

Carbon capture, utilization and storage



S C H O O L O F E N E R G Y R E S O U R C E S

Scott Quillinan

Director, Research

School of Energy Resources, University of Wyoming

Scottyq@uwyo.edu (307) -399-7119

Joint Minerals Committee, May 16th and 17th



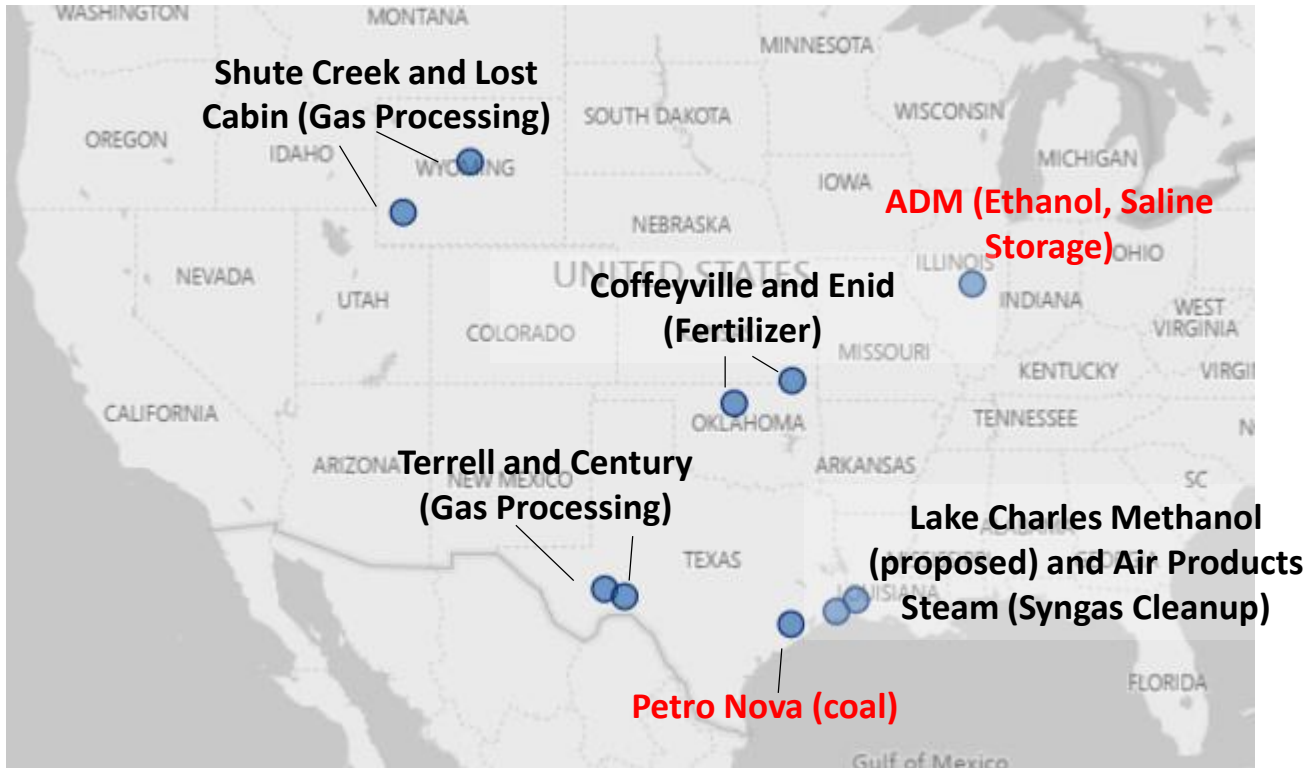
Components of Carbon Capture, Utilization and Storage (CCUS)

The CCUS Supply Chain:

- Capture
 - Pre combustion
 - Post Combustion
 - OxyFuel
- Transport
- Utilization and Storage
 - Enhanced oil recovery
 - Storage in depleted oil and gas fields
 - Saline aquifer storage



Current commercial scale projects CCUS



Some observations for successful projects...

- Almost all successful projects include CO₂-Enhanced Oil Recovery as a driver
- Coal-fired and saline storage projects have required funding from the Department of Energy
 - **Petro Nova**, \$190M
 - **Archer Daniels Midland**, \$141M
- Up and coming projects....
 - Project Tundra in North Dakota
 - Lignite-fired
 - Planned 100mi pipeline
 - Hosting the North Dakota CarbonSAFE Project (\$9.4 from DOE)
 - Wyoming CarbonSAFE at Dry Fork Station
 - Adjacent to the WY Integrated Test Center
 - Proximal EOR
 - Proximal saline storage



