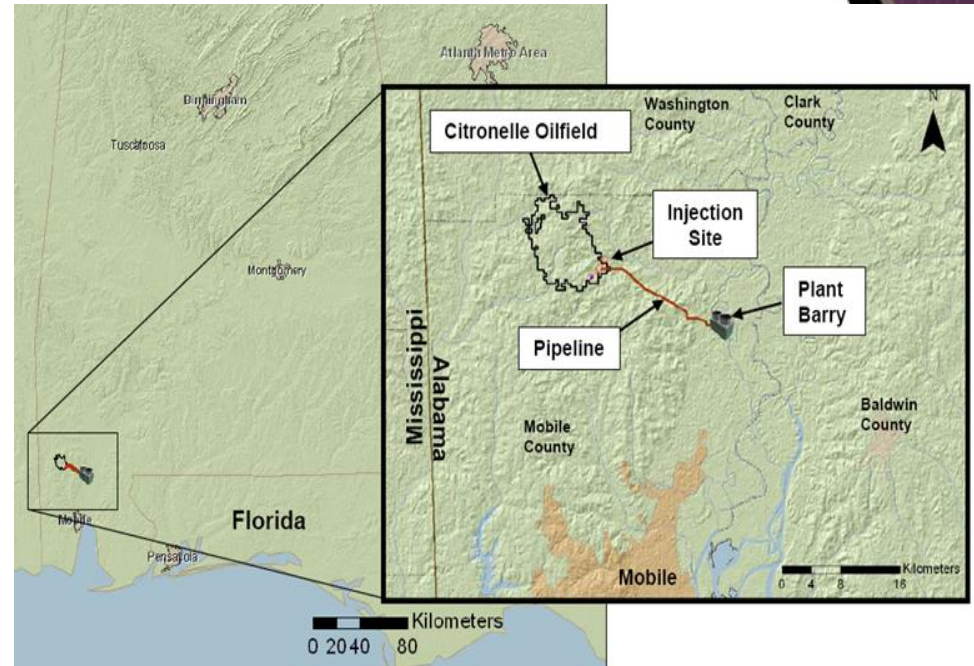


SOUTHERN
COMPANY

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 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

