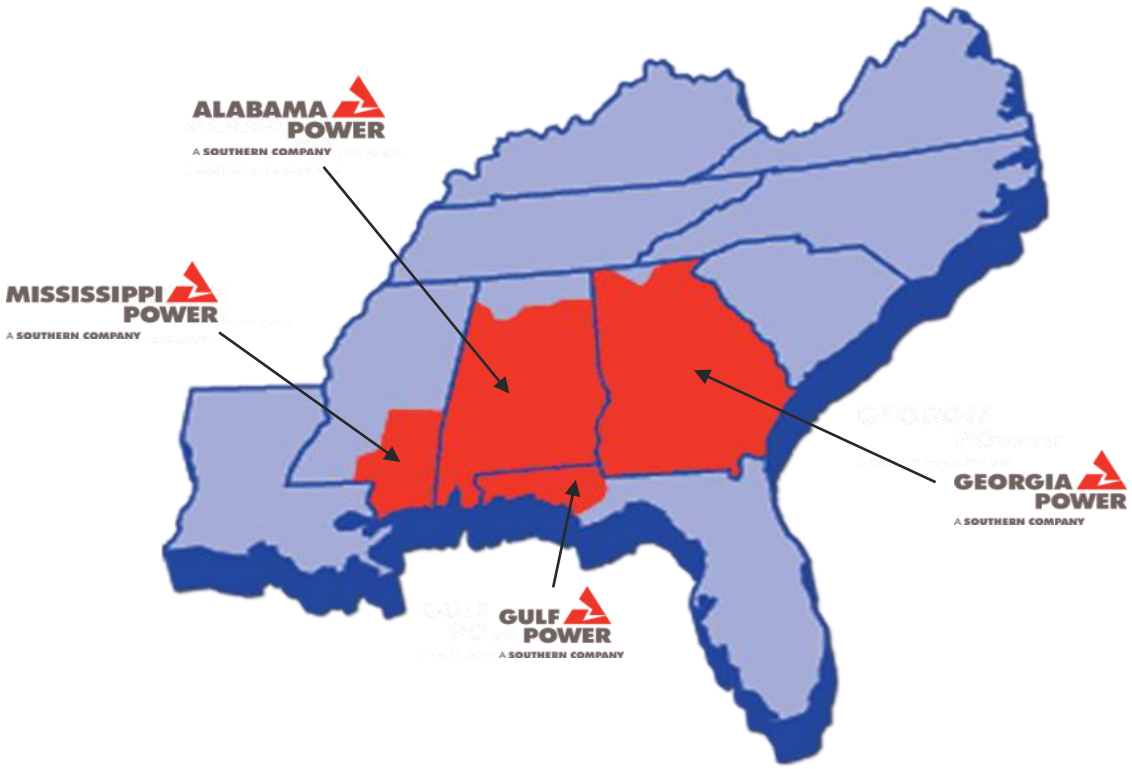
Southern Company Carbon Management

Randall Rush, General Manager - Gasification Technology

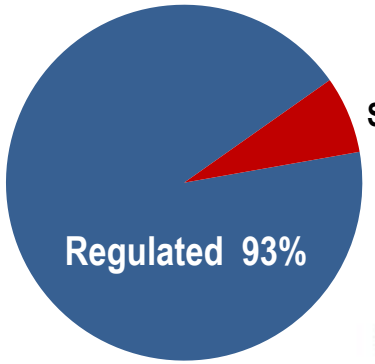
Roxann Laird, Director - National Carbon Capture Center

Southern Company at a Glance



Category	Value	US Rank
Market Capitalization ($B)	$40.3	2nd
Enterprise Value ($B)	$62.7	2nd
Total Assets ($B)	$59.3	2nd
Electric Customers (M)	4.4	8th
Summer Capacity (MW)	43,955	2nd
Coal	*20,426*	
Gas / Oil	*16,912*	
Nuclear	*3,644*	
Solar	*46*	
Biomass	*103*	
Hydro	*2,824*	
Coal Usage (tons)	44,765	3rd
Gas Usage (bcf)	600	
3rd		
Transmission (miles)	26,874	3rd
Distribution (miles)	167,853	5th

2011 Net Income



Source: SNL & Energy Velocity
Assets, customers, transmission , distribution and fuel usage data as of 12/31/2011
Ranking includes combined Duke/Progress

SOUTHERN COMPANY

Southern Company Strategic Priorities

Complete Vogtle & Kemper

Promote Smart Energy

Preserve and Enhance the Circle of Life

Support Building of National Energy Policy

Value and Develop People

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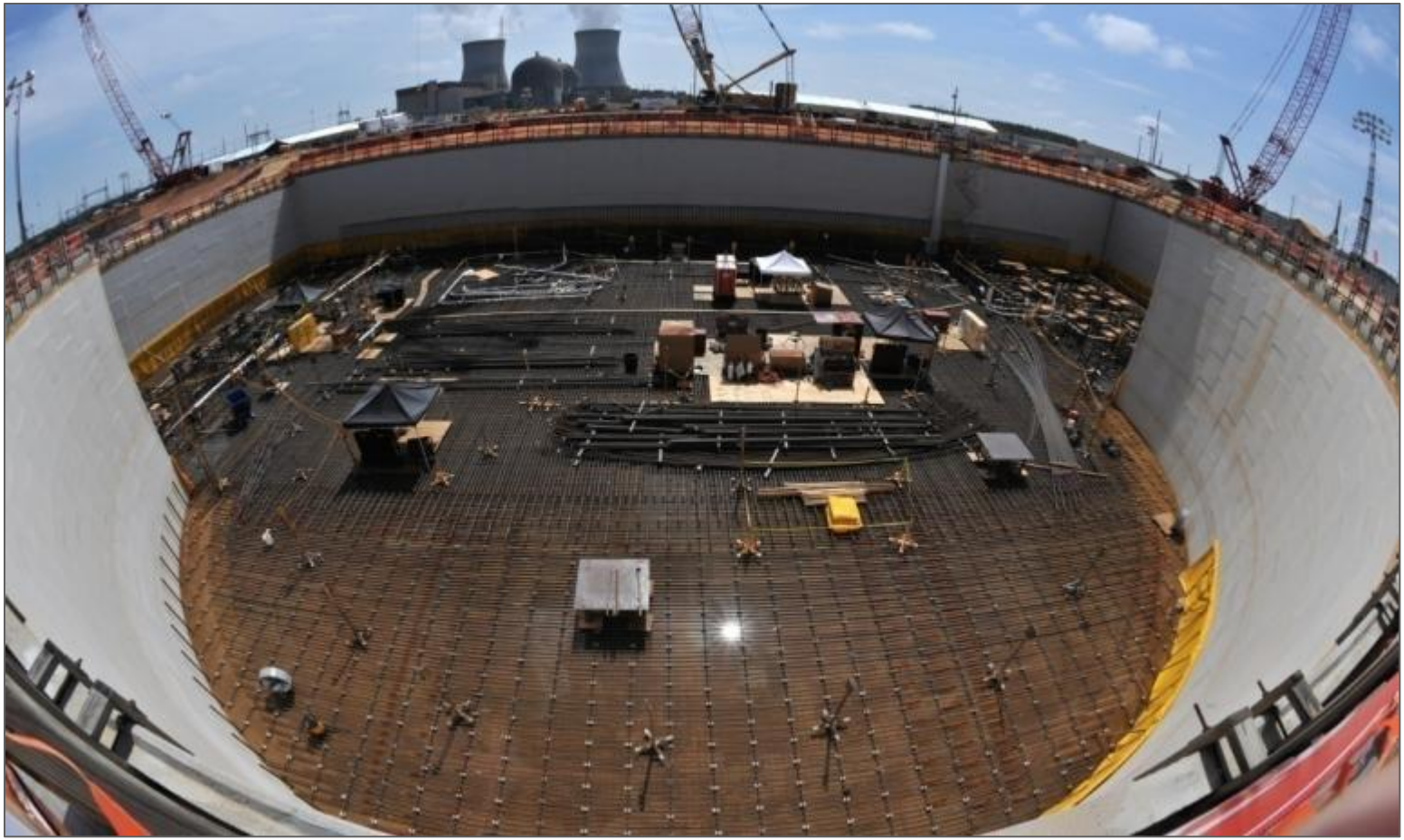
First New US Nuclear Plant in a Generation - Vogtle 3&4