Department of Energy Carbon Storage Initiative



Wellbore Integrity and Mitigation



Storage Complex Efficiency and Security



Monitoring, Verification, Accounting (MVA),
and Assessment



Regional Carbon Sequestration Partnerships Initiative

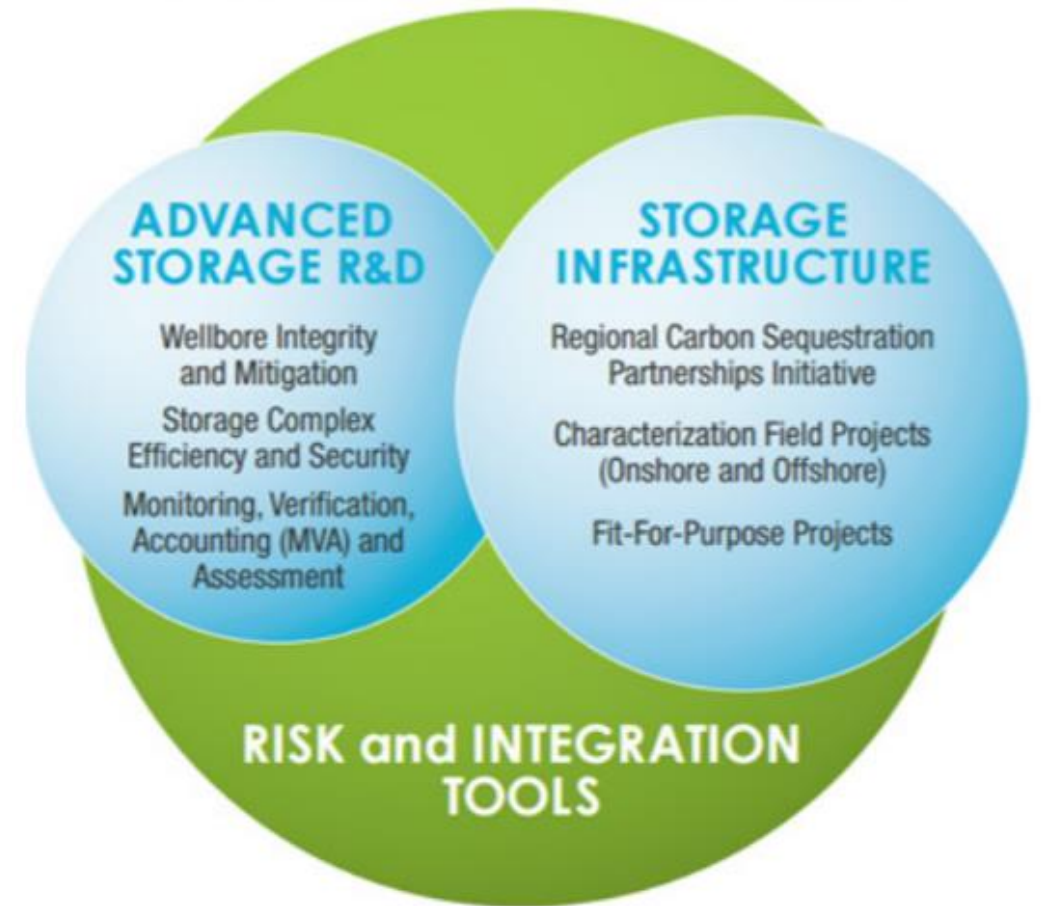


Characterization Field Projects (Onshore & Offshore)



