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BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEE ON ENERGY AND COMMERCE, ENERGY SUBCOMMITTEE HEARING ON AMERICAN ENERGY DOMINANCE: DAWN OF THE NEW NUCLEAR ERA

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Chairman Latta, ranking member Castor, and members of the subcommittee, thank you for the opportunity to testify today. My name is John Wagner, and I am the director of the Idaho National Laboratory (INL), the nation's nuclear energy research and development center. In this role, I lead a Department of Energy (DOE) national laboratory with more than 6,000 scientists, engineers, and support staff focused on changing the world's energy future and securing our nation's critical infrastructure.

I hold a Bachelor of Science degree in nuclear engineering from the Missouri University of Science and Technology and Master of Science and Doctorate degrees in nuclear engineering from the Pennsylvania State University. My career has been intimately involved with every aspect of the nuclear fuel cycle. My first position following graduate school was with a private company designing and licensing spent nuclear fuel storage and transportation systems. Later, during my 17-year tenure at Oak Ridge National Laboratory, I supported DOE and the Nuclear Regulatory Commission (NRC) on long-term storage, transportation, and disposal issues, ultimately serving as director of the Reactor and Nuclear Systems Division. I joined INL in February 2016, progressing from chief scientist for the Materials and Fuels Complex (MFC) to associate laboratory director for the Nuclear Science and Technology Directorate before becoming laboratory director. I am the author and co-author of more than 170 refereed journal and conference articles, technical reports, and conference summaries. I am a Fellow of the American Nuclear Society and the American Association for the Advancement of Science.

Thank you for inviting me to discuss a topic I care deeply about: American energy dominance through the new nuclear era.

OPENING: AMERICA'S NEW NUCLEAR ERA

Setting the Context

We stand at an unprecedented inflection point for American nuclear energy. For the first time in decades, market forces, national-security imperatives, and federal policy have achieved remarkable alignment. The question is no longer whether America needs nuclear energy, but how much, how quickly, and how to make it happen.

This moment differs from past nuclear "renaissances" in fundamental ways. Historic energy-demand growth driven by data centers and artificial-intelligence (AI) infrastructure, unprecedented private-sector investment flowing into nuclear technologies, the emergence of new innovative reactor developers and critical national-security needs requiring reliable baseload power have converged with bipartisan Congressional support and a federal commitment to removing decades of regulatory barriers.

The Urgency

The scale and timeline of what's required cannot be overstated. Secretary of Energy Chris Wright has outlined the administration's goal to "Unleash Commercial Nuclear Power in the United States" as a pillar of American energy dominance.[1] The policy imperative is clear: expand from 100 to 400 GW of nuclear capacity by 2050.[2] To achieve this, we must facilitate 5 GW of power uprates at our 94 existing reactors, restart shutdown reactors where possible, demonstrate and deploy the next generation of advanced microreactors and small modular reactors, and have at least 10 new large reactors under construction by 2030.

Four executive orders signed in May 2025 established the most-aggressive nuclear-deployment timelines in American history, with a goal of three reactors achieving criticality by July 4, 2026.[3] While ambitious, these timelines reflect the administration's recognition that the United States has fallen dangerously behind our global competitors in deploying new nuclear reactors.

China and Russia have advanced their nuclear capabilities while American deployment has stagnated for nearly 40 years, and they account for the vast majority of planned new reactors globally.[4] China and Russia account for 94% of all reactors currently under construction worldwide (59 of 63 units) and initiated 44 of 45 reactor construction starts globally from January 2020 through mid-2025. China alone has 32 reactors under construction, while Russia's state-owned Rosatom is building 27 units, including 20 reactors in seven other countries, dominating the international-export market.[5, 6, 7] China and Russia have engaged in successful nuclear diplomacy and have commercial nuclear export programs intended to reduce costs and increase certainty for countries interested in expanding existing nuclear programs and nuclear

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[1] Chris Wright, Secretarial Order, "Unleashing the Golden Era of American Energy Dominance." February 5, 2025. https://www.energy.gov/articles/secretary-wright-acts-unleash-golden-era-american-energy-dominance.

[2] Executive Order 14300, "Ordering the Reform of the Nuclear Regulatory Commission." May 23, 2025. https://www.govinfo.gov/content/pkg/FR-2025-05-29/pdf/2025-09798.pdf.

[3] Executive Order 14301, "Reforming Nuclear Reactor Testing at the Department of Energy." May 23, 2025. https://www.govinfo.gov/content/pkg/FR-2025-05-29/pdf/2025-09799.pdf.

[4] Daniel Helmeci and Jonas Goldman, "Reframing the U.S. Role in a New Nuclear Renaissance: Ensuring Flexibility in Fuel Procurement as a Counter to FEOC Influence." November 17, 2025. Carnegie Endowment for international Peace. https://carnegieendowment.org/research/2025/11/reframing-the-us-role-in-a-new-nuclear-renaissance-ensuring-flexibility-in-fuel-procurement-as-a-counter-to-feoc-influence?lang=en.

[5] International Atomic Energy Agency (IAEA), "Six Global Trends in Nuclear Power You Should Know." November 24, 2025. https://www.iaea.org/newscenter/news/six-global-trends-in-nuclear-power-you-should-know.

[6] World Nuclear Association, *World Nuclear Performance Report 2025*, January 2025. https://world-nuclear.org/our-association/publications/global-trends-reports/world-nuclear-performance-report.

[7] Mycle Schneider Consulting, World Nuclear Industry Status Report 2025: The Independent Assessment, Paris, France, September 2025. https://www.worldnuclearreport.org.

newcomers.[8] Competition for nuclear expansion is not limited to terrestrial applications. China's reported collaboration with Russia on a 1.5 MW nuclear reactor deployed on the moon by 2036,[9] demonstrates how our competitors are positioning nuclear technology as the foundation for long-term strategic advantage in space. We must reclaim nuclear leadership to project American values and standards globally.

PROGRESS: WHAT'S ACTUALLY HAPPENING ON THE GROUND

Legislative Wins Creating Momentum

Congress has provided critical bipartisan support through landmark legislation that has fundamentally reshaped the policy landscape for nuclear-energy deployment.

FY2026 National Defense Authorization Act (December 2025): The FY2026 National Defense Authorization Act provides critical statutory clarity for Department of Defense (DoD) nuclear-energy deployment. Section 318 designates an executive agent within the DoD for installation and operational nuclear energy, establishing clear organizational responsibility for what has historically been fragmented across multiple DoD components. This designation creates a single point of accountability for military nuclear power policy, procurement strategy, and operational oversight—addressing the coordination challenges that have slowed military-microreactor deployment. Section 321 establishes a 10-year Navy small modular reactor (SMR) pilot program to evaluate SMRs and microreactors for Navy shore-installation energy needs, building on the Navy's unparalleled nuclear expertise while creating pathways for broader military adoption of advanced reactor technologies.

These provisions directly support the Army's Project Janus plans to deploy microreactors at multiple military bases by 2028, providing the organizational structure and demonstration framework necessary to move from concept to operational deployment. Military nuclear power deployment serves dual purposes: meeting critical defense energy-security needs while serving as a pathfinder for commercial applications, demonstrating reactor technologies in demanding operational environments, and building the trained workforce that will support broader civilian deployment.

ADVANCE Act (July 2024)[10]: The Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act represents some of the most-significant nuclear energy legislation since the Atomic Energy Act. The ADVANCE Act sought to modernize the NRC through comprehensive reforms that address longstanding barriers to advanced-reactor

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[8] Sarah Sobalvarro, "US Inaction Is Ceding the Global Nuclear Market to China and Russia." April 2, 2025. Wilson Center. https://www.wilsoncenter.org/article/us-inaction-ceding-global-nuclear-market-china-and-russia.

[9] Bhavya Lal and Roger Myers, "Weighing the Future: Strategic Options for U.S. Space Nuclear Leadership." INL/RPT-25-85616. https://inl.gov/content/uploads/2023/07/Weighing-the-Future_Strategic-Options-for-U.S.-Space-Nuclear-Leadership.pdf.

