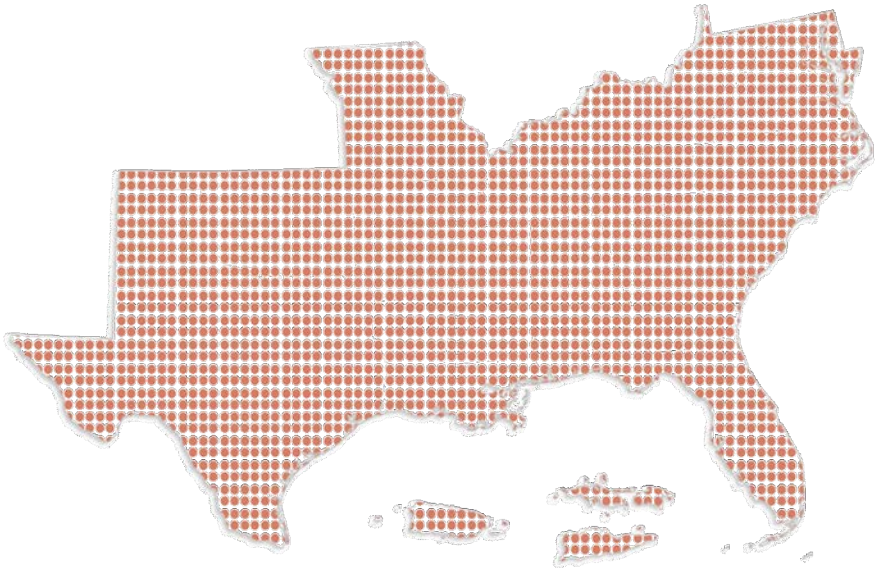
CCUS Commercialization: Leadership in the South

Jointly Presented by:
Kenneth J. Nemeth, Southern States Energy Board
Charles McConnell, University of Houston, Center for Carbon Management in Energy

2021 CO_2 Conference
December 6-9

“Through innovations in energy and environmental policies, programs and technologies, the Southern States Energy Board enhances economic development and the quality of life in the South.”

SSEB Mission Statement



- Interstate Compact Organization, created by state law and consented to by Congress (PL 87-563, PL 92-440)
- 16 U.S. States and Two Territories
- Each jurisdiction represented by the governor, a legislator from the House and Senate, and a governor’s alternate
- Federal Representative appointed by U.S. President
- Secretary, who serves as Executive Director

61st Annual Meeting

- 5th Governors Energy Caucus
  - Governor Kevin Stitt, Oklahoma
  - Governor Asa Hutchinson, Arkansas
  - Governor Mark Gordon, Wyoming
  - Energy and Environment Secretary Ken Wagner moderated the session
- Address the energy transition
- Responses from their states

Board Resolutions – 2021

1.2021 **Reliable & Resilient Electricity |** Sen. Hughes (TX), Rep. Gooch (KY), and Sen. Allen (OK)

2.2021 **Promoting Energy Security, Resilience and Reliability |** Dr. Tung (MD) and Sen. Allen (OK)

3.2021 **Project Advancing Grid Modernization Technologies |** Rep. McBride (OK) and Mr. Lee (SC)

4.2021 **Resolution on the Importance of Beyond Visual Line of Sight for Drone Operations in Maintaining the Safety and Security of America's Utilities |** Rep. McBride (OK)

5.2021 **Study Commission for the Commercial Application of Existing Technology to Reclaim and Repurpose Spent Nuclear Fuel |** Rep. Beck (AR)

6.2021 **Resolution in Support of Preserving State Water Allocation Authority for Energy Development & Environmental Restoration Efforts |** Rep. Payne (FL) and Rep. Sandifer (SC)

7.2021 **Continued Impact of Energy Costs on Covid-19 Recovery |** Dr. Tung (MD)

8.2021 **Enhanced Support for Carbon Dioxide Capture, Utilization, and Storage |** Dr. Tung (MD)

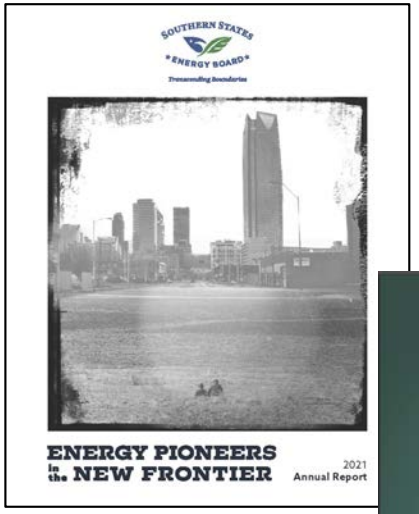
9.2021 **Recognizing Edgar "Ed" Glenn Harvey Emery of Lamar, Missouri |** SSEB Members

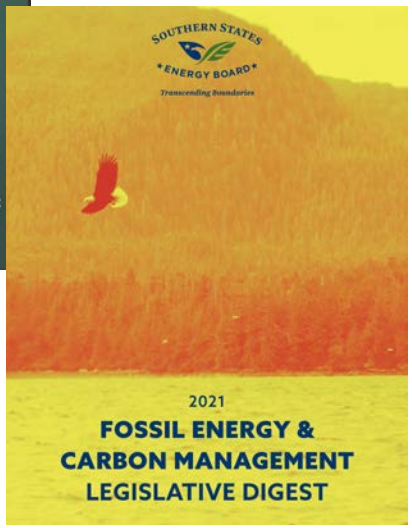
https://www.sseb.org/events/61st-annual-meeting/

New Publications

- **Annual Report**

- **Energy & Environment Legislative Digest**
  - Over 540 energy & environmental measures
  - Trends
    - Energy discrimination
    - Broadband deployment
    - Electric vehicle infrastructure
    - Renewable energy
- **Fossil Energy & Carbon Management (FECM) Digest**
  - Covers notable FECM bills across all 50 states





FECM State-level Legislative Trends

- CCUS development and deployment trends: funding carbon capture studies and offering tax incentives for technology deployment.
- Advanced Recycling continues to trend in our member states and legislatures across the nation.
- Kansas and Montana join the ranks of nearly every SSEB member with the passage of their critical infrastructure trespass protection laws.
- Twelve states, six of which are SSEB members, passed laws concerning greenhouse gas emissions mitigation via a variety of methods.

