ENVIRONMENTAL QUALITY COUNCIL 2017-18

Sept. 12, 2018 Exhibit 28

ITC WYOMING INTEGRATED TEST CENTER

The Wyoming Integrated Test Center (ITC) is a research test facility located on the site of Basin Electric Power Cooperative's Dry Fork Station near Gillette, Wyoming. The ITC provides space for researchers to test Carbon Capture, Utilization and Sequestration (CCUS) technologies using 20 MW of actual coal based flue gas. The ITC is one of only a handful of facilities around the world, and only the second in the United States, that enables researchers to test their technologies at an operating power plant.

How It Works: At the ITC, researchers are working to perfect technologies that can remove CO2 from exhaust produced when burning coal and turn it into valuable products.

Just prior to entering the stack, about five percent of the flue gas from Dry Fork Station will be delivered to the ITC through a carbon steel duct. There, researchers will have access to test their technologies under real-word conditions, providing scientists a setting unlike anything achievable in a laboratory.

Some of the ITC's first tenants are teams competing for the NRG COSIA Carbon XPRIZE. They are testing technologies that will capture CO2 and turn it into products like fertilizer, fish food and building materials.

Testing Technologies at the Wyoming ITC

The ITC features six test bays designed to accommodate projects of varying sizes and power needs. Each individual test bay is fed with flue gas directly from Dry Fork Station. The test bays are gravel pads where modular test apparatuses can be brought in, attached to the flue gas delivery system and run to gather data. This modular design allows for maximum flexibility in test capacities and scale-up capabilities.

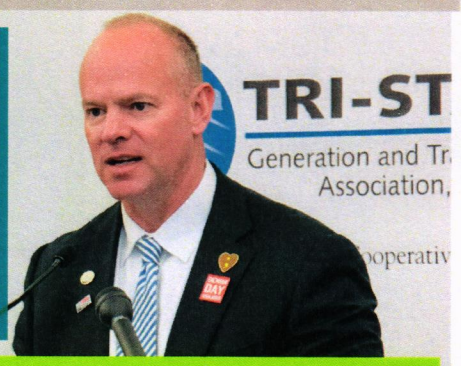
There is office space available for research teams' on-site. Basic utilities including electricity and water will be provided. Interested tenants can visit wyomingitc.org/tenants for additional information on the facility.

Public-Private Partnership

The ITC is funded by $15 million from the State of Wyoming, $5 million from Tri-State Generation and Transmission Association and $1 million from the National Rural Electric Cooperatives Association. Basin Electric Power Cooperative is providing the host site and various technical services. Additional partners that have contributed goods and services include:

- Black Hills Corporation
- Rocky Mountain Power
- NRG COSIA Carbon XPRIZE
- University of Wyoming School of Energy Resources

"I can't wait to see what great minds come up with to reimagine CO2. I believe the innovations will be breathtaking and will make a profound difference in the future of coal."
– Wyoming Governor Matthew H. Mead



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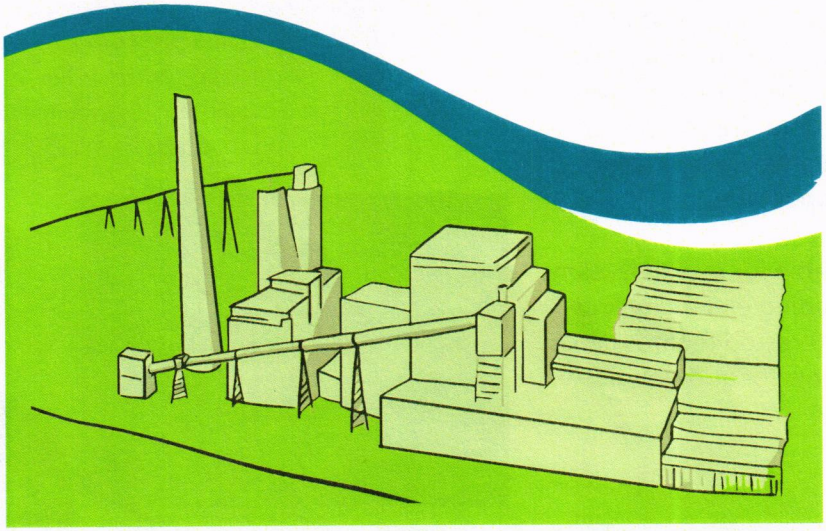
ITC WYOMING INTEGRATED TEST CENTER

The Wyoming Integrated Test Center (ITC) is a public-private partnership designed to foster the next generation of energy technology by enabling real world research and testing at Basin Electric Power Cooperative's Dry Fork Station near Gillette, Wyoming.



