

Site Visit by Southern Legislative Group

Southern Company Research Program

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Advanced Energy Systems and CCUS
Research & Technology Controls

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OPERATIONS

**SOUTHERN
COMPANY**

Southern Company (NYSE:SO)

- **Regional energy company**

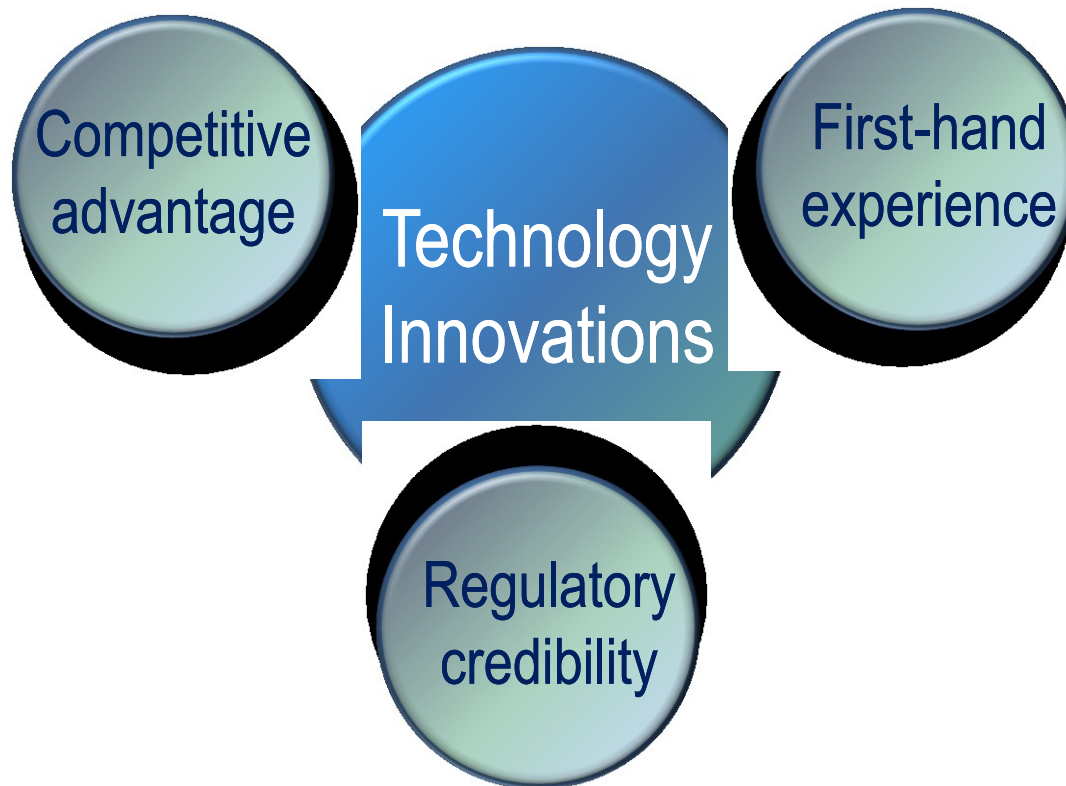
- Wholly owned subsidiaries of Alabama, Georgia, Gulf, Mississippi, and Southern Nuclear
- Southern Power is the largest wholesale producer in the Southeast
- Southern Company Services is an in-house engineering design, construction management, and research organization

