



ITC

WYOMING
INTEGRATED
TEST CENTER

The Wyoming Integrated Test Center: A Venue for up to 20 MWe Scale-up of Developing CO₂ Capture Technologies

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Outline

- Introduction.
- Background on formation of the Integrated Test Center (ITC) and host site.
- ITC design and construction.
- ITC specifications and commissioning.
- Current tenants and technology descriptions.
- Future testing and partnership opportunities.
- Brief introduction of economic opportunities for CO₂ enhanced oil recovery for CO₂ capture technology providers.

Introduction

- One of the largest post-combustion demonstration scale test facilities.
- 20+ MW of coal derived flue gas from the Dry Fork Power Station.
- Simple design minimizes costs, provides flexibility & quick turnaround times.
- Designed for maximum flexibility and scalability for testing.
- Focused on larger scales to compliment NCCC and create a space for further scale up.



Who is invested in the ITC?

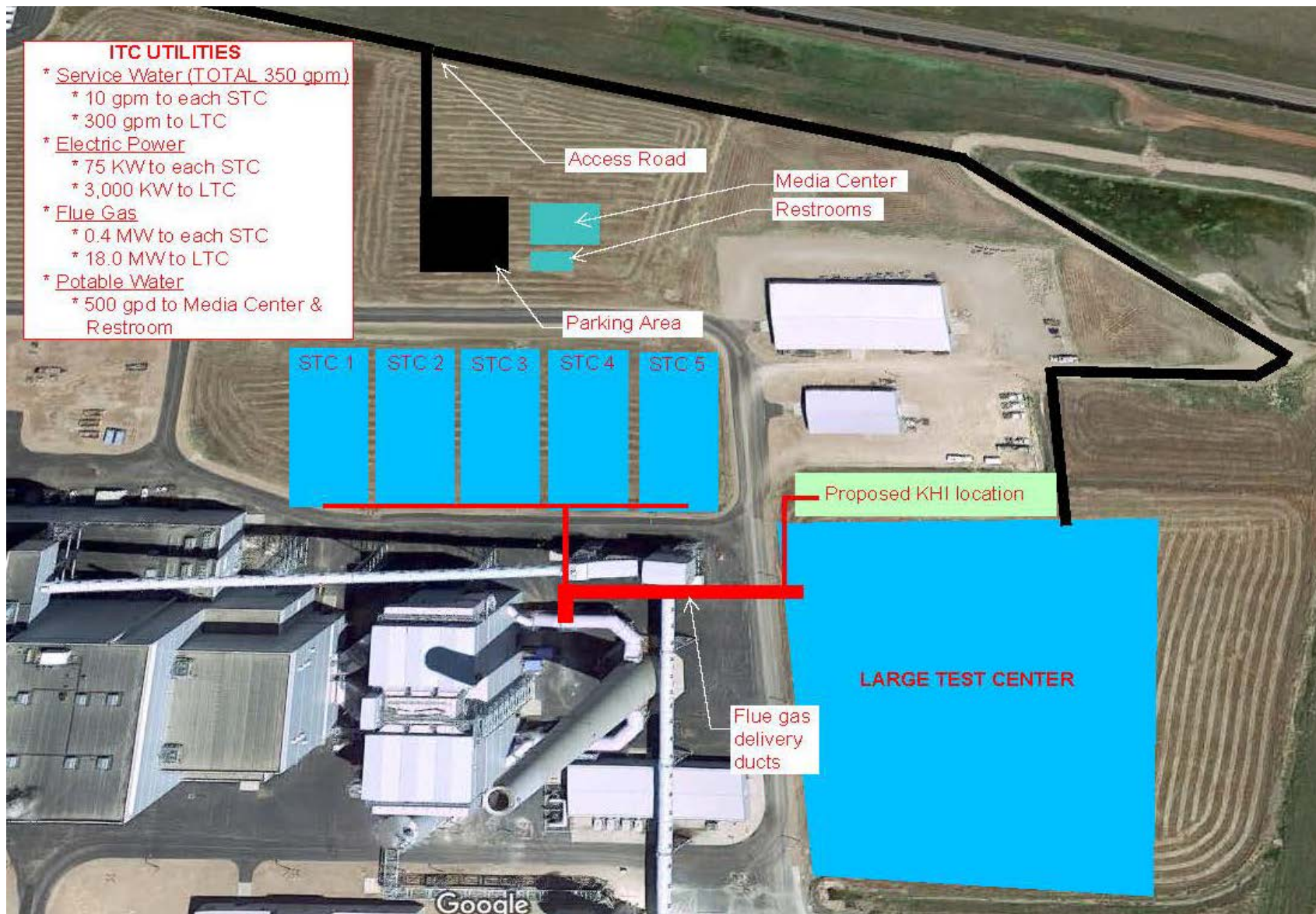
- State of Wyoming – \$15 million
- Basin Electric – Host at Dry Fork Station
- Tri-State G&T – \$5 million
- National Rural Electric Cooperatives Association – \$1 million
- Wyoming Infrastructure Authority – Managing Entity
- Black Hills Corp. and Rocky Mountain Power providing technical expertise and in-kind contributions
- XPRIZE Foundation – First tenant