Wyoming: Powering the Nation, Fueling Innovation
Wyoming is committed to perfecting and deploying technologies that can efficiently capture carbon dioxide from power plants, reducing emissions and ensuring our nation's coal fleet has economically viable carbon solutions.

Wyoming is leading the way in an international collaboration on the commercialization of CO2 utilization technologies that have the potential to forever change the face of energy production.

Partners
The ITC is funded by $15 million from the State of Wyoming, $5 million from Tri-State Generation and Transmission Association and $1 million from the National Rural Electric Cooperatives Association. Basin Electric Power Cooperative is providing the host site and various technical services. Additional partners that have contributed goods and services include:

- Black Hills Corporation
- Rocky Mountain Power
- NRG COSIA Carbon XPRIZE
- University of Wyoming School of Energy Resources

How It Works
At the ITC, researchers will have access to scrubbed flue gas to scale-up carbon management solutions under real world conditions. The facility will host teams working on both carbon capture and carbon conversion technologies. Some of the ITC's first tenants are teams competing for the NRG COSIA Carbon XPRIZE. They are testing technologies that will capture CO2 and turn it into products like fertilizer, fish food and building materials.

Testing Technologies at the Wyoming ITC
The ITC is one of only a handful of facilities around the world sited at a power plant, allowing larger-scale projects to test under actual operating conditions. This will provide more detailed information for technology evaluation, helping to alleviate typical concerns over scaling technologies from laboratories to commercial sizes.

The ITC features multiple test bays capable of hosting projects up to 20 MW. Each test bay will be provided flue gas from the Dry Fork Station, water, electricity service and access to on-site offices. Interested tenants can visit wyomingitc.org/tenants for additional information on the facility.

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WYOMING INTEGRATED TEST CENTER

Tenants at the Integrated Test Center

The Integrated Test Center is drawing tenants from around the world to test at this state-of-the-art facility; which is located at an operating power plant and gives researchers direct access to coal-fired flue gas. The ITC is able to host multiple research teams at any given time. The facility is designed to accommodate projects of varying sizes and power needs. Each individual test bay is fed with flue gas directly from Basin Electric Power Cooperative's Dry Fork Station.

XPRIZE

Five finalists for the NRG COSIA Carbon XPRIZE will be testing their technologies at the ITC. The $20 million Carbon XPRIZE is a global competition to develop breakthrough technologies that will convert CO2 emissions from power plants and industrial facilities into valuable products like building materials, alternative fuels, and other items that we use every day. The teams testing at the ITC represent five different countries and will be testing at the ITC through 2020.

- Breathe (Bangalore, India) – Led by Dr. Sebastian Peter, the team is producing methanol, a common fuel and petrochemical feedstock, using a novel catalyst.
- C4X (Suzhou, China) – Led by Dr. Wayne Song and Dr. Yuehui Li, the team is producing chemicals and bio-composite foamed plastics.
- Carbon Capture Machine (Aberdeen, Scotland) – Led by Dr. Mohammed Imbabi, the team is producing solid carbonates with applications to building materials.
- 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 CO_2 during the production process to replace concrete.

Kawasaki Heavy Industries, Ltd.

Kawasaki Heavy Industries, Ltd. (KHI) announced in April 2018 that they will test their solid sorbent capture technology at the Wyoming Integrated Test Center (ITC).

The State of Wyoming and the Japan Coal Energy Center (JCOAL) have been working together since 2016, when Governor Mead and Osamu Tsukamoto, President of JCOAL, signed a Memorandum of Understanding (MOU) committing to cooperation in coal research and development of technologies and coal trade.

DAKOTA GASIFICATION COMPANY
A BASIN ELECTRIC POWER COOPERATIVE SUBSIDIARY

CO2 Capture and Storage

Dakota Gasification Company's Great Plains Synfuels Plant is an international leader in technologies that capture, compress, and transport carbon dioxide (CO_2) emissions from a coal gasification process. The Synfuels Plant captures more CO_2 from coal conversion than any facility in the world, and is a participant in the world's largest carbon sequestration project. Dakota Gas sends CO_2 through a 205-mile pipeline to Saskatchewan, Canada, where oil companies use it for enhanced oil recovery operations that result in permanent CO_2 geologic sequestration. The geologic sequestration of CO_2 in the oil reservoir is monitored by the International Energy Agency (IEA) Weyburn CO_2 Monitoring and Storage Project.

