

Wyoming CarbonSAFE:

Accelerating CCUS Commercialization and Deployment at Dry Fork Power Station and the Wyoming Integrated Test Center

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Wyoming Legislature Joint Minerals, Business & Economic Development, June 25th, 2021



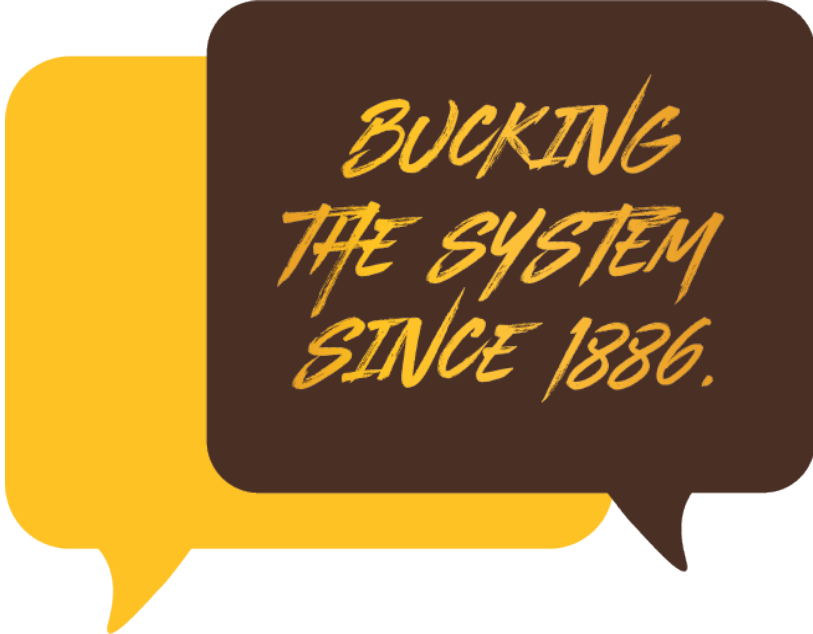
UNIVERSITY
OF WYOMING

School of
Energy Resources

THE WORLD NEEDS MORE COWBOYS.

SER's Mission:

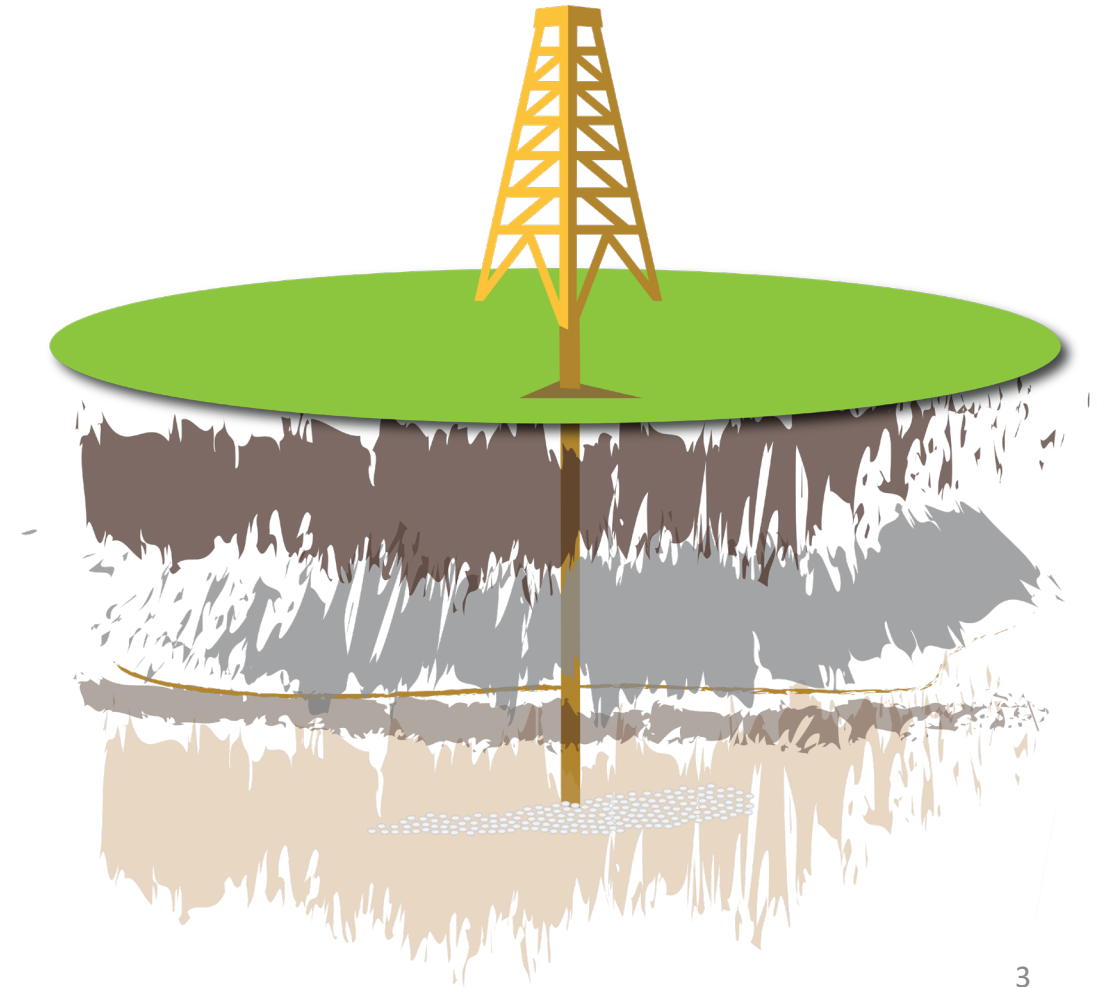
Energy-driven
economic
development for
Wyoming