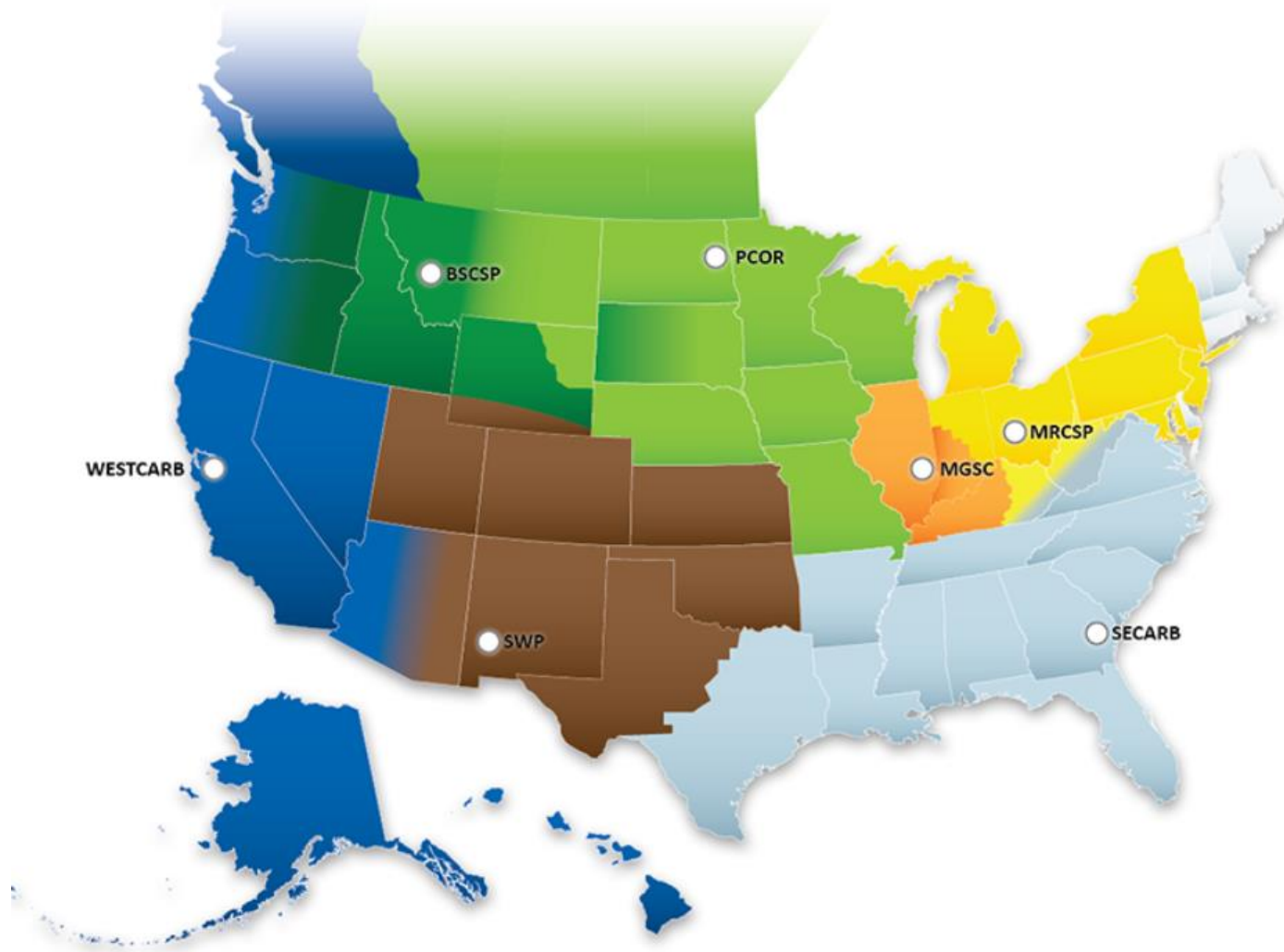
Fit for Purpose Projects

CARBON STORAGE PROGRAM



Opportunity no.1 : Regional Carbon Sequestration Partnership Initiative

Initiative



RCSP	Abbreviation	Lead Organization
Big Sky Carbon Sequestration Partnership	BSCSP	Montana State University – Bozeman
Midwest Geological Sequestration Consortium	MGSC	Illinois State Geological Survey
Midwest Regional Carbon Sequestration Partnership	MRCSP	Battelle Memorial University
Plains CO ₂ Reduction Partnership	PCOR	University of North Dakota Energy and Environmental Research Center
Southeast Regional Carbon Sequestration Partnership	SECARB	Southern States Energy Board
Southwest Regional Partnership on Carbon Sequestration	SWP	New Mexico Institute of Mining and Technology
West Coast Regional Carbon Sequestration Partnership	WESTCARB	California Energy Commission

Regional Carbon Sequestration Partnerships (RCSPs)

- 2003 (Characterization Phase)
- 2005 (Validation Phase)
 - 19 small-scale field projects in a variety of projects
- 2008 (Development Phase)
 - Large-scale field laboratories (1MT)

