



U.S. DEPARTMENT OF  
**ENERGY**

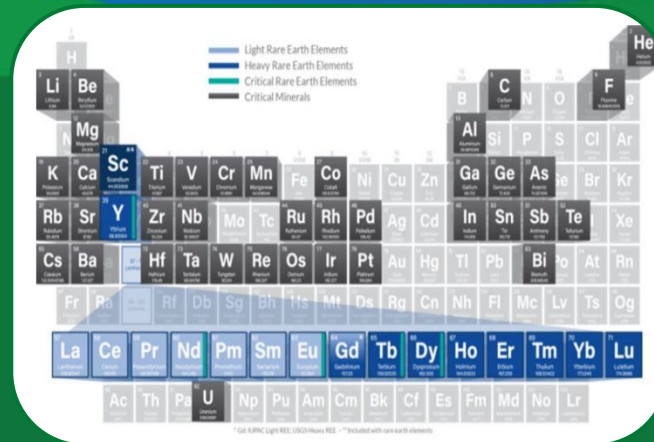
Fossil Energy and  
Carbon Management

# Developing Carbon Storage Infrastructure through Carbon Storage Assurance Facility Enterprise (CarbonSAFE)

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“The following PowerPoint slides presented at the Groundwater Protection Council Annual Forum.

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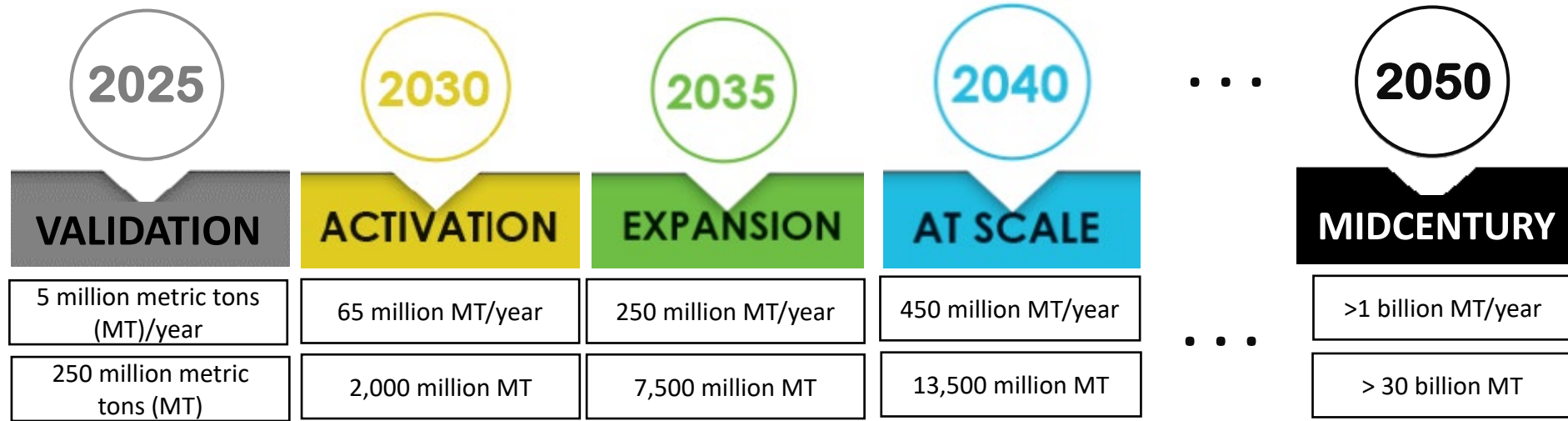
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# Meeting the Decarbonization Challenges



**Injectivity**

**Commercial Storage Capacity**



North Dakota CarbonSAFE



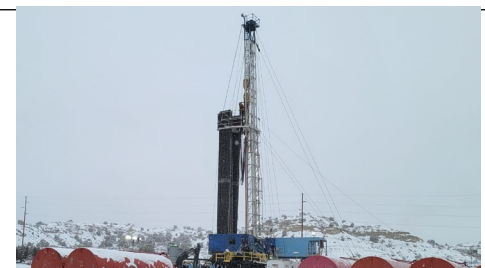
CarbonSAFE Project ECO2S



Wyoming CarbonSAFE



Illinois Basin CarbonSAFE



San Juan Basin CarbonSAFE

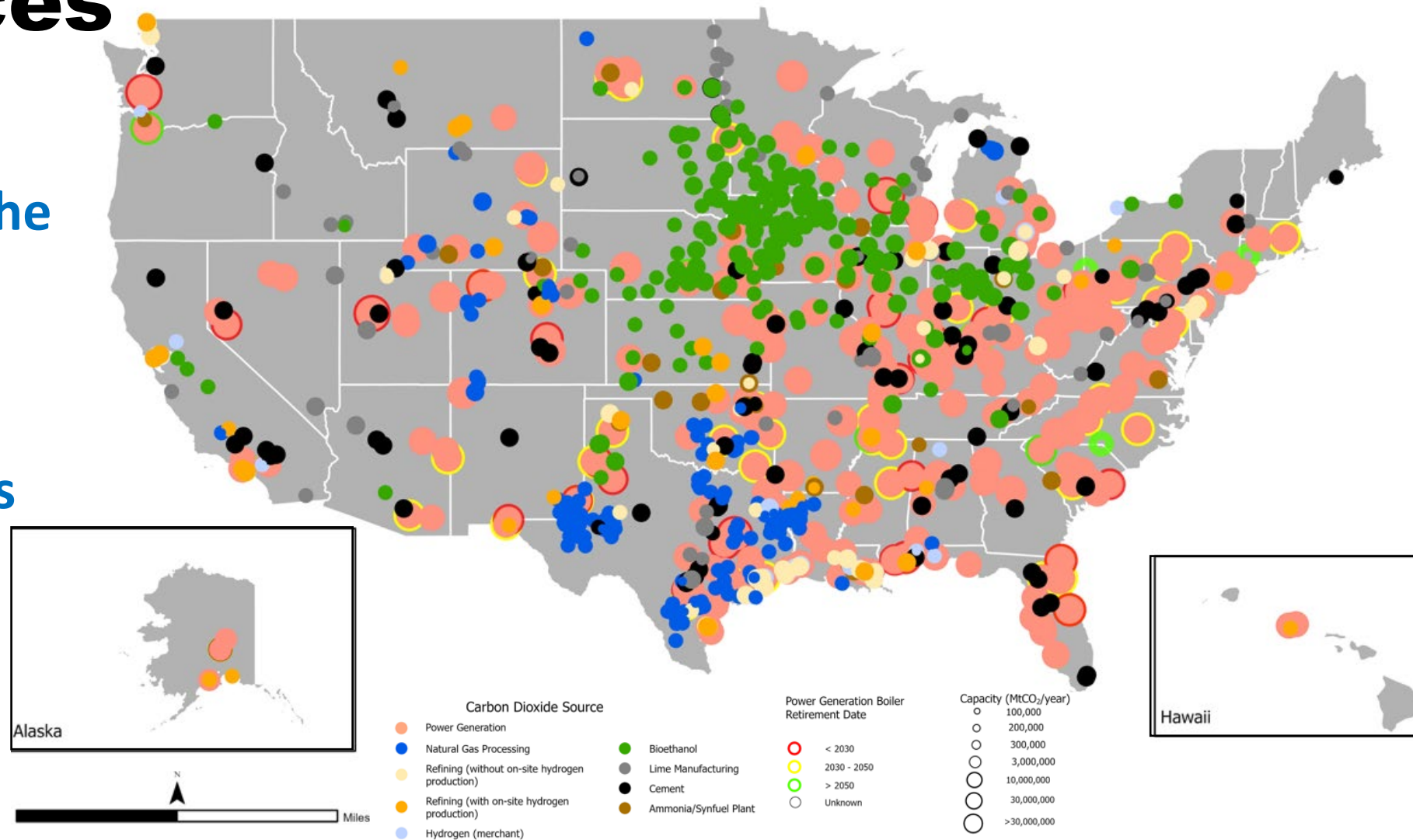
**...every Region is Different, but ALL Regions Contribute!**