*BUCKING
THE SYSTEM
SINCE 1886.*

Outline

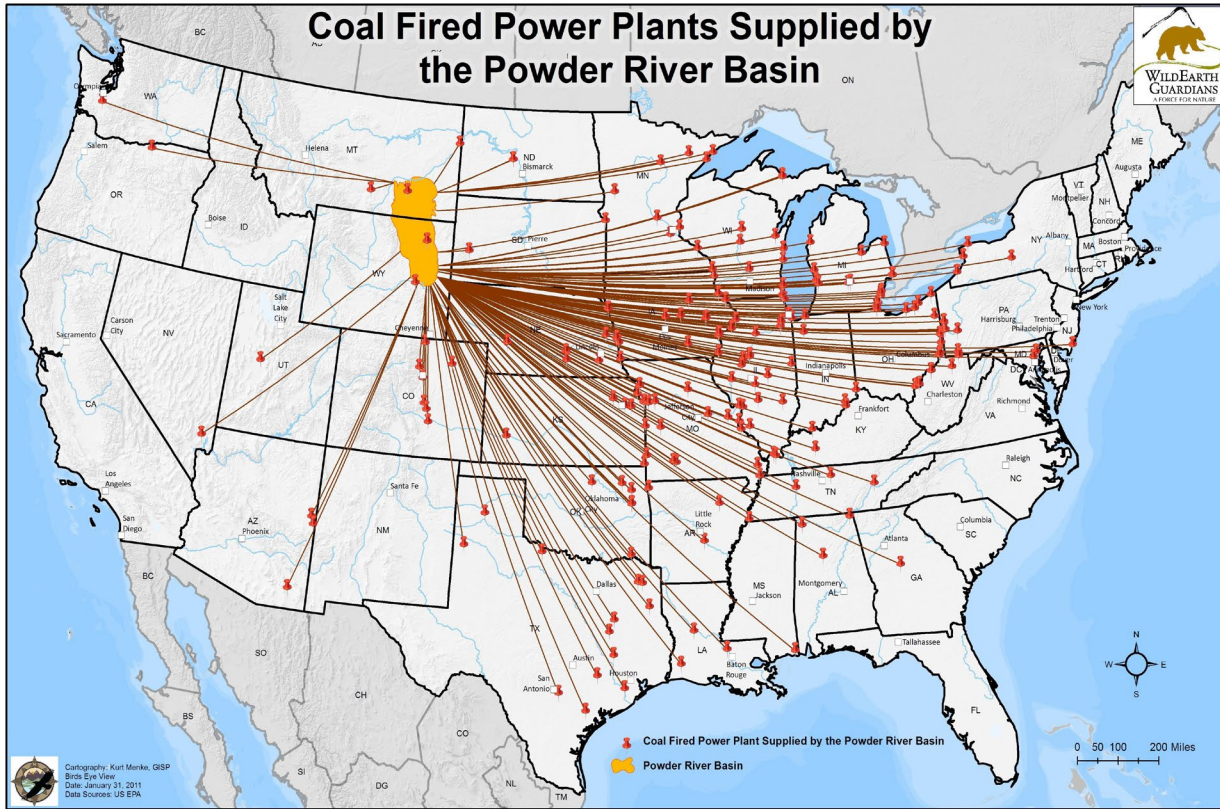
- Importance of carbon capture and storage (CCS)
- Other School of Energy Resources CCS work
- Wyoming CarbonSAFE



