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Financial Services Committee
Subcommittee on National Security, Illicit Finance, and International Financial Institutions

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Thank you Chairman Luetkemeyer and Ranking Member Beatty for holding this important hearing. Thank you also for the invitation to share my experience on behalf of X-energy.

Introduction

My name is Benjamin Reinke and I serve as X-energy's Vice President of Global Business Development. After completing a Ph.D. in Nuclear Engineering at Ohio State, I joined the Majority professional staff of the Senate Committee on Energy and Natural Resources and later served as the senior policy advisor to the U.S. Secretary of Energy while serving as the Executive Director of the Department of Energy's Office of Strategic Planning and Policy. During my time in government, I had the opportunity to craft and shape many clean energy policies, including a heavy dose of nuclear policy, and have seen first-hand many of the existing government programs to support nuclear energy technology development in the U.S. and deployment at-home and abroad. I then joined X-energy, where I ran our Corporate Strategy function for about two years before taking the lead on our business development efforts about one year ago. I also hold an unpaid position as a non-resident Senior Fellow of the Atlantic Council's Global Energy Center.

X-energy is a nuclear reactor and fuel design engineering company headquartered in Rockville, Maryland, with over 400 employees and hundreds more contractors that are part of our design team. To-date, the federal government and the private sector have invested over $600 million in the development of our intellectual property and infrastructure, all focused on bringing our reactors and fuel to market in a disruptive way that scales with global demand.

X-energy was founded 15 years ago by Dr. Kam Ghaffarian our Executive Chairman to bring energy technology to the market that is clean, affordable, safe, and secure. Kam's journey led him to Generation IV reactors, often called advanced reactors, and he selected the High-Temperature Gas-Cooled pebble-bed Reactor (HTGR) because of its technology maturity, demonstrated safety case, and ability to provide both affordable electricity and high-temperature process heat. Moreover, the investments that the U.S government had previously made in developing HTGR technology, and more importantly the fuel that powers them formed the platform from which X-energy was launched.

Today, X-energy has three main products:

- **The Xe-100**: our commercial, advanced grid-scale High Temperature Gas-Cooled small modular reactor, which produces 200 megawatts-thermal or 80 megawatts-electric;
- **Mobile Micro Reactor**: which is a 5 megawatt-electric commercial variant of the mobile micro reactor we developed for the U.S. Department of Defense under Project Pele; and our ongoing work is sponsored by the DoD and DOE; and

- **TRISO-X Fuel**: our proprietary version of tri-structural isotropic (TRISO) coated particle fuel, developed and improved over 60 years. We manufacture our own proprietary version (TRISO-X) to ensure supply and quality control.

We also have teams focusing on space applications of our HTGR technology and coated particle fuel, for nuclear propulsion systems and fission power for the lunar surface, work supported by NASA, DOE, and DOD.

To bring these products to market, a combination of:

- Technology maturity;
- Risk-tolerant private investment;
- U.S. Government support; and
- Addressable market were all required.

I will address each of these throughout this testimony, but it is important to highlight that they work together positively to reinforce our position that the time is now for American advanced nuclear technology to enter the global market and to enable the U.S. to reestablish is global nuclear energy leadership position.

The Global Race Against Russia and China

To begin, I want to recognize the critical topic of this hearing and the importance of its timing. There is a global race underway for the development, and more importantly the deployment, of clean energy technologies.

The geostrategic focus on energy security, evidenced by the pivot away from Russian and Chinese sources of energy and infrastructure marks a pivotal moment in global history. The atrocious invasion by autocratic Russia of its democratic neighbor Ukraine sparked an evolution in the fundamental nature of Western customers views toward the state-owned energy enterprises of Russia and China, which were inherently tools of their undemocratic regimes, used to undermine free enterprise in the Western global order. However, the pivot began much earlier, as many Central and Eastern Europe nations expressed their desire to break free from their historical ties to Russian natural gas and nuclear energy. Similarly, the United Kingdom recognized the risks associated with Chinese state-owned telecom infrastructure and changed its laws to extricate critical national security industries from ties to companies controlled by the Chinese Communist Party.

Yet, it is important that we recognize today that decades have past since the U.S. held its proper role as the global nuclear energy leader and in that vacuum Russian and Chinese state-owned enterprises have firmly established their positions. This is all the more troubling when we consider the 80-100 year relationships enabled between a nuclear exporting nation and a client nation and when we recognize that nations that are not competitive in the global nuclear marketplace, with leading technologies, abdicate their seats at the global non-proliferation table.

To put this in context, today, the U.S. has just finished constructing two new nuclear reactors from scratch for the first time in 30 years. During that period we have built very few reactors abroad. We currently have a handful of U.S. government-supported projects under way, including X-energy's first project (described in greater detail below). Meanwhile, together China and Russia together account for 70% of planned or under-construction reactors worldwide.[1]

The good news is that the U.S. is positioned to jump back into the lead. The very nature of the next generation of nuclear technologies under develop in the U.S. will provide an asymmetric advantage in the marketplace that will disrupt today's global nuclear energy order, as described in further detail below.

Thanks to the examples provided by countless disruptive/breakthrough technologies developed through U.S. private sector innovators, often in partnership with U.S. government-sponsored research and development, we can have confidence that recapturing global market share is achievable. For example, today, the U.S. dominates technologies ranging from data centers to Artificial Intelligence, enabling it to lead on digital services and technologies in the global marketplace. Importantly, our technology leadership position enables the U.S. to also lead in discussions around the global rules of the road and the potential nefarious uses of these technologies. This market segment is a fruitful analogy, because the underlying technologies were first developed here and the most cutting-edge technologies in this sector still emerge from the cauldron of competition and the hotbed of innovation based in the U.S.

However, advanced nuclear is not yet back in this position. In fact, the U.S. nuclear sector is more like a once globally dominant steel forge. The fundamentals are still there – the best and brightest nuclear engineers, the most innovative nuclear energy technologies, the most trusted nuclear regulatory body, and the transparency of a truly private-sector nuclear industry that is supported by the U.S. government. Led by private sector entrepreneurs and stoked by a combination of visionary investors and government support, the U.S. is today developing and deploying the world's most advanced nuclear technologies; it is pulling the forge out of cold standby and reigniting the flame.

The opportunity is enormous. However, major challenges remain.

Today, I will describe several critical challenges and hope to leave you with proposed solutions, across several key themes:

1. **We must deploy domestically before we can sell internationally, and U.S. deployment relies upon a fully implemented ARDP, a technology-neutral tax environment that enables the deployment of new clean energy technologies, and the redevelopment of a nuclear fuel supply chain that inspires confidence in U.S.-led energy security for our allies and partners;**
2. **We must remove barriers to entry for new advanced nuclear technologies, first in the U.S. and then abroad;**
3. **We must have all possible financing tools in the toolkit to support U.S. nuclear exports; and**
4. **We must lead from the front on nuclear energy.**

[1] https://asia.nikkei.com/Business/Energy/China-and-Russia-account-for-70-of-new-nuclear-plants

X-energy Technology

TRISO-X

It really all starts with the fuel. The safety and economic cases for our reactors comes from our TRISO-X fuel. In fact, we like to say that we design our reactors from the fuel out. Five years ago, when X-energy won its first cooperative agreement with DOE, we decided that we needed to make our own fuel so that we could meet the schedule, quality, and the quantity requirement of fuel that we be required for the deployment of our reactors. Indeed, today TRISO-X is a pivotal part of our business case and business model.