# CO<sub>2</sub> Sources

How do you develop the Storage Infrastructure needed to address the challenge of decarbonization across all source types?



# CO<sub>2</sub> Transport Must Expand Rapidly

The build out of CO<sub>2</sub> transport infrastructure enables CCUS and CDR industry growth and meeting midcentury decarbonization goals.

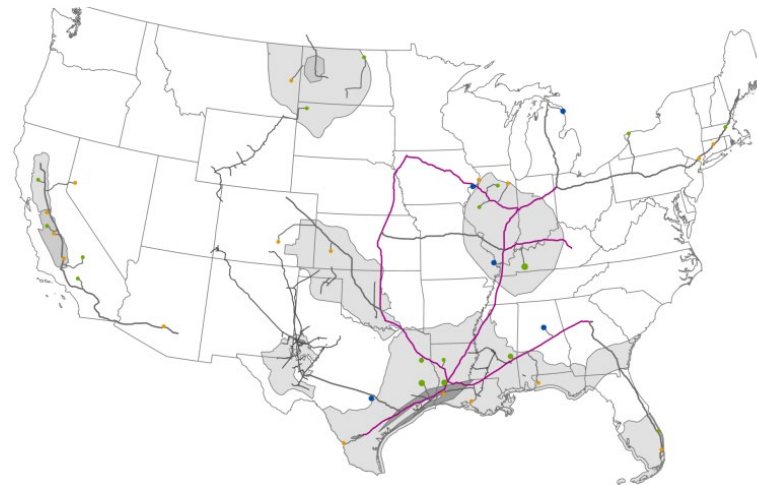
Today



NPC: Meeting the Dual Challenge (2019)

5,000 miles of pipelines

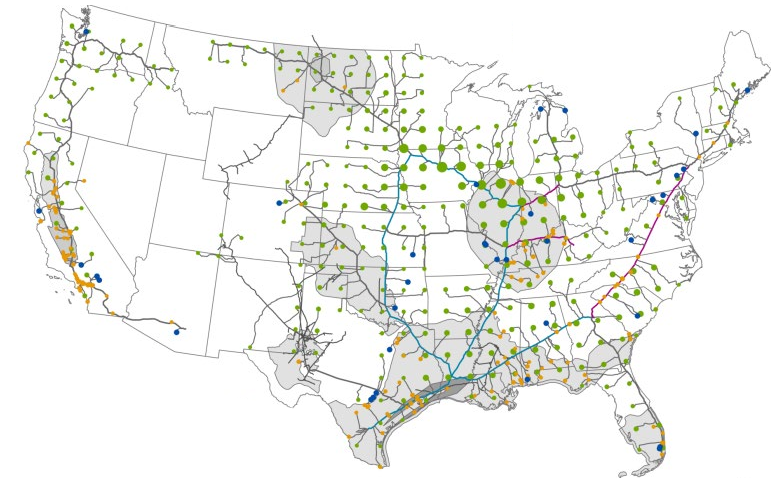
2030



Modeling from Princeton's Net-Zero America Study (2020)

11,000+ miles of pipelines

2050



Modeling from Princeton's Net-Zero America Study (2020)

13,000+ miles of trunk pipelines  
52,000+ miles of spur pipelines

- *SimCCS* by LANL, an open-source toolset for regional CCS infrastructure decision support, can help determine optimal, regional networks of CO<sub>2</sub> sources, sinks, and transport infrastructure

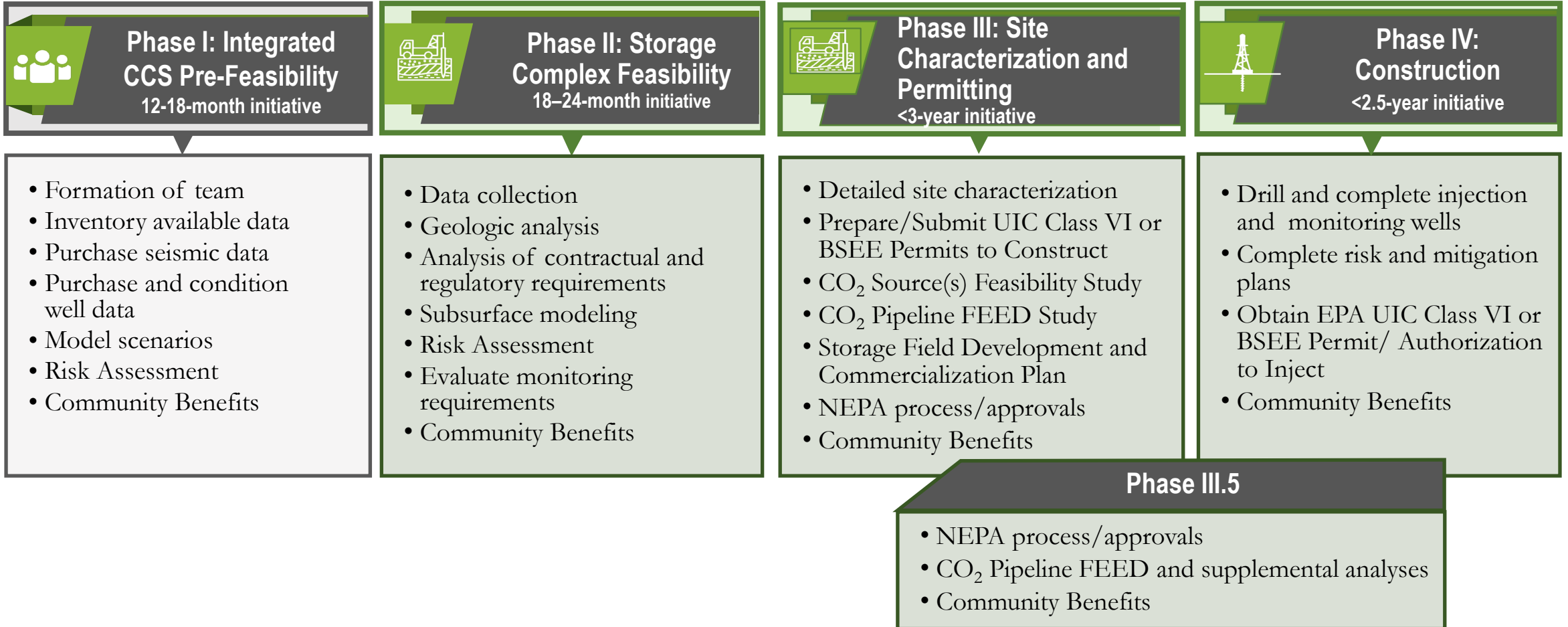
- Interactive **EDX4CCS Smart CO<sub>2</sub> Transport** to assist in planning routes of new CO<sub>2</sub> pipelines while also considering multiple environmental and social justice variables (for public release in early 2024)