Monitoring Federal Action

- White House - Executive Orders (EO) and Scientific Integrity Presidential Memorandum
- U.S. Department of State & White House Executive Offices– "The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050" (Nov. 2021) https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf
- Congress - Infrastructure Bill – CCS (including CarbonSAFE expansion) and H_2 hubs; Build Back Better Act; and more!
- Office of Science and Technology Policy's (OSTP) New Energy Division
  - Dr. Sally Benson appointed new Deputy Director for Energy and Chief Strategist for the Energy Transition at OSTP (Nov. 2021)
- U.S. Department of Energy
  - Energy Earthshots (expecting 6-8 total), currently includes Hydrogen Shot, Long Duration Storage Shot, and Carbon Negative Shot
  - Carbon Dioxide Removal (CDR) Mission
  - CCS Centres of Excellence (US, UK, Canada, Indonesia, IEA GHG R&D Programme)
  - Incorporation of EO 14008 mandates

- EO 14007, President's Council of Advisors on Science and Technology (Jan. 2021)
- EO 14008, Tackling the Climate Crisis at Home and Abroad (Jan. 2021)
- EO 14027, Establishment of the Climate Change Support Office (May 2021)
- EO 14030, Climate-Related Financial Risk (May 2021)
- EO 14048, Continuance or Reestablishment of Certain Federal Advisory Committees and Amendments to Other Executive Orders (Sept. 2021)
- EO 14052, Implementation of the Infrastructure Investment and Jobs Act (Nov. 2021)

https://www.federalregister.gov/presidential-documents/executive-orders/joe-biden/2021

SOUTHERN STATES ENERGY BOARD

Transcending Boundaries

Carbon Management Program

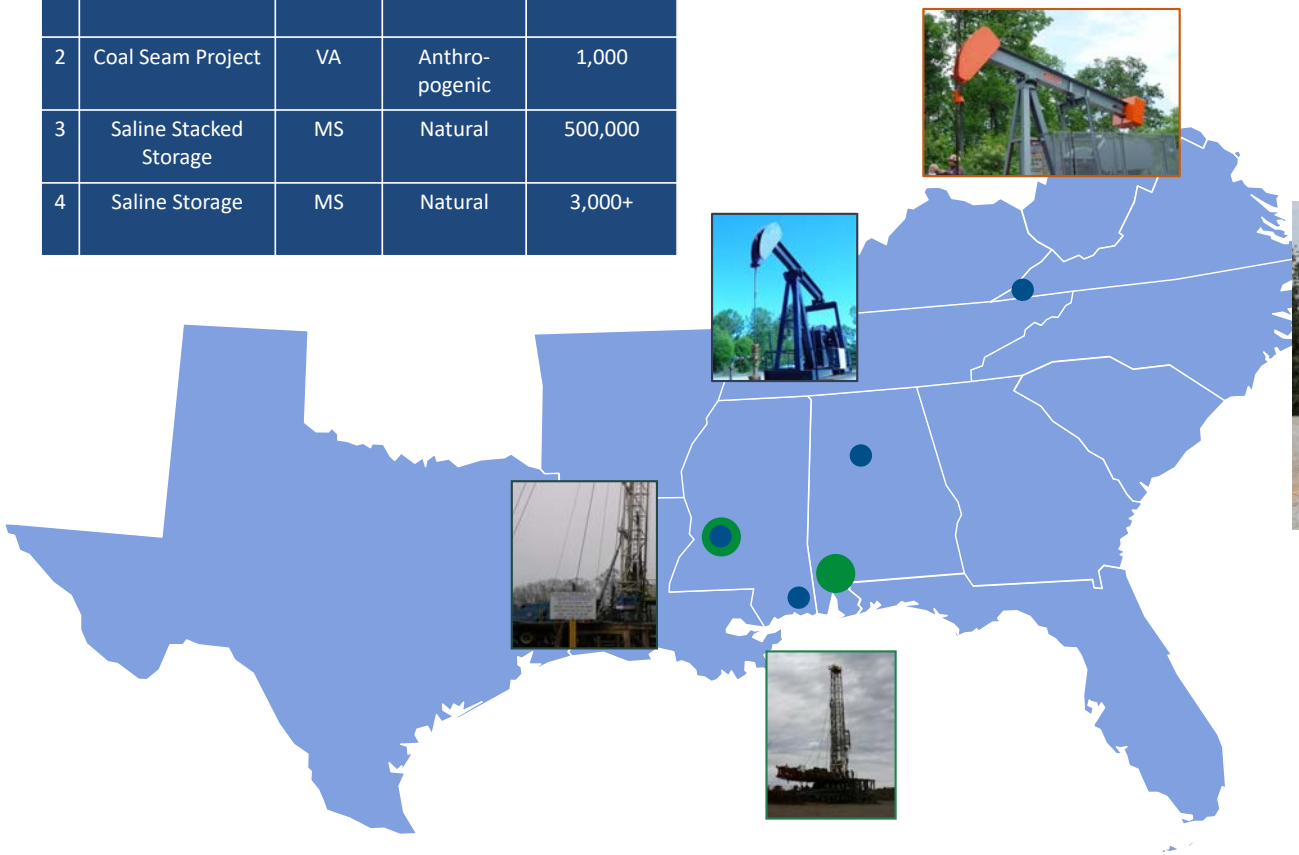
Carbon Management Program Acknowledgements

This presentation is based upon work supported by the Department of Energy and was prepared as an account of work sponsored by an agency of the United States Government.

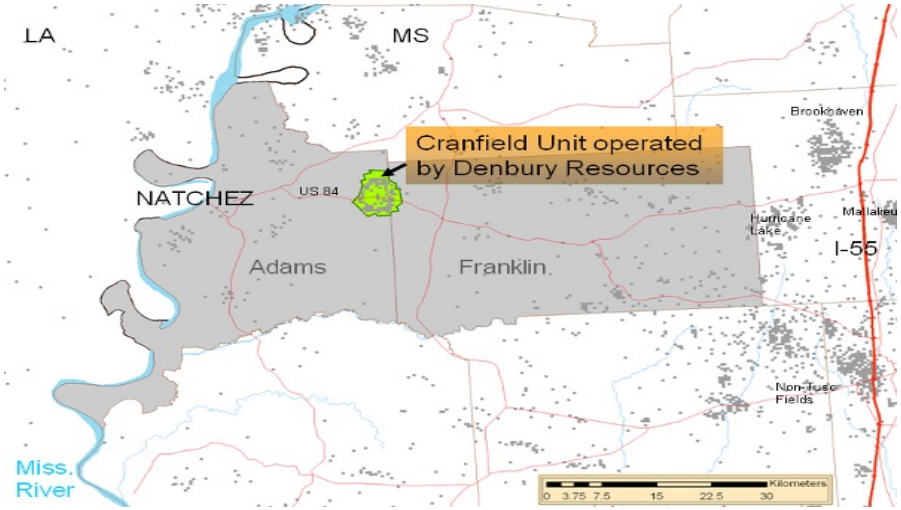
SECARB Phase II & Phase III Project Sites

