Dr. Glen Richard Murrell
Executive Director
Wyoming Energy Authority

TESTIMONY OF DR. GLEN RICHARD MURRELL

EXECUTIVE DIRECTOR OF THE WYOMING ENERGY AUTHORITY

BEFORE THE

U.S. SENATE ENERGY AND NATURAL RESOURCES COMMITTEE

ON

Opportunities and Challenges in Using Clean Hydrogen in the Transportation, Utility, Industrial, Commercial, and Residential Sectors.

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Chairman Manchin, Ranking Member Barrasso, and Members of the Committee thank you for the opportunity to testify today on this important topic.

My name is Dr. Glen Murrell, and I am the Executive Director of the Wyoming Energy Authority (WEA). The WEA plays a key role in strategically positioning the energy economy of Wyoming for the future, and with Wyoming having one of the largest energy economies in the nation I feel confident, though humble, in believing that my comments today may represent the sentiments of many other energy producing states. In this context, I feel privileged to be here today to talk about Hydrogen and the role it can play in securing and sustaining the energy economy of Wyoming, and by extension, that of the nation.

Mr. Chairman, energy production has played a long and important role in the Wyoming economy. For the last 100 years or so, Wyoming's energy production has contributed to the standard of living and well-being of not only Wyomingites but literally hundreds of millions of Americans. Wyoming produces ~14 times as much energy as it consumes, meaning that we export over 90% of what we produce. As a state, Wyoming is ranked third in total energy production[1]. It also has one of the most diverse energy mixes in the country. We are blessed with an abundance of natural resources including coal, oil, natural gas, wind, solar and uranium. This diversity is reflected in our energy exports: our largest geo-commodity market is natural gas to California, while our second-largest market is coal to Texas. As you all might imagine, those are two very different markets on opposite sides of the consumer spectrum. However, the one thing common to both – and in fact with every energy market that Wyoming exports energy to – is a prevailing

[1] U.S. Energy Information Administration, 2022. Wyoming State Profile and Energy Estimates. https://www.eia.gov/state/?sid=WY

and increasing demand for low-emissions energy. This sentiment is also growing among consumers in Wyoming.

This creates an immense opportunity and a challenge for Wyoming. It is an opportunity to meet Governor Gordon's ambition to lower the carbon footprint of our energy, increase our export of Responsibly Sourced Gas, showcase our emissions-free energy sources such as our wind and solar, and promote advanced reactors and the resurgence of nuclear power.

But it is a clear challenge for our hydrocarbon resources and requires that we develop and deploy technologies that allow us to continue utilizing those resources while delivering energy in a decarbonized form. As we address the very real problem of rising carbon emissions it is important to remember that it is not the *source of energy* that is the problem – but rather, its emission profile.

Early last year, we summarized the evolving energy economy in our Wyoming Energy Strategy, which includes a primary objective of continuing to power the nation with an all-of-the-above net-zero energy mix. Above all, the Wyoming Energy Strategy is a vision to transform a hydrocarbon-based energy economy in such a way as to remain relevant and sustainable in a decarbonized future.

The reality of changing consumer demands has not come as a surprise to us in Wyoming. On the contrary, our deep energy expertise keeps us committed to providing decarbonized solutions for the 21st Century. For one, we have been pursuing advancements in Carbon Capture Utilization and Storage for many years. The commercialization and deployment of CCUS continue to be the highest priority objectives we have as a state, and it is a technology we can and must deploy at scale immediately. In the past, our CCUS efforts have been predominantly focused on application to thermal coal plants. Looking forward we are pursuing a broader application to incorporate applications that include Hydrogen.

Why Hydrogen is important for Wyoming, other energy states and the nation

I will not speak today on the details of Hydrogen production as I am sure my co-panelists will cover that in significantly more detail. I would like, however, to point out a few key characteristics that make the potential development of the Hydrogen economy crucial to Wyoming's future and the future of the nation's energy system.

Hydrogen is, like electricity, an energy carrier. According to the Energy Information Agency, energy carriers allow the transport of energy in a usable form from one place to another – and must be produced from another substance. Hydrogen can be produced in broadly two ways: one, a thermal process that breaks up hydrocarbon molecules, and

secondly, an electrochemical process that splits a water molecule. What brings us here today is the key point that both processes can result in the production of Hydrogen with low or zero-carbon emissions. This characteristic creates multiple opportunities for Wyoming, and other energy producing states, to move forward into a decarbonized future. For example, Wyoming has the lowest emissions related to oil and gas production in the nation[2] and Hydrogen produced with natural gas coupled with high CCUS rates, represents at first glance an opportunity to convert the hydrocarbon resource to another decarbonized form and preserve its relevance and utility to consumer markets. Furthermore, an established decarbonized hydrogen system could be used to lower the carbon emissions of our existing thermal fleet by co-firing coal or natural gas thermal plants with ammonia or it could even be used to produce synthetic net-zero petrochemicals.

A second key point is that hydrogen can exist in different forms. Pure Hydrogen is a gas but it can also be condensed and liquefied. It can be also chemically transformed to a liquid form as Ammonia, or even to a solid form as Urea. This flexibility provides for flow-on benefits associated with transportation and use. Firstly, it provides multiple different options for transportation via pipeline, rail, road, or maritime methods. Secondly, it also presents multiple utilization options and can be used as a transportation fuel, a source of heat, or as a component of an industrial process.