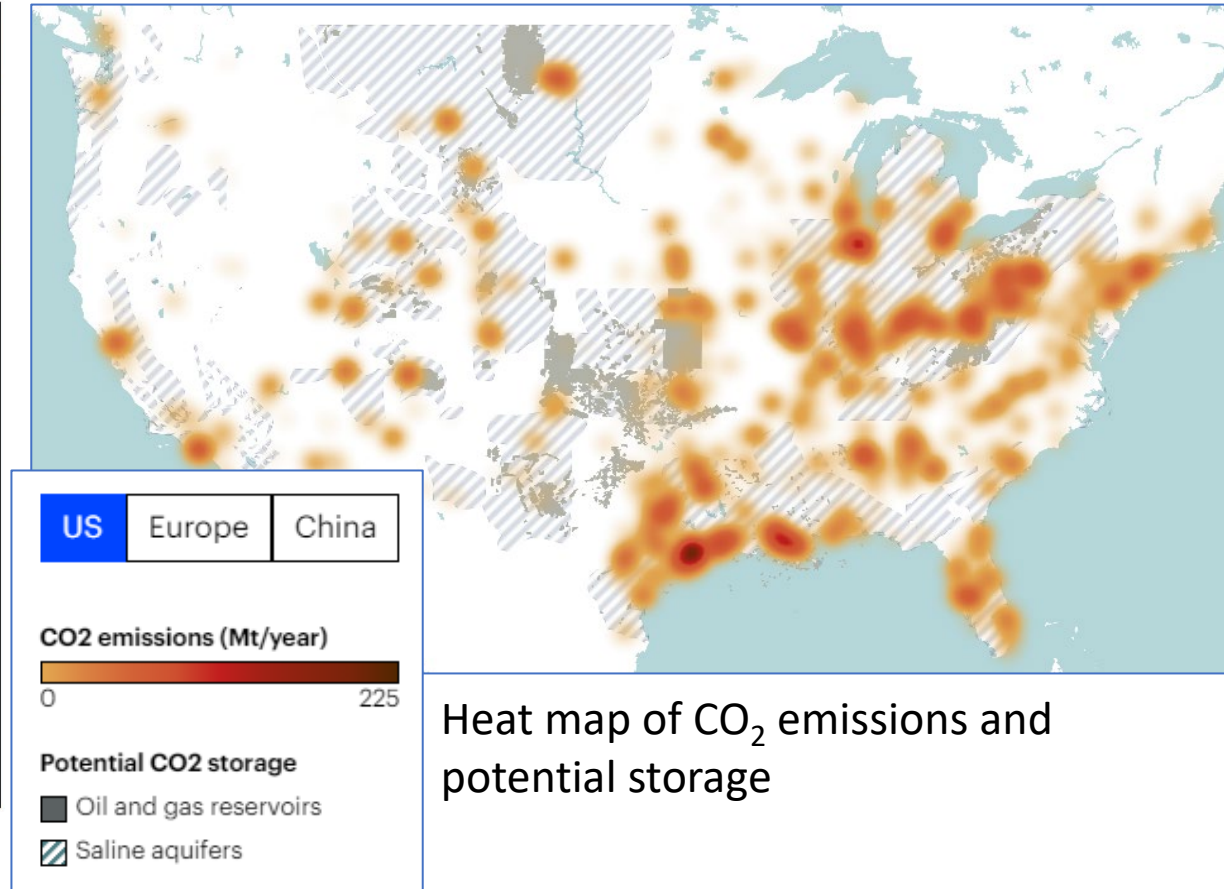
Importance of Carbon Capture and Storage

*THE WORLD NEEDS MORE
ADVENTUROUS SPIRIT.*

Carbon storage: Key to net zero emissions



This is where Wyoming coal goes.



CO₂ storage potential exists in nearly every location WY coal is shipped... 5

Carbon capture and storage, broadly

Net-zero means decarbonization of all industries not just coal

Other applicable Wyoming industries

- Natural gas processing
- Trona
- Oil and gas refining
- Cement production
- Natural gas-fired electricity

And creating new industries

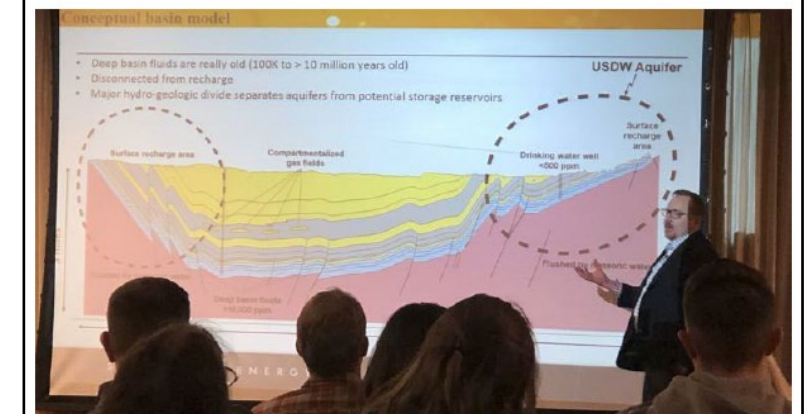
- (Blue) Hydrogen production
- Air capture (carbon removal)