[10] Public Law 118-67, Division B, "Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy." July 9, 2024. https://www.congress.gov/118/plaws/publ67/PLAW-118publ67.pdf.

deployment. The Act mandates that the NRC update its mission statement to reflect modern beneficial use of nuclear material and not "unnecessarily limit" nuclear energy benefits, establishing a regulatory philosophy that balances safety with enabling innovation. This update was approved on January 24, 2025, and the new mission statement reads: "The NRC protects public health and safety and advances the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment."[11]

It establishes efficient, timely, and predictable licensing review structures that provide the certainty investors require for project financing decisions. Critically, the Act requires completion of licensing reviews within 18 months for certain new reactors, eliminating the open-ended timelines that have historically plagued nuclear projects. To reduce financial barriers for innovative companies, it cuts licensing fees for advanced reactor applicants by 50%, recognizing that smaller companies developing novel designs cannot bear the same regulatory cost burden as established utilities. Finally, it streamlines National Environmental Policy Act (NEPA) environmental review processes, addressing costs and potential delays even when environmental impacts were minimal.

Prohibiting Russian Uranium Imports Act (May 2024)[12]: This Act, banning imports of low-enriched uranium from Russia beginning August 2024, unlocked $2.72 billion for domestic low-enriched uranium (LEU) and high-assay, low-enriched uranium (HALEU) production, in addition to $700 million specifically for HALEU from the Inflation Reduction Act. This investment addresses one of our most-critical vulnerabilities: virtually all uranium currently used in American reactors is imported, with Russia supplying approximately 25–27% of enrichment services—posing a threat to national security.[13] By simultaneously cutting off adversary supply and funding domestic alternatives, this legislation charts a course toward fuel independence that strengthens both energy security and national security.

Further Consolidated Appropriations Act, 2024 (March 2024): The Act extends Price-Anderson Act nuclear-hazards indemnification coverage through 2045, providing the liability protection essential for both existing and new nuclear facilities. It further broadens and increases this coverage for work performed overseas, supporting U.S. nuclear work abroad.

Infrastructure Investment and Jobs Act (November 2021) and Inflation Reduction Act (August 2022): The 117th Congress provided substantial federal support for nuclear energy through complementary legislation that addresses both immediate economic challenges facing the existing fleet and longer-term deployment barriers for advanced reactors. Together, these bills deliver over $40 billion in direct funding and tax incentives that are reshaping the economics of nuclear power in the United States. The bipartisan Infrastructure Investment and Jobs Act established the $6-billion Civil Nuclear Credit Program to prevent premature closure of

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[11] NRC News Release, "NRC Approved Updated Mission Statement." January 24, 2025. https://www.nrc.gov/cdn/doc-collection-news/2025/25-005.pdf.
[12] Public Law 118-62, "Prohibiting Russian Uranium Imports Act." May 13, 2024. https://www.congress.gov/118/plaws/publ62/PLAW-118publ62.pdf
[13] "US Nuclear Fuel Cycle." World Nuclear Association. November 20, 2024. https://world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-fuel-cycle.

economically viable reactors threatened by wholesale-electricity-market conditions that fail to value reliability and carbon-free generation. The Act appropriated $2.4 billion for advanced-reactor demonstration projects, including substantial support for TerraPower's Natrium reactor in Wyoming and X-energy's Xe-100 deployment while providing additional support for microreactor development, SMR deployment, and critical investments in rebuilding America's nuclear fuel supply chain.

The Inflation Reduction Act created production and investment tax credits that fundamentally improve nuclear energy's competitive position in electricity markets. These credits—estimated to provide approximately $30 billion in support for existing plants over their remaining operational lives—signal recognition of nuclear energy's contribution to grid reliability and carbon reduction in ways that wholesale electricity markets historically have not. For new nuclear projects, the investment tax credits make project economics viable for the first time in decades by reducing the capital-cost burden that has deterred investment despite nuclear's operational advantages. By addressing the economic challenges that have historically undermined nuclear development—both the premature retirement of existing assets and the inability of new projects to compete against subsidized alternatives—these legislative achievements ensure nuclear energy remains available to meet the nation's growing electricity demands while providing the reliable, carbon-free power essential for grid stability, economic growth, and the AI infrastructure that will drive 21st-century competitiveness.

These legislative achievements demonstrate unprecedented bipartisan recognition that nuclear energy is essential for national security, economic competitiveness, and clean-energy goals.

Executive Orders Accelerating Action

The four nuclear energy executive orders signed May 23, 2025, represent the most comprehensive reform in American history:[14]

1. **Reinvigorating the Nuclear Industrial Base (EO 14302):** This order establishes America's path to nuclear energy dominance by securing fuel supply chains, expanding domestic uranium capabilities, and leveraging the Defense Production Act to build nuclear-industry consortia. It directs comprehensive action on everything from mining and enrichment to recycling and reprocessing.

2. **Reforming Nuclear Reactor Testing at DOE (EO 14301)**: This order finds that design, construction, and operation of non-commercial advanced reactors under DOE control are for research purposes; thus, they fall within DOE jurisdiction. It creates the Reactor Pilot Program with a goal of at least three reactors achieving criticality by July 4, 2026, and authorizes DOE to expedite qualified test reactors to operational status within two years of substantially complete applications. The order explicitly recognizes that "The Idaho

[14] "9 Key Takeaways from President Trump's Executive Orders on Nuclear Energy." U.S. Department of Energy, Office of Nuclear Energy. June 10, 2025. https://www.energy.gov/ne/articles/9-key-takeaways-president-trumps-executive-orders-nuclear-energy

National Laboratory has principal responsibility for constructing and testing new reactor designs."

3. **Ordering the Reform of the Nuclear Regulatory Commission (EO 14300)**: This order mandates comprehensive regulatory reform, directing the NRC to complete rulemakings within 18 months, provide final decisions within 18 months for new reactors, adopt science-based radiation limits, and establish expedited pathways for reactors tested by DOE and DoD. It will accelerate many reforms identified in INL's April 2025 report, "Recommendations to Improve Nuclear Licensing."

4. **Deploying Advanced Nuclear Reactor Technologies for National Security (EO 14299)**: This order positions nuclear energy as critical defense infrastructure. The Army must establish nuclear-reactor operations at a military base by September 2028, DOE must deploy advanced reactors within 30 months, and the State Department will pursue 20 new international nuclear-cooperation agreements.

These four nuclear-specific executive orders were accompanied by Executive Order 14303, "Restoring Gold Standard Science," which establishes principles applicable across all federal scientific activities, including nuclear regulation. The Gold Standard Science order directs that federal agencies ensure their scientific activities are "skeptical of findings and assumptions" and critically, that "highly unlikely and overly precautionary assumptions and scenarios should only be relied upon in agency decision-making where required by law or otherwise pertinent to the agency's action." This principle has direct relevance to nuclear regulation, where decades of overly conservative assumptions have imposed substantial costs without commensurate safety benefits. The order's requirement to acknowledge scientific uncertainties, communicate data accurately, and avoid unnecessarily precautionary approaches provides additional foundation for the comprehensive regulatory reforms directed in the nuclear-specific orders. Together, these executive orders create a comprehensive framework for accelerating nuclear deployment while ensuring regulatory decisions rest on sound scientific evidence rather than unnecessarily conservative assumptions.

Under Executive Order 14301, DOE established the **Reactor Pilot Program** to accelerate reactor demonstrations through streamlined authorization pathways. As of December 2025, ten companies and eleven projects have been selected as participants: Aalo Atomics, Oklo, Radiant, Antares, Natura Resources, Deep Fission, Terrestrial Energy, Last Energy, Valar Atomics, and Atomic Alchemy.[15]

We are witnessing accelerated progress towards achieving rapid deployment, facilitated by the streamlining of bureaucratic barriers, meanwhile maintaining our high levels of nuclear safety and security. I am optimistic that we will see three reactor criticalities by July 4 of this year and that these reactors will demonstrate that achievement with full adherence to the longstanding gold standard of safety and security we expect from American reactors.

[15] U.S. DOE, "U.S. Department of Energy Reactor Pilot Program." Accessed January 2026 https://www.energy.gov/ne/us-department-energy-reactor-pilot-program.

Multiple reactors are targeting the July 4, 2026, criticality deadline, many with support from INL and other national laboratories, demonstrating the program's momentum.[16] Similarly, DOE's **Fuel Line Pilot Program** is accelerating domestic fuel fabrication by establishing a domestic nuclear-fuel supply chain under DOE authorization to build and operate nuclear-fuel production lines for research, development, demonstration, and expedited commercial-licensing pathways. Five companies have been selected: TRISO-X (X-energy), Oklo, Terrestrial Energy, Standard Nuclear, and Valar Atomics.[17]

PROMISE AND CURRENT STATUS OF ADVANCED NUCLEAR TECHNOLOGIES

Nuclear Fundamentals Refresher

For members less familiar with nuclear technology, a brief explanation to put the accelerated timetables described above and the promise of these projects into perspective. Put very simply, nuclear fission occurs when an atom's nucleus splits, releasing enormous amounts of energy. When enough fissile material is assembled in the right configuration, it achieves "criticality," which is a sustained fission chain reaction. Reactors are carefully designed systems that control this process to generate heat, which produces electricity.