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# Methodical Approach to Developing Storage Infrastructure—CarbonSAFE





# De-risking Storage Pay Targets

## From Storage Potential to Practical Storage Estimates

Storage Potential

Confirm Resource Potential and Site Suitability

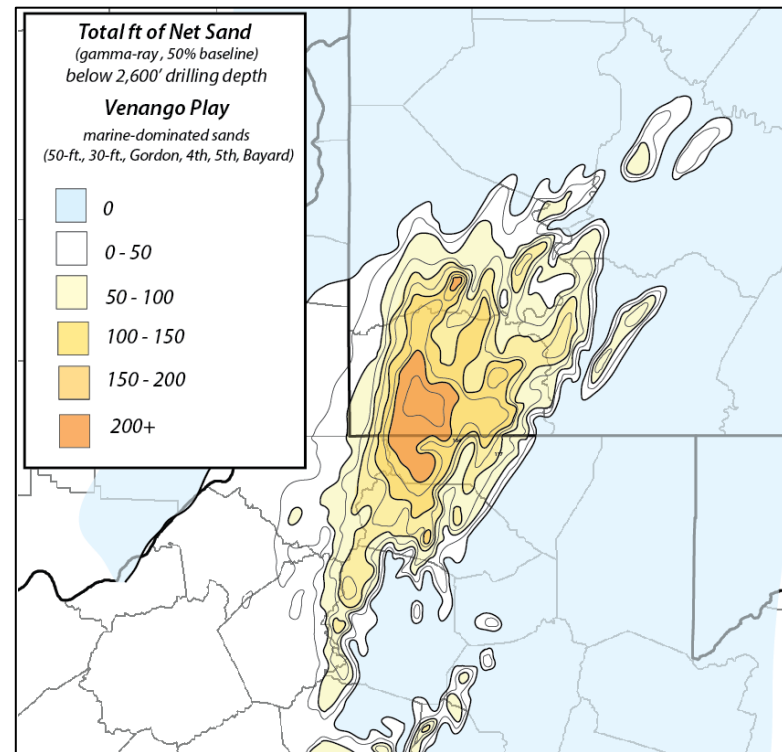
Capacity

Stored

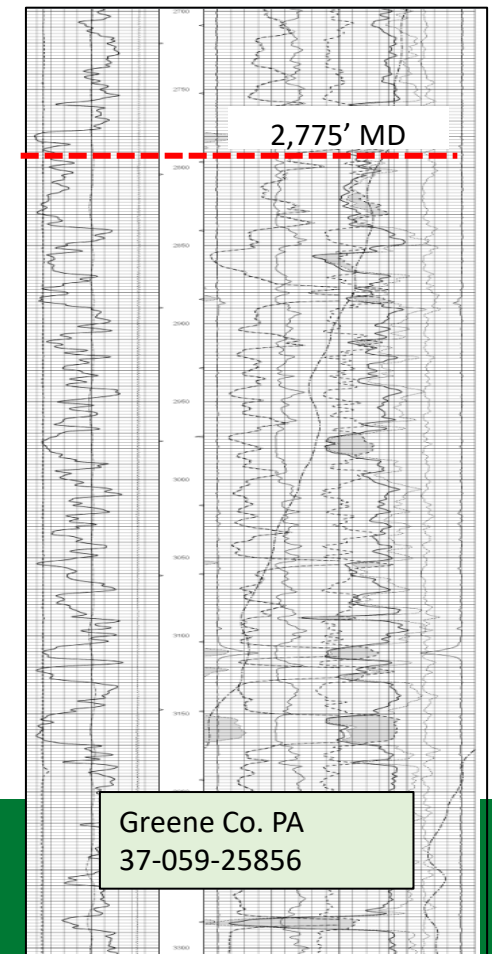
CarbonSAFE

### Identify specific areas/targets

- Geology must drive project site selection!
- Detailed local mapping.
  - Establish local pay criteria as possible.
  - Map H, Porosity, Sw, P/T in current condition utilizing all known wells.
  - Refine local CO<sub>2</sub> density calculation and depth “cut-off”.
- Acquire samples for petrophysics (permeability) where possible
- Conduct modeling studies to determine practicable storage of specific site.
- Consider seal integrity, seismicity concerns, ...



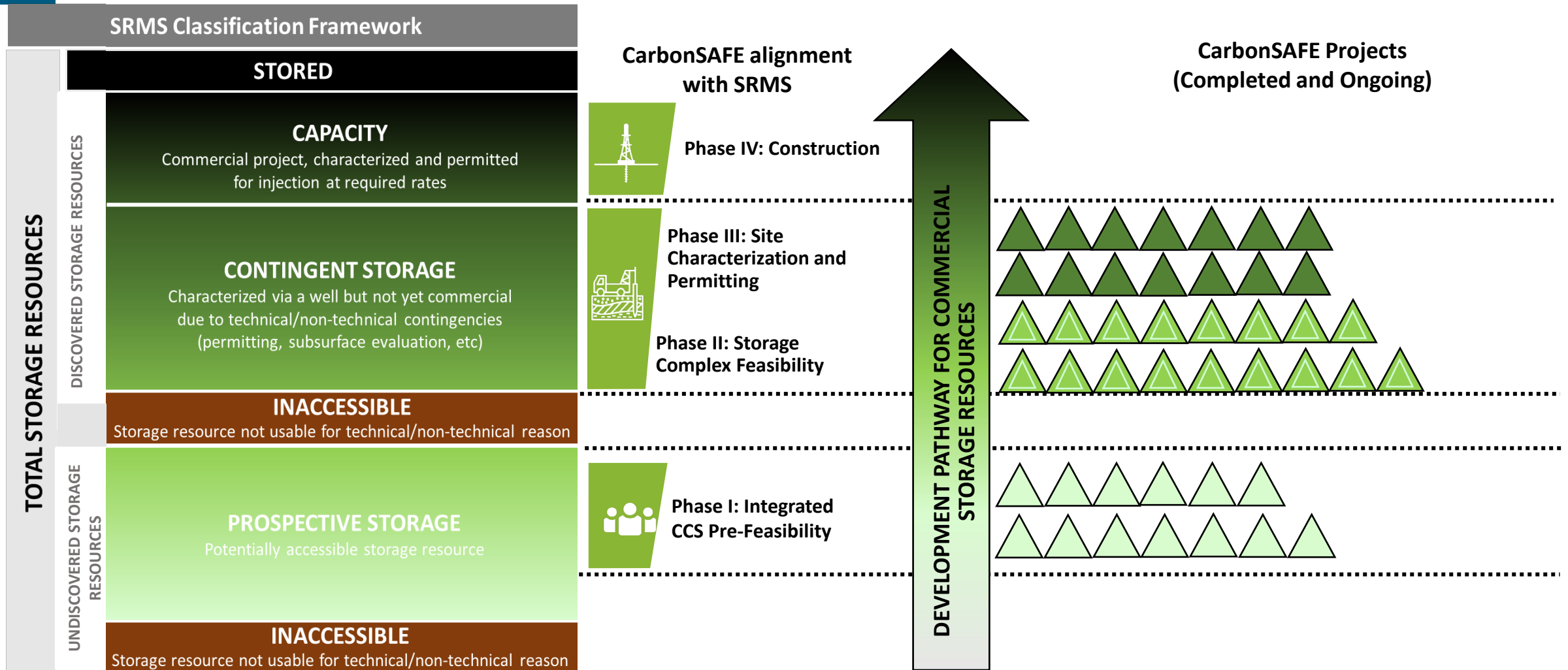
From Ray Boswell (publication in prep.)