This decision built upon over $350M of Federal investment in TRISO fuel that was enabled through the Advanced Gas Reactor fuel program, enabled by the Bipartisan Energy Policy Act of 2005. The AGR campaign involved fundamental R&D that evolved the chemistry of TRISO fuel kernels to allow for higher burnup to be achieved. It also funded a fuel testing and qualification campaign leading to a series of experiments that validated the safety case of this next generation TRISO fuel and a U.S. NRC-reviewed Topical Report[2] for TRISO fuel qualification. Under the AGR program, TRISO particles made to spec were demonstrated to provide a barrier to radiation release (99.999% of radioactive fission products retained) at 1800 degrees Celsius over a 12+ day period. The success of this fuel campaign led the Department of Energy to call TRISO fuel "the most robust nuclear fuel on Earth."[3]

X-energy's TRISO-X fuel is a proprietary version of the fuel qualified in this program, a successful commercialization of fundamental R&D sponsored by DOE's Office of Nuclear Energy in partnership with several of its National Laboratories, in particular Oak Ridge National Laboratory (ORNL) and Idaho National Laboratory (INL).

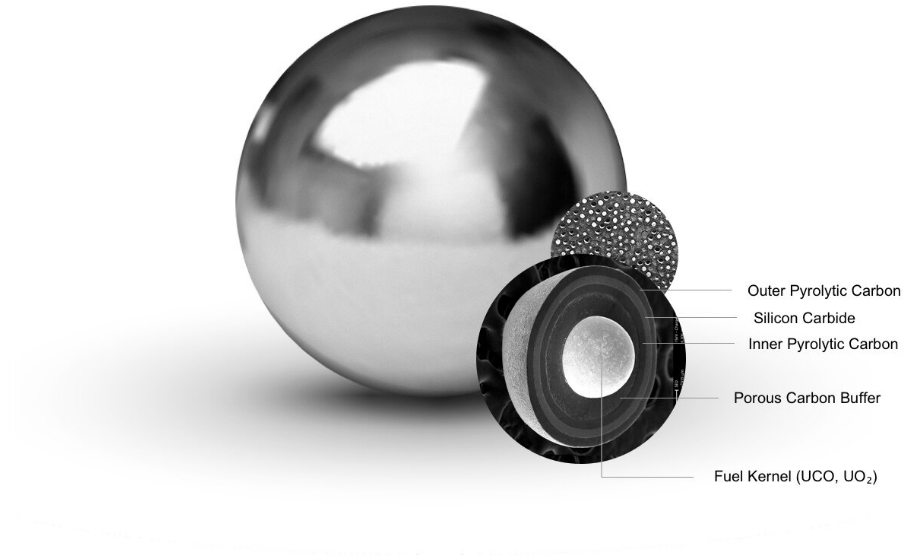
X-energy's founder's investment was then leveraged against an initial 5-year funding program from DOE to the tune of $40M (with a $13M X-energy cost-share) to build a TRISO pilot-scale manufacturing facility at ORNL that we have been running since 2017. We chose to build not a lab, but a single commercial production line, to enable our licensing process, produce TRISO-X kernels and pebbles, analyze them, and develop the quality control and quality assurance processes that would be required to ensure adherence to the Advanced Gas Reactor standards for qualified TRISO fuel.

At the heart of the TRISO-X fuel particle is the uranium oxycarbide kernel, which utilizes high-assay low-enriched uranium ("HALEU") for higher energy content than the uranium used in conventional LWRs. Each kernel is surrounded by four barrier layers that act in concert to support the uranium-containing kernel, moderate nuclear reactions, ensure passive safety, and contain fission products. These particles retain their integrity during all foreseeable adverse conditions and the set of boundary layers act as functional containment for the radioactive fission products in the fuel kernel, obviating the requirement for the typical expensive and large concrete and steel containment structures required in conventional reactors. The robust graphite pebble, about the size of a billiard ball, contains approximately 18,000 of these TRISO particles.

[2] https://www.epri.com/research/products/000000003002015750

[3] https://www.energy.gov/ne/articles/triso-particles-most-robust-nuclear-fuel-earth#:~:text=TRISO%20particle%20fuel%20is%20structurally,temperatures%20than%20traditional%20reactor%20fuels.&text=TRISO%20particles%20have%20a%20fuel,then%20coated%20with%20four%20layers.

We plan to provide our Xe-100 customers with their initial fuel loads and refueling needs throughout their anticipated 60-plus-year Xe-100 plant lives.



Xe-100

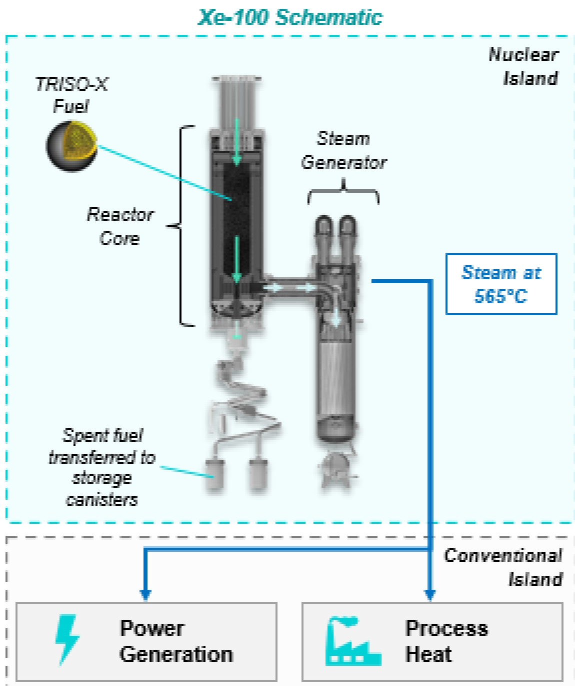
The Xe-100 is an HTGR with advantages in sustainability, economics, reliability, and safety over conventional LWRs and other advanced SMR designs. The Xe-100 is a Generation-IV advanced nuclear technology that has been designed to remedy weaknesses associated with traditional LWR designs. The Xe-100 can efficiently produce electricity or process heat. The Xe-100 produces 200 megawatts of thermal power in the form high-temperature superheated steam at 565 degrees Celsius and 16.5 megapascals. When configured for electricity generation, each reactor can power an 80 megawatt-electric turbine generator. We anticipate that many customers will select a 4-pack 320 MW electric power plant orientation. However, with our modular design, the number of reactors (scale of the plant) can be matched to the needs of each customer, with up to 12 reactors operating from a single control room in our largest plant configuration.

Our elegant and simple design maximizes the use of factory-manufactured components, which will be shipped to site using existing road and rail networks. The design affords a high level of modularization of plant systems, and we are working to optimize modularity in our construction plans.

The Xe-100 has the following characteristics:

- *Safe* – Each Xe-100 will use 220,000 of our TRISO-X fuel pebbles, with approximately 18,000 uranium oxycarbide TRISO fuel particles in each pebble, which helps to contain fission products and aids in long-term nuclear-waste storage.
- *Designed to not Melt* – High-temperature-tolerant graphite-based fuel structure does not melt under any accident scenario.
- *High Temperature Technology* – By using a helium coolant as compared to water the Xe-100 is designed to deliver heat at higher temperatures (750°C helium outlet temperature and 565°C steam from the steam generator) than conventional reactors, providing a clean solution for various use cases, including power generation and process heat for critical industrial applications.

- *Online refueling* – Online refueling capabilities provide an average of 95% plant availability, unlike conventional nuclear facilities, which requires shutdown and refueling every 18-24 months.
- *Efficient* – High burn-up fuel cycle (160,000 megawatt-days per ton of uranium) means the Xe-100 more efficiently utilizes its fuel than conventional reactors.
- *Resilient* – Designed for a 60-year operational life.
- *Load*-following – high-temperature reactors offer the ability to truly load-follow the fluctuations in power production that accompany high penetrations of renewables; the Xe-100 can load follow in increments of 5% of reactor power per minute between 40% and 100% power, meaning it can ramp up or down from 40 to 100% power in 12 minutes.