Carbon research earning a 'social license' in Gillette

UW CarbonSAFE project will drill more than 10,000 feet into the Powder River Basin

By GREG JOHNSON NEWS RECORD MANAGING EDITOR gjohnson@gillette-newsrecord.net Feb 22, 2019



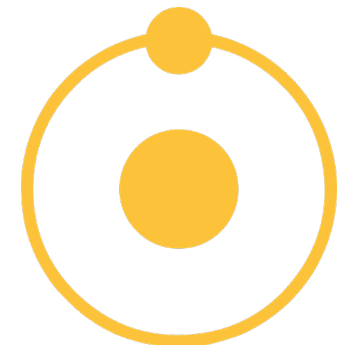
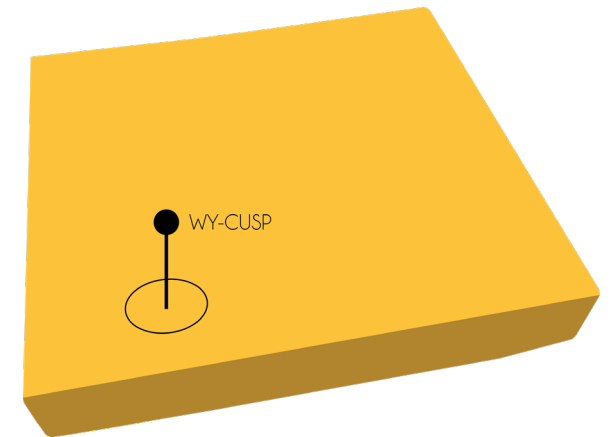
Carbon capture, and storage is more important than ever for Wyoming....

SER CO₂ Capture and Storage Projects

*THE WORLD NEEDS MORE
ADVENTUROUS SPIRIT.*

Highlighted CO₂ research/activities

- Plains CO₂ Reduction Partnership (Regional CCUS technical and regulatory analysis)
- Flameless Pressurized Oxy Combustion (Combustion Technology)
- Wyoming Carbon Underground Storage Project (Regional CO₂ storage hub with approximately 25 billion tons of CO₂ storage potential)
- U.S. China Clean Energy Research Center (International Collaboration on CCUS)
- Initial Engineering of Advanced CO₂ Capture from Hydrogen Production (Proposal Pending)



Wyoming CarbonSAFE

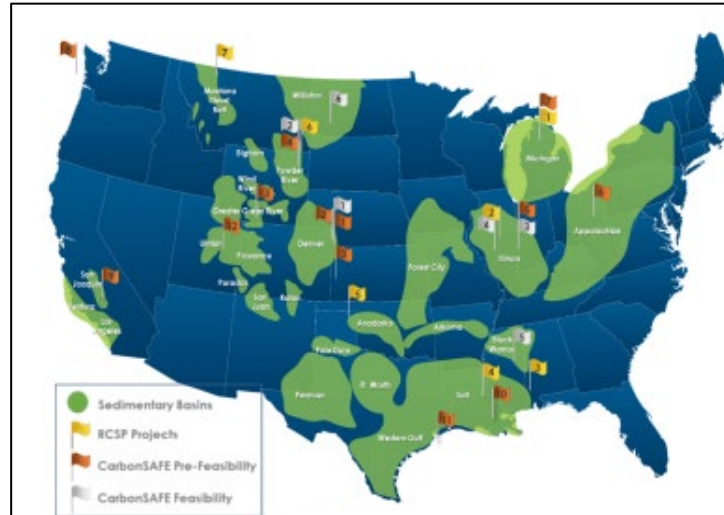
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Department of Energy-CarbonSAFE

Carbon Storage Assurance Facility Enterprise (CarbonSAFE)

CarbonSAFE Objectives

- ⇒ Address the R&D knowledge gaps and develop the technologies needed to nationally deploy commercial scale (50+ million metric tons) CO₂ storage.
- ⇒ Understand the development of a CCUS storage complex from the feasibility study through the point of injection.
- ⇒ Improve understanding of commercial-scale project screening, site selection, geologic characterization, modeling, and monitoring.
- ⇒ Address both the technical and non-technical challenges associated with characterization, permitting, and monitoring of a geologic storage complex.



