Non-Electric Applications of Nuclear Energy

Shannon Bragg-Sitton, Ph.D.

Director, Integrated Energy and Storage Systems Division
Energy & Environment Science & Technology Directorate
Idaho National Laboratory

Good morning. I want to thank Chairman Manchin and Ranking Member Barrasso for scheduling this important hearing and the opportunity to participate.

My name is Shannon Bragg-Sitton, and I am the Director of the Integrated Energy and Storage Systems Division at Idaho National Laboratory. INL is the nation's center for nuclear energy research and development.

The Biden administration has committed to full decarbonization of the U.S. electricity grid by 2035 and economy-wide net zero emissions by 2050. These aggressive goals demand immediate action if we are to be successful, and they require us to think more holistically about our clean energy options. A variety of low- or zero-carbon technologies can be employed in various combinations to meet energy demand, particularly in the electricity sector.

Renewable energy technologies are being deployed in significant numbers around the world in response to the desire to reduce emissions, coupled with decreasing costs for these technologies. Despite this growth, data compiled in the May 2019 International Energy Agency (IEA) *Nuclear Power in a Clean Energy System* report[1] indicates that the fraction of clean energy contributions to electricity generation has not changed over the last 20 years. This unexpected trend results from the premature shutdown of large-scale, non-emitting generators, such as nuclear power plants, in some regions in response to the pressures created by historically low-cost renewable generation sources, alongside the low cost and high availability of natural gas. These combined factors have driven down the price of electricity and decreased the minimum baseload generation required to meet load at certain times of the day or year.

Many nuclear plants have responded to increasing volatility in net electricity demand by operating flexibly, reducing power output to reduce the financial impact to the plant from very low or negative market prices. This practice preserves the contribution of nuclear energy to grid stability and reduces economic losses associated with negatively priced electricity sales, but it does not reduce plant operating costs. Nuclear energy is a proven, low-emission option that can provide consistent, dispatchable power to meet electricity demands while also providing high-quality heat that can meet energy demands beyond the electricity sector. Energy system design should seek to maximize these assets. Several recent studies indicate that without

---

[1] International Energy Agency, *Nuclear Power in a Clean Energy System*, May 2019, https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system.

contributions from nuclear, the cost of achieving deep decarbonization targets increases significantly.[2]

As the nation's nuclear laboratory, INL works with industry to develop and deploy the non-emitting, advanced nuclear reactors that will power American prosperity into the future. INL also leads DOE's Light Water Reactor Sustainability program, which is working to extend the operating lifetime of America's high-performing nuclear fleet. A major emphasis for both currently operating plants and new, advanced nuclear plants is expanding nuclear energy's use beyond electricity generation.

Integrated energy systems refer to power plants that can leverage multiple energy sources to meet a variety of energy demands.[3] These systems can provide many benefits, including:

- The ability to couple diverse energy sources, such as nuclear, renewable, and fossil with carbon capture, allowing us to leverage the benefits of each source.
- More efficient energy use, which helps the environment while keeping consumer costs down.
- Increased revenues for plant owners by providing multiple product streams.
- Potential for cleaner, lower cost, and more efficient transportation and industrial applications.

Integrated systems will enhance power grid reliability and resilience, and they will help stabilize the grid through their increasingly flexible operation.

Traditionally, electricity generation and management, and then meeting energy demands for industry and transportation, are considered independently. As we seek to achieve net-zero carbon emissions, we need to pause and reassess our energy demands. When we consider overall energy use, only one-third is in the form of electricity. Additional energy demands are in the form of heat or steam for industrial processes, as well as transportation. These sectors are much harder to abate, and electrification may not be the best option. The primary output from a nuclear plant is heat, and we should leverage that heat effectively as we seek to decarbonize industry and the primarily fossil-fuel dependent transportation sector. The non-grid applications of non-emitting nuclear energy are vast, including, but not limited to:

- Seawater or brackish water desalination;
- Clean hydrogen production via water and steam electrolysis;
- Synthetic fuel production for transportation systems;

---

[2] For example, Massachusetts Institute of Technology, *The Future of Nuclear Energy in a Carbon-Constrained World*, 2018, https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf.

[3] Integrated Energy Systems Program, DOE Office of Nuclear Energy, program website, https://ies.inl.gov/SitePages/Home.aspx.

- Production of heat and hydrogen for industrial processes, such as steel manufacturing; and
- Fertilizer production for the agricultural sector.

This is not just theoretical. We are currently partnering with the private sector on important projects to demonstrate how existing nuclear power plants can use excess heat and electricity that aren't needed by the grid to produce hydrogen without emissions.