Combined Construction & Operating License (COL) issued by NRC on Feb 10, 2012

Unit 3 COD – 2016; Unit 4 COD – 2017

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Plant Ratcliffe IGCC in Kemper County, Mississippi

- Southern Company Proprietary TRIG™ Technology
- 15 years of development/demonstration
- 580MW Capacity with 65+% CO_2 capture
- CO_2 emissions ~equal to natural gas
- 3 MM TPY CO_2 for EOR
- COD: May 2014

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Southern Company

Engineering, Procurement & Construction (EPC) Capability

- Only US electric power company with in-house EPC capability (1,600 employees)
- Perform all EPC activities for Southern's fossil and hydro fleet
- Act as Owner's engineer for nuclear EPC
- Integrated strategy development, technology selection, EPC execution and operating fleet O&M lessons learned
- Deployed/managed over 72M construction man-hours, 2007 to Mid-2012
- Highlights of construction project results since 2000:
  - 11,200 MWs of new gas-fired generation at costs 35% below national average*
  - 3,100 MWs of selective catalytic reduction (SCR) at costs 10% below national average*
  - 3,800 MWs of flue gas desulfurization (FGD) at costs 18% below national average*

* "SCR Cost Construction Survey Results" – 2010 Electric Utility Cost Group (EUCG) survey

"Scrubber Cost Construction Survey Results" – 2009 Electric Utility Cost Group (EUCG) survey

Industry database: All-in cost in nominal $, F Class 2x1 CCs > 500 MWs. Total database of 7000 MWs in AL, FL, LA, MS, SC for 2003COD.

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Southern Company R&D

- Only US electric power company with internal R&D organization
- Approximately 150 centrally located engineers and scientists
- Laboratories dispersed across operating assets
- Active collaboration with other utilities
- Leveraged by external funding partners
- Research portfolio managed to provide hardened technology options

R&D Areas

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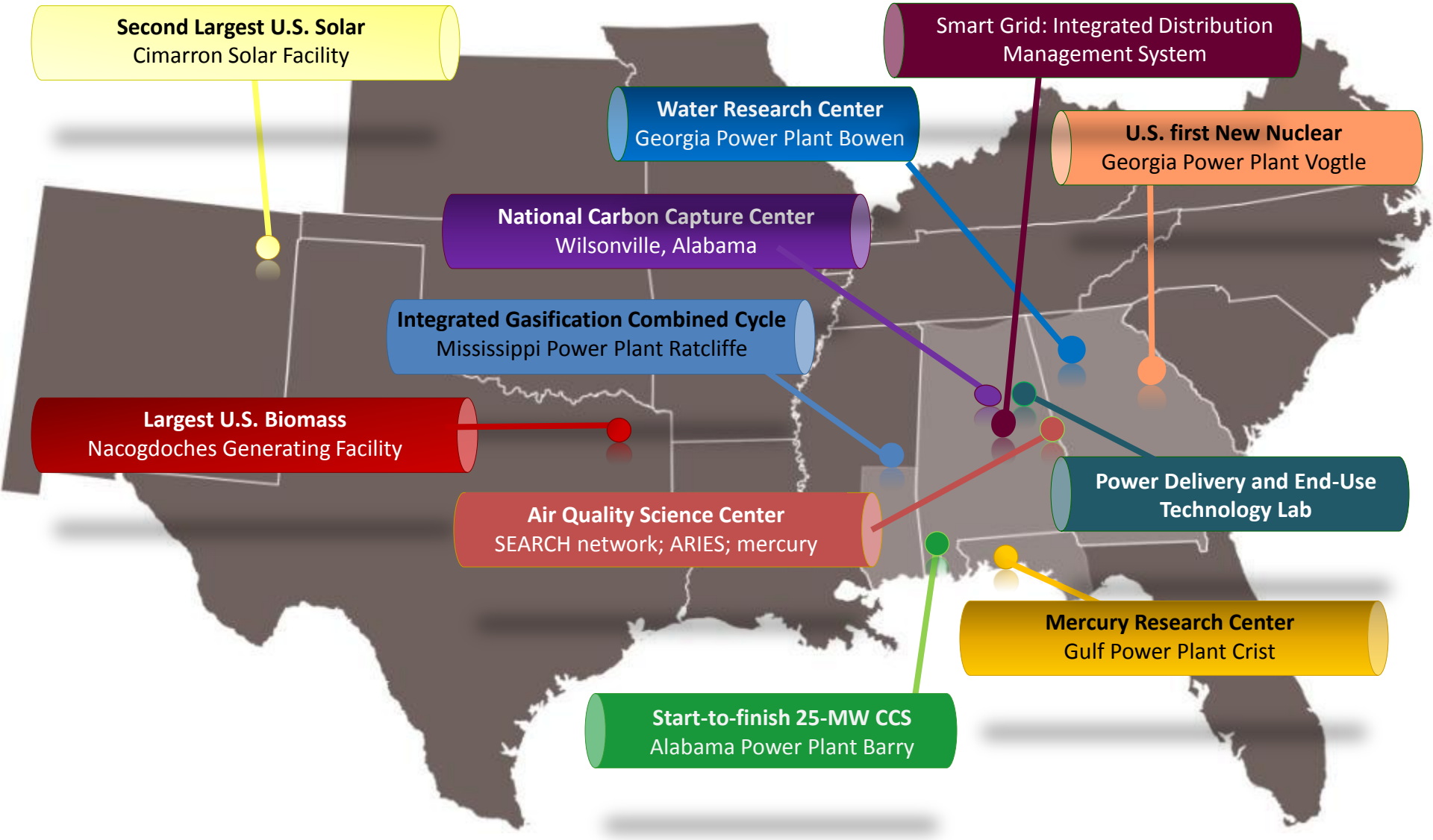
Recent Southern Company Projects with R&D Foundations



Southern Company's Technology Culture

- Recognizes that new technologies will address the difficult challenges ahead.
- Focused through a centralized R&D organization
- Belief that a broad technology portfolio brings multiple options to business decisions.
- Extensive external collaboration to ensure broad technical input and leverage resources.
- Adopt intellectual property positions that do not impede technology deployment.
- Stay focused on the most strategic issues.

