CCUS Transitional Technology: Risks and Solutions

AAPCA Spring Meeting

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THE WORLD NEEDS MORE COWBOYS.

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Topics

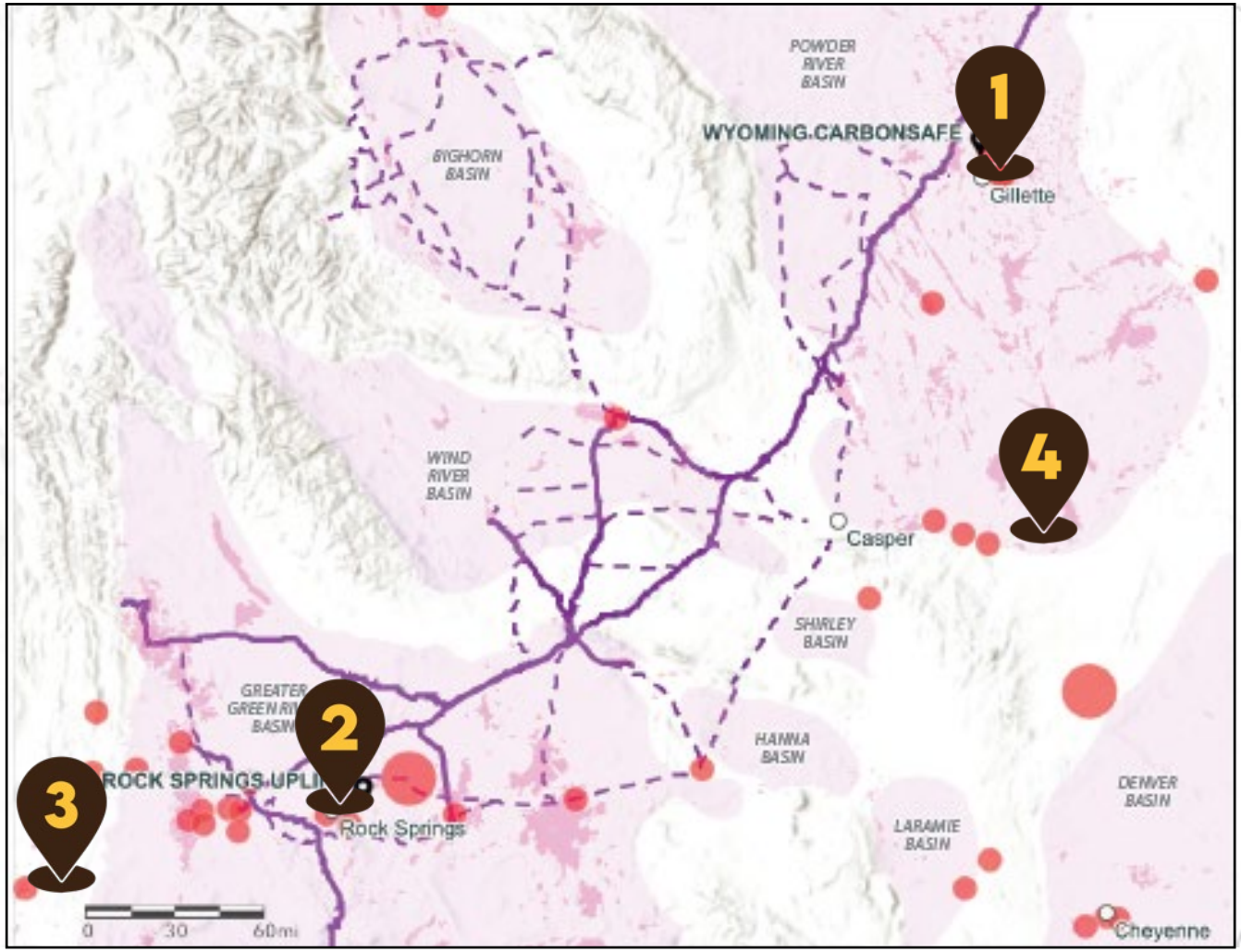
- ✓ Wyoming CCUS
- ✓ CO2 Storage Risks and Solutions

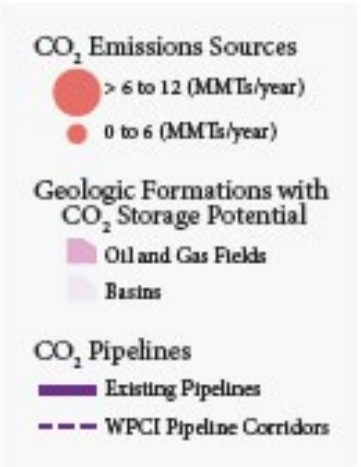
Wyoming CCUS

UWyo/SER CCUS Projects

Carbon Capture and Storage (CCS) projects in Wyoming

1. Wyoming CarbonSAFE Project at Dry Fork Station
2. Rock Springs Uplift-Regional CCUS Hub
3. Depleted Gas Fields (Transition of fossil assets)
4. Project Blue Bison (Blue Hydrogen)