Why is this important? Wyoming is a massive exporter of energy. But our exports have a very low value associated with them. Wyoming's energy economy is based on the simple value chain of 'extract-transport-consume', with little opportunity for value-added processing or consumption within the state. Incorporating Hydrogen into the energy system allows the energy economy multiple opportunities to preserve the value of the raw resource but also add value. One option is to upgrade the hydrogen to ammonia, or even green diesel, and open up the opportunity to utilize other transport modes and access other markets. Using Hydrogen as the energy carrier, instead of electricity, would provide alternative storage and delivery methods for renewable resources. This would contribute to grid resiliency and negate the need to build out more transmission lines. In short, this is not just about hydrogen and nor is it just about Wyoming repeating the successes of our past by producing abundant amounts of energy for consumption elsewhere. Hydrogen's role as a decarbonized energy carrier with unprecedented transportation and consumption utility makes it a truly a transformational opportunity for the entire state's economy, and by extension the nation's.

[2] Diana Burns and Emily Grubert 2021 Environ. Res. Lett. 16 044059

Why Wyoming is important for Hydrogen and emblematic of other energy states.

With our abundant coal, natural gas, wind and solar resources, Wyoming is home to as much as 25% of the nation's naturally existing commodity and energy feedstock for the production of Hydrogen[3]. Wyoming is also geographically well-positioned to access multiple markets from the West Coast to the Denver metropolitan area and greater Mountain West Region, to the Midwest. Wyoming also has extensive existing infrastructure including pipelines, rail and interstate to reach those markets. The I-80 corridor in southern Wyoming, where most of the Hydrogen production opportunity is located, also hosts one of the most important trans-continental transportation corridors in the nation, providing a critical inter-state commerce and commodity transportation connection.

With one of the most well-established carbon management infrastructure systems in the world, backed up by proactive state policy and regulatory frameworks including class VI primacy, Wyoming is a dedicated partner within the energy sector. Between our natural resources, the business-friendly environment and Wyoming's strategic vision, there has been a groundswell of interest in the pursuit of Hydrogen development. These innovative and creative projects reflect Wyoming's all-of-the-above strategy and include everything from natural gas to hydrogen and wind-power to hydrogen approaches. These developers have been welcomed by the state and I am proud to say that the WEA has approved more than $5.5 million in cost-share support for several of them. Today we are working with Tallgrass Energy on advanced reforming technologies in partnership with the US Department of Energy. We also have projects ongoing with North Shore Energy on natural gas to ammonia conversion, Black Hills Energy on co-firing turbines with natural gas-hydrogen blends and sourcing Hydrogen from renewable energy, Jonah Energy on synthetic natural gas production and Williams Companies on pipeline transportation of Hydrogen and water source compatibility.

Beyond our borders, we have been proactive and seeking to partner with other states in the mountain west region to pursue a regional hub approach. This includes Utah, Colorado and New Mexico. These discussions have been fruitful and demonstrate a mutual interest in the demonstration and growth of clean hydrogen production, transport and utilization, with a shared interest in addressing the three-part problem of reconciling a robust economy, with a resilient energy system and a healthy environment. The

[3] Milbrandt, A., Mann, Margaret, M. 2009, Hydrogen Resource Assessment: Hydrogen Potential from Coal, Natural Gas, Nuclear, and Hydro Power, Technical Report NREL/TP=560-42773.

potential of the area was recently highlighted in an analysis conducted by the Great Plains Institute[4]. I look forward to the formalization of this vision in the near future.

The 2021 Infrastructure Investment and Jobs Act contains numerous opportunities for Wyoming across different economic sectors. The program most relevant to today's testimony is the Clean Hydrogen Hub program. As mentioned, Wyoming's unique combination of characteristics makes the state a prime candidate for the development of such a hub. We will certainly be submitting an application, likely in partnership with our neighboring states.

Wyoming's leadership, including Ranking Member Barrasso, has been working for years to pursue opportunities that would provide growth, sustainability and resiliency. A successful application to the Clean Hydrogen Hub program would be nothing short of transformative for the State of Wyoming and its citizens. It would preserve existing jobs by providing prospects for currently impacted workers in the oil, gas and mining industries and provide growth and long-term jobs for our renewable sector. It would also help to secure the future of industry partners who have been struggling for years as the energy economy moves toward a decarbonized future. The positive impact of a successful build out of Hydrogen infrastructure on jobs and the energy sector would be mirrored in many other energy states.

The benefits of a Clean Hydrogen Hub extend beyond our borders. The establishment of hydrogen production would directly benefit the consumers in the two nearest high population centers of Denver and Salt Lake City, and help both Colorado and Utah achieve their own low emissions targets. Utilizing the existing infrastructure would benefit communities even further afield – on the West Coast – in the same way. Building hydrogen infrastructure along the I-80 corridor could lead to the creation of a critical component in a trans-continental hydrogen system.

In summary, Mr. Chairman, Wyoming should be front and center of any discussion regarding the development of Clean Hydrogen Hubs, not just for the benefits it would provide to the citizens of Wyoming but the benefits it would bestow on millions of Americans across the county.

[4] Great Plains Institute, 2022 An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization. https://carboncaptureready.betterenergy.org/analysis/