

Getting Projects Off The Ground

Prepared For:

Maryland CO_2 Sequestration Workshop

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November 20, 2019

Unconventional Resources • Enhanced Recovery • Carbon Sequestration

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Acknowledgement

This presentation is based upon work supported by the Department of Energy National Energy Technology Laboratory under **DE-FC26-05NT42590** and was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Getting Projects Off the Ground

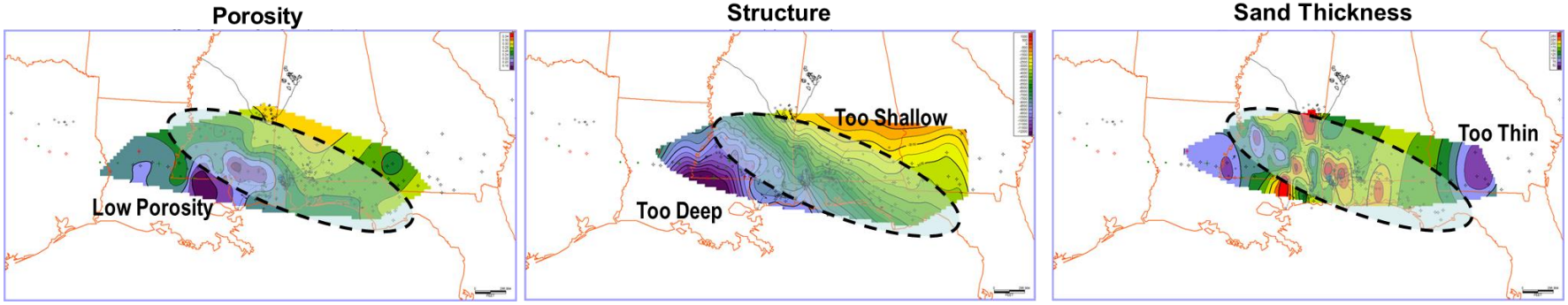
1. Regional characterization using existing data sources
   - Storage Complexes
   - CO2 sources
2. Pilot injection test(s)
3. Integrated CO_2 capture, transportation and storage demonstrations
4. Commercialization
5. So how do we get projects off the ground?

Regional Characterization

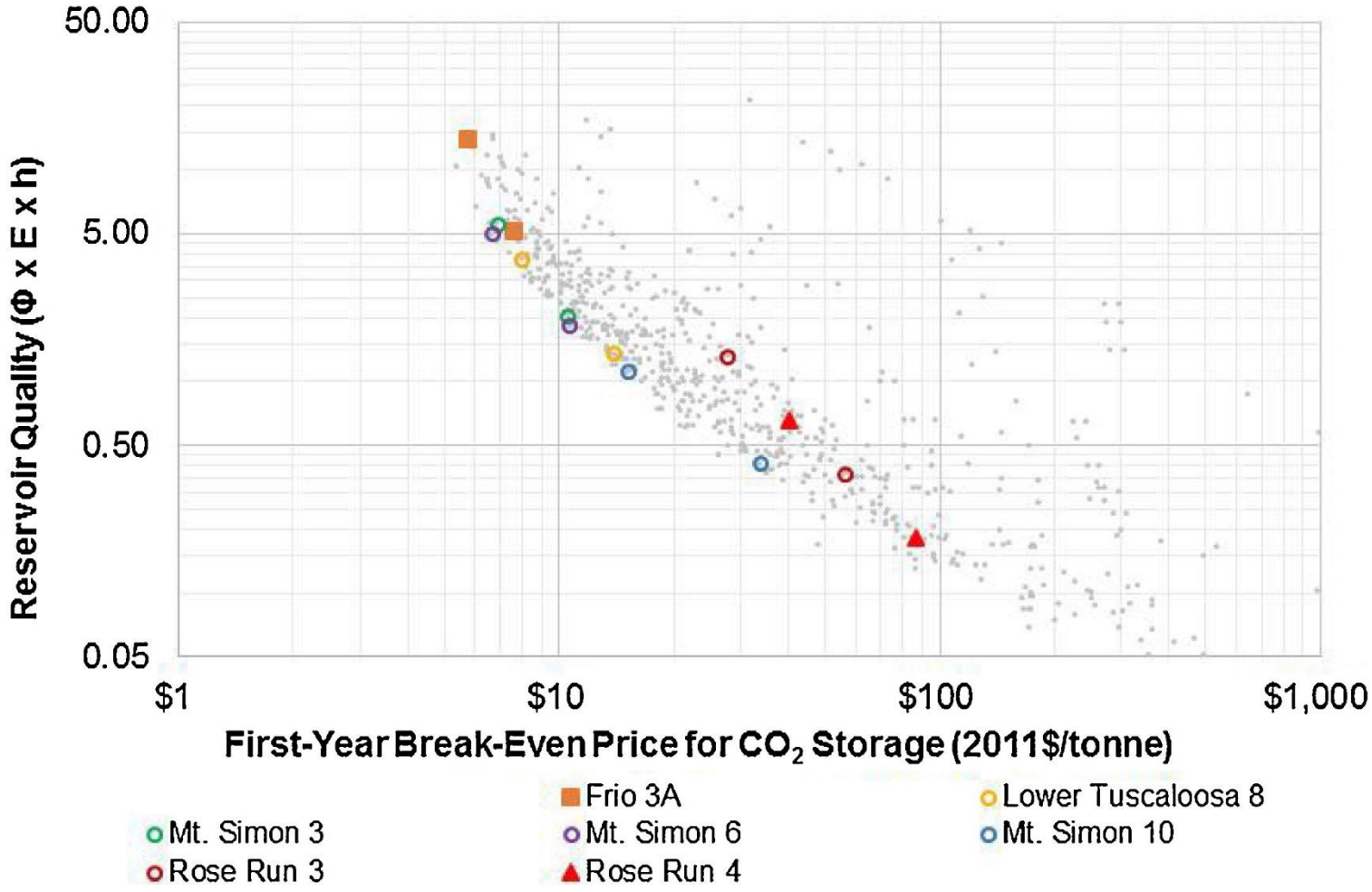
SECARB
Southeast Regional Carbon Sequestration Partnership