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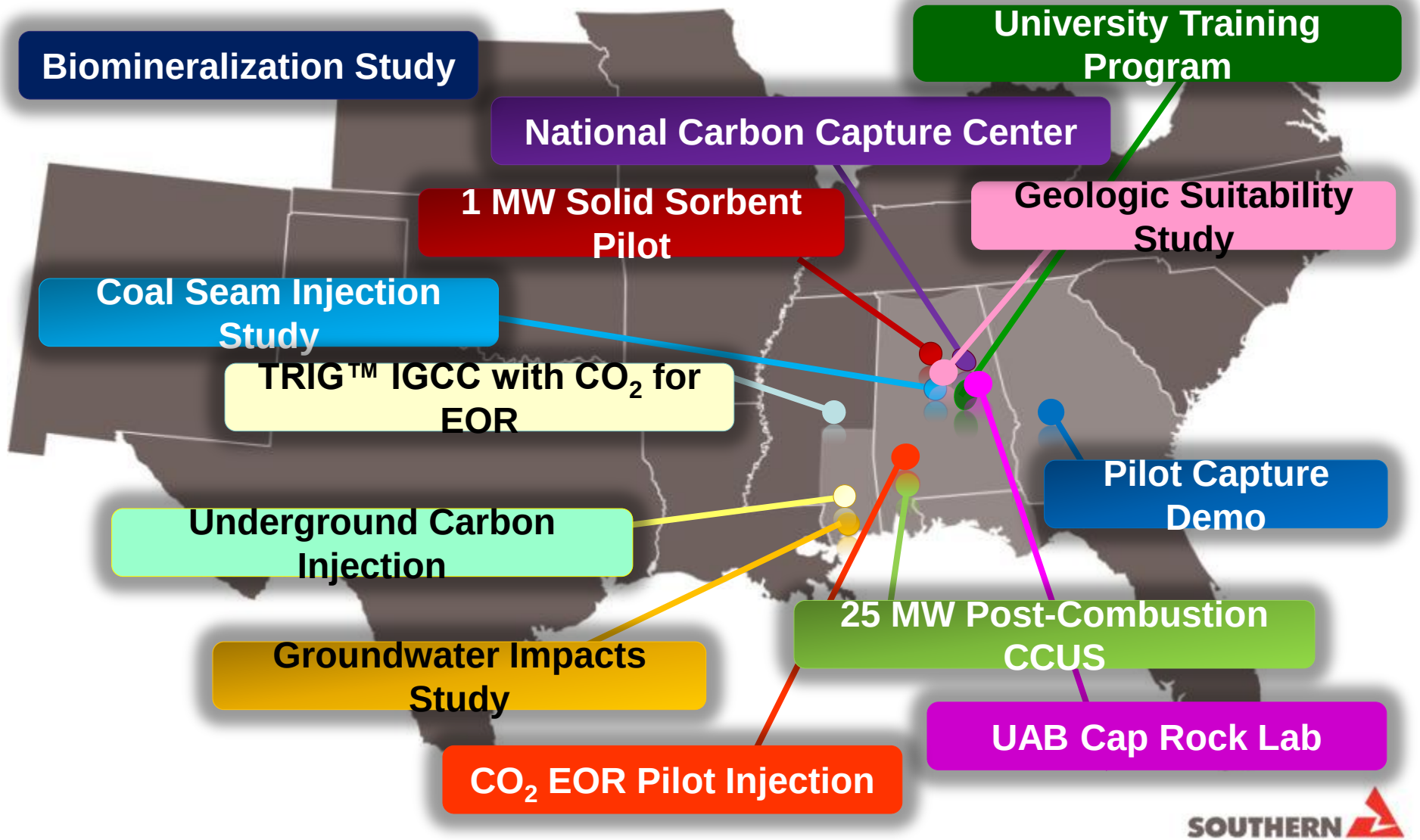
Current Southern Company Projects Related to Carbon Capture, Use and Storage (CCUS)



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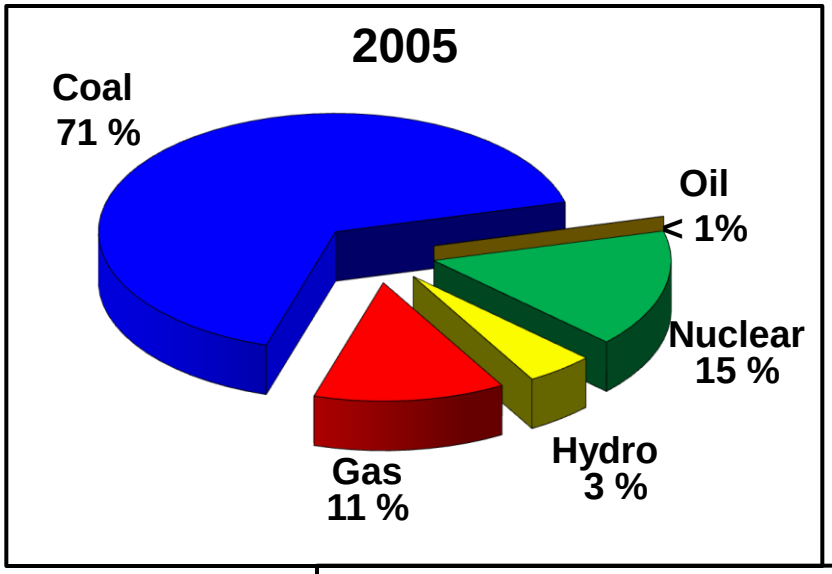
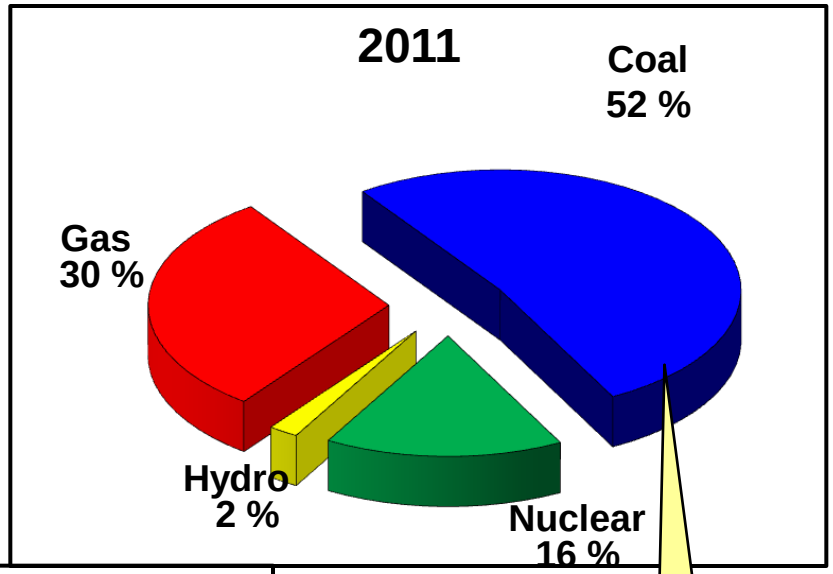
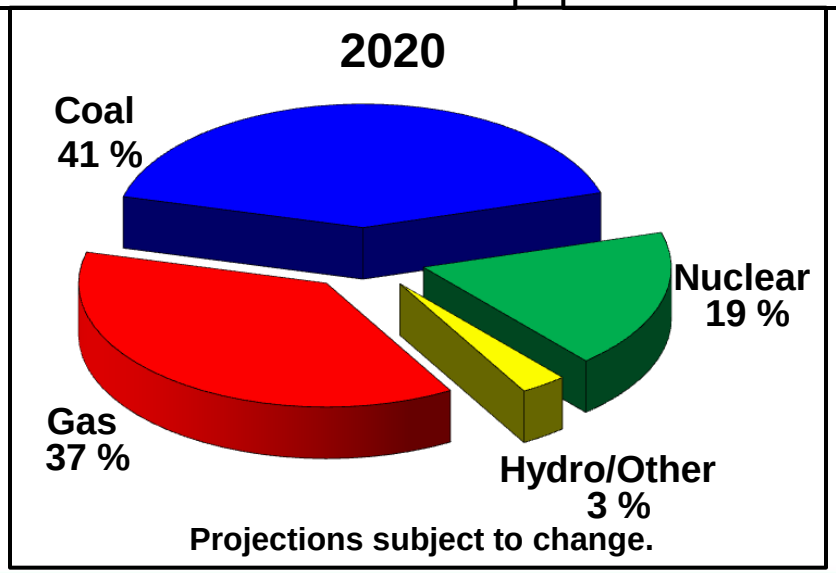
Coal is Expected to Remain a Major Part of Southern Company's Generation Mix





