Testimony of Nuclear Energy Institute
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Subcommittee Chairman Cleaver, Subcommittee Ranking Member Stivers, and Distinguished Colleagues, it is an honor to participate in this hearing of your Subcommittee on National Security, International Development, and Monetary Policy. The Nuclear Energy Institute (NEI) appreciates the opportunity to provide testimony on the importance of nuclear energy in addressing climate change, in the nation's electricity portfolio, and in national security.

I currently serve as Vice President for Policy Development and Public Affairs for NEI, where I work to raise awareness of the role nuclear energy plays in slowing the changes to our climate by reducing the emission of carbon dioxide and other greenhouse gases from electricity production. Before joining NEI, I ran the U.S. Department of Energy's Office of Nuclear Energy from mid-2015 to early 2017. Prior to that I served in a variety of capacities in the U.S. Department of Energy, at Argonne National Laboratory, as a consultant and as a Congressional fellow.

The Role of Nuclear Power in the United States

Our nuclear power plants represent a vital resource for the nation. Nuclear power provides almost one-fifth of U.S. electricity and is the source of more than half of the nation's carbon-free electricity generation. Nuclear plants are by far the most resilient component of our nation's electrical grid, as has been proven in extreme weather events in the last few years. They provide the highest capacity factors of any generation source, averaging 92.6% in 2018. As DOE Secretary Perry said recently, "I don't know how anybody who cares about the climate can't be for nuclear energy."

When the 18-24-month fuel supply on-site at a nuclear plant is contrasted with the need for continued shipment of coal, operation of gas pipelines to run fossil fuel plants, or dependence on intermittent wind and solar resources, the vital role of nuclear power plants in resilience of the grid is clear. The high capacity factors for nuclear plants provide superb reliability and give confidence to consumers that the plants will be providing power when they need it. They also contributed over $2B in state taxes and about $10B in federal taxes. The broader nuclear energy sector in the U.S. supports about 475,000 jobs. Estimates are that the nation's nuclear power plants add about $60B to the nation's GDP.

Nuclear power demonstrates impressive economics. In 2018, the average generation cost for U.S. nuclear power plants was about 3.2 cents per kWh. That figure results from a continued focus on improved economics. For example, by comparison, in 2012 the average cost for U.S.

nuclear power was 4.2 cents per kWh. Note that individual plant costs are distributed around the average. Smaller and single-unit plants may experience higher than average costs.

While further economies are being sought, the situation remains complicated by the very low generation costs for natural gas and by the fact that intermittent solar and wind operate with zero fuel cost, solar construction costs are reduced by federal investment tax credits, and wind farms (and some solar installations) earn federal production tax credits whenever they operate. In many states, wind and solar also benefit from Renewable Portfolio Standards that exclude nuclear energy. The federal and state incentives provided to solar and wind mean that they can profitably run even when their abundance in some locations and at some times of the day leads to negative electricity prices. But since consumers need electricity when the sun and wind do not cooperate, other sources of power must be standing by to provide power as needed.

Role of Nuclear in Decarbonization Scenarios

As broader carbon reduction goals have been brought to the forefront by the IPCC report, a growing series of analyses have called for the inclusion of nuclear in the portfolio of energy technologies. Noted climate scientist, Dr. James Hansen has noted that "Nuclear will make the difference between the world missing crucial climate targets or achieving them." And in May, the International Energy Agency noted that "A range of technologies, including nuclear will be needed for clean energy transitions around the world." Their report also called for an 80% increase in global nuclear power production by 2040.

This realization of the role of nuclear energy in decarbonization represents a shift in academic assessments of the policy framework to reduce emissions.[1] Recent work has emphasized the role that firm, dispatchable nuclear energy can fill in complementing variable sources such as wind and solar.[2] Massachusetts Institute of Technology released a major study[3] that showed including nuclear energy in decarbonization scenarios significantly reduced the cost of energy transition. This finding fit with the conclusions of Jesse Jenkins and Sam Thernstrom whose literature review of academic studies found excluding nuclear increased the cost of decarbonization.[4]

Analysts who have looked at the global evolution needed to address climate change have pointed to the need for nuclear energy. The International Energy Agency calls for an expansion of

[1] Stanford's Mark Jacobson had received great attention for his analyses that showed all energy needs could be met by wind, solar and hydropower (https://www.pnas.org/content/112/49/15060). These findings were refuted by a cadre of researchers that challenged Jacobson's findings (Clack, *et al*: https://www.pnas.org/content/114/26/6722).

[2] Nestor Sepulveda, Jesse Jenkins, Fernando de Sisternes and Richard Lester, "The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation." *Joule*, Volume 2, Issue 11, November 2018. Available at: https://doi.org/10.1016/j.joule.2018.08.006.