- Underground CO_2 storage capacity is a function of reservoir depth, thickness and porosity
- Underground CO_2 storage security is a function of geologic structure, overlying rocks that will contain the CO2, and permeability
- We can often scope for reservoirs with these characteristics using existing data

Lower Tuscaloosa Formation Regional Maps



Saline Aquifer Storage Costs



From Grant et al., IJGGC, Volume 72, May 2018, Pages 175-191

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Pilot Test Example: Mississippi Test Site 2008-2010

- **Purpose**: Locate and test suitable geological sequestration sites in proximity to large coal-fired power plants in the Southeast region
- **Initial Target**: Deep saline reservoirs along MS Gulf Coast with high potential CO2 storage capacity
- **Objectives**:
  - Build geological and reservoir maps for test site
  - Conduct reservoir simulations to estimate injectivity, storage capacity, and long-term fate of injected CO2
  - Address state/local regulatory and permitting issues
  - Foster public education and outreach
  - Inject 3,000 tons of CO_2
  - CO2 monitoring

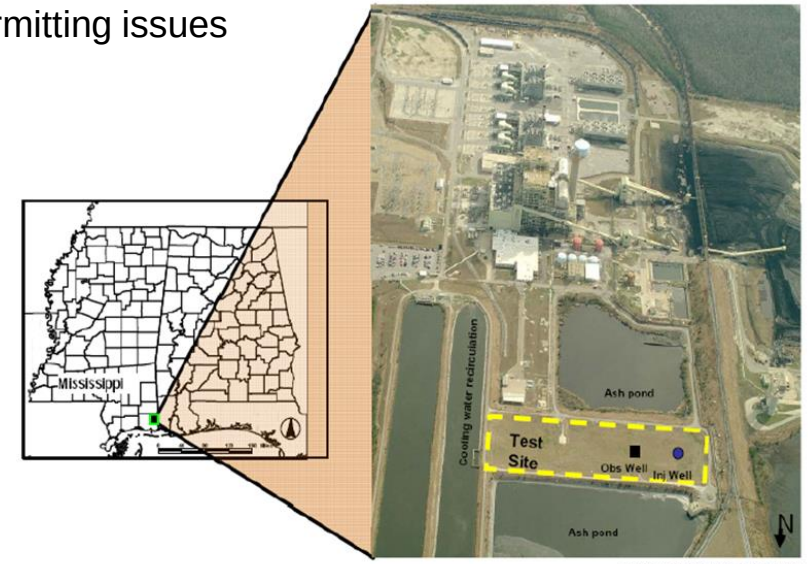


Image Source: Google Earth

Citronelle Phase III Integrated Demo 2008 - 2018

Power Plant

Capture

Transport

Storage

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Anthropogenic Test

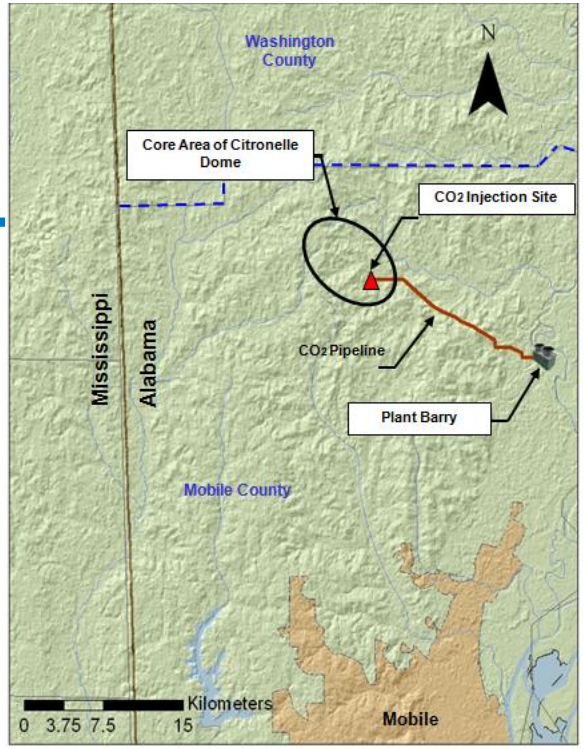
Capture: Alabama Power 's Plant Barry, Bucks, Alabama

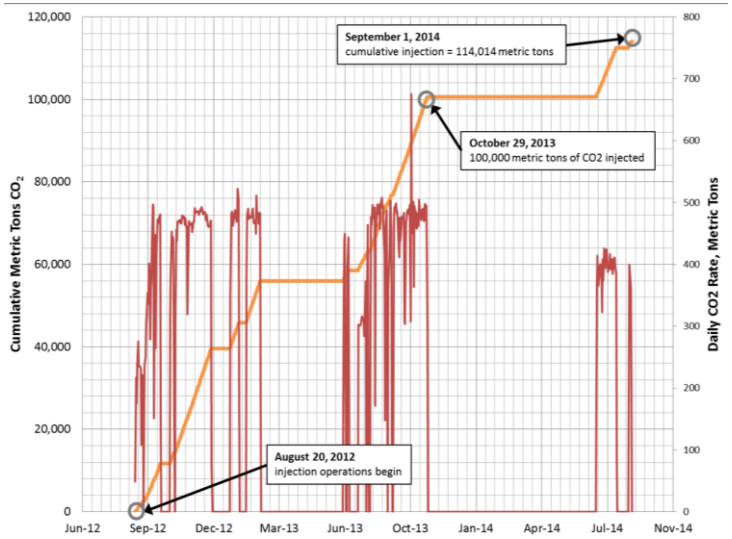
Transportation: Denbury

Geo Storage: Denbury's Citronelle Field, Citronelle, Alabama

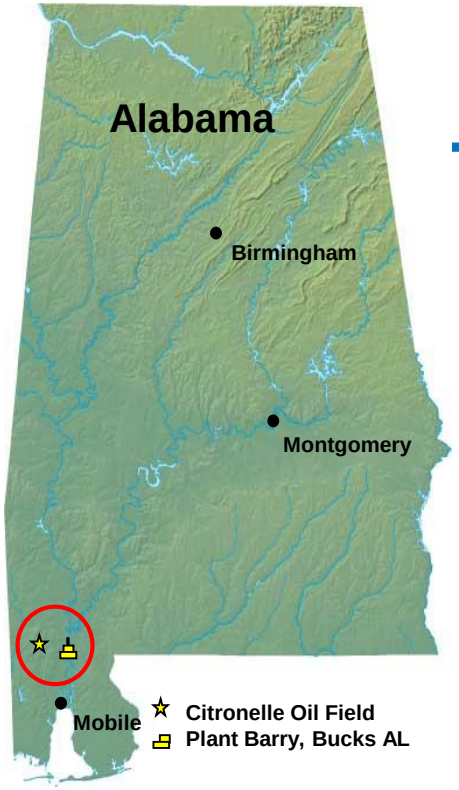
Citronelle Phase III Integrated Demo

- Inject, stored, and monitored 114 kt for the largest (at the time) integrated commercial prototype CCTS project at a coal-fired power plant.
- First time CO2 transfer of custody occurred between an anthropogenic source and a transport/storage operator.
- First with Class VI elements in their CO2 injection permit