Greene Co. PA  
37-059-25856

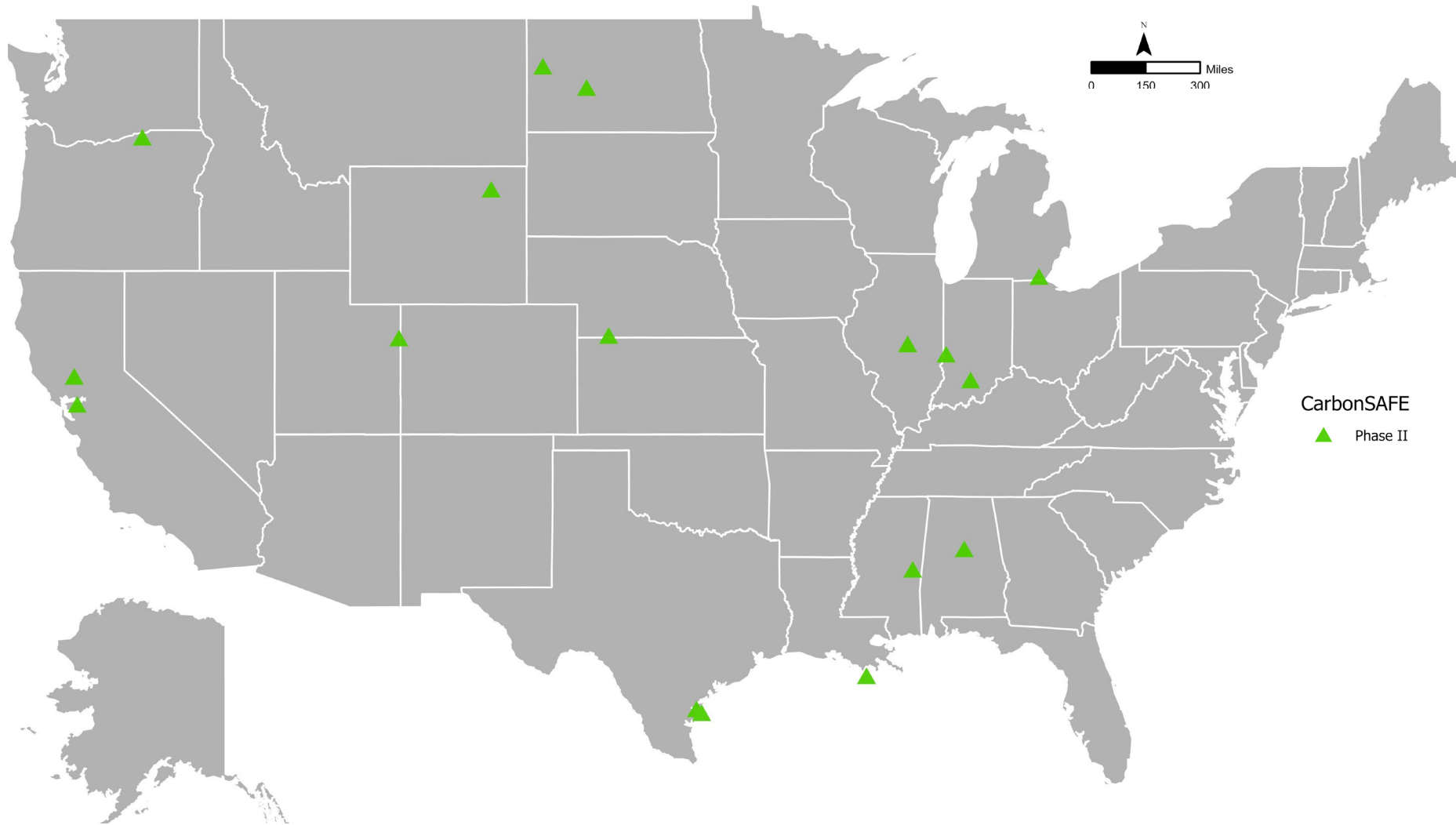
# Storage Resources Management System (SRMS)

Commercial viability framework [CO2 Storage Resources Management System \(spe.org\)](https://www.spe.org/CO2-Storage-Resources-Management-System)