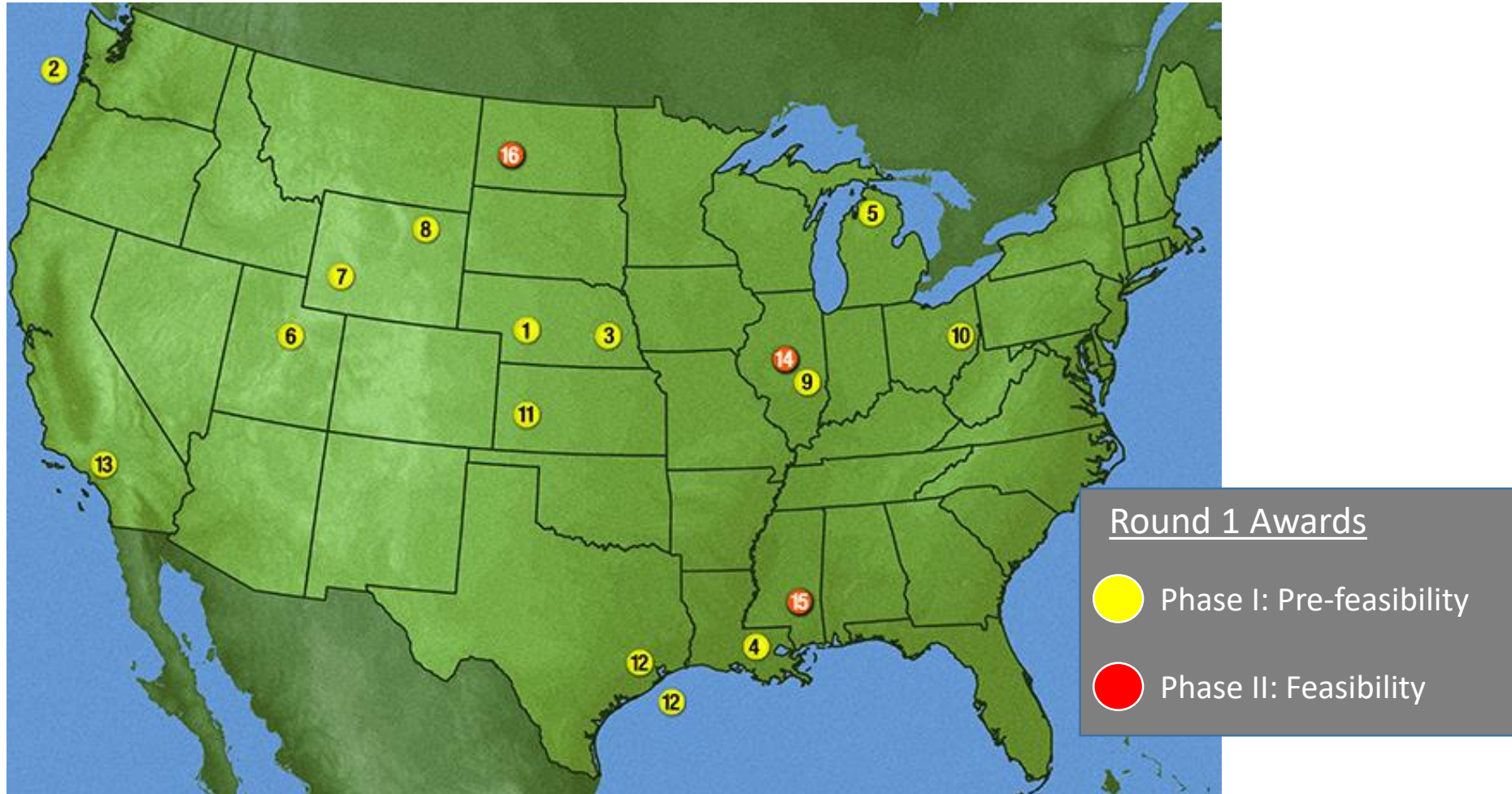


CarbonSAFE (Storage, Assurance, and Facility Enterprise)

- Projects... will address **key research gaps** in the path toward the **deployment** of carbon capture and storage (CCS) technologies, including the development of **commercial-scale** (50+ million metric tons CO₂) **geologic storage sites for CO₂ from industrial sources...**
- Projects under CarbonSAFE aim to **develop integrated CCS complexes** that are **constructed and permitted for operation in the 2025 timeframe**
- **Get there through sequential Phases...**
 - *Phase 1* Integrated CCS Pre-Feasibility,
 - *Phase 2 Storage Complex Feasibility,*
 - *Phase 3* Site Characterization,
 - *Phase 4* Permitting and Construction.
- **What about Carbon Capture?** That's a different DOE program

