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Hearing on Nuclear Energy

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Thank you, Chairman Manchin, Ranking Member Barrasso and members of the Committee. My name is Chris Levesque, and I am the Chief Executive Officer of TerraPower, an advanced nuclear technology company.

Including the past 6 years at TerraPower, I have spent my entire career working in nuclear energy, beginning with my service in the US Navy on submarines. I have also had the opportunity to work on civilian nuclear projects in the US and internationally. These experiences greatly inform my comments today, as well as my belief that the US must retain its leadership in nuclear energy technology.

In 2006, our company's founders - Bill Gates and Nathan Myhrvold – began looking for a technological solution to the dual challenges of the growing global demand for energy and the rising threat of climate change. A key tool, they discovered, is advanced nuclear technology.

The mission of advanced nuclear energy companies like TerraPower is to improve nuclear energy technology on a number of fronts, using the capabilities offered by 21st century technologies and digital modeling previously unavailable. These technologies move well beyond our country's 20th century fleet of light water reactors, including safety improvements, reductions in the risk of weapons proliferation, minimization of waste production, more efficient use of uranium supplies and lower costs. We believe that we, as an American company, have a duty to innovate in clean energy. No other country has the capacity for innovation, and the freedom and cross-discipline capabilities to think innovatively, like the United States. We benefit from the investments made by past Congresses, and the work of the engineers and scientists who have gone before us. TerraPower's goal is to provide a commercial product that provides reliable, zero-carbon, cost-effective electric and thermal energy solutions that can be deployed in the United States and abroad.

Last year, TerraPower was grateful to win a competitive award from the Advanced Reactor Demonstration Program to demonstrate our Natrium technology, which we developed in partnership with GE-Hitachi. Natrium is specifically designed to meet the needs of a twenty-first century grid. Natrium uses the heat from our reactor to power a molten salt storage system that allows the system to store 500MWe of power for five and a half hours, making it four times larger than the largest lithium battery storage system in the world. This allows Natrium to work well with variable renewables like wind and solar. This is beneficial because, as more utilities plan to dramatically reduce, or even eliminate, emissions and pollution from their power system, they need firm dispatchable power in addition to renewables to meet rising demand.

While we are confident these attributes will make Natrium attractive to customers, we know that any nuclear reactor will also need to be both safe and cost effective. Because of our novel architecture, Natrium provides significant improvements in safety over conventional designs. Instead of water, Natrium uses sodium as our coolant which has a boiling point of 882 degrees Celsius. Unlike conventional reactors, Natrium operates at atmospheric pressure and its operating temperature is hundreds of degrees below the coolant boiling point, which greatly reduces the likelihood of a significant accident. Our design relies on natural forces, like convection, to cool the reactor after an unexpected shutdown. Because inherent or natural

safety is built into the reactor design, we are able to reduce the number of man-made systems needed to ensure safety, which results in significant cost savings. In addition, the Natrium design also separates the energy storage and electricity production systems from the nuclear island, which allows us to further decrease costs. We are confident that Natrium's cost and safety profiles will make it an attractive option for utilities around the world.

But getting this product to market will be surely helped by the actions this Committee has taken to support the demonstration of advanced reactors like Natrium. Companies like TerraPower and X-Energy have spent many years and hundreds of millions of dollars to develop our technologies. However, Congress's authorization of the ARDP, which establishes a 50/50 cost share program to build the first commercial scale units to demonstrate the technology comes at a critical moment. Like all peaceful, civil nuclear technology advances over the past half century, today's new reactor designs need government support to reach commercialization. If Congress continues to fully fund the ARDP, we will have multiple advanced reactors fully demonstrated and commercially available in the late 2020s. These tools will help the United States decarbonize, create good, high paying jobs, and allow our country to reestablish leadership in an industry critical to our nation's security. We urge Congress to continue funding the ARDP at the levels required to demonstrate both of these reactors under the timeframe Congress mandated.

The Role of Advanced Nuclear in Meeting Ambitious Climate Goals.