Most advanced-reactor designs build on concepts demonstrated decades ago, including many proven at INL. The development process follows a structured path from initial product development and investment, as in any industry, through design and technology development, through critical experiments (demonstrating the physics), dry or low-power criticality (operating a critical reactor without generating significant power and without introducing coolant), and finally a fully operational power system generating electricity. This progression allows us to validate safety and performance at each stage before moving to the next.

This reactor-development process is highly interdependent with the reactor-physics, nuclear-materials and fuels research, and research and development cycle conducted at INL, other national laboratories, and universities. This yields essential data to inform the design process, safety analysis, and qualification of materials and fuels. It is also reliant on the fuel cycle to provide fuel materials and to ensure that fuel is fabricated and ready for a reactor design at each phase of development.

These interdependencies underscore why achieving the aggressive timelines outlined in this testimony requires unprecedented collaboration across the entire nuclear-innovation ecosystem. National laboratories provide specialized testing infrastructure and research expertise, universities advance fundamental science while training the workforce, and private companies bring innovation and commercial discipline. When these sectors work in true partnership, sharing

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[16] Nuclear Newswire. "The progress so far: an update on the Reactor Pilot Program. November 14, 2025. https://www.ans.org/news/2025-11-14/article-7543/the-progress-so-far-an-update-on-the-reactor-pilot-program/.
[17] U.S. DOE, "U.S. Department of Energy Fuel Line Pilot Program." https://www.energy.gov/ne/energy-department-fuel-line-pilot-program.

data, facilities, and expertise, we can compress development cycles that historically took decades into timeframes measured in years.

Real Reactors, Real Progress

In addition to the projects in the Reactor Pilot Program, other reactor experiments and demonstrations are also making significant progress and providing lessons learned to support industry.

Microreactor Applications Research Validation and EvaLuation (MARVEL)[18]: This 85 kW DOE test reactor has helped us reestablish our ability to develop new reactor systems. MARVEL provides a research platform for understanding microreactor applications while supporting licensing, environmental assessments, and deployment strategies. Recent milestones include completion of the Primary Coolant Apparatus Test in May 2025, submission of the updated Preliminary Documented Safety Analysis in September 2025, and start of fuel fabrication at TRIGA, International, in November 2025, with initial dry criticality targeted for calendar year 2026.

Project Pele: Developed by BWXT for the DoD, Pele is a mobile microreactor delivering 1–5 MW of electrical power that will help our armed forces reduce dependence on diesel fuel in remote or emergency locations. INL received TRISO fuel, a fuel form enabled through collaborative R&D at national laboratories with private industry, in November 2025, validating the fuel supply chain and paving the way for military and eventual commercial applications. Full-power demonstration operations are planned for late 2028 at INL's Critical Infrastructure Test Range Complex, with early 2028 initiation of testing.

Molten Chloride Reactor Experiment (MCRE): In partnership with Southern Company and TerraPower, INL will conduct the world's first fast-spectrum molten-salt reactor experiment. The partnership successfully completed the first production of fuel for such a reactor in 2024 and achieved the first full-scale production of enriched fuel salt in Fall 2025 via the newly installed Fuel Salt Synthesis Line. Production of the required fuel salt batches using the synthesis line is scheduled for completion by September 30, 2026, with the reactor-experiment startup targeted for 2028.

Test-Bed Infrastructure to Support Deployment

State-of-the-art research infrastructure is fundamental to American technological leadership. INL's test beds streamline the path from concept to deployment.

Demonstration of Microreactor Experiments (DOME): The decommissioned EBR- II facility is being repurposed as DOME, with construction completion anticipated by March 31, 2026, on a timeline accelerated by almost a year to meet the goals of the executive orders. This facility will enable rapid microreactor demonstrations in existing infrastructure, significantly reducing time and cost compared to greenfield construction. DOME is designed for advanced microreactors up to 20 MWth using HALEU fuels. The facility is scheduled to be ready for

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[18] Learn more at https://inl.gov/marvel/.

installation of the first demonstration system in April 2026. To support reactor testing in DOME, INL is developing a reactor-testing ecosystem that includes facilities for fueling, transporting, defueling, and decommissioning reactors. Radiant's Kaleidos Demonstration Unit (KDU) is the first reactor scheduled for installation and testing in DOME in Spring 2026.

Laboratory for Operation and Testing in the United States (LOTUS): The LOTUS test bed will host experimental microreactors up to 500 kWth that require an enhanced security posture, providing a safe environment for developers to test nuclear systems going critical for the first time. LOTUS will help accelerate development timelines and reduce costs for private industry as they work toward commercializing their technology. The Molten Chloride Reactor Experiment (MCRE) is the first experiment to be performed in LOTUS in 2028 to provide information to support the development of the Molten Chloride Fast Reactor. Current efforts are underway to streamline costs and schedule to meet the accelerated demand for testing this innovative technology.

Reactor and Critical Experiment Facility (RACE): To be developed to support defense and space reactor systems including Antares' reactor experiments and future projects, the RACE facility currently supports MFC sodium-waste-management activities. The facility structure originally housed the ML-1 reactor in the 1960s and will undergo anticipated modifications to support upgrade to Hazard Category 2 nuclear facility status.

System Physics Advanced Reactor Critical Facility (SPARC): SPARC will reclaim U.S. capability for large-scale critical experiments using a horizontal split table (HST), which provides a flexible experimental capability for nuclear-physics testing of new fuels. The facility will support licensing, deployment, and optimization of advanced fuels and reactors, enhance criticality-safety research infrastructure, and has received strong industrial support that demonstrates its direct relevance to executive-order implementation. INL is leading engineering, installation, and future operations, with collaborative support from Oak Ridge National Laboratory, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory.

Nuclear Energy Launch Pad: This initiative represents a comprehensive approach to accelerating deployment by providing an integrated demonstration platform for nuclear technology developers. The launch-pad concept integrates site access, infrastructure support, regulatory guidance, and technical expertise to reduce barriers for private-sector innovation. By consolidating resources and streamlining processes, it enables multiple companies to move from design to demonstration simultaneously.

This initiative represents a transformative approach to accelerating advanced nuclear deployment by addressing the critical "demonstration gap" that has historically impeded the transition from laboratory validation to commercial operation. Launch Pad establishes the nation's first modern comprehensive nuclear-demonstration ecosystem—a 2,300-acre dedicated site at INL specifically designed to support privately funded advanced nuclear facilities across the full spectrum of reactor demonstration and fuel-cycle activities.

Launch Pad's scope encompasses the entire nuclear enterprise. The site will accommodate advanced reactors of diverse designs and scales, fuel-fabrication facilities for new fuel forms, fuel-recycling and reprocessing operations, and other innovative nuclear technologies. The

Launch Pad concept leverages the successful NASA Stennis and Marshall Space Flight Center models to fundamentally reimagine how the United States supports nuclear innovation by consolidating resources that individual developers cannot efficiently duplicate. Rather than requiring each company to independently navigate site characterization, environmental reviews, infrastructure development, and regulatory pathways—a process that typically consumes years and millions of dollars—Launch Pad provides established frameworks and shared infrastructure that allow developers to focus resources on advancing their core technologies.

Launch Pad provides demonstration and deployment flexibility that accommodates different business models and regulatory strategies. Developers can choose between DOE authorization pathways that accelerate demonstration timelines or pursue NRC licensing for facilities intended for commercial power production or services. This dual-pathway approach recognizes that different technologies and business models require different regulatory frameworks while they maintain an option to transition from DOE-authorized demonstrations to NRC-licensed commercial operations as technologies mature. Successful demonstrations under DOE authorization provide validated operational data and regulatory precedents that advance subsequent NRC licensing and commercial deployment at private sites.

By providing an integrated platform for reactor development, fuel fabrication, and fuel recycling demonstrations, Launch Pad positions the United States to recapture end-to-end reactor and fuel cycle capabilities that have atrophied during decades without domestic demonstration and deployment. This comprehensive approach ensures that, as advanced reactors mature toward commercial deployment, the supporting fuel-cycle infrastructure—from fuel fabrication through recycling and waste management—matures in parallel, eliminating the sequential dependencies that have historically delayed nuclear innovation.

These facilities represent decades of federal investment and cannot be rapidly replicated. They provide American companies with capabilities unavailable anywhere else in the world, creating a competitive advantage in global reactor markets.