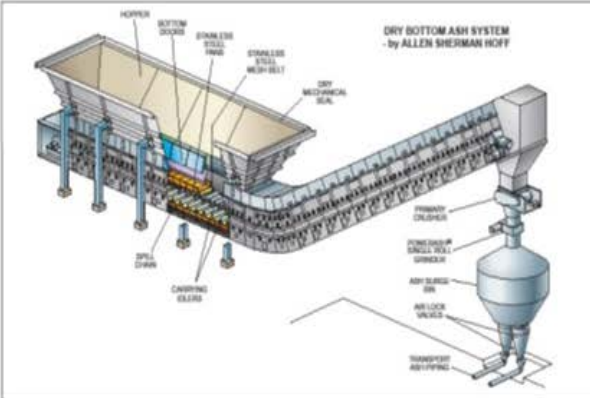
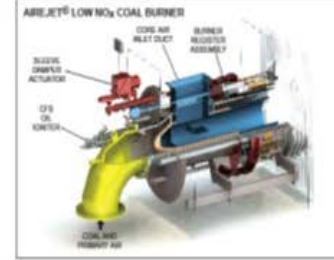
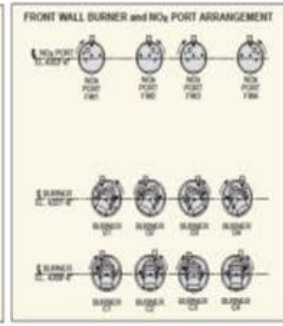
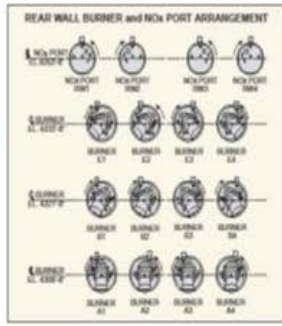
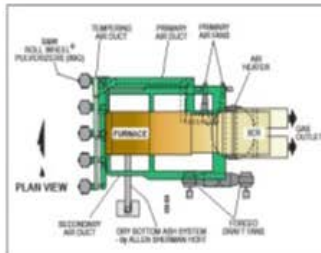
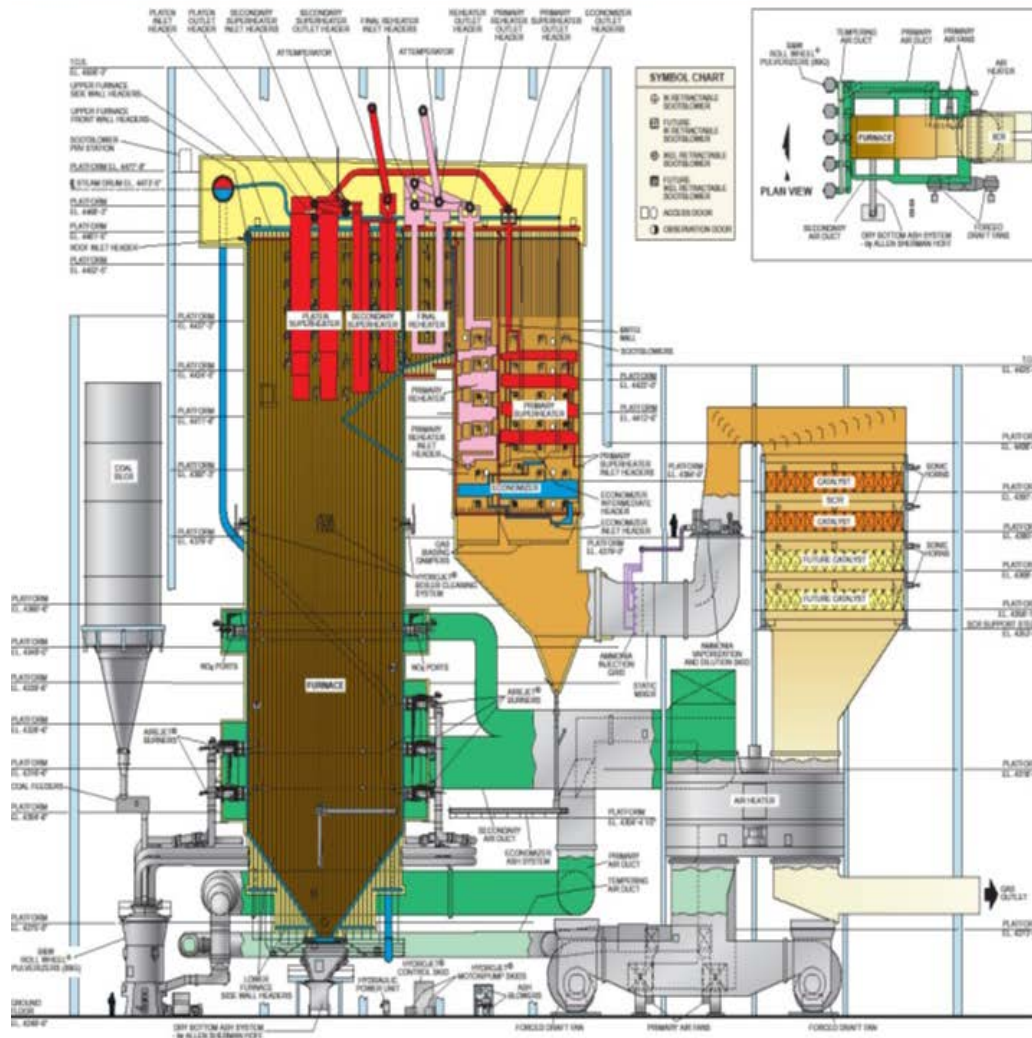
The History of the Integrated Test Center