3 *The Future of Nuclear Energy in a Carbon-Constrained World: An Interdisciplinary MIT Study*, 2018. Available at: https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf.

[4] Jesse Jenkins. Max Luke and Samuel Thernstrom, "Getting to Zero Carbon Emissions in the Electric Power Sector," *Joule*, Volume 2, Issue 12, December 2018. Available at: https://doi.org/10.1016/j.joule.2018.11.013.

nuclear as part of their 2DS scenario intended to cap warming at 2 degrees C.[5] The OECD's Nuclear Energy Agency has released the latest[6] in a series of reports that estimate the economic burden of increasing reliance on renewables in terms of the costs borne by the rest of the system to integrate variable sources whose generation is concentrated in terms of time and geography (Figure 2). A financial perspective yields a similar conclusion. The analysis done by the Risky Business Project shows that including nuclear energy in the portfolio delivers better results.[7] The cost of deploying a low-carbon energy system was lower with a more diversified portfolio that has nuclear providing a significant portion of electricity than in scenarios that rely heavily on renewables.

We are seeing companies and states committing to carbon-free electricity by 2050 or sooner. As industry leaders and analysts have really begun to grapple with what it will take to get there they have concluded that they can make quite a bit of progress with the renewable technologies available today, but those only get part of the way to these goals and then they have a problem.

Google is already facing the issue.[8] They aspired to run all of their operations with renewables. They drove the development of renewable projects and purchased renewable credits to match with the rest of their load. But when they looked at the electricity they were actually using they found that the renewables-only approach fell short. The places where they came closest were areas that already had nuclear or hydro that were available when renewables weren't.

There is a clear need for firm, dispatchable, carbon-free power. Nuclear energy can fill this role.

Action to Preserve Nuclear Plants

Low prices for natural gas, electricity markets that do not recognize nuclear energy's attributes, and renewable energy mandates and tax incentives have impacted the economics of many nuclear plants. Looking at just the past several years, nine nuclear power reactors will have closed by the end of 2019, eight more have announced plans to close by 2025, and several more are facing severe economic pressures. Some states have enacted mechanisms to recognize the zero-carbon attributes of nuclear energy and avoid plant closures. When nuclear plants have closed, their outputs have been predominantly replaced with natural gas with increased emissions. Loss of nuclear resources is a serious setback for reduced carbon emissions.

State actions to preserve their nuclear plants, while important, are insufficient to preserve our total national nuclear resources – a federal solution is needed. Several studies, such as those done by the Idaho National Laboratory[9] note that while many of the nation's nuclear power units

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[5] International Energy Agency, *Energy Technology Perspectives*, 2017. Available at: https://www.iea.org/etp2017/summary/. Nuclear is specifically assessed: https://www.iea.org/tcep/power/nuclear/.

[6] OECD Nuclear Energy Agency, *The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables*, January 2019. Available at: https://www.oecd-nea.org/ndd/pubs/2019/7299-system-costs.pdf.

[7] Risky Business, *From Risk to Return: Investing in a Clean Energy Economy*, Appendix 1: Model, Methodology, Key Results, p. 22-24. Available at: https://riskybusiness.org/fromrisktoreturn/.

[8] Google, *Moving toward 24x7 Carbon-Free Energy at Google Data Centers: Progress and Insights*, October 2018.

[9] See https://gain.inl.gov/Shared%20Documents/Economics-Nuclear-Fleet.pdf

are not profitable today, their negative margins are fairly modest. These shortfalls could be addressed through a range of policy options if preservation of our nuclear energy assets was appropriately valued by the nation. These options could include production or investment tax credits to better value nuclear generation or a more fundamental approach to create equal treatment for all clean energy sources, such as through a clean energy standard, replacement of renewable energy mandates with clean energy mandates, or some form of price on carbon emissions.

Effective Decarbonization of the Economy

Since the electricity sector emits only about 40% of the total carbon entering the atmosphere, effective decarbonization of our overall energy system must extend far beyond the electricity sector. Thus, carbon emissions must be minimized in all economic sectors. Today, only two energy sources offer zero carbon emissions today, renewables and nuclear energy, and hopefully clean fossil sources may become economic soon.

Our nation can be powered with minimal carbon emissions if we transition across all sectors of the economy to a future with only clean energy sources: renewables, fossil fuels with carbon capture or utilization, and nuclear power. There is a great deal of research, both in this country and abroad, now focused on developing paths that best utilize all these clean energy sources for significant decarbonization of the world's energy requirements.