Phase I: Integrated CCS Pre-Feasibility 18-month initiative

- Formation of a team; development of a feasibility plan; and high-level technical evaluation of the sub-basin and potential CO₂ sources
- Thirteen projects funded



Phase II: Storage Complex Feasibility 2-year initiative

- Data collection; geologic analysis; analysis of contractual and regulatory requirements; subsurface modeling; risk assessment; evaluate monitoring requirements; and public outreach
- Six projects funded



Phase III: Site Characterization and CO₂ Capture Assessment 3-year initiative

- Detailed site characterization; obtain Underground Injection Control (UIC) Class VI Permit to construct; CO₂ Capture Assessment; NEPA approvals



Phase IV: Permitting and Construction of Storage Complex 2.5-year initiative

- Obtain UIC Class VI permit to inject; drill and complete injection and monitoring wells; develop risk and mitigation plans
- Subject to future funding

Wyoming CarbonSAFE

Wyoming CarbonSAFE is focused on investigating the **feasibility** of practical, secure, permanent, **geologic storage** of carbon dioxide (CO_2) emissions from coal-based electricity generation facilities near Dry Fork Station Gillette, Wyoming.

Things we are looking for.....

- ✓ Is there sufficient volume in the subsurface to store commercial quantities of CO_2 ?
- ✓ Can the CO_2 be injected safely? Stored permanently?
- ✓ Permitting, environmental, economics...

¹ Commercial quantities = at least 50 million metric tons over 30 years (approximately 2 million tons per year)

https://www.youtube.com/watch?v=UoYnC4h7_Dg&feature=youtu.be

Cyclone Rig #32 at Dry Fork Station



Wyoming CarbonSAFE Program (CO₂ source)

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

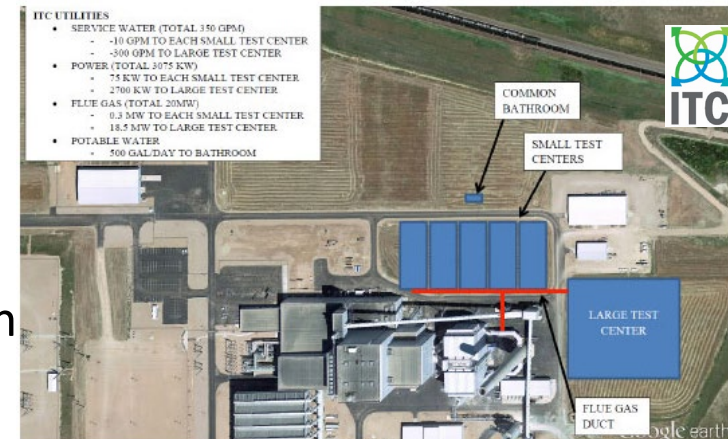
Dry Fork Station

- ✓ Built in 2007
- ✓ Operating life 2072
- ✓ 385 MW Power Plant
- ✓ 3.3 Million tons of CO₂/year



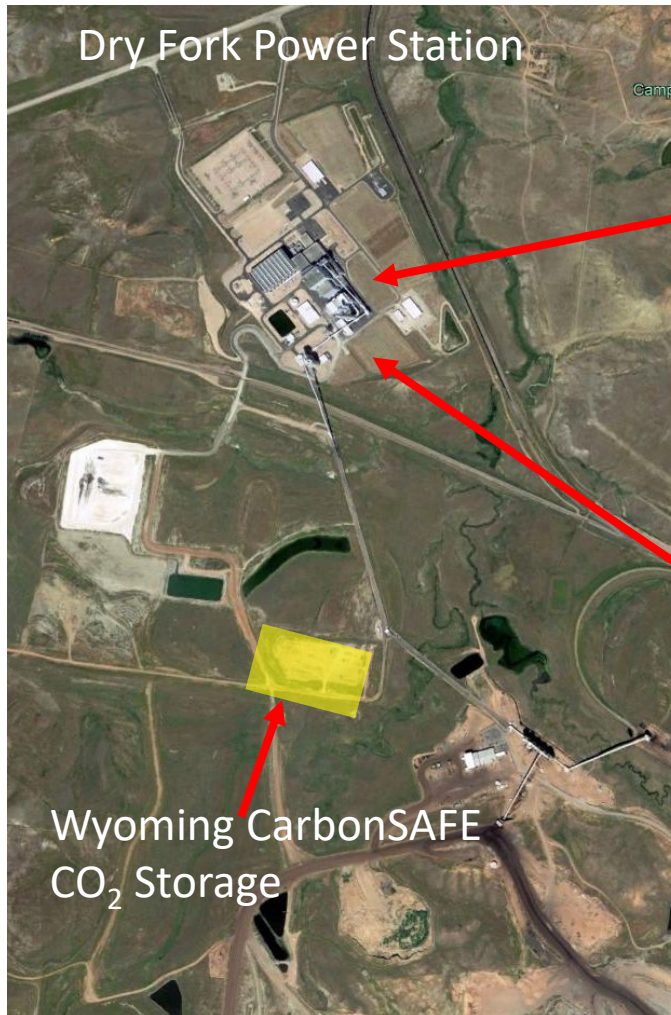
WY-Integrated Test Center (ITC)