- 2014 - WY Legislator appropriates \$15 million with an additional \$5 million secured from Tri-State Generation & Transmission along with \$1 million pledged from the National Rural Electric Cooperative Association.
- Summer 2014 - Governor Mead hosts ITC Kickoff meeting with Black Hills Power, Pacific Power & Light and Basin Electric Power Cooperative.
- June, 2015 - A&E contract awarded to Sargent & Lundy.
- April, 2016 - Duct damper installed.
- April 27, 2016 - ITC dedication at Dry Fork Station.
- October, 2016 - phase 2 construction awarded to Hladky Construction.
- June, 2018 - Site ready for first tenants.

The ITC Layout



The ITC's Host Site Boiler

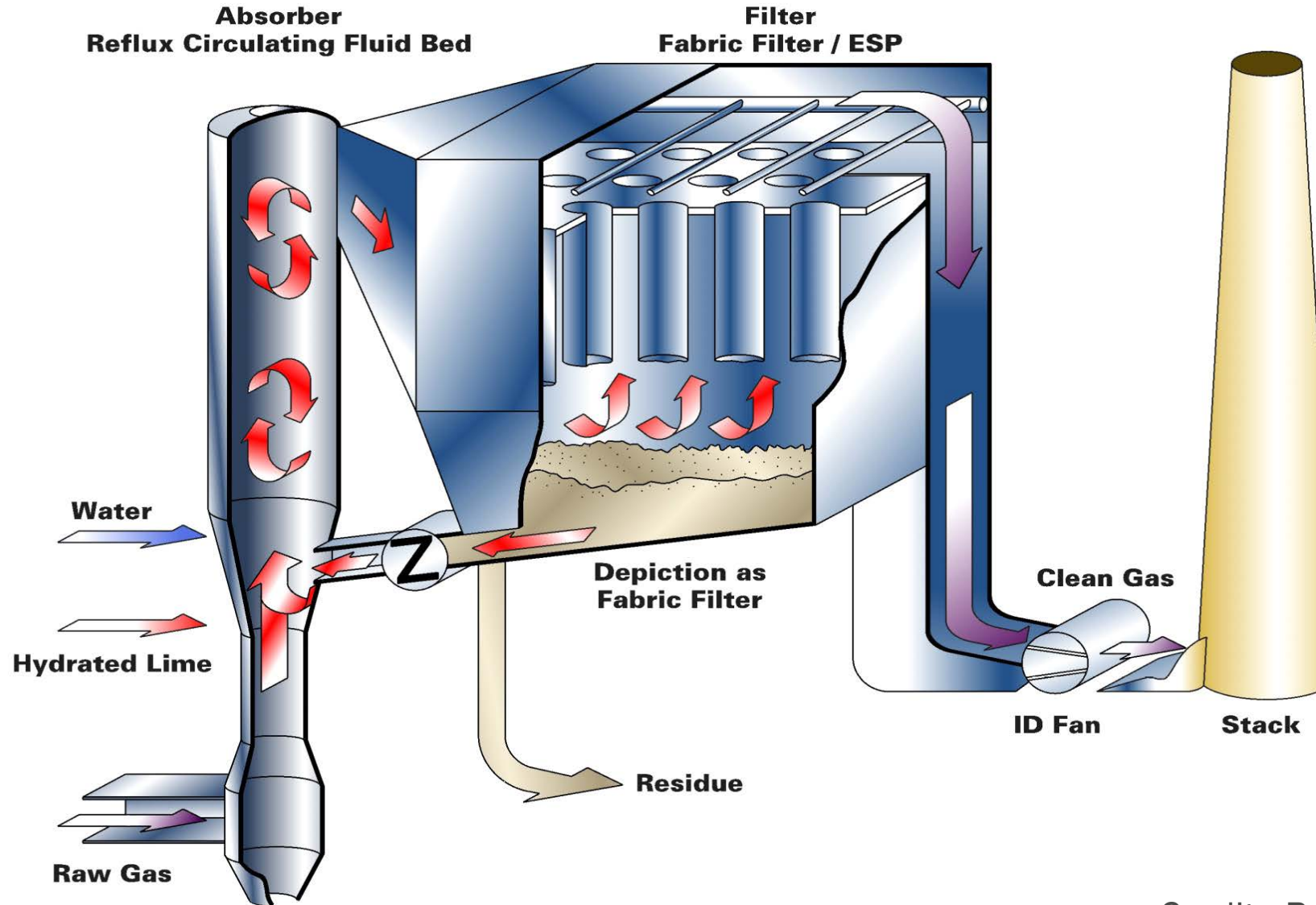


BASIN ELECTRIC POWER COOPERATIVE
DRY FORK STATION UNIT 1
 B&W CONTRACT: RB-655

Nominal Capacity 422 MW Superheater Outlet Pressure 2483 psig (17.1 MPa)
 Steam Capacity 2,887,000 lb/hr (364 kg/s) SH/RH Outlet Temperatures 1055/1055F (568/568C)