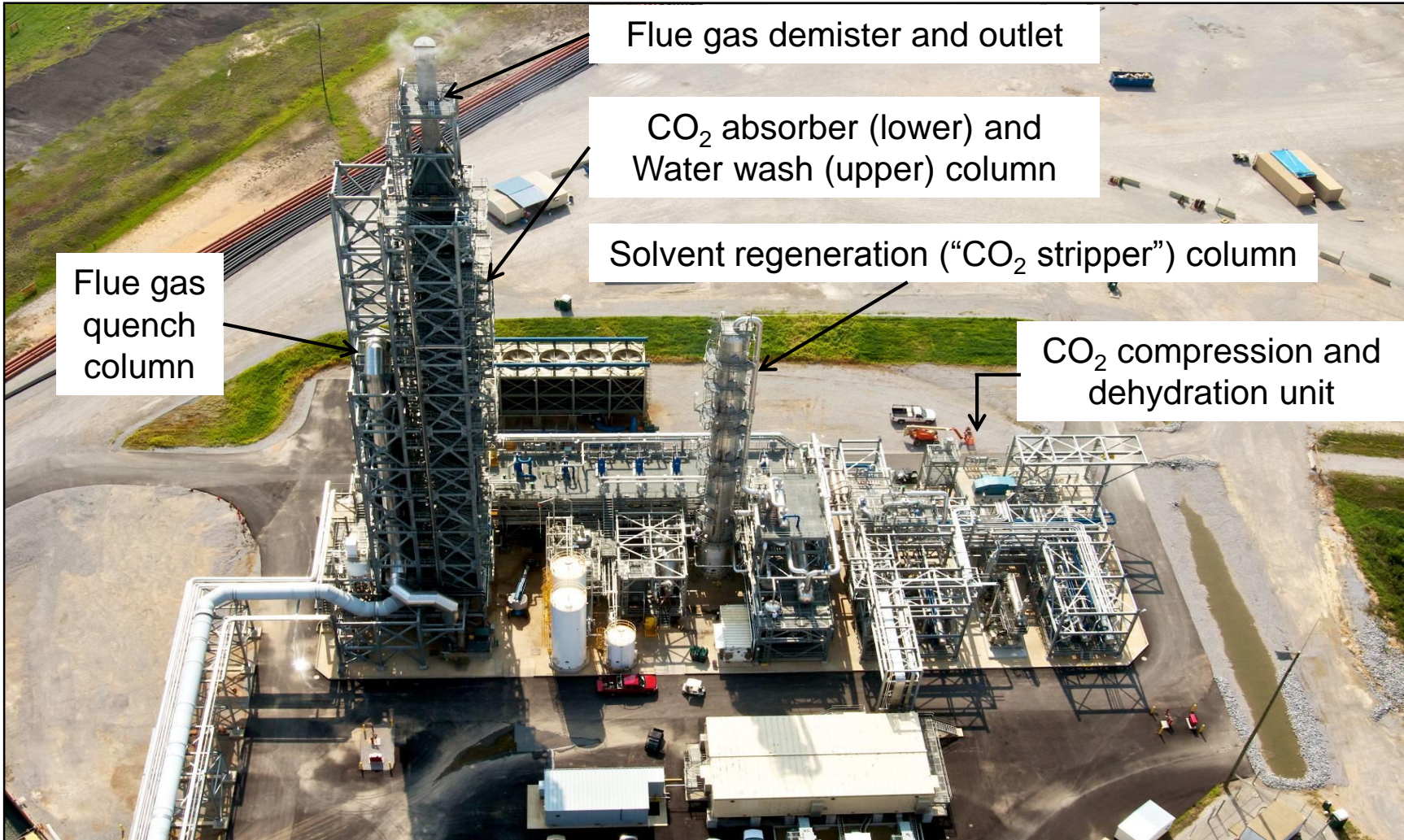


Transport

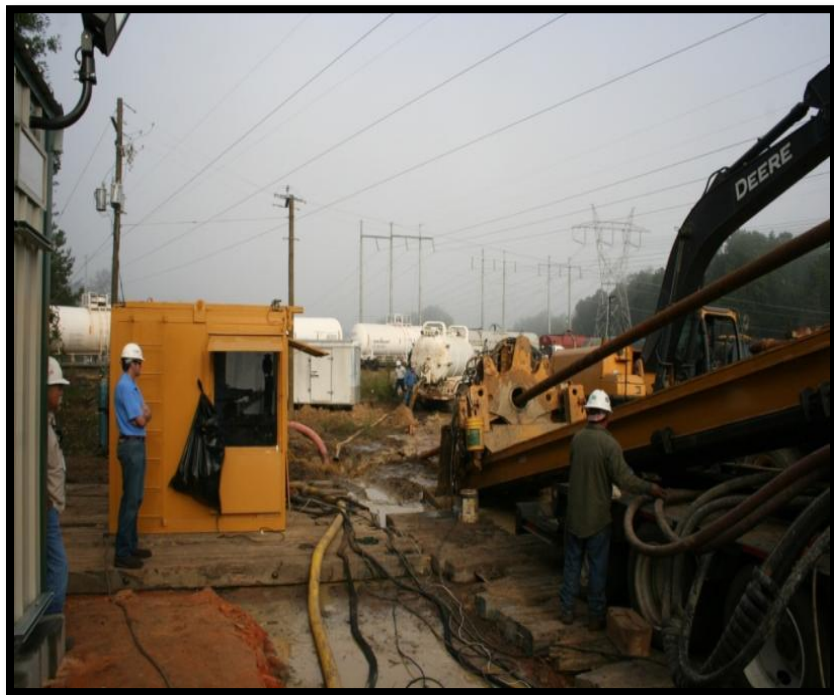


Storage

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 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