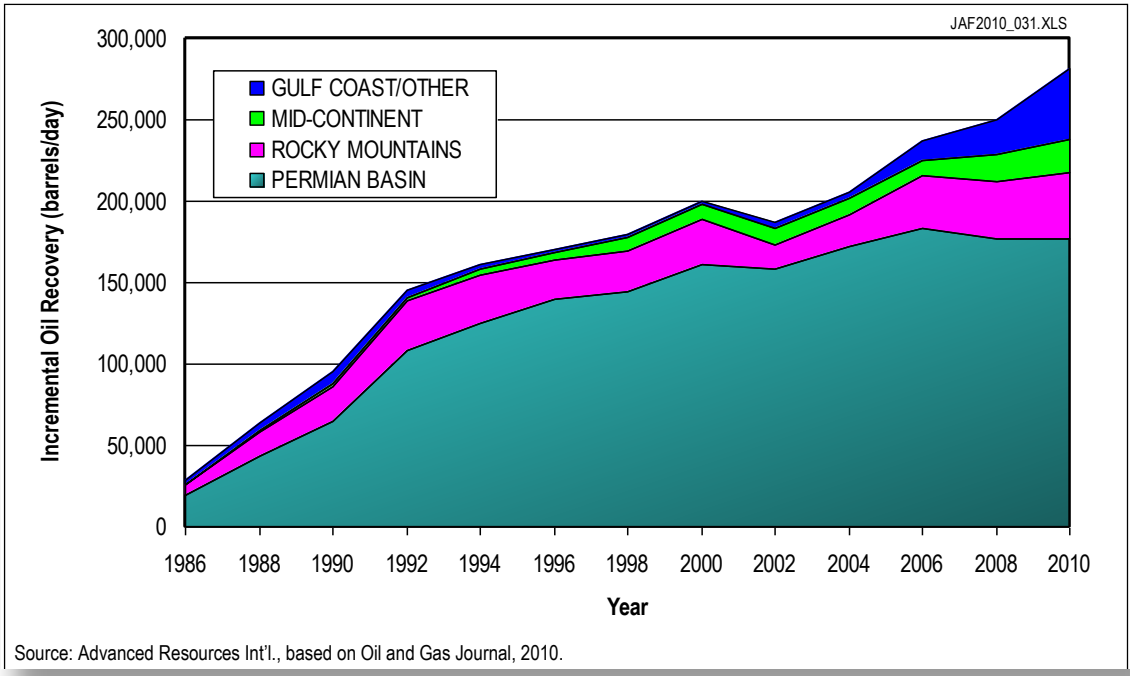


100MM TPY CO_2

SOUTHERN COMPANY

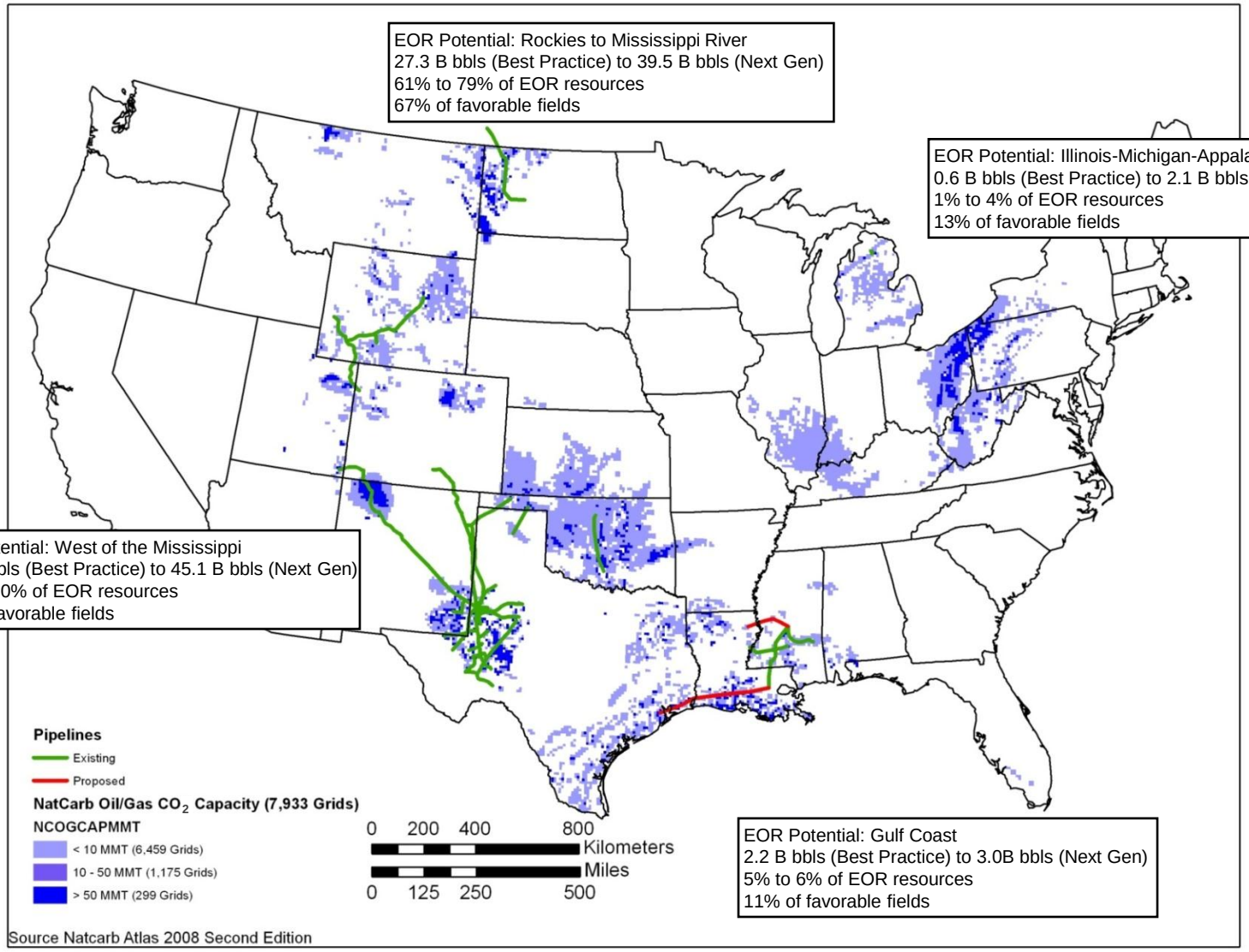
Carbon Capture, Utilization and Storage (CCUS) through EOR is the Business Driver to Catalyze Continued Coal use for Power Generation

- **Production from CO_2 EOR has *increased 40% over the past 6 years***
- **In 2010 it was 5% of total domestic production**
- **EOR is the highest-value, highest-volume use of CO_2**
- **EOR could potentially use CO_2 from 60 GW of power plants with CCUS**
- **EOR will catalyze CCS technologies while providing economic drivers for commercial projects**



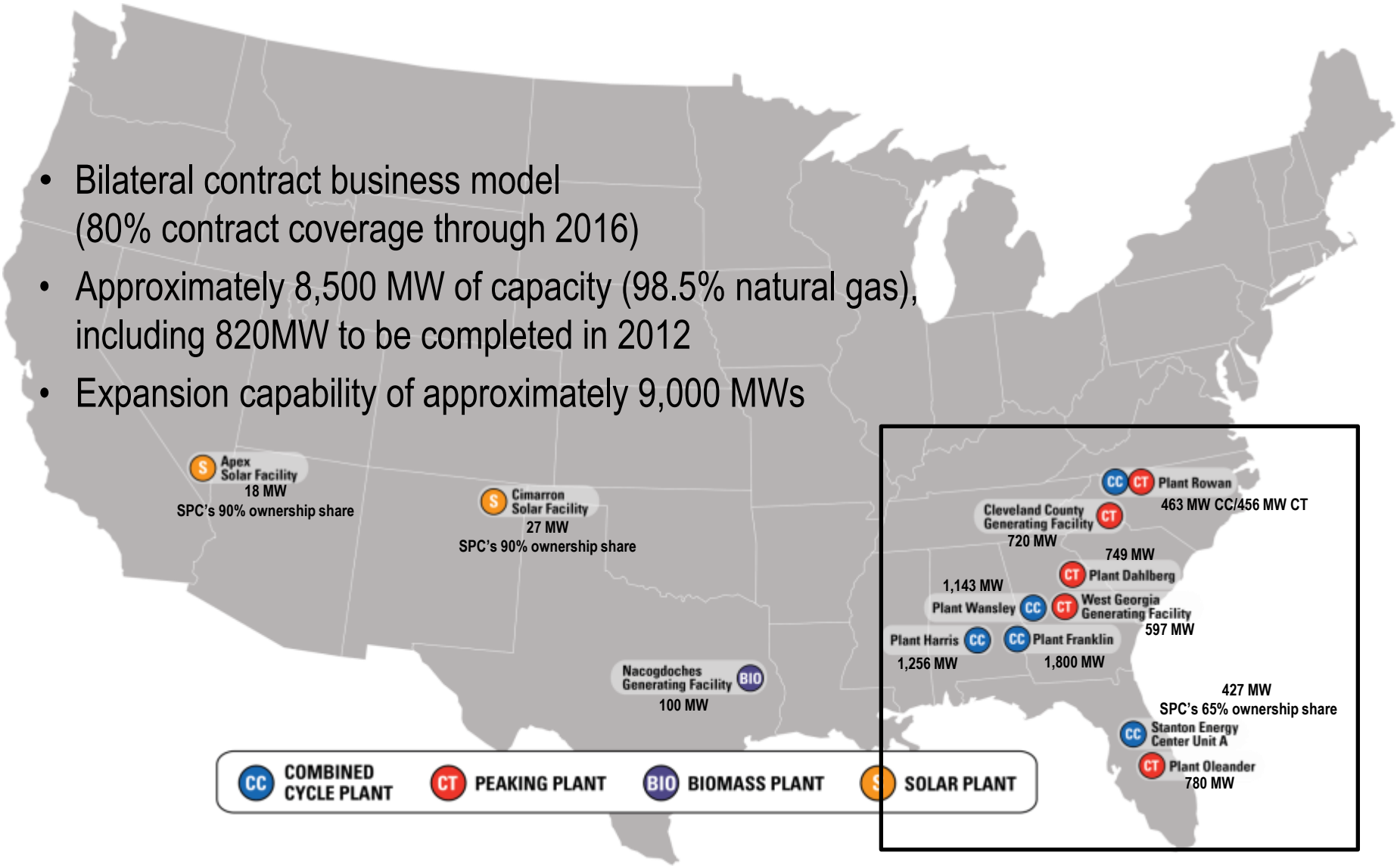
Source: Advanced Resources Int'l., based on Oil and Gas Journal, 2010.