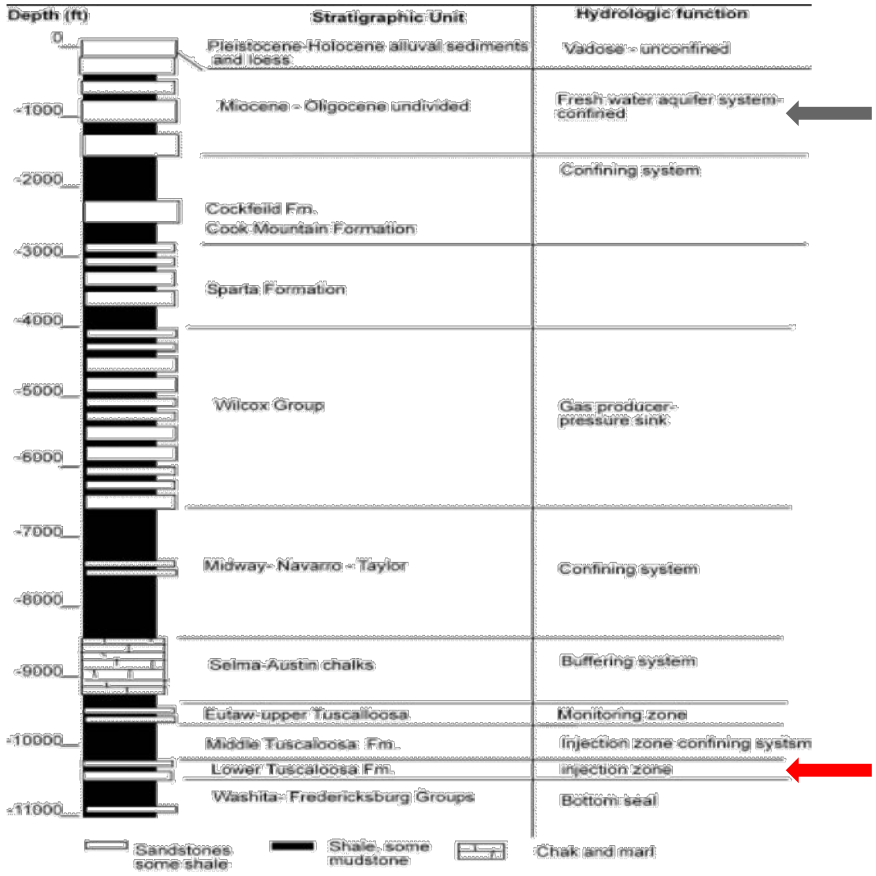
#	Name/Description	Location	CO_2 Source	CO_2 Stored (metric tons)
1	Coal Seam Project	AL	Natural	1,000
2	Coal Seam Project	VA	Anthro-pogenic	1,000
3	Saline Stacked Storage	MS	Natural	500,000
4	Saline Storage	MS	Natural	3,000+

#	Name/Description	Location	CO_2 Source	CO_2 Stored (metric tons)
5	CO_2-EOR	MS	Natural	5,000,000+ (10MM injected)
6	Saline Storage	AL	Anthro-pogenic (from new CO_2 capture facility)	100,000+



SECARB Phase III Early Test





Location

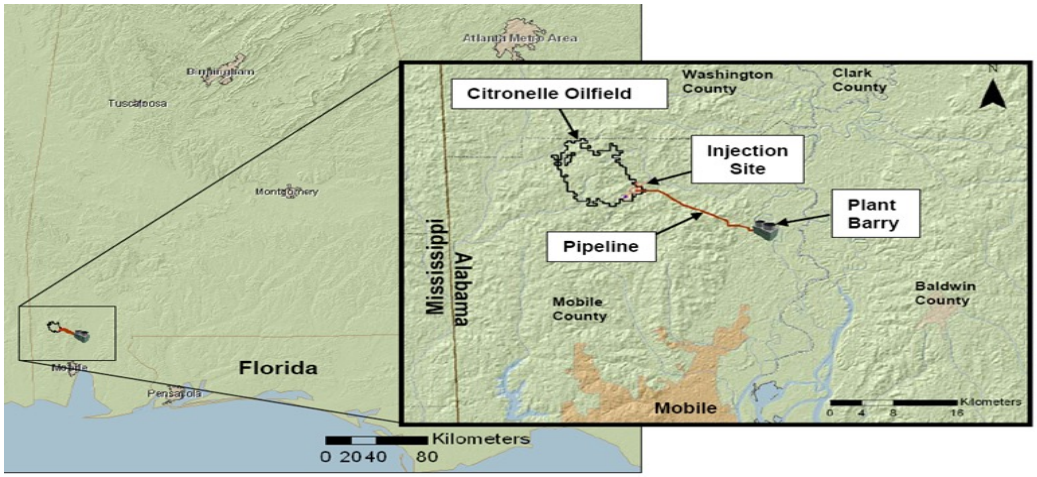
- 15 miles east of Natchez, MS
- Oilfield discovered in 1940s and abandoned in 1960s
- Currently owned/operated by Denbury Onshore LLC
- CO_2-EOR injection since 2008, Natural CO_2, Jackson Dome

Geology

- Target Injection Zone: Lower Tuscaloosa Formation – saline reservoir at depth of >10,000 feet

SECARB Phase III Anthropogenic Test

- Carbon capture from Plant Barry, 25MWe
- 12-mile CO_2 pipeline constructed by Denbury Resources
- CO_2 injection into ~9.400 ft. deep saline formation (Paluxy), Class V Experimental UIC Permit
- 114,000 metric tons injected
- Monitoring CO_2 during injection



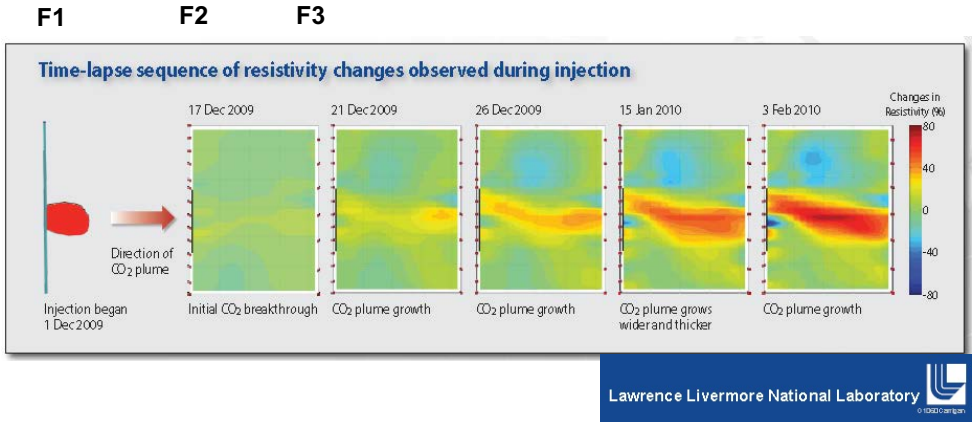
SECARB to Petra Nova

SECARB (AL)

Petra Nova (TX)

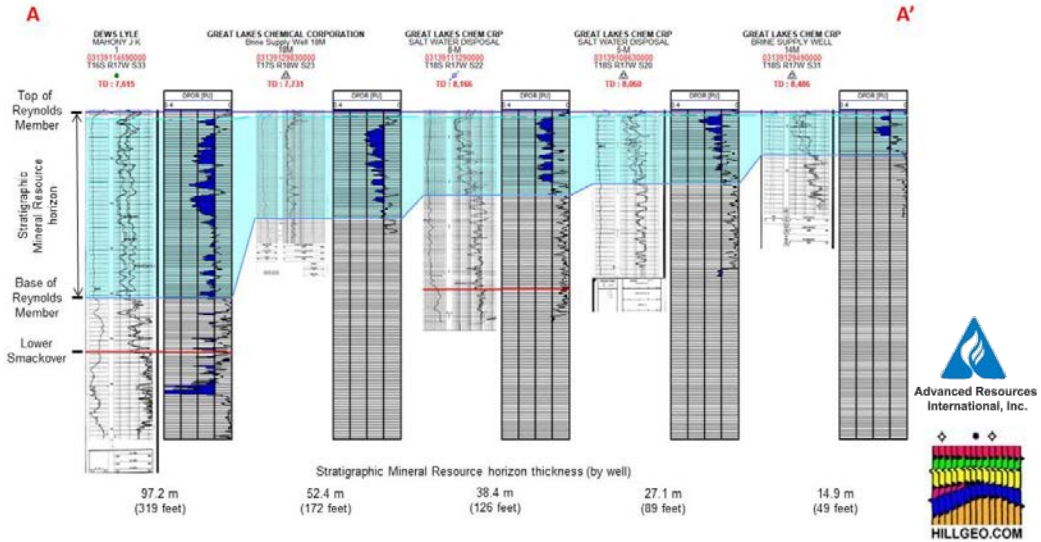
SECARB Firsts (selected)

