

**CARBON CAPTURE, UTILIZATION, AND  
SEQUESTRATION: A STATE COMPARISON OF  
TECHNICAL AND POLICY ISSUES**

**Shari Ring  
The Cadmus Group LLC  
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# CCUS Background

- CCUS can play a critical role in decarbonizing the global economy and achieving climate change goals
- Provides economic benefits, creates jobs
- Significant research is complete, technology is mature
- Expansion is anticipated over the next several years



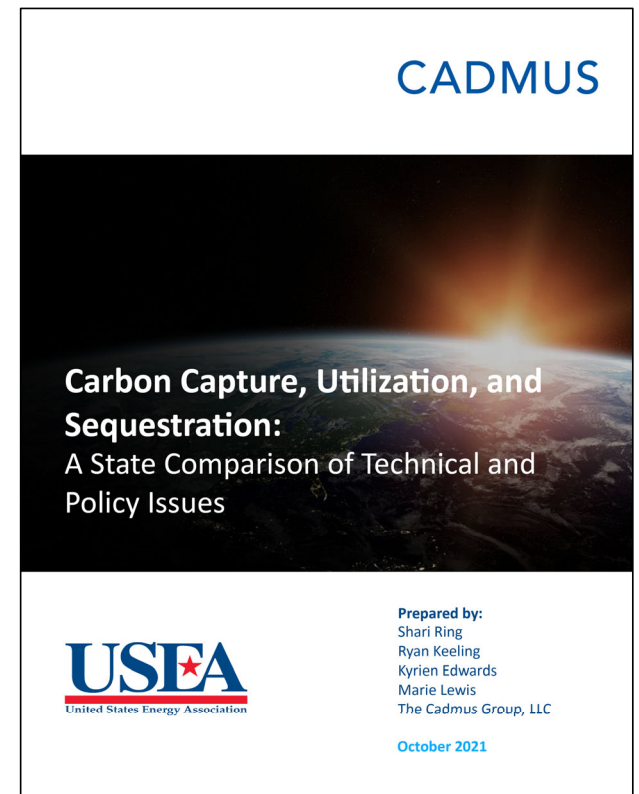
# The Need for Regulatory Certainty

- Permitting and federal/state rules apply to the siting and initiating CCUS projects
- Prospective CCUS project operators must consider and understand policy nuances
- States' policies expand on long-standing legal frameworks, e.g., for oil and gas exploration
- Regulations are informed by science and experience

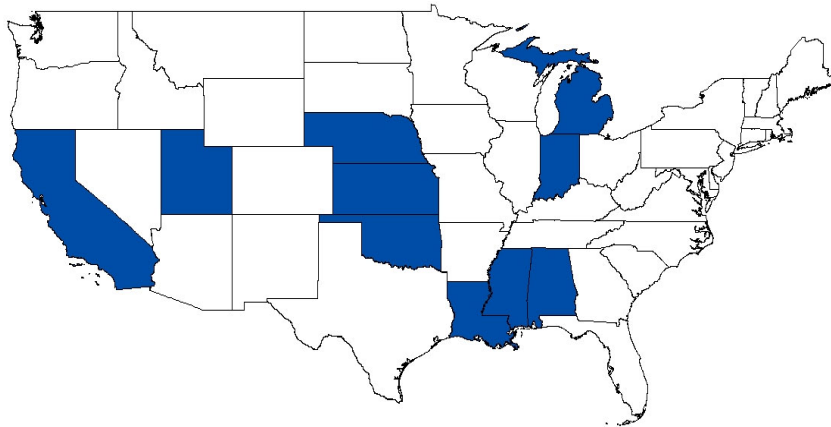


# Our Research

- CCUS Activities the State
- Regulation of CO<sub>2</sub> Pipelines, Geologic Storage, and Production and Injection Wells
- Environmental Laws and Water Rights
- Eminent Domain
- Land Use, Mineral, Water, and Pore Space Rights



