

# Southern Company's Carbon Management R&D Technology Portfolio

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## Southeast Regional Carbon Sequestration Partnership 12<sup>th</sup> Annual Stakeholders' Briefing

**R&EA** RESEARCH AND ENVIRONMENTAL AFFAIRS

**SOUTHERN  
COMPANY** 

# Southern Company - 2014



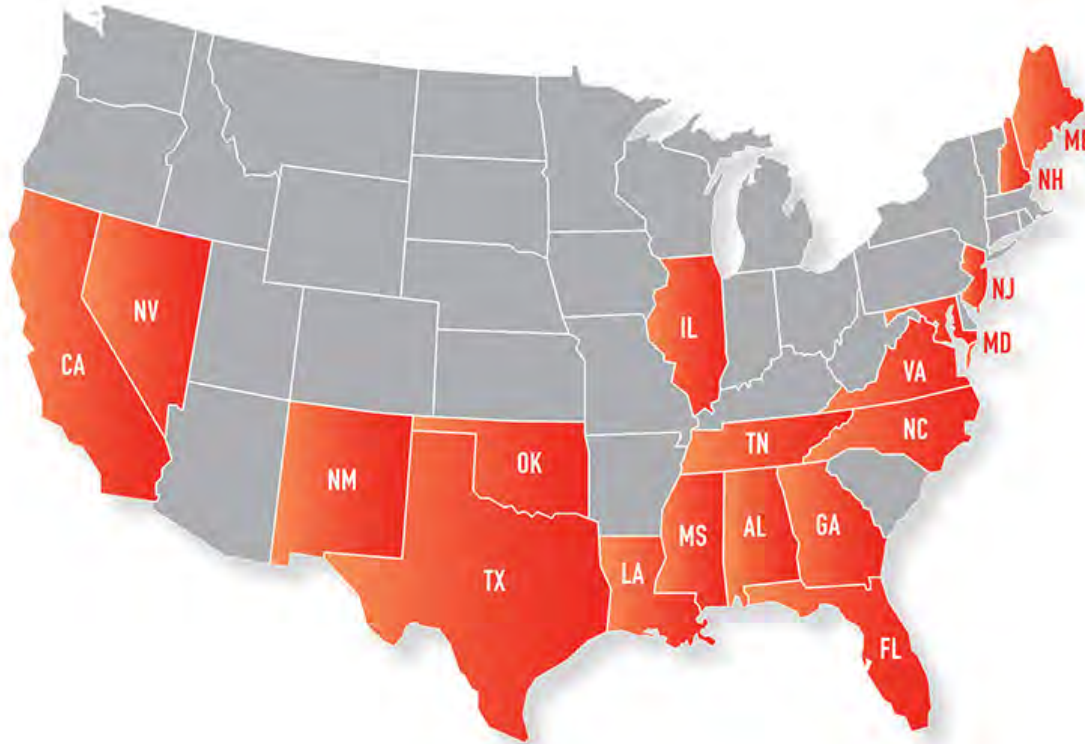
# Who is Southern Company in 2017?

APPROXIMATELY  
**44,000 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  
**18 STATES**

**11**  
ELECTRIC & NATURAL  
GAS UTILITIES

**32,500**  
TOTAL EMPLOYEES

**9 MILLION**  
UTILITY CUSTOMERS

MORE THAN  
**1 MILLION**  
RETAIL CUSTOMERS

# Who is Southern Power?

- Leading U.S. wholesale energy provider
- Nationally recognized renewable energy portfolio
- Provides electricity for municipalities, electric cooperatives and investor-owned utilities
- More than 10,800 megawatts of generating capacity
  - Including 2,200 megawatts of renewable capacity
- 39 facilities in 10 states operating or under construction
- Operating or under development in Alabama, California, Florida, Georgia, Maine, Nevada, North Carolina, Oklahoma, Texas and New Mexico

# Southern Power Portfolio



July 2016

# Renewables

**Southern Company supports the development and use of renewable energy sources and has added more than 4,000 megawatts since 2012**

- **Solar**

- Southern Power and partners operate or are constructing 26 solar plants in six states
- Georgia Power has a growing solar power portfolio expected to be the largest of any investor-owned utility operating without a renewable standard
- Developing projects with the U.S. military in Alabama, Florida, Georgia and Mississippi