- First RCSP in the field
- First RCSP to inject CO_2
- First RCSP to monitor a 1 million metric ton injection
- First deep and first U.S. use of electrical resistance tomography (ERT) in CO_2 setting
- First application of pressure surveillance in an above-zone monitoring interval
- Process-based soil gas monitoring method (also used at the Kerr farm in Canada)
- First U.S. and first onshore use of borehole gravity to quantify CO_2 displacing water
- World's first fully integrated CO_2 capture (amine), transportation, storage (saline) project utilizing anthropogenic CO_2 from a coal-fueled power plant



Arkansas CCUS Assessment

- Gov. Asa Hutchinson requested a robust assessment of CCUS opportunities in Arkansas.
- Results presented to Arkansas-based government officials and industry in April 2021 and to community stakeholders in June 2021.
- May provide a means for revitalization of southwest Arkansas.

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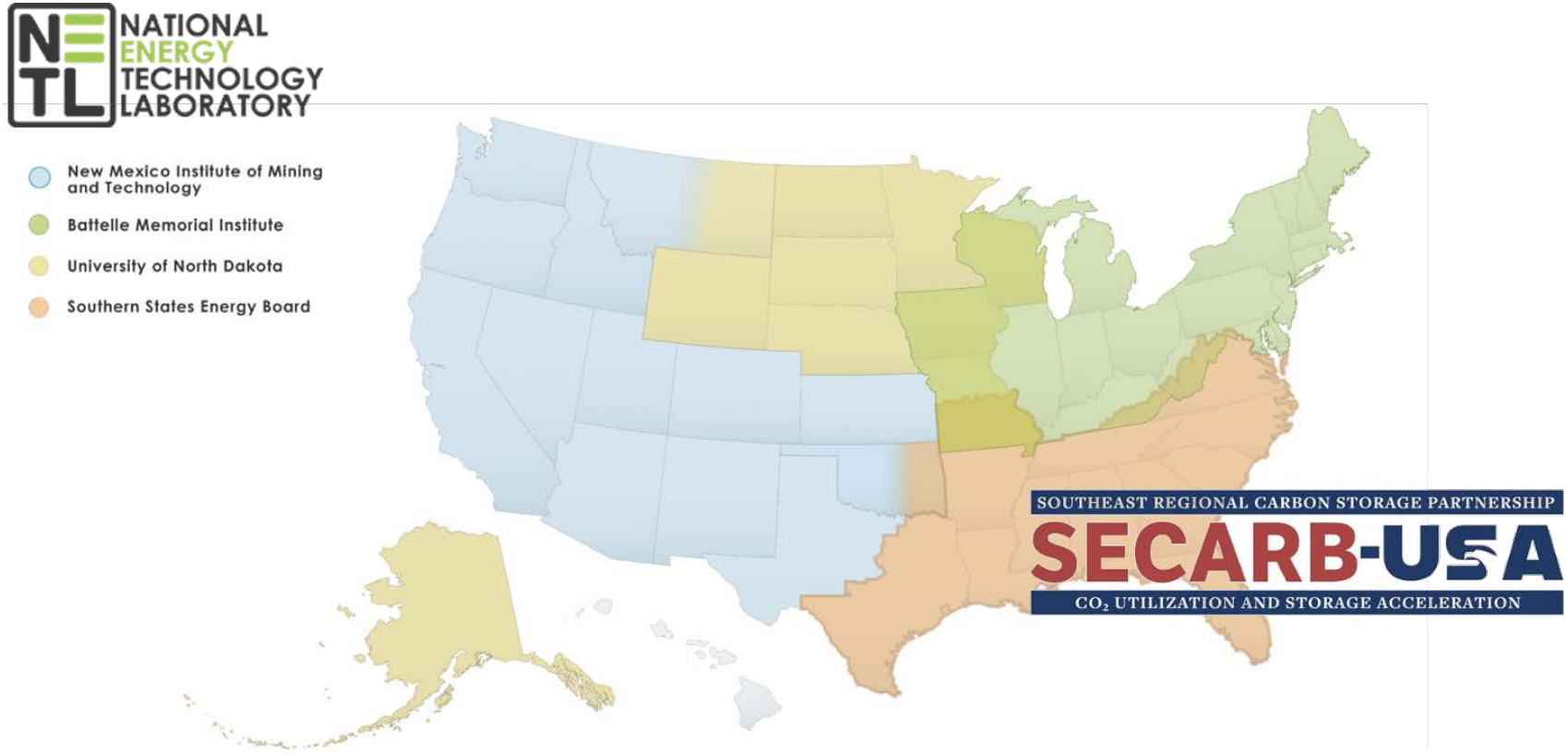
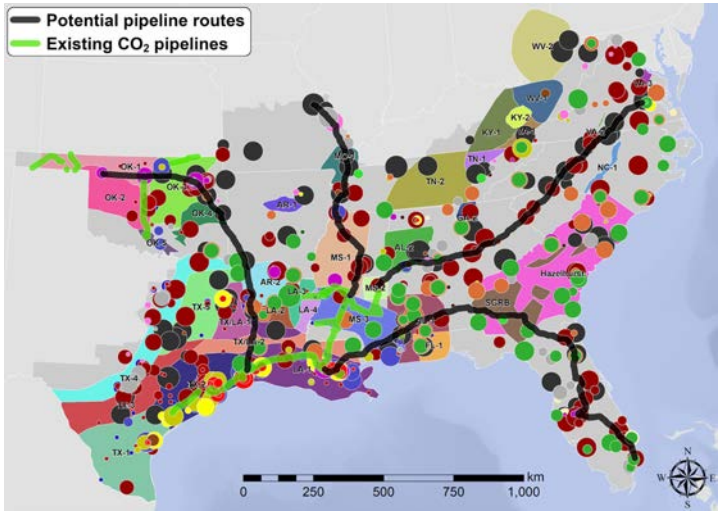
ENERGY BOARD
Transcending Boundaries
Southwest Arkansas Revitalization Wo
A Pre-Feasibility Assessment of Carbon Capture, Utiliza
Storage (CCUS) Opportunities to Spur Economic Devel
El Dorado, Arkansas & Virtual | June 23, 2021

SECARB-USA | Regional Initiatives Map



SECARB-USA

- Identify and address regional onshore storage and transport challenges facing commercial deployment of carbon dioxide (CO_2) capture, utilization, and storage (CCUS) technologies.
- The project team has evaluated the costs associated with site characterization and Class VI UIC permitting while identifying areas requiring additional characterization.
- Will continue to evaluate infrastructure buildout scenarios to better understand project costs and stakeholder engagement strategies.
- Continue to meet with stakeholders to discuss CCUS opportunities in the southeast and identify potential areas of collaboration.



