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Before the Senate Committee on Environment and Public Works
July 27, 2022

Good morning, Chairman Carper, Ranking Member Capito, and members of the committee. My name is John Harju, and I am the Vice President for Strategic Partnerships at the University of North Dakota's (UND's) Energy & Environmental Research Center (EERC). Thank you for the invitation to provide testimony concerning current challenges and opportunities in deploying carbon capture utilization and storage (CCUS).

The EERC is a business unit of UND focused on practical solutions to our world's vexing energy and environmental challenges. The EERC was initially founded in 1951 as the Robertson Lignite Research Laboratory under the U.S. Bureau of Mines. With the creation of the U.S. Department of Energy (DOE) in 1977, we became one of the nation's five energy technology centers and have been part of UND since 1983. The EERC's mission has evolved considerably since that time, from a mission focused exclusively on the utilization of the low-rank coals that predominate our nation's resources west of the Mississippi River to a mission that focuses on all fossil fuels, as well as renewable and alternative fuels, and on attendant environmental challenges associated with their development and utilization.

As global population continues to grow and nations with underdeveloped economies strive to improve their citizens' quality of life, the need for reliable, affordable energy will only grow. In addition to this demand, recent international events have highlighted the importance of energy security and reliability to the

United States and its allies. Meanwhile, there is also a societal call for dramatic reductions in carbon intensity as a means of mitigating climate change. Given the limited ability of renewables alone to meet energy demand in the coming decades, continued use of fossil fuels will be needed to maintain our current standard of living. The only way to meet the demand for more energy and lower carbon intensity is with an "all-of-the-above" energy strategy with a mix of sources, including coal, oil, natural gas, nuclear, and renewables such as wind and solar. CCUS is a critical and versatile technology in any meaningful attempt to mitigate carbon accumulation in the atmosphere and reduce the carbon intensity of the American economy. CCUS works in many contexts, including fossil fuel applications, direct air capture (DAC), hydrogen and ammonia production, as well as industries such as cement, steel, and agricultural production.

In the arena of CCUS, the EERC has had the privilege of serving not only DOE, but also more than 200 nonfederal partners across the entire CCUS value chain. With support and guidance from DOE and these partners, the EERC has conducted projects focused on CO_2 capture and geologic storage. These projects range from reconnaissance-level assessments to field validation of geologic CO_2 storage, as well as laboratory and pilot-scale testing of capture technologies and field campaigns evaluating the performance of full-scale commercial CCUS implementation. These tests have ranged in size from pilot-scale tests involving the capture or injection of hundreds of tonnes of CO_2 to commercial-scale operations involving millions of tonnes of CO_2. And each of these field experiments and commercial-scale operations has added to the wealth of knowledge regarding the full life cycle of a CCUS project, from permitting, to construction, to operation, to site closure. These projects were made possible

because of ongoing, robust financial support via DOE's Fossil Energy and Carbon Management Program and our 200+ partners.

To provide further background on the EERC's CCUS experience, in 2003 DOE released a solicitation for the establishment of a series of Regional Carbon Sequestration Partnerships to develop an inventory of our nation's major stationary CO_2 emission sources, as well as regional storage reservoirs, or "sinks." My team at the EERC was fortunate enough to be selected as one of the original seven partnerships in a region that ultimately spanned all or part of ten U.S. states and four Canadian provinces, which we refer to as the Plains CO_2 Reduction Partnership, or PCOR Partnership. In 2019, the EERC was awarded funding from DOE to continue the PCOR Partnership, with the goal of using the knowledge and experience gained over the previous two decades to address current challenges and accelerate commercial CCUS deployment.

What has become apparent over the course of PCOR Partnership activities is that while our region has astounding potential for geologic CO_2 storage, our region's emissions are inextricably linked to our economic bases—from the mining, manufacturing, and industrial centers around the Great Lakes and Mississippi River Valley; to the agribusinesses of Iowa, Minnesota, Nebraska, and the Dakotas; and to the oil-, gas-, and coal-producing regions of North Dakota, Wyoming, Montana, Alaska, and the Canadian provinces. Each of these distinct areas has an economic engine, and each of those economic engines represent the primary emission of CO_2. What also became apparent was that engaging key stakeholders within each of those economic bases creates significant opportunity to accelerate development of CCUS technologies and deploy them commercially.

With that as a backdrop, we set out to find and develop economically motivated carbon management opportunities.