Credit: Basin Electric Cooperative

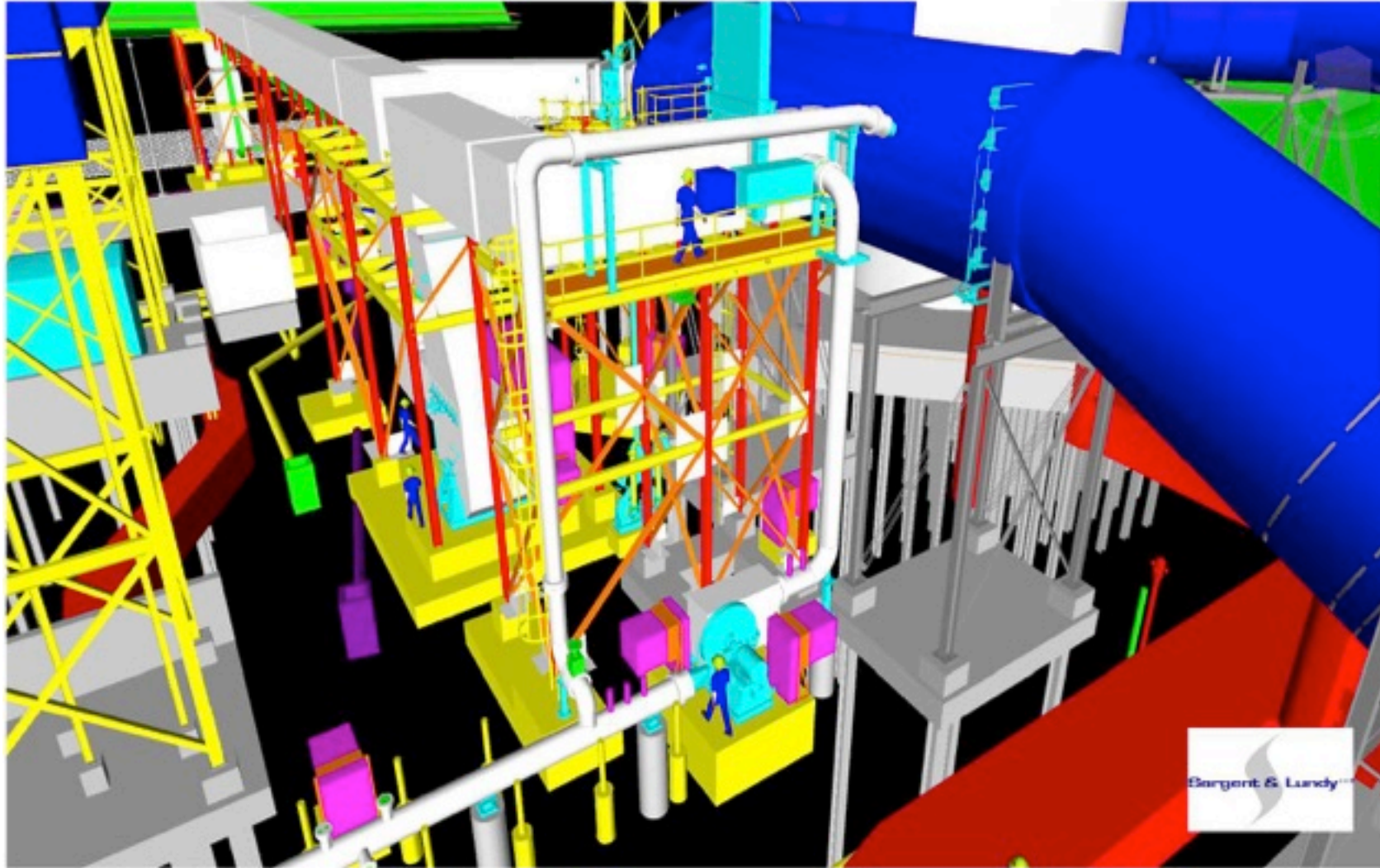
The ITC's Host Site APC



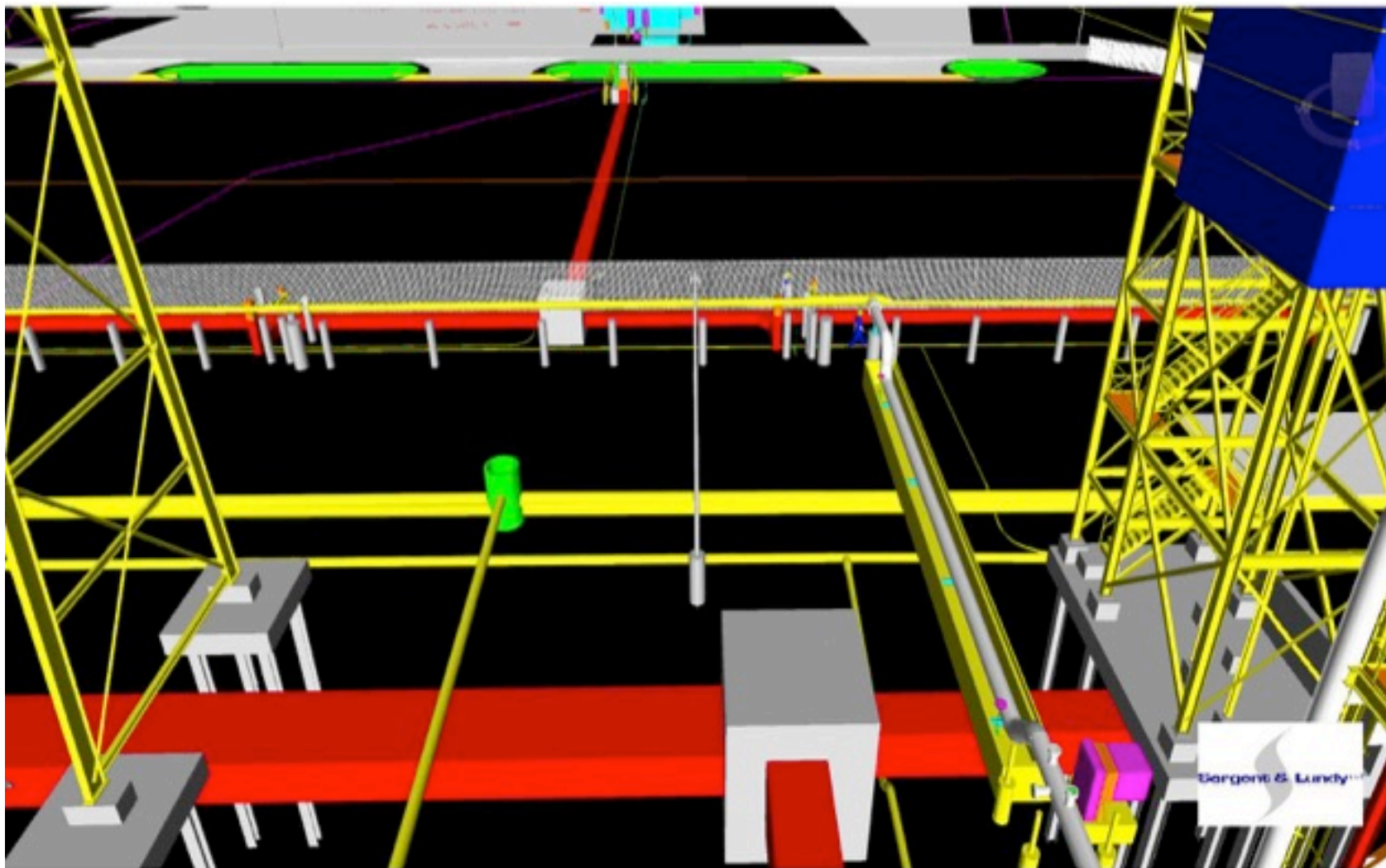
Flue Gas For Testing CO₂ Capture

Component	Minimum	Maximum	Average
CO ₂	12%	13.1%	12.7%
O ₂	1.7%	4.2%	2.5%
N ₂ + Ar	65.7%	69.7%	66.7%
H ₂ O	15.2%	18.3%	18.1%
SO ₂	0.0 ppm	114.9 ppm	23.1 ppm
NO _x	19.2 ppm	38.4 ppm	27.8 ppm
Temperature	177 F (81 C)	194 F (90 C)	185 F (85 C)