Demo Project Coordination

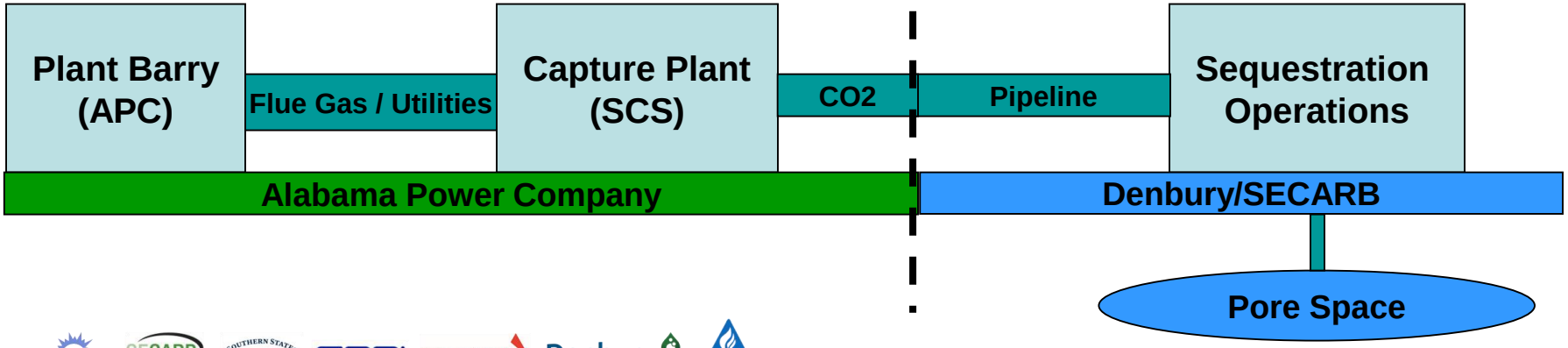


Capture Project

- SO collaborating with MHI
- Location: APC's Plant Barry
- Execution/contracting: SO

Sequestration Project

- Project: DOE's SECARB Phase III
- Prime contractors: SSEB and EPRI
- CO_2 : SO supplying
- Sequestration: Denbury Citronelle Field



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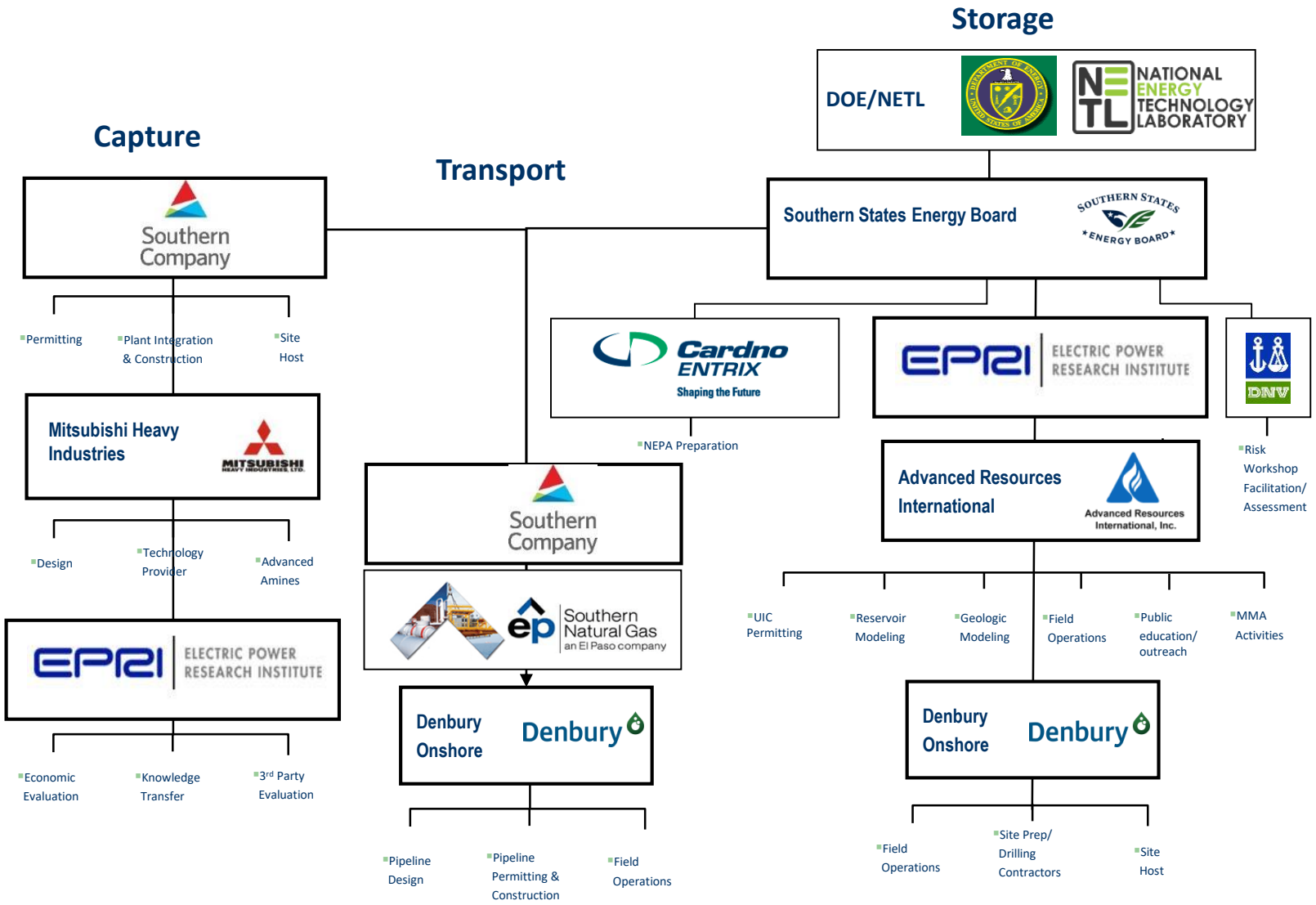