# Ten States Reviewed



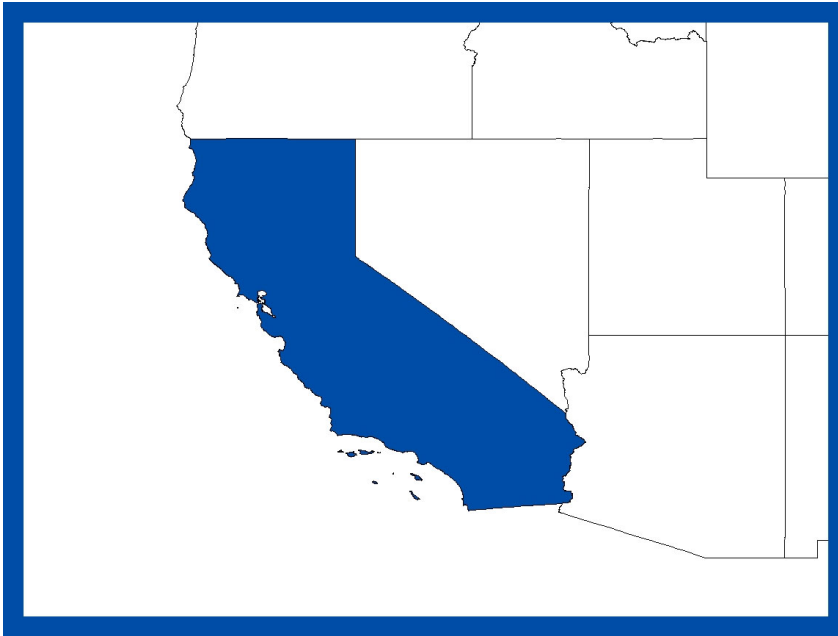
Alabama  
California  
Indiana  
Kansas  
Louisiana  
Michigan  
Mississippi  
Nebraska  
Oklahoma  
Utah

# Alabama



- CO<sub>2</sub> storage potential in the Black Warrior Basin/ other coal reserves, as well as oil and gas reservoirs and saline formations
- Pilot-scale injection project into the Paluxy saline formation at Citronelle oil field
- Potential for connection to CO<sub>2</sub> pipelines in neighboring Mississippi

# California



- Oil and gas fields offer significant CO<sub>2</sub> storage capacity
- GS permit application pending at a BECCS project in Mendota

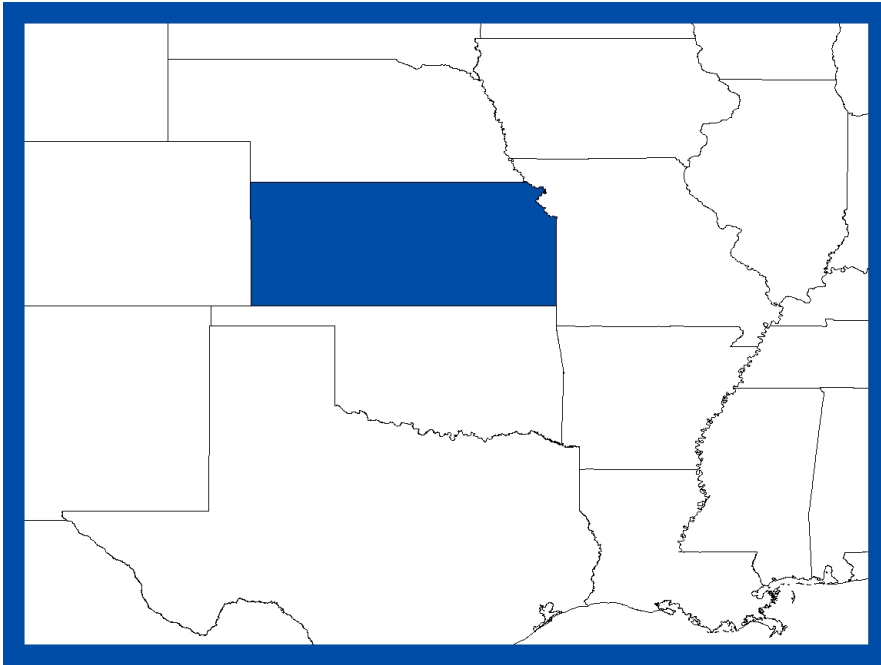
# Indiana



- Storage capacity in coal beds and saline formations (including the Mt. Simon Sandstone)
- Proposed or completed CCUS projects:
  - Small-scale CO<sub>2</sub> injection test in Barrett into the Clore sandstone
  - Wabash Valley Resources

