**Written Testimony Submitted to the United States Senate Committee on Environment and Public Works Subcommittee on Clean Air and Nuclear Safety**

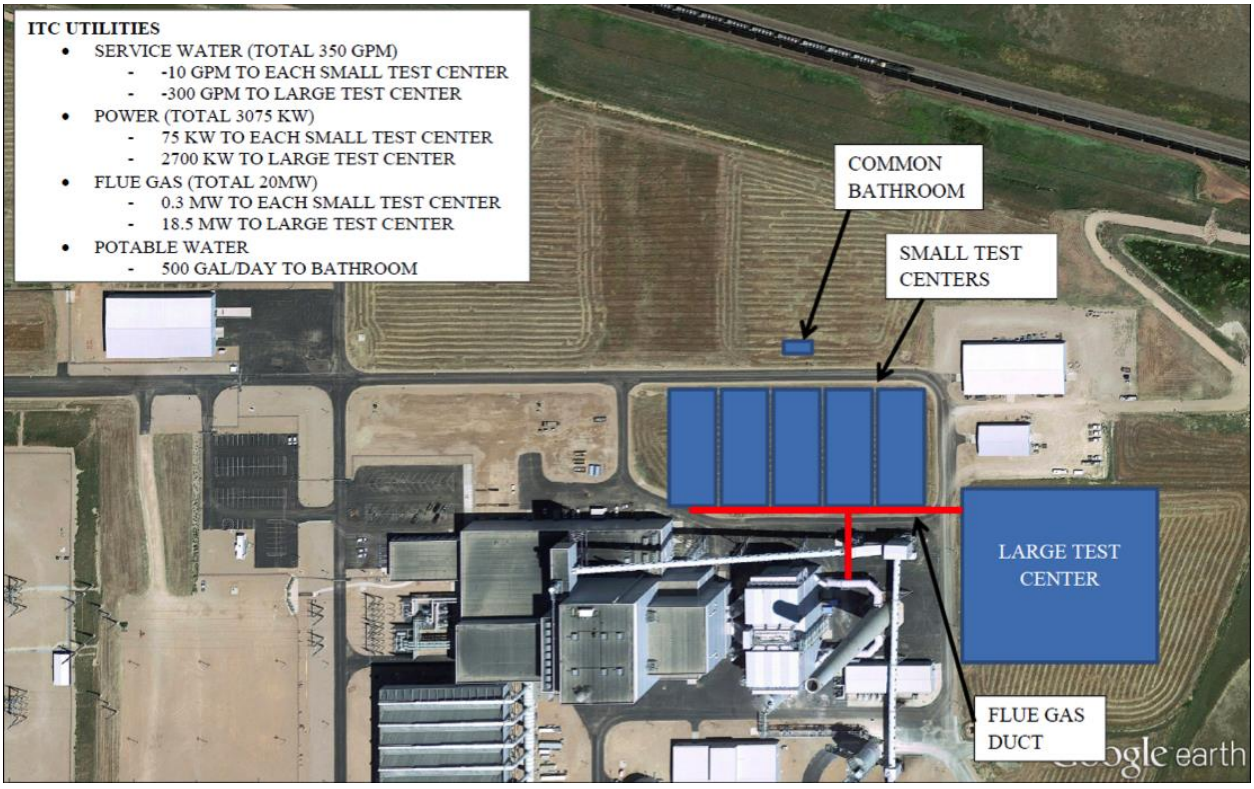
**Testimony on Developing and Deploying Advanced Clean Energy Technologies**

**Submitted by Jason Begger, Executive Director, Wyoming Infrastructure Authority, July 25, 2017**

Madam Chairman, members of the Subcommittee, I appreciate the opportunity to speak to you today about our carbon technology efforts in Wyoming. My name is Jason Begger and I am the Executive Director of the Wyoming Infrastructure Authority. The WIA is a state instrumentality created by the Wyoming Legislature in 2004 to promote and assist in the development of energy infrastructure. Under our legislative authority, we work to construct electrical transmission lines, advanced generation facilities and coal export terminals. We also have the ability to issue up to $1 billion in industrial revenue bonds to assist with project financing.

Currently, our largest project is the Wyoming Integrated Test Center, which is a private/public partnership between the State of Wyoming, Basin Electric Power Cooperative, Tri-State Transmission and Generation Association and the National Rural Electric Cooperatives Association (NRECA). We have also received various in-kind contributions from Black Hills Energy and Rocky Mountain Power.

The ITC is a post-combustion, flue gas research facility located at Basin Electric's Dry Fork Power Station near Gillette, Wyoming. It will be the largest facility of its kind in the United States, delivering up to 18 MW worth of scrubbed flue gas to researchers testing CCUS technologies. The power plant will provide flue gas to five small research bays, each capable of hosting tests up to 0.4 MW and a large test bay that can host two demonstration projects with a cumulative total of 18 MW.



We have raised $21 million in funding, $15 million from the State of Wyoming, $5 million from Tri-State G&T, and $1 million from NRECA. $14.9 million has been budgeted for capital construction and approximately $900,000 for annual operating costs, providing us with the resources to construct and operate the ITC for 7 years. While we believe there is an important role for the Federal Government to play in advancing technology and we would welcome such a partnership, not one cent of federal funding has been utilized at the ITC.