Integrated Test Permitting Process

- **Aabama Department of Environmental Management (ADEM) Air Permit**
  - Capture unit operation

- **Army Corps of Engineers permit – Wetlands Impacts**
  - Covers wetland impacts due to pipeline and injection site construction
  - Pipeline crosses 15 acres of wetlands
  - Horizontal drilling under wetlands is preferred over “open-cutting” and mitigation
  - Wetland impacts during well pad construction operations (fill) mitigated after well drilling completed

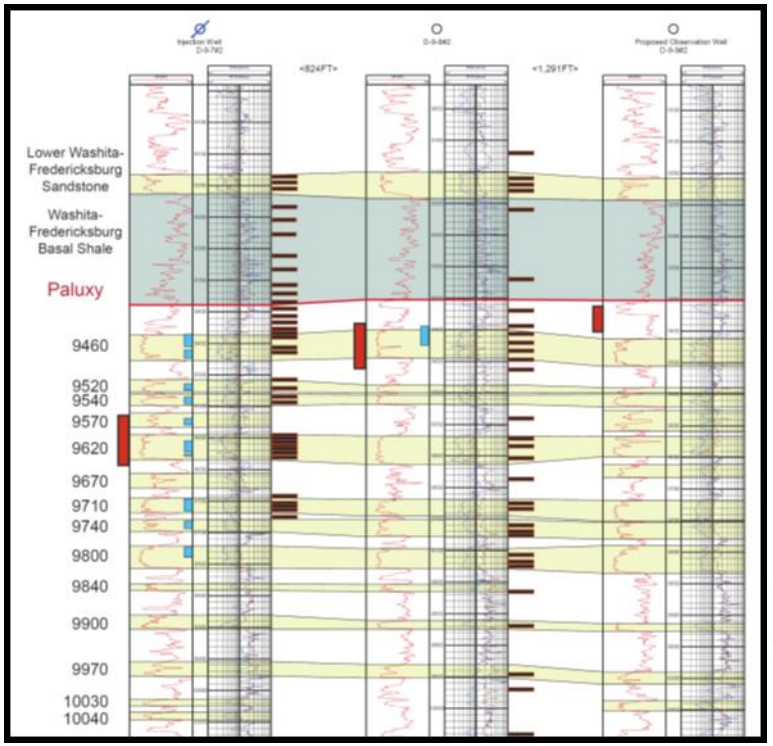
- **U.S. Fish and Wildlife permit – Threatened and Endangered Species**
  - Potential impacts to threatened species (flora & fauna)
  - Over 30 gopher tortoise burrows encountered long pipeline easement
  - Directional drilling under tortoise burrows/colonies is preferred over temporary relocation

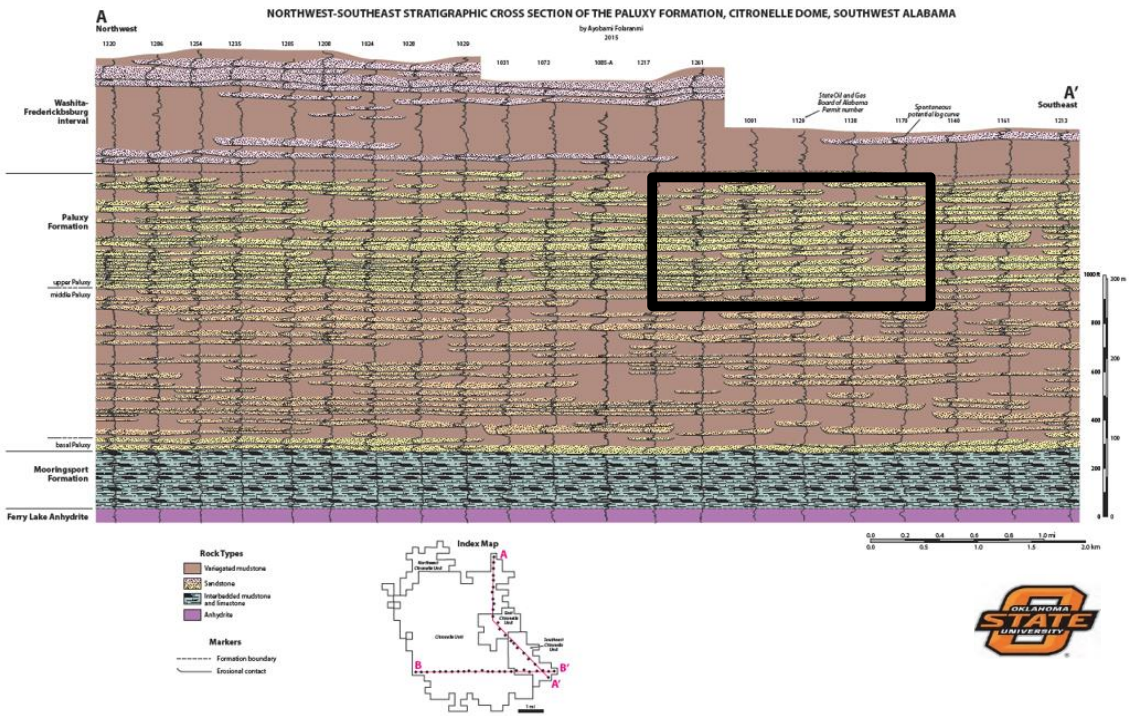
- **SHPO (State Cultural/Archaeological Assets)**