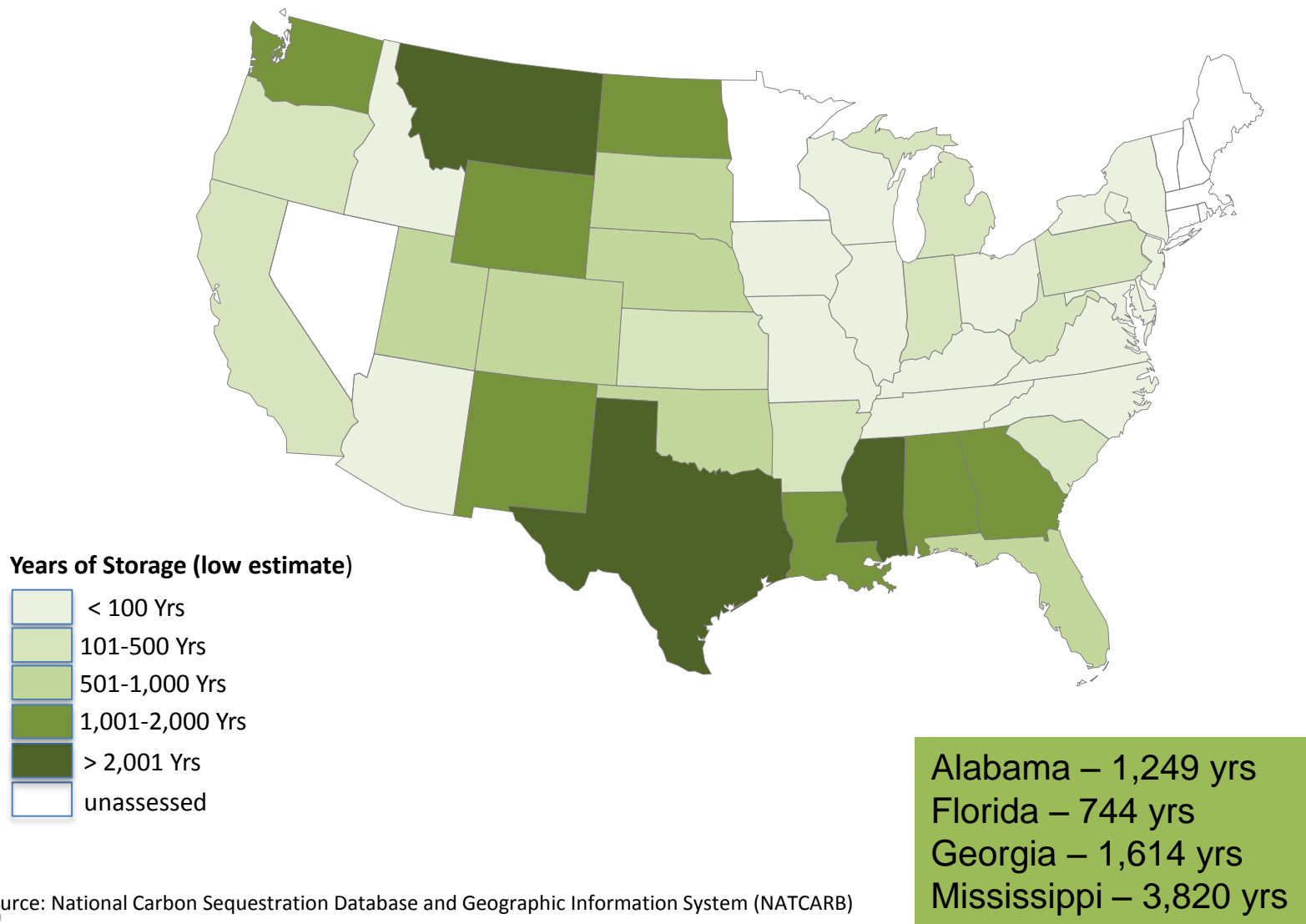
Alabama Power James M. Barry
CO₂ Injection Demonstration