Opportunities for Large Reactors

While advanced reactors generate significant attention, proven large reactor designs remain essential for achieving 400 GW by 2050. The Westinghouse AP1000 represents a mature technology that can be deployed at scale. Currently, six AP1000 reactors are operating worldwide—four in China (two each at Sanmen and Haiyang nuclear power plants) and two at Vogtle in Georgia—with an additional 11–12 units under construction in China.[19] The AP1000 design has achieved significant international momentum beyond these operating units. Poland selected AP1000 technology in November 2022 for its first nuclear power plant, with three units planned at the Lubiatowo-Kopalino site in Pomerania, representing approximately $47 billion in

[19] Westinghouse Electric Company, "Four Additional Westinghouse AP1000 Reactors to be Built in China." September 6, 2023. https://info.westinghousenuclear.com/news/four-westinghouse-ap1000-reactors-in-china.

total investment, with first commercial operation targeted for 2033.[20] Ukraine has committed to nine AP1000 reactors, with construction activities initiated at Khmelnitsky Unit 5 in April 2024 as the first of a planned fleet that will replace aging Soviet-era reactors and enhance the nation's energy independence.[21] Bulgaria selected the AP1000 in 2023 for two units at its Kozloduy site, with commercial operation anticipated around 2035.[22] Additional AP1000 projects are under evaluation in India, the Netherlands, and multiple other sites across Central and Eastern Europe and North America.

Pathway to Scaled Deployment

The successful completion of Vogtle Units 3 and 4 has established a foundation for accelerated AP1000 deployment. An August 2024 INL analysis identified 65 potential sites across the United States, finding that 18 sites are particularly promising for near-term AP1000 deployment, with an additional 29 sites having strong potential.[23]

Cost Reduction Trajectory

Learning from the construction challenges of these first-of-a-kind projects in the United States, subsequent AP1000 builds can achieve dramatically improved cost and schedule performance through several key improvements. Standardized designs will eliminate the engineering changes during construction that plagued Vogtle and Summer because the design is now complete and NRC-approved. Modular-construction techniques proven during recent builds can be replicated and refined, reducing field assembly time and improving quality control. An experienced construction workforce now exists with direct Vogtle experience, and established supply chains for major components eliminate the development costs and delays that affected first units. Finally, regulatory familiarity gained through the Vogtle licensing process significantly reduces licensing uncertainty for subsequent projects because both the NRC and applicants now understand AP1000-specific requirements and review processes.

Industry analysis suggests subsequent AP1000 deployments could achieve 25–55% construction-cost reductions relative to Vogtle.[24] Some observers noted that Vogtle Unit 4 may have realized approximately 30% cost savings compared to Unit 3, demonstrating the learning curve in action. DOE analysis in the "Pathways to Commercial Liftoff: Advanced Nuclear" report projects that

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[20] U.S. Department of Energy, "United States Signs Agreement to Advance American Civil Nuclear Deal in Poland." April 28, 2025. https://www.energy.gov/articles/united-states-signs-agreement-advance-american-civil-nuclear-deal-poland

[21] World Nuclear News, "Work under way for first Westinghouse AP1000 in Ukraine." April 15, 2024. https://www.world-nuclear-news.org/Articles/Work-under-way-for-first-Westinghouse-AP1000-in-Uk.

[22] Westinghouse Electric Company, "Westinghouse Signs Contract for Engineering of AP1000 Reactors in Bulgaria." Press release, November 4, 2024. https://info.westinghousenuclear.com/news/westinghouse-signs-contract-for-engineering-of-ap1000-reactors-in-bulgaria.

[23] Bradley J. Williams, John C. Wagner, and Jess C. Gehin, "Opportunities for AP1000 Deployment at Existing and Planned Nuclear Sites." Idaho National Laboratory. INL/MIS-24-80216. https://inldigitallibrary.inl.gov/sites/STI/STI/Sort_128167.pdf.

[24] Ryan Spangler, Summing Qin, Levi Larsen, Chandu Bolisetti, Abdalla Abou-Jaoude, Mehdi Asgari, Koroush Shirvan, W. Robb Stewart, James Krellenstein, and Garrett Wilkinson, "Potential Cost Reduction in New Nuclear Deployments Based on Recent AP1000 Experience." Idaho National Laboratory. INL/RPT-25-84701. https://sai.inl.gov/content/uploads/29/2025/06/M3_SAI-AP1000_Lessons_Rev6-nocomments-002.pdf.

the next AP1000 could achieve levelized costs under $100/MWh, and approach approximately $60/MWh when combining possible incentives with construction improvements that include shorter build times (six years versus Vogtle's 11 years) and reduced overnight capital costs (targeting $8,300/kW). [25] This trajectory suggests that a robust AP1000 construction program could achieve highly competitive economics while providing the reliable, carbon-free baseload power essential for meeting our 400 GW goal and supporting the AI and data-center infrastructures that will drive 21st-century economic competitiveness.

Opportunities for Small Modular Reactors

SMRs are generally defined as nuclear power reactors with electric output levels of approximately 300 MWe or less, designed for modular manufacturing and scalable deployment. These attributes support improved construction certainty, incremental capacity additions, and greater siting flexibility compared to traditional large nuclear plants. The SMR concept was developed and advanced largely in the United States, where a broad portfolio of both Generation III+ light-water and advanced-reactor technologies is now emerging. U.S. Generation III+ SMR designs include NuScale's Power Modules, Holtec International's SMR-300, GE Hitachi's BWRX-300, and Westinghouse's AP300. In parallel, the United States is leading development of advanced-reactor technologies, including X-energy's Xe-100 high-temperature gas-cooled reactor, Kairos Power's fluoride-salt-cooled reactor program—for example, the Hermes 2 test reactor—and TerraPower's Natrium sodium-cooled fast reactor. This last, at approximately 345 MWe, is slightly above the conventional SMR threshold, but it is often considered within this category due to its modular design and integrated energy storage that enhances grid flexibility.

Several U.S. SMR and near-SMR designs are advancing through licensing and early deployment, both domestically and internationally. GE Vernova Hitachi's BWRX-300 is under construction at Ontario Power Generation's Darlington site in Canada, positioning it as one of the most-advanced SMR projects globally, with first operation expected later this decade. The DOE recently announced two Generation III+ SMR cost-shared awards of up to $400 million each to accelerate domestic deployment, one supporting Holtec's plan to deploy SMR-300 units at the Palisades site in Michigan, and one supporting the Tennessee Valley Authority's planned SMR deployment at the Clinch River site in Tennessee. Internationally, U.S. SMR technologies are gaining traction worldwide, including the BWRX-300 planned deployments in Poland, Westinghouse's AP300 engagement in the United Kingdom, Romania's advancement of NuScale Power's VOYGR SMR project at the Doicești site, and emerging SMR engagements in countries such as Ghana. Together, these developments highlight U.S. leadership in SMR innovation and the growing global demand for American nuclear technology to support energy security and economic competitiveness.

Fuel-Cycle Onshoring

A comprehensive nuclear strategy requires addressing the entire fuel cycle. A highly anticipated deliverable required by Section 3 of EO 14032 is a comprehensive report on spent-fuel

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[25] U.S. DOE, *Pathways to Commercial Liftoff: Advanced Nuclear*, September 2024. https://gain.inl.gov/content/uploads/4/2024/11/DOE-Advanced-Nuclear-Liftoff-Report.pdf.

management and recycling. This report is expected to recommend restarting a disposal program, piloting a recycling demonstration, and exploring a range of fuels for advanced reactors.

HALEU Production: HALEU (uranium enriched to 5–20% U-235) enables advanced-reactor designs to achieve smaller physical footprints with improved efficiency. Currently, no commercial-scale HALEU production exists in the United States. As discussed above, Congress has taken actions to specifically addresses this constraint.

INL supplies small quantities of HALEU to industry from its existing inventories for fuel qualification and testing. This material, recovered and downblended from highly enriched uranium, provides a bridge supply while commercial capabilities develop. Scaling to commercial volumes remains a critical priority.

The Centrus enrichment demonstration facility in Ohio began limited HALEU production in October 2023 and, as of June 2025, has produced 900 kg of HALEU, the first HALEU enrichment production in the United States in over 70 years.

Fuel Line Pilot Projects: Beyond the examples already discussed, additional fuel-line projects are advancing to support diverse reactor designs. Each demonstration validates processes that can be replicated and scaled commercially.