- ✓ Completed fall 2017
- ✓ Test CO₂ capture/CCUS technologies
- ✓ \$20M public/private investment
- ✓ \$65M Membrane Technology Research Large Scale Pilot



WYOMING
INTEGRATED
TEST CENTER

Wyoming CarbonSAFE Program

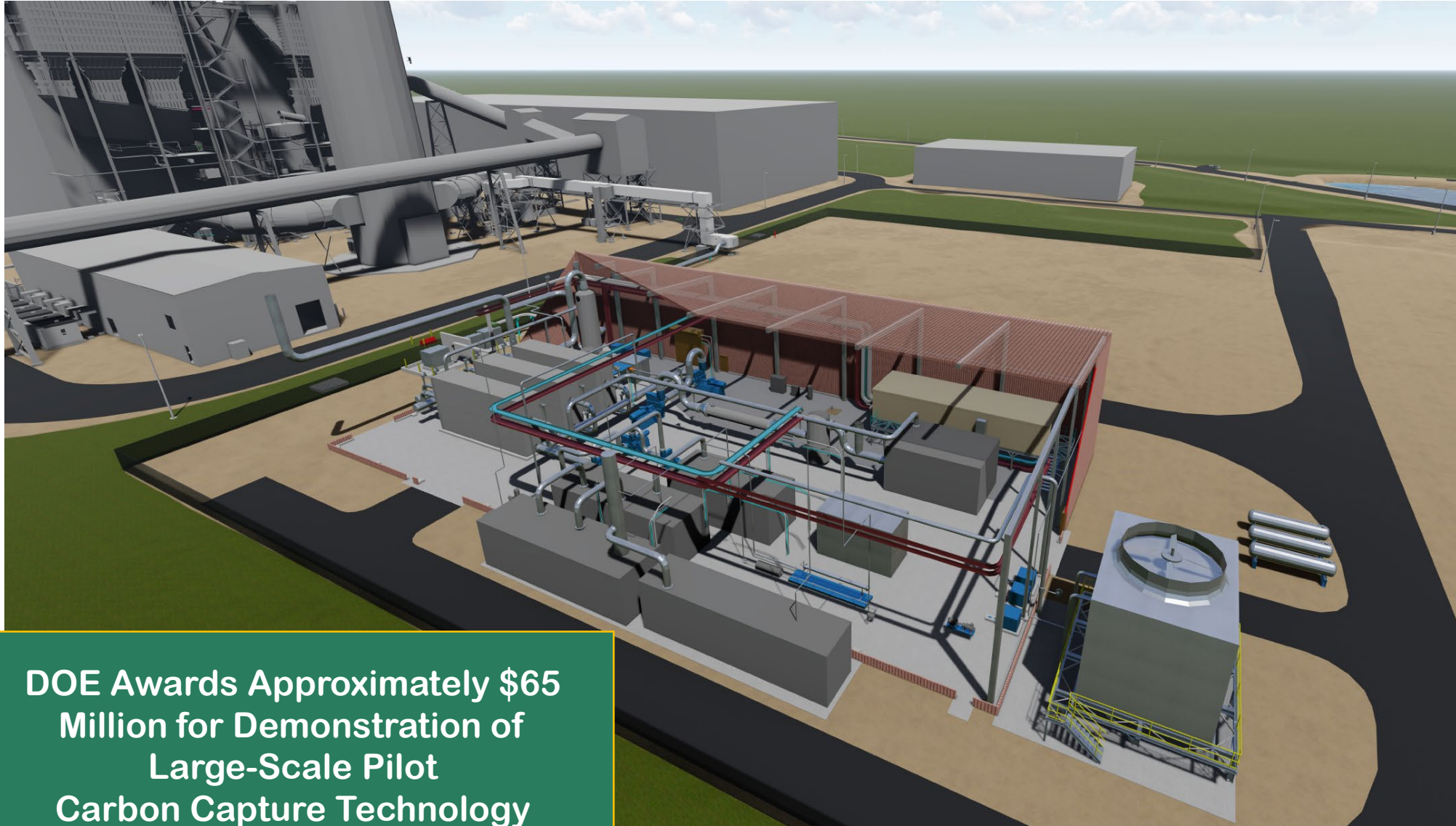


