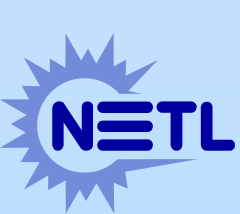


The SECARB Anthropogenic Test: CO₂ Capture/Transportation/Storage

Richard A. Esposito, Southern Company

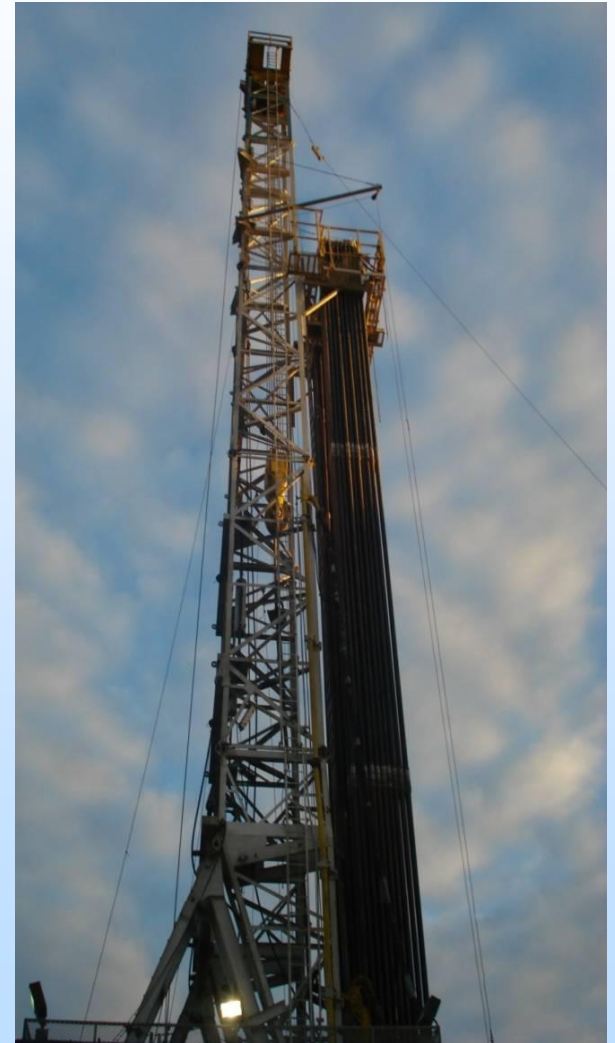
Dave Riestenberg, Advanced Resources International

IEA International CCS Regulatory Network Web Conference on Project Experience with CCS Permitting



Webinar Presentation Outline

- Project Overview & Partners
- Technical Status
 - CO₂ Capture
 - CO₂ Transportation
 - CO₂ Storage
- Permitting Activities
 - CO₂ Capture
 - CO₂ Pipeline and Surface Impact
 - CO₂ Injection and subsurface monitoring



Project Overview

- Fully integrated CO₂ capture, transport and storage project
- Construct and operate a 25 MW (182,500 tpy) equivalent CO₂ capture unit at Alabama Power Plant Barry
- Construct and operate a pipeline that will transport 550 tpd CO₂ from Plant Barry to a Citronelle Dome
- Inject 100,000 metric tons of CO₂ into a saline reservoir over a period of 2 years
- Conduct 3 years of monitoring after CO₂ injection is concluded and close the site



