Testimony
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to the
Subcommittee on Energy of the House Science, Space and Technology Committee
Field Hearing
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Chairman Lamb, it is an honor to testify in this field hearing of your Subcommittee on Energy of the House Science, Space, and Technology Committee. I compliment your strong support for Pennsylvania's nuclear plants. I concur in your position and hope my testimony today expands on my rationale.

By way of introduction, my recent government service was as President Obama's Senate-confirmed nominee for the position of Assistant Secretary of the Department of Energy for Nuclear Energy, a position I held for more than four years. Prior to that, I was appointed by President George W. Bush and subsequently nominated by him and Senate-confirmed to serve one five-year term as a Commissioner of the U.S. Nuclear Regulatory Commission. That service followed eight years as Science Advisor to the U.S. Senate Energy and Natural Resources Committee and U.S. Senator Pete Domenici. I also served in many research and management positions at Los Alamos National Laboratory after my 1969 graduation from the California Institute of Technology.

Since my retirement in 2015, I have been active in many activities related to preserving the vital resource represented by the nation's nuclear power plants. I served as co-chairman of the American Nuclear Society's Special Committee on Nuclear in the States. In addition to helping in New York and Illinois, as they were some of the first states to consider development of legislative initiatives to prevent potential nuclear plant closures, the Special Committee published two documents that have been widely cited. One was "The U.S. without Nuclear Energy: A Report on the Public Impact of Plant Closures," and the other was a "Toolkit" designed to provide states with a menu of potential actions that could be taken to protect their nuclear power plants. In addition, I serve on the Advocacy Council of Nuclear Matters. And, more recently, I accepted the role as Co-chairman of the Subcommittee on the Existing Fleet for the U.S. Department of Energy Nuclear Energy Advisory Committee or NEAC. The Subcommittee's report on the sustainability of the existing fleet was accepted as a NEAC document and approved for public release in late March. The "Key Recommendation" of that report was that "Policy changes are necessary to assure survival of the existing fleet of U.S. commercial nuclear plants." Such changes could occur at the state or federal level; either way, they are essential!

When I served at the NRC, we were focused on planning for a potential "nuclear renaissance," a rapid growth in nuclear power that was widely anticipated. Even when I started at the DOE, the magnitude of the impact of low-cost shale gas was not yet appreciated. When fracking began to sharply reduce the prices of natural gas, my first inclination was to remember the past instabilities in those prices and assume they would soon increase. But here in Pennsylvania, you are enjoying a remarkable boom in production of that gas that has proved to be of tremendous economic benefit to your State and the nation. Furthermore, any forecasts for the future price of natural gas reflect its sustained abundance and provide assurance that the price of natural gas will remain very low far into the future.

The low prices for natural gas are one key factor that has impacted profitability of many of the nation's nuclear power plants. That factor and many state mandates for use of intermittent renewable energy, along with federal and state tax benefits for renewables, have also complicated the sustainability of nuclear power in the United States. Today, we have seen several premature nuclear plant closures, long before the end of their licensed operation, and more plants have announced plans to close, including some of the plants in Pennsylvania. The NEAC Report noted that this trend toward early closures, if not arrested, could lead to a point in time when the remaining nuclear plants in the United States view their ability to maintain the requisite infrastructure for nuclear energy as unsustainable. This could precipitate a loss of our entire nuclear power industry. And in every case, here in the United States as well as abroad, when nuclear plants have closed, the use of fossil fuels has increased with a concomitant increase in greenhouse gas emissions.

Our nuclear power plants represent a vital resource for the nation. They are by far the most resilient component of our nation's electrical grid, as has been proven in some of the extreme weather events in the last few years. Pennsylvania has certainly experienced some of these severe events and your former Governor Tom Ridge noted in a 2017 editorial that the polar vortex of 2014 posed a serious threat to Pennsylvania's electrical grid. He stated, "Forty thousand megawatts of forced outages almost plunged the Northeastern and Midwestern United States into darkness." He also wrote in that same editorial that "The goal of grid resilience cannot be met without nuclear power."