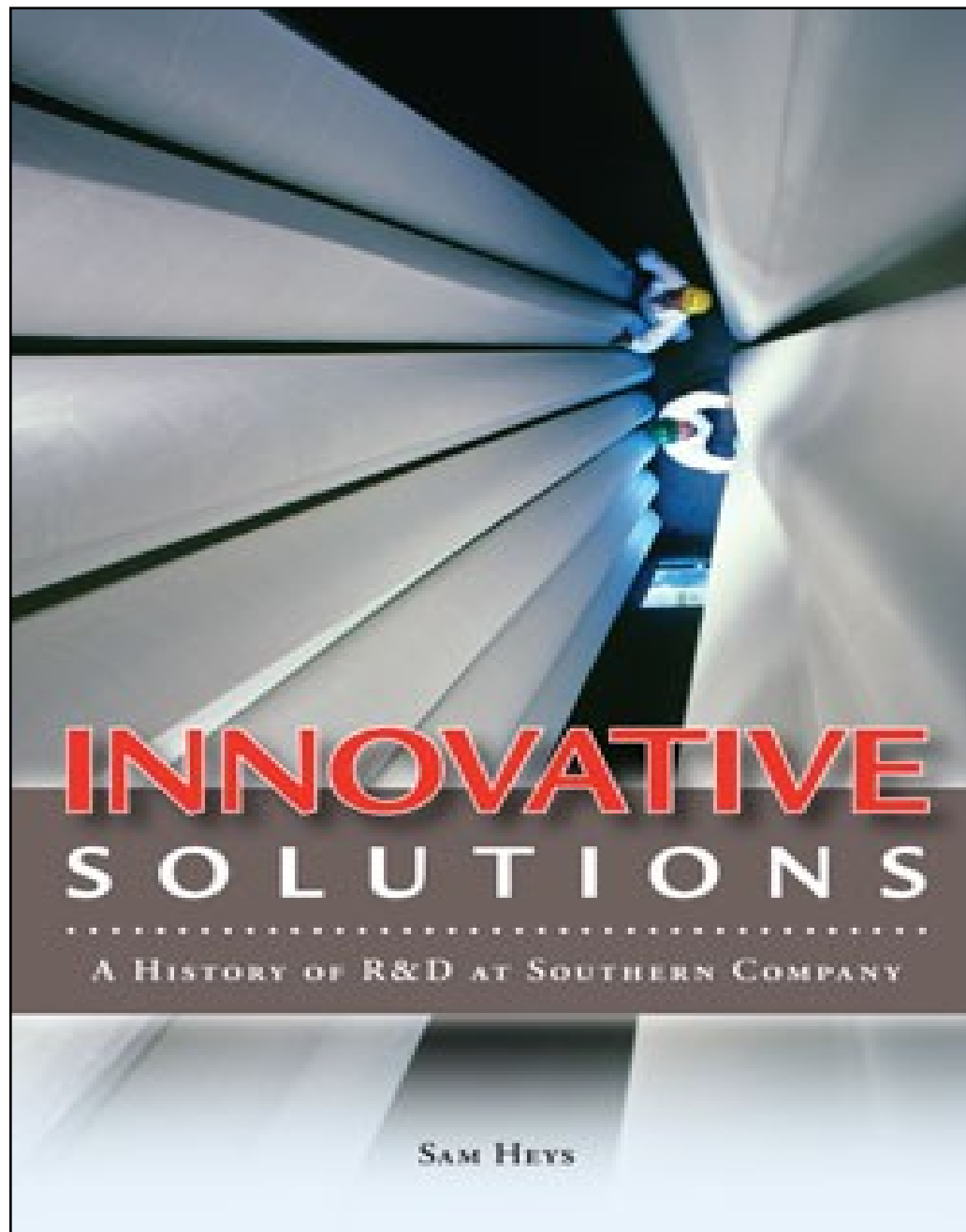


- **Core service area**

- 120,000 square miles in four southeastern states; 4.4 million retail customers and 26,000 employees
- More than 45,000 MW of electric generating capacity (79 plants; 300 generating units)
- One of the largest producers of electricity in the U.S. and one of the largest users of fossil fuels