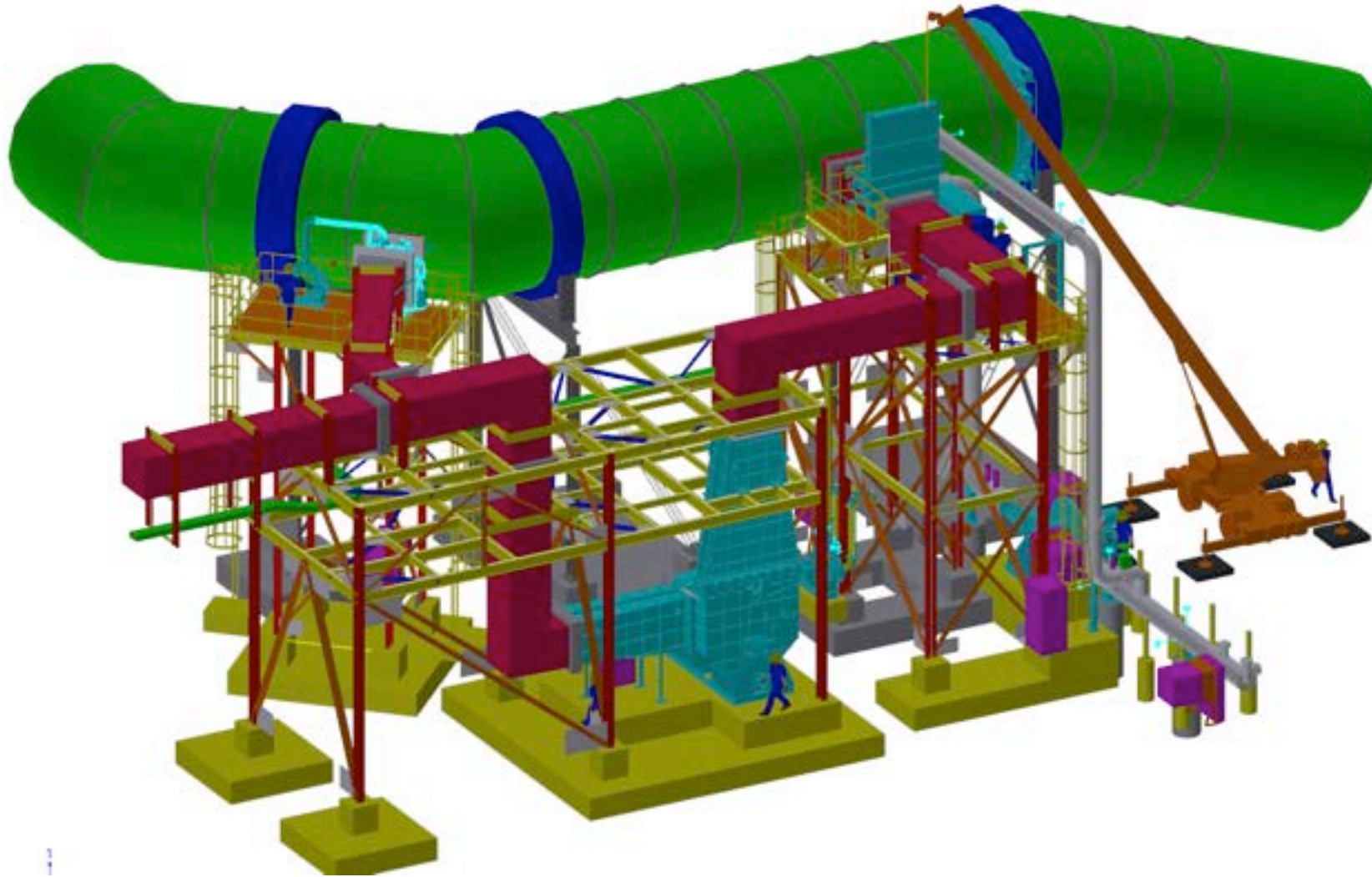
Small Test Center Flue Gas Loop



Small Test Center Flue Gas Distribution



Large Test Center Flue Gas Loop



ITC Construction



Large Test Bay Construction



Completion of Large Test Bay



Completed Small Test Bay



Dedication – May 16, 2018



ITC Infrastructure

- Utilities
 - Electrical
 - Each small test bay is equipped with a 750 kVA transformer and 3 phase power at 480 volts with a 1,000 amp disconnect.
 - The large test bay is equipped with a 3 MVA transformer.
 - Water
 - Each small test bay features 38 lpm (10 gpm) of process/cooling water at 5.5 bar (80 psi).
 - The large test bay is equipped with 1,136 lpm (300 gpm) of cooling/process water at 5.5 bar (80 psi).

Site of XPRIZE competition - Small Test Bays



XPRIZE is a temporary tenant of the ITC and at the completion of the competition, the space will be available to new testers.

XPRIZE competition



Breathe (Bangalore, India) – Led by Dr. Sebastian Peter, the team is producing methanol, a common fuel and petrochemical feedstock, using a novel catalyst.



Carbon Capture Machine (Aberdeen, Scotland) – Led by Dr. Mohammed Imbabi, the team is producing solid carbonates with applications to building materials.



C4X (Suzhou, China) – Led by Dr. Wayne Song and Dr. Yuehui Li, the team is producing chemicals and bio-composite foamed plastics.



CarbonCure (Dartmouth, Canada) – Led by Jennifer Wagner, the team is producing stronger, greener concrete.