Georgia Power Plant Bowen
Deep Site Geology Investigation



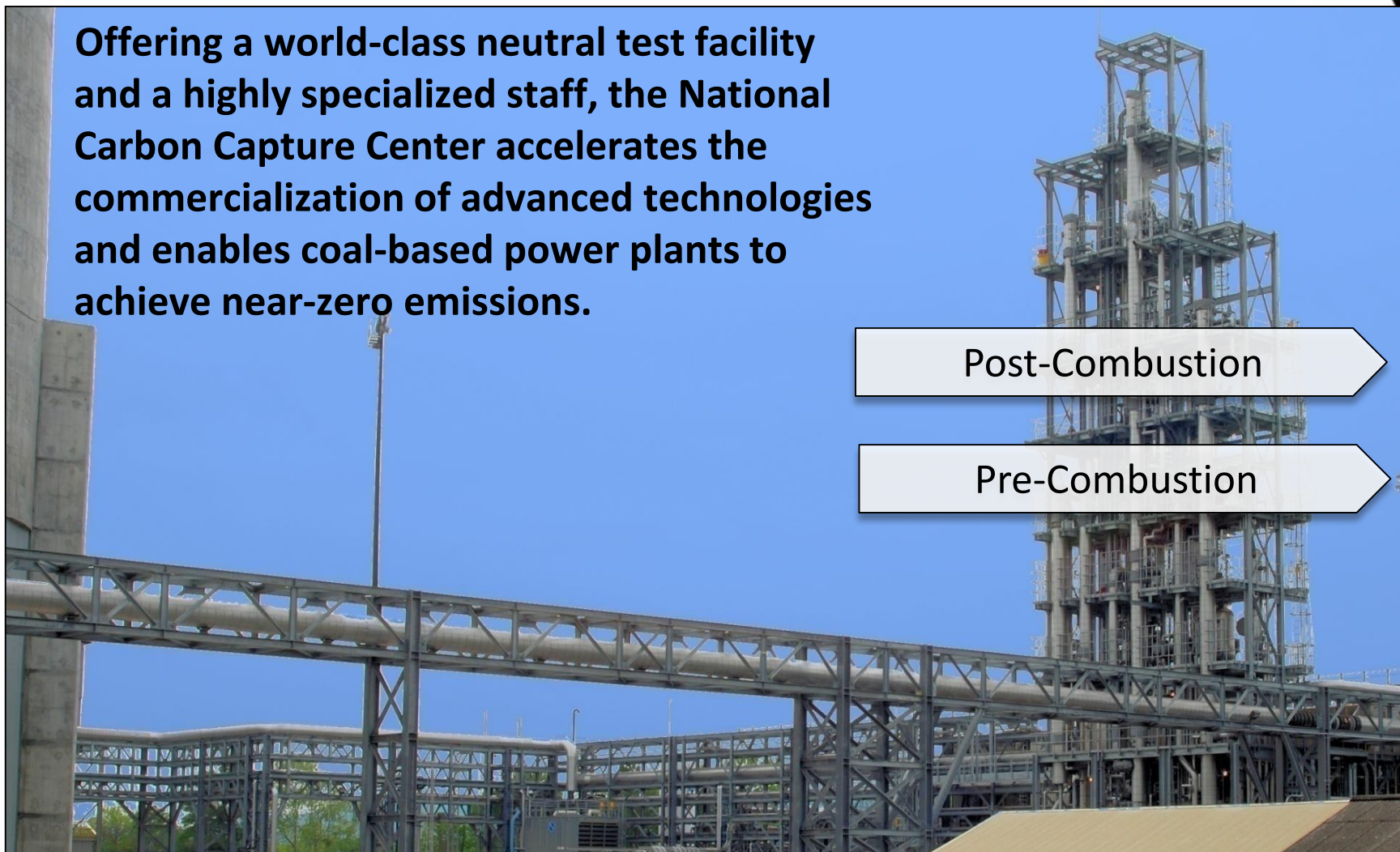
Estimated years of onshore geologic storage per state for all CO₂ emission sources