The Committee has explored the need for the federal government to address climate change; nuclear technology is a key tool in solving that problem. The United Nations' Intergovernmental Panel on Climate Change (IPCC) provides a number of pathways to keep global emissions below 1.5 degrees Celsius. None of those pathways allow for a reduction of the share of global power provided by nuclear, and the high economic growth scenario – the one that lifts billions out of poverty –calls for global nuclear power demand to increase by five times current levels.[1]

Nuclear is a key part of the plans of many states and utilities to reduce or eliminate emissions from the power sector. Like wind and solar, nuclear power is carbon-free. And like coal and natural gas, nuclear power can provide power 24 hours a day, 7 days a week. But unlike coal and natural gas, nuclear neither emits carbon dioxide or other air pollutants, nor does it require continual delivery of commodities to produce power. The result is always-available, carbon free power that does not require a natural gas pipeline or a coal train to operate, and can operate in increasingly volatile weather conditions. No other form of power has all these attributes.

We also know that we need to decarbonize the power sector quickly. Nuclear is the only option that can scale fast enough to address the urgency of this need. We saw the benefits of rapid deployment from 1969 to 1990 when the U.S. built more than 100 nuclear plants. Rapid build and heavy investment in research and development were primary contributors to the stable, emissions-free power that cleared pollution from our cities and fueled growth.

[1] https://www.iph/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf

In addition, as the Committee knows, getting to a 100 percent carbon free future will require us to eliminate emissions in more difficult to decarbonize sectors of the economy like industry. We will have to develop strategies to produce chemicals, cement, metals and other products without burning fossil fuels. Advanced nuclear technologies like ours can provide reliable, very high temperature heat for industrial processes. Our designs can provide heat in excess of 500 degrees Celsius without emitting any carbon dioxide or methane.

The Economic Case for Investing in Advanced Nuclear

These attributes are good for the environment, but also present substantial economic opportunity for our country. Today, most Americans either live in states with emissions targets or are served by utilities who have put forth ambitious emissions goals. While variable renewable technologies like wind and solar are becoming the lowest cost options for the next-kilowatt-hour of new generation, getting to a completely decarbonized system will require firm, flexible zero carbon sources of energy that can produce power at all hours of the day. Our home state of Washington passed an ambitious climate law that will require us to achieve zero emissions in the power sector. Energy Northwest commissioned a study by the consulting firm E3 which found, that to reach that goal, including new nuclear in addition to massively increasing wind, solar and storage penetration would reduce the cost to ratepayers by nearly $8 billion per year.[2] While wind and solar continue to get cheaper, zero carbon dispatchable power is incredibly valuable for achieving decarbonization goals.

More and more corporations also are committing to bold climate goals, including two powerhouse global companies headquartered in our home state—Microsoft and Amazon. Microsoft has promised to become carbon negative by 2030, removing more carbon than it emits, and by 2050 it has vowed to erase a volume of carbon equal to all of the greenhouse warming gas that the company has emitted since launching in 1975. Amazon has pledged to reduce its carbon footprint by investing in electric vehicles, reforestation projects and to achieve net zero annual carbon emissions by 2040.

Globally, every potential export market in the world has signed onto the Paris Climate Agreement. To meet the Paris goals, those countries will need energy sources with attributes like advanced nuclear. And our case in these markets mirrors the economic case here. In December, the International Energy Agency noted that "new nuclear power will remain the dispatchable low-carbon technology with the lowest expected costs in 2025."[3] As more countries make more ambitious pledges, the market for advanced nuclear will grow.

We are excited about the domestic market for our products, but it's hard to overstate the potential of the global market for firm, carbon free energy technologies like advanced nuclear. Given that, it should not be surprising that other countries are working to develop advanced nuclear technology. Countries like China and Russia are actively supporting the development of advanced reactors with significant direct investment by government into state-supported companies. This direct government support helps these countries establish a valuable export

[2] https://www.powermag.com/energy-northwest-study-makes-a-case-for-smrs-in-future-power-mix/
[3] https://www.iea.org/news/low-carbon-generation-is-becoming-cost-competitive-nea-and-iea-say-in-new-report

product, but the sale of a reactor also brings important national security benefits for those governments. Some of these state-supported companies sell their reactors with a multi-decade contract to provide fuel, operations and maintenance and waste services. This creates a multi-decade strategic partnership between the country selling nuclear reactors, and the country purchasing that technology. Russia, for example, is currently offering these "Build, Own, Operate" contracts in Europe and the Middle East.[4] Those contracts will enable Russia to increase its influence in those regions.