U. S. EOR Opportunities



Southern Power – Unregulated Subsidiary

- Bilateral contract business model (80% contract coverage through 2016)
- Approximately 8,500 MW of capacity (98.5% natural gas), including 820MW to be completed in 2012
- Expansion capability of approximately 9,000 MWs



25 MW Post-Combustion CCUS Demo

at Alabama Power's Plant Barry

- World's largest carbon capture unit on a coal-fired power plant
- 90% CO_2 capture, approximately 150,000 TPY
- Evaluate performance in a coal environment
- June 2011 initial operations

- CO_2 Capture and Compression
  - SCS/MHI collaboration with partners
- Transportation and Sequestration
  - DOE SECARB Phase III "Anthropogenic Test"
  - ~15 mile CO_2 pipeline to Citronelle Field
- Objectives/Goals
  - Advance saline sequestration technology through large field test
  - Characterize CCS operations to support full-scale deployment
  - Continue outreach and education to ensure seamless deployment

SOUTHERN COMPANY

National Carbon Capture Center

U.S. DEPARTMENT OF ENERGY

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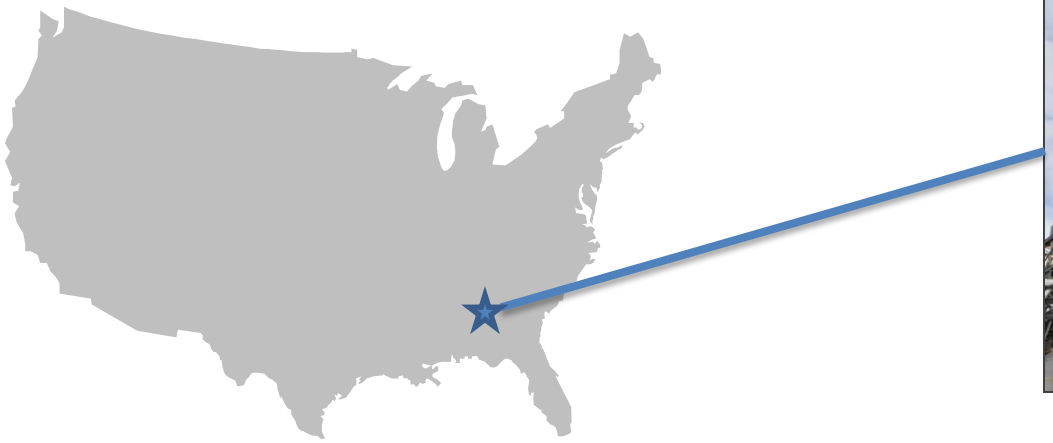


Project Partners

SOUTHERN COMPANY

Luminant

NRG

Peabody

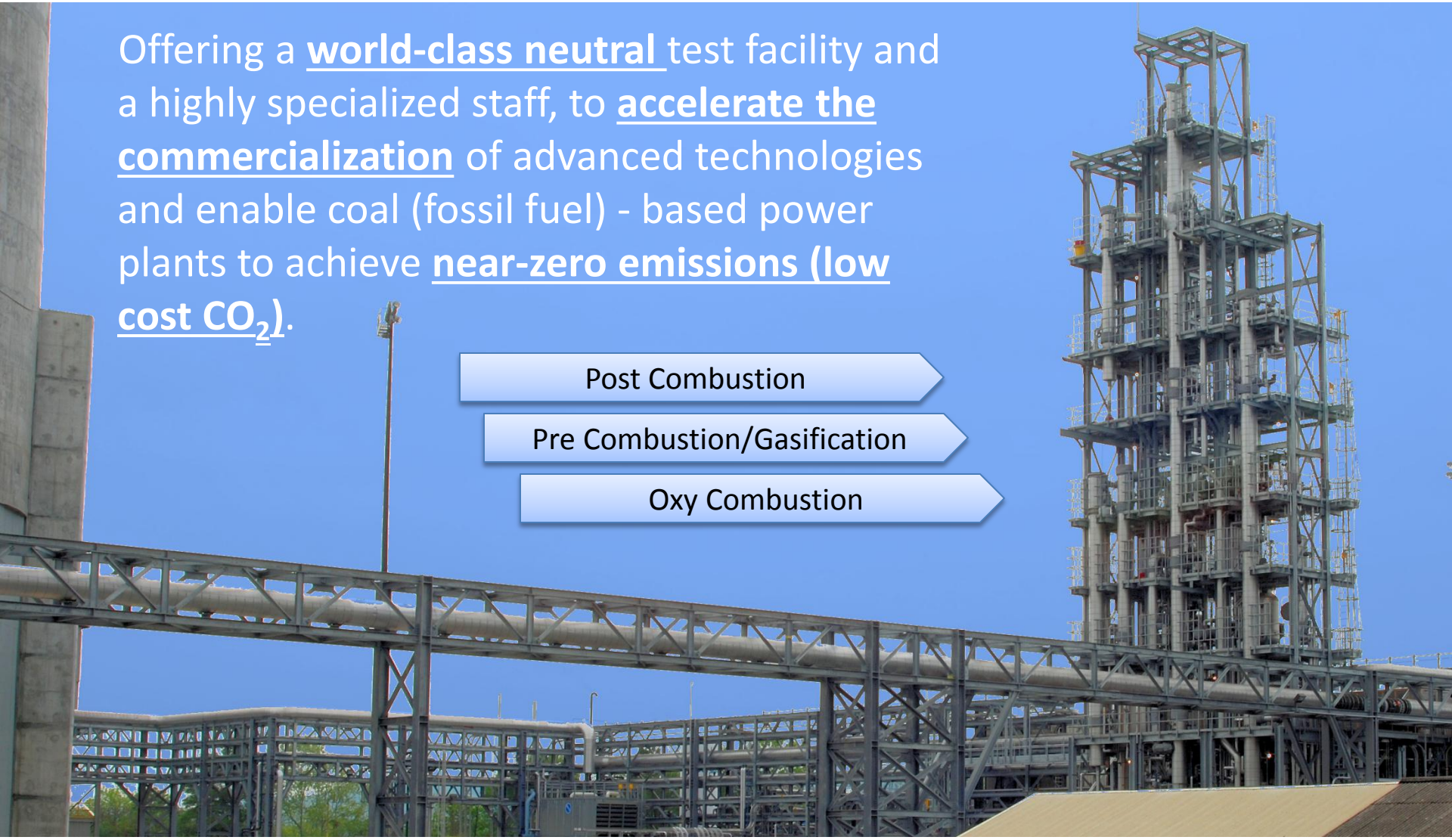
ARCH COAL, INC.