<u>*Mobile Micro-Reactor*</u>

The X-energy mobile micro-reactor is a commercial variant of a micro-reactor that we originally developed as part of the U.S. Department of Defense's Strategic Capabilities Office Project Pele. Our Project Pele design had very strict performance requirements, such as:

- Rail, truck, and U.S. military transport aircraft compatibility;
- All components housed in standard ISO containers;
- The ability to operate at full power for more than 3 years, with a 100% duty cycle;
- Utilizing our proprietary TRISO-X fuel that is designed to not melt; and
- Producing 1 MW or more of electric power at 4160 volts.

Since then, we have pivoted the innovation developed by our design team to a commercial variant with less stringent transportation requirements that we believe can potentially address the following use cases:

- *Remote communities* – Island and remote communities, especially in Canada and Alaska, rely on petroleum fuel to maintain their power. Delivery disruptions and service difficulties can significantly affect availability and reliability of power in these settings, while the diesel generators are a source of air pollutants and greenhouse gases.

- *Disaster Relief* – The mobile micro-reactor is a transportable and flexible electricity solution that does not require fueling for years and can power critical infrastructure like hospitals, water purification facilities, railyards, and ship harbors on rapid deployment timelines.
- *Defense and military* – As the U.S. military prepares to further "electrify" the warfighter, highly portable, reliable power will be a revolutionary technology, and resilient power for permanent military installations can enable a more nimble and reliable defense posture for our troops.
- *Off-grid small industrial sites* – Smaller industrial sites in harsh conditions, such as at altitude or in high latitudes, or island operations, are similarly currently exposed to expensive diesel supply chains.

Today, our Mobile Micro-Reactor design team is working under a follow-on expanded Project Pele contract and a DOE Cooperative agreement to further the design and study the market applicability of a 5 megawatt-electric variant of our mobile micro-reactor.

Global Business Development

To be very clear, the most important datapoint I can share with you today from discussions with international customers is that <u>we must build first in the U.S. before we can build abroad</u>. Many customers in the U.S. and abroad, comprised of both heavy industrials and utilities, are engaging with X-energy and our competitors. We conduct most of this business under strict confidentiality agreements until a customer is ready to make a public announcement. Much of the early work involves developing a relationship with a customer and earning their trust while we jointly define the customer's requirements and assess the applicability of our technology.

We work under paid contracts to estimate the economics of projects and to determine whether a customer's site is suitable from a nuclear regulatory perspective. This work allows a customer to take a risk-adjusted approach to our engagement and move a project through the customer's gate review process. This is the work that my team lives and breathes every day as we manage the contractual work for our customers and work with them to the point that they are prepared to make a substantial investment in a project.

International customers want to see any technology that they would consider deploying first deployed in its country of origin. In other words, most foreign customers want to see the Xe-100 licensed and constructed in the U.S. before they move forward. Why? Customers require social license and technology demonstration for the deployment of new reactor technologies. While many global customers say they want to work with the U.S. and likeminded nations, they want to see a top tier regulator provide a "stamp of approval" regarding the safety case for a reactor before they ever begin major investment in new nuclear. Historically, many international nuclear customers were either owned by their governments or were at least closely coordinated with their governments. This means that there has been a heavy-handed role to play in government-to-government relationships to enable and allow a business-to-business or business-to-government sale to move forward. It is no surprise that such sales structures require the U.S. technology vendor to first successfully navigate its own home-government regulatory process. This is one of the key differentiators between the U.S. and China or Russia. As discussed above, the Russians and Chinese have been deploying technologies at home and then supporting sales of the demonstrated reactors abroad. It is time for the U.S. to get back in the game.

<u>Market Opportunity for Advanced Nuclear</u>

X-energy has initially targeted the U.S., Canada, and the United Kingdom for the deployment of Xe-100s. The selection is not coincidental. These three nations have substantial power needs and substantial heavy industry, requiring a combination of heat/steam and power. All three have a substantial decarbonization policy. Finally, all three have existing nuclear industries and top tier nuclear regulators – these nations have a strong nuclear pedigree. When taken together, the market opportunity is substantial and the market has a regulator that is ready to receive an application for an Xe-100 project from an X-energy customer. These are the markets with the greatest short-term need and opportunity for us.

According to PA Consulting, the U.S., U.K. and Canada comprise approximately one-third of potentially serviceable global electricity usage. Across these three geographies, there is an estimated Total Addressable Market (TAM) of 471 gigawatts and 676 gigawatts of cumulative capacity additions by 2040 and 2050, respectively. Of this TAM, PA Consulting estimates that 67 GW and 134 GW of the cumulative capacity additions by 2040 and 2050, respectively, will be best served by SMRs, considering grid needs, siting efficiencies, demand for zero carbon generation and co-generation. These capacity additions, which represent all potential use cases for SMRs, including utility power generation, industrial applications, and behind-the-meter ("BTM") generation, imply a need for approximately 400 Xe-100 reactor 4-packs, representing an estimated $500 billion market opportunity for SMRs in 2040, growing to approximately $1 trillion by 2050. To put this in further context, the deployment of 134 GW by 2050 implies more than 400 Xe-100 reactor 4-packs in these three nations alone. We believe this to be a conservative TAM in the three nations and anticipate an even greater TAM will become accessible as we grow our engagements in other nations.

Indeed, the global market for SMRs is likely to be much bigger. There is evidence around the globe that nuclear energy is back in vogue and that the fundamentals are better now than they have ever been. For example, in its Commercial Liftoff Report,[4] the Department of Energy estimates that the U.S. alone will actually require an additional 550 – 700 gigawatts of clean and firm power by 2050, with nuclear being one of the few technologies available. The report estimates an incremental 200 gigawatts of new nuclear in the U.S. by 2050, from today's approximately 100 gigawatts. This ambition for tripling nuclear power was carried forward by the Biden Administration to COP 28, where it received support from an additional 21 nations, which all pledged to triple nuclear capacity by 2050.[5] And, the International Energy Agency's tracking of energy poverty showed recently that three quarters of a billion people still live in energy poverty.[6] If the world is able to eliminate energy poverty while decarbonizing, economic growth will be ignited in developing nations and countless people will be lifted from hunger and abject poverty. In such a scenario, global power demand will increase further.

In each of the above scenarios, SMRs are positioned to capture a larger portion of the market and Gen-IV reactors that are able to achieve higher temperatures will have a larger TAM within the market because of their applicability to industrial power and decarbonization. This is fundamentally due to the fact that not all customers need, or can afford, a gigawatt-scale reactor like today's fleet of large light-water reactors. In fact, the scale of these projects is inherently self-limiting; there are only so many places in the world that need incremental power in a gigawatt-size chunk. There are many more economies and customers that require less power. Moreover, a project that is gigawatt-scale typically comes with a $20+ billion price tag, which is another reason that most customers of large light-water reactors are state-owned utilities. In those cases, backing by a federal government is required to finance megaprojects of this scale. This is not the case for SMRs, which will be projects on the order of low-single-digit billions, bite sizes that more customers can afford to take and to

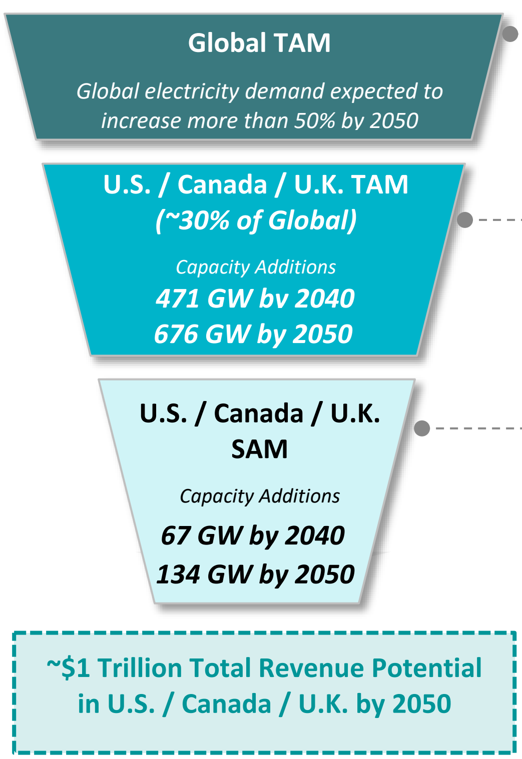
[4] https://liftoff.energy.gov/advanced-nuclear/