Today's economic drivers such as 45Q tax credits and low-carbon fuel markets have created business cases that are driving unprecedented interest in the PCOR Partnership's CCUS knowledge base and spurring the implementation of the region's first commercial CCUS projects.

However, the emergence of these economic drivers is only one side of the equation for accelerating CCUS deployment. Comprehensive rules regarding legal aspects such as pore space ownership and long-term liability, as well as clearly defined communication pathways and the ability to directly interact with regulators, are key tools in facilitating rapid commercial deployment. These tools become readily available when a state has primary enforcement authority (or "primacy") over CO_2 injection and storage. Efforts of the PCOR Partnership, in conjunction with numerous additional stakeholders, supported North Dakota's development of comprehensive geologic storage rules for CO_2, ultimately leading to North Dakota being the first state to be granted primacy for the U.S. Environmental Protection Agency's (EPA's) Class VI Program. As of today, North Dakota and Wyoming remain the only states with this primacy. The value of state primacy is evidenced by the number of calls the EERC gets from state agencies, both in and outside of the PCOR Partnership region, asking for help and guidance as they consider the prospect of applying to EPA for Class VI primacy. These states include Texas, Alaska, Utah, Colorado, Louisiana, Nebraska, Montana, and Kansas.

I can testify that commercialization of CCUS is beginning. Nowhere is this more evident than in the PCOR Partnership region. Real-world examples of the

region's emerging CCUS industry are numerous. Red Trail Energy, an ethanol production facility in Richardton, North Dakota, began commercially injecting CO_2 for storage in June of this year, with a goal of injecting 180,000 tonnes a year over 20 years. Summit Carbon Solutions has publicly announced plans to capture approximately 10 million tonnes of CO_2 per year from over 30 ethanol plants located in multiple states in our region and transport it via pipeline to North Dakota for geologic storage. Minnkota Power Cooperative has secured a CO_2 storage facility permit to allow CO_2 from a coal-fired electric generating facility to be geologically stored in central North Dakota. In Wyoming, Basin Electric Power Cooperative has been working with the University of Wyoming and the EERC to determine the feasibility of applying CCUS to Dry Fork Station, a coal-fired power plant near Gillette, Wyoming. Finally, Denbury Resources' recent initiation of enhanced oil recovery operations in North Dakota promises the production of expanded amounts of lower carbon domestic oil, due to the concurrent storage of industrially sourced CO_2 that is injected during its production. Denbury estimates that more industrially sourced CO_2 will be stored over the life of this project than will be emitted from its operations and from the oil that is produced. All of these companies have been financial supporters of the EERC's PCOR Partnership and have been critical collaborators in helping lead us toward a world with abundant, affordable, reliable, secure, domestically sourced energy with the lowest possible carbon footprint.

It is important to note that an essential component of these projects, and the CCUS industry as a whole, is transporting the CO_2 from where it is captured to where it is stored. A pipeline is the most efficient way to do this. Pipelines for CO_2 have been operating in the United States since the 1970s. They have been shown

to be safe, posing manageable risk, with an established legal and regulatory framework for construction and operation at both state and federal levels. Given their importance to developing a nationwide CCUS industry, pipelines should be treated fairly in the greater context of carbon management and permitting.

Historically, Congress has been a staunch supporter of research and development programs focused on CCUS. We see the fruit of this support in the emergence of a nascent commercial CCUS industry. While this success is encouraging, challenges remain. A few, but not all, of these challenges include the high costs of CO_2 capture technology and long-term CO_2 monitoring, orderly development of close-proximity large-scale projects, lack of a clear process for using federal lands for CO_2 storage, and public acceptance. We encourage Congress to maintain a robust level of financial support for CCUS research that includes funding the existing Regional Carbon Sequestration Partnerships, which provide invaluable knowledge centers to our nation.

In terms of the Executive Branch of the Federal Government, we beseech a return to the all-of-the-above energy strategy for the United States, one that recognizes the importance of the environment, through lowering carbon intensity, as well as our economic and national security. We can immediately begin this effort by establishing policies that support developing and deploying commercial CCUS technologies.

None of the outstanding research and development work performed by the EERC would have been possible without the foresight of this key committee, your counterparts on the Energy & Natural Resources Committee and Appropriations Committees, and DOE. With your direction and leadership, I believe that we are

poised to continue our nation's progress toward broad, economically viable carbon management.

Thank you, again, Chairman Carper, Ranking Member Capito, and members of the committee for your invitation to provide these remarks. I would be happy to answer any questions you might have regarding my testimony and my views on carbon management.