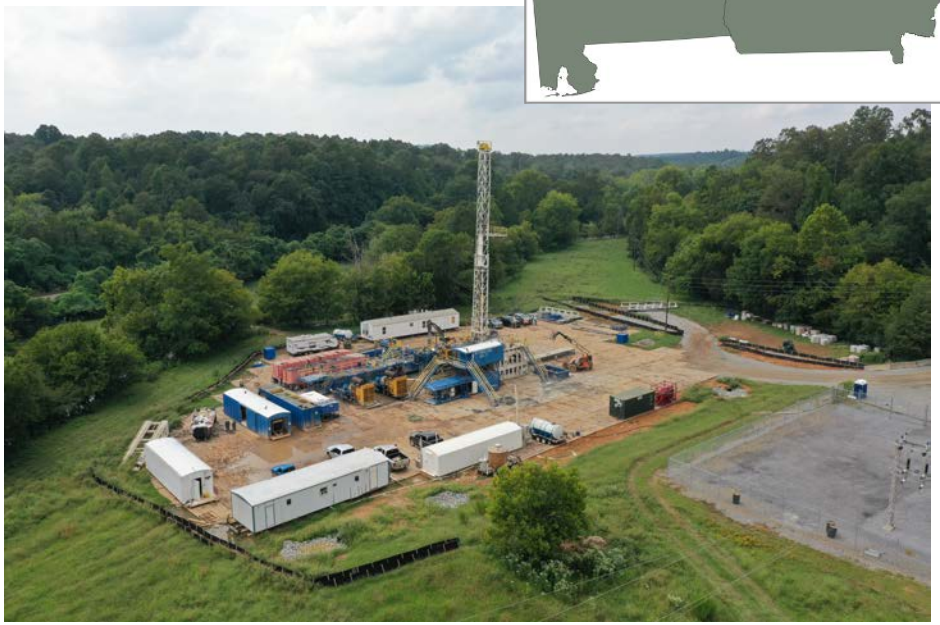
Hypothetical pipeline routes connecting major point-source emitters to existing pipeline infrastructure.

Industry Partners

SECARB-USA

CCS Prospects in Georgia & Alabama

- Partnered with Southern Company and Advanced Resources International to drill two stratigraphic/characterization wells in the Valley and Ridge province of northern Georgia and north-central Alabama.
- An area of the region that has not experienced historical oil and gas exploration so there is limited existing data.
- Important to understanding CCUS commercialization opportunities in the region.
- Cassville Stratigraphic Test Well (Bartow Co., GA):
  - Total Depth of 6,030 ft reached on September 14, 2021
  - Collected open-hole geophysical data, formation microimager data, and side-wall core
- Westover Stratigraphic Test Well (Shelby Co., AL):
  - Total Depth of 6,500 ft reached on November 5, 2021
  - Collected open-hole geophysical data and formation microimager data



Aerial photograph of the Cassville stratigraphic test well located in Bartow County, GA.

Webinar Series

- SSEB hosts a regular webinar series to discuss timely news related to energy and the environment.
- Almost 400 total attendees over 4 separate webinars.
- Over 100 individuals registered for the July 15, 2021, Regional Initiative Webinar
- 150 individuals registered for the August 25, 2021, SECARB-USA Webinar
- Effective means to generate interest in CCUS and the work of the Regional Initiatives while engaging with a diverse group of stakeholders.
- For more information and to view past webinars visit www.sseb.org/webinar-archive/

CarbonSAFE - Project ECO$_2$S Phase III (Mississippi)

- Establishing a regional storage complex for CO_2 from stationary sources.
- **Estimated storage capacity of almost 1 billion metric tons (P_{50})!**
- Three new characterization wells drilled and nearly 100 linear miles of 2D seismic acquired.
- Currently drafting EPA Underground Injection Control Class VI well permit.

Research Partners

National Energy Technology Laboratory
Southern Company
Mississippi Power
Advanced Resources International, Inc.
BATTELLE
Christensen CCUS Consult
CRESCENTRI
International CCS Knowledge Centre
IOM Law
Leonardo Technical Resources LLC
OSU
sas
Trimeric Corporation
UAB
Enhanced Oil Recovery Institute, University of Wyoming
USGS science for a changing world

Specialized Partners & Vendors

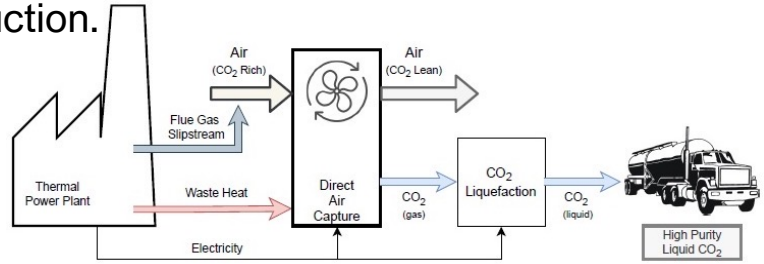
DNV·GL
ECT Environmental Consulting & Technology, Inc.
Linde
Mitsubishi Heavy Industries
Schlumberger
SPECTRUM
Stantec

PROJECT ECO$_2$S


SPECTRUM
Solutions to Your Environmental Challenges

Direct Air Capture of CO_2 (Alabama)

- Decreasing CO_2 capture costs through testing in integrated field units that produce a concentrated CO_2 stream of at least 95% purity.
- Completed engineering and design of test skid.
- Procuring materials required for test skid construction.



Synapse Build Labs

CO_2 Processing Skid

National Carbon Capture Center
https://www.nationalcarboncapturecenter.com

DAC RECO$_2$UP Stakeholder Network

BP

Clean Air Task Force

Carbon Utilization Research Council

Georgia Tech Agricultural Technology Research Institute

Good People Brewing Company

Marathon Petroleum

Pilgrim's Pride

Shell

Southern Company Services

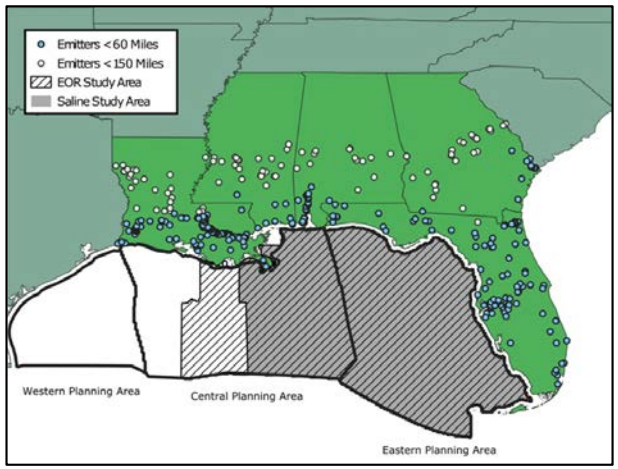
Tennessee Valley Authority

University of Georgia College of Engineering

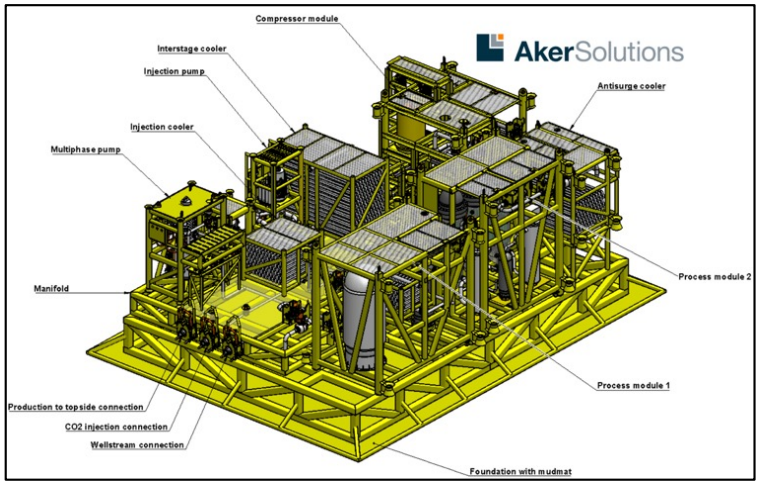
Virginia Center for Coal and Energy Research at Virginia Polytechnic Institute and State University