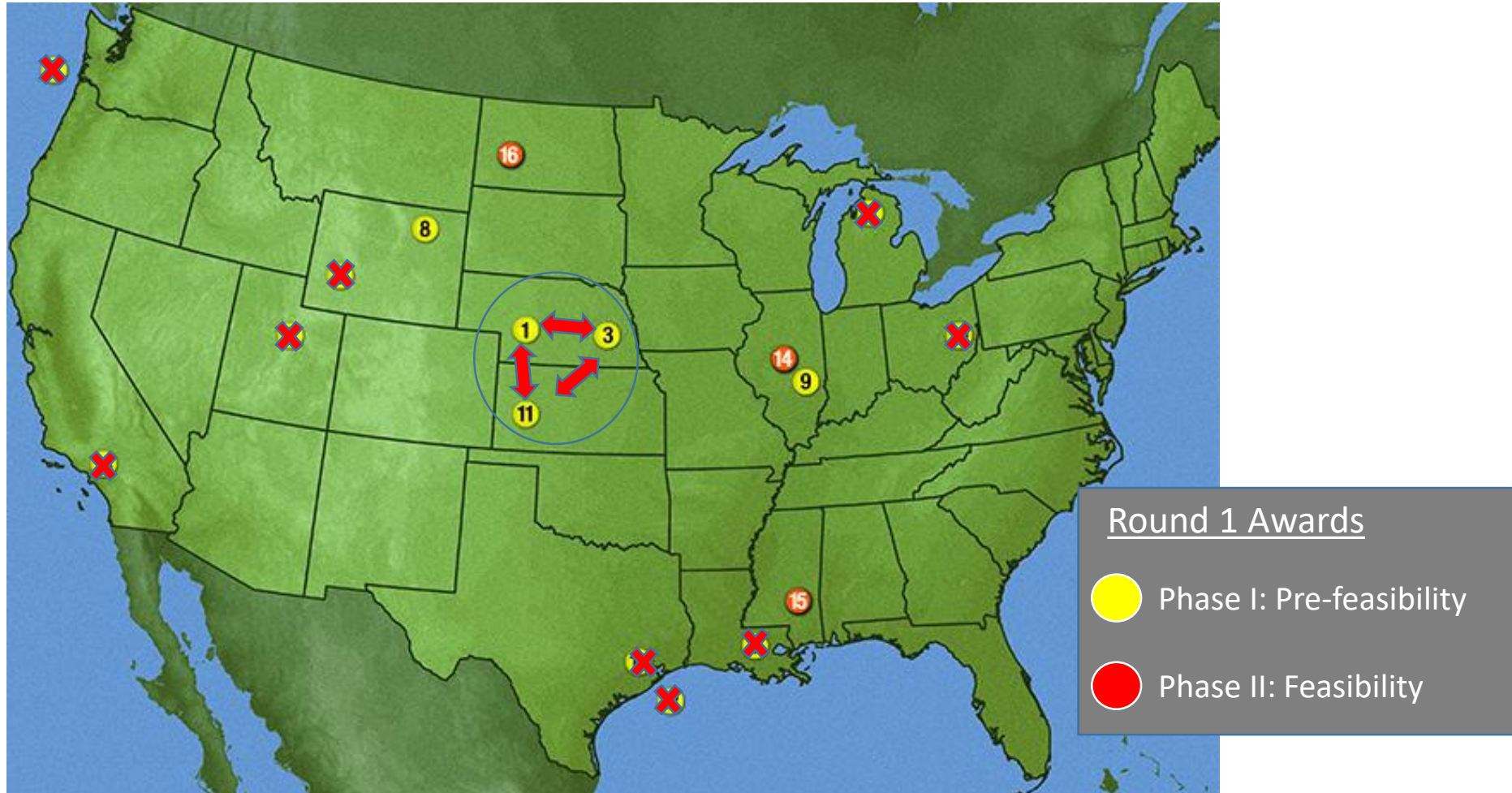


CarbonSAFE (Storage, Assurance, and Facility Enterprise)



CarbonSAFE (Storage, Assurance, and Facility Enterprise)

And then there were 6.....



What is Wyoming CarbonSAFE?

Goal: Wyoming CarbonSAFE is focused on investigating the feasibility of practical, secure, permanent, geologic storage of carbon dioxide (CO₂) emissions at Dry Fork Station

Timeline:

Phase I: 2017-2018 (Prefeasibility, \$1.1M)

Phase II: 2018-2020 (Feasibility, \$9.77)

Phase III: 2020-2023 (Geologic Characterization)

Phase IV: 2023-2025 (Construction and Deployment)

Things we are looking for:

- ✓ Is there sufficient volume in the subsurface to store commercial quantities of CO₂?
- ✓ Can the CO₂ be injected safely? Stored permanently?
- ✓ What are the risks/costs/legalities?

Project Team: *University of Wyoming-School of Energy Resources, Basin Electric Power Cooperative, Energy and Environmental Research Center, Advanced Resources International and others.*



Drilling the University of Wyoming CO₂ test well at Dry Fork Station (April -13th May 11th)



CarbonSAFE Wyoming: Study Area

- Dry Fork Station (Basin Electric Power Coop)
- Wyoming Integrated Test Center (WY-ITC)