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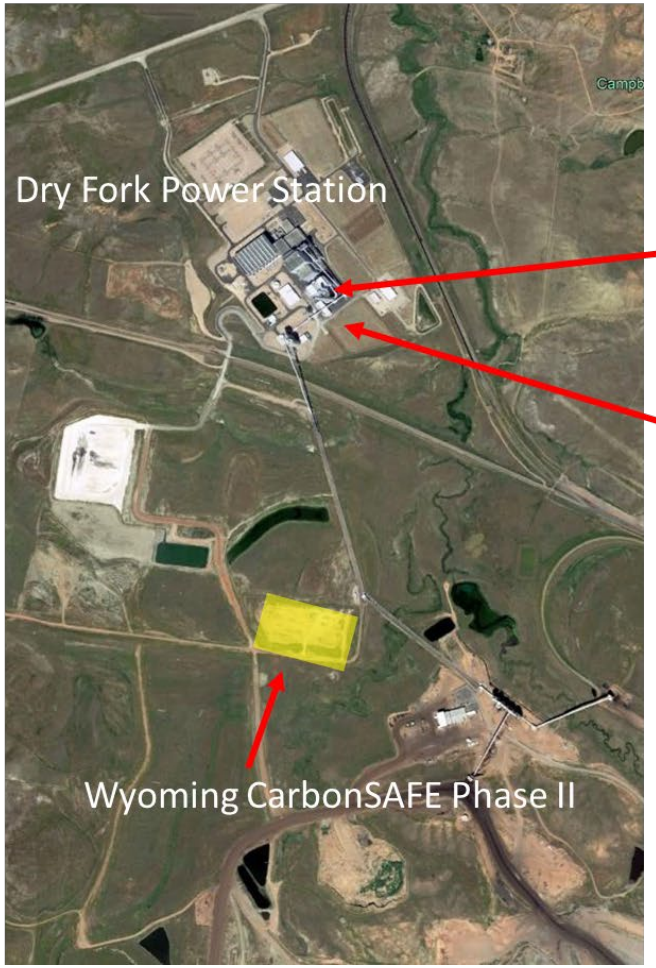
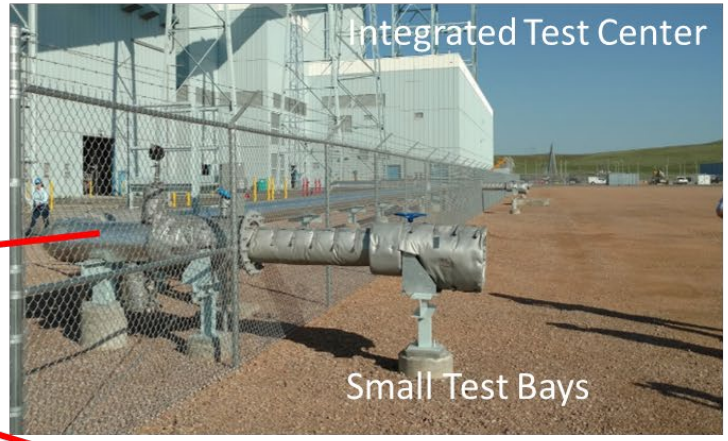
Wyoming CarbonSAFE: CO_2 capture and storage innovation