SECARB Offshore Partnership: Gulf of Mexico

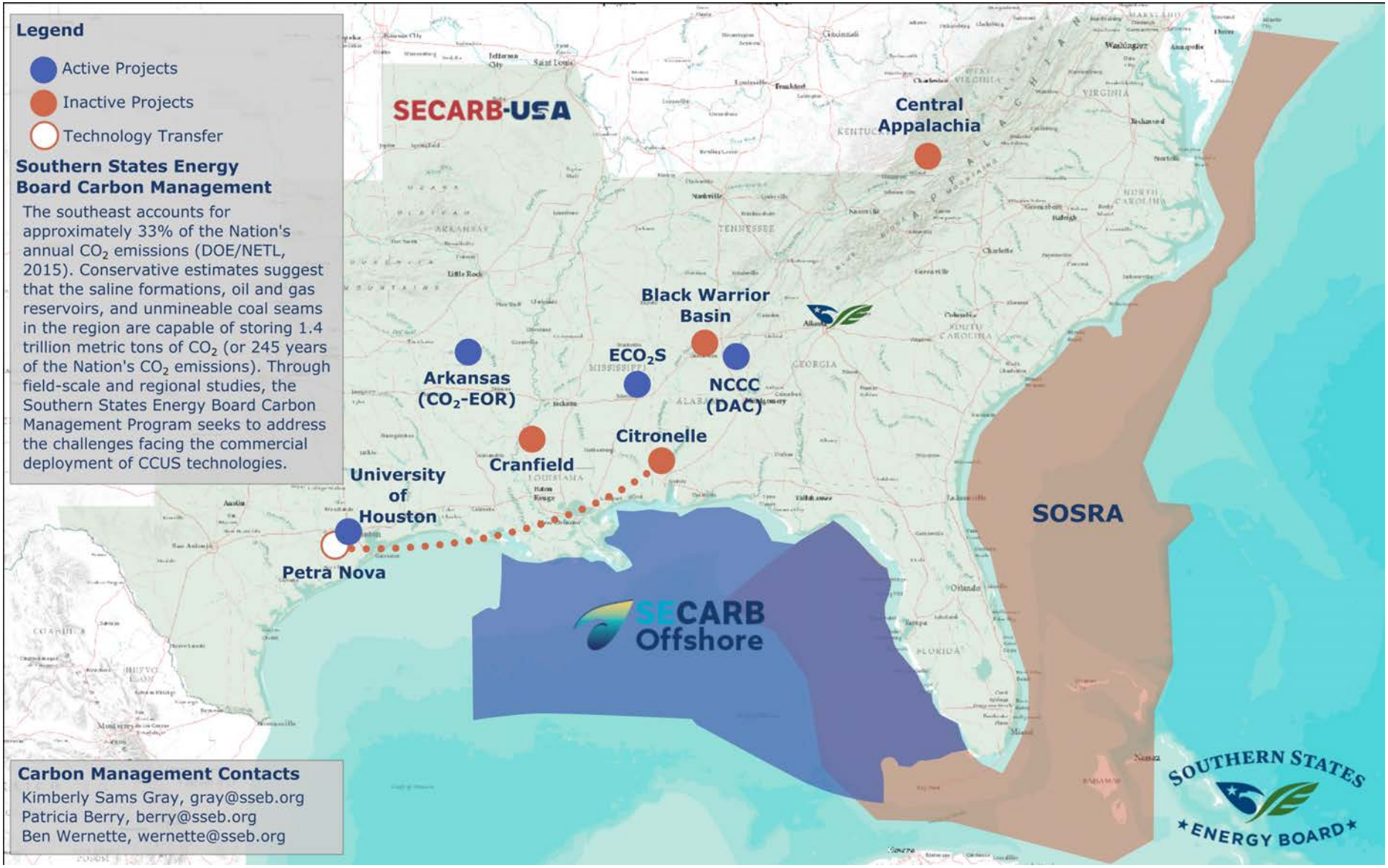
- CO_2 storage and Enhanced Recovery Assessment for eastern GOM, including the analysis of existing and required legal and regulatory frameworks in anticipation of commercial deployment.
- The project team continues to assess CO_2 storage opportunities, evaluate infrastructure options, and identify risks associated with legacy infrastructure and geology.



Onshore CO_2 sources within 150 miles of the coast. Also shown are the Gulf Planning Areas and the SECARB-Offshore study area.