[5] https://www.energy.gov/articles/cop28-countries-launch-declaration-triple-nuclear-energy-capacity-2050-recognizing-key

[6] https://www.iea.org/commentaries/for-the-first-time-in-decades-the-number-of-people-without-access-to-electricity-is-set-to-increase-in-2022

which more financial institutions will be willing to lend. These are inherently less complicated and expensive projects. As we've seen with most energy technologies, when projects become smaller and less complicated, deployment scales faster with increasingly available financing. SMRs will follow the deployment-at-scale demonstrated by coal in the 20th century and renewables and natural gas in the 21st century.

At X-energy, we have already seen growing evidence of customer interest from around the world. In Central and Eastern Europe there has been a growing drumbeat for a pivot away from Russian nuclear technologies toward U.S. and allied nuclear technologies. We have already conducted a paid study for a coal-to-nuclear conversion feasibility study in this region to understand the fundamentals of an Xe-100 project and are bullish on the opportunities to deploy throughout the region in the 2030s, with multiple customer interactions underway. We have seen similar increasing support for new nuclear in Northern Europe as multiple nations that had previously banned new nuclear have pivoted to supporting new projects. Meanwhile, the Middle East is showing increased interest in SMRs, driven by its heavy industrial decarbonization challenge. While at COP 28 in Dubai, we participated in multiple nuclear energy events hosted by the Emirates and signed an MOU with the Emirates Nuclear Energy Corporation focused on the deployment of our Xe-100 nuclear technology in the UAE, with a particular focus on decarbonizing their heavy industry. Additionally, the U.S. Government recently completed a 123 Agreement with the Philippines, a signal that the need for power and electricity in the IndoPacific region is growing. We at X-energy have already seen tremendous interest in the region, evidence by a strategic investment in our company made by one of the region's top construction and engineering firms, South Korea's DL E&C. Finally, African nations have been strong participants in U.S. Government programs to support nuclear industry like the State Department's Foundational Infrastructure for the Responsible use of SMR Technologies, or FIRST Program, partnering with Ghana and the Three Seas Initiative. The interest and TAM will continue to grow.



Global Electricity Demand: Initial X-energy target markets – the U.S., U.K., and Canada – comprise about a third of serviceable global electricity usage, so the rest of the world represents additional upside to market size

TAM: Cumulative potential use cases for SMRs and all energy alternatives, including utility power generation, industrial applications, and BTM generation

- TAM is driven by retirement of existing U.S. capacity (e.g., coal) and expected growth in energy demand

Serviceable Addressable Market ("SAM"): Share potentially served by SMRs, which identifies GWs that are best served by SMR due to differentiated attributes such as ability to provide energy, capacity, and steam

- SMRs are anticipated to capture 20% of the TAM by 2050
- SMRs are well positioned to gain market share at higher electrification levels as it becomes increasingly difficult to site reliable clean alternatives

The Advanced Reactor Demonstration Program

Adopted as part of the Energy Policy Act of 2020, the Nuclear Energy Leadership Act (NELA) coalesced various initiatives needed by the advanced reactor community into an overall advance nuclear policy. Of these, the cornerstone was the Advanced Reactor Demonstration Program, or ARDP, which was a bold policy initiative designed to restore U.S. global nuclear leadership by enabling the commercial demonstration of advanced reactors by the end of the decade through a government cost-share program. The Department of Energy initiated the procurement for this program in 2020. Two companies, X-energy and TerraPower, were selected for initial deployments, which would demonstrate two different advanced reactor technologies. Terrapower is demonstrating a molten salt reactor with a thermal storage system in partnership with Pacificorp. at a former coal plant site in Kemmerer, Wyoming. X-energy is demonstrating a High Temperature Gas Reactor, in partnership with Dow at an existing polyethylene manufacturing facility in Seadrift, Texas. Both the TerraPower and X-energy technologies are considered Generation-IV technologies, as they do not use water in the reactor cores like today's light-water reactors. In comparison to existing reactors, proposed non-light water SMR designs are generally simpler, and the safety concept for SMRs often relies more on passive systems and inherent safety characteristics of the reactor, such as low power and operating pressure. This means that in such cases no human intervention or external power or force is required to shut down systems, because passive systems rely on physical phenomena, such as natural circulation, convection, gravity, and self-pressurization. Physics-based systems increase safety margins, in some cases, which can eliminate or significantly lower the potential for unsafe releases of radioactivity to the environment and the public in case of an accident.

In 2020 we were awarded our contract and signed our cooperative agreement with the U.S. Department of Energy (DOE) to deliver an HTGR to market. ARDP is not like a conventional government research and development program. We must deliver a nuclear power plant to market. Government funds must be matched with non-Federal capital on a dollar-for-dollar basis – a 50%-50% cost-share. We had to bring a customer with us during the application that was willing to participate from the time of selection. Finally, we needed to provide a business plan that shows real potential for multiple sales beyond the first reactors. Our ARDP goal is to commercially demonstrate the Xe-100 and show that it can be affordably deployed.

Under ARDP X-energy will accomplish three objectives:

1. Complete the design and licensing of the Xe-100, a goal that is significant because no nuclear power plant in the U.S. has ever been fully designed, through detailed construction drawings and plans, before construction begins.
2. Construct a commercial-scale TRISO-X Fuel Fabrication Facility, which we call TX-1, with sufficient capacity to support our ARDP plant and further early deployment Xe-100 projects.
3. Construct the first Xe-100 plant for Dow, commission the plant, and demonstrate commercial-scale operations.

Under the ARDP, X-energy and its investors match dollar-for-dollar the investment by the taxpayer in objectives 1 & 2, completing design of the Xe-100 and completing licensing and construction of TX-1, our first fuel facility. Dow, as the customer of the Xe-100 nuclear power plant matches the government cost-share for 3, the overnight capital expenditure required to construct and commission the Xe-100 nuclear power plant.

The X-energy engineering team is in the detailed design phase of our technology development (final of three typical nuclear engineering design phases) and will docket our construction permit application with the NRC to begin formal review for the Dow project later this year. Our first commercial scale fuel facility, the TX-1, is currently under licensing review by the NRC,[7] which remains on track to support the Dow project and we will complete construction and begin licensed operations in 2026. There are currently no commercial-scale fuel fabrication facilities in the U.S. capable of fabricating HALEU fuel (Category II facilities), and thus we believe the TX-1 will address a key gap in the advanced nuclear fuel supply chain.

Our partnership with Dow on ARDP is significant in several ways. Not only will this be the Global West's first grid-scale Gen-IV nuclear plant, and quite possibly the first commercial grid-scale small modular reactor deployed in the West, but it will be the first nuclear power plant to provide combined heat and power to a heavy industrial facility. Nuclear advocates have always discussed the promise of Gen-IV reactors achieving higher temperature, high enough to provide industrial process heat in addition to electricity. But, there has never been a true commercial demonstration of such an industrial deployment, because the technology and market were not ready. This decade, that will change.

Dow uses approximately 10 gigawatts of energy from fuel to produce heat, power, and steam at 25 major manufacturing sites worldwide – that's enough energy for more than 7 million homes, which is more than the number of homes in Michigan and Louisiana combined (6.64 MM homes). That energy powers more than 50 gas and steam turbines and boilers, as well as more than 100 furnaces around the world. Dow's corporate goals are to deliver a 30% reduction in scope 1 and 2 carbon emissions since 2005 by 2030, and to achieve carbon neutrality by 2050.