Earlier this year, another record cold snap hit Pennsylvania such that electricity demand within this region came within a very few percent of setting a record for electricity demand. Pennsylvania citizens should be most appreciative that in the January 2019 polar vortex, all of Exelon's Pennsylvania nuclear plants operated at full power while wind chill factors went as low as minus 35 Fahrenheit. Former Governor Ridge also noted in April of this year that "Despite the abundance of natural gas from shale deposits that has done so much for the Commonwealth's economy, we still must maintain diverse energy supplies to prevent us from becoming overly dependent on any one source." A related important point is that electricity prices from some sources skyrocket on very cold days, with a recent example topping a 500 percent increase for New England customers, while the cost of generation for nuclear power stays quite constant.

When the 18-24-month fuel supply on-site at a nuclear plant is contrasted with the need for continued shipment of coal or operation of gas pipelines to run fossil fuel plants, the vital role of nuclear power plants in resilience of the grid is beyond question. The high capacity factors for nuclear plants, averaging over 92% across the country in 2018, 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, and the broader nuclear energy sector in the U.S. supports almost 500,000 jobs. Estimates are that the nation's nuclear power plants add about $60B to the nation's GDP.

The carbon-free generation of electricity by nuclear plants is critical as clean air and mitigation of climate change are increasingly valued. In fact, nuclear plants provide more than half of the nation's emissions-free electricity. An interesting statement from Secretary Perry at a conference in March, coming from an Administration that does not agree with the threat of climate change, was: "I don't know how anybody who cares about the climate can't be for nuclear energy."

Pennsylvania's nine nuclear power plants provide about 42% of the State's electricity and provide an extremely high percentage of your clean energy, around 94%. In Pennsylvania, the capacity factors for the State's nuclear plants, averaged over the last three years, exceeded the national average by a significant amount at 96%. There are about 5000 workers in Pennsylvania's nuclear plants, with over 500 Pennsylvania companies supporting the nuclear industry. And the Governor of Pennsylvania has issued an executive order, setting goals to slash the State's emissions by 26% by 2025 and 80 percent by 2050. That won't be accomplished with closure of Pennsylvania's nuclear power plants.

A recent report of The Brattle Group titled "Pennsylvania Nuclear Power Plants' Contribution to the State Economy" noted that: "Absent the energy from these nuclear plants, Pennsylvania would need to rely more heavily on natural gas and coal-fired generating plants, many of which are outside Pennsylvania. Pennsylvania would be transformed from a substantial net exporter of power to an importer." Pennsylvania's bipartisan Nuclear Energy Caucus reported in late 2018 that the state's nuclear plants moderated electricity prices, benefitting Pennsylvania customers by an estimated $788M per year in lower bills. Pennsylvania's nuclear plants pay about $69M in State tax revenues annually. In addition, your universities benefit from and contribute to your commercial nuclear plants. Pennsylvania's educational resources for nuclear power include some of the nation's leading programs. The University of Pennsylvania, University of Pittsburgh, Carnegie-Mellon University, Penn State University, and others provide the State with immense intellectual capacity for nuclear issues, and they will be negatively impacted if Pennsylvania's nuclear plants close.

By any standard, 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. (However, these impressive averages obscure some details, such as higher costs for operating single-unit sites as opposed to multi-unit sites.) 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. The federal tax credits and other policy 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. Obviously, no energy source that purchases its fuel can compete at negative pricing. 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.

The NEAC Report also noted the unfortunate trend, which is also happening in Pennsylvania, that whenever preservation of nuclear power assets is discussed in a state legislature, that preservation is fought by natural gas companies and, all too frequently, also by companies selling renewables. We noted appreciation in the NEAC Report that Secretary of Energy Rick Perry has stated that the grid is too reliant on natural gas and we even suggested that the Secretary be still more vocal in addressing such attacks against nuclear power. There can be no question that a diverse energy supply is of monumental importance to consumers. Any energy sources can experience problems, although nuclear energy is the least likely of any large energy source to experience an interruption, and it is vital that the citizens are protected from any lapses in generation In my opinion, when natural gas and renewable interests argue against nuclear power, they are certainly not arguing in the best interests of the citizens.