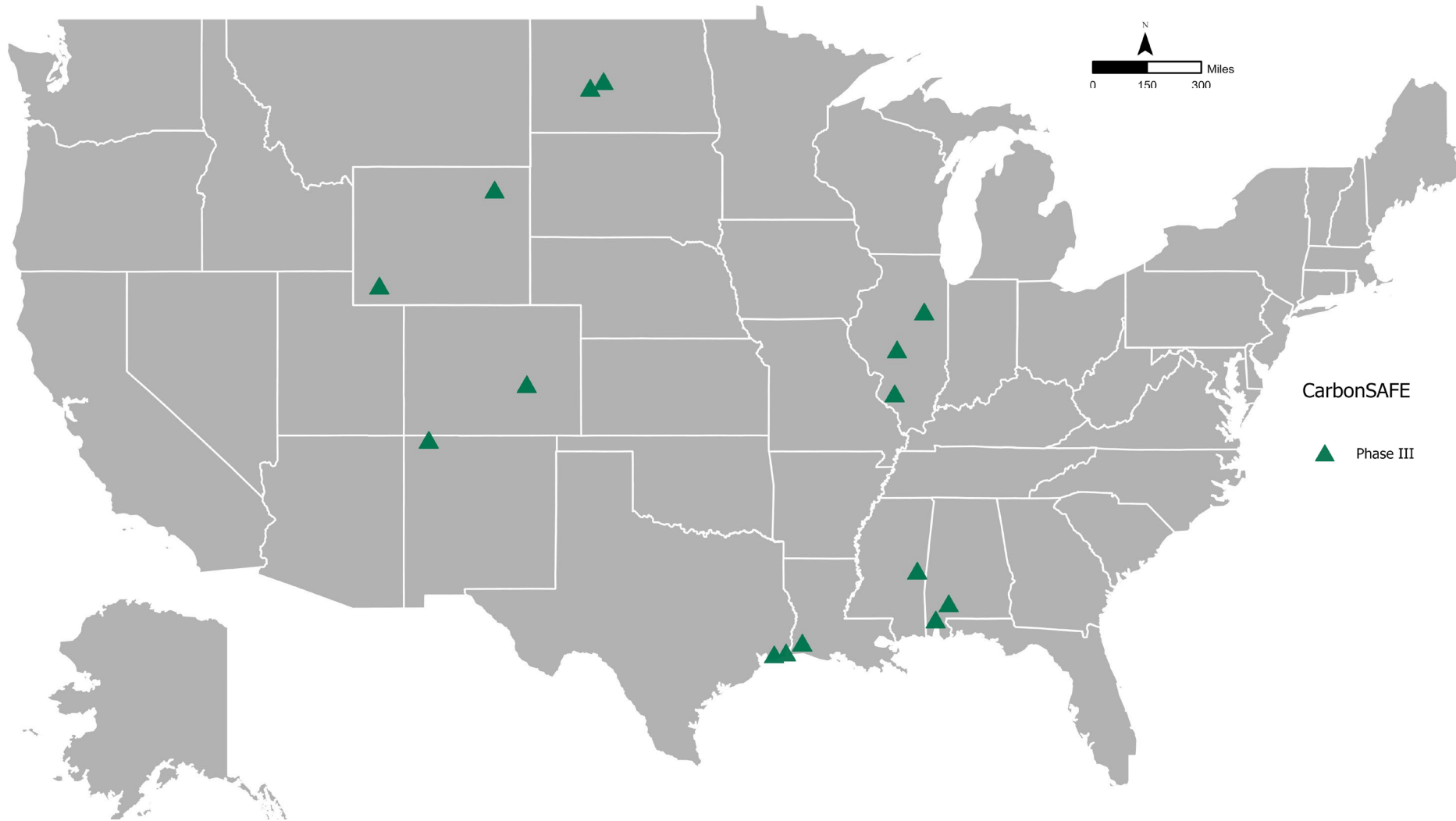




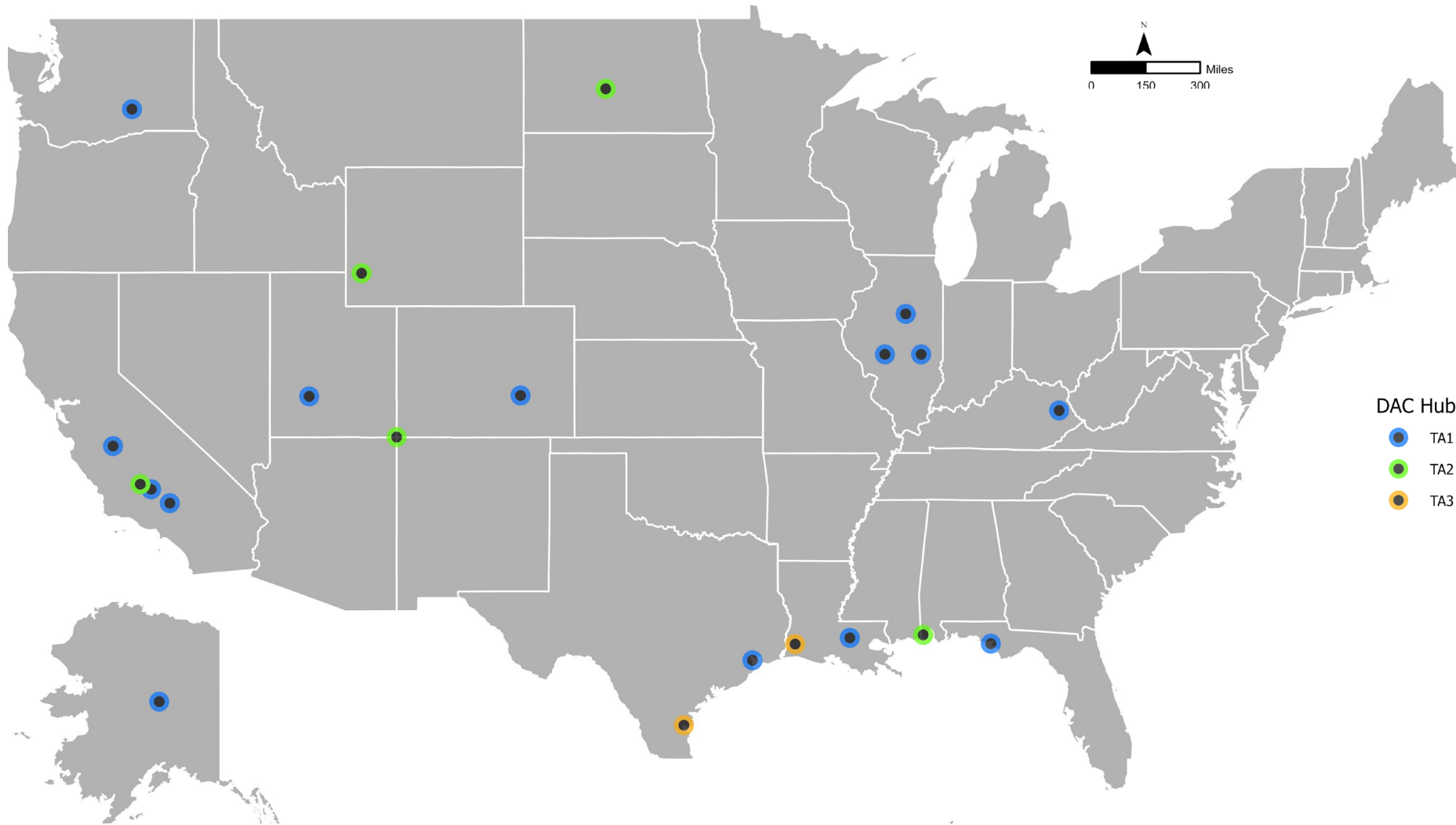
# CarbonSAFE Phase II Projects



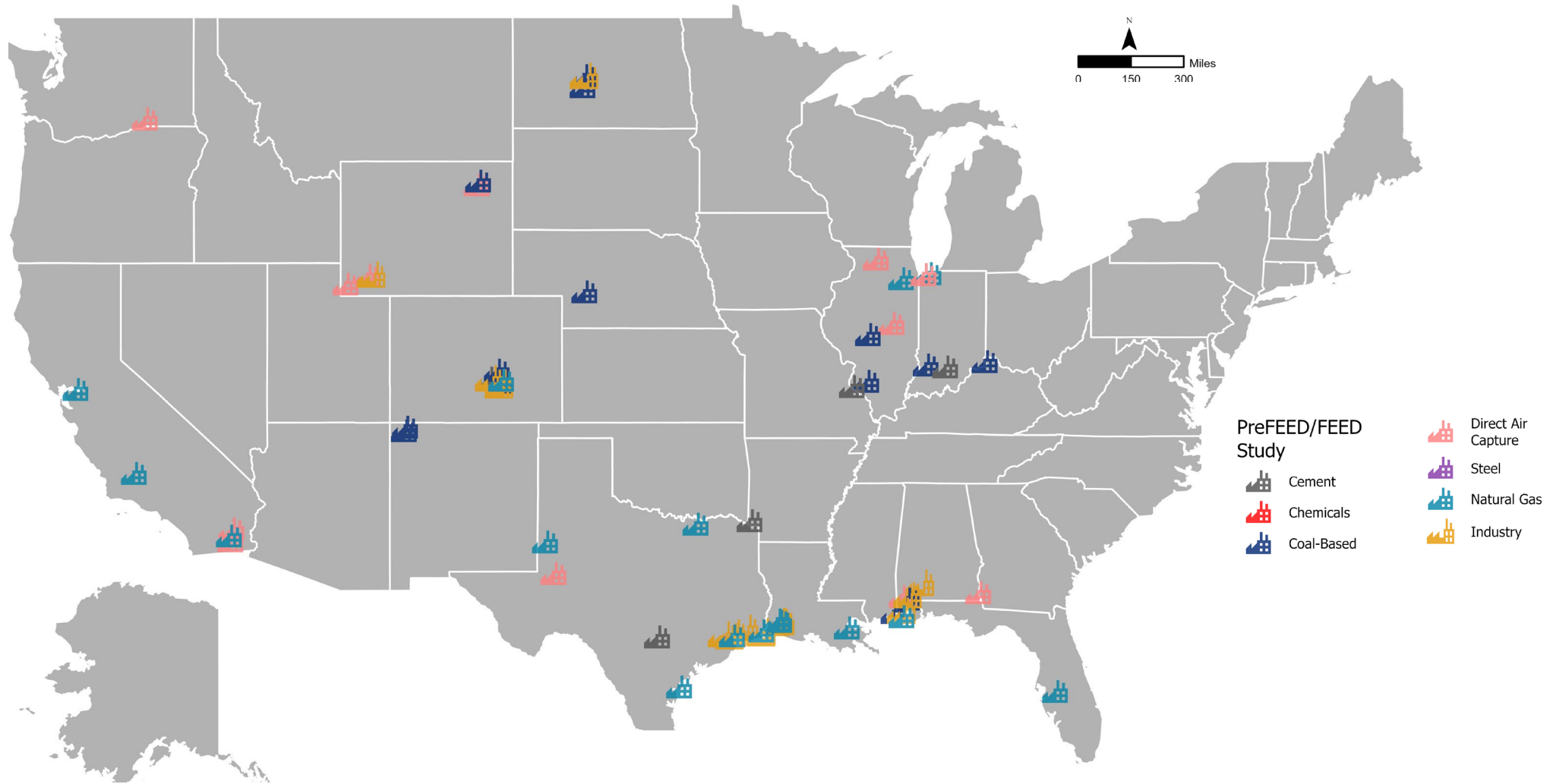
# CarbonSAFE Phase III Projects



# (Direct Air Capture) DAC Projects

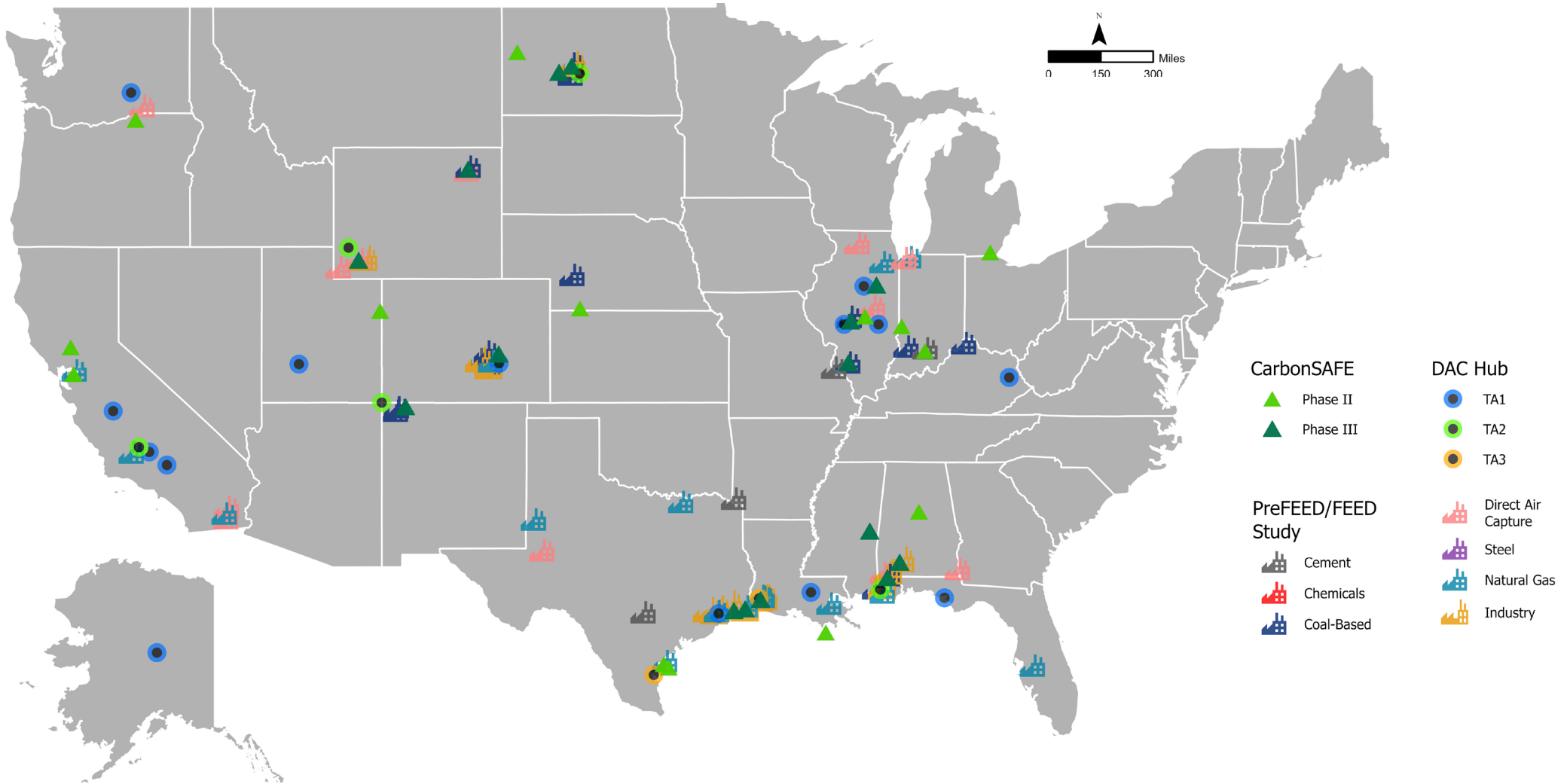


# Pre-FEED/ FEED Capture Projects





# Capture and Storage Infrastructure Projects



# Basin-scale Management for Rapid Deployment

## Major Basins Requiring Basin Management Strategies

Major basins of the US represent diverse geological settings and stakeholder group interests