Private, state and federal investment

Full-Scale FEED of MTR's Capture Process at Dry Fork Station



MTR's CO₂ Capture Projects Update



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

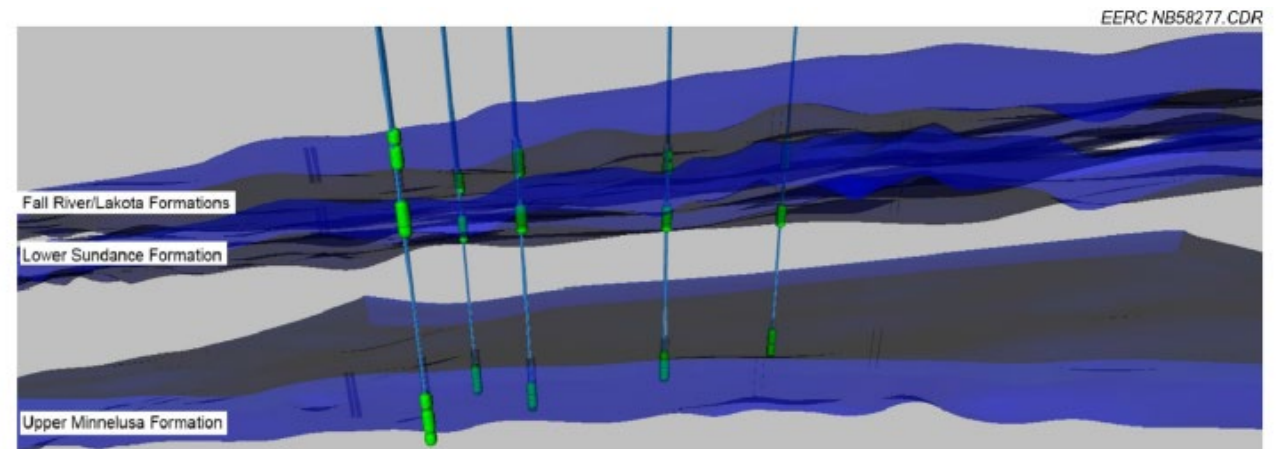
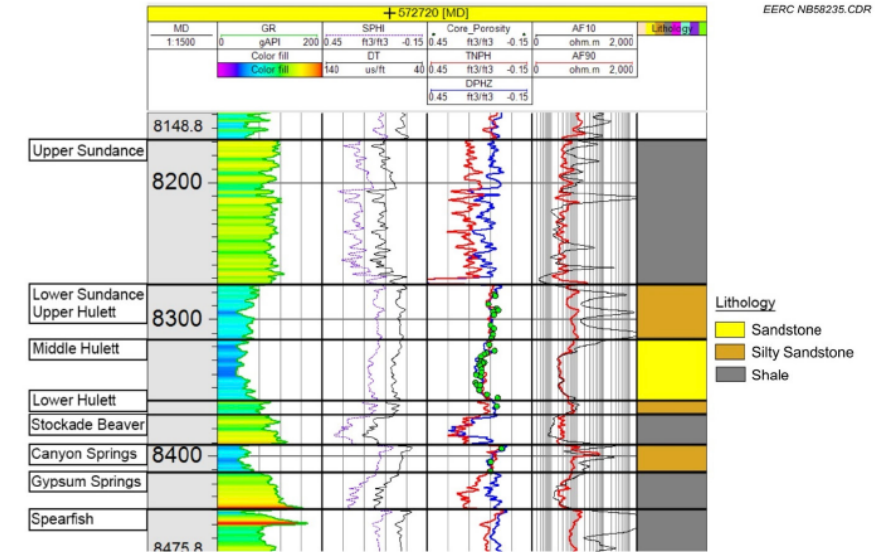