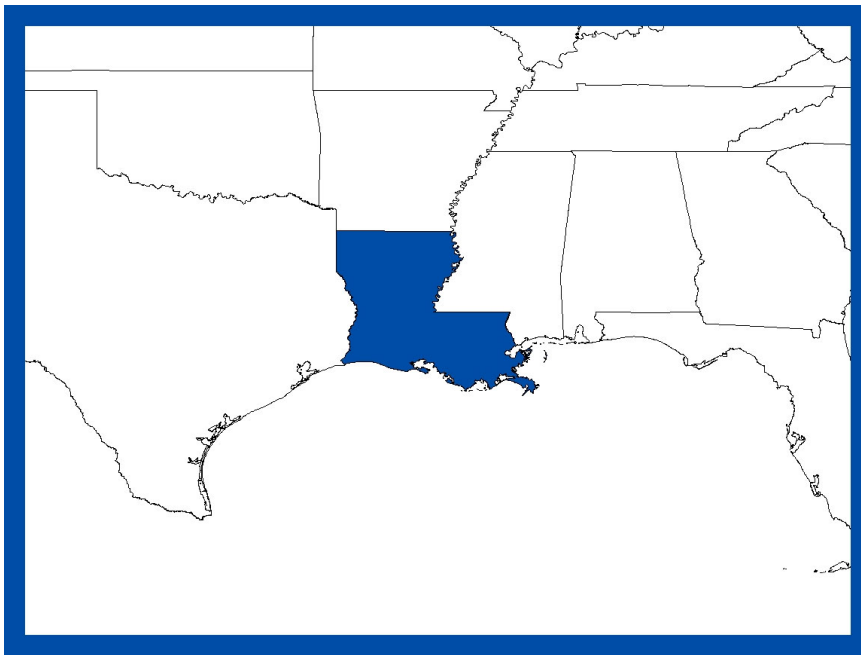


# Kansas



- Potential CO<sub>2</sub> storage in the Osage, Viola, and Arbuckle saline formations
- State-industry studies of EOR at Wellington Field and the Hall-Gurney Field

# Louisiana



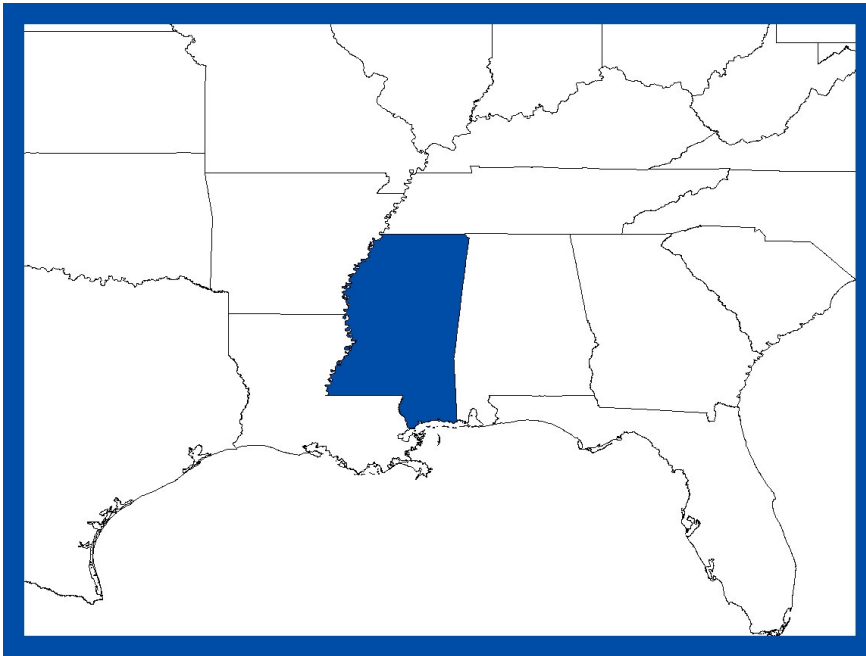
- Capacity for up to 2 trillion metric tons of CO<sub>2</sub> in saline formations
- Research on the State's "industrial corridor"
- Planned CCUS projects include Lake Charles Methanol and Gulf Coast Sequestration