### CarbonBASE Initiative – FY 2024

(Carbon Basin Assessment and Storage Evaluation)



- Multiyear initiative – 5+ years
- \$35M in FY 2024
- Embark on a national geologic data collection/drilling campaign in basins where storage potential is high and geologic data availability is low
- Models for basin management

### NRAP Phase III

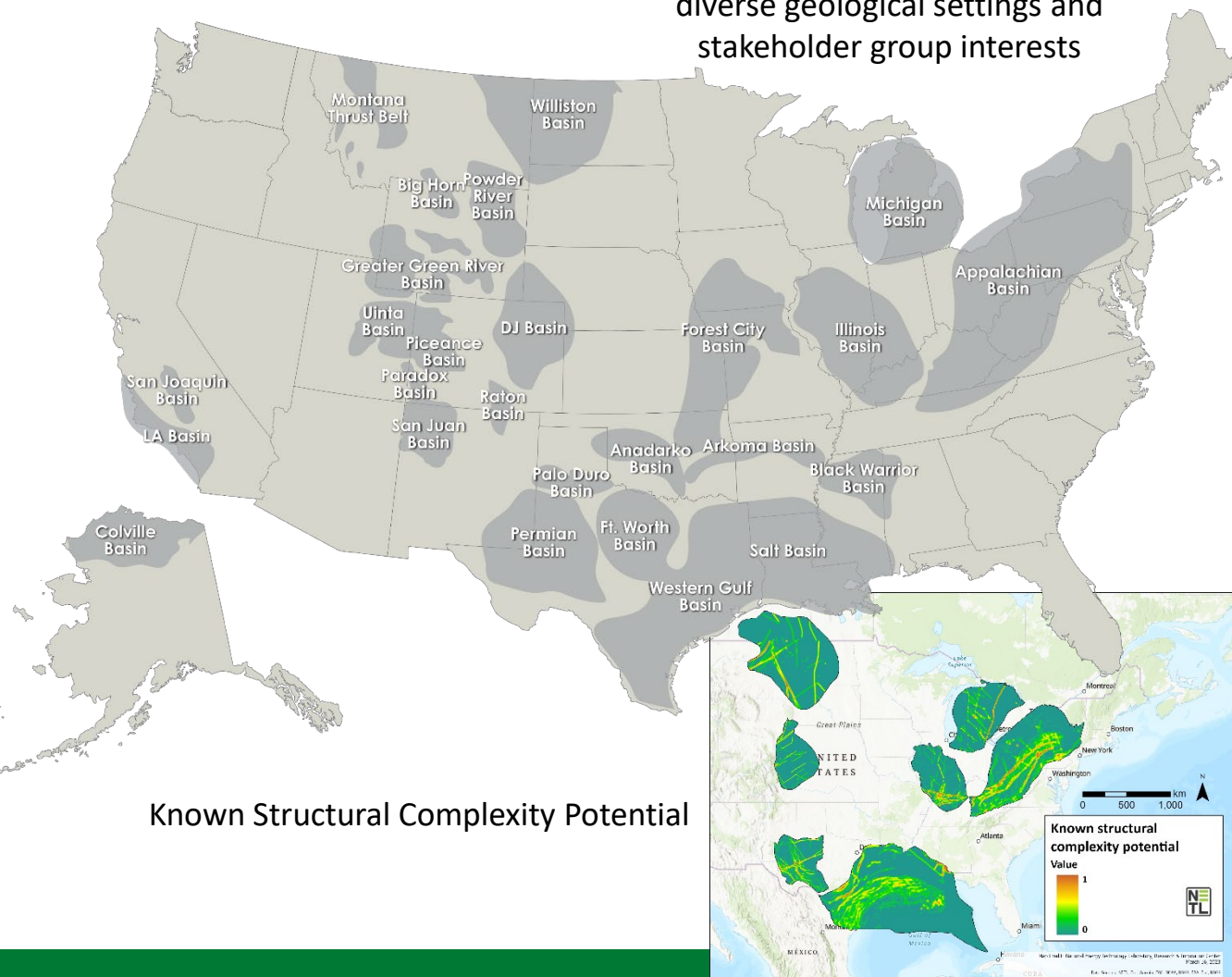
- Assessing and managing basin-scale risks associated with rapid, commercial-scale GCS deployment



### A Framework for Basin-Scale Storage

#### Optimization based on Geomechanical Studies

- LBNL – Sept 2022 – Sept 2025
- Translate fault geomechanics knowledge derived from *in-situ* experiments to larger scales and simulate geomechanical effects for large CO<sub>2</sub> storage hubs



Known Structural Complexity Potential

# CTS Base Program Integration with BIL



- Data collection & tools to support **CarbonSAFE** site selection.
- Develop basin-scale resource management frameworks.
- Risk-based decision making (permit restriction, leasing, etc).



- \$2.5B BIL funding. 20-40 commercial storage projects; >100 wells.
- Site specific geologic data collection as input to **CarbonBASE** tools.
- Host **CarbonSTORE** projects in different settings.



- Provides field laboratories to test & compare carbon storage technologies, useful for next generation **CarbonSAFE** projects.

Base Program

BIL

Regional Initiatives/NRAP

RIs Provide technical assistance and community engagement.

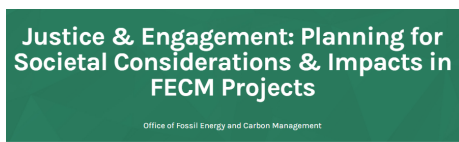
NRAP developing basin-scale risk management strategies



# Resources and Engagement Opportunities



[FECCM Strategic Vision](#)



Office of Fossil Energy and Carbon Management | Resources |  
Justice & Engagement: Planning for Societal Considerations & Impacts in FECCM Projects

The projects that build the clean energy economy will create new infrastructure that holds the potential to drive new regional economic development, technological innovation, and high-wage employment for communities across the United States as we work to make progress on the nation's climate goals. At the same time, it is critical to understand and address the societal considerations and impacts of these projects at local, regional, and global levels.

Projects funded by the Office of Fossil Energy and Carbon Management will develop the following plans to address societal considerations and impacts, ensuring projects center on justice and engagement:

- Community, Tribal, and Stakeholder Engagement
- Diversity, Equity, Inclusion, and Accessibility
- Environmental Justice
- Quality Jobs

Learn more about each of these project plan areas below.