Integrated Test Permitting Process

- **ADEM Underground Injection Control (UIC) Permit – Protect Underground Sources of Drinking Water (USDWs)**
  - In 2010, a Class V Experimental Well permit allowed, because
    - Short duration of injection (3 years) and modest volumes of CO_2
    - Characterization and modeling of "stacked" CO_2 storage
    - Demonstration of innovative monitoring tools and methods
- **It is likely that all future integrated CO_2 storage demonstrations will require a Class VI CO_2 sequestration permit**
  - States with UIC Class VI primacy have an advantage here

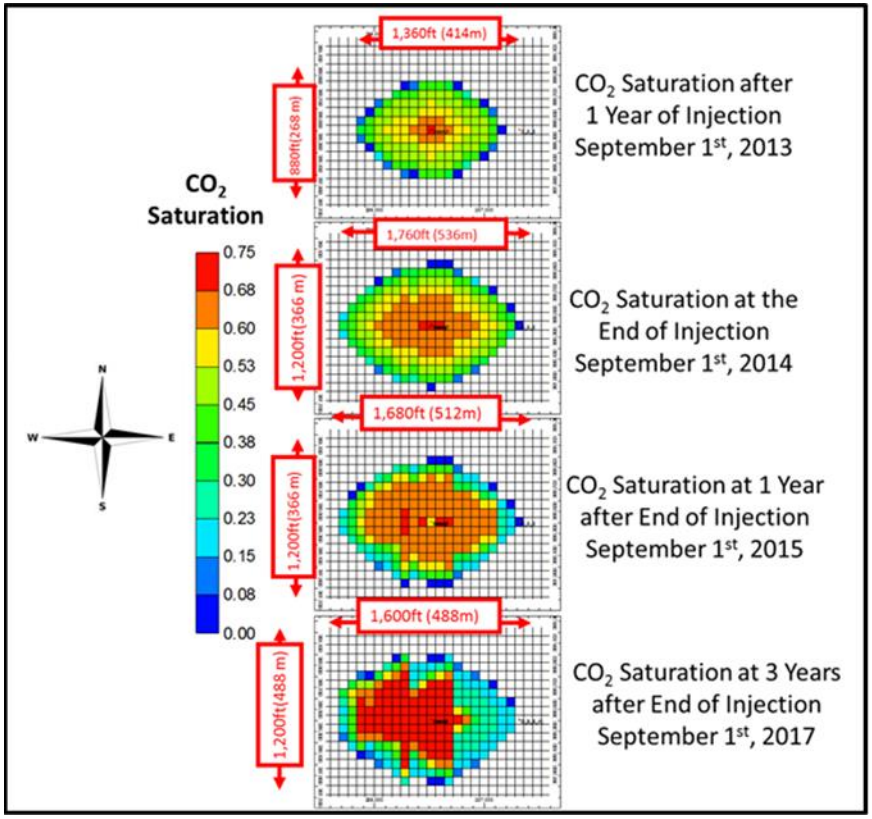
Geologic Characterization

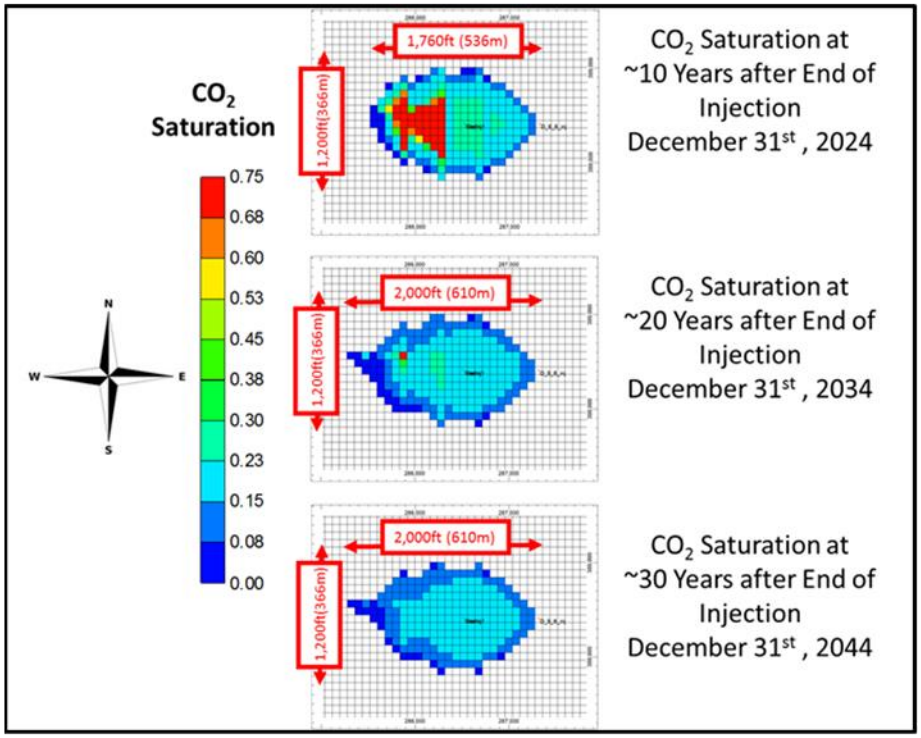




Cored Intervals
Perforation Intervals
Sidewall Core

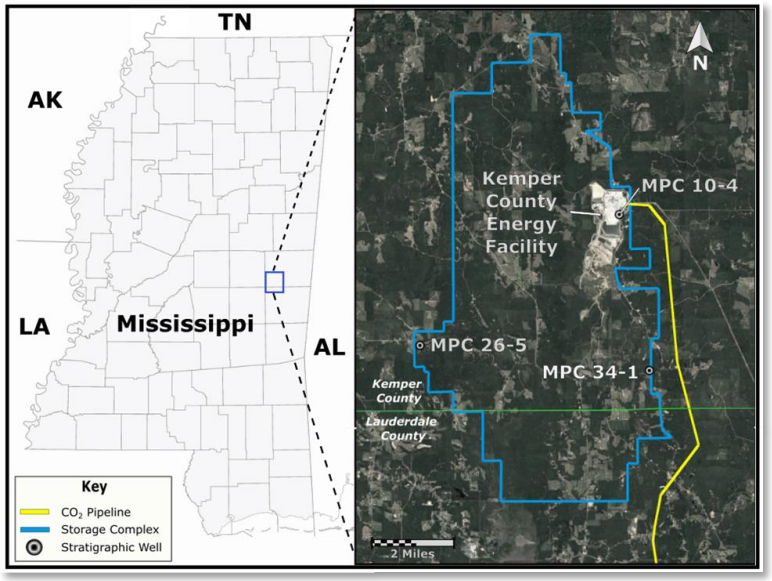
Detailed Reservoir Simulations

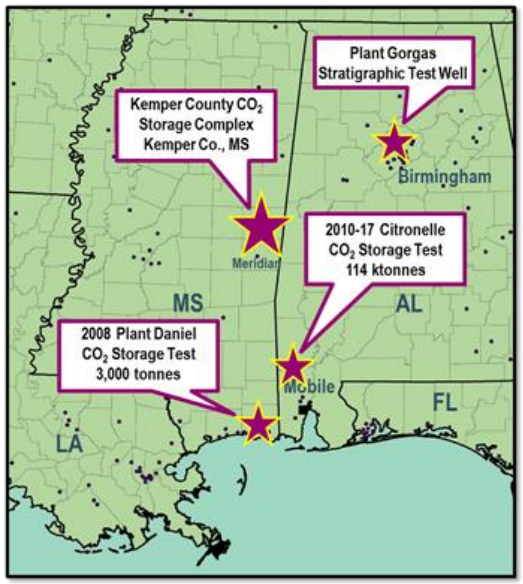


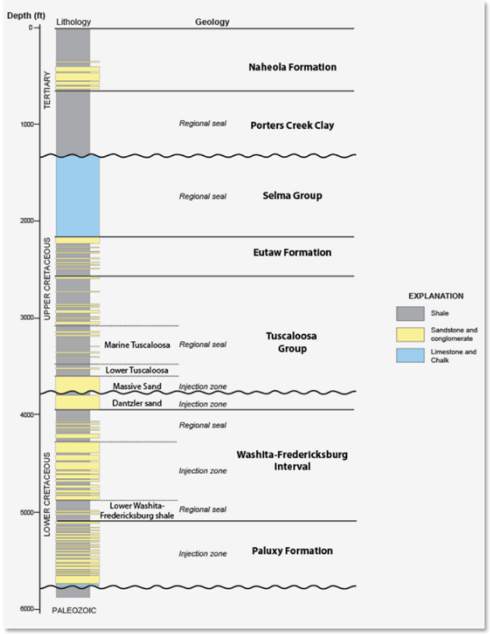


The estimated radius of the CO_2 plume 30 years after cessation of injection is approximately 1000 ft. (305m), which is less than the project's initial AoR of 1,700 ft.