Fuel diversity is simply a logical and necessary requirement for a stable grid. Any statement to the contrary is inviting an energy and economic disaster for the country. It is instructive to note that the two most recent Secretaries of Energy have each echoed the need for an "all-of-the-above" energy strategy. Former Secretary Ernest Moniz used this phrase frequently as he discussed the need to strive towards cleaner energy options through a diverse set of sources. And Secretary Perry stated a few months ago that "I don't believe in putting all your eggs in one basket. Right now, the gas industry is a fabulous blessing, and thank God that we have it. But it's the ability to have a resilient grid, a reliable supply of energy, that I think is tantamount to our national security." Former Governor Ridge also addressed fuel diversity in his April 2019 editorial when he stated, "Only an electric grid built on diverse and stable sources of energy can withstand evolving threats … and make sure the lights stay on."

Nevertheless, articles still appear claiming that a 100% renewables future is within our reach. When I see such statements, I can only laugh. No matter what time scale anyone proposes, in my view it is not realistic or possible. For example, when such an article appeared a few years ago, a group of 27 scientists wrote a paper with strong counter arguments. Papers making arguments for 100% renewables claim wonderful contributions from batteries coupled with renewables, but the simple fact is that no battery, available today or in the foreseeable future, could possibly power our grid in an economic way for long periods of time. (Depending on weather patterns, we could easily face days or even weeks without production from renewables!) Secretary Perry recently commented, "Is the money spent on keeping baseload worth it? I think it is." And even if any single source like renewables could theoretically power the country, the loss of fuel diversity should invalidate such speculation.

Many discussions of late have considered the so-called Green New Deal. It's interesting to see how other leaders have changed those words. In an editorial a few months ago, Dr. Moniz emphasized that "a wise and just transition to a low-carbon economy, moving as fast as is technically and socially possible" is needed; he called this a Green Real Deal. And when Secretary Perry spoke recently in Georgia at the construction site for two new nuclear plants, he stated, "Look around you, this is the real new green deal."

In that same editorial, Dr. Moniz recommended "looking hard at advanced nuclear technologies" in the essential transition to clean energy sources. He also emphasized that decarbonization of our overall energy system must extend far beyond the electricity sector, since the electricity sector emits only about 40% of the total carbon entering the atmosphere. There are many studies underway of innovative ways to extend the use of renewables and nuclear energy into the transportation and industrial sectors to help in this decarbonization effort. In that context, I devoted significant effort when I was Assistant Secretary to seek solutions for decarbonization across all energy sectors. Our nation can be powered with minimal carbon emissions if we transition 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.

The NEAC Report, of course, focused on national benefits and, from that perspective, the national security benefits of our nuclear power plants can not be understated. We quoted and strongly agreed with Secretary Perry who stated that "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 the Report also quoted many studies noting that our nuclear navy and nuclear weapons

programs are supported by the infrastructure, including educational institutions, of the nation's nuclear power industry. The Report quoted a June 2018 letter to the Secretary of Energy from a group of 77 prominent Americans commending him "for recognizing the important role our civil nuclear energy sector plays in bolstering America's national security," and asking 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.

The importance of the commercial nuclear energy industry was also recently noted in a report from the Energy Futures Initiative, whose President and CEO is Dr. Moniz. That report, "The U.S. Nuclear Energy Enterprise; A Key National Security Enabler," noted that "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." It also stated that "The U.S. nuclear navy relies on a robust domestic nuclear energy supply chain."