Carbon Upcycling UCLA (Los Angeles, CA, USA) – Led by Dr. Gaurav Sant, the team is producing building materials that absorb CO₂ during the production process to replace concrete.

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JCOAL – KHI Test



- July 2016 – State of Wyoming - JCOAL (Japan Coal Energy Center) MOU.
- April 2017 – WY delegation meetings in Japan.
- Sept. 2017 – JCOAL/UWSER conference in Gillette.
- March 2018 – WY delegation meetings in Japan.
- April 2018 – Announcement of JCOAL-KHI (Kawasaki Heavy Industries) test at ITC – dry sorbent, fixed bed technology.
- May 2018 – Japan Ministry of Environment, JCOAL and KHI trip to Gillette.

Membrane Technology and Research



- MTR has a successful CO₂ capture research portfolio.
- Has received initial phase 1 funding from U.S. DOE.
- Partnering with Wyoming ITC for phase 2 application for design and permitting and phase 3 operation.
- 200 ton per day of liquid CO₂ product system will be located in the large test bay.

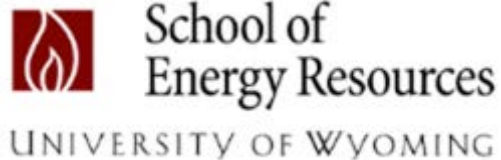
Photo Credit: NETL

Tenant Summary

- XPRIZE
 - 5 teams competing for best commercial CO₂ utilization offering will produce building materials, polymers, and methanol using various CO₂ capture technologies.
- KHI
 - Fixed bed adsorbent optimization testing.
- MTR
 - Proposed 200 ton per day CO₂ capture project in the large test bay using membrane separation system combined with cryogenic distillation.