Research: Customer Benefits





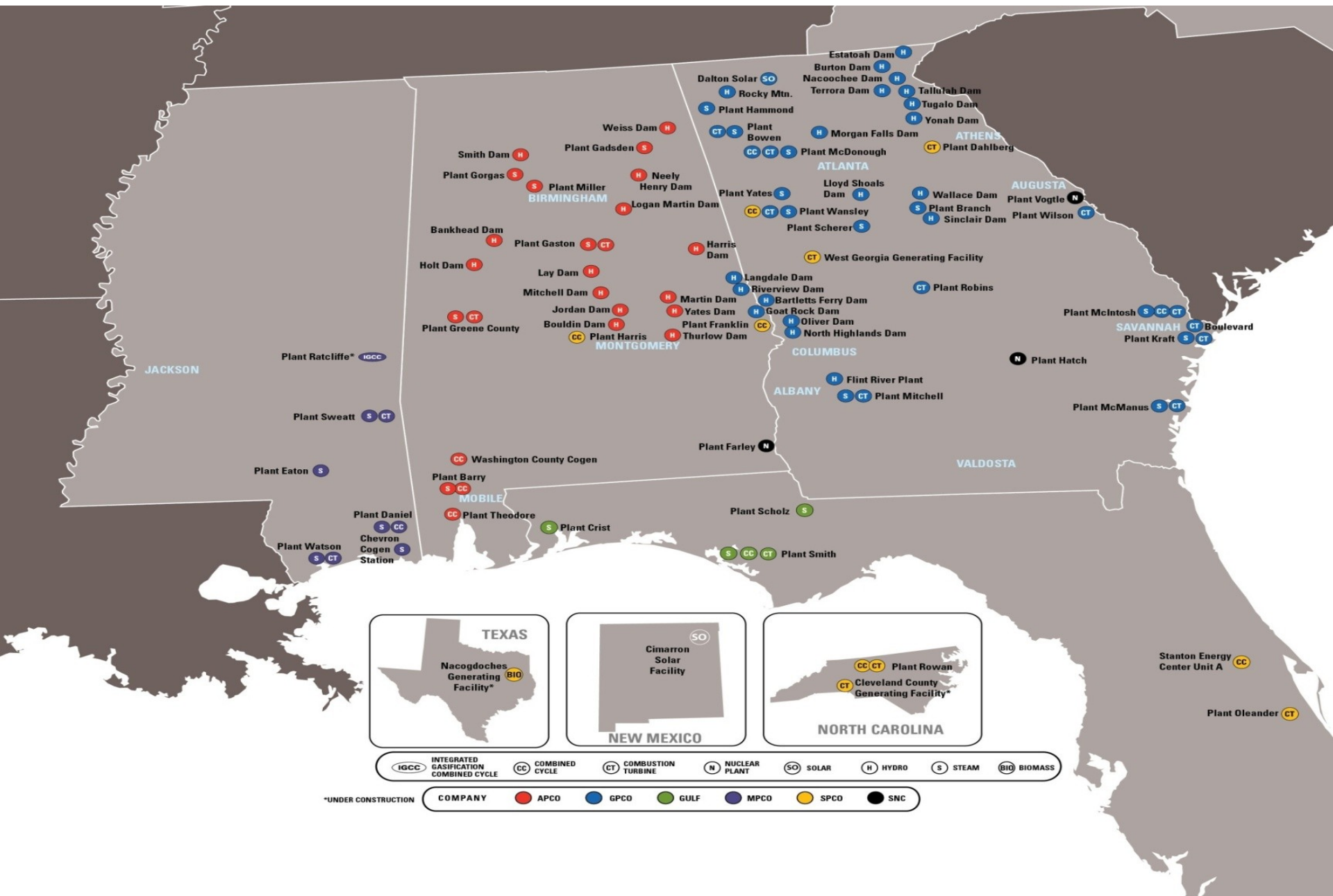
INNOVATIVE SOLUTIONS

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A HISTORY OF R&D AT SOUTHERN COMPANY

SAM HEYS

Southern Company Generating Facilities



National Energy Policy Priorities

- Need a full portfolio of energy resources.
 - Nuclear
 - 21st Century Coal
 - Natural Gas
 - Renewables
 - Energy Efficiency
- Need a national, robust research and development effort to create new technologies to maintain fuel diversity for our future.

- **CCS Technology Drivers**
 - Compliance with carbon legislation or GHG environmental regulation
 - 200 years of domestic fossil-fuel resources with stable pricing
 - Depreciated fossil-fuel generation assets with state-of-the-art environmental controls
 - Challenging regional renewable portfolio
 - World class sequestration geology with strong demand for CO₂-EOR



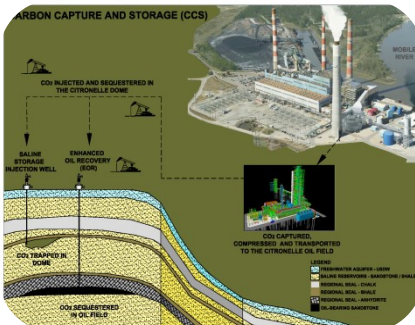
CCS R&D Program

“R&D efforts are key to our long-term clean coal success”