# Renewables

- **Wind**
  - Alabama Power is purchasing 404 megawatts of wind energy
  - Georgia Power contracted to purchase 250 megawatts of wind energy
  - Gulf Power contracted to purchase 180 megawatts of wind energy
  - Southern Power “owns” three wind energy facilities in Oklahoma and Maine
- **Biomass**
  - Southern Power operates one of the nation’s largest biomass power plants in Texas
- **Hydro**
  - 33 hydro facilities in Alabama and Georgia provide clean, renewable energy
  - Ranked No. 7 among U.S. utilities in hydro capacity

# Direct Carbon R&D with Technology

- DOE National Carbon Capture Center (Alabama Power) - SCS
- Kemper County energy facility - 70% CO<sub>2</sub> CCUS (Mississippi Power)
  - TRIG Gasification Technology via Southern Generation Technology
- DOE CarbonSAFE (Mississippi Power) - SSEB
- DOE Brine Extraction Storage Test (Gulf Power) - EPRI
- DOE Biomineralization Wellbore Integrity (Alabama Power) - MSU
- Post-Combustion Carbon Capture (Alabama Power) – MHIA
  - SECARB Phase III Integrated CCS Demonsration

# National Carbon Capture Center



U.S. DEPARTMENT OF  
**ENERGY**



10/08 to 9/14

Project Value \$251M

6/14 to 5/19

Project Value \$188M



## Industry Partners



ELECTRIC POWER  
RESEARCH INSTITUTE



CLOUD PEAK  
ENERGY®



Luminant



AMERICAN  
ELECTRIC  
POWER

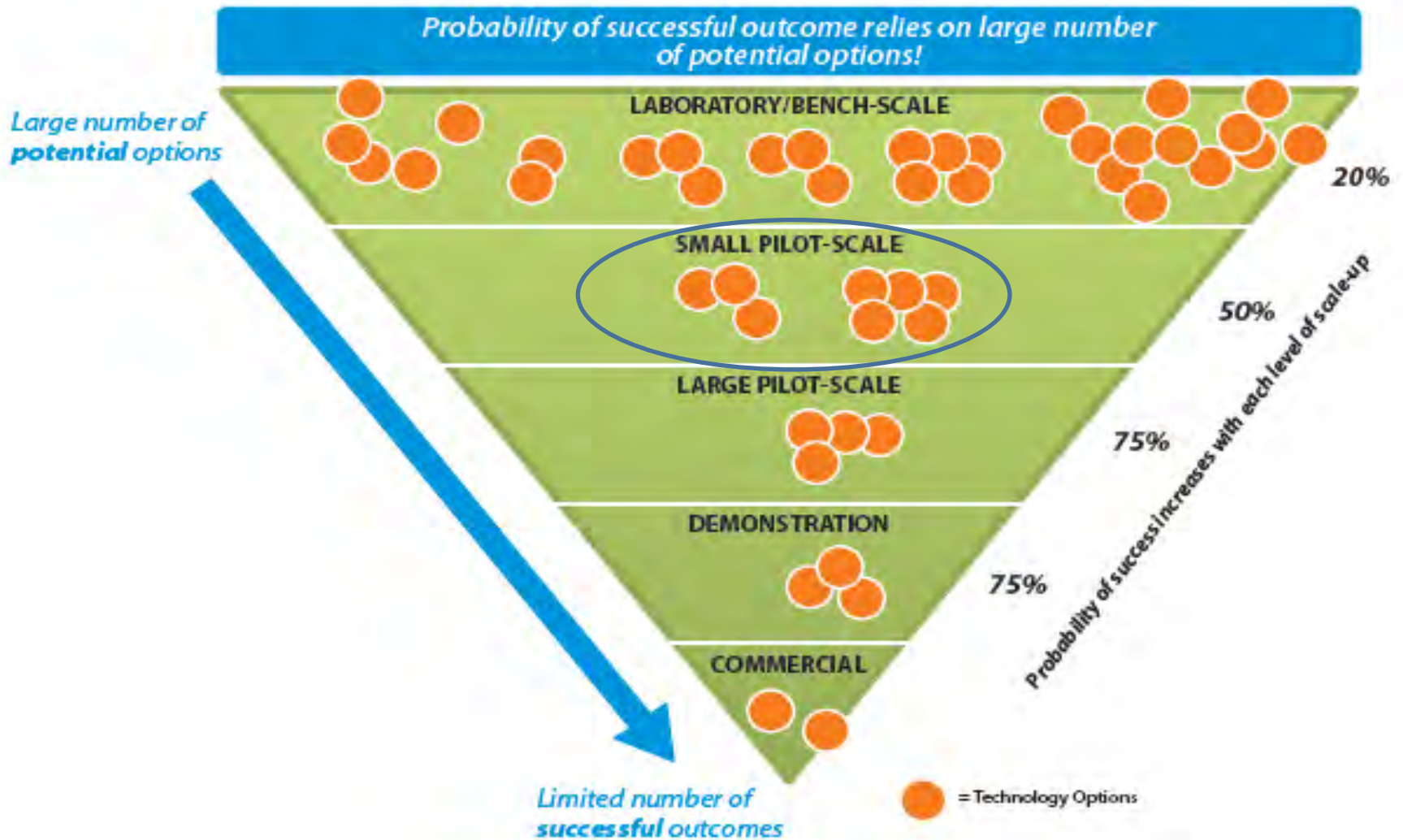


DUKE  
ENERGY®



ArchCoal

Offering a world-class neutral test facility and a highly specialized staff, to accelerate the commercialization of advanced technologies and enable coal based power plants to achieve near-zero emissions (low cost CO<sub>2</sub>).

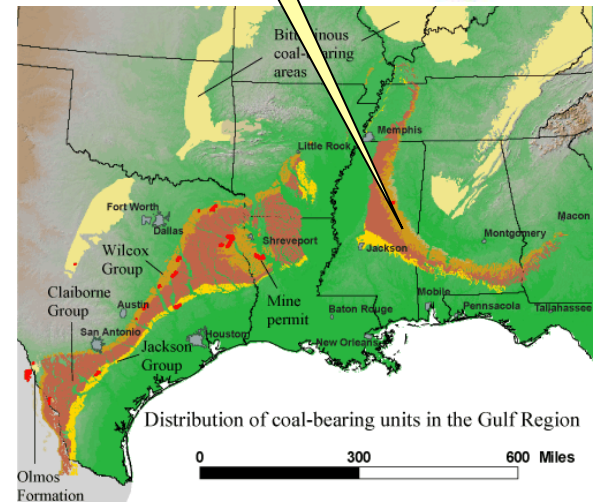
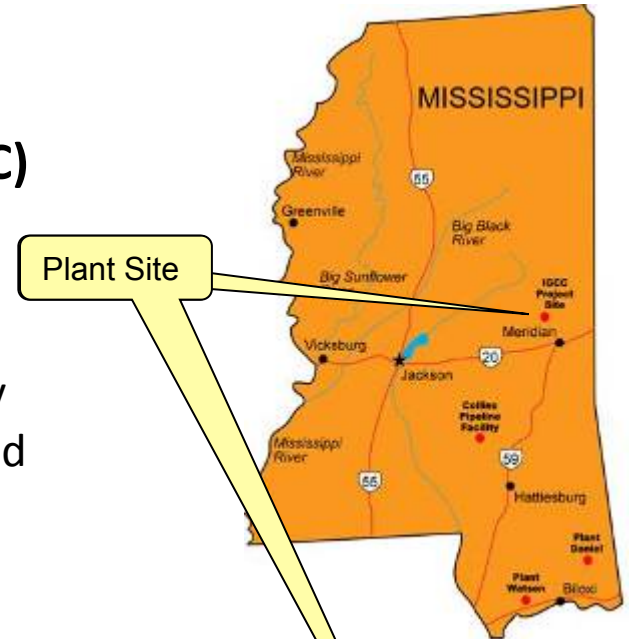