Additionally, the investment in nuclear technology yields applications that go beyond energy. Because of the technical expertise we've gained from working to build reactors, TerraPower is working with Oak Ridge National Laboratory to separate life-saving medical isotopes from cold war era nuclear waste currently stored in Tennessee. These rare isotopes can be used to attack cancer cells without damaging surrounding tissue and could lead the way to dramatic improvements in cancer treatment.

Civil nuclear technology was invented in the United States, as was every advanced nuclear technology currently under development across the globe. Our nation should benefit from that investment, both in terms meeting our domestic clean power needs, and in terms of the economic and national security opportunity for American companies to sell their products around the world.

What is Advanced Nuclear, or "Generation IV?"

Light water reactors have served us very well, but new designs can improve fuel cycles, proliferation, safety, and the cost of light water technologies. TerraPower's designs, including Natrium, are walk away safe, and use natural forces like gravity and air cooling, not human intervention, to keep the reactor safe when faced with unplanned events. Our Natrium plants can reduce heavy metal waste volume over conventional designs by two-thirds and future Natrium units that can run on natural or depleted uranium by 80 percent. Because of reduced enrichment needs, and because more of the fuel is burned in the reactor core, the risk of proliferation is significantly reduced. These improvements make our reactors safer, cheaper, and able to operate with lower volumes of waste.

In the nuclear industry, safety is always our first and highest priority. Regulators and operators globally share experiences allowing knowledge transfer broadly across the industry, and virtually every meeting in the industry starts with a conversation about safety. Safety is deeply ingrained in the nuclear industry's culture. As a result, nuclear power has consistently proven to be the safest way to make electricity, with a lower mortality rate per terawatt hour of power produced than any other source of power[5]. America's nuclear reactors have a tremendous record in terms of operating safely, and safety is at the core of our advanced reactor designs.

Advanced designs build on that success. Advanced reactors offer next-generation safety benefits that permit new applications and expand the potential to use nuclear energy for more

[4] https://www.belfercenter.org/publication/russian-nuclear-energy-proposal-offer-you-cant-refuse
[5] https://www.statista.com/statistics/494425/death-rate-worldwide-by-energy-source/

than electricity production. Like other advanced designs, Natrium will not require active safety systems, eliminating the need for diesel engines, multiple back-up systems and human intervention under emergency scenarios. Natrium also avoids high pressure and relies on the natural laws of physics to maintain the safety of the plant without needing operator intervention or auxiliary power, using air and the properties of natural convection, rather than water, as the ultimate heat sink. Safety features in the selection of fuels and coolants provide for enhanced versatility and allow for flexibility in siting a reactor as sites can be much more compact with a smaller emergency planning zone within the site boundary. If you compare these reactors to the one in Fukushima, there would not have been an accident. A fast reactor like Natrium would have shut itself down independently, indefinitely.

We also know that our potential customers are very concerned about the cost of nuclear. We are too, and our reactor is specifically designed to reduce cost. Because of our passive safety designs, TerraPower's advanced reactors have less of a need for multiple, redundant safety systems. Our advanced reactors operate at higher temperatures and burn more of the fuel, yielding more electricity and lower costs per kilowatt-hour for the same plant size. Our reactors also require less maintenance and fuel, and as we move beyond our demonstration design, we have the potential to make up to 30 times more energy out of each ton of natural mined uranium used to provide carbon free power. Eventually, we envision that our reactors can run on depleted uranium - waste product from enrichment that is currently managed by the U.S. Government. These attributes result in substantial savings over light water designs.

Finally, we know that America's energy system is going through tremendous change. Tomorrow's grid will rely heavily on wind and solar. Natrium is specifically designed to integrate into a grid with high levels of variable renewable penetration. Natrium will use the high temperature heat from our reactor to power a molten salt storage system that can store tremendous amounts of energy, levels of magnitude larger than the energy stored by typical battery storage facilities. That energy can be used to power the grid at peak demand when the wind isn't blowing, or the sun isn't shining. We view our technology as a key enabler of wind and solar technologies, and part of the fastest way to get to the 100 percent clean energy future envisioned by the Committee.