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

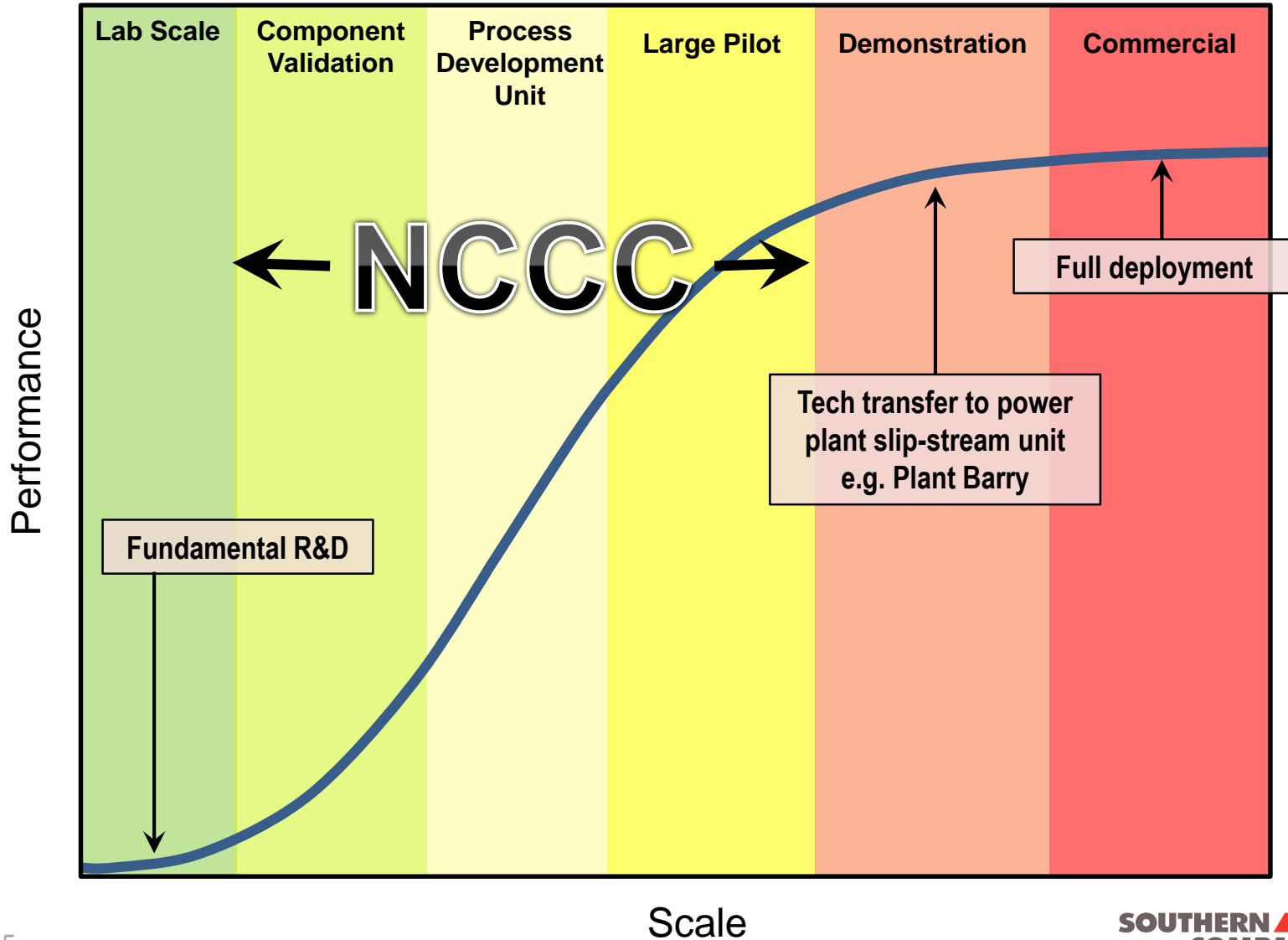
Pre-Combustion



ELECTRIC POWER
RESEARCH INSTITUTE



R&D Role of the NCCC/PC4



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% CO₂ 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 CO₂-EOR
 - Proximity to pipeline infrastructure
- **Barriers to wide-spread deployment:**
 - Cost of CO₂ 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