Dry Fork Station

- ✓ Built in 2007
- ✓ 385 MW Power Plant
- ✓ 3.3 Million tons of CO₂/year

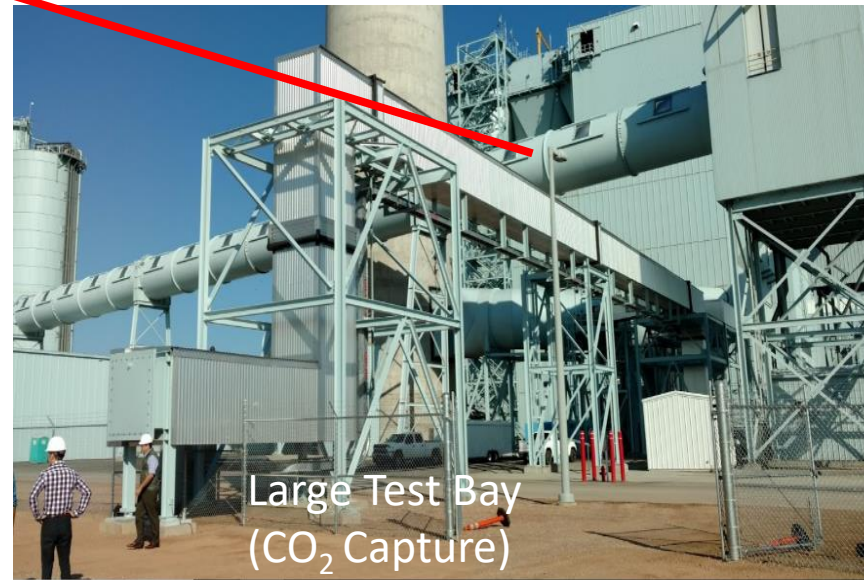
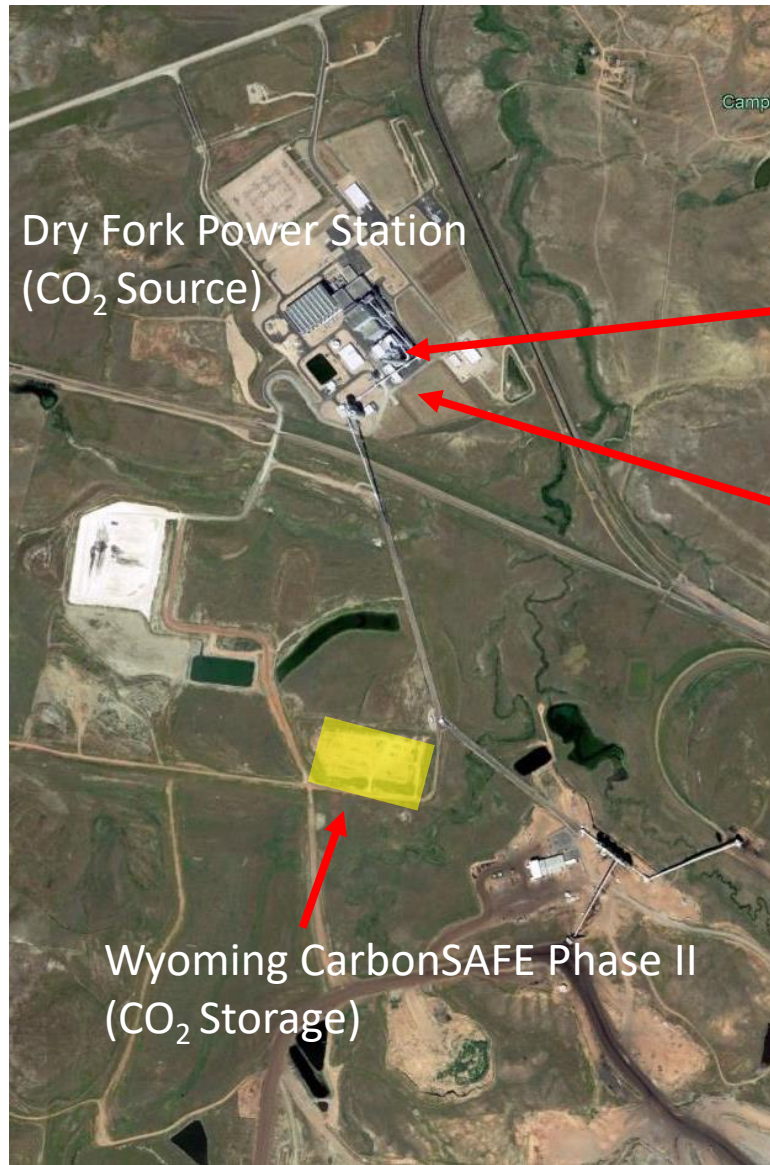


WY-Integrated Test Center (ITC)

- ✓ Completed fall 2017
- ✓ Test CO₂ capture/CCUS technologies
- ✓ \$20 Million public/private investment
- ✓ NRG COSIA Carbon XPRIZE (\$20M global competition to develop breakthrough technologies for CO₂ emissions)