U.S. nuclear technologies and research and development capabilities are envied around the world, and the U.S. enjoys close political and commercial relationships with many countries forged over decades through the construction of U.S.-origin nuclear plants. Exports of U.S. nuclear technology allow the U.S. to set global standards for nuclear security, safety and nonproliferation. New designs will enable advanced nuclear to fit seamlessly into systems with high penetrations of variable renewable sources. U.S. nuclear innovators, including TerraPower, have advanced their technology readiness levels sufficiently for demonstration and offer substantial advances in economics, safety and proliferation resistance. Now is the time to build on the momentum of these innovators, demonstrate advanced reactors, and deploy this important tool in the fight against climate change. I thank the Committee for its leadership in helping to get us to this critical point in the technology's development.

The Role of the Federal Government

Unlike many of our foreign competitors, America's advanced nuclear industry is made up of private companies backed by private investors who partner with our national laboratories, research universities, and agencies, like the U.S. Department of Energy, to develop domestic advanced nuclear technology.

Clean energy technologies have long benefited from partnering with the federal government to make it through the "valley of death" that new technologies face initially. Wind and solar are no exceptions and would not have taken off without subsidies, power-purchasing targets and government funding for research and development activities. The result is clean technology innovations with reduced costs and faster development and deployment timelines than previously imagined. This is especially the case for technologies like advanced nuclear that are expensive to demonstrate.

As such, we were ecstatic that Congress picked up on the work of this Committee in authorizing and funding the Advanced Reactor Demonstration Program in the FY2020 and FY2021 Appropriations bills and the Energy Act of 2020. We were equally pleased that Natrium was selected alongside the X-energy's Xe-100 as winners of the ARDP demonstration competition. We thank the Department of Energy for selecting two truly advanced designs and we are committed to meeting the ambitious demonstration schedule outlined by Congress. Having these two advanced technologies available to the market will play a key role in meeting America's environmental, economic, and national security goals.

Given the importance of the ARDP to America's future, we are humbled to be a partner with the federal government in bringing Natrium to market. As we begin work on our ARDP demonstration projects, the most important thing Congress can do is to ensure the federal cost share for these projects is available each year. As is the case with any megaproject, the cost and schedule for these projects will follow an S-curve, with funding increasing in each of the first give years, and then tailing off for the last two years. Unlike a traditional R&D program, this will require sustained budget increases for the next few years. We know that Congress is serious about meeting an aggressive timetable, and we are too. And while this project is a big undertaking, we are prepared to meet our half of the cost-share agreement going forward. We will need Congress to ensure that the federal government can meet their share as well.

In addition, we appreciate the efforts of the committee to ensure the availability of High Assay Low Enriched Uranium (HALEU) to customers like TerraPower. Like most advanced designs, we will require HALEU to run our demonstration reactor. HALEU will be necessary to fuel our reactors and we appreciate your efforts to ensure the availability of HALEU for our growing advanced nuclear industry.

Conclusion

TerraPower very much appreciates the broad bipartisan support nuclear power has received from this Committee and is grateful that you all have set advanced nuclear technology on a path to play a key role in America's energy future. The country that owns the advanced nuclear

transition will be a leader in the global nuclear market and empower countries around the world to ensure access to reliable, clean and abundant energy. The advanced nuclear industry is critical to providing the safe, emissions-free, firm power the world will require over the coming century.

We know America can lead in nuclear innovation. In 1957, the Shippingport Atomic Power Station - the world's first full-scale commercial nuclear power plant, came online in Pennsylvania. Shippingport was the cornerstone for commercial light water reactor technology and led to the construction of hundreds of reactors around the world employing U.S. born technology. In the coming decades, many new countries will employ nuclear energy for the first time to meet their growth needs. China and Russia stand poised to supply these countries with their technology. The U.S. needs to be ready with ours. It is time to repeat the story of Shippingport, this time with next generation technology that can help bring clean power to the United States and around the world. This must happen if we are to meet the goal of a 100 percent clean economy.

Our company was founded on the premise that we must end both global energy poverty and solve climate change. We believe that we can provide safe, reliable, cost-competitive advanced nuclear technologies that can help meet those difficult challenges. We also know that this committee is no stranger to tough problems, and bold solutions. And we appreciate everything you have done to help bring advanced nuclear technology to market. We look forward to working with you as we begin building the first Natrium reactor as a part of the Advanced Reactor Demonstration Program.

On behalf of TerraPower's nearly two hundred employees working to make that goal a reality, thank you for the opportunity to appear before the Committee.