The State of Wyoming is the nation's largest coal producer, producing approximately 300 million tons in 2016. While this is still a significant amount of production, it is down from the peak in 2008 of 480 million tons, a drop of 37.5%. Coupled with similar drops in crude oil and natural gas prices and production, Wyoming has experienced significant reductions in tax revenues.

Given fossil energy's prominent role in the state, investment in carbon control technologies by Wyoming may seem unusual, but it all stems from Governor Matt Mead's directive to move beyond the political rhetoric surrounding climate change science and focus on discovering technology solutions to ensure the long-term economic viability of Wyoming's fossil energy resources. The ITC is just one of a number of Wyoming programs aimed at commercializing next generation coal technologies. The University of Wyoming School of Energy Resources works on small scale, academic research; the Wyoming Pipeline Initiative is working to pre-permit corridors for CO2 pipelines; the Wyoming Enhanced Oil Recovery Institute researches the reservoir geology and is identifying carbon sinks for EOR opportunities and the Carbon Management Institute has active grants with the Department of Energy to study permanent geologic sequestration.

The one constant variable for all of these state entities is a push to commercialization. Every project needs to continuously track costs and economics, because without a demonstrable path to commercialization, all you have is an interesting idea. Strong partnerships with the private sector, especially those industries that would ultimately be a customer of the technology, helps ensure our research objectives are aligned with their economic needs. A great example of how this has been successful for Wyoming is the ITC Technical Advisory Committee. This committee is comprised of representatives from major utilities who are involved in the technology evaluation processes for their various companies. If a utility does not see a particular technology as something they would employ, it is not given priority.

The most commercial post combustion CO2 capture technology utilizes amine solutions. Boundary Dam and Petra Nova utilize amines, and the Technology Centre Mongstad in Norway and National Carbon Capture Center in Alabama are leading research on solution based CO2 capture. In Wyoming, we didn't want to duplicate work already being done; we wanted to compliment other test centers by providing a place to scale up current laboratory research or look at other novel technologies.

One technology that has received support from Wyoming is cryogenic Carbon Capture. The various components in flue gas freeze and vaporize at different temperatures. This technology involves freezing the flue gas and capturing CO2 as a frozen solid. Early tests have shown a 99% CO2 capture rate, costing less than $30/ton and less than a 15% parasitic load. This method has also proven to be very successful at removing sulfur dioxide, nitrous oxide and mercury. While we've seen promising results at a small scale, further funding is necessary to test this as a larger pilot project.

One of the most exciting partnerships we've developed is with the XPRIZE Foundation. XPRIZE organizes and administers competitions looking to solve complex engineering challenges. One of the best-known XPRIZE competitions was the Ansari XPRIZE, which awarded the first team to fly three people to space and back twice within 14 days.

The NRG COSIA Carbon XRPRIZE will award $20 million in prizes to the teams that are best able to convert CO2 into other valuable products. Currently, 27 teams from six countries are working on ways to convert CO2 into things carbon nanotubes, methanol, building materials, fish food and plastics. The goal is to turn CO2 into an asset.

Later this year those 27 teams will be narrowed down to the final ten based upon the technical and economic feasibility. Five will test for two years at the ITC on coal derived flue gas and five will test in Canada at a natural gas facility. In 2020, the grand prize winners will be announced. When you add together all the funds the teams have already raised, the prize money and the costs of the facilities, the total Carbon XPRIZE investment is about $70 million dollars.

While on the surface, the prize money itself is not a significant amount in the overall energy R&D space, the competition model provides a few advantages. First, it provides a mechanism to vet technologies. Only the projects that work advance. Secondly, it sets an aggressive timeline. If they don't meet certain benchmarks, they don't advance. Thirdly, it opens to door to entrepreneurs and small inventors. Access to capital isn't an immediate barrier to entry. Lastly, the notoriety and public recognition for winning the competition will bring investors to them.

The model of providing a cash prize, following the testing, is a 180 degree turn from the current grant based model of funding R&D. However, it is hard to argue with the XPRIZE's success with the Ansari XPRIZE competition. One $10 million prize spurred 27 teams to invest over $100 million in technology development. Eventually, Richard Branson licensed the technology to create Virgin Galactic and today, the private space travel industry is worth $2 billion, only 22 years after the idea for a competition was created in 1995.

Last month, Apple celebrated the ten-year anniversary of the first iPhone model. This first version came with 4 GB of memory, a 2-megapixel camera, no flash, no zoom and no video camera. Today's iPhone 7 Plus has up to 256 GB of storage, fingerprint recognition, a 12-megapixel camera and HD video recording capabilities. Yes, today's CCUS technology is expensive and still evolving, but as we know, technology gets better and less expensive over time.

We need to begin to think about energy technology as we do with the technologies we utilize and take for granted every day and recognize the important contributions early government support provided to make them reality. Touch screen glass, which is a staple of today's smart phones, was developed in the United Kingdom funded Royal Radar Establishment in the 1960's for air traffic control use. GPS, canned food, microwave ovens, the internet, microchips, vaccines and nylon are items all developed by federal research.

Technology is apolitical and the U.S. can make its greatest impact by investing in technology development that can be utilized around the world. There is considerable debate over the future of coal within the United States. However, every credible energy analysis from the UN Intergovernmental Panel on Climate Change to DOE acknowledges large amounts of coal will be used globally for the foreseeable future. Technology is the best way to ensure these countries have access to power, yet can meet environmental goals.

I appreciate the opportunity to speak with you today and will gladly answer any questions. Thank you.