CarbonSAFE Wyoming: Research Area

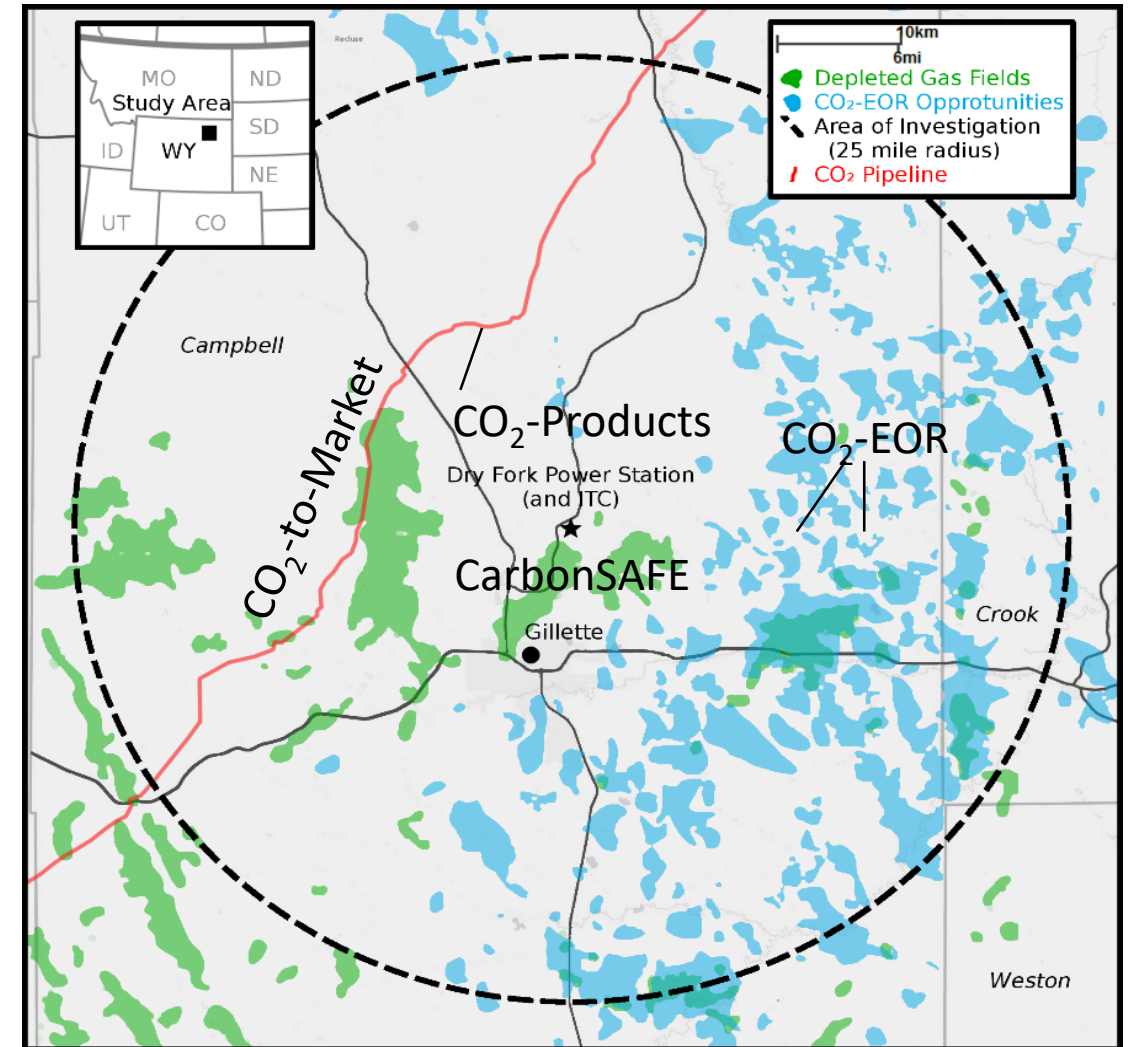


Note: The Industry, State, and Federal commitments



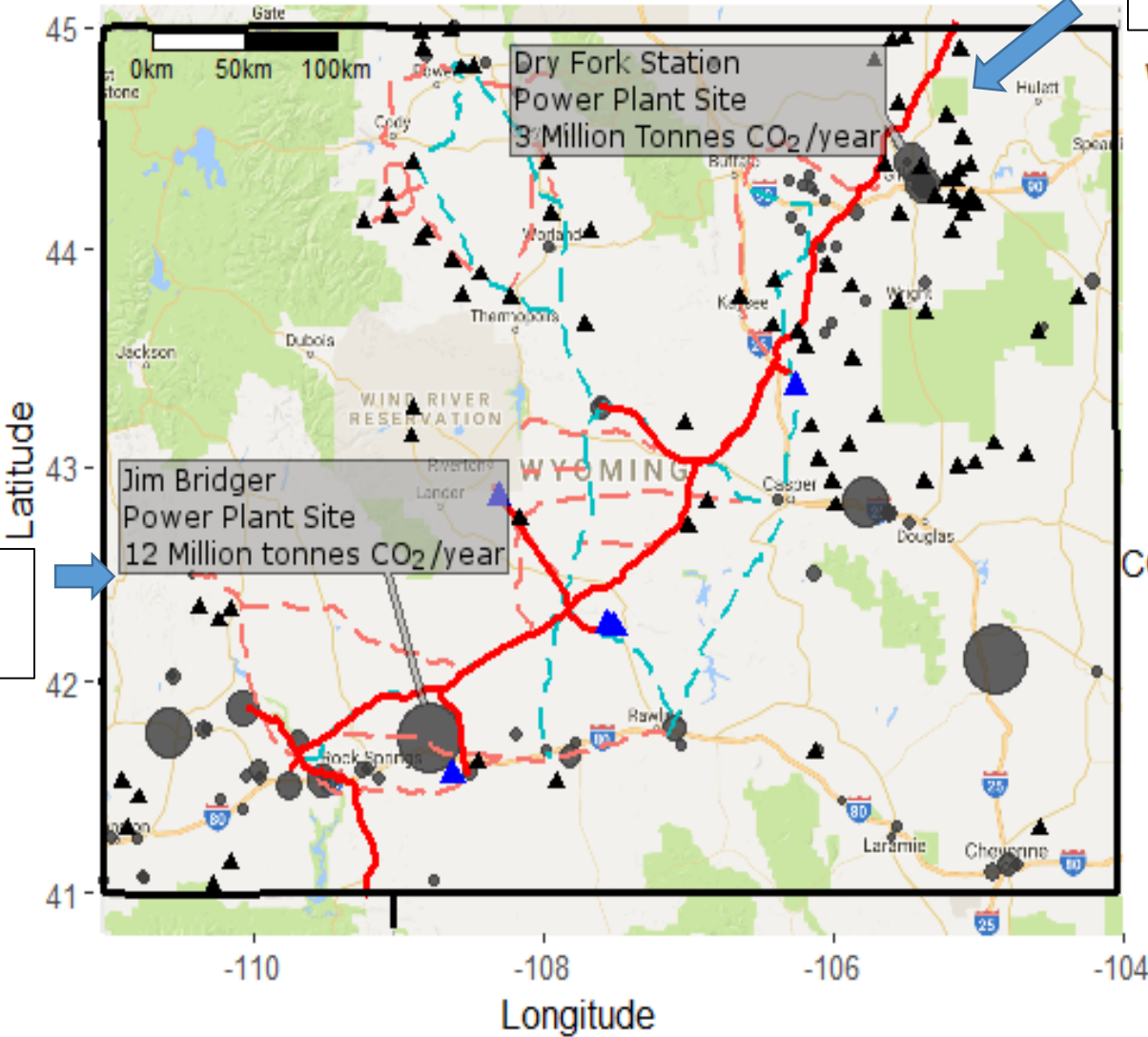
Gillette WY-Low Carbon Research Hub

- ✓ **Storage:** Saline reservoirs (Wyoming CarbonSAFE)
 - Located below Dry Fork Station
- ✓ **Utilization:** CO₂-EOR opportunities
 - Proximal EOR fields
 - Proximal to CO₂ pipeline
- ✓ **Capture/Utilization:** WY Integrated test Center
 - [Breathe](#) (Bangalore, India)-common fuel and petrochemical feedstock.
 - [C4X](#) (Suzhou, China) –chemicals and bio-composite foamed plastics.
 - [Carbon Capture Machine](#) (Aberdeen, Scotland) –solid carbonates and building materials.
 - [CarbonCure](#) (Dartmouth, Canada) –stronger, greener concrete.
 - [Carbon Upcycling UCLA](#) (Los Angeles, CA, USA) – CO₂ absorbing concrete replacements .
 - [JCOAL & Kawasaki Heavy Industry](#) (Japan) – CO₂ Capture
 - [MTR/UK?](#) (CA/KY) Capture



Wyoming Integrated CO₂ Map

Wyoming CO₂ Network & CarbonSAFE Projects



CO₂ Storage: Wyoming CarbonSAFE at Dry Fork

CO₂ Storage: Rock Springs Uplift

WY CO₂ Pipeline Network

- CO₂ Pipeline