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative





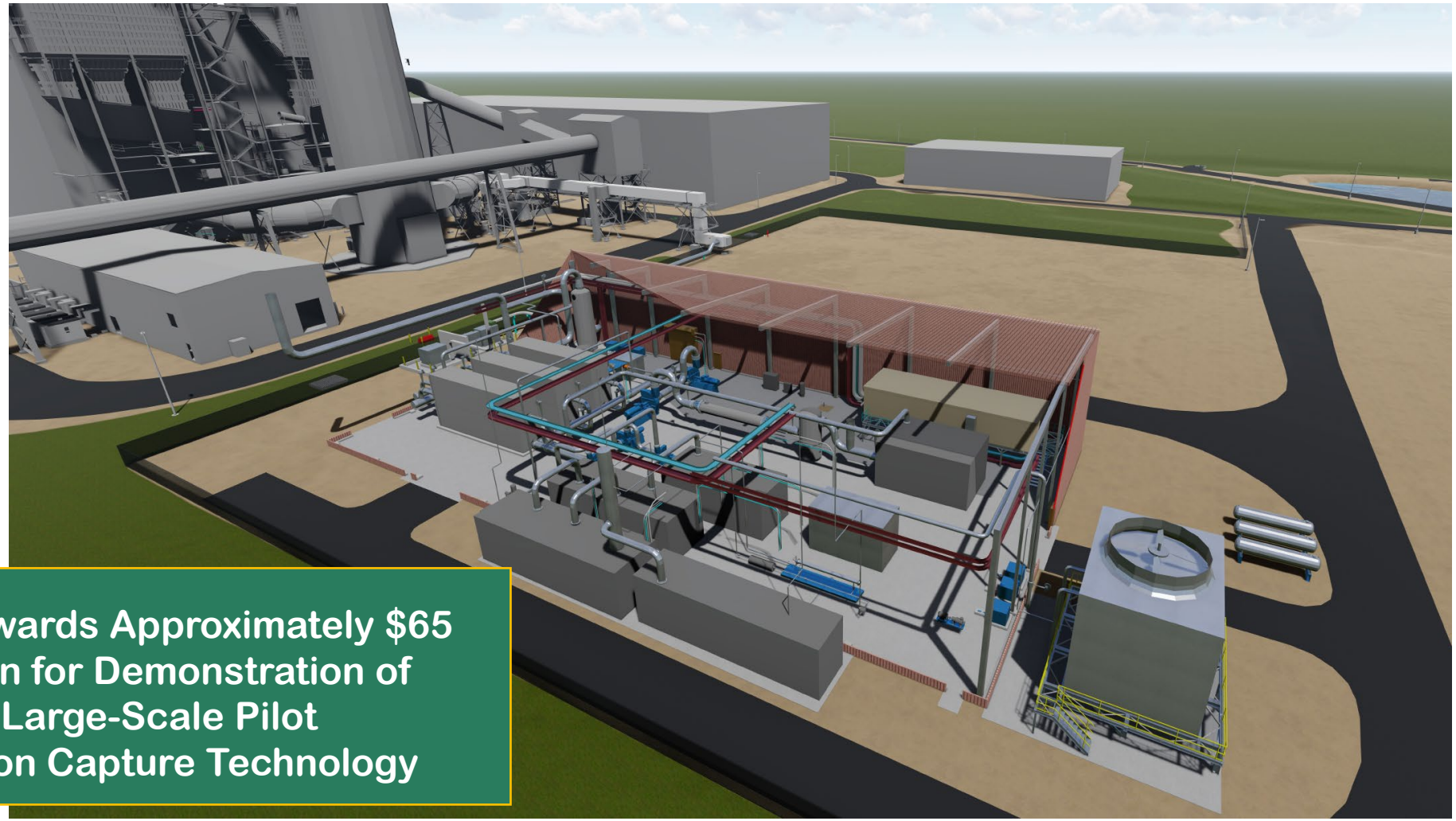
Dry Fork Station

- ✓ Built in 2007
- ✓ 385 MW Power Plant
- ✓ 3.3 Million tons of CO_2/year
- ✓ ZERO H_2O discharge
- ✓ Newest, cleanest, PC plant

ITC WYOMING INTEGRATED TEST CENTER

Carbon Capture Program at the ITC

Membrane Technology Research FEED And Large-Scale Capture Pilot



DOE Awards Approximately $65 Million for Demonstration of Large-Scale Pilot Carbon Capture Technology

NATIONAL ENERGY TECHNOLOGY LABORATORY

DE-FE0031587

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MTR

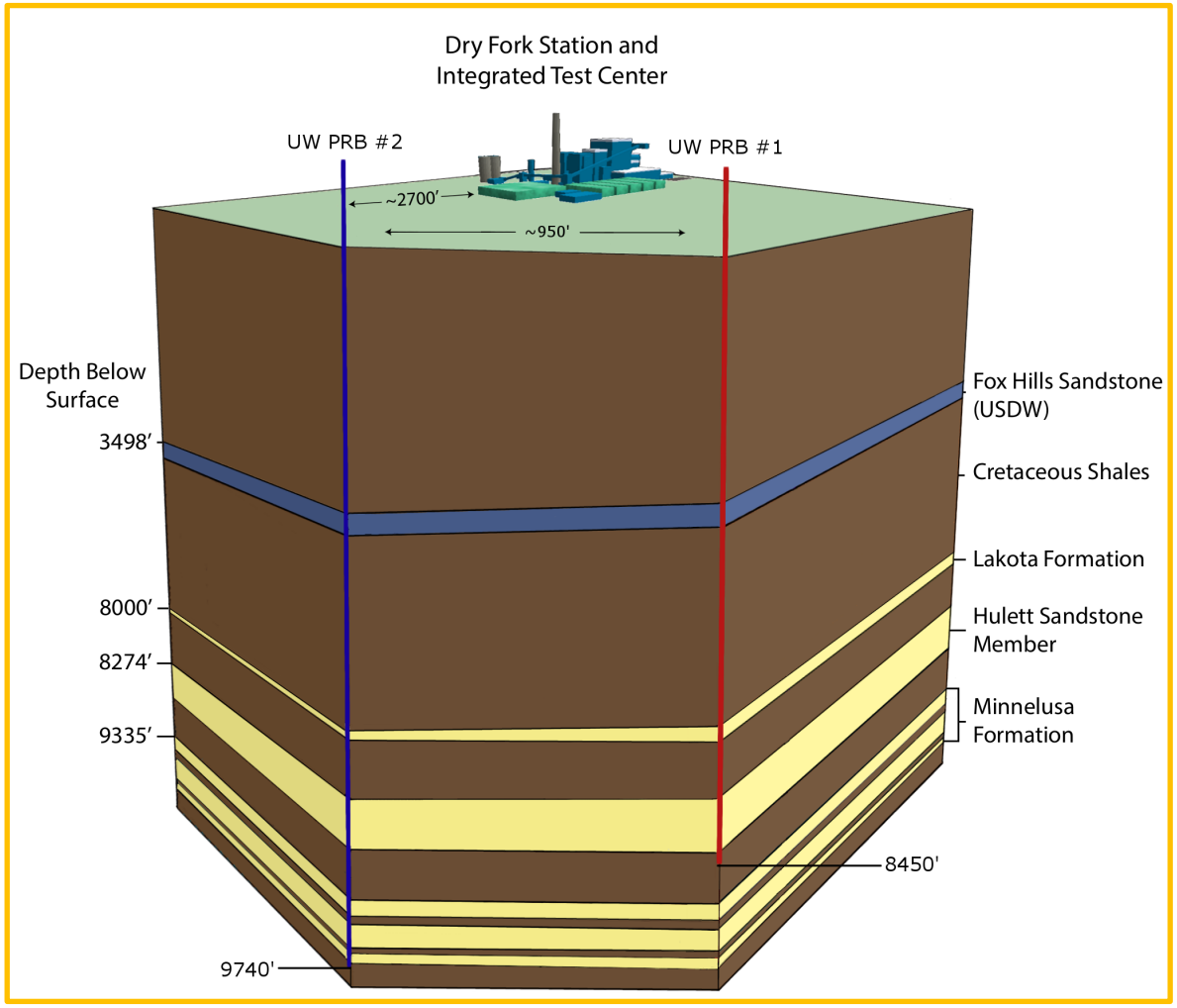
Sargent & Lundy

TRIMERIC CORPORATION

MTR

Wyoming CarbonSAFE Storage Site

- Designed to test and optimize stacked storage CO_2 injection
- Provides a "template" to design other sites within the storage hub
- Finalizing site specific lessons learned and permitting