Out of these facilities, Dow selected Seadrift because it is an important manufacturing site for current and future products. The Seadrift site covers 4,700 acres and the Xe-100 nuclear plant will occupy a little over 30 acres in total. The site manufactures more than 4 million pounds of materials per year used across a wide variety of applications including food packaging and preservation, footwear, wire and cable insulation, solar cell membranes, and packaging for medical and pharmaceutical products. Dow currently operates three natural gas boilers that provide steam and electricity to the manufacturing facilities at Seadrift. This existing infrastructure is coming to the end of its useful life and will be replaced by a four-unit Xe-100 plant by the end of the decade. The four reactors will provide extremely highly reliable steam production to match Dow's expectation of greater than 99% reliable uptime for its operations. It will also provide all of the electricity required for the site, with the excess power sold into the Texas market, or to secondary off-takers. By deploying four 80 megawatt-electric reactors, Dow will be able to achieve the redundancy in power supply required to match its reliability requirements, while offering excess power into a market that is in need of excess firm capacity. Dow estimates that when deployed, the reactors will displace approximately 440,000 metric tons of CO2 emissions from the site annually.[8]

Navigating the deployment challenges will require continued engagement between the private sector and federal government, particularly around the financial and operating risks to early adopters of this technology. As Dow's Vice President of Energy and Climate, Edward Stones, testified recently before the U.S. Senate Energy and Natural Resources Committee:

"To realize the opportunity of advanced nuclear technology in the U.S., we see three key areas of risk and opportunity and they are all inextricably linked: fuel, timing, and budget.

[7] https://www.nrc.gov/info-finder/fc/triso-x.html & https://www.nrc.gov/info-finder/fc/triso-x/project-status.html

[8] https://x-energy.com/media/news-releases/dows-seadrift-texas-location-selected-for-x-energy-advanced-smr-nuclear-project-to-deliver-safe-reliable-zero-carbon-emissions-power-and-steam-production

1. Fuel Assurance: Concerns about the long-term availability and geopolitical issues related to uranium supply could impact the sustainability of nuclear power. Industrial customers need confidence that fuel supply will enable steady operation and operating costs.
2.Timing: Most industrial users will install advanced nuclear technologies to replace existing assets reaching end-of-life. Therefore, projects must be delivered on strict timelines. Ensuring that regulatory frameworks are adaptable and efficient is crucial to avoiding prolonged approval timelines.
3. Budget: Capital costs must be clear, competitive, and constant. Significant changes in timing affect costs. And the lack of a fuel source affects both timing and costs."

The ARDP program offers a unique pathway for the deployment of advanced reactors. However, we must recognize that these are first-of-a-kind reactors that require a strong public-private partnership through the delivery of the project. We must further recognize that circumstances and economic conditions change over time. For example, when ARDP was launched, we were in a pre-inflationary environment with infrastructure funding flowing freely and growth capital markets flush with investment. Since then, the global economic picture has changed substantially affecting all clean energy infrastructure projects, with the costs of materials, labor, and financing increasing substantially. The U.S. has only built only a handful of reactors in the past 30 years. This is why, in addition to a firm commitment to ARDP, we must also have a durable set of clean energy deployment incentives to support early movers in deploying new nuclear.

Historically, nuclear has not had equal treatment on the U.S. tax credit system to other technologies, despite its many positive attributes. For example, the Advanced Nuclear Production Tax Credit (PTC) that existed since the adoption of the Energy Policy Act of 2005, could not sufficiently move the needle to incentivize new nuclear projects – project Vogtle was the only new nuclear project to continue forward under that tax credit. Simultaneously, the Wind PTC and Solar Investment Tax Credit (ITC) rapidly incentivized the deployments of both wind and solar technologies enabling each to march down the cost curve and achieve substantial reductions in overall project cost. Those tax credits were further enhanced by state laws to enable, and sometimes require, the deployment of solar and wind. Today, we finally have tax credit parity under the Inflation Reduction Act. There is a single ITC and a single PTC available for any technology that is clean, putting new nuclear on the same level as wind and solar. This is moving the needle in the marketplace with customers. Such a technology-neutral tax credit is critically important for our customers to agree to move forward and take on early project development risk with an otherwise new technology. Furthermore, we are seeing states stepping up to further enable new nuclear, often with an emphasis on SMRs or advanced reactors in particular. Several states have removed previous prohibitions, many are in the process of studying policy mechanisms, and several are putting nuclear energy into their clean energy standards. You can find an updated list of active state policies and policy considerations in a compendium produced by my fellow panelist Maria Korsnick's Nuclear Energy Institute team.[9] For example, I currently serve on the Texas Advanced Nuclear Reactor Working Group, which operates under the Texas Public Utilities Commission, chartered by Texas Governor Abbott, and will make policy recommendations before the end of the year to the Governor and Legislature of Texas. It is critically important that the technology neutral clean energy incentives under the IRA be maintained.

Finally, the U.S. nuclear fuel supply chain is a shell of its former strength. Importantly, all steps in the supply chain, prior to fuel fabrication, were decimated over the past two decades by a combination of effects of global slumping demand for nuclear fuel (driven by Fukushima, political decisions to shut down reactors before the end

[9] https://www.nei.org/resources/reports-briefs/state-legislation-and-regulations

of their useful life (e.g. Germany), and a dearth of new deployments in the Global West) and state-owned enterprises in Russia and its allies strategically undercutting Western-based market participants. The effects were the lowest uranium mining records in U.S. history, an extended mothballing of the only U.S. nuclear fuel conversion facility (Honeywell's Converdyn facility), and the failure to launch of a U.S.-based enrichment company from the denationalization of our former federally-owned domestic enrichment company. The notable exception was the market entrance of Urenco USA, a U.S.-based subsidiary of Urenco, an enrichment company owned by the UK government, Dutch government, and two German utilities. However, even Urenco was not able to expand operations during this period due to sustained low fuel supply chain commodity prices. Now today, the advanced nuclear industry faces a further challenge – the only global supplier for the level of enrichment required in most advanced reactors, including both ARDP technologies, referred to as high-assay low-enriched uranium (HALEU), is the Russian state-owned enricher Tenex.

Fortunately, the U.S. Government has already begun supporting a solution, and utilities around the world are sending the market signal that they want off Russian and Russian-aligned suppliers. Under a DOE-funded program, the U.S. enrichment company Centrus has been able to successfully demonstrate HALEU enrichment at its Piketon, Ohio facility at pilot levels. Meanwhile, as directly authorized by the previously discussed Nuclear Energy Leadership Act, enacted as part of the Energy Act of 2020, the Department of Energy has begun implementing the HALEU Availability Program, with an existing total appropriation of $700 million to support the initial procurement of HALEU enrichment and deconversion services to help launch the domestic supply chain. While all engaged stakeholders agree that this is not enough money to build a successful program, Congress is currently considering over $2 billion in additional funding under bipartisan negotiations for the supplemental military aid supplemental, as the funding is directly tied to increasing our national security position by enabling U.S. nuclear fuel security. Furthermore, the U.S. led a group of five allies in announcing ambitions for a total of $4.2 in enrichment funding support on the sidelines of COP 28 just last month.[10] This was closely followed by a commitment from the United Kingdom (one of the five signatories) to make a 300 million pound investment in HALEU production domestically.[11] While DOE has worked closely with X-energy and Dow to secure sufficient supplies for several years of operations of our first plant, our fast-following customers need to see the development of the U.S. HALEU nuclear fuel supply chain and Dow needs security of supply for its long-term operations of the X-energy plant. We are at a critical crossroads and increased appropriations for securing our domestic nuclear fuel supply chains will greatly increase our likelihood of launching the U.S. advanced reactor industry and greatly enhance its perception in the global marketplace.