# Kemper County Energy Facility

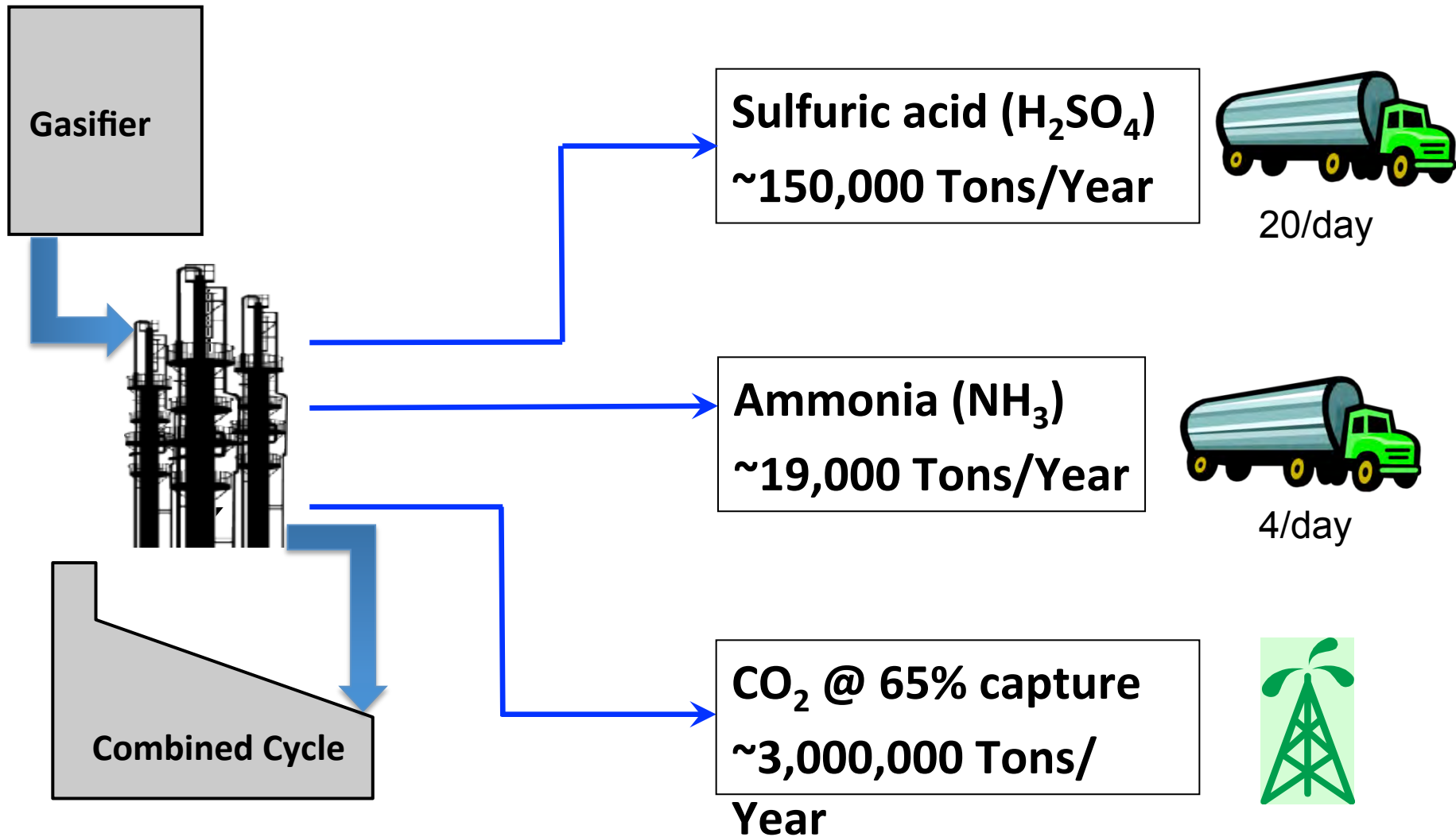


# Project Overview

- **2x1 Integrated Gasification Combined Cycle (IGCC)**
  - 2 Transport Gasifiers
  - 2 Siemens SGT6 - 5000F gas turbines
  - 1 Toshiba steam turbine
  - 740 MW gross capacity; 582 MW net peak capacity
  - Chemical products: carbon dioxide, sulfuric acid, and ammonia
- **Project Information**
  - Mine-mouth lignite (brown coal)
  - Zero liquid discharge
  - Uses treated effluent as makeup water
- **Mine Operations**
  - Commercial operation; June 5, 2013
  - Dragline in-service; Fall 2013
  - More than 1 million tons of lignite mined
  - 20 acres of mined property reclaimed already