Partner Responsibilities

Alabama

Birmingham

Montgomery



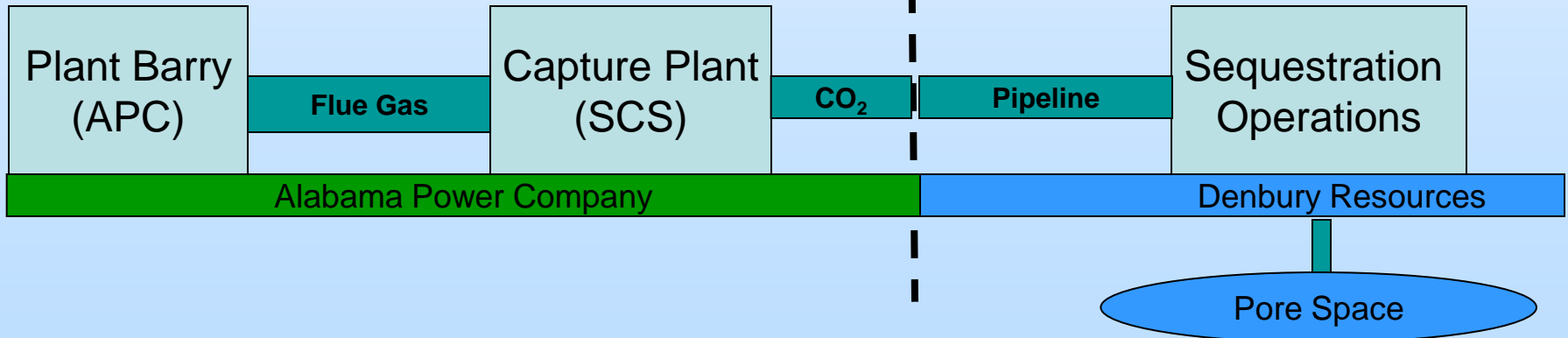
Mobile ★ Citronelle Oil Field
■ Plant Barry, Bucks AL

Capture Project

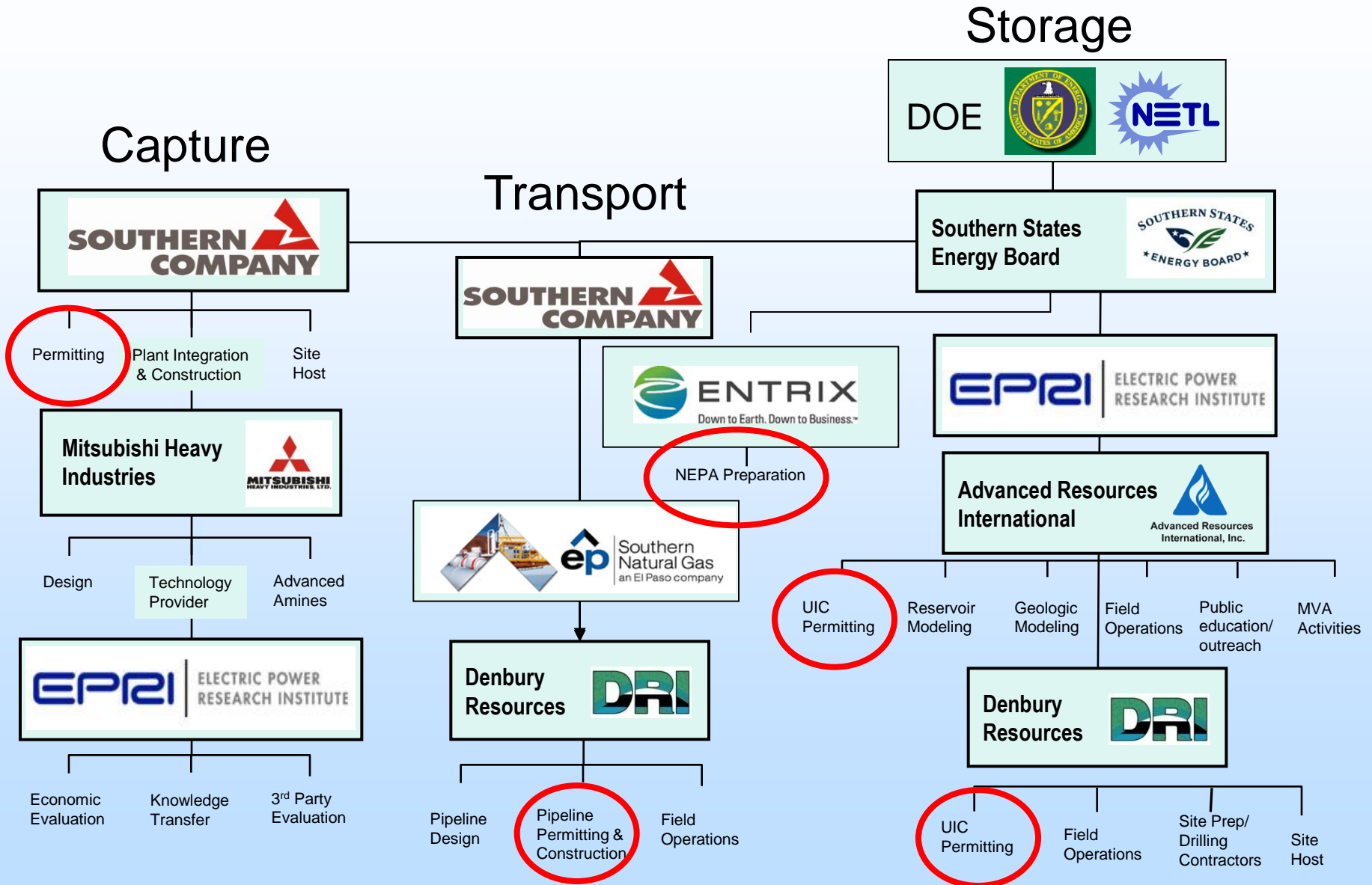
- Southern Company collaborating with MHI
- Host Site: Alabama Power Plant Barry
- Southern Company execution/contracting