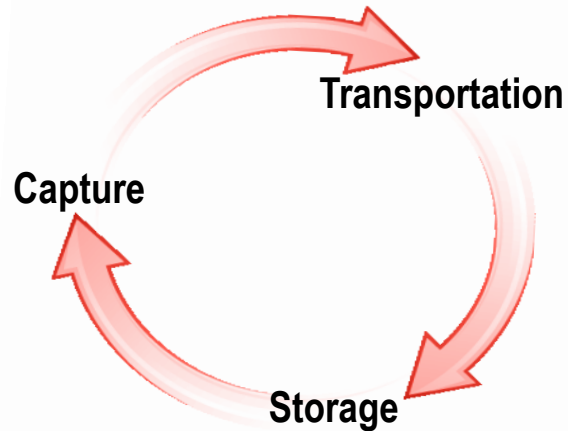
Pilot Scale



Demonstration Scale



Carbon Capture Utilization Storage

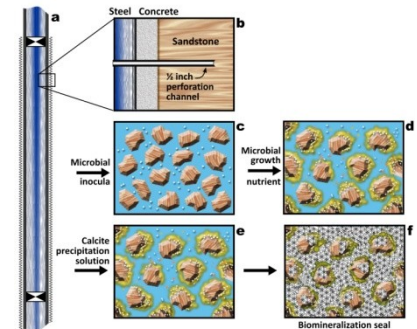


Commercial Deployment

Laboratory Testing



Applied Science



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

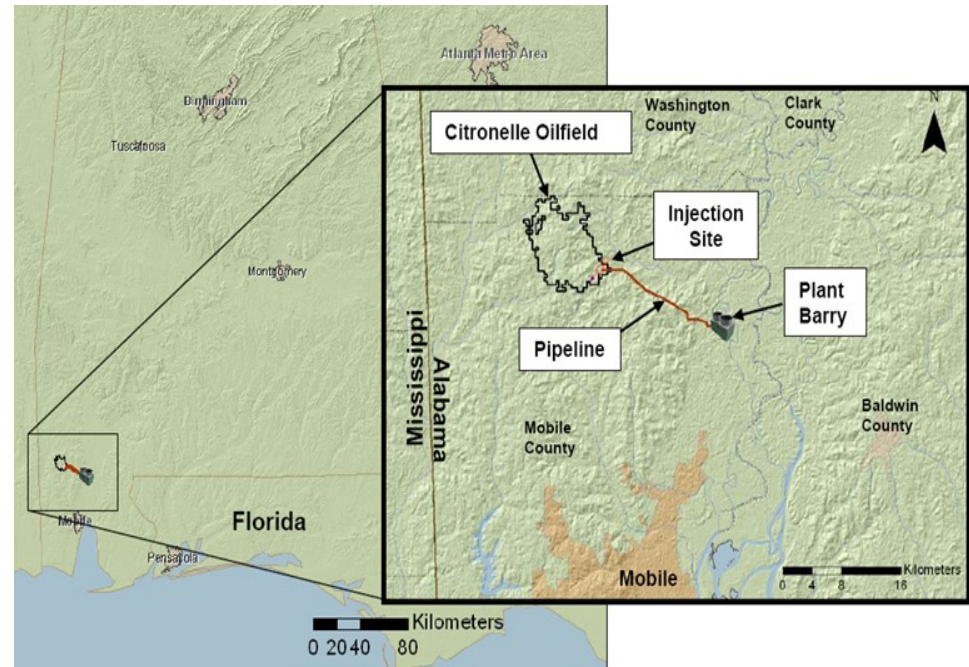
Oxy-Combustion



ELECTRIC POWER
RESEARCH INSTITUTE

Plant Barry CCS Demonstration

- Carbon capture from Plant Barry (equivalent to 25MW of electricity).
- 12 mile CO₂ pipeline constructed by Denbury Resources.
- CO₂ injection into ~9,400 ft. deep saline formation (Paluxy) above the Citronelle Oil Field.
- Monitoring of CO₂ storage during injection and three years post-injection.