# Saleable by-products



# Plant and Aerial View - 2016



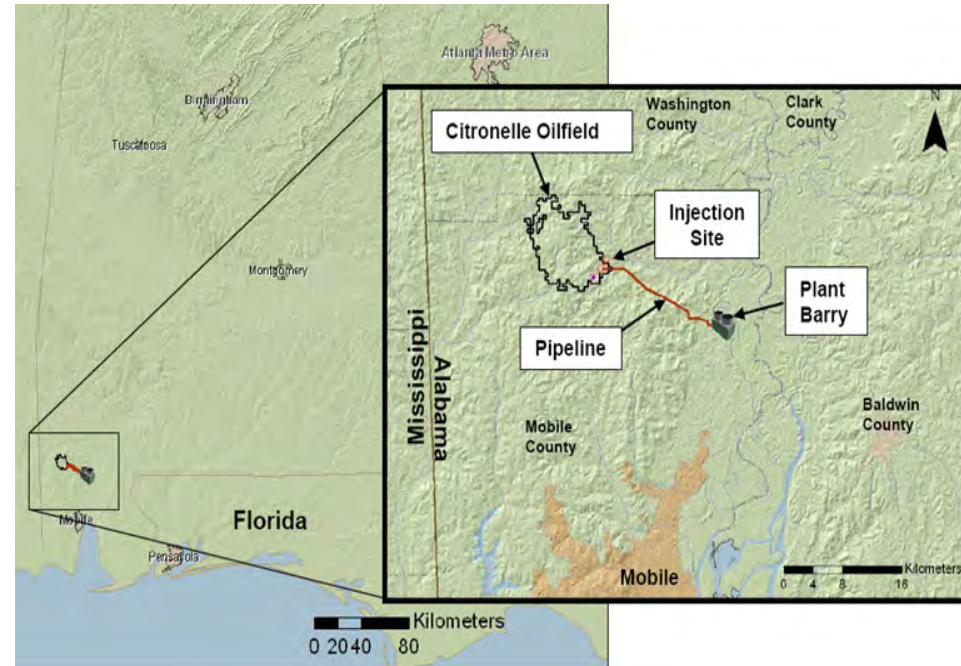
# Lignite Handling and Drying



# Plant Barry CCS Demonstration

*“Largest capture facility on a fossil-fueled power plant in the USA”*

- Carbon capture from Plant Barry (equivalent to 25MW of electricity).
- 12 mile CO<sub>2</sub> pipeline linking captured CO<sub>2</sub> with the injection site.
- CO<sub>2</sub> injection of 115,000 metric tons of into ~9,400 ft. deep saline formation.
- Monitoring of CO<sub>2</sub> storage during injection and three years post-injection.



Power Plant



Capture



Transport



Storage

# New Testing Proposed Objectives

- Develop and quantify viable cost and energy saving methods for the capture and sequestration of CO<sub>2</sub> produced from pulverized coal (PC) combustion
  - **Built-in Reboiler:** Construct and test built-in-reboiler to confirm technology is suitable for the regenerator
  - **Particulate Matter Management:** Complete Particulate Management Test to determine maximum allowable PM concentration and determine if solvent purification steps can be eliminated
  - **New Solvent:** Demonstrate performance and energy efficiency improvements of New Solvent A over KS-1 and MEA
- Evaluate the technical and economic feasibility of full-scale implementation of this technology

# Geologic Characterization

*“to advance site certification for commercial storage”*

Alabama Power Plant Gorgas Stratigraphic Test Well (one 5,000 foot well drilled)



Mississippi Power Plant Daniel CO<sub>2</sub> Pilot Injection Study (two 8,500 foot wells drilled/ 3,000t/injected)



Alabama Power Plant Barry CO<sub>2</sub> Injection Demonstration (three 9,500 foot wells drilled, 115,000 t/injected)



Kemper County Energy Facility CarbonSAFE (three wells proposed to be drilled in 2017)