A full treatment of the HALEU supply chain issues and recommendations, consistent with my recommendations above can be found in the work of numerous non-partisan and partisan think tanks, including the excellent work of my fellow panelist Niko McMurray's team at ClearPath.[12]

I would like to make final point. The world is watching us. China has just started operating an HTGR under a project they began over a decade ago. In recent discussions with Emirates Nuclear Energy Corporation, they cited the value of actually being able to see the Chinese reactor operating. Similarly, both China and Russia are pursuing molten salt reactor designs. The race to globally dominate in an advanced nuclear energy world is on today and the combination of ARDP, a consistent and supportive technology-neutral tax credit policy like the ITCs and PTCs provided under the IRA, and the reestablishment of a U.S. nuclear fuel supply chain are the three

[10] https://www.energy.gov/articles/cop28-us-canada-france-japan-and-uk-announce-plans-mobilize-42-billion-reliable-global

[11] https://www.reuters.com/business/energy/britain-invest-300-mln-pounds-next-generation-nuclear-fuel-programme-2024-01-07/

[12] https://clearpath.org/our-take/re-establishing-american-uranium-leadership/

required features to enable U.S. innovators to catch up to Russian and Chinese state-owned enterprises. We must remain dedicated to the path that allows us to demonstrate here and deploy abroad.

- **Take-home message 1: We must deploy domestically before we can sell internationally, and U.S. deployment relies upon a fully implemented ARDP, a technology-neutral tax environment that enables the deployment of new clean energy technologies, and the redevelopment of a nuclear fuel supply chain that inspires confidence in U.S.-led energy security for our allies and partners.**

Market Segments

Industrial Heat and Power Generation

In the US, gross domestic industry represents nearly one-third of the total primary energy-related Greenhouse Gas and CO2 emissions annually. Of that one-third, nearly half come from the energy-intensive industrial sectors of petroleum process refining, chemicals manufacturing, iron and steel production, along with the production of cement-lime production, and even including food and beverage production.

Within petroleum refining and production, crude hydrocracking, distillation, and steam methane reforming represent the largest consumption of steam and electrical energy within the downstream process. Similar to petroleum refining, chemical processing and manufacturing methods also utilize a combination of both high-temperature process heat, often in the form of high-quality steam and electrical power. Iron and steel production represent one of the largest and most energy-intensive industrials within global commerce due to the amount of energy input required for the chemical reduction of iron. Meanwhile, the cement and lime production industry needs high levels of heat to perform calcination in kiln and other operations with large amounts of electricity to operate production facilities.

The use of nuclear energy to decarbonize the process heat and electricity requirements of the backbone sectors of American and international industrial commerce is a novel use case of nuclear power and a massive opportunity. Using nuclear energy will provide clean, carbon emissions-free process heat and electricity to the varied industry sectors with deep decarbonization of the hardest-to-abate sectors of the economy. Gen-IV Advanced SMRs such as the Xe-100 Plant, will demonstrate the best form, fit, and function to decarbonize power and heat generation for industrial applications that require electricity and high-temperature process heat. Furthermore, not all industrial commerce happens in convenient locations. X-energy's SMR offers the ability to site carbon-free, quality heat and power for remotely located campuses and facilities, at the point of need and highest demand, without the need for extensive cross country transmission infrastructure. As described above, our first project with Dow is bringing this former dream of the nuclear industry into reality and opening up markets that were never previously achievable.

X-energy is actively engaged and working with numerous industrial market customers who have recognized the global challenge to carbon and other greenhouse gas emissions and have already stepped up to decarbonize their industrial portfolio. X-energy is currently or has recently conducted work under contract to support projects within the steel manufacturing and hydrogen production industries and expects to soon begin work for customers in the oil and gas and mining sectors. For example, X-energy is currently performing a pre-feasibility assessment and study for a leading North American producer of iron and steel that wants to drive deep decarbonization within the steel producing industry. X-energy's scope of work includes performing feasibility, siting, and other advanced characterization and pre-investment studies to assess the overall suitability of the client's facilities to deploy the Xe-100 SMR.

Utility Power Generation - Baseload Generation

Global energy and electricity demand is up and continues to rise at a staggering pace as more and more e-technologies continue to develop. In opposition to the energy demand is the need to drastically reduce carbon and other greenhouse gas emissions within the power generation industry, and supply clean green decarbonized electricity to the national grid. Traditional power generating utilities across the globe are seeking advanced nuclear reactors as their most logical choice to meet the clean and carbon-free demand. Our utility customers are seeking a carbon-free baseload power source that can be located near their largest and most needed load center demands. X-energy is working with many global and domestic utilities with a varied pedigree of nuclear ownership and operations. Our DOE-ARDP fast-follower project is with Energy Northwest, in Richland, WA for a project to develop a minimum of four reactors and up to 12 Xe-100 SMR units on their central WA project site. Energy Northwest is a nuclear plant owner and operator, whose primary nuclear plant asset is the Columbia Generating Station. Just last week, Energy Northwest announced that Puget Sound Energy, a large investor-owned utility is investing $10 million in the project. X-energy is performing work today for Energy Northwest under contract to support the delivery of the project. Also previously announced is the selection of the Xe-100 by Grant Public Utility District, a member of Energy Northwest, which has stated its desire to bring online a four unit Xe-100 plant by 2032 at the latest, to be sited nearby in Central Washington State. While a few utilities like Energy Northwest and Grant PUD are moving forward with their projects, there are many more, including large traditional nuclear operators that we expect to begin deploying reactors in the mid-2030s. All utilities must struggle with the challenges of large light-water reactor deployment, as evidenced by the significant cost and schedule overruns at the Plant Vogtle AP1000 project. This has led several utilities to signal their desire to build SMRs through their IRP process such as Duke Energy,[13] Dominion Energy,[14] and Northwestern Energy[15] to name a few. While these utilities must find creative ways to move projects forward in light of their prudence doctrine requirements and regulatory oversight by state boards, there is a growing recognition of the role that SMRs must play in an economic decarbonized future U.S. grid and many utilities will look to deploy those SMRs that are most successfully demonstrated in the mid-2030s and beyond.

Utility Power Generation - Coal-to-Nuclear Transition

A specific business case within the power generation market segment, Coal-to-Nuclear (C2N) transition, is receiving great attention worldwide. Transitioning an existing coal-fired power generation asset at end of economic life, could be more affordable and feasible for new market entrants and could be a lower initial investment and capital expense. In general, the retrofit decarbonization of coal-fired power plants, usually includes three main options 1) Repowering of a coal power unit with a new low-carbon energy source, 2) Conversion of feedstock from coal to a new fuel source (i.e., natural gas), or 3) Installation of carbon capture at a coal power unit. Repowering and retrofitting a coal-fired power plant to operate carbon-free means replacing the fossil fuel energy source with a nuclear energy resource. That is, replacing the coal-fired boiler and combustion ancillaries with a nuclear island steam supply system consisting of a nuclear reactor and primary coolant circulation and heat exchange system. A similar approach has been demonstrated widely in switching from coal-to-natural gas which re-uses the steam and heat rejection systems while decommissioning the coal boilers and further installing natural gas turbines and a heat recovery steam generator(s). Retrofitting a coal-

[13] https://www.duke-energy.com/our-company/about-us/irp-carolinas

[14] https://www.dominionenergy.com/-/media/pdfs/global/company/desc-2023-integrated-resource-plan.pdf

[15] https://www.northwesternenergy.com/docs/default-source/default-document-library/about-us/erp-irp/2023_montana_irp_final.pdf?Status=Master/2023_Montana_IRP_Final.pdf & https://www.northwesternenergy.com/docs/default-source/default-document-library/about-us/regulatory/2022-south-dakota-irp.pdf

fired plant with a nuclear heat source is similar in reconstruction to the conversion and reconstruction using natural gas in that a coal-fired boiler is removed and replaced in whole by a nuclear steam supply system. However, in X-energy's experience, having conducted multiple C2N preliminary feasibility assessments, the utilization of much the available remaining generation infrastructure is often not economically viable due to fit or lifespan of existing equipment. Nonetheless, existing transmission infrastructure and rights-of-way, water infrastructure and water rights, available workforce, and community acceptance are all key features that could enhance a given project.