Another important point must be emphasized on the national benefits of the nation's nuclear power plants. In years past, the United States was the unquestioned leader in nuclear energy. Our exports of nuclear power provided the foundations for a large fraction of the nuclear plants around the world. When U.S. companies exported their designs and expertise, they also exported U.S. safety and nonproliferation standards. In addition, they created long-term, close to a century, relationships between the U.S. and other nations. Now Russia is, by far, the dominant international builder of nuclear power plants. 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 safety and nonproliferation to Russia and China and those countries will build a century-long global dependence on their nuclear energy suppliers. Loss of domestic nuclear power plants seriously undercuts our international competitiveness with dangerous implications for national security.

I noted that you, Chairman Lamb, have discussed the possible closure of Pennsylvania nuclear power plants with Secretary Perry. The Secretary last March supported state initiatives to sustain their nuclear plants and has also proposed approaches for federal initiatives to accomplish this end. As I noted earlier, he has stated that the grid is too reliant on natural gas. I might note that the NEAC Report was strongly supportive of a range of federal initiatives that could help to address market failures that are undermining nuclear energy in this country. Such initiatives would sustain our vital nuclear power industry. But the Report also recognized that the only successful such measures to date have been at the state, not federal, level.

In preparing for this testimony, I studied the pioneering roles that Pennsylvania has played in our nation's energy development. I found reports developed by the Pennsylvania Historical and Museum Commission to be most informative. These reports described the wide range of energy sources that have shaped this State's and the nation's history. From the time of the earliest Native Americans in this area, residents have depended on the vast timber resources. In the early colonial days, wind-powered

sailing ships traveled on Lake Erie. Somewhat later, Pennsylvania's coal and charcoal fueled the State's blast furnaces and water-driven mills powered large mills. The first successful commercial oil well was near Titusville in 1859. And I noted interesting reports that long before 1859, as early as 1410, Native Americans were using that same oil for medicinal purposes and that early settlers used it as fuel for lamps. Most recently, your successes with fracking technology have revolutionized production of natural gas such that Pennsylvania is now the country's second largest producer of natural gas.

In nuclear energy, Pennsylvania has figured prominently in two of the technology's most important events, and the decision on pending State legislation to sustain Pennsylvania's nuclear plants may prove to be another such event. As folks here should know well, the era of commercial U.S. nuclear power began here with the 1957 operation of the Shippingport Atomic Power Station. Westinghouse Electric Company, the Duquesne Light company, and the Bettis Atomic Power Laboratory collaborated to construct that Power Station using a reactor core from a cancelled nuclear-powered aircraft carrier, under the overall guidance of Admiral Hyman Rickover, the father of the nuclear navy. That reactor operated until 1982. The State's role in our nuclear navy traces back even further, when collaboration of Westinghouse with Argonne National Laboratory for submarine power began in 1948…

The other defining event was the Three Mile Island accident. I traveled to TMI early in my NRC tenure to learn in detail about that accident. As you know, there were no health consequences from that accident, but the stress induced by the accident and the resultant evacuations certainly negatively impacted the public. That TMI visit helped to cement in my mind how the regulatory agency and the entire nuclear industry learned vital lessons on safety from that accident, which led to massive changes in NRC regulations and procedures. Those lessons have played a vital role in the superb safety record that nuclear plants have demonstrated in the United States ever since. The nation's current nuclear fleet owes an immense debt to the vital lessons learned from the TMI accident.

In closing, I want to comment on two pieces of legislation, HB 11 and SB 510, introduced in the Pennsylvania legislature by Representative Tom Mehaffie and Senator Ryan Aument, along with many co-sponsors. Those bills would recognize nuclear energy in the Pennsylvania Alternative Energy Portfolio Standards for its contribution to the State's zero-carbon energy production. These legislative proposals follow the general model of successful outcomes in Illinois, New York, and other states and incorporate approaches discussed in the American Nuclear Society's Toolkit that I described earlier

As one deeply concerned about our nation's energy future and the world we leave for our children and grandchildren, it is my sincere hope that the framework of these two legislative vehicles provides a basis for a favorable outcome for nuclear energy in Pennsylvania. With that outcome, Pennsylvania would join other states that have recognized and are preserving the benefits of nuclear power for future generations.