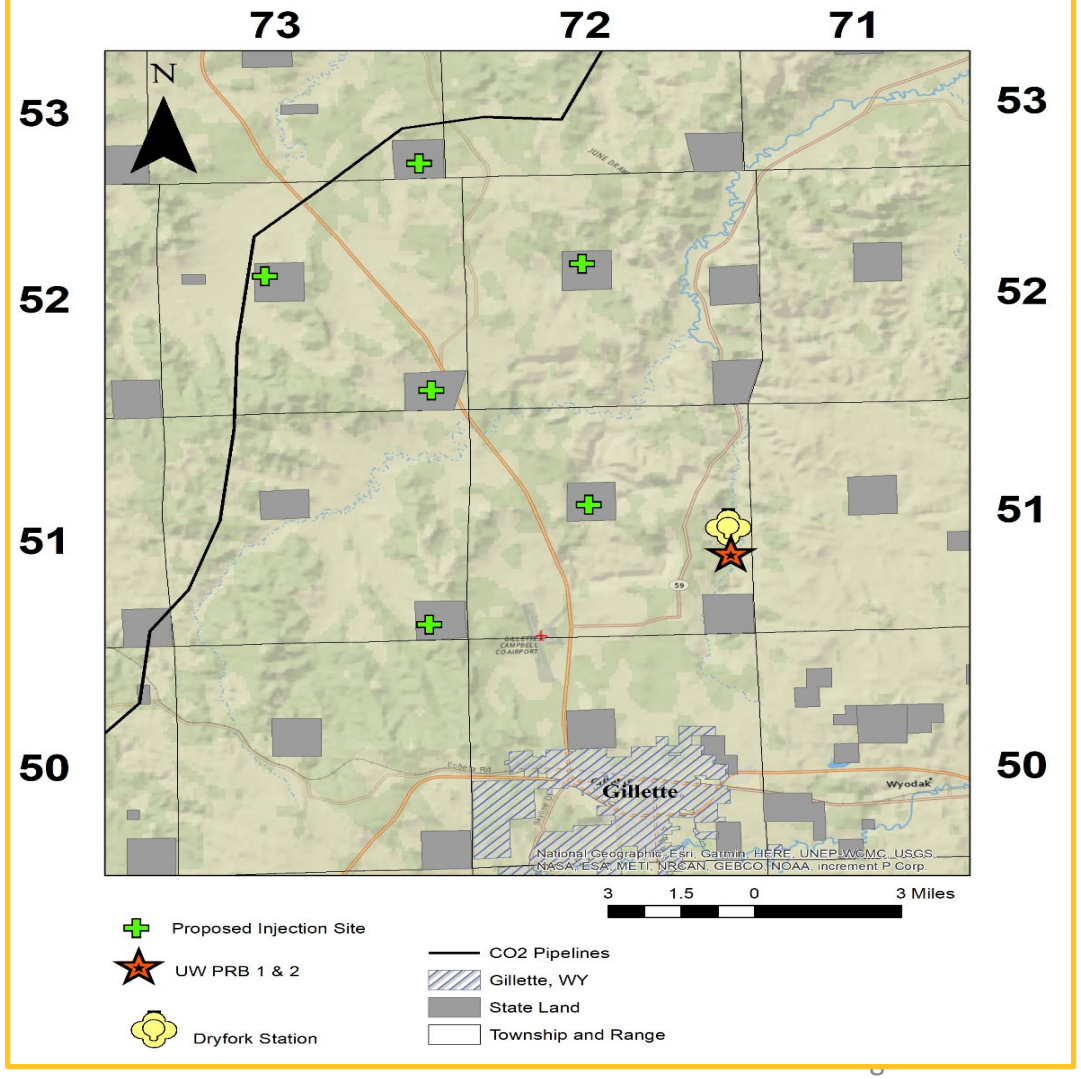
Wyoming CarbonSAFE Storage Hub

Work to date

- ✓ Site characterization (2 wells, 3-D seismic, high resolution, well logs, geologic models)
- ✓ Shallow monitoring network (groundwater and soil gas)
- ✓ Model agreements (pore space, off-take)
- ✓ Economic models
- ✓ Permitting (in progress)
- ✓ NEPA
- ✓ Public outreach (Social license to operate)

