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Five Steps Toward an American Nuclear Renaissance

Oliver McPherson-Smith, Ph.D.

MAIN POINTS

To realize the potential of nuclear power and to increase American energy abundance, Congress should prioritize the following 5 regulatory policies:

1. Comprehensive permitting reform would spur further domestic uranium production and fortify nuclear fuel supply chains.
2. Nuclear reactor licensing procedures should reflect the latest scientific knowledge and be technology-inclusive to the maximum extent possible.
3. Lowering regulatory fees for start-up nuclear companies would support innovation and competition.
4. The Nuclear Regulatory Commission's mandate, and the deployment of its resources, should explicitly support the expansion of domestic nuclear power.
5. Granting a generic nuclear cooperation agreement to countries that have mutual defense treaties with the United States, or that are formally designated as major allies, would open new export markets for American nuclear technology and products.

Energy policy in the United States is at a crossroads. Spurred by environmental concerns, current federal efforts to replace fossil fuel electricity generation with wind and solar are making the nation's grid dangerously unreliable. This vulnerability is due to wind and solar's reliance on favorable weather conditions, coupled with the absence of battery technology needed to balance unpredictable electricity supply with consumer demand. At a recent congressional hearing, half of commissioners on the Federal Energy Regulatory Commission (FERC) warned that the United States is on the brink of an electricity reliability catastrophe (Christie, 2023; Danly, 2023). The human and economic costs of electrical grid failure are not hypothetical; the power outages associated with Winter Storm Uri in February 2021 were responsible for more than 200 deaths (FERC et al., 2021) and tens of billions of dollars of economic damage (Golding, et al., 2021). Amid changing weather patterns, a national reliance upon weather-dependent sources of electricity—the generation of which cannot be ramped up on demand—risks sleepwalking the United States into an avoidable disaster.

However, these catastrophic scenarios can be avoided by fostering a competitive energy industry in which sources of electricity compete on their merits without government prejudice or favor. Through market forces, true competition would help naturally tailor energy generation in each context to climatic conditions, natural resources, and consumer demand. Leveling this playing field among energy technologies requires a close analysis of the regulations that uniquely inhibit the growth of specific forms of energy technology—such as nuclear power.

Nuclear power is a widely tested and safe avenue to produce reliable and affordable electricity, with little ambient pollution. The United States pioneers the world's leading nuclear research (Buchan and Smith, 2022), and America should be a natural global leader in the development of civilian nuclear facilities. Although the American nuclear power industry currently produces more electricity than do wind and solar combined (U.S. Energy Information Administration, 2023a), it is governed by outdated federal regulations that bedevil almost every segment of the industry. Particularly for the most advanced nuclear technology, these regulations inhibit the development of supply chains, domestic deployment, and international export.

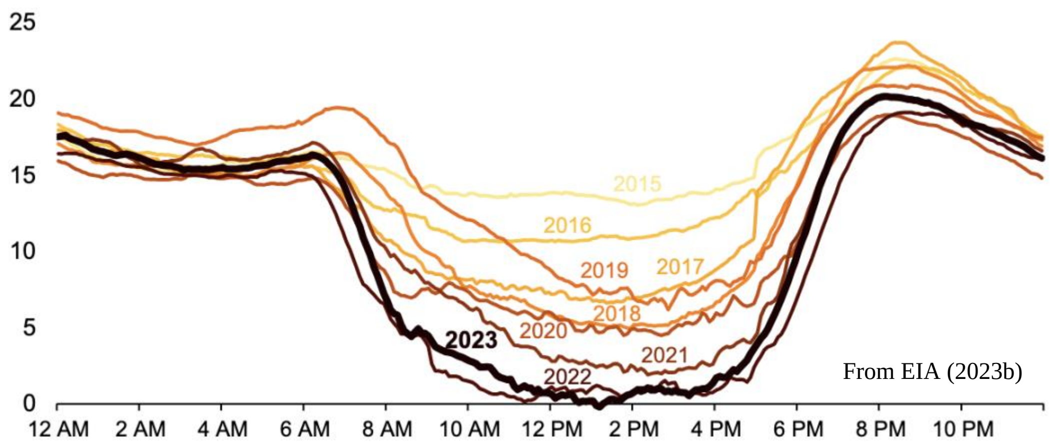
This report details five such federal-level regulatory challenges that Congress can address, ranging from the procurement of nuclear fuel to the export of nuclear technology abroad, each concerning a unique segment of the nuclear power industry. Accompanying each challenge is a detailed and actionable policy solution. The challenges outlined in this report represent just a selection of the industry's regulatory headwinds. However, by facilitating the stability, growth, and export potential of the American nuclear industry, the solutions provided here offer five clear steps toward an American nuclear renaissance.