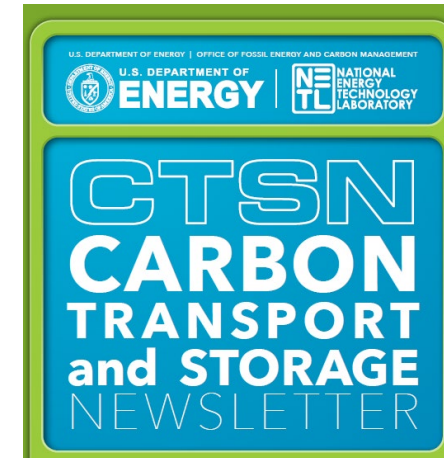
[Justice & Engagement](#)



[Industrial Decarbonization Roadmap](#)



[Workshop R&D Priorities for Repurposing Infrastructure](#)



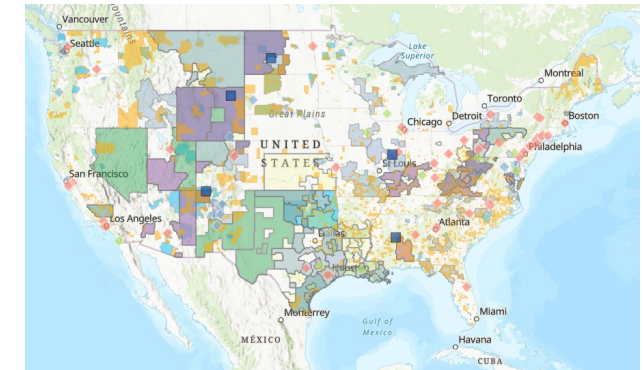
[Program Publications](#)



DOE-funded Carbon Management Projects—held Pittsburgh, PA  
Over 1,200 registrants [2023 Conference Proceedings](#)



[EDX 4CCS](#)



[Carbon Matchmaker](#)





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# Thank You!



Legend:

- Light Rare Earth Elements
- Heavy Rare Earth Elements
- Critical Rare Earth Elements
- Critical Minerals

H																	He
Li	Be											B	C	N	O	F	Ne
Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og	
Lanthanide Series																	
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Actinide Series																	
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

\*Gd, Yb, Lu, REE, U, Th, Pa, REE, \* included with rare earth elements.



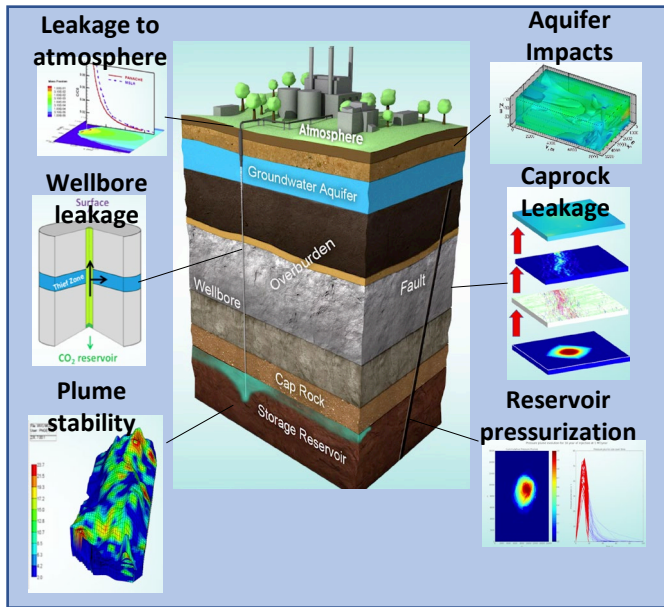
# Storage Facilities Decision Support Tools

Technologies to improve performance and reduce the cost



[National Risk Assessment Partnership](#)

Site specific risk-based decision support tools for Stakeholders



[SMART Initiative](#)

Real-time Visualization, Forecasting, and Virtual Learning for Decision Makers

## Primary Focus Areas of SMART

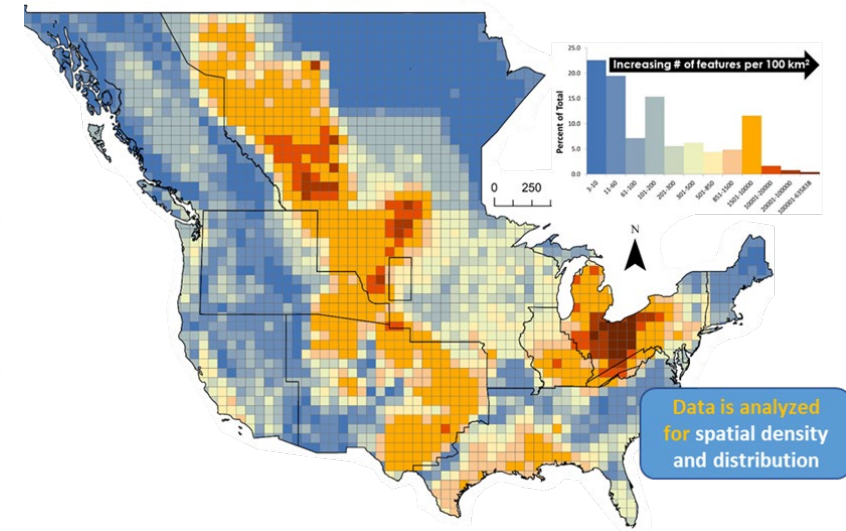
<b>REAL-TIME VISUALIZATION</b>	Enable dramatic improvements in the visualization of key subsurface features and flows by exploiting machine learning to improve speed and enhance detail.
<b>REAL-TIME FORECASTING</b>	Transform reservoir management: perform rapid analysis of real-time data to inform operational decisions.
<b>VIRTUAL LEARNING</b>	Develop a computer-based experiential learning environment to improve field development and monitoring strategies.

Science-informed Machine Learning for Accelerating Real-Time Decisions in Carbon Storage Applications



[Welcome - EDX \(doe.gov\)](#)

Providing stakeholders/community access to CCS data resources



DisCO<sub>2</sub>ver



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# Objectives and Benefits

## (Carbon Basin Assessment and Storage Evaluation)

### *Objectives:*

- ⇒ Embark on a national geologic data collection/drilling campaign in basins where storage potential is high and geologic data availability is low
- ⇒ Develop user-friendly site screening and selection tools that enable more rapid and accurate decision making on site screening and selection
- ⇒ Develop basin scale management tools that assess storage performance and risks at the basin scale over time
- ⇒ Design and deploy basin-wide monitoring systems (collab USGS/NSF)

### *Benefits:*

- ⇒ Reduces cost to project developers that might otherwise have to drill more exploration wells to identify a suitable storage site (more wells means more penetrations of the caprock(s))
- ⇒ Identifies areas to avoid either due to poor reservoir quality or potential hazard (e.g., critically stressed faults)
- ⇒ Supports transparency by providing the public, regulators, and other stakeholder access to the same data
- ⇒ Refines estimates of the nations “practical” carbon storage resources.



### **CarbonBASE Concept:**

- Stakeholder engagement 2023
- Multiyear initiative – 5+ years
- EDX data warehouse



# CarbonSTORE

(Carbon Storage Technology and Operations Research Facility)



*Field laboratories to test & compare carbon storage technologies*

**Leverage CarbonSAFE and other injection sites to ...**

- ⇒ Compare performance of advanced vs. existing technologies
- ⇒ Gain R&D data from operating injection facilities to improve performance, and reduce uncertainty
- ⇒ Conduct experiments at different times to assess performance and potential long-term impacts



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