- Dakota Gas has the ability to capture up to 3 million tons of CO_2 per year, or about 8,000 metric tons of CO_2 daily.
- Dakota Gas captures about two-thirds of the readily available CO_2 when running at full rates.
- Since 2000, CO_2 emissions at the Synfuels Plant have been reduced by about 45 percent.
- Dakota Gas is making research contributions to CO_2 sequestration technology.
- The plant has captured and transported nearly 35 million metric tons of CO_2 for geologic sequestration since 2000.

With increasing demand for the capture and storage of CO_2, Dakota Gas has seen a dramatic reduction in its CO_2 emissions at the Synfuels Plant. As an added environmental benefit, virtually all of the injected CO_2 is expected to remain permanently sequestered in the depleted oil fields long after they have been abandoned.

Capturing carbon dioxide

When coal is burned, it produces sulfur dioxide and nitrogen oxide as well as particulate matter and mercury. Under the Clean Air Act, those pollutants must be removed from exhaust gases that come out of the smoke stack.

Coal combustion also produces carbon dioxide, which is not currently regulated. When coal is gasified, the process removes the sulfur dioxide, mercury and carbon dioxide from the syngas before it is combusted, making the "syngas" cleaner than raw coal. The other gases are lowered in the process, and the carbon dioxide is more concentrated, which makes it easier to capture.

Delivering carbon dioxide

The Great Plains Synfuels Plant has built a 205-mile long, 14-inch and 12-inch carbon steel pipe through western North Dakota into southern Saskatchewan. During construction, the pipeline had to cross the Little Missouri River and Lake Sakakawea.

At first, two compressors pushed the CO_2 to Canada. In 2006, a third compressor was added, so more CO_2 could move through the pipeline.

Storing carbon dioxide

Sequestration means to set apart something for safekeeping. Carbon sequestration encompasses the processes of capture and storage of CO_2 that would otherwise reside in the atmosphere for long periods of time.

In the case of CO_2, many consider it to be a greenhouse gas that contributes to the phenomenon of global warming. There is much debate over this issue with popular opinion supporting the theory that capturing human-produced CO_2 emissions is a step in the right direction. On that basis, enhanced oil recovery via CO_2 flooding is an example of how one project can be a benefit to both industry and the environment.

How enhanced oil recovery works

The gas in the pipeline is at very high pressure (about 152 bar), which makes it a supercritical fluid. Supercritical fluids are gases under such high pressures that the vapor (gas) phase becomes as dense as the liquid phase. Supercritical fluids have high density, but flow easily like gases, so are ideal for transporting through pipelines. The Weyburn oil

field has a total of 720 wells. The vertical wells were drilled in a 9-spot grid pattern – eight producing wells in a square around an injection well and typically have a spacing of around 150 meters. The high pressure CO_2 is pumped into 37 injection wells, helping oil to flow towards 145 active producer wells.

The level of purity of the CO_2 supplied is ideal for use in enhanced oil recovery. This is because CO_2 dissolves more readily into oil when small impurities are present. Hydrogen sulphide (H_2S), which makes up 1.0 percent of the injection gas, is particularly beneficial at helping CO_2 to mix with oil.

When CO_2 supercritical fluid is pumped at high pressure into the reservoir, the CO_2 mixes with the oil, causing it to swell and become less viscous. The swelling forces oil out of the pores in the rocks, so that it can flow more easily. Water is pumped into the injection wells, alternating with CO_2, to push the released oil towards producer wells. Some CO_2 comes back out of the ground at producer wells; this is recycled, compressed and re-injected along with gas from the pipeline.

It is predicted that the CO_2 enhanced oil recovery operation will enable an additional 130 million barrels of oil to be produced, extending the field's commercial life by around 25 years. It is also anticipated that about 20 million tons of CO_2 will be injected and become permanently stored 1,400 meters underground over the lifetime of this project.

Although using CO_2 to increase oil production is not new, prior to the Dakota Gas and Cenovus Energy project, the CO_2 primarily came from natural sources. Because the naturally occurring ground source CO_2 was removed and injected into the geological structure, there was no net reduction in CO_2 emissions in the atmosphere. Dakota Gas is unique in that its CO_2, which would have previously been emitted into the atmosphere, is permanently injected into a geological sink, thereby reducing the total annual emissions of CO_2.

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