Future work

- ✓ Deep monitoring network
- ✓ CO_2 Hub build-out
- ✓ Finalize permitting



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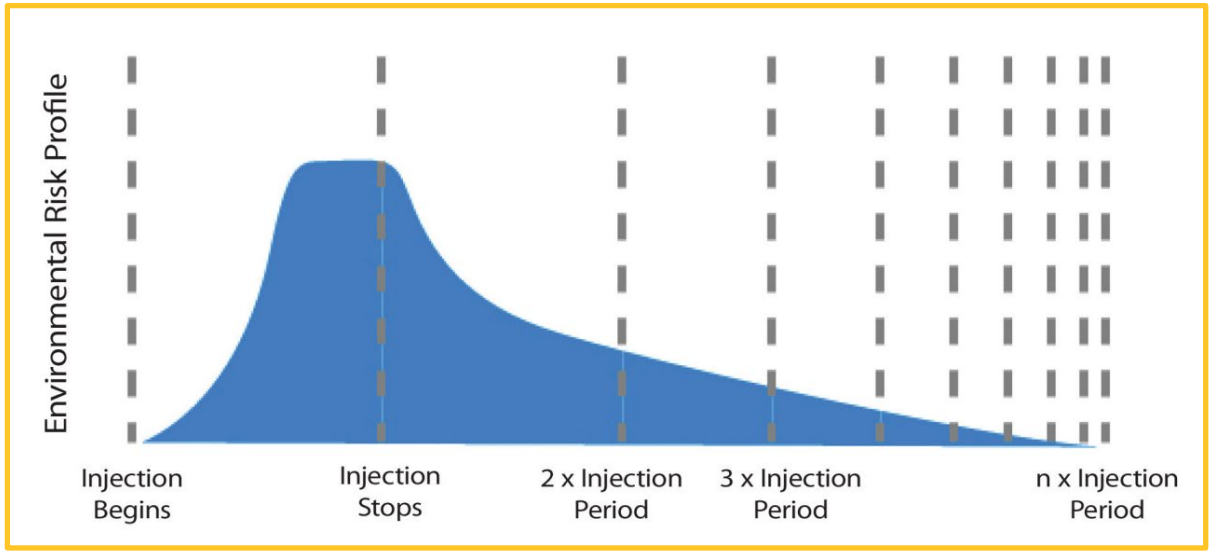
CO_2 Storage
Risks and Solutions

CO_2 Storage Risks in Perspective