X-energy is currently or has recently conducted contract work for major, top-tier US and European utilities on C2N transition projects where the customer is seeking to transition and convert active coal power plant facilities and assets to generate electricity using an Xe-100 plant in place of the coal combustion systems and components, and potentially utilizing existing infrastructure. For each of these clients, X-energy is performing various facility and asset evaluations as well as system and component assessments. Our approach considers technical, regulatory, schedule, and risks, in addition to many other various key factors.

Datacenter and Cloud Infrastructure

The single largest demand growth driver in the developed world is the need for clean energy with high load reliability for datacenters and cloud computing infrastructure clientele. The increase in the amount of data created and the need for indefinite security and storage is exponential. Datacenters have grown from locally owned and operated, computer mainframe hardware/software components, with dedicated power constructs to modern, hyperscale, massive data processing and storage capacities, with high load demands for secure, reliable, and quality electrical power. Furthermore, modern hyperscale datacenters are geographically located facilities and campuses that serve data infrastructure for a multitude of clients and cloud-based enterprise and hyperscale demand is expected to rapidly grow based on the accelerating use of Artificial Intelligence. To put this in concrete terms, Dominion Energy's previously referenced IRP for Virginia is projecting annual electric load growth for the coming decades, heavily driven by data centers, to achieve percentage increases surpassing GDP growth and not seen since the U.S. grid was first developed.

Nuclear Project Structures and Financing

Nuclear projects are long-term commitments that require trust-building between vendors, customers, and financiers. They take many years to complete and substantial overnight capital investment. To put this in context, a typical Xe-100 project today takes about 7 years to achieve commercial operations from the start of significant work with a customer. The phases of nuclear project development generally fall into mostly sequential categories of feasibility, engineering, procurement, construction, and commissioning. Each phase increases the required capital expenditure (roughly in order-of-magnitude steps) for the customer, while simultaneously decreasing risk. Licensing spans this period, from early project environmental sampling and pre-licensing engagement through receipt of an operations license. Typically, the early years of project development require all equity investment, while later stages can be mostly funded through debt. This makes sense as debt enters the equation during the higher spend phases, which are also lower risk phases of the project.

For simplicity's sake imagine two nuclear projects, one is a large light-water reactor deployment for two gigawatt-scale reactors at a cost of $20-30 billion. The second is an SMR project of around 300 megawatts (an order of magnitude smaller) and a price tag of one-tenth, or $2-3 billion. Typical nuclear projects require 20-30% equity and 70-80% debt. As you can see, the first project requires a customer raise around $7.5 billion in equity and $22.5 billion in debt. These are substantial figures. As described above there are far fewer customers globally that can handle such a large equity investment in a nuclear project when compared to alternatives. Then even if the customer has the will and capacity for the equity investment, they will then need to find financing to support the debt portion of the project. This scale is an impediment to getting a project off the ground, which is why government and multi-lateral financial institutions are so important in global nuclear exports.

On the other hand, the SMR project requires an order of magnitude less equity and debt, $750 million and $2.25 billion, respectively (taking the higher end of the $2-3 billion range for argument's sake). These numbers are far more accessible for customers and financial institutions, which could enable the scale described above in the TAM discussion for SMRs. Nonetheless, these are still substantial figures. In the U.S. the applicability of the DOE Loan Program is of crucial importance in enabling projects and abroad, various national export financing mechanisms and multilateral banks (as discussed below) will play a critical role in enabling follow-on private financing of SMR exports.

One day we will see financing structures similar to those achieved today by renewables and natural gas power plants, in which new sources of capital seek to enter nuclear projects in a "project finance" model, with project developers leading the way and various levels of equity and debt joining projects from early investors, to traded infrastructure funds, to bonds and bank debt-financing. We believe that future is not far off, but it will not be achieved until we first demonstrate on-time and on-budget delivery of nuclear projects in the U.S.

International Financing Mechanisms

International financing mechanisms for civil nuclear projects are necessary for several reasons. Historically, nuclear has been considered a higher risk technology due to regulatory uncertainty, intervener risk, and the difficulty of not being able to transfer from one technology vendor to another to complete a project. As a result, commercial lenders seek guarantees or to only finance projects after a technology and vendor have been perceived to be de-risked. Moreover, some financial institutions, including multilateral governmental financial institutions like the World Bank have outright bans on loaning to nuclear projects as a matter of policy, often due to outdate perceptions of nuclear power. In this vacuum, Russia and now China have sought to force other nations' vendors out of the market by filling the role of both vendor and lender (and sometimes equity investor) by creating packaged deals that cut across their own technology and financial state-owned institutions. They will sell you a reactor and offer a low-interest loan with very generous terms to finance the deal, often with other *quid pro quo* strings attached.

The Export-Import Bank (ExIm) of the United States, or ExIm, is the primary source of U.S. financing for U.S. nuclear export projects. ExIm provides financing to foreign buyers as a function of the value of U.S. goods and services provided for individual nuclear projects. Exim's flexibility provides it with broad applicability in terms of countries and project sizes for financing nuclear projects. The nuclear industry relies on ExIm loans and guarantees to foreign buyers throughout the project lifecycle, including feasibility, engineering, procurement, and construction. ExIm can cover:

- The lesser of 85 percent of the value of all eligible goods and services in the U.S. supply contract or 100 percent of the U.S. content in all eligible goods and services in the U.S. supply contract;
- Between 30 and 50 percent of local costs, depending on the country;
- Valuable debt financing for pre-construction engineering work; and
- Loan terms of up to 22 years.

Once ExIm has committed to lend to a project, it is typically much easier to attract commercial lender participation. Putting it simply, knowledge of the nuclear industry is lacking among financial institutions broadly, especially private financial institutions. In a world where infrastructure lending leans conservative, private financial institutions will often look to the country of origin's government to understand if there is "skin in the game" as a signal of overall project risk.

ExIm is authorized through 2026, and it is fundamental to US commercial nuclear competitiveness that it continue to be thereafter, as it is often a necessary tool to counter generous foreign government support for Chinese and Russian state-owned competitors. While our terms will likely never match those provided by China and Russia, our technology could become the superior market option once again (as outlined above through U.S. demonstration of advanced nuclear technologies like the Xe-100), and the U.S. is the trustworthy partner. Therefore, if we can ensure that our ExIm tools are applicable to the broad range of new technologies under development, SMRs in addition to today's large light-water reactors, we will be well-positioned to again compete for global market share against our adversaries.

As China has become more active in supporting its export projects in third countries (see the well documented Belt and Road Initiative), Congress has authorized ExIm to match terms and compete through the China and Transformational Export Program in 10 transformational export areas. However, commercial nuclear energy is not included in the renewable energy, storage, and efficiency area eligible for support. Nor is there a similar program or authority to allow ExIm to match Russian offers that are subsidized or diverge from OECD financing standards. This situation allows Chinese and Russian companies an advantage that US suppliers do not today have the tools to counter. These authorities should be amended to allow nuclear technologies equal treatment among export energy technologies and to allow ExIm to match both Chinese and Russian terms in the marketplace.