# Carbon Storage Assurance Facility Enterprise

## *Host Site is Kemper County Energy Facility*

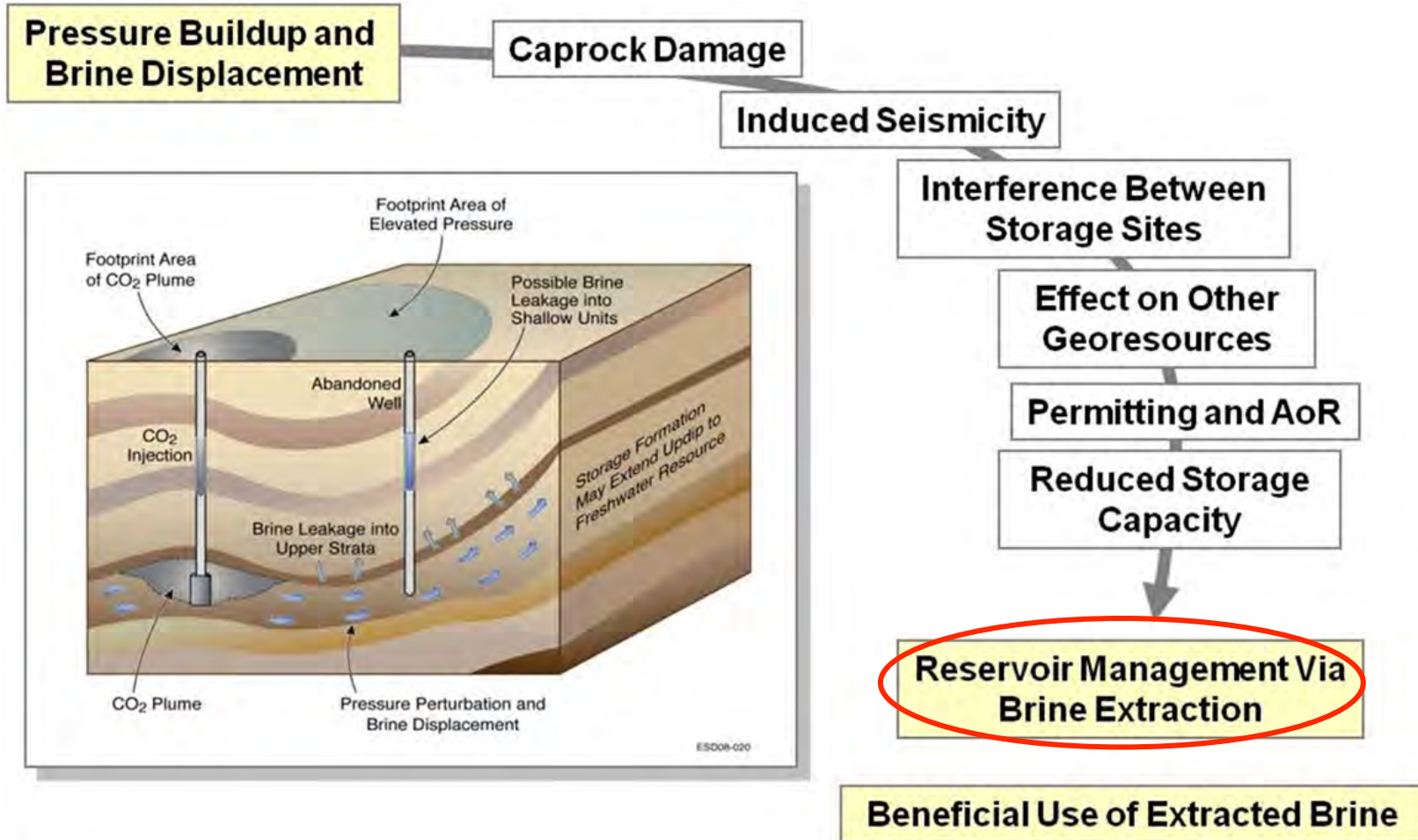
- **Program Goals:** DOE – Office of Fossil Energy effort to develop a commercial-scale integrated CCS storage complex constructed and permitted in the 2025 timeframe over a series of sequential phases of development.
- **Program Phases:**
  - Phase 1. Integrated CCS Pre-Feasibility Study  
Develop plans encompassing technical requirements, as well as both economic feasibility & public acceptance of an eventual storage project
  - Phase 2. Storage Complex Feasibility Study  
Perform initial site characterization of a storage complex having high potential for commercial storage (50+ million tonnes CO<sub>2</sub>)
  - Phase 3. Site Characterization
  - Phase 4. Permitting & Construction