INL's Fuel Cycle Capabilities: The MFC at INL represents unmatched fuel-cycle research infrastructure. The Hot Fuel Examination Facility enables post-irradiation examination of spent fuel to understand performance and failure mechanisms. The Fuel Cycle Facility produces HALEU from spent nuclear fuel from EBR-II by pyroprocessing this DOE-owned sodium-bonded metal fuel. Several other INL facilities support material recovery, waste-form development, fuel fabrication, and other fuel-cycle research needs to support the current reactor fleet, advanced-fuel development, and expansion of recycling and reprocessing technologies.

Updating the Nuclear Waste Policy Act: The Nuclear Waste Policy Act of 1982, as amended in 1987, reflects national priorities and circumstances from four decades ago. Despite various attempts to modernize it over the years, none has succeeded in establishing a framework adequate for today's challenges and tomorrow's opportunities. The present approach to interim storage and disposal was designed for a very different nuclear landscape—one dominated by large light-water reactors, with no consideration of advanced-reactor fuel cycles, potential recycling pathways, or the need for consolidated interim storage while permanent disposal solutions are developed.

A new policy framework is needed to address the full spectrum of spent-fuel management challenges facing our expanding nuclear enterprise. This must include clear pathways for consolidated interim-storage deployment that can accept spent fuel from decommissioned reactors and provide centralized management while permanent disposal facilities are sited and constructed. It must establish viable deep geologic disposal pathways that reflect current scientific understanding and international best practices. The framework must account for advanced-reactor spent-fuel characteristics that differ significantly from current light-water reactor fuel in terms of composition, burnup, decay heat, and long-term radiotoxicity. Finally, it should address potential recycling and reprocessing strategies that could reduce waste volumes, recover valuable materials, and support closed fuel cycles for advanced reactors.

As I testified before the Senate Committee on Energy and Natural Resources in November 2023, only Congress can provide this updated framework. The technical community—including the national laboratories, the Nuclear Waste Technical Review Board, and the broader scientific establishment—can inform policy debates with data, analysis, and international experience. However, the fundamental policy choices about storage locations, disposal approaches, and fuel-cycle strategies require legislative action that balances technical feasibility with public acceptance, economic considerations, and regional equity.

CHALLENGES: WHAT'S STANDING IN THE WAY

Fuel Cycle Bottlenecks

As mentioned above, the current state of America's nuclear fuel cycle represents a critical vulnerability that must be addressed urgently. We import virtually all of the uranium used in American reactors, maintain limited domestic enrichment capacity—with only one facility capable of meeting approximately one-third of current fleet needs[26]—and possess virtually no commercial-scale HALEU-production capability. This dependence on foreign sources particularly from adversary nations creates both national-security risks and supply-chain uncertainties that threaten our energy security and ability to achieve deployment goals.

The Russian ban and associated $2.72 billion funding represent significant progress toward addressing these vulnerabilities, but execution timeline is critical to success. Building enrichment capacity typically requires 7–10 years from design to full operation, meaning investments made today will only begin producing material in the early 2030s. We must therefore expand aggressively across multiple parallel pathways to ensure adequate supply. Urenco's New Mexico facility plans a 0.7 million separative-work-unit expansion by 2027, providing near-term capacity increases for the existing fleet. Orano's Oak Ridge facility is targeting 1 million separate work units by 2030, representing substantial new domestic capacity that will reduce import dependence. Centrus is scaling HALEU production from 2026 onward, building on its successful demonstration campaign. Additionally, new entrants are developing next-generation enrichment technologies that could provide step-change improvements in efficiency and cost, although these remain several years from commercial deployment.

Similar to the EBR-II example mentioned above, spent fuel from INL's Advanced Test Reactor (ATR) and other similar sources across the DOE complex have been identified as a potential resource for HALEU production. While this pathway would also require time and investment, it represents an additional domestic-feedstock option beyond currently utilized sources.

INL is developing the Zirconium Extraction (ZIRCEX) process specifically to recover HEU from a range of spent fuels. ZIRCEX represents a hybrid approach that uses a dry head-end

[26] URENCO press release. "URENCO USA Expands U.S. Enrichment Capability With Second New Cascade." September 10, 2025. https://www.urenco.com/news/usa/2025/urenco-usa-expands-u.s-enrichment-capacity-with-second-new-cascade.

process to remove cladding prior to a compact solvent extraction system. ZIRCEX then downblends the recovered uranium to HALEU levels by addition of natural uranium, potentially providing another source of HALEU feedstock.

Even with rapid progress across all these initiatives, we face significant challenges meeting projected HALEU demand through this decade and the next. Advanced-reactor demonstrations, military deployments, and potential commercial orders will all compete for limited HALEU supplies during the critical 2026–2030 period. Sustained federal support beyond initial appropriations may prove necessary if market conditions prove less favorable than anticipated or if technical challenges arise during scale-up.

Regulatory-Process Gaps

The ADVANCE Act and executive orders deliver substantial improvements, yet challenges remain.

Ongoing Licensing Burdens: Although many improvements have been made to streamline the licensing process, additional burdens remain. As one example, the Atomic Energy Act of 1954, as amended, continues to require an uncontested "mandatory hearing" for all new reactor-construction permits, notwithstanding that such hearings serve little or no purpose and add to the timelines for these licensing actions. Additionally, creative approaches to allow for generic reviews of reactor designs are possible with legislative changes. INL's report to Congress, "Recommendations to Improve Nuclear Licensing,"[27] provides detailed recommendations, including potential legislative actions, that remain relevant.

Timeline Certainty: While NRC now faces 18-month licensing-decision requirements, until this requirement is reliably and consistently achieved, first-of-a-kind demonstrations will continue to lack the type of schedule certainty that ensures favorable project financing. Uncertainty about regulatory timelines increases cost of capital and discourages investment.

Technology-Neutral Framework: The NRC's ongoing rulemaking to establish risk-informed, technology-inclusive frameworks (10 CFR Part 53) represents important progress. However, implementing regulations to support diverse advanced (that is, molten-salt, gas-cooled, sodium-cooled, etc.) reactor designs remain incomplete. Each reactor type presents unique regulatory questions requiring NRC staff expertise.

Regulatory Capacity: The NRC faces workforce challenges that include an aging staff with pending retirements and insufficient recruitment to review many simultaneous advanced-reactor applications. The ADVANCE Act provides hiring authority and fee relief, but developing technical expertise takes time.

Environmental-Review Streamlining: NEPA reviews historically consume significant resources even when safety is not at issue. The executive order to accelerate environmental

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[27] Stephen J. Burdick, John C. Wagner, and Jess C. Gehin, "Recommendations to Improve Nuclear Licensing." Idaho National Laboratory. INL/RPT-25-84292. https://inl.gov/content/uploads/2024/11/Recommendations-to-Improve-Nuclear-Licensing.pdf.

reviews for reactors on DOE sites helps for those projects, but broader NEPA reform is needed, including consideration of excluding certain new nuclear projects from NEPA reviews.

Authorization vs. Licensing: Developing Transition Pathways: A unique challenge exists in transitioning from DOE-authorized demonstrations to commercially licensed deployment. Reactors demonstrated under DOE authority generate invaluable operational data, but those data must inform subsequent NRC licensing for commercial deployment.

Establishing clear pathways where DOE demonstration experience directly contributes toward NRC licensing requirements could significantly accelerate commercial deployment. The executive order requiring NRC to establish expedited pathways for DOE/DoD-tested reactors addresses this, but implementation details matter enormously. Close coordination between DOE and NRC during demonstrations is already underway, and its continuation will ensure data collected meet NRC needs for subsequent licensing.

Navigating Statutory and Regulatory Uncertainty with Other Federal Agencies

Advanced reactor deployment crosses multiple agency jurisdictions, creating coordination challenges that require congressional attention to resolve effectively. Among the most pressing are statutory ambiguities affecting DoD nuclear-power deployment.

Department of Defense Project Janus: The Army plans to deploy microreactors at nine bases by 2027–2028 under Project Janus[28]; this represents a major commitment to nuclear power for defense energy security. However, this ambitious timeline faces significant statutory challenges that current law does not clearly address. Military-contracting mechanisms were not designed for purchasing power plants as long-term energy infrastructure; instead, they evolved to procure weapons systems, vehicles, and equipment with fundamentally different life-cycle characteristics, ownership models, and operational requirements. The question of acquisition authority for nuclear power plants operating on military installations remains ambiguous, with unclear answers about whether reactors should be procured as facilities, energy services, or some hybrid arrangement.