 - Planned Pipeline
 - Lateral Corridor
 - Trunk Corridor
- CO₂ Transport
- EOR Target
 - CO₂-EOR Field
- CO₂ Utilization

CO₂ Emissions (Million tonnes)

- 0
 - 3
 - 6
 - 11
- CO₂ Source



Advantages of CCUS in Wyoming

- ✓ **Capable Coordination Team:** Experienced and diverse coordination team (University, Industry and Community)
- ✓ **CO₂ Source:** Engaged Industry Partners- Coal fired power plant and the ITC CO₂ Capture and Utilization test facility
- ✓ **CO₂ Transport:** Existing statewide CO₂ pipeline and pipeline ROW's
- ✓ **Saline Storage:** Text book geologic reservoirs for storage
- ✓ **Pore Space Ownership:** Pore space ownership is defined
- ✓ **Regulatory:** CCUS friendly regulatory environment, pending application for WY Class VI primacy
- ✓ **Induced seismicity:** Low risk of induced seismicity
- ✓ **Public Awareness:** Energy educated community
- ✓ **Favorable Economics:** Proximal enhanced oil recovery and CO₂ transport opportunity
- ✓ **Trained Workforce:** CCUS industry jobs analogous to energy industry jobs



Thank you. Any questions?

Scott Quillinan, scottyq@uwyo.edu (307) 766-6697



Meet the CarbonSAFE Team

