The Wyoming Integrated Test Center: A Venue for up to 20 MWe Scale-up of Developing CO$_2$ 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.

Credit: Basin Electric Cooperative
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.
- 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

ITC UTILITIES
- Service Water (TOTAL 350 gpm)
  - 10 gpm to each STC
  - 300 gpm to LTC
- Electric Power
  - 75 KW to each STC
  - 3,000 KW to LTC
- Flue Gas
  - 0.4 MW to each STC
  - 1.6 MW to LTC
- Potable Water
  - 500 gpd to Media Center & Restroom

Credit: Basin Electric Cooperative
The ITC’s Host Site Boiler

Credit: Basin Electric Cooperative
The ITC’s Host Site APC

Absorber
Reflux Circulating Fluid Bed

Filter
Fabric Filter / ESP

Depiction as Fabric Filter

Water

Hydrated Lime

Raw Gas

Residue

Clean Gas

ID Fan

Stack

Credit: Basin Electric Cooperative
## Flue Gas For Testing CO₂ Capture

<table>
<thead>
<tr>
<th>Component</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>12%</td>
<td>13.1%</td>
<td>12.7%</td>
</tr>
<tr>
<td>O₂</td>
<td>1.7%</td>
<td>4.2%</td>
<td>2.5%</td>
</tr>
<tr>
<td>N₂ + Ar</td>
<td>65.7%</td>
<td>69.7%</td>
<td>66.7%</td>
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<tr>
<td>H₂O</td>
<td>15.2%</td>
<td>18.3%</td>
<td>18.1%</td>
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<tr>
<td>SO₂</td>
<td>0.0 ppm</td>
<td>114.9 ppm</td>
<td>23.1 ppm</td>
</tr>
<tr>
<td>NOₓ</td>
<td>19.2 ppm</td>
<td>38.4 ppm</td>
<td>27.8 ppm</td>
</tr>
<tr>
<td>Temperature</td>
<td>177 F (81 C)</td>
<td>194 F (90 C)</td>
<td>185 F (85 C)</td>
</tr>
</tbody>
</table>
Small Test Center Flue Gas Loop

Credit: Basin Electric Cooperative
Small Test Center Flue Gas Distribution
Large Test Center Flue Gas Loop

Credit: Basin Electric Cooperative
ITC Construction

Credit: Basin Electric Cooperative
Large Test Bay Construction
Completion of Large Test Bay
Completed Small Test Bay
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.
- 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 CO$_2$ 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 CO$_2$ 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
Stay in Touch!

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