Power Plant



Capture



Transport

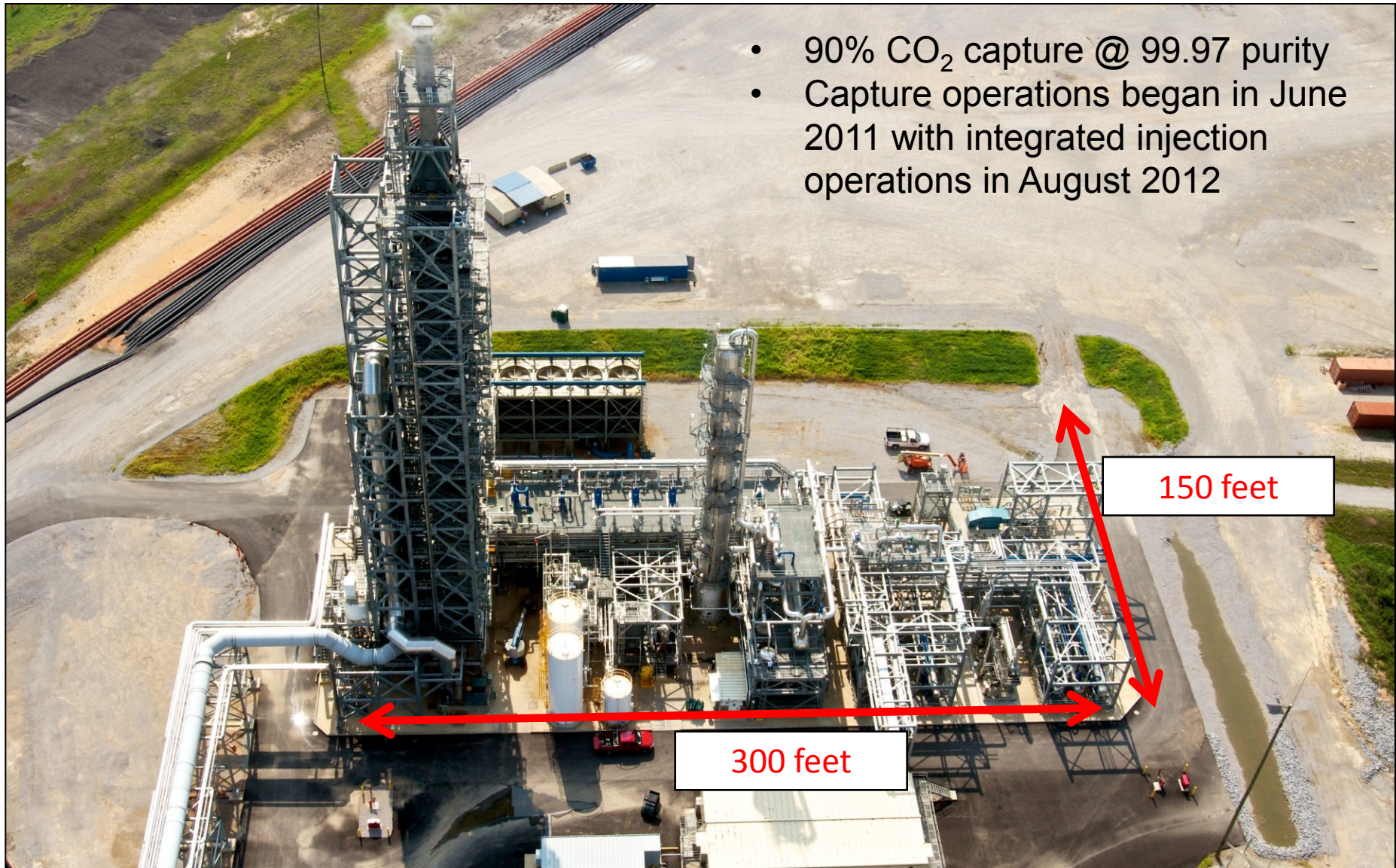


Storage

25-MW CCS Demo

“World’s largest carbon capture facility on a fossil-fueled power plant”

- 90% CO₂ capture @ 99.97 purity
- Capture operations began in June 2011 with integrated injection operations in August 2012





Expect the Unexpected: Teenage Mutant Ninja Turtles

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

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





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 transportation and injections operations