Modular units for subsea processing


Legend
Active Projects
Inactive Projects
Technology Transfer
Southern States Energy Board Carbon Management
The southeast accounts for approximately 33% of the Nation's annual CO_2 emissions (DOE/NETL, 2015). Conservative estimates suggest that the saline formations, oil and gas reservoirs, and unmineable coal seams in the region are capable of storing 1.4 trillion metric tons of CO_2 (or 245 years of the Nation's CO_2 emissions). Through field-scale and regional studies, the Southern States Energy Board Carbon Management Program seeks to address the challenges facing the commercial deployment of CCUS technologies.
SECARB-USA
Central Appalachia
Black Warrior Basin
Arkansas (CO_2-EOR)
ECO_2S
NCCC (DAC)
Citronelle
Cranfield
University of Houston
Petra Nova
SECARB Offshore
SOSRA
Carbon Management Contacts
Kimberly Sams Gray, gray@sseb.org
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Ben Wernette, wernette@sseb.org
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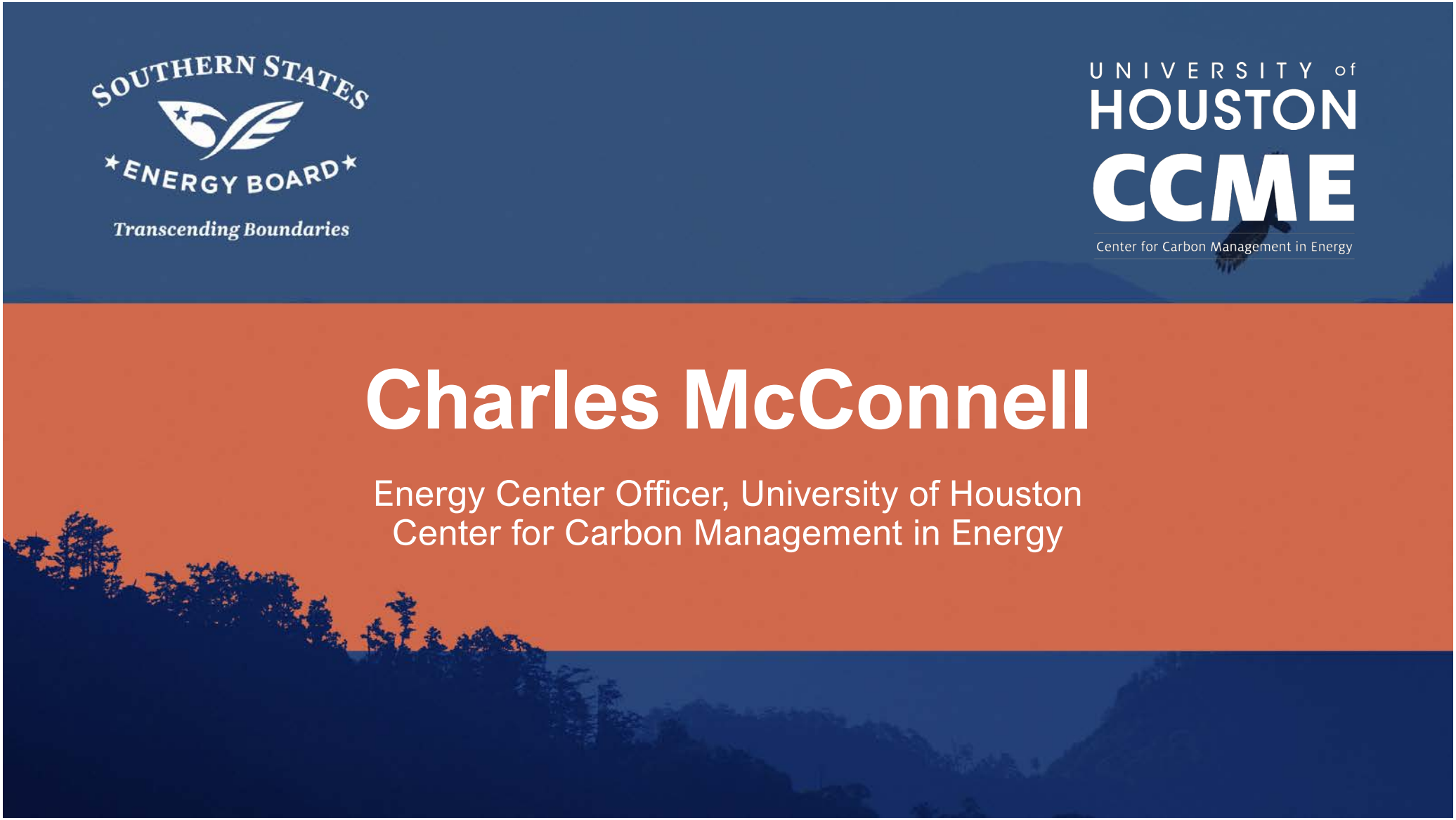
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Center for Carbon Management in Energy
Charles McConnell
Energy Center Officer, University of Houston
Center for Carbon Management in Energy

CCUS Leadership Consortium

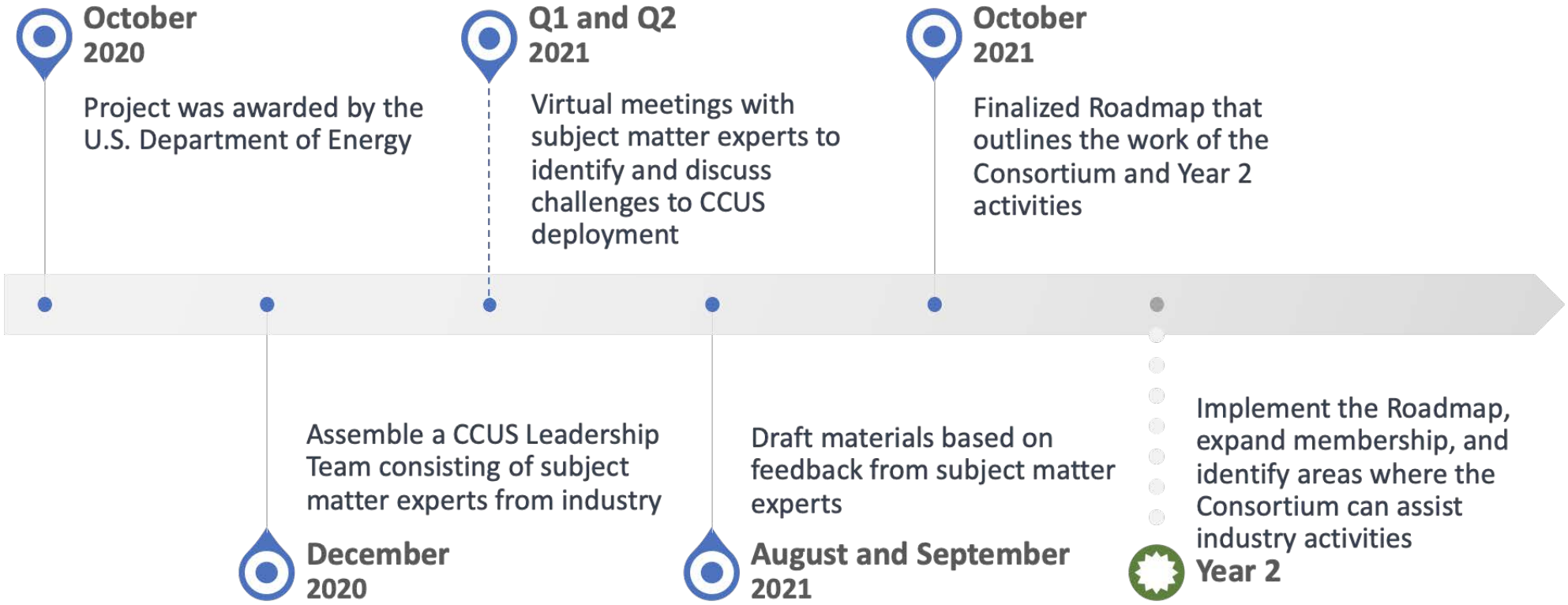
- Collaborative effort between the **Southern States Energy Board** and the **University of Houston's Center for Carbon Management in Energy**
- Mission: coordinate the capabilities and experience of industry, academia, and government to accelerate CCUS deployment in the Southern region, address key challenges, and promote regional technology transfer and knowledge dissemination – in response to NPC study
- Worked with subject matter experts to develop a roadmap that enumerates challenges to the commercial deployment of CCUS technologies and tasks to eliminate these challenges (finalized October 15, 2021)
- **The consortium is a mechanism for CCUS knowledge sharing**

"The solution is going to come from the private sector, and what government needs to do is create the framework within which the private sector can do what it does best, which is allocate capital and innovate..."