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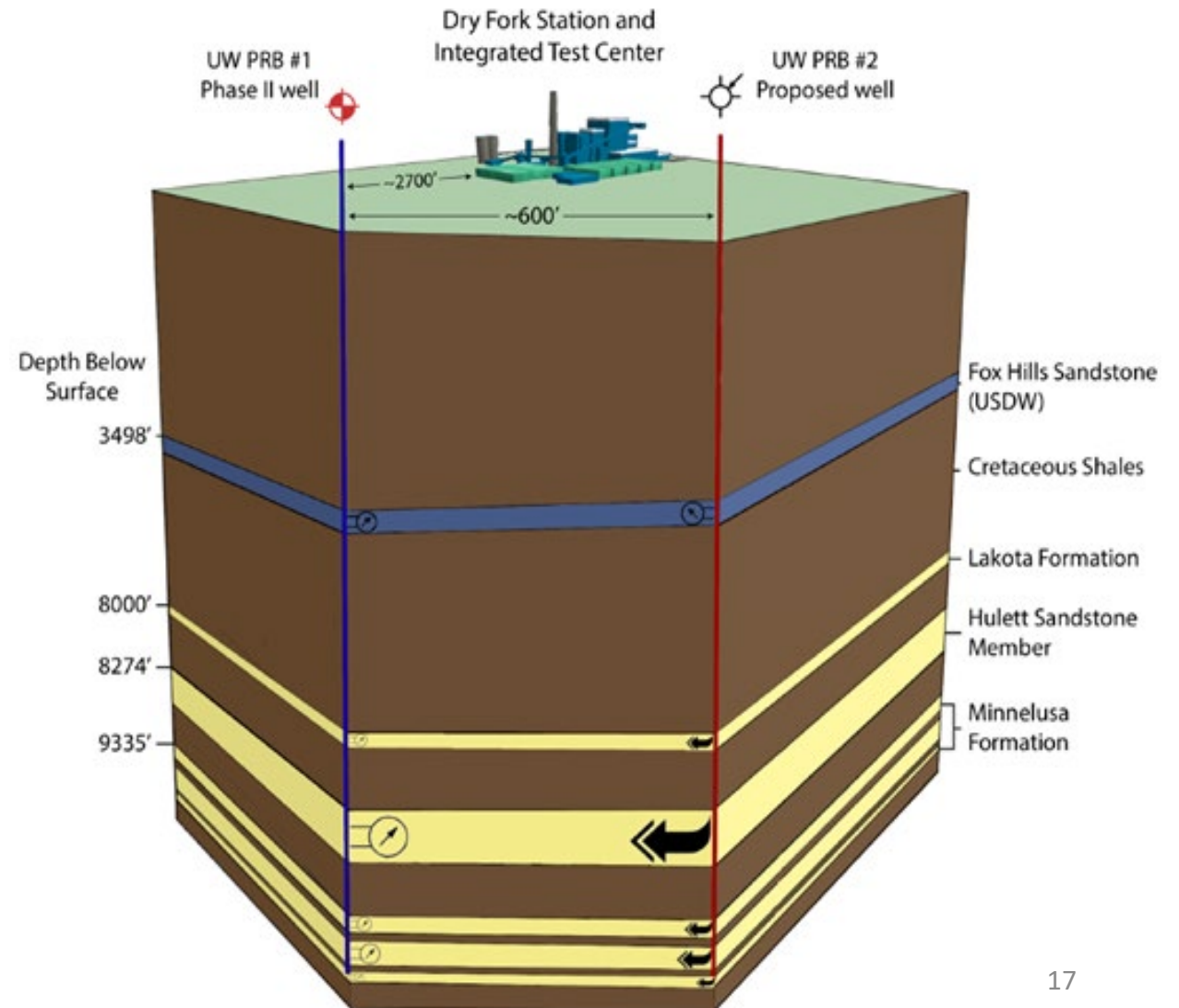
Work completed to date:

1. Infrastructure: Injection well, soil gas monitoring system
2. Geologic site characterization (well logs, core, thin sections, fluid, 3D seismic, etc.)
3. Geologic/geochemical/geomechanical models
4. Storage capacity estimates
5. Risk assessment
6. Testing and monitoring plans
7. Monitoring verification and assessment plans
8. Public outreach, surveys, communication materials
9. Legal and regulatory analyses
10. Economic analyses
11. Workforce assessment
12. Statewide interoperability assessment
13. Plans for future site development
14. Model project agreements
15. Nearby enhanced oil recovery potential



What is next for Wyoming CarbonSAFE

1. Reservoir injection tests
2. Integrate MTR's CO₂ FEED and large-scale capture assessment
4. Complete Class VI permits
- 5. Advance commerciality within the Wyoming CarbonSAFE storage hub**



Wyoming CarbonSAFE: Other benefits

Phase I (2017) to Phase III (2023) by the numbers:

- ✓ Total funding to date: \$33,525,672
 - \$26.5M Federal
 - \$5.5M Private
 - \$1.5M UW (state)
- ✓ Local impact: \$11.1M spent in Campbell County, Wy
- ✓ 14 Graduate students funded
- ✓ 27 research jobs since 2017 at UW



Phase IV: Complete Construction

Phase IV: Construction and full permitting (2023-2026)

Keys to moving to moving forward:

1. Phase IV: \$40-\$50M project
 - FY23 federal appropriations
 - Cost share \$8-\$10M
2. Successful completion of Phase III
3. Continued support from the State, Industry Partners, and Regional Partners



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