EPRI ELECTRIC POWER RESEARCH INSTITUTE

AEP AMERICAN ELECTRIC POWER

RioTinto

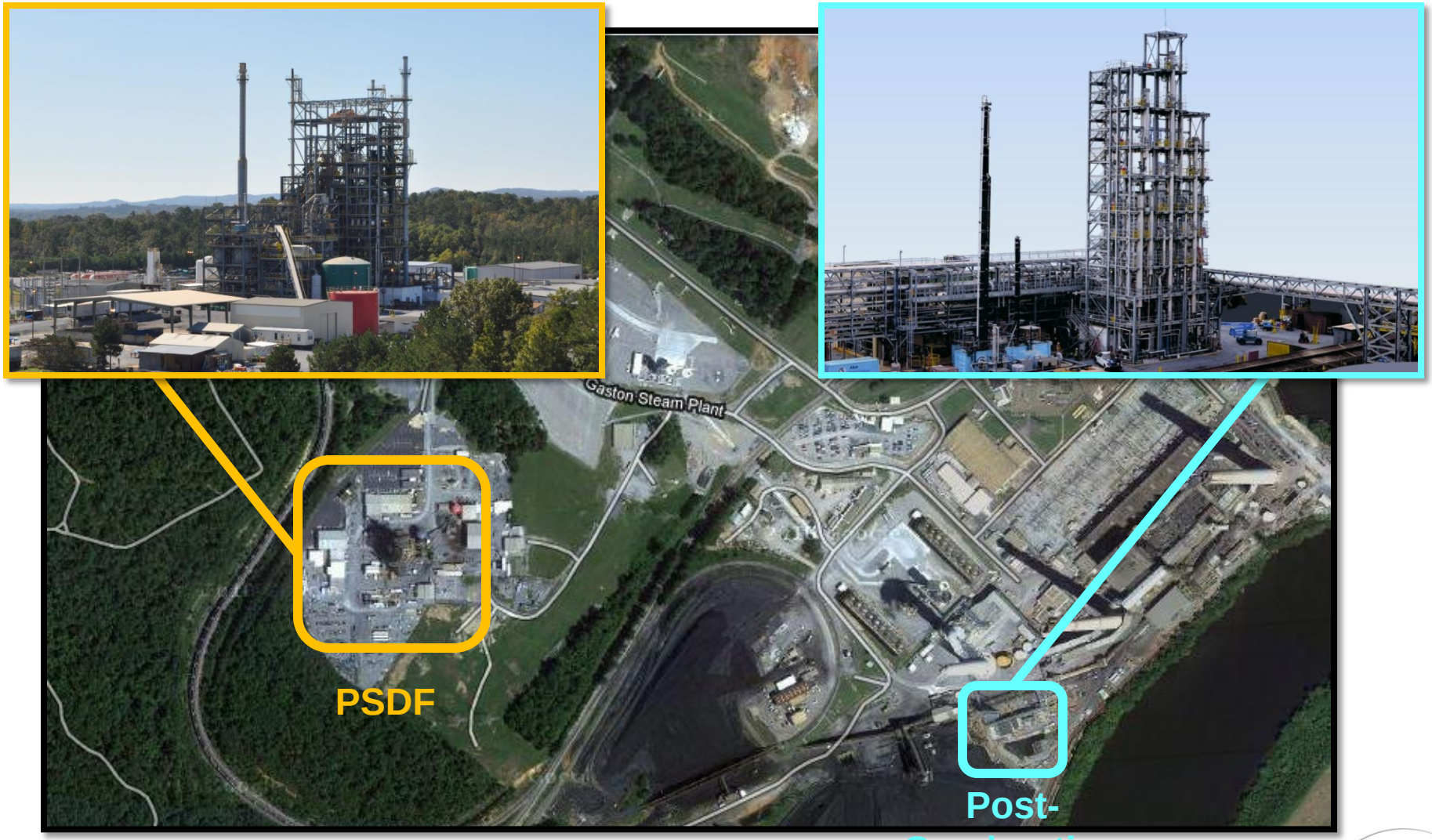
NCCC Mission



Offering a **world-class neutral** test facility and a highly specialized staff, to **accelerate the commercialization** of advanced technologies and enable coal (fossil fuel) - based power plants to achieve **near-zero emissions (low cost CO_2)**.

- Post Combustion
- Pre Combustion/Gasification
- Oxy Combustion

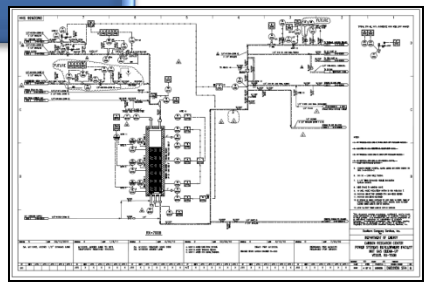
Site Layout



Technology Development Process

Evaluate and Screen Technologies

Define Scope of Work with Technology Developer

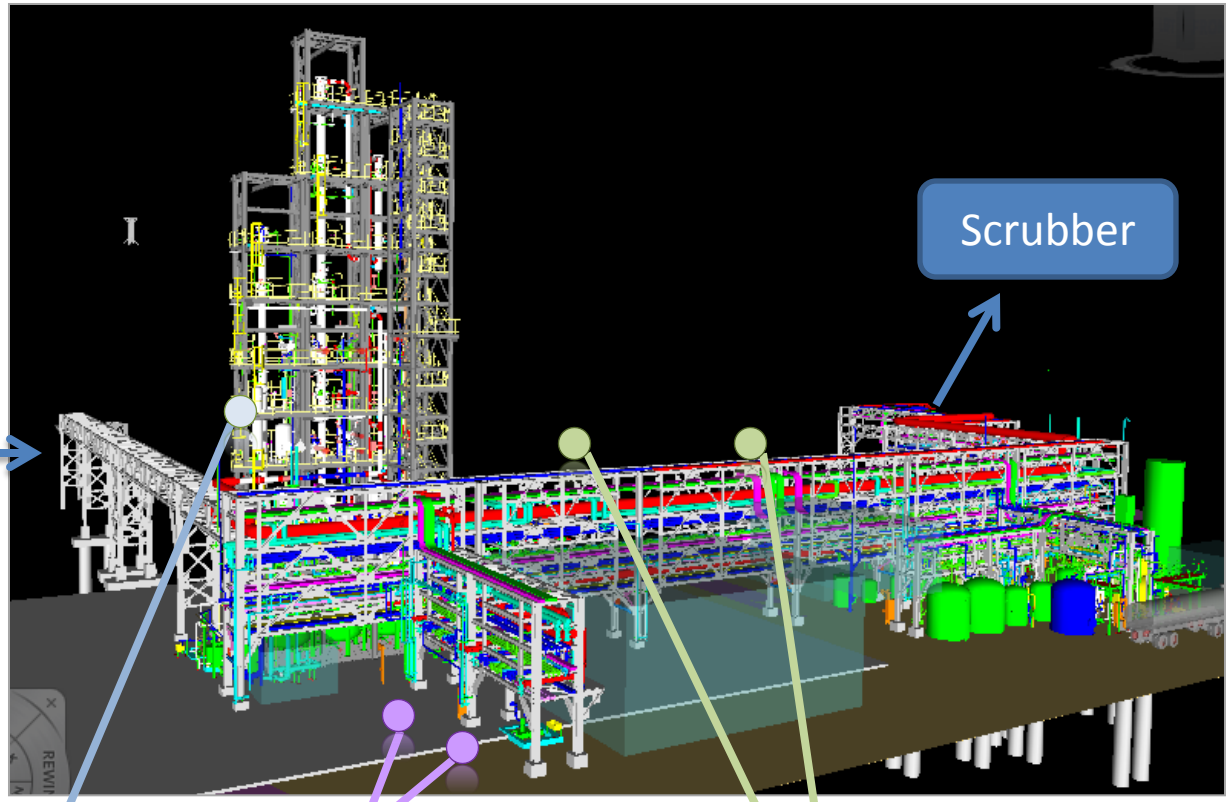


Design and Construct

Operate according to Test Matrix

Analyze Data and Report

Post Combustion Carbon Capture Center (PC4)