# Budget Periods/Program Cost-Share

- Approximately 44M available in FY2017 through FY2020.
  - Eleven (11) Phase I awards were selected (average award was 1.0M)
  - Three (3) Phase 2 awards were selected
    - SSEB - \$11,220,537 DOE Funds
    - University of North Dakota - \$8,787,662 DOE Funds
    - University of Illinois - \$8,906,264 DOE Funds
- To expedite being “storage ready” we are accelerating the schedule to be “injection ready” in FY2022 by moving directly into Phase 2 (by-passing Phase 1).
- Phase 2. (Jan, 2017 - Sept, 2018)
- Phase 3. (Oct, 2018 - Sept, 2020)
- Phase 4. (Oct, 2020 - Sept, 2025)

# DOE EPRI Brine Extraction Storage Test

## *Host Site is Gulf Power – Plant Smith*



**Research Focus - Managing CO<sub>2</sub> Injection Pressures to Facilitate Commercial CO<sub>2</sub> Storage**

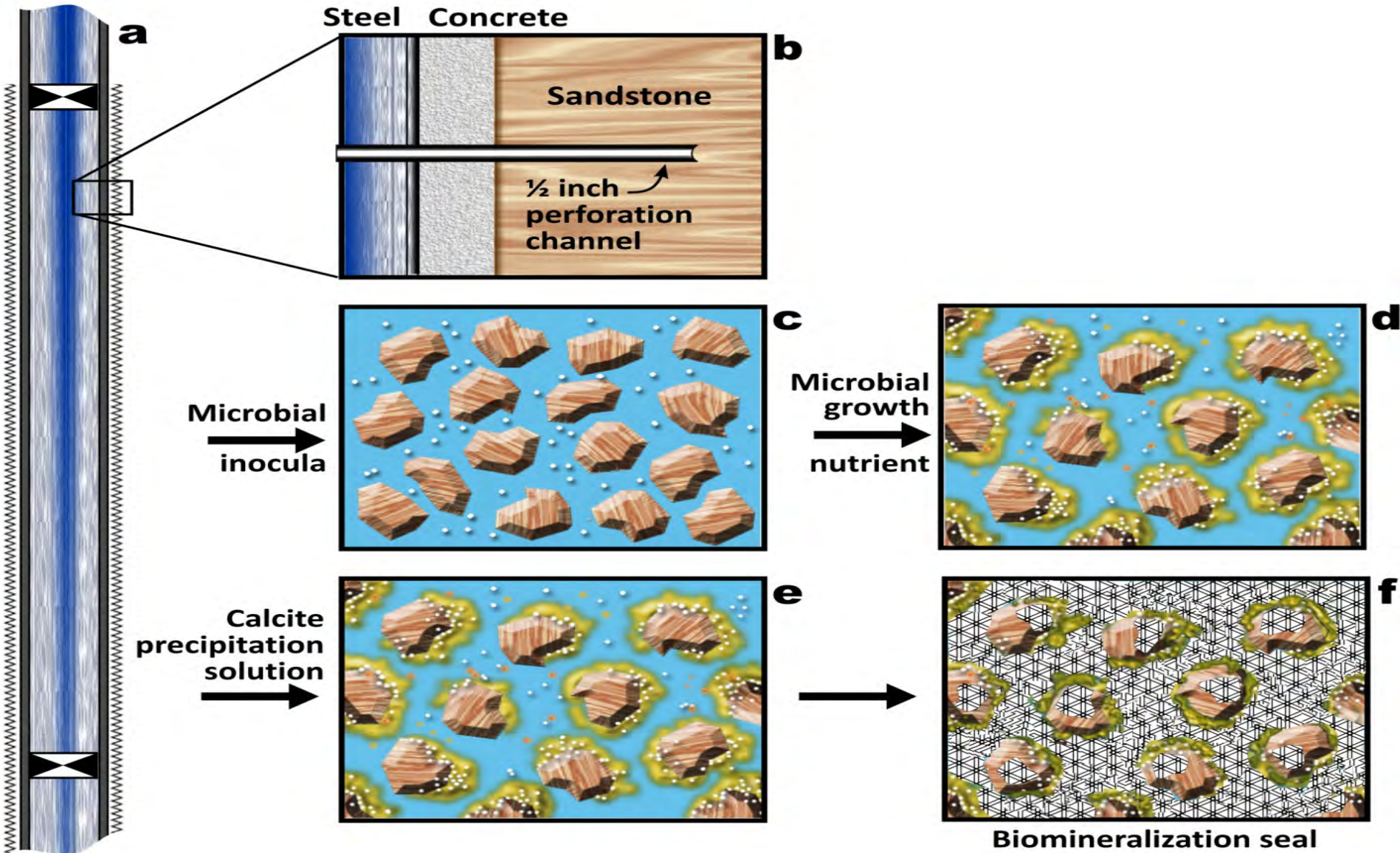
# DOE – MSU Well Bore Leakage Mitigation