Mainline valve station along pipeline

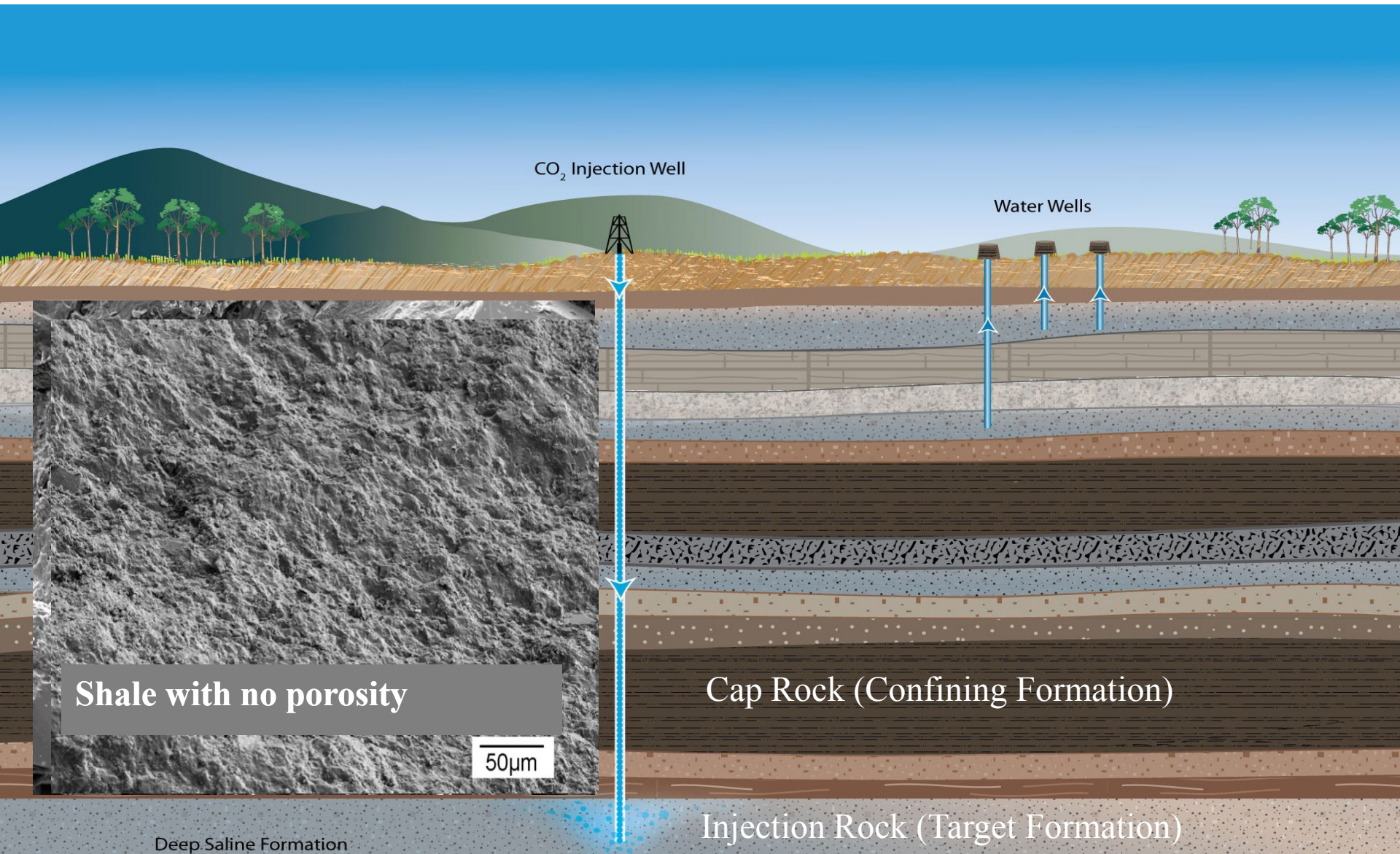


Check meter station & building at Citronelle Field



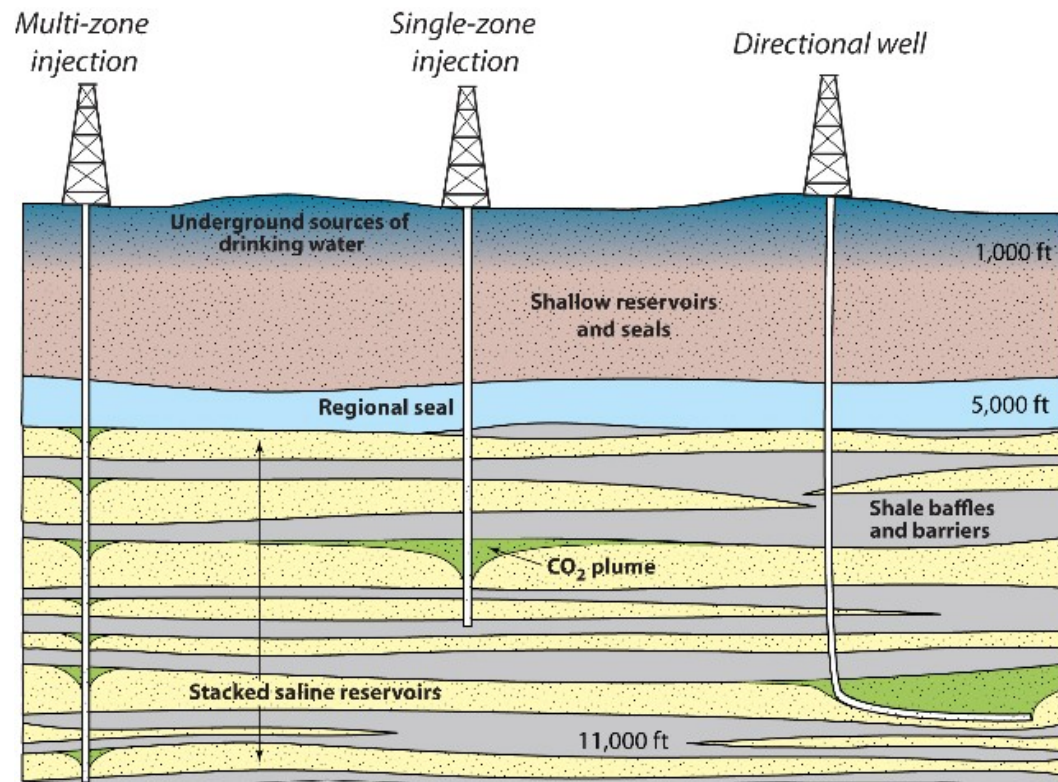
Horizontal CO₂ Booster Pump @ D-9-7 #2 Wellsite

Geologic storage or sequestration



System	Series	Stratigraphic Unit	Major Sub Units		Potential Reservoirs and Confining Zones
Tertiary	Plio-Pliocene		Citronelle Formation		Freshwater Aquifer
	Miocene	Undifferentiated			Freshwater Aquifer
	Oligocene	Vicksburg Group	Chicasawhay Fm. Bucatunna Clay		Base of USDW
					Local Confining Unit
	Eocene	Jackson Group			Minor Saline Reservoir
		Claiborne Group	Talahatta Fm.		Saline Reservoir
		Wilcox Group	Hatchetigbee Sand		Saline Reservoir
	Paleocene		Bashi Marl		
			Salt Mountain LS		
		Midway Group	Porters Creek Clay		Confining Unit
Cretaceous	Upper	Selma Group			Confining Unit
		Eutaw Formation			Minor Saline Reservoir
		Tuscaloosa Group	Upper Tusc.		Minor Saline Reservoir
			Mid. Tusc.	Marine Shale	Confining Unit
			Lower Tusc.	Pilot Sand Massive sand	Saline Reservoir
		Cretaceous	Lower	Washita-Fredericksburg	Dantzler sand Basal Shale
				Primary Confining Unit	
Paluxy Formation	'Upper' 'Middle' 'Lower'			Proposed Injection Zone	
Mooringsport Formation				Confining Unit	
Ferry Lake Anhydrite				Confining Unit	
Donovan Sand	Rodessa Fm. 'Upper' 'Middle' 'Lower'			Oil Reservoir	
				Minor Saline Reservoir	
			Oil Reservoir		

Opportunity to study optimizing stacked storage reservoirs with multiple seals and four-way closure



Project recognition

- Mobile Partner's for Environmental Progress
- Alabama Engineering Hall of Fame
- Savannah Ocean Exchange Industry Solutions
- Mobile County Chamber of Commerce Innovator of the Year

Questions