This research shows that the intermittent character of renewables and the baseload operation of nuclear energy are complementary and can be effectively integrated into clean energy options that impact a range of sectors of the economy, not just electricity. Studies are exploring how these integrated systems can be used in the transportation, industrial, and residential sectors through options like production of hydrogen, provision of process heat for industrial needs, or desalination of water.

One example has moved to deployment in France for clean hydrogen production for "decarbonization of industry and mobility using low-carbon electricity from its nuclear and renewable energy fleet." And, just last month, Exelon and its partners received a grant from the U.S. Department of Energy in response to its proposal to explore the use of nuclear power in hydrogen production. Exelon has stated: "Carbon-free nuclear power is critical to our clean energy future. Just think: One day in Illinois, where nuclear is 90% of the state's clean energy, existing sites could be used to produce clean hydrogen to further combat climate change."

One development of immense significance is that the United States, Japan and Canada founded the Nuclear Innovation Clean Energy (NICE) Future Initiative and introduced the Initiative at the 2018 Clean Energy Ministerial. Many countries have joined the NICE Future. NICE Future goals include "address[ing] improved power system integration ...[by] nuclear-renewable systems, combined ..heat and power, hydrogen production, and industrial decarbonization." This Initiative provides a global framework for decarbonization.

Climate change is a global problem – and if nuclear power is critical to achieving our climate goals in the United States, it is even more vital to the many nations that are expanding their electricity generation capacity. And the United States cannot lead the world toward a low-carbon future without nuclear power. Small and advanced nuclear power technologies, with lower capital cost and smaller generation capacity, could dramatically expand the potential market for nuclear power to nations in Africa, Asia and elsewhere that have never considered developing a large nuclear power plant.

Innovation

Investment is being made in advanced nuclear technologies that promise improvements over the current plants. These designs generally take advantage of physical properties and novel materials to create plants with enhanced safety and operational characteristics. Private companies, including many small startups backed by venture capital, lead the development and commercialization of individual designs, but these efforts are largely supported by federal R&D investments. Direct federal research on cross-cutting scientific questions, often through the national laboratories, as well as funding of public-private partnerships has advanced the state-of-the-art for new reactor designs. In the near-term, small modular reactors could be operational within a decade.

The long timelines to develop nuclear technologies and demonstrate their safety to independent federal regulators have made consistent federal R&D funding an important part of a long-term strategy. Federal investments in developing clean energy technologies, including advanced nuclear designs, need to reflect the urgency of the need to transform the energy system

Innovation must extend beyond the technology developers to the regulators who are tasked with assessing new designs. These new reactor concepts are built upon inherent safety characteristics that should be welcomed by those who seek to ensure public safety. The NRC's expertise, however, is steeped in its deep knowledge of the operating fleet. The successful deployment of these improved designs will require the NRC to modernize how they assess new nuclear technologies. Similarly, the licensing of new designs should efficiently enable their deployment to other nations seeking to deploy non-emitting nuclear energy. Harmonizing international approvals of advanced designs will allow the most modern, most appropriate technologies to reach the markets that need them.

National Security Attributes of Nuclear Energy

The role of nuclear energy in providing reliable, safe, highly resilient, clean power on demand at reasonable costs is of inestimable value to the nation and its security, but it is only one facet of national security to which the nuclear industry contributes.

The national security benefits of our nuclear power plants cannot be understated. I strongly agree with Secretary Perry when he says "Energy security is national security." Certainly, the reliability and resilience contributed by nuclear power to our national grid are fundamental to our energy and national security. But many studies note that our nuclear navy and nuclear weapons

programs are supported by the same infrastructure, including educational institutions, as that of the nation's nuclear power industry. For example, a June 2018 letter to the Secretary of Energy from a group of 77 prominent Americans commended him "for recognizing the important role our civil nuclear energy sector plays in bolstering America's national security," and asked that he "continue to take concrete steps to ensure the national security attributes of U.S. nuclear power plants are properly recognized by policymakers and are valued in U.S. electricity markets." That letter was signed by a host of former leaders: 4 Senators; over 20 top military leaders; several White House officials; a number of Secretaries and other senior leaders from State, Defense, Energy, and Veterans Affairs; two Chairs of the Nuclear Regulatory Commission; 7 directors of national laboratories; and several Ambassadors.

A 2018 Report from the prestigious Center for Strategic and International Studies, "Back from the Brink," discusses the national security implications of a strong domestic nuclear industry. In fact, the sub-title of that Report is "A Threatened Nuclear Energy Industry Compromises National Security." The Report notes that:

- "United States' dominance in nuclear has allowed the U.S. government to … support our naval propulsion program and nuclear weapons program,"
- "our nuclear navy depends heavily on the health of the broader U.S. nuclear energy industry for fuel, technical support, and knowhow," and
- "U.S. Naval reactors rely on a U.S. nuclear fuel cycle, a healthy U.S. nuclear support community, and staying at the cutting edge of nuclear innovation."