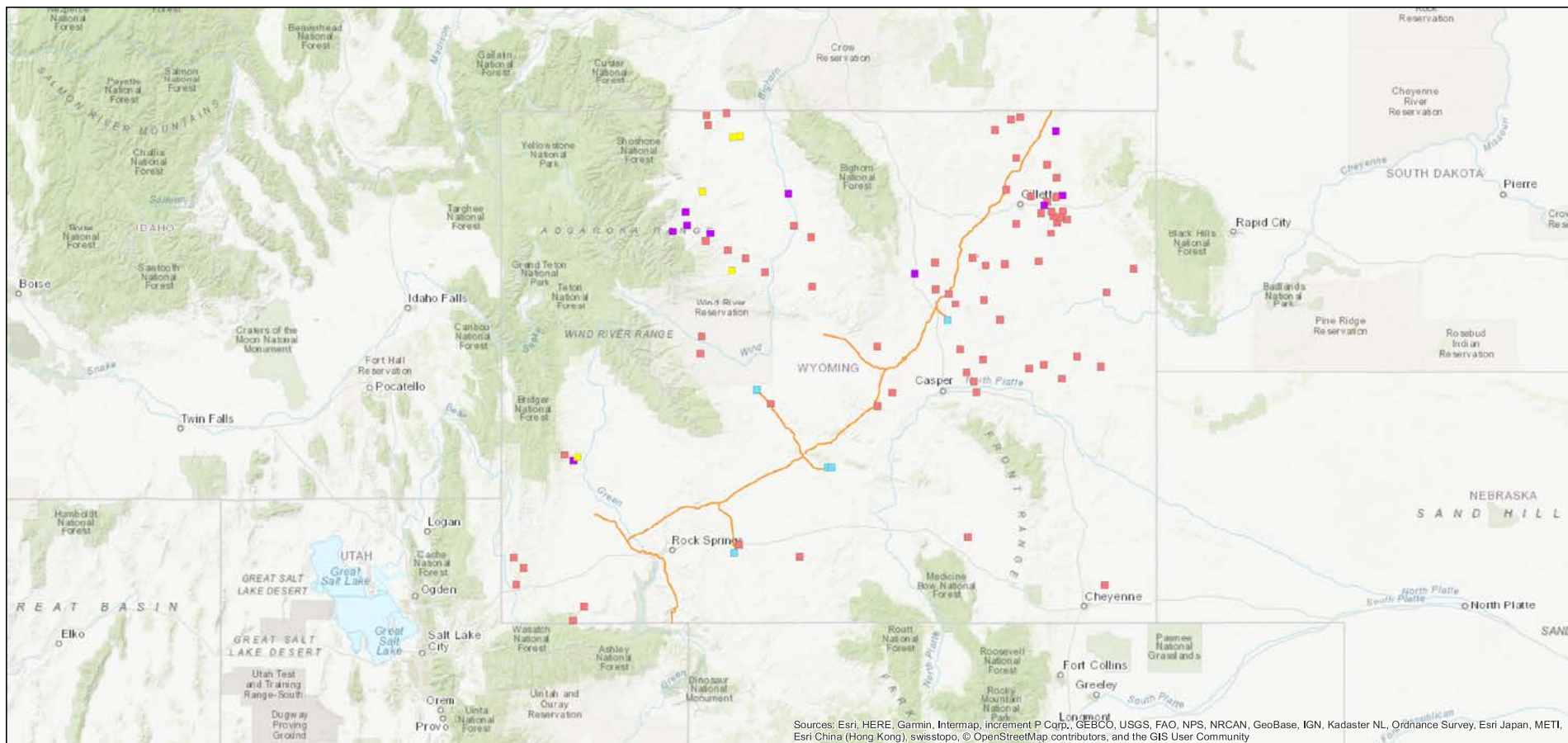
Further Collaboration Potential

- University of Wyoming School of Energy Resources
- Carbon Management Institute
- Enhanced Oil Recovery Institute
- Wyoming Integrated Test Center
- Wyoming Corridor Initiatives
- ENDOW



CO₂ Commercial Needs in the State

Wyoming Reservoir Information Tool (WyRit)



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community



Credit:
Enhanced Oil Recovery Institute
University of Wyoming



Stay in Touch!

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