The report begins with an overview of the potential benefits of nuclear power expansion, then considers the five challenges and their corresponding solutions. The first challenge is the United States' heavy reliance on nuclear fuel imports, which could be addressed through comprehensive permitting reform to facilitate domestic uranium production. The second is the ossification of outdated approaches to nuclear safety at the Nuclear Regulatory Commission (NRC) and the potential for them to be updated. The third is the relatively high fees placed on small nuclear companies and, correspondingly, the merits of adopting a more gradual fee structure. The fourth is the drift of the NRC's mandate and the opportunity to refocus its resources on promoting the expansion of nuclear power. The fifth is the self-defeating restrictions on American nuclear exports and the rationale for liberalizing these restrictions to echo American foreign policy more generally. A conclusion follows, which underscores the need for these America First policy solutions.

The Potential for Nuclear Expansion

Nuclear power exhibits a variety of unique benefits, relative to its peers. The price of nuclear fuel is typically less volatile than that of feedstocks for combined-cycle natural gas or coal-fired plants (U.S. Energy Information Administration, 2013; Mari, 2014). While weather-dependent renewable energy generation—such as that from wind or photovoltaic solar—is inherently unreliable, nuclear power plants produce electricity at a consistent pace throughout the day and night. For example, figure 1 illustrates the annual record lows of residual demand for electricity in California in excess of that supplied by solar power in the middle of the day in spring. While solar is increasingly meeting this demand during daylight hours, its generation falls away around sunset and thus requires other sources to meet electricity demand through the evening. Nuclear, by contrast, is a uniquely predictable and reliable source of electricity.

Figure 1. The California Renewable 'Duck Curve' (Gigawatts).[1]



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The controlled nature of nuclear power's by-products and waste is another advantage. Most nuclear power plants produce toxic waste that must be safely stored. However, this waste is not unforeseen or unmitigated. Whereas coal-fired plants might generate hazardous particulate air matter that requires capturing technologies to mitigate (Gasparotto and Martinello, 2021), nuclear waste is always under the control of plant employees. Due to isolated incidences of industrial mishaps, popular sentiment toward nuclear power can sometimes be mixed. While safety is indeed a concern, maintaining a calibrated perspective is also important. As Ellis and Schultz (2017, p. VII) observe, "with a long track record, the rate of human injury caused by nuclear power production is the lowest of any power generation technology, including renewable resources."

[1] From U.S. Energy Information Administration (2023c), 'CAISO Lowest Net Load Day Each Spring (March-May, 2015-2023).'

New technological advances in nuclear electricity generation are increasingly making it a potential source of power in increasingly diverse contexts. Historically, nuclear plants have been large installations that were expensive to build and custom designed for an individual site. They required a large pool of consumer demand to make them economically feasible. However, technological advances have enabled the creation of small-modular reactors (SMRs) and microreactors that can be fabricated en masse and assembled onsite. Microreactors have a power capacity of up to about 10 megawatts (MW), and SMRs have a power capacity of up to 300 MW. For conventional reactors, capacity ranges from 700 MW to 1,200 MW (Liou, 2021). For reference, a 300 MW SMR could power about 250,000 homes in America.[2] Similarly, a 10 MW reactor could power 10 Walmart Supercenters (Nuclear Innovation Alliance, 2022, p. 8).

In addition to potentially being smaller, some of the most cutting-edge reactors could produce heat comparable to fossil fuel combustion—allowing the deployment of nuclear technology in a greater number of industrial processes (Nuclear Innovation Alliance, 2022, p. 3). Other types of reactors have the potential to revolutionize the challenge of nuclear waste. New reactors that use molten fluoride or chloride as coolant, rather than light water, produce relatively less nuclear waste, while sodium-cooled 'fast' reactors can recycle spent fuel (U.S. Department of Energy, Office of Nuclear Energy, 2021).[3] Although up to 97% of spent nuclear fuel can currently be reused for conventional reactors (Rodríguez-Penalonga and Soria, 2017, p. 1236), the high cost of reprocessing fuel has made it commercially unviable in the United States. However, sodium-cooled reactors have the potential to use spent fuel with comparatively little reprocessing (U.S. Department of Energy, Office of Nuclear Energy, 2021). Some reactor designs employ a 'closed' fuel

[2] Per the U.S. Energy Information Administration (2022), an average residential utility customer used an "average of about 886 kWh per month," or roughly 1.2 kilowatt-hours (kWh) each hour of the day. At full capacity, a 300 MW (or 300,000 kW) reactor could power 250,000 homes. See Montgomery (2018), which arrives at a comparable figure.