- CO_2 underground occurs naturally
- Storage is deep underground
- Supercritical fluid in subsurface
- Pressure declines over time
- Most risk is not technical



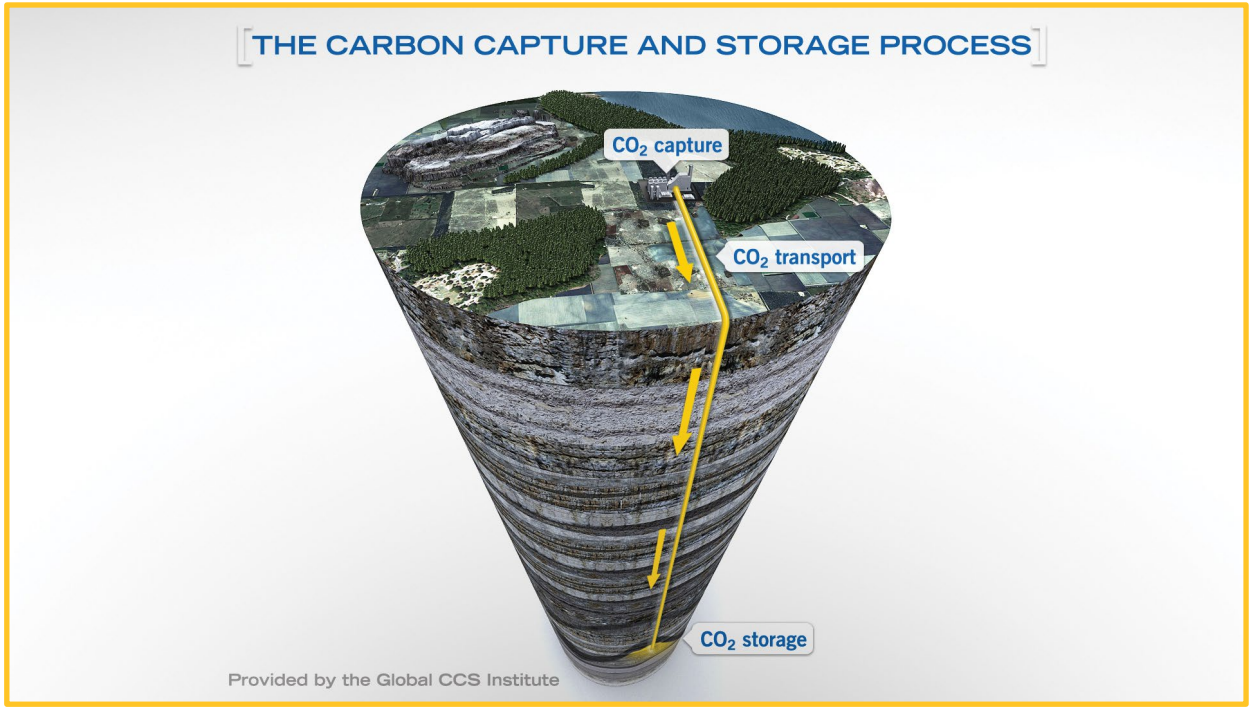
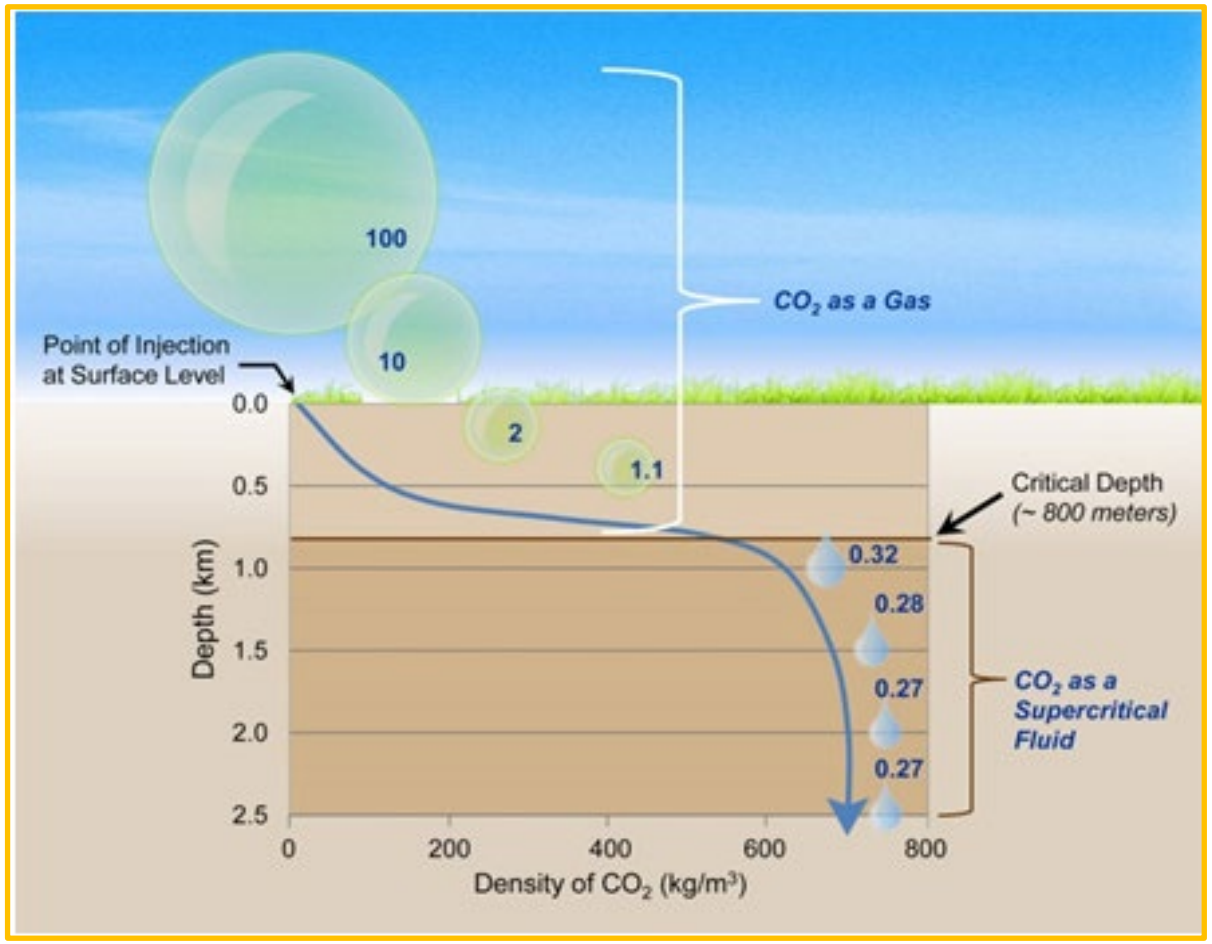