# Michigan



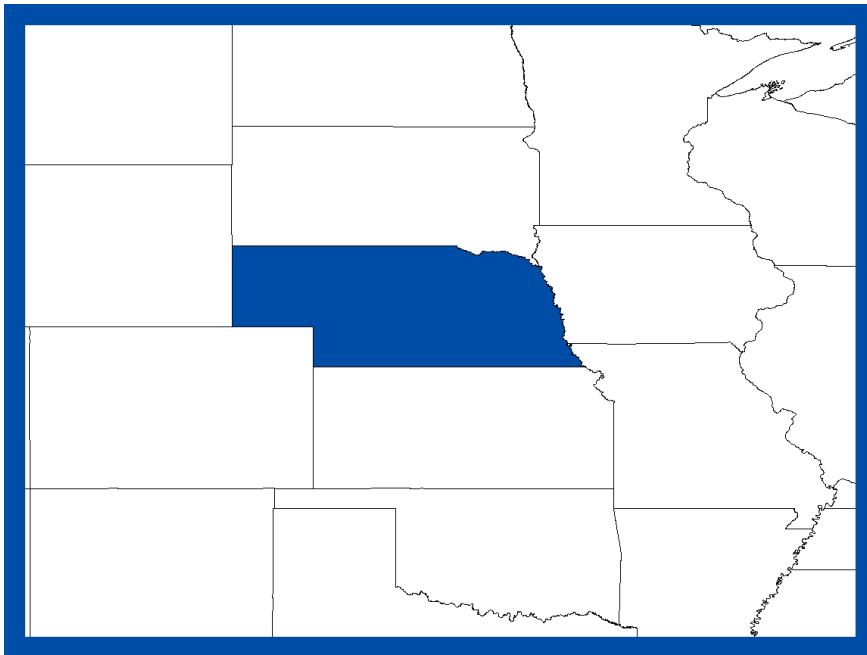
- Storage potential in the Niagaran Pinnacle Reef Trend and Mt. Simon Sandstone
- Core Energy CO<sub>2</sub> -EOR program, Otsego County
- Small-scale CO<sub>2</sub> injection test within the Northern Pinnacle Reef Trend

# Mississippi



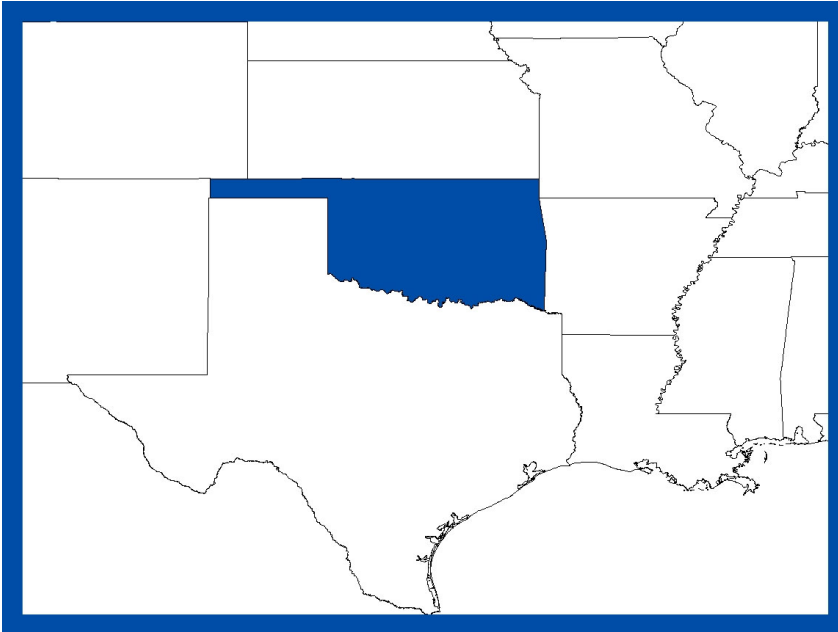
- Significant CO<sub>2</sub> storage capacity in saline formations
- Cranfield CO<sub>2</sub> storage project—over 5 million metric tons of CO<sub>2</sub> injected for EOR
- CO<sub>2</sub> pipelines run from Mississippi into neighboring states

# Nebraska



- Significant CO<sub>2</sub> storage capacity in the Cloverly Formation and Cedar Hills saline formations
- Feasibility study at the Gerald Gentleman Station
- Planned 1,200-mile CO<sub>2</sub> pipeline