Today, hydrogen is produced by breaking down methane, which produces C02. Using non-emitting nuclear energy to produce hydrogen from water could result in enormous emissions savings across multiple industries.

These demonstration projects are important contributors to DOE's Earthshot Initiative, which aims to significantly reduce the cost of clean hydrogen over the next decade, decarbonize the industrial sector, and realize a net-zero economy by 2050.

INL is partnering with a tri-utility consortium that will first demonstrate clean hydrogen production at the Energy Harbor Davis-Besse Nuclear Power Station in Ohio using water electrolysis.[4] This work will be followed by demonstration of steam electrolysis at an Xcel Energy plant in Minnesota.[5] The recently awarded third phase in the utility consortium will demonstrate larger-scale hydrogen production at the Palo Verde Generating Station in Arizona, in collaboration with Arizona Public Service.[6]

INL, the National Renewable Energy Laboratory, and Argonne National Laboratory are also working with Exelon Generation on a hydrogen demonstration project at its Nine Mile Point Nuclear Station in New York.[7]

And these projects will produce hydrogen within the next year. These efforts will enhance grid stability and create an additional revenue stream for nuclear plant owners and operators. This is important because the financial pressures on our existing fleet are increasing, as evidenced by recent plant closures and with more closures being scheduled for the near future.

---

[4] Energy Harbor begins hydrogen fuel project at Davis-Besse, *Crain's Akron Business*, October 19, 2021, https://www.crainscleveland.com/energy-and-environment/energy-harbor-begins-hydrogen-fuel-project-davis-besse.

[5] Xcel Energy, INL to use nuclear energy for clean hydrogen production, *Green Car Congress*, December 13, 2020, https://www.greencarcongress.com/2020/12/20201213-xcel.html.

[6] S. Patel, Power-to-Power Hydrogen Demonstration Involving Largest U.S. Nuclear Plant Gets Federal Funding, *Power*, October 14, 2021, https://www.powermag.com/power-to-power-hydrogen-demonstration-involving-largest-u-s-nuclear-plant-gets-federal-funding/.

[7] Exelon to build hydrogen electrolyser at New York nuclear plant, *Power Engineering International*, August 23, 2021, https://www.powerengineeringint.com/hydrogen/exelon-to-build-hydrogen-electrolyser-at-new-york-nuclear-plant/.

Because traditional nuclear power plants operate 24/7, they are impacted by negative power prices, which occur when generation appears simultaneously with reduced electricity demand – something that is becoming more prevalent with increased deployment of variable renewables.

Hydrogen production will enable these plants to become more profitable as they continue to produce 20% of our nation's electricity, representing more than half of America's carbon-free electricity, while contributing roughly $600 billion annually to our economy. The hydrogen produced will also support decarbonization of the industrial and transportation sectors, which will be critical to achieving our nation's net-zero goals.

I also want to thank this committee for your support of legislation that enables research and development of Integrated Energy Systems and hydrogen. The Energy Act that was enacted at the end of last Congress established an Integrated Energy Systems program within the U.S. Department of Energy, which will be a vital part of achieving our decarbonization goals. I appreciate the bipartisan support for collaborative efforts in this area, including Idaho National Laboratory's work with the other applied energy laboratories, such as the National Energy Technology Laboratory and the National Renewable Energy Laboratory, as well as other DOE labs.

Finally, I want to emphasize that integrated systems research is not just focused on the current fleet.

Advanced nuclear reactors in development today – and scheduled for deployment within the next decade – are designed to operate at higher temperatures, run more efficiently, and provide greater flexibility. Working in concert with renewables such as solar and wind, these advanced reactors can power microgrids in isolated communities, supply heat and electricity to remote mining operations, help produce synthetic fuels, and so much more.

All of this is vital to our nation's economy and environment as we develop technologies that create clean energy jobs, reduce land use and the impact on air and water, promote energy independence, and increase our nation's economic competitiveness. As we consider our future energy systems, we need to think more broadly and more collaboratively than our current experience about how each of these resources might support growing energy demands. Separating the electric sector from other energy demands may cause us to miss the truly elegant solution of using multiple clean generation sources collectively to support multiple demands simultaneously.

I truly believe that integrated energy systems based on clean energy options have nearly limitless potential. Through vigorous R&D, robust industry involvement, and bipartisan support at all levels of government, we can revitalize American communities, reinvigorate domestic manufacturing with clean energy, and reinvent industrial and transportation processes.

Thank you again for the opportunity to testify before the committee. I look forward to answering any questions you may have.