Figure sourced from Workshop Summary. Addressing Long-Term Liability of Carbon Dioxide Capture and Geological Sequestration, pp. 1-10.

CO_2 Storage Risks in Perspective



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Dense phase or supercritical CO2 is much smaller in volume.

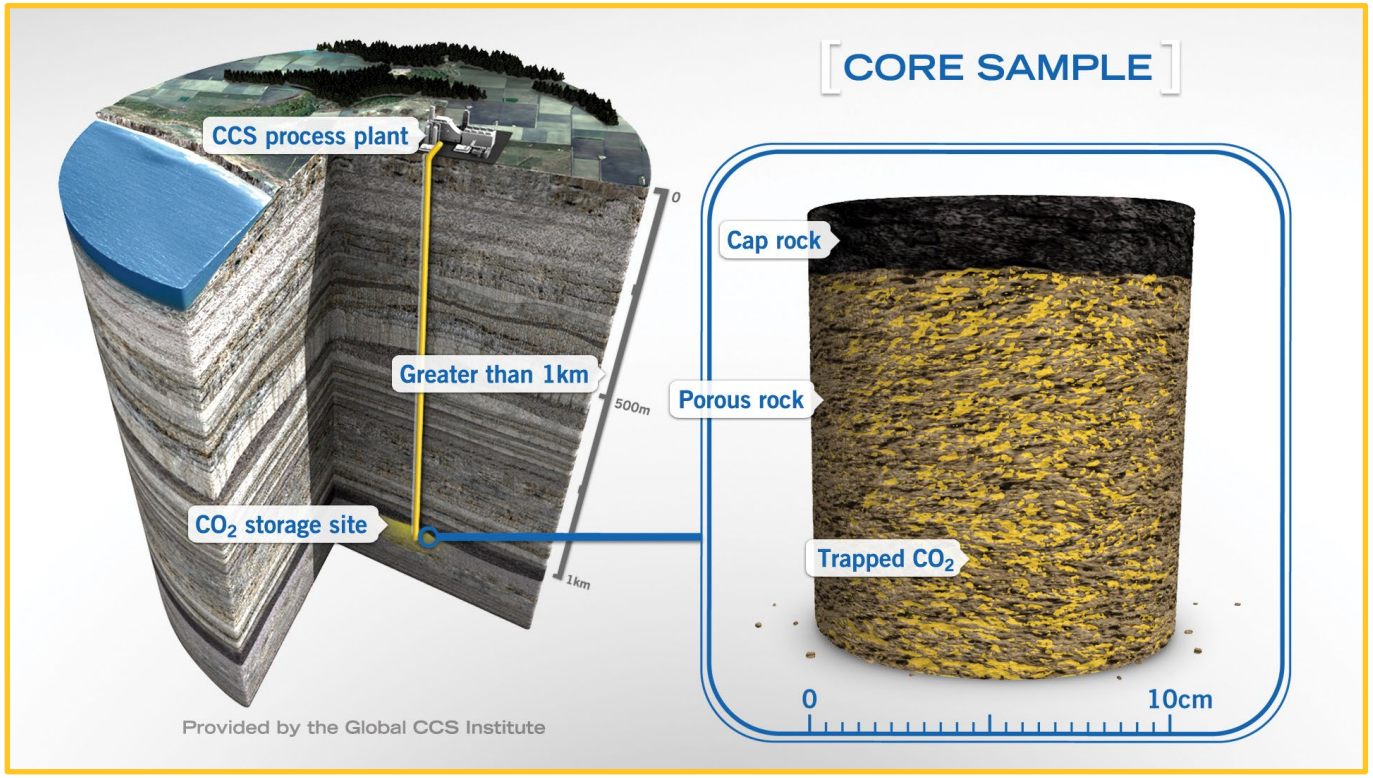
Risks and Solutions: Technical

Risks: Loss of Containment

- Shallow groundwater
- Atmosphere
- Lateral migration in reservoir

Solutions

- Rigorous geologic characterization of the reservoir and caprock
- Installation of early detection monitoring network
- Identification and proper closure of legacy well bores
- UIC Class VI program



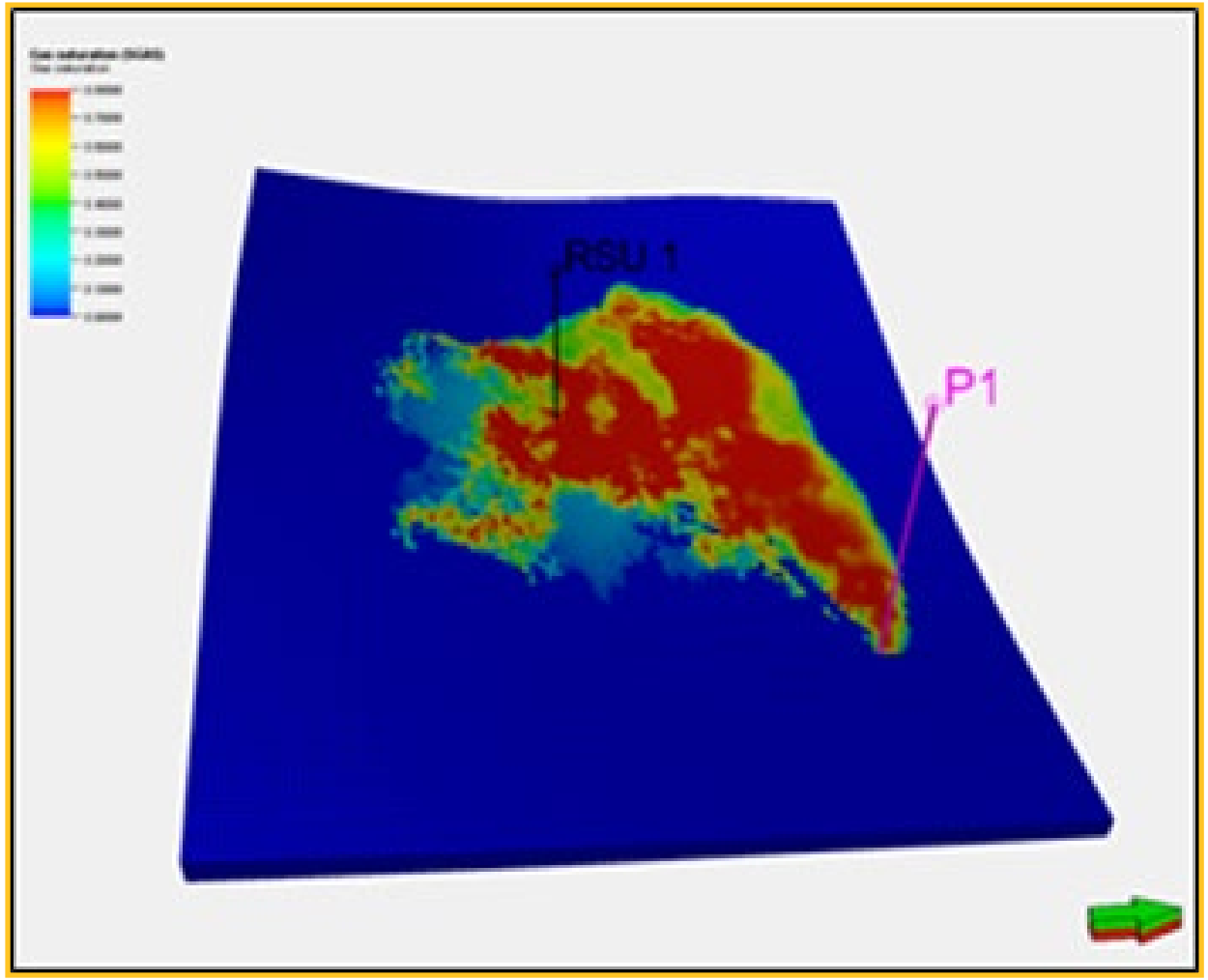
Risks and Solutions: Technical

Risks: Induced Seismicity

- Increasing formation pressure causes faults and or fractures to slip causing minor seismicity