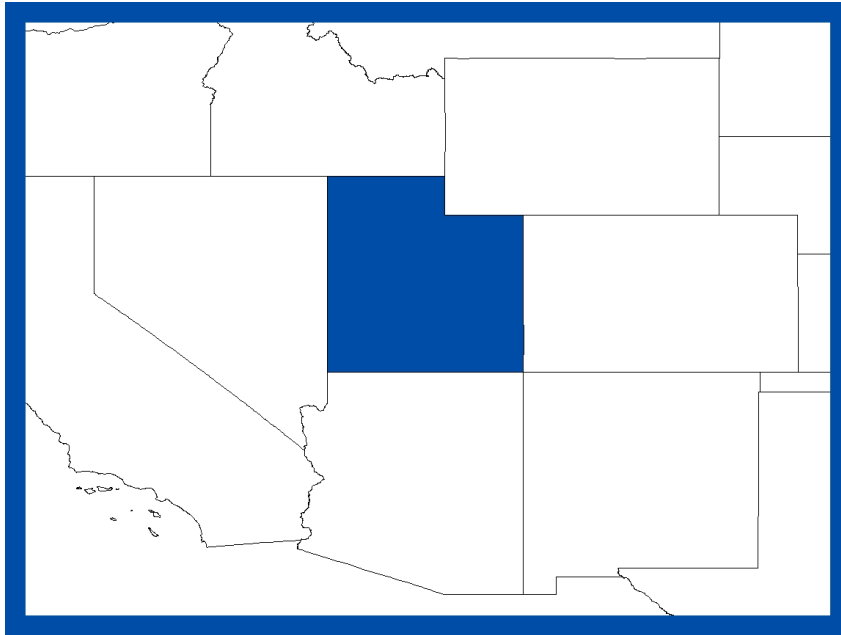
# Oklahoma



- Potential CO<sub>2</sub> storage in the oil and gas reservoirs of the Anadarko Basin and in saline formations
- CO<sub>2</sub> generated at Enid Fertilizer facility stored in depleted oil fields in the Anadarko Basin
- Network of CO<sub>2</sub> pipelines