U.S. Climate Envoy John Kerry describing solutions to climate change at the Institute of International Finance's 2021 Washington Policy Summit

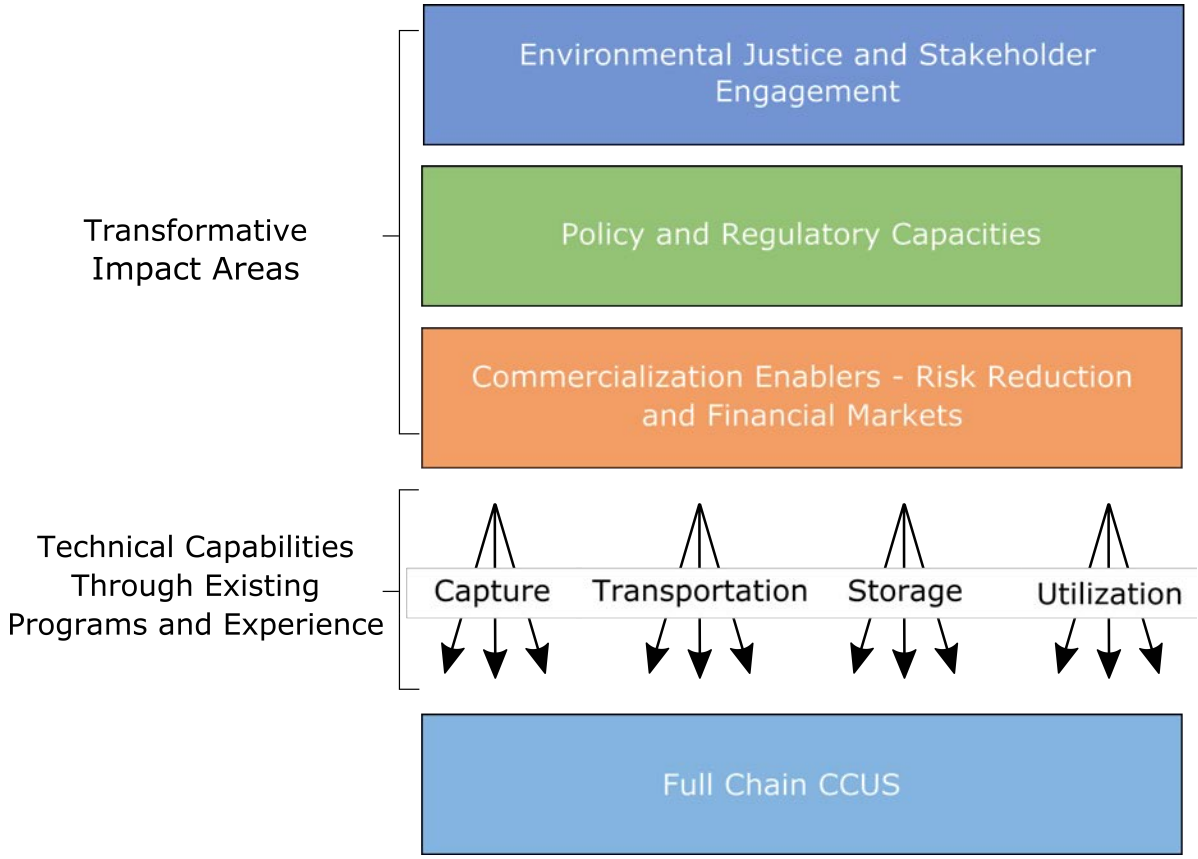
Leadership Consortium - Membership

Leadership Consortium - Timeline



Leadership Consortium - Challenges

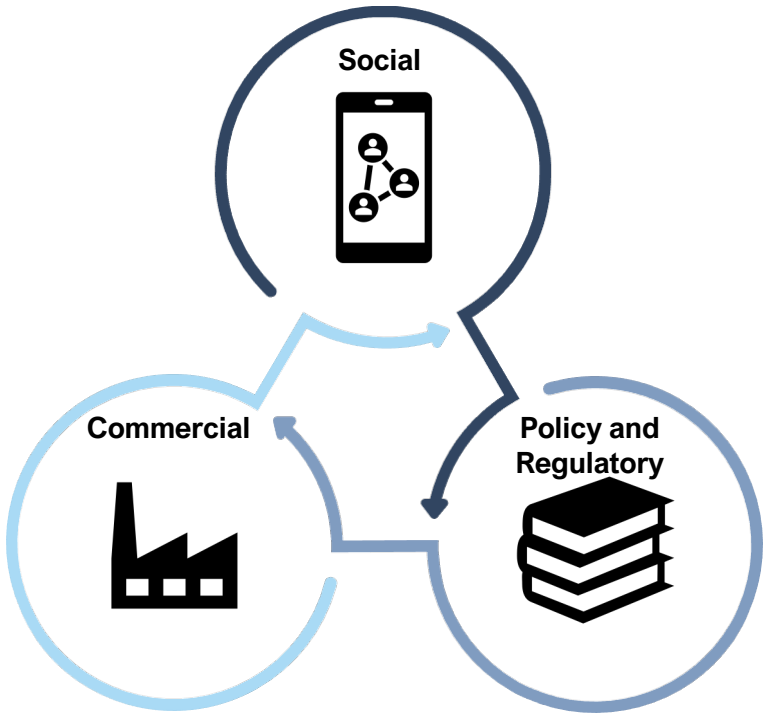
- Subject matter experts identified a wide array of challenges to the commercialization of CCUS
- Many existing technical challenges are addressed by existing research programs
- A general need to focus on transformative challenges or those that apply to all aspects of the CCUS value chain
- **Required for far-reaching and just deployment of CCUS**



Leadership Consortium – Challenges to Be Addressed

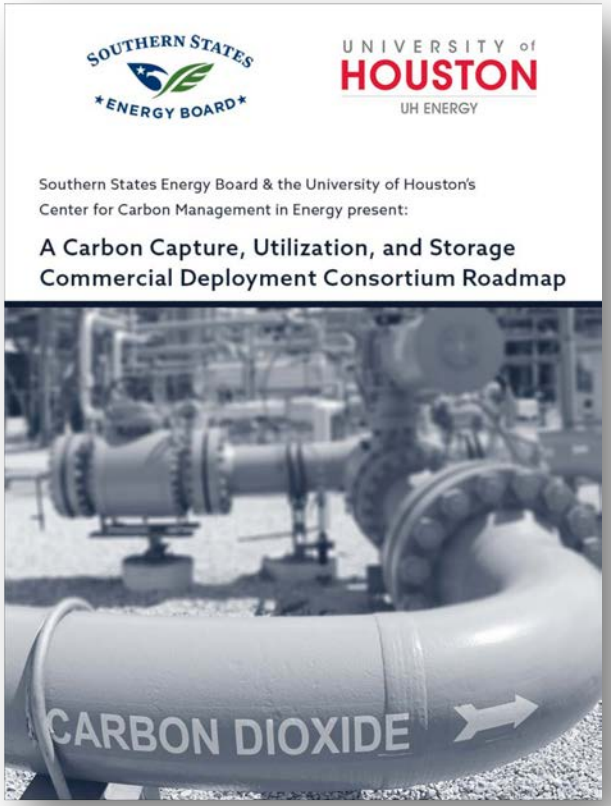
- **Leverage the experience and membership of SSEB, the location and expertise of UH-CCME, and Consortium membership to address Transformative Impact Areas**
- **Social Enablers:** Stakeholder Engagement; Environmental Justice; Workforce and Community Transition
- **Policy and Regulatory Enablers:** Facility Permitting; Pipeline Permitting; Class VI Primacy; Site Stewardship
- **Commercialization Enablers – Risk Reduction and Financial Markets:** Storage Risks; Life-Cycle Assessment; Cost-Benefit; Standards, Certification, and Marketing

Transformative Impact Areas



Leadership Consortium – Next Steps

- Continue to maintain the Consortium and host regular virtual and in-person meetings
- Identify opportunities to support industry activities
- Begin to carry out the activities outlined in the Roadmap
- **If you are interested in joining the Consortium or our activities, please reach out to SSEB and UH-CCME**



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