[3] Light water reactors use regular water as a coolant and are the most common type of reactor in use. They differ from pressurized heavy water reactors, which use deuterium oxide (D_20) as a coolant.

cycle that perpetually recycles its fuel, thereby eliminating the need for future enrichment of uranium (The National Academies of Sciences, Engineering, and Medicine, 2023, p. 5). These diverse, next-generation nuclear reactors are collectively known as 'advanced' nuclear reactors.[4]

The volume of nuclear power generation is also increasingly flexible. Nuclear power plants typically run at full capacity, but this is not a necessity (Jenkins et al., 2018). Nuclear plants can thus serve as a useful complement to other sources of electricity generation to fill shortfalls in production, such as when fossil fuel input prices rise or intermittent renewables cease to generate electricity. Nuclear power can also be used to generate novel forms of energy storage, such as hydrogen fuel, which typically require significant amounts of energy to create (Vasquez and McPherson-Smith, 2023).

Nuclear expansion also brings ancillary benefits. According to Kenley et al. (2009, p. 8495), dwindling demand for domestic nuclear plant components since the 1970s has atrophied the domestic nuclear energy manufacturing base. Conversely, as the authors note, expanding domestic nuclear generation has the potential to create tens of thousands of construction and operational jobs in the United States, while repatriating manufacturing jobs.

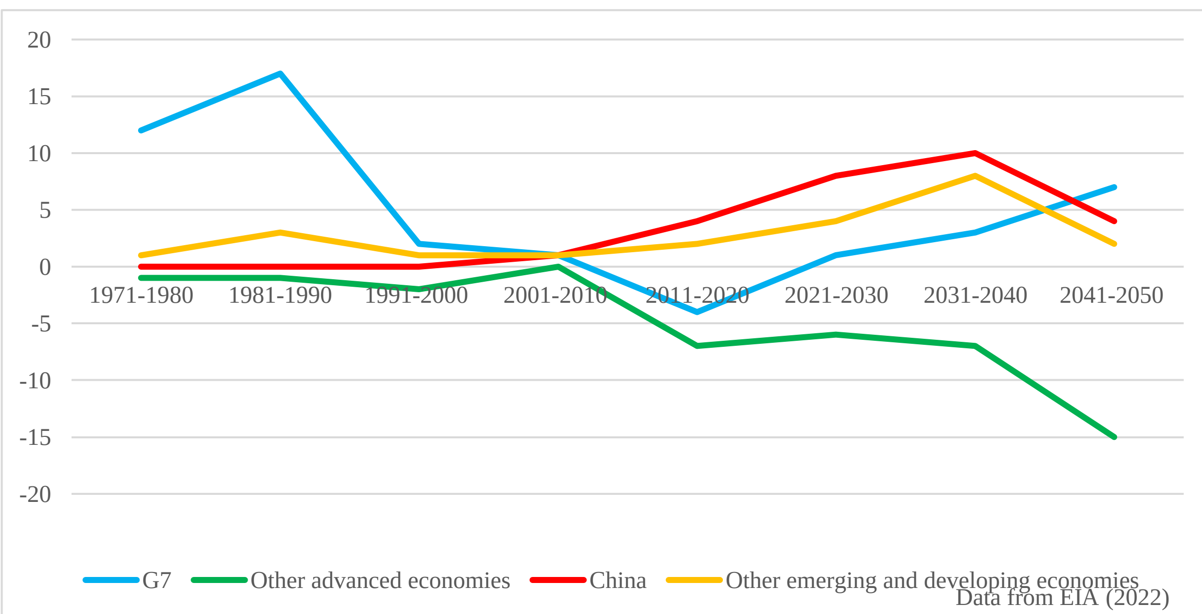
The benefits of nuclear power are not exclusive to the American context. Around the world, various countries are seeking to develop their electricity generation with nuclear technology. Japan and its recent history provide an acute example. In an area prone to seismic activity and periodic tsunamis, the Fukushima Daiichi nuclear power plant was

[4] The Energy Act of 2020, Section 2002, broadly defines an advanced nuclear reactor as "a nuclear fission reactor, including a prototype plant…with significant improvements compared to reactors operating on the date of enactment." The Nuclear Energy Innovation and Modernization Act of 2019, Section 3, subsection 1 expands this definition to include both fission and fusion reactors that improve upon commercial reactors under construction at the time of enactment.

built to a specification "not designed to withstand a tsunami even half the size of the one that ultimately struck the Japanese coast in March 2011" (Acton and