Commercial Scale CarbonSAFE Project ECO$_2$S 2017+



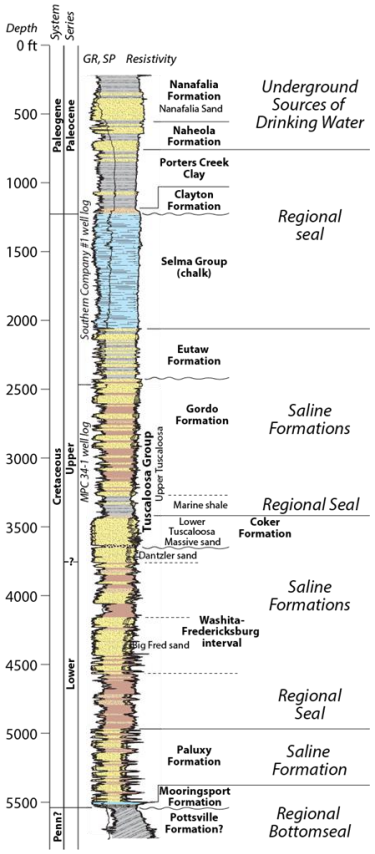


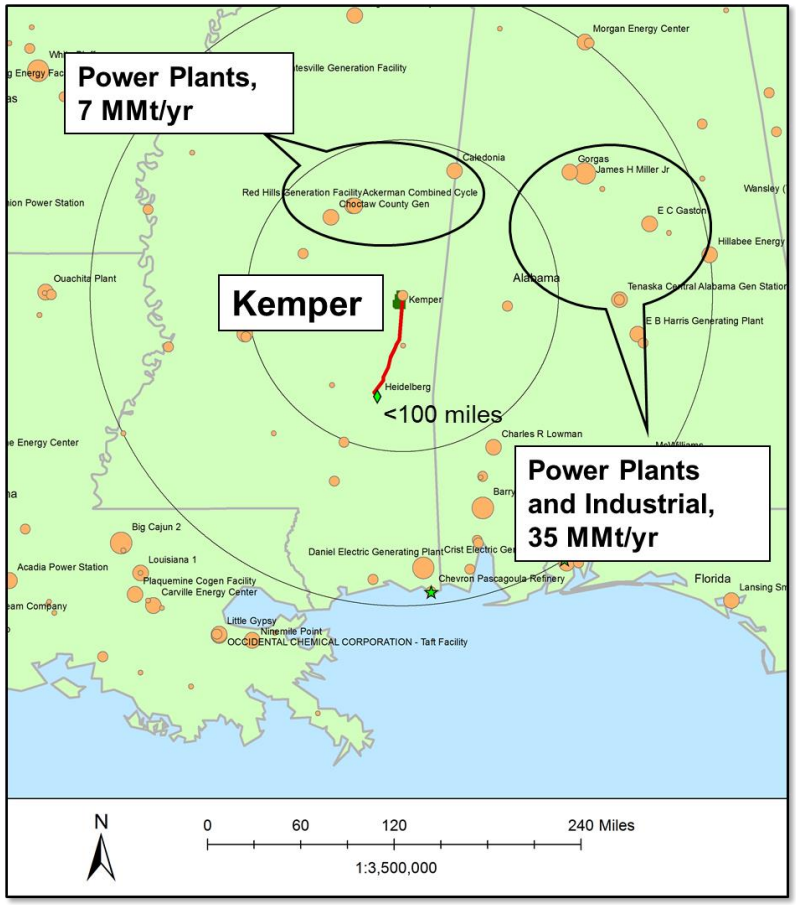


- **The goal of Project ECO$_2$S is to demonstrate that the subsurface at Kemper can safely and permanently store commercial volumes of CO$_2$**
- **The project team has established a 30,000 acre area of interest which contains commercial-scale CO$_2$ storage potential**
- **Significant Southern Company/Mississippi Power support for evaluating CO$_2$ storage in the Southeast.**

Commercial Scale CarbonSAFE Project ECO_2S

- Three storage zones provide nearly a gigatonne capacity CO_2 storage complex
- Low cost, low risk storage potential
- Southern Company is evaluating ECO_2S site as a regional storage hub





So How Do We Get Projects Off The Ground?

- Great storage geology leads to low costs and low risks
- A phased project approach is an effective outreach to regulators, potential CO_2 sources and the public
- CO_2 source engagement and participation are critical
- A management team that can interface with technical folks, government and the public
- Regulatory setting matters – States with UIC Class VI primacy have an advantage

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