PC4 Design and Construction

- Initiated site preparation
- Completed design
- Awarded bids - major equipment
- Began fabrication of PSTU
- Started negotiations with developers

- Completed site preparation and installation of the PSTU and utility bridge
- Developed quality control procedures and analytical methods
- Established PSTU commissioning team

PC4 Testing Completed

PSTU

MEA baseline test
Commissioning, confirm design and validate data

B&W
Advanced solvent, support modeling

Hitachi
Advanced amine, preparation for pilot test

Cansolv
Advanced polyamine in preparation for demonstration

Pilot

Aker
Mobile test unit, test emission control system, advanced amine solvent, long-term operations

Bench

Codexis
Enzyme module, encapsulation process

MTR
Membrane, long term testing, generate critical data to use in scale-up

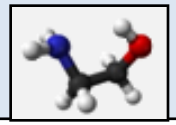
PC4 Ongoing Tests/Future Plans

PSTU

Chiyoda
Advanced amine to establish commercial design

Cansolv
Advanced polyamine under simulated natural gas fired conditions

MEA
Test modified demister, conduct reclaimer tests



Pilot

BASF/Linde
Novel amine solvent based process

MTR
Scale-up of membrane, long term operations

Bench

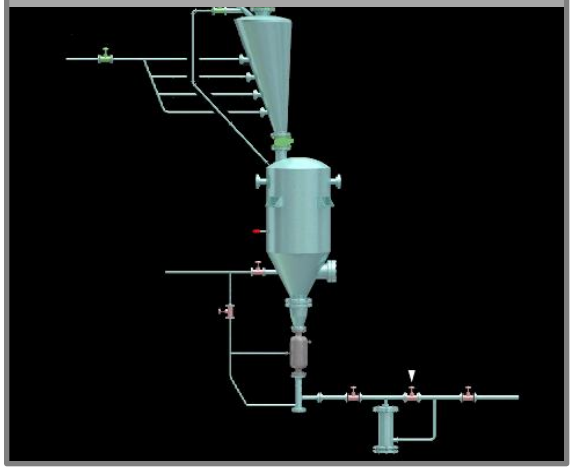
Akermin
Modular unit utilizing carbonic anhydrase enzyme with potassium carbonate

MTR
Membrane, long term testing, generate critical data to use in scale-up

SSTU
Slipstream Solvent Test Unit, test innovative solvents

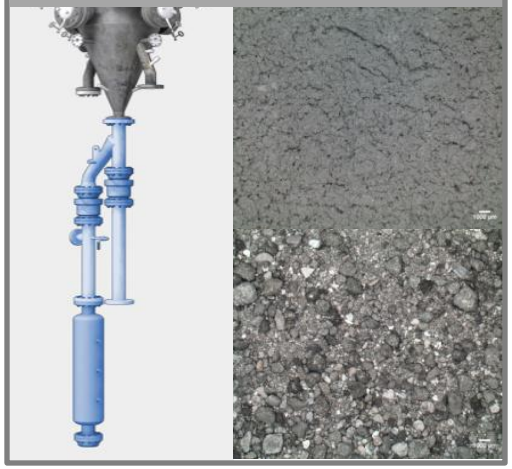
Gasification Technology

Feed System Development



Particulate Removal

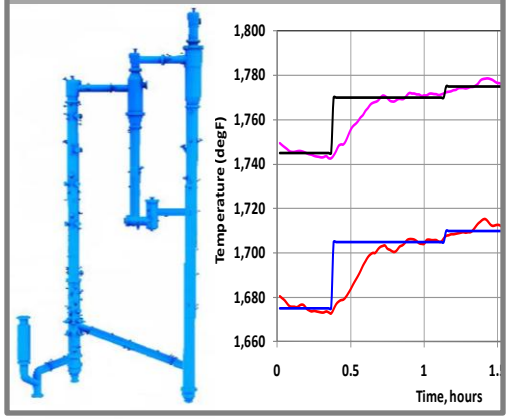
Ash Removal



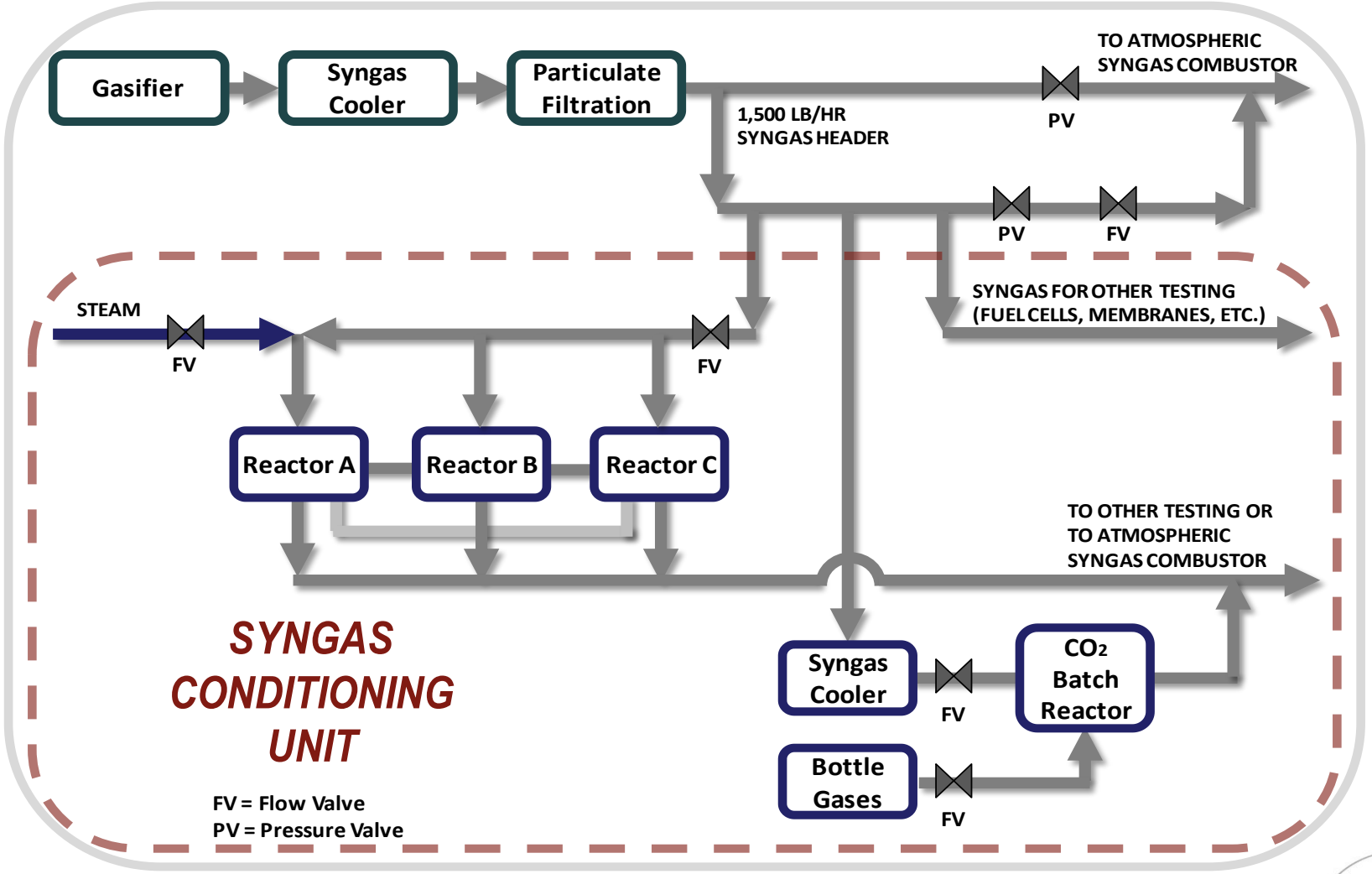
Fuel Flexibility

Sensor Development

Automation



Pre-Combustion CO_2 Capture



Testing Completed/Ongoing

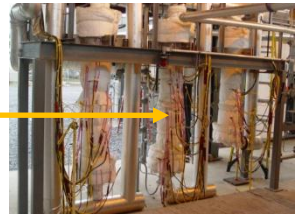
Water Gas Shift Catalyst

- evaluating the effects of temperature, pressure, steam-to-CO molar ratio, and space velocity.
- good mass balance