Installation of reactors on military bases raises complex questions about facility siting criteria, security requirements, and emergency planning that existing regulations do not adequately address. Military installations operate under different security frameworks than civilian facilities, with classified activities, weapons storage, and operational security considerations that complicate reactor siting and emergency-response planning. Environmental compliance presents additional complications because NEPA and other environmental laws apply differently on military installations than on civilian sites, creating uncertainty about review processes and approval timelines. Perhaps most critically, military facilities lack NRC licenses and operate under different safety-oversight regimes, yet establishing DoD authority and capability for fuel

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[28] Army Communications and Outreach Office. “Army announces next steps on Janus Program for next-generation nuclear energy.” November 18, 2025. https://www.army.mil/article/289074/army_announces_next_steps_on_janus_program_for_next_generation_nuclear_energy.

handling, reactor operations, and waste management requires statutory clarity that does not currently exist.

Congressional direction clarifying DoD's authority to procure and operate reactors for base power—not just propulsion, which has historical precedent in naval reactors—would significantly accelerate military deployment. Such clarification would address acquisition authority for energy infrastructure, establish siting criteria appropriate for military installations, define environmental-review processes, and create frameworks for fuel handling and waste management under DoD rather than NRC oversight. Military deployment can serve as a pathfinder for commercial applications, demonstrating reactor technologies in demanding operational environments while meeting critical defense energy security needs. The lessons learned from military deployments—in logistics, operations, maintenance, and workforce training—will directly benefit subsequent commercial applications.

Scale and Supply Chain

Moving from demonstrations to deployment at the scale needed for 400 GW requires industrial transformation across manufacturing, workforce, and supply-chain infrastructures. The challenges are substantial, but they are challenges of scale and coordination rather than fundamental technical feasibility.

Manufacturing Capacity: Current manufacturing capacity for reactor components, particularly large forgings and specialized materials, is inadequate for deploying more than 300 GW of new nuclear capacity over the coming decades. Many critical capabilities were lost during the decades without new builds in the United States as suppliers exited the nuclear market or shifted focus to international customers. Rebuilding this industrial base requires coordinated investment in manufacturing facilities capable of producing reactor pressure vessels, steam generators, and other major components to nuclear quality standards. It demands development of qualified suppliers across the entire component spectrum, from specialized alloys to instrumentation and control systems. Quality-assurance programs for nuclear-grade components must be established or reestablished at facilities that may have decades of general manufacturing experience, but lack nuclear-specific certifications. Finally, effective long-lead procurement management is essential because critical components like reactor pressure vessel forgings can require 3–5 years from order to delivery, necessitating careful coordination between reactor developers, component manufacturers, and construction schedules.

Transmission Infrastructure: Deploying more than 300 GW of new nuclear capacity requires substantial but strategic investment in transmission infrastructure. DOE's 2024 National Transmission Planning Study indicates the United States must expand its transmission system by 2.1–2.6 times its 2020 size by 2050 to support decarbonization goals and accommodate growing electricity demand, implying the need to build approximately 5,000 miles of new high-capacity transmission annually.[29] However, in 2024, only 888 miles of high-voltage transmission lines were completed nationwide, the third slowest year for such construction in the past 15 years, and far below the pace required. Nuclear energy offers strategic advantages that can help optimize

[29] U.S. DOE, *National Transmission Planning Study*. 2024. https://www.energy.gov/gdo/national-transmission-planning-study.

transmission investments relative to alternative scenarios relying primarily on variable renewables. Nuclear's high capacity factors that average 93%—compared to 23% for solar and 34% for wind—mean transmission infrastructure connected to nuclear plants achieves far higher utilization rates, delivering more total energy per mile of transmission built.[30] Additionally, nuclear power's geographic flexibility allows siting closer to demand centers and at existing power plant sites with established transmission connections, potentially reducing total new transmission miles required by up to 50% compared to scenarios dominated by geographically constrained renewable resources that must transmit power from remote high-resource areas to population centers.[31]

Many existing nuclear sites and retiring fossil-plant locations already possess robust transmission infrastructure that can be leveraged or upgraded for new nuclear capacity, avoiding the decade-plus timelines typically required for greenfield transmission development. The existing fleet of 94 reactors at 54 sites provides proven transmission connections that can often accommodate additional generation capacity through targeted upgrades to substations, transformers, and line capacity rather than entirely new transmission corridors. Similarly, the approximately 245 GW of coal capacity retiring between now and 2050 leaves substantial transmission infrastructure that can be repurposed for nuclear replacement generation, preserving these valuable grid connections while avoiding the siting, permitting, and community engagement challenges of new transmission routes. Nonetheless, strategic transmission investments, including substation upgrades, increased line voltages, and targeted new interconnections, remain essential to integrate more than 300 GW of new nuclear capacity into a reliable, resilient grid.

Workforce Pipeline: The nuclear industry needs tens of thousands of workers—engineers, operators, technicians, and craft workers—to build and operate new capacity at the scale envisioned. Current training pipelines are insufficient to meet this demand, and the challenge is acute across multiple skill categories. Recent analyses indicate that a shortfall in young engineers threatens the nuclear renaissance, with many university programs lacking sufficient enrollment to meet projected industry needs.

The workforce challenge spans diverse skill categories, each requiring different educational pathways and training infrastructure. Engineering and technical staff needs include nuclear engineers for design, licensing, and operations; mechanical, electrical, and civil engineers for construction and plant systems; health physicists and radiation protection specialists; and quality-assurance and regulatory-compliance professionals. The skilled-trades requirements are equally substantial, encompassing welders certified for nuclear-grade work who can meet the exacting standards for pressure-boundary welds; pipefitters and millwrights for complex piping and mechanical systems; electricians and instrumentation technicians capable of installing and maintaining sophisticated control systems; and heavy-equipment operators experienced with the specialized machinery required for nuclear construction. Operations personnel represent a third critical category, including licensed reactor operators and senior reactor operators who must complete rigorous NRC qualification programs; maintenance technicians trained in nuclear-

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[30] U.S. Energy Information Administration, "Capacity factors for utility scale generators primarily using fossil fuels." 2023 data. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a.
[31] U.S. DOE, *Pathways to Commercial Liftoff: Advanced Nuclear*, September 2024. https://gain.inl.gov/content/uploads/4/2024/11/DOE-Advanced-Nuclear-Liftoff-Report.pdf.

specific procedures and radiological controls; and chemistry and radiological control technicians who ensure plant safety and environmental compliance.

Expansion of workforce capacity requires comprehensive investment across the entire educational pipeline. Community college programs for technicians and operators provide the two-year pathways essential for producing the skilled workforce that represents the majority of plant personnel. University engineering programs with nuclear emphasis must expand enrollment and faculty to meet demand for degreed professionals. Craft trades training for nuclear construction must be established or expanded, building on apprenticeship models but incorporating nuclear-specific quality and safety requirements. Military-to-civilian transition programs leveraging Navy nuclear experience represent a particularly valuable pipeline because Navy-trained reactor operators and technicians bring both the technical skills and the rigorous operational discipline that nuclear power demands. INL and other national laboratories are working extensively with universities and community colleges on workforce-development initiatives that provide models for broader expansion.

Domestic Supply-Chain Security: Beyond workforce, reliance on foreign suppliers for critical reactor components creates vulnerabilities that extend beyond immediate supply-chain disruptions to long-term strategic dependencies. Strategic investments in domestic manufacturing capability for reactor components are necessary for long-term energy security. This includes not only the major components like pressure vessels and steam generators, but also the thousands of smaller components, specialized materials, and instrumentation systems that comprise a complete reactor system.

OPPORTUNITIES: AI AND NUCLEAR SYNERGY AND ENHANCED GLOBAL COMPETITIVENESS

AI as Game-Changer for Nuclear Development

Secretary Wright has stated: “AI is going to rapidly accelerate our ability to make nuclear reactors fast, cheap, and get more power.” This isn’t hyperbole. AI and advanced computing represent transformative tools across the nuclear enterprise, and the impacts are already visible in our work at INL.

Real-World Applications at INL

AI integration already delivers measurable benefits across INL’s nuclear mission. INL collaborates with world leaders in AI—Amazon, Microsoft, NVIDIA, and Atomic Canyon—to develop customized generative-AI tools aimed at enhancing design, safety analysis, manufacturing, and operational processes. Recently, in partnership with Oak Ridge and Argonne National Laboratory, INL showcased a conceptual design tool capable of generating 3D computer-aided design models, building multi-physics input decks, running advanced simulations, and rendering results with significant automation. Although this research is still in its early stages, and many functions require further automation, it demonstrates a promising integration of national-laboratory simulation capabilities and industry generative-AI models, with the potential to revolutionize the design process. In the realm of nuclear regulatory processes, INL works alongside industry partners to introduce initial automation for documented safety analyses, adhering to the DOE-STD-3009 format. While these documents are still led by human engineers, the automation has the potential to significantly reduce the time required for preparing documentation artifacts for submission. Regarding operations, INL has achieved significant milestones, including the first autonomous non-nuclear demonstration at the MAGNET test bed and the first digital twin of a nuclear reactor in collaboration with Idaho State University.