Sequestration Project

- Project: DOE's SECARB Phase III
- Prime contractors: SSEB & EPRI
- Subcontracts: Denbury, ARI, & Southern Company
- Sequestration: Within Citronelle Dome in a saline reservoir stratigraphically above the Citronelle Oilfield's producing reservoir



Organization Chart



CO₂ Capture Update

2010



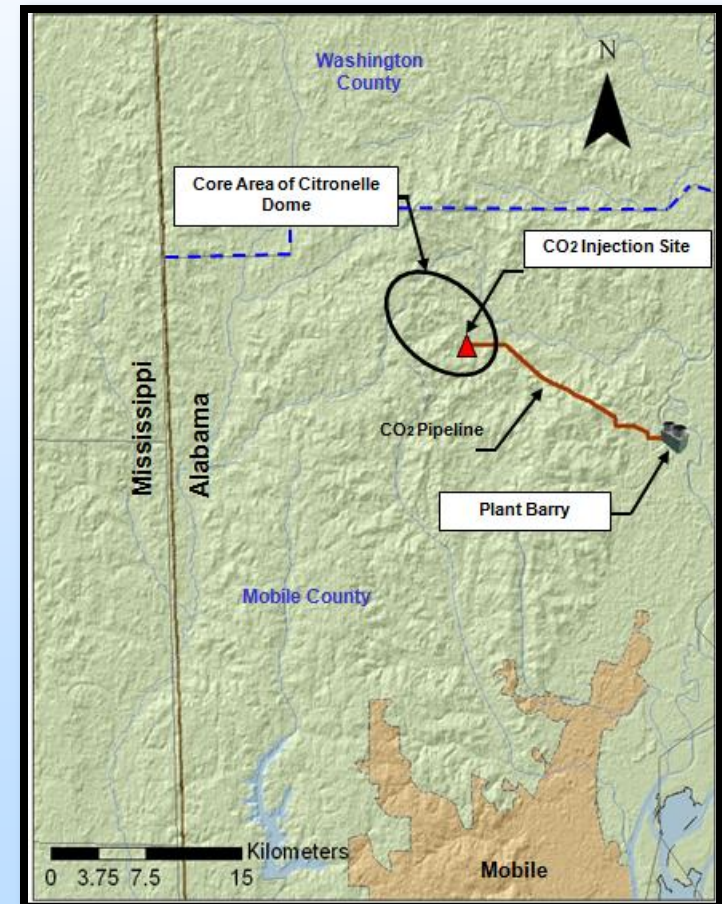
2011



Capture plant and compression operations started on June 4, 2011 with over 100,000 metric tons of CO₂ captured to date.

CO₂ Pipeline Update

- Approx. 12mi (19km) to the SE operators unit in Citronelle Field
- Pipeline was commissioned March 8, 2012
- Over 20,000 metric tonnes of CO₂ transported to date for injection
- Pipe specifications
 - 4-in (10cm) pipe diameter
 - X42/52 carbon steel
 - Normal operating pressure of 1,500 psig (10.3 MPa)
 - DOT 29 CFR 195 liquid pipeline; buried 5 feet with surface re-vegetation and erosion control



CO₂ Storage Update

- **Scope:**

- Demonstrate safe, secure CO₂ injection and storage in regionally significant saline reservoirs in the southeast U.S. region