## *Host Site is Alabama Plant Gorgas*

### **Motivation behind the leakage mitigation study:**

- Wellbores are identified as a leakage pathway risk in many storage systems
- Biological control of permeability and sealing leaking boreholes
- Sealing fractures and cap rocks
- Reassure stakeholders that geologic sequestration is safe and secure

# Proof of concept to field demonstration

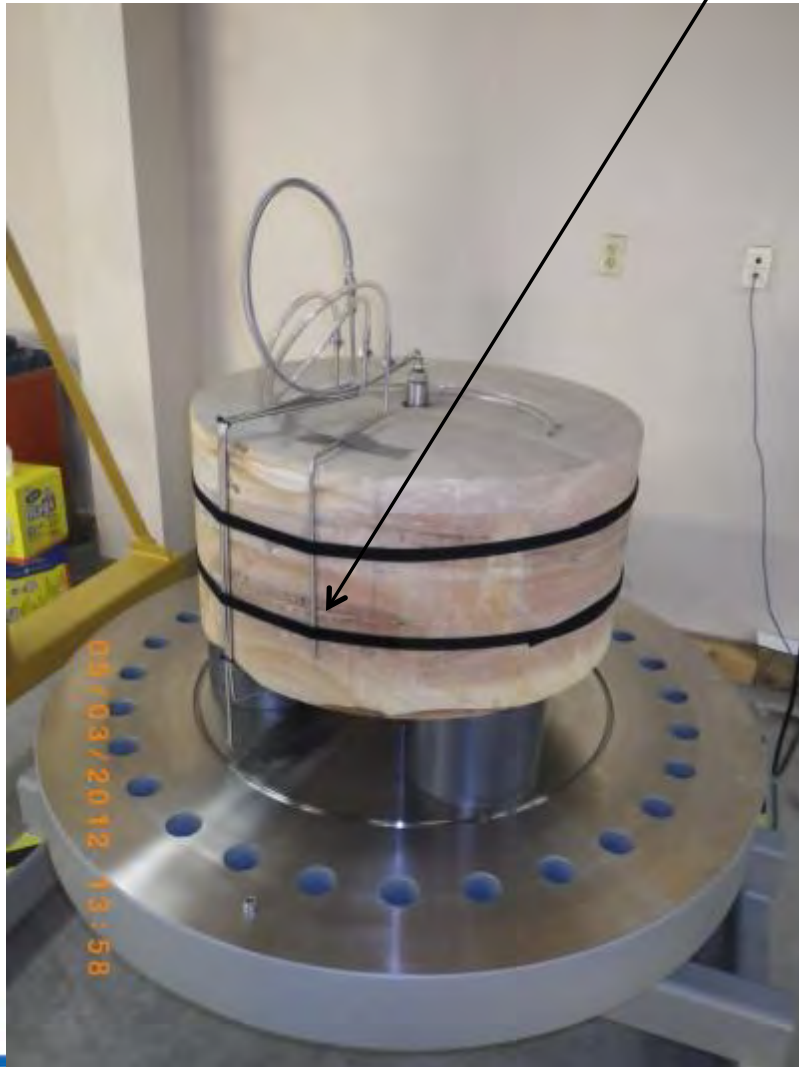


# Sample collection in the field

Sample collection for  
“field-scale lab study”



# Before images of induced fractures



Region of fracture



The core was hydraulically fractured under ambient conditions right before loading into the vessel. Distinct flow channels were formed.



**After images of  
sealed fractures**



## Path Forward (2017-2018)

- Continued focus on CCS R&D with both basic science, field science, and commercial-demonstration
  - Support CarbonSAFE program at Mississippi Power - Kemper County Energy Facility
  - Support BEST project at Gulf Power - Plant Smith
  - Open to new funding opportunities with R&D due diligence with CCUS including non-EOR utilization