Our computational scientists have experienced notable productivity improvements while developing DOE-Nuclear Energy Advanced Modeling and Simulation and MOOSE-based applications used by much of the nuclear-energy community. Early feedback from our researchers indicates that development speed has more than doubled for these researchers on tasks such as drafting documentation, writing tests, and integrating algorithm details into these codebases. Furthermore, these tools have been invaluable in debugging and assisting developers with resolving compilation errors. INL, in partnership with other world leaders, hopes to enable these transformational gains across the nuclear-energy life cycle.

Enhanced Reactor Operations

Beyond design and development, AI promises substantial improvements in reactor operations through capabilities that augment rather than replace human judgment. Predictive-maintenance algorithms can identify component degradation before failure occurs, analyzing subtle patterns in sensor data that predict impending problems days or weeks in advance. Real-time optimization of reactor operations maximizes efficiency by continuously adjusting operating parameters within safety limits to achieve optimal performance. Anomaly-detection systems alert operators to unusual conditions earlier than traditional monitoring approaches, often identifying potential issues before they trigger conventional alarms. Automated-routine operations reduce human workload for repetitive monitoring tasks, allowing operators to focus on complex decision-making and system-level awareness while AI handles continuous data analysis and parameter tracking.

These capabilities don’t replace the licensed reactor operators and experienced engineering staff who maintain ultimate responsibility for plant safety—they augment human capabilities by handling the routine monitoring and optimization tasks that consume attention and can mask more-significant developments.

AI-Nuclear Symbiosis and Data Center Demand

The technology sector’s recognition that nuclear is the only viable 24/7 non-carbon-emitting power source for AI infrastructure creates an opportunity for symbiotic development. An advanced reactor co-located with a data center at a national laboratory would demonstrate this partnership in action—with the reactor providing reliable, clean power for energy-intensive AI computing while AI algorithms continuously optimize reactor operations and accelerate safety validation. This pairing addresses two challenges simultaneously: data centers obtain the reliable, carbon-free power that AI training and inference require while reactor developers gain access to the computational resources necessary to accelerate nuclear-power deployment.

This model could extend to commercial deployment, with reactors providing power for data centers while AI improves reactor performance and economics. Major technology companies signing long-term power purchase agreements for nuclear power—Microsoft's 20-year commitment to Three Mile Island Unit 1 and similar announcements from Google, Amazon, and Oracle—demonstrate the market pull that makes this symbiosis economically viable.

The Genesis Mission and AI Integration Across DOE

The DOE's Genesis Mission represents a coordinated national effort to accelerate AI adoption across all 17 national laboratories, creating a unified framework that applies AI to complex scientific and engineering challenges. This national initiative aims to use AI on a platform utilized by national labs, academia, and industry to address complex energy, science, and security challenges. The initiative establishes a coordinated framework that breaks down traditional silos between laboratories and creates a unified approach to leveraging AI for complex scientific and engineering challenges. By aligning resources, expertise, and strategic priorities across the laboratory system, Genesis aims to amplify the impact of AI investments and position the national laboratories as a cohesive force in advancing critical technology applications. The Genesis Mission will apply this AI platform directly to nuclear-energy challenges, where engineers and AI tools work together to optimize reactor design, materials, licensing, manufacturing, and operations, creating a new paradigm for nuclear energy that shortens development timelines and strengthens safety and performance.

Building on this foundation, INL is pursuing two signature AI projects, PROMETHEUS and VULCAN, that exemplify the bold vision of Genesis. PROMETHEUS is America's nuclear moonshot: a first-of-its-kind demonstration of an autonomous reactor, designed, analyzed, manufactured, and operated by AI systems with minimal human intervention. By validating a complete AI-driven pipeline—from generative design and autonomous safety analysis to advanced manufacturing and operations—PROMETHEUS promises up to fivefold schedule acceleration and multi-billion-dollar cost savings, enabling rapid deployment of reactors for critical applications such as AI data centers and national-security missions. Complementing this, VULCAN tackles one of the most-persistent bottlenecks in nuclear innovation: materials discovery and qualification. Through AI-driven discovery, high-throughput autonomous experimentation, and regulatory-compliant data generation, VULCAN could compress decadal timelines to years, unlocking revolutionary alloys and fuels essential for advanced reactors. Together, these initiatives redefine what is possible in nuclear energy, ensuring that America leads the world in safe, efficient, and AI-enabled nuclear technologies.

International Nuclear Leadership and Export Competitiveness

American nuclear technology leadership translates directly into international influence, economic opportunity, and safety and security objectives. According to a recent Morgan Stanley analysis,[32] investments in the nuclear value chain could reach $2.2 trillion through 2050, with each reactor sale creating long-term partnerships spanning 60–80 years or longer.

[32] Morgan Stanley, "Nuclear Renaissance Gains Momentum." August 2025. https://www.morganstanley.com/insights/articles/nuclear-energy-investment-renaissance-2050.

Export Market Dynamics

Nations purchasing nuclear reactors select not just technology, but long-term strategic partners. The vendor relationship encompasses fuel-supply and enrichment services, operational training and technical support, maintenance and component manufacturing, regulatory-framework development, research collaboration and technology transfer, and nonproliferation monitoring and cooperation. These multifaceted relationships extend across generations, thereby creating enduring bonds between vendor and customer nations.

When American companies win reactor contracts, these relationships advance U.S. foreign-policy objectives, strengthen alliances, and ensure global nuclear development follows robust safety and security standards. Conversely, Russian and Chinese nuclear exports extend their geopolitical influence while potentially compromising safety and nonproliferation standards. The choice of nuclear vendor thus carries profound strategic implications that extend far beyond the economic opportunity.

Current Export Landscape

The United States has historically been the world's leading nuclear-technology exporter, but market share has declined significantly over recent decades. During the 1970s and 1980s, U.S. companies dominated global nuclear exports, establishing American technology as the international standard. However, a multidecadal stagnant domestic U.S. market led to diminished export competitiveness as companies lost the operational experience and supply-chain depth that foreign customers demand. Since 2017, 92% of all nuclear-reactor construction starts have been Chinese or Russian designs, fundamentally reshaping the international nuclear landscape. Further, China is likely to become the world's leader in nuclear capacity by 2030, surpassing the U.S.

Recent developments suggest potential for American resurgence in the global market. Poland selected Westinghouse AP1000 technology for its first nuclear power plant, a three-unit project valued at approximately $40 billion that represents a major strategic win for U.S.-Polish partnership. Romania selected NuScale for SMR deployment, demonstrating international confidence in American advanced-reactor technology. The Czech Republic is actively evaluating AP1000 and other U.S. technologies for its nuclear expansion while additional negotiations are underway in Ukraine, the Philippines, and other nations seeking alternatives to Russian and Chinese vendors.

International Nuclear Energy Act of 2025 (FY2026 NDAA, Section 8366) Holds Key Provisions Related to Global Competitiveness

The FY2026 National Defense Authorization Act, signed into law by President Trump on December 18, 2025, includes the International Nuclear Energy Act of 2025 as Section 8366—a comprehensive legislative framework designed to reassert U.S. leadership in the global civil-nuclear market and provide coordinated tools to compete with Chinese and Russian state-backed nuclear exports. This bipartisan legislation establishes a Nuclear Export Working Group to develop a comprehensive 10-year civil-nuclear trade strategy with specific export targets for reactors, equipment, fuel, and materials. The Act authorizes $65.5 million over fiscal years 2026–2030 to support these export efforts, including $50 million in technical-assistance grants to help emerging nuclear nations develop infrastructure, regulatory frameworks, and project capabilities in partnership with U.S. companies.

The Act directly addresses a fundamental competitive disadvantage: while China and Russia operate state-owned enterprises offering comprehensive “one-stop-shop” capabilities bundling financing, construction, operations, and fuel supply through single entities, the United States has historically provided fragmented support that cannot compete effectively. The legislation directs development of a strategy to counter Russian influence in nations currently served by Rosatom, mandates pursuit of at least 20 new Section 123 peaceful nuclear-cooperation agreements and establishes biennial international conferences on nuclear safety and security to promote U.S. standards globally. By providing coordinated whole-of-government support and enhanced financing mechanisms, the International Nuclear Energy Act equips American industry to compete for the hundreds of billions of dollars in global reactor contracts that will be awarded over the coming decades.