- **Accomplishments:**

- Drilled 3 wells for injection/characterization
- Over 20,000 metric tonnes of CO₂ injected for saline reservoir storage to date
- Good reservoir characteristics identified and confirmed
- Wide range of MVA tools successfully deployed
- Few interruptions related to operations



CO₂ Capture Plant Permitting

- Updated air emissions permit for Plant Barry to incorporate new emissions point from CO₂ absorber
- Update Plant's NPDES permit for new process and cooling water discharges



Pipeline Right-of-Way

- Right-of-Way Ownership
 - 1¼ mi (2 km) inside Plant Barry property
 - 8 mi (13 km) along existing high-voltage power corridor
 - 2 mi (3 km) undisturbed forested land
 - Permanent cleared width 20 ft (6 m)
 - Temporary construction width 40 ft (12 m)
- Right-of-Way Habitat
 - 9 mi (14.5 km) of forested and commercial timber land
 - 3 mi (5 km) of emergent, shrub, and forested wetlands
 - Endangered Gopher Tortoise habitat
 - 110 burrows in or adjacent to construction area





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).



Pipeline and Surface Impact Permitting

- **National Environmental Policy Act (NEPA) - Environmental Assessment (EA)**
 - DOE requires this document to evaluate the potential environmental consequences of providing a financial assistance in a cooperative agreement to a research project
- **ADEM NPDES Storm-Water Management Permit**
 - Covers injection/ monitoring well pads and booster pump
- **ADEM Storm -Water Management Plan**
 - BMPs for clearing and construction of pipeline
- **ADEM Hydrostatic Test-Water Discharge Permit**
 - Iron, oil and grease, turbidity, dissolved solids, discharge erosion
- **Army Corps of Engineers Cleanwater Act-Section 404 Permit – Wetlands Impacts**
 - Covers wetland impacts due to pipeline and injection site construction
 - Pipeline crosses approximately 15 acres of wetlands
- **U.S. Fish and Wildlife Services Permit /Section 7 - Threatened and Endangered Species Act**
 - Potential impacts to threatened species (gopher tortoises)
- **Alabama State Historic Preservation Office (SHPO) Section 106 - State Cultural/Archaeological Assets (Study and Clearance Letter)**

Pipeline and Surface Impact Permitting

U.S. Fish and Wildlife permit and Federal NEPA compliance mandate the protection of threatened and endangered species.

- Potential impacts to an threatened species and habitat (Gopher Tortoise)
- Over 100 tortoise burrows encountered long pipeline easement
- Addressed by directional drilling under tortoise burrows/colonies less expensive than temporary relocation
- Burrows identified at or near most well sites
- Avoid drilling/monitoring activities in close proximity to burrows
- Special auto speed limits in tortoise habitat



Underground Injection Control Permitting

- **Class V Experimental Well permit application submitted in December 2010**
 - Short duration of injection (2 years) and modest volumes at 100,000 metric tonnes (550 tpd)
 - Demonstration of experimental monitoring tools and methods
- **Class VI (CO₂ sequestration well) standards were applied**
 - Injection Area of Review (AOR) determined by modeling and monitoring results; updated annually
 - Extensive deep, shallow and surface CO₂ monitoring
 - Monthly injection stream monitoring
 - Periodically updated Corrective Action Plan
 - Site closure based on USDW non-endangerment demonstration (5-yr renewal)
 - Pressurized annulus throughout injection (+/- 200 psig)
- **Class V Experimental injection permit was awarded in November 2011, eleven months after initial draft application was submitted**
- **Permission to operate request submitted in April 2012; awarded in August 2012**

CCS Permitting Lessons Learned

- Capture and pipeline permitting efforts were very efficient based on existing procedures already developed with commercial operations.
 - Denbury's expertise and past experiences were critical
 - Existing Southern Company right-of-way facilitated construction
 - Biggest delays in permitting were weather and contracts/procedures
- For storage operations, regulators were cautious "but cooperative" due to a lack of deep well and CO₂ injection experience.
 - The entire project team did a great job of working with the regulators
 - Geology cooperated
- Timing of new CCS Class VI UIC regulations posed challenges in permitting and enforcement.
 - Class V (experimental) versus Class VI (commercial)
 - Permit issuance and "permission to operate" are two separate steps
- Each site in CCS permitting will be different base on site-specific conditions. Regulations and previous permits may not always be a cookbook for efficient permitting.