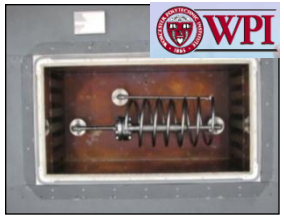
CO_2 capture solvent

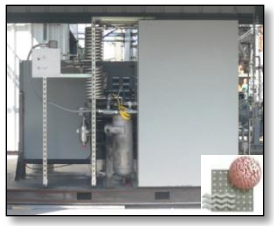
- advanced physical solvents
- confirm the CO_2 capture results with syngas
- evaluate the absorption and regeneration characteristics of H_2S

High-temperature mercury sorbent



Gas Separation Membranes

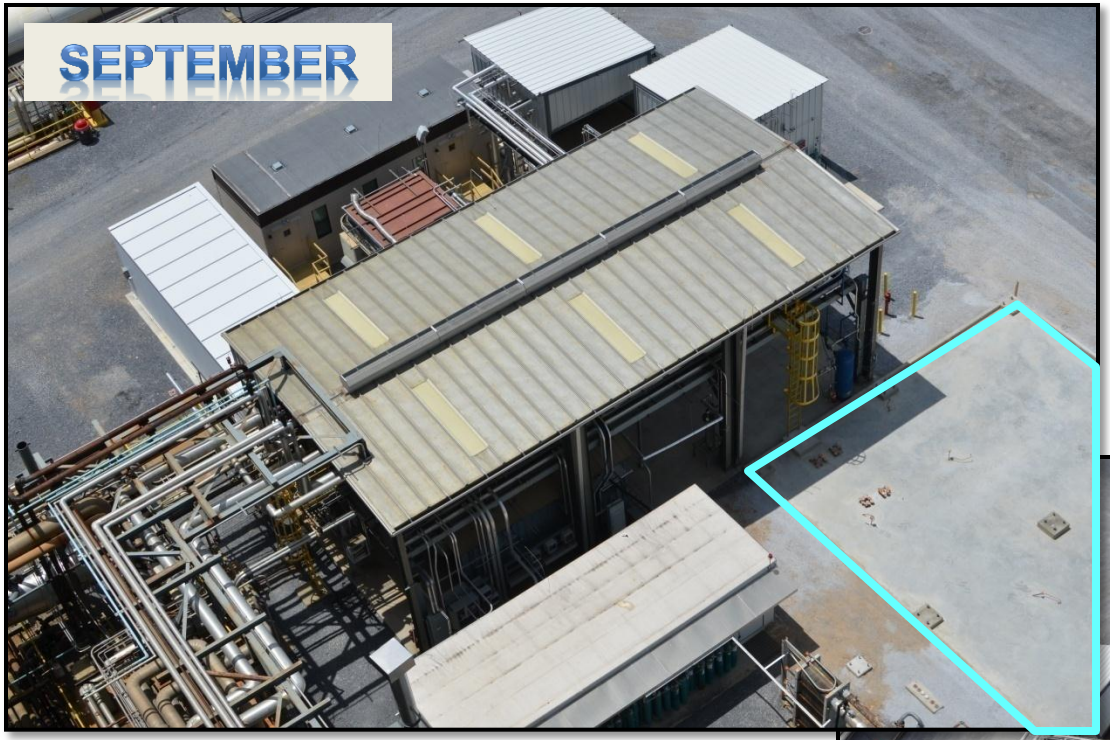




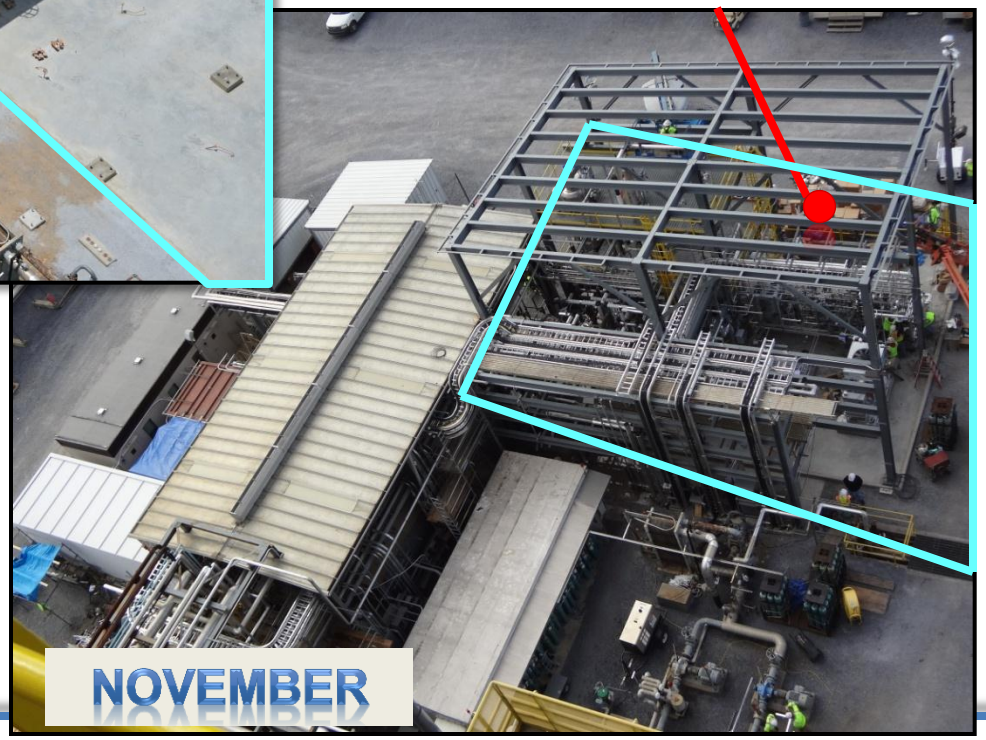
CO_2 capture sorbent

- features 4 sorbent reactors
- novel sorbent is mesoporous carbon-based materials modified with surface functional groups

Pre-Combustion Expansion



MTR CO_2 membrane



Oxy-Combustion

- **Based on the Transport Reactor Technology**

  Adaptation of core technology from Kemper County IGCC Plant and National Carbon Capture Center for high CO_2 capture.

- **An Environmentally Attractive Coal Based Technology**

  Technology offers “near zero” emissions while burning coal, with emissions comparable to a natural gas combined cycle (a Power Plant with no Stack).

- **An Economically Competitive Option for CO_2 Capture**

  Technology is an alternative CO_2 capture technology with a projected lower cost of electricity than other coal and natural gas based alternatives for CO_2 capture.

National Carbon Capture Center

U.S. DEPARTMENT OF ENERGY

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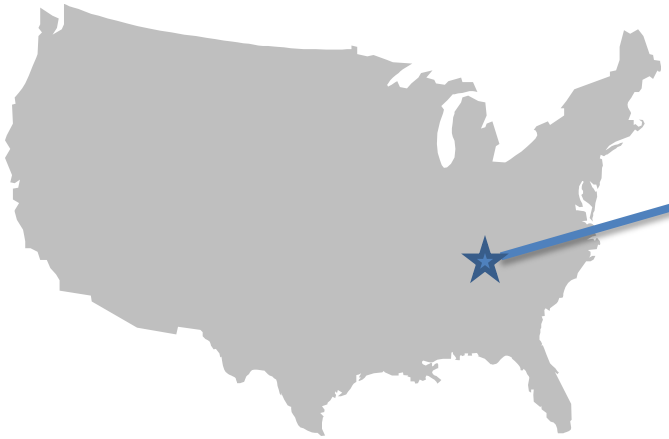

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