

Mister Chairman, members of the Committee, I appreciate the chance to speak to you today about the opportunities that support energy innovation right here in Wyoming. My name is Dr. Holly Krutka and I am the Executive Director of the University of Wyoming School of Energy Resources (SER). SER is focused on energy-driven economic development for the state of Wyoming, which means that we're focused on technologies that will help support the needs of Wyoming and its energy customers. If there's one thing you take from my testimony, let it be that Wyoming is an ideal place to drive innovation and deployment of climate-focused technologies, such as carbon capture, use and storage (CCUS), because the state boasts vast fundamental subsurface knowledge, world-class research programs, the ability to execute large demonstration projects and the will to drive technology development with the necessary policy support that can ultimately result in commercialization.

The University of Wyoming boasts a world-class research program in the Center of Innovation for Flow through Porous Media, led by Professor Mohammad Piri. The Center is located at University of Wyoming's High Bay Research Facility, which contains more than 90,000 square feet that makes up, to the best of my knowledge, the world's largest experimental research facility focused on flow through porous media problems with applications in hydrocarbon recovery, geologic sequestration

of greenhouse gases, and multiphase fluid flow through porous media in other science and engineering applications. It has been developed using more than \$100 million investment from the state of Wyoming and corporate sponsors.



Figure 1. The High Bay Research Facility was inaugurated in August 2017.

The Center provides imaging and flow capabilities at the atomic, nano, micro, and macro scales. It is home to a large, high-caliber international research team that is focused on advanced reservoir characterization and enhanced hydrocarbon recovery studies with direct relevance to the technical challenges encountered during exploitation of unconventional and conventional reservoirs. They develop and utilize leading-edge technologies to gain significantly improved insights into complex recovery schemes deployed in the US and abroad including those in Wyoming, North Dakota, Texas (west Texas and Gulf of Mexico), South America, and the Middle East. In the drive toward commercializing novel technologies, a commercial entity has been spun off and is offering services today.

The drive toward innovation continues to our current location, at the Wyoming Integrated Test Center, where carbon capture and conversion technologies are being applied to coal-fired power plant flue gas. There are many more examples of applied research, demonstration and commercialization proceeding around the state.

SER and our project partners are reimagining the use of coal as we develop a thermo-chemical process that produces nonfuel and energy products from Wyoming coal, to create products like soil amendments, building materials, asphalt replacements, electro-spun carbon fiber mats that could be used for energy storage, and much more. In addition, SER is developing a dry methane reforming catalyst that uses carbon dioxide (CO_2) and natural gas to generate syngas ($\text{CO} + \text{H}_2$) that can be used to produce petrochemicals or, alternatively, carbon monoxide-based chemicals and hydrogen. Our current estimates are that this dry-methane reforming process could create hydrogen at half the cost of current steam methane reforming technologies. This use for CO_2 is an important component of the thermo-chemical process because it allows the products I mentioned to be created from Wyoming coal with most of the carbon locked up in the products and near-zero carbon footprint.

SER's Center for Economic Geology Research (CEGR) is made up of internationally recognized experts in the topic of CO₂ geologic storage. Funded by the Department of Energy through the Carbon Storage Assurance Enterprise (CarbonSAFE) program, CEGR is investigating the commercial feasibility of geologic CO₂ storage of two million tons per year and a total of at least 50 million tons of CO₂, located right here at Dry Fork Station. This project—referred to as Wyoming CarbonSAFE—possesses favorable technical, economic, and policy attributes to advance the eventual commercialization of large-scale, carbon capture and storage at a modern coal-fired power plant. CEGR is a group of applied geoscientists that explores Wyoming's distinctive geology for energy storage, critical minerals development, CO₂ sequestration, oil and gas recovery and more. CEGR is dedicated to developing these opportunities to diversify Wyoming's economy and to maintain competitiveness in a low-carbon energy future.

The Enhanced Oil Recovery Institute's mission is to facilitate a meaningful and measurable increase in recoverable reserves and production of oil and natural gas in Wyoming. While necessary to help drive the state GDP, CO₂ enhanced oil recovery (EOR) is also a commercial-scale climate change mitigation technology. Historical storage of CO₂ with EOR typically sequestered 0.2 metric

tons of CO₂ per barrel of oil produced. Today, with the current and next generation technologies being tested and applied in Wyoming, up to 0.5 metric tons of CO₂ can be stored per barrel of oil produced. With funding from the Department of Energy, SER, EORI, and CEGR are testing new methods – next generation residual oil zones (ROZ) and next generation EOR storage plus – that could store >0.6 metric tons of CO₂ per barrel of oil produced. These technologies could provide a threefold increase in the amount of CO₂ stored, while producing the same amount of oil.ⁱ

The final ingredient needed to commercialize CCUS and other environmentally focused technologies is the right policy framework. Wyoming has applied for, and should be the second state to receive, Class VI well primacy, allowing the state to implement CCUS projects that are in its interests on a timeline that works for commercial developers. In addition, SER's recently launched Center for Energy Regulatory and Policy Analysis (CERPA) is embarking upon a variety of interdisciplinary energy policy studies to focus on the state of Wyoming's economy. CERPA is poised to begin an assessment of Wyoming House Bill 200, which established a nation-leading CCUS standard for electricity generation. The legislation will be implemented by the Wyoming Public Service Commission in the years ahead. Among other CCUS-related activities, CEPRA is

also preparing model CCUS project agreements for the Wyoming CarbonSAFE project.

In summary, while we face many challenges in the global energy sector and with widespread deployment of CCUS, Wyoming stands ready to help and has the necessary tools to make CCUS and other energy technologies a commercial reality.

ⁱ “Establishing a Business Case for CO₂-EOR with Storage”, Wyoming Oil and Gas Fair 2018, Michael Godec, Advanced Resources International, Inc.