Revitalizing Export Competitiveness

Domestic deployment drives export competitiveness in ways that cannot be substituted through other means. Countries preferentially purchase proven technologies with established operating histories, viewing domestic deployment as essential validation of both technical maturity and vendor commitment. The Vogtle AP1000 completion and potential additional U.S. deployments significantly strengthen American export credentials by demonstrating that these systems can be successfully constructed and operated in the United States. Similarly, successful advanced-reactor demonstrations at INL will position U.S. companies to capture the emerging SMR and microreactor global markets, where international competition is intensifying rapidly.

The ADVANCE Act’s export provisions, combined with international nuclear-energy financing initiatives, provide important mechanisms to support U.S. nuclear exports through streamlined regulatory cooperation, financial backing for overseas projects, and diplomatic engagement. However, robust domestic deployment remains essential; foreign customers want technology proven at home, not systems that exist only for export. No amount of export financing can substitute for the credibility that comes from active domestic deployment and operational experience.

The strategic implications extend beyond technology leadership and economic opportunity. When the United States exports nuclear reactors, we export a century-long relationship encompassing fuel supply, technical support, training, regulatory cooperation, and nonproliferation standards. Every reactor China or Russia, instead of an American company, builds will represent not just lost economic opportunity, but diminished American influence over global nuclear safety, security, and nonproliferation norms. The competition for nuclear exports is ultimately a competition to shape international standards, regulatory approaches, and the global nonproliferation regime itself.

CLOSING: THE PATH FORWARD

What Success Looks Like

Success in nuclear deployment has concrete, measurable outcomes that build progressively across the coming decades.

Near-Term Success (2026–2027)

In the immediate term, success means meeting the aggressive timelines established by the May 2025 executive orders. Multiple reactors should achieve criticality by July 4, 2026, demonstrating that the United States can move from policy directive to operational hardware in unprecedented timeframes. Additional Reactor Pilot Program projects will advance through design, licensing, and construction phases while the DoD initiates its first military-base reactor projects, demonstrating nuclear power's viability for defense energy security.

Medium-Term Success (2028–2030)

By the end of the decade, regulatory pathways will be established for clear transitions from DOE-authorized demonstrations to NRC-licensed commercial deployment, minimizing the ambiguity that has historically deterred investment. The domestic fuel cycle will show increasing independence from foreign sources, with HALEU production scaling from experimental quantities to commercial volumes sufficient to support multiple reactor programs simultaneously. Supply chains will ramp up to support accelerated construction, with domestic manufacturing capacity expanding for reactor components, fuel fabrication, and specialized materials.

The existing nuclear fleet will demonstrate renewed vitality through achievement of the executive order's goals of 5 GW in power uprates across operating reactors and successful restart of three previously shutdown reactors: Palisades in Michigan, the Crane Clean Energy Center in Pennsylvania, and Duane Arnold in Iowa. These achievements will validate both the technical and economic viability of extending nuclear assets' productive lives while adding significant firm capacity without new construction.

The DoD will successfully operate microreactors on multiple military bases, validating both the technology and operational concepts while building the trained workforce necessary for wider deployment. Technology-sector anchor customers will de-risk first commercial units through long-term power-purchase agreements, providing the revenue certainty that enables project financing.

Advanced-reactor deployment will achieve critical milestones as the first generation of commercial-scale SMRs and Gen IV reactors transition from demonstration to operation. TerraPower's Natrium sodium fast reactor in Wyoming will be operational or nearing completion. X-energy's Xe-100 high-temperature gas reactors at multiple sites will be under construction, with initial units approaching startup. Kairos Power's Hermes fluoride salt-cooled reactor will have successfully demonstrated molten-salt technology at commercial scale. And there are many others, as mentioned previously. These pioneering deployments will validate diverse advanced-reactor concepts while establishing supply chains and operational experience for subsequent commercial units.

Most critically, at least ten new large reactors will be under construction, demonstrating sustained momentum beyond initial demonstrations and establishing the industrial capacity necessary to achieve our long-term capacity goals. Together, these achievements—uprates, restarts, advanced-reactor demonstrations, and new large-reactor construction—will demonstrate that the United States has successfully reestablished its nuclear industrial capacity and is on a credible trajectory toward 400 GW by 2050.

Long-Term Success (2030–2050)

Sustained success through mid-century requires maintaining deployment momentum of 15 or more GWe annually, a pace that reflects mature supply chains, trained workforce, and established regulatory efficiency. The domestic fuel cycle will achieve full independence, with uranium mining, conversion, enrichment, and fuel fabrication all performed domestically at scales sufficient to support both the existing fleet and new deployments. American reactor exports will establish U.S. standards globally, reclaiming the international market share lost over recent decades while ensuring that nuclear development worldwide follows American safety and security norms. Supply-chain and workforce capacity will prove adequate for continued growth, with educational pipelines, manufacturing facilities, and construction capabilities expanding in proportion to deployment needs. Ultimately, the path to 400 GW by 2050 will be demonstrably achievable, with clear line of sight from current capabilities to the quadrupling of nuclear capacity necessary to achieve American energy dominance.

Why This Matters

The consequences of success—or failure—extend far beyond electricity generation.

Energy Security: Energy security is national security. We end dependence on adversaries for fuel and technology. A robust domestic nuclear industry ensures America controls its energy destiny. We cannot allow nuclear capability to follow the path of solar manufacturing, which was invented in America but became dominated by foreign competitors. Also, dramatic energy growth is essential to U.S. leadership in AI and manufacturing.

Economic Prosperity: Nuclear energy creates high-paying, long-term jobs that sustain communities across America. Construction of a nuclear power plant means thousands of construction jobs, followed by hundreds of permanent operations positions, providing careers for generations. These aren't just concentrated in major metropolitan areas; nuclear plants revitalize smaller communities with high-wage employment. Multiplying this impact across dozens of new reactor sites means substantial economic benefit distributed throughout the country. Advanced reactor manufacturing creates additional opportunities in component fabrication, fuel production, and supply chain.

National Security: Nuclear energy directly supports national security in multiple ways. Military-base energy security reduces vulnerability to attacks on fuel supply lines. Space nuclear systems enable defense missions. Most importantly, American reactor exports project our values globally while countering Russian and Chinese influence.

Research, Development, and Demonstration (RD&D) Infrastructure: The Foundation of American Leadership

I want to emphasize to this committee that state-of-the-art RD&D infrastructure is not optional for achieving the administration's goals—it is absolutely essential. No other nation possesses facilities comparable to INL's test beds, hot cells, materials-characterization capabilities, and fuel-fabrication infrastructure. This represents decades of federal investment that cannot be quickly replicated.

These capabilities enable American companies to move from concept to demonstration faster than foreign competitors. When private-sector developers access INL facilities, they leverage billions of dollars of federal investment in unique capabilities—test reactors, post-irradiation examination equipment, fuel-fabrication infrastructure, and specialized expertise—that would be prohibitively expensive to develop independently.

However, maintaining world-class RD&D infrastructure requires sustained investment. Equipment ages, technologies advance, and new capabilities become necessary. Increased Congressional support for national-laboratory infrastructure directly determines whether America maintains technological leadership or cedes it to foreign competitors.

America's Choice

The technology exists. The market demand is real. The policy framework is emerging. Private investment is mobilizing.

We can reclaim nuclear leadership and project American standards globally, thereby ensuring reactors built worldwide meet our safety and security standards. Or we can continue decades of stagnation while China and Russia expand their influence through reactor exports.

The reactors we build now will operate for 80 years or more. The decisions this Congress makes will shape American energy security, economic prosperity, and global influence for the rest of the century.

At INL, we're doing our part. We're accelerating test beds and reactor-demonstration projects to meet aggressive timelines. We're supporting the Reactor Pilot Program and Fuel Line Pilot Program. We're expanding technical capabilities for military and space applications and data-center infrastructure. We're strengthening fuel-cycle expertise. We're building workforce-development programs. We're preparing for international leadership as America expands nuclear cooperation globally. And we're embracing AI and streamlined processes while maintaining uncompromising commitment to safety excellence.

I appreciate the opportunity to testify, and I want to thank the committee for its attention to this critical issue for our nation. I look forward to your questions.