Solutions

- Geomechanical models
- Injection wells must operate below a minimum fracture pressure per Class VI rules
- Industry expertise from fracking
- Active pressure management



Risks and Solutions: Policy

Risks	Solutions
Lack of adequate federal and state laws and regulations governing the geologic storage of CO_2	• The U.S. Environmental Protection Agency finalized the Class VI rules in December 2010 • More than a decade ago, the State of Wyoming enacted a suite of laws governing CCS/CCUS • More recently, in 2020, the State of Wyoming obtained primacy for the Class VI program
International policy under the Paris Agreement needs to acknowledge CCS/CCUS	International climate policy experts have broadly concluded that CCS/CCUS are needed to achieve Paris Agreement goals
Federal law needs to “acknowledge” CCS/CCUS as a carbon mitigation compliance pathway under statutes such as the federal Clean Air Act	For more than a decade now key federal regulatory programs have acknowledged that CCS/CCUS may be used as a compliance approach to decarbonize
It remains unclear how to acquire federal pore space	**TBD**

Risks and Solutions: Financial

Risks	Solutions
First-of-a-kind technology demonstrations are uneconomic without support	Incentives for early demonstration and deployment: • Section 45Q • DOE Loan Program Office • DOE grants
Private sector investor/lender technology uncertainty	See above
Complicated business models (e.g., utilities may not want to own/operate pipelines or CO2 storage sites)	Development of business models to support large-scale deployment (e.g., CarbonSAFE)
Private sector investor and lender questions about long-term CO_2 stewardship	• Enactment of state-based legislative approaches (e.g., ND, LA) and perhaps soon to be introduced in Wyoming • Engagement with the insurance industry • Federal government engagement as a means to de-risk

Risks and Solutions: Societal

Risks

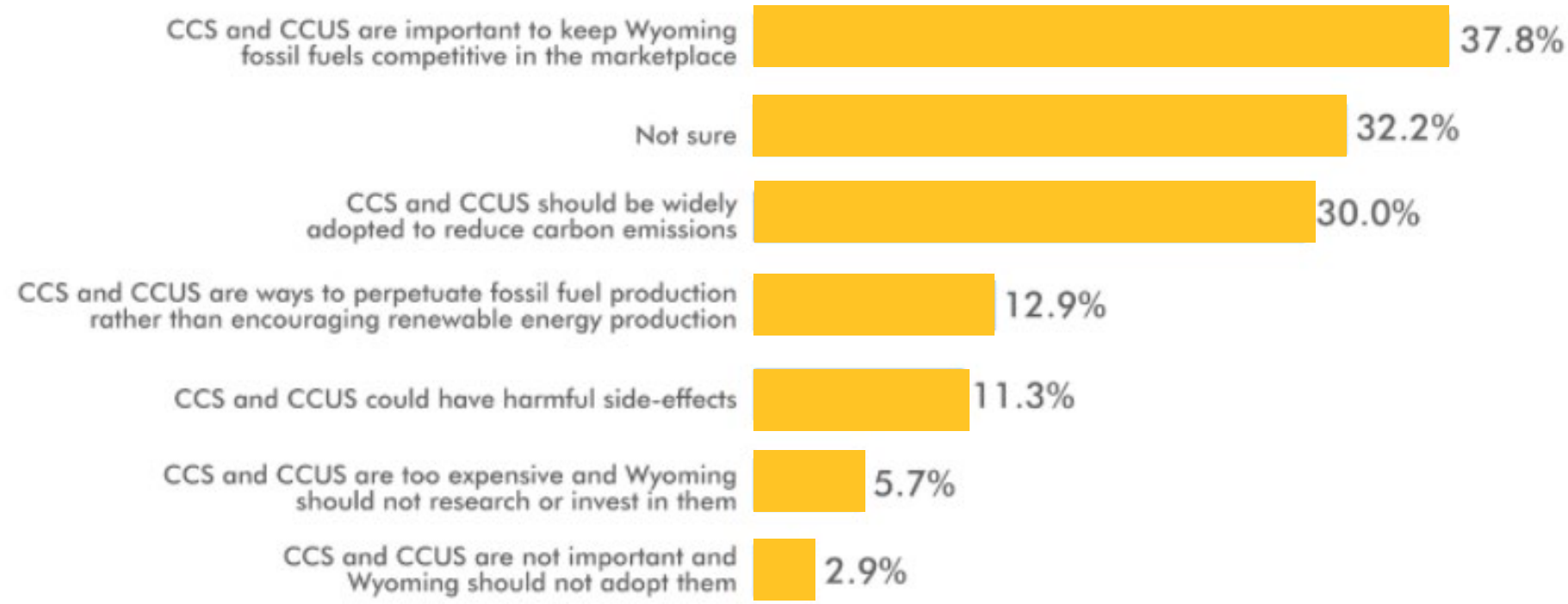
- Social License not achieved

Solutions

- Engage with the local public extensively and thoughtfully
- Conduct rigorous site selection and characterization, as required by the Class VI regulations
- Site project(s) in accepting jurisdictions that have established CCS/CCUS regulations and policies (e.g., Wyoming)

Risks and Solutions: Societal

Wyoming residents' opinions about CCS & CCUS



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