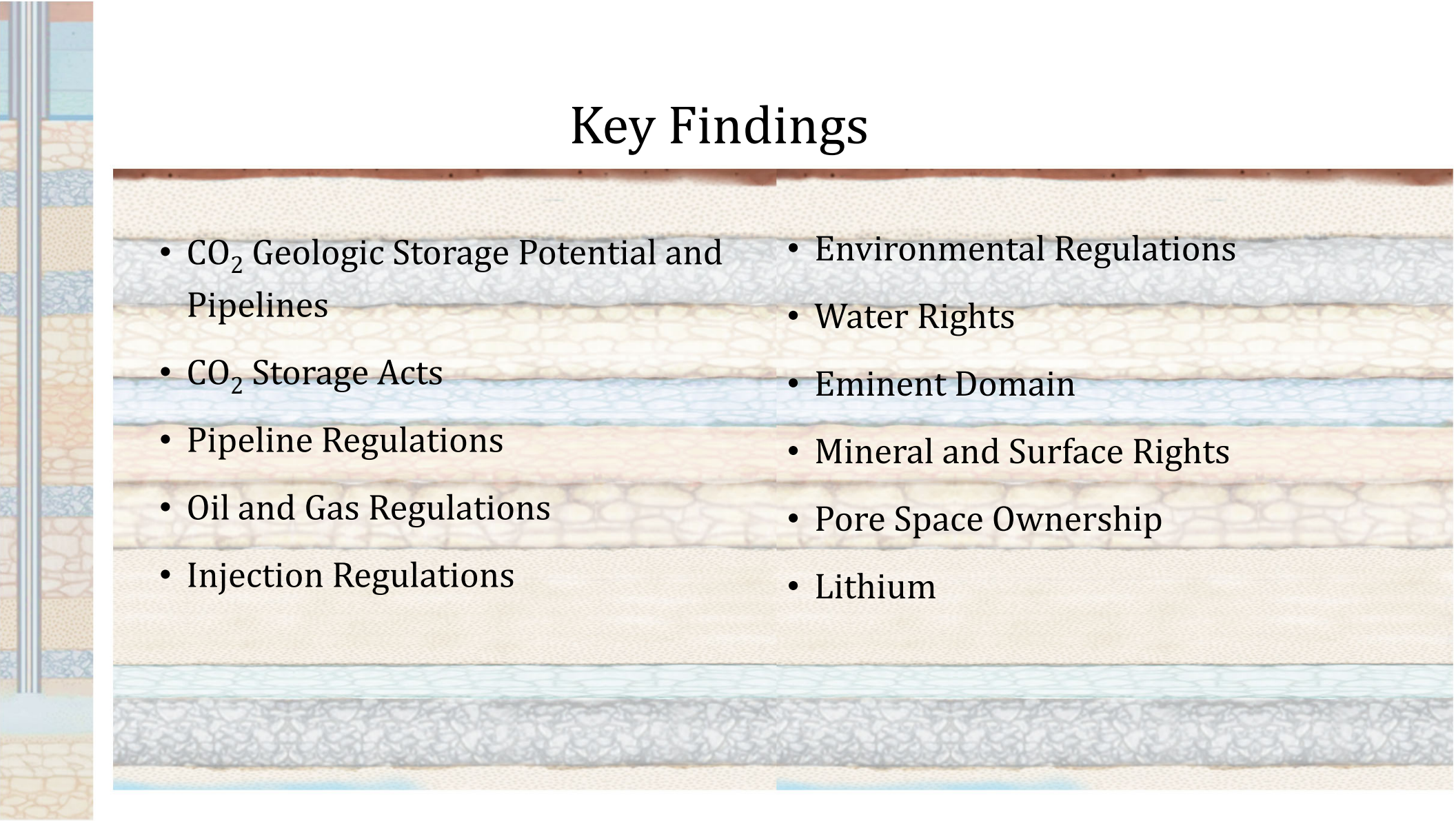
# Utah



- CO<sub>2</sub> storage capacity in saline formations and in oil fields
- CCUS research projects along existing CO<sub>2</sub> pipelines in the Rocky Mountain region



# Key Findings

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- CO<sub>2</sub> Geologic Storage Potential and Pipelines
  - CO<sub>2</sub> Storage Acts
  - Pipeline Regulations
  - Oil and Gas Regulations
  - Injection Regulations
  - Environmental Regulations
  - Water Rights
  - Eminent Domain
  - Mineral and Surface Rights
  - Pore Space Ownership
  - Lithium



# CO<sub>2</sub> Geologic Storage Potential



From "Best Practices: Site Screening, Site Selection, and Site Characterization for Geologic Storage" NETL. 2017.

- CO<sub>2</sub> repositories—including saline formations, EOR fields, and coal beds—exist throughout the US
- Storage formations should be extensive with sufficient pore space, and overlain by a confining zone
- Research/projects from feasibility studies to full-scale Class VI projects

# CO<sub>2</sub> Pipeline Capacity



*From DOE's Carbon Storage Atlas, 5<sup>th</sup> Edition. 2015.*

- “Source-sink” matching
- Extensive, existing oil and natural gas pipelines
- Lack of CO<sub>2</sub> pipeline infrastructure in many states



## CO<sub>2</sub> Storage Acts

- Provide regulatory certainty
- Clarify how CCUS fits into existing state policy
- Financial incentives
- Class VI injection rules
- Consider CO<sub>2</sub> to be a commodity



# Pipeline Regulations

- Regulations in Louisiana, Michigan, Mississippi, Oklahoma, and Utah
  - Minimum safety standards, inspections
  - Comply with US DOT requirements
  - Authority to counties
  - Hazardous waste exemptions

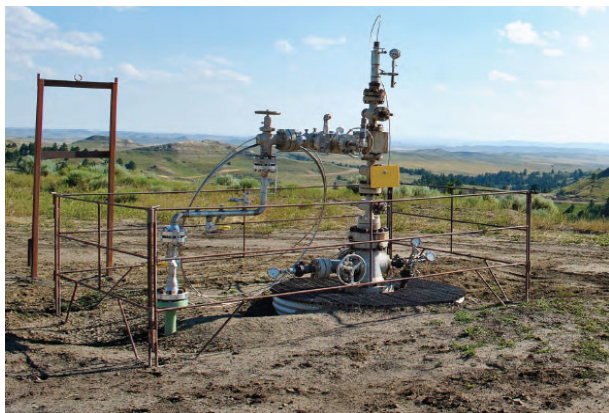
# Oil and Gas Field Requirements



*From DOE's Carbon Storage Atlas, 5<sup>th</sup> Edition. 2015*

- Important consideration in use of depleting oil and gas fields for storage
- Well design requirements/transitioning for Class VI
- Siting, spacing, unitization, pooling requirements

# Injection Regulations



From DOE's Carbon Storage Atlas, 5<sup>th</sup> Edition. 2015.

