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Written Testimony of Brian J. Anderson to the Senate Committee on Energy and Natural Resources' Subcommittee on Energy

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Chair Gardner, Ranking Member Manchin and members of the Subcommittee, thank you for the opportunity to offer relevant testimony and to answer your questions in my areas of experience and expertise.

I am the Director of the WVU Energy Institute at West Virginia University in Morgantown, West Virginia. The WVU Energy Institute is the central organization on the West Virginia University campus with a mission to coordinate cross- and multi-disciplinary research across our 14 schools and colleges in energy as well as working with the state of West Virginia to stimulate economic development while utilizing our energy resources responsibly. The West Virginia University Energy Institute has 167 affiliate faculty members across many different areas of research in the university. In addition to my role as director, I am the GE Plastics Materials Engineering Professor of Chemical Engineering and have 17 years of energy research experience primarily in chemical engineering and in subsurface science as related to CO_2 sequestration, natural gas hydrates, unconventional gas production, and geothermal energy.

West Virginia University is a public, land-grant, research-intensive university founded in 1867. It is designated an "R1" Research University (Very High Research Activity) by the Carnegie Foundation for the Advancement of Teaching; funding for sponsored research programs exceeds $170 million. The Morgantown campus houses the West Virginia University Energy Institute, the National Research Center for Coal and Energy, and the Center for Alternative Fuels, Engines and Emissions which discovered the Volkswagen diesel engine emissions software installation that allowed its diesel engines, in test mode, to meet emissions compliance standards, but to operate out of compliance when not in test mode.

The university has active and ongoing research related to operating improvements on existing coal-fired power generation, the recovery of rare earth elements from coal wastes, instrumentation and sensor development to accurately measure fugitive emissions from shale gas wells, analysis of sub-surface geological structures and their applicability to store gas liquids, store carbon or produce gas. The university also has developed sophisticated software and algorithms that can model complex fossil fuel combustion systems, as well as complex electric transmission grids responding to variable generation from intermittent sources like solar and wind. In the renewable space, we are a leader in biomass as well as geothermal and in energy storage to enable renewable energy technologies into the grid.

Additionally, the U.S.-China Clean Energy Research Center Advanced Coal Technology Consortium (CERC-ACTC) is based in the WVU Energy Institute at West Virginia University in Morgantown, West Virginia. The consortium is one of five consortia that were created through a bi-lateral Protocol signed in 2009 between the United States Department of Energy and two agencies of the People's Republic of China: the Ministry of Science and Technology and the National Energy Administration. The initial phase of Center's Protocol spanned five years (2011-2015) and in 2015 was extended an additional five years (2016-2020) under the direction of Jim Wood.

Most of our major research initiatives at WVU involve U.S. Department of Energy National Laboratory collaborations. The CERC-ACTC has as national laboratory project partners Lawrence Livermore National

Laboratory, Los Alamos National Laboratory, and the National Energy Technology Laboratory. These lab partners are in addition to a number of private sector and academic institutions in the U.S.

A second project that I do want to draw attention to is called the Marcellus Shale Energy Environment Laboratory. As we know, much of our power sector is shifting to natural gas and there's a lot of natural gas and natural gas liquids being produced from the region in Appalachia. Our Marcellus Shale Energy Environment Laboratory called MSEEL is the world's first transparent well in the sense that all the data collected in terms of its water footprint, its air footprint, noise, light and the full cycle of the production of natural gas from this Marcellus Shale site in Morgantown is open to the public. This is one of the most instrumented wells in the world and we have a full record of all of its emissions through the cycle with the design on reducing emissions during production as well as emissions during transportation and distribution of natural gas. This project is not only funded by the DOE Fossil Energy Program, but the National Energy Technology Laboratory is an active research partner.

In addition to the partnership on CERC-ACTC that includes the National Energy Technology Laboratory, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory, WVU has active relationships with the National Renewable Energy Laboratory (geothermal, biomass, hydroelectric), Brookhaven (catalysis and chemistry), Oak Ridge National Laboratory (manufacturing and materials), Pacific Northwest National Laboratory (gas hydrates, catalysis, materials, and reaction chemistry), and Lawrence Berkeley National Laboratory (gas hydrates, geothermal, and geosciences).

West Virginia University has worked with NETL or its precursor laboratories since 1946 supporting NETL's R&D efforts. In 1946, research came to Morgantown in the form of the Synthesis Gas Branch Experiment Station, exploring coal-gasification research at WVU. WVU has collaborated with the NETL as the Morgantown Energy Center, the Morgantown Energy Technology Center, the Federal Energy Technology Center, and since 1999, the National Energy Technology Center. West Virginia University is currently supporting all five core competency research directorates: Computational Science and Engineering, Energy Conversion Engineering, Materials Engineering and Manufacturing, Geological and Environmental Systems, and Systems Engineering and Analysis. West Virginia University brings expertise to the LRST in many of the programmatic areas including: Rare Earth Elements, Energy Systems, Carbon Capture, Carbon Storage, Natural Gas Resources, Methane Hydrates, EOR, and Natural Gas Infrastructure.

For the better part of the last decade, WVU has, through the on-site Research and Engineering Services (RES) contract, been a part of the NETL-Regional University Alliance (RUA). This vehicle provided a formal mechanism for direct collaboration on-site between the member universities (West Virginia University, University of Pittsburgh, Carnegie Mellon University, Penn State University, and Virginia Tech) and the NETL. Many of my own students have completed the bulk of their PhD dissertation work at or in direct collaboration with the NETL. Not only does this provide a broad and talented research workforce at the fingertips of the NETL, but has directly resulted in a number of R&D 100 awards and commercial technologies.

Generally, innovation ecosystems often include innovation clusters at the scale of a metropolitan area from a core group of research universities or companies. These innovation clusters are typically driven by the interaction of early stage technology ideas or firms with financing and related companies in a geographically concentrated area that has an enabling environment (e.g. supportive state policies and market pull). Geographic proximity encourages rapid commercialization through increased

communication and collaboration among the organizations. The DOE National Laboratories act as not only a convening party but a catalyst and a hub for innovation ecosystems across the United States.

I sincerely thank the committee for their time and attention today and for allowing me to speak about West Virginia University's experience with the National Laboratories and their role in fostering innovation.

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