The Report discusses how a decline in the commercial nuclear energy industry would undermine our universities' ability to offer the programs needed for other elements of our national security. In addition, many retirees from the nuclear navy look forward to extending their careers in the commercial nuclear industry, and those retirees are typically in great demand by the industry. All these factors are seriously jeopardized if our commercial nuclear industry continues to wither and will seriously complicate the long-term viability of both the nation's nuclear navy and nuclear weapons programs.

Other studies reach the same conclusion. The August 2017 report of the Energy Futures Initiative, whose President and CEO is Dr. Moniz, titled, "The U.S. Nuclear Energy Enterprise; A Key National Security Enabler," stated that:

- "Meeting national security priorities requires a robust nuclear energy industry,"
- "Nuclear power and a robust associated supply chain (equipment, services, people) are intimately connected with U.S. leadership in global nuclear nonproliferation policy and norms and with the nation's nuclear security capabilities." and
- "The U.S. Nuclear Navy relies on a robust domestic nuclear energy supply chain."

In addition, William Ostendorff, now a Distinguished Visiting Professor of National Security at the U.S. Naval Academy (previously a Commissioner of the Nuclear Regulatory Commission,

Principal Deputy Administrator of the National Nuclear Security Administration, and Staff Director of the House Strategic Forces Subcommittee of the House Armed Services Committee) wrote in November 2018: "There is a vital and deep nexus between the health of the U.S. nuclear industry and national security."

The International Trade, National Security and the Export of Nuclear Technologies

In years past, the United States was the unquestioned leader in nuclear energy. Our exports of nuclear power provided the foundations for well over half of the nuclear plants around the world. When U.S. companies exported their designs and expertise, they also exported U.S. standards for nuclear safety, security and nonproliferation. In addition, they created long-term, close to a century, relationships between the U.S. and other nations. Yet today, 2/3 of the nuclear plants under construction are being led by Russia or China.

Russia is, by far, the dominant international builder of nuclear power plants today. China, while currently focused on building their own domestic plants, is beginning to explore significant international opportunities and, with high confidence, international construction of nuclear power plants will be dominated by Russia and China in the foreseeable future unless the U.S. nuclear industry is revitalized. If the U.S. loses its ability to compete on the international market, we cede those markets to Russia and China. At the same time, we will be ceding international leadership on nuclear safety, security and nonproliferation to Russia and China and those countries will build a century-long global dependence on their nuclear energy suppliers. Loss of our domestic nuclear power plants seriously undercuts our international competitiveness with dangerous implications for national security.

Preventing countries like Russia and China from partnering with other countries on civil nuclear energy development must be ranked as a top nuclear security and nonproliferation priority for the United States. To be successful, the United States must recognize the new competitive landscape posed by Russia and China and remedy U.S. policies that are imposing competitive disadvantages on U.S. nuclear energy suppliers.

First, the United States must enable export financing to support U.S. nuclear exports. Export credit agency support is a bid requirement for virtually every nuclear energy tender. Earlier this year, the U.S. Export-Import Bank regained a quorum on its board of directors, enabling it to approve transactions over $10 million for the first time since 2015. This progress will be lost if Congress does not extend the Bank's charter before its expiration at the end of this month. To be competitive against Russian and Chinese nuclear exports, the United States must have a competitive and durable Ex-Im Bank. Additionally, the U.S. Development Finance Corporation should be enabled to support nuclear energy projects.

Second, the United States must have access to international nuclear energy markets. This requires the bilateral negotiation and implementation of framework agreements for civil nuclear cooperation, also known as Section 123 agreements. With the market potential of small and advanced plants, the United States must pursue bilateral engagement earlier and more broadly.

The Department of State's recently adopted policy to seek Nuclear Cooperation MOUs for this purpose should be applauded.

Third, U.S. industry must also be enabled to engage early in markets. This requires reforming U.S. nuclear export controls, which despite recent improvements continue to pose a competitive disadvantage on U.S. suppliers.

To be sure, other nations still have motivations to cooperate with the U.S. on nuclear energy development, including our regulatory system, the excellent operation of nuclear plants, our university system, and the innovation the U.S. is leading on advanced reactor systems. But for nations that simply want to jump-start their journey in nuclear power, they may be far more interested in seeking quick nuclear energy import opportunities and utilizing low cost loans from countries that underwrite their exports.

Conclusion

Thank you again for the opportunity to testify. Nuclear energy can play a significant role in meeting our climate change, energy, national security, international goals. We look forward to working with the Committee to ensure nuclear energy remains a significant contributor to the nation's and the world's clean energy portfolio.