- All states studied, except Michigan, have Class II primacy (SDWA Section 1425)
  - Regulations implemented by states' oil and gas agencies
- Several are contemplating Class VI rules, primacy
  - For now, permitting is under the Federal Class VI Rule (40 CFR 146.81 *et seq.*)
- Wells transitioning for GS would need to meet Class VI requirements

# Environmental Regulations

- USDW/Freshwater definition
  - Significant for purposes of well construction/conversion
- Rules or guidelines for induced seismicity
- Air quality regulations; CO<sub>2</sub> as a contaminant



*From DOE's 2007 Carbon Storage Atlas*



# Water Rights

- Riparian: Alabama, Indiana, Louisiana, and Mississippi
- Appropriative: Kansas, Nebraska, Oklahoma, and Utah
- California and Michigan observe both systems
- Preference for usage; withdrawal limits; restriction during water emergencies



*From DOE's 2007 Carbon Storage Atlas*



# Eminent Domain

- Authorized in all the states, with procedures identified
- Typically applies to oil and gas development, transportation
- Specific applicability to CCUS/CO<sub>2</sub> storage is limited or may be interpretive
  - Indiana, Louisiana, Michigan, and Mississippi address eminent domain for CO<sub>2</sub> pipelines
  - Louisiana addresses expropriation of property for CO<sub>2</sub> storage



*From DOE's 2007 Carbon Storage Atlas*

# Mineral and Surface Rights

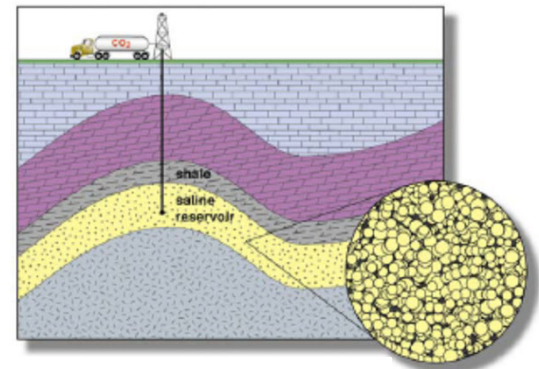


*From "Overview of Failure Modes and Effects Associated with CO<sub>2</sub> Injection and Storage Operations in Saline Formations." DOE, 2020.*

- CO<sub>2</sub> may or may not be included in states' definitions of a "mineral"
- It is unclear whether CCUS operators must possess surface rights, mineral rights, pore space rights, or a combination
- Louisiana, Mississippi, and Nebraska specifically address CO<sub>2</sub> ownership
- Surface access to develop the mineral estate may be limited

# Pore Space Ownership

- Pore space generally belongs to the surface owner
- Mississippi and Nebraska directly address pore space ownership for CO<sub>2</sub> storage
- In other states, legal language regarding CCUS in the context of subsurface rights is largely interpretive



*From DOE's 2007 Carbon Storage Atlas*



# Lithium

- Lithium is in demand in the transportation sector
- California: evaluating economic and environmental impacts, opportunities, and proposed regulations
- Utah: research on the feasibility of extracting lithium from oil and gas wastewater brines

# Conclusions

- Increasing interest in CCUS
- Source-sink matching is a critical element
- CO<sub>2</sub> pipeline development is limited
- CO<sub>2</sub> Storage Acts are filling in regulatory gaps



*From DOE's 2007 Carbon Storage Atlas*

# Thanks and Appreciation



CADMUS

- Cadmus Co-authors:
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  - Kyrien Edwards
  - Marie Lewis



Thank You!

Questions?

Shari Ring

[shari.ring@cadmusgroup.com](mailto:shari.ring@cadmusgroup.com)

(703) 247-6159

The report is available at: <https://usea.org/sites/default/files/event-/CCUS%20State%20Comparisons%20Report.pdf>