Other agencies and tools while more focused in purpose and/or limited in capacity remain important. These include the:

- International Development Finance Corporation, which plays a significant role in providing debt <u>and equity</u> support for projects in countries with lower per capita GDPs;
- US Trade and Development Agency, which funds very early-stage feasibility projects, albeit with repayment terms for U.S. participants, which can be less useful in a world in which customers of nuclear technologies typically pay for project development work at-profit;
- US Department of State's Foundational Infrastructure for Responsible Use of Small Modular Reactor Technology (FIRST) program, which supports capacity building for SMR deployment in partner countries; and
- The many programs of the U.S. Department of Energy, U.S. Nuclear Regulatory Commission (NRC), and the U.S. Department of Commerce to advocate for U.S. nuclear exports and support knowledge transfer and capacity building bilaterally or through multinational programs like those of the OECD's Nuclear Energy Agency and United Nations' International Atomic Energy Agency.

These entities and programs play a key role in signaling the US Government's interest in and support for civil nuclear programs. As described above, customers and their governments look to such signals to determine the viability of a technology and vendor based on the support indicated by the exporting country's government.

One additional key challenge facing new technologies is the capability to license and regulate them efficiently. Today there is limited global capacity among regulators in emerging advanced nuclear reactor technologies. We have heard first-hand from customers, especially in Central and Eastern Europe who want to be early movers in deploying our technology, that this is a crucial impediment. When they speak to their own governments about deploying our technology they are met with a statement that the government will be required to build new capacity at its regulator to consider a HTGR technology and that it will not commit the resources to do so without a significant support from the U.S. Government.

However, working in our favor is the fact that the NRC will soon establish itself as the world's leading expert regulatory body regarding the Xe-100 and other advanced reactors, as we move through the regulatory process for our first projects. During this period, it is crucial that the NRC right size regulatory expectations for advanced reactor designs. As described above, Gen-IV reactors have inherent safety features that differentiate them from light-water reactors and they should be treated as such in the regulatory space. Congress and the U.S. NRC have indicated a desire to do just that through the adoption and work toward implementation of the Nuclear Energy Innovation and Modernization Act. While the first movers like X-energy (see ARDP) are expected to move forward under existing regulatory rules (commonly referred to as Part 50), they will do so through the implementation of the NEI 18-04 Regulatory Guide process and rely on exemptions from light-water reactor-specific rules and regulations, as applicable. Therefore, while the sale of a nuclear technology and financing for nuclear projects involves due diligence that includes the maturity of the regulator and regulatory environment in the host country, it will be critical to transfer this regulatory knowledge efficiently. Circling back to the original take-home message provided in this testimony, it is critical that our U.S. technologies be deployed successfully first here at home, and successful deployment includes the demonstration of a right-sized efficient regulatory process for Gen-IV reactors. Based on strong statements from the NRC commission and leadership and from the very recent successful review of the recent Kairos Power Hermes Demonstration (Test) Reactor,[16] X-energy believes that this demonstration will be achieved. Nonetheless, it will be important that advanced nuclear stakeholders, including Congress, remain vigilant as we work through the process.

Even with successful demonstration of regulatory processes in the U.S. knowledge must be transferred and follow-on nuclear markets' regulators must implement similarly right-sized regulatory approaches. While many in the nuclear industry have called for regulatory harmonization, we recognize the challenge of multilateral coordination between sovereign nations with distinct regulatory laws and the need for social license in perception and fact. Therefore, in our opinion, the best approach is to begin through bilateral coordination among top tier nuclear regulators, like those of our targeted initial markets (the U.S., Canada, and the U.K.). As evidenced by work recently completed and ongoing under the NRC-Canadian Nuclear Safety Commission Memorandum of Cooperation, we believe this is possible. If successfully demonstrated among some of the top tier nuclear regulators, it will likely be copied by future market regulators. Nonetheless, global implementation remains a great challenge.

If this expertise were deployed proactively, for example, through USNRC international cooperation programs helping targeted third countries to develop advanced reactor regulatory frameworks and licensing regimes that align with US frameworks and standards, it could pave the way for accelerated US exports. It is worth noting here that ExIm's financial due diligence requires assessment of the host country's regulator and regulatory framework. While the many support programs above are crucial to our collective success, the coordination across the U.S. interagency over an extended period remains a challenge faced daily by our advocates in the U.S. Government. Frankly, there is only so much total capacity within the U.S. Government to support nuclear exports and the opportunity is immense. Therefore, adoption and implementation of the bipartisan International Nuclear Energy Act would enable additional coordination and programs across the interagency to accelerate U.S. global nuclear deployment, including financing of projects abroad and be a strong signal of the commitment of the U.S. Government.

Finally, there are no alternatives to ExIm. Although there are many international agencies capable of financing entire civil nuclear export projects, many have outright bans on financing nuclear projects in place, as a matter of policy. Chief among these is the World Bank Group, which has outlawed lending to nuclear projects since the Obama Administration. The World Bank committed or deployed over $18B in non-nuclear energy and

[16] https://kairospower.com/external_updates/nuclear-regulatory-commission-approves-construction-permit-for-hermes-demonstration-reactor/

infrastructure projects in 2023 alone. It has the capacity to be a major driver in expanding U.S. nuclear energy exports, but it does not have the will to do so. This is a huge impediment. As described above, many financial institutions lack the technically expertise to assess nuclear projects from a financial risk perspective. They look to recent project as examples. If you have a conversation with anyone at a Wall Street bank, you will hear this directly. They will assess the prospects of a project, even a simplified design like the Xe-100 SMR in terms of recent large light-water reactor projects like the AP1000 project at Plant Vogtle. They take cues from governments, regulators, and other financial institutions (like government and multinational institutions) to assess risk of lending to a project. Meanwhile future models for financing, as described above, will be impossible to achieve without building confidence among financial institutions and demonstrating successful projects at home and abroad. Changing World Bank policy to allow nuclear financing would be an important first step.

The US is the largest contributor to the World Bank, providing ~10% of its annual support. Changing the anti-nuclear World Bank policy (and any other multinational financial institution in which the U.S. has influence) should be a priority for the every U.S. Administration and should be supported in bipartisan fashion by members of the U.S. House and Senate to ensure that all tools in the toolkit are available for the support U.S. nuclear exports.

- **Take-home Message 2: We must remove barriers to entry for new advanced nuclear technologies, first in the U.S. and then abroad**

- **Take-home Message 3: We must have all possible financing tools in the toolkit to support U.S. nuclear exports**

Leading From the Front

Four successive administrations have supported new nuclear. Not to be outdone, advanced nuclear legislation has been led by Congress in bipartisan and bicameral fashion. Through this period pro-nuclear policy has seen votes in the House and Senate often surpassing 90% in-favor, levels that would have seemed impossible even a decade ago. The support is driven by recognitions of the role of nuclear technology in national security and energy security and in meeting the global challenge of decarbonization. Nuclear power production will continue to grow globally and in Chinese and Russian nuclear exports will continue to grow in the vacuum that was left when the U.S. vacated the global nuclear marketplace. Today we have an opportunity to ride a wave of U.S. private-sector led and government-supported nuclear technology innovation back into our proper lead in the global nuclear marketplace. This opportunity will nonetheless be a great challenge to fully recognize. Therefore, continued support from the U.S. government to deploying our advanced nuclear technologies first here at-home, removing barriers to entry for new advanced reactor technologies here and abroad, and enabling all possible financing tools for U.S. nuclear exports are all required.

Therefore, I want to thank you for holding this important hearing and continuing bipartisan support for the U.S. trajectory back to the front of the global nuclear energy leadership pack. We are not there yet, but we are gaining speed. At fully velocity, no nation can match American innovators when they are sprinting. But, to get to and maintain full speed we need a continued commitment from the U.S. government.

That is leading from the front.

- **Take-home Message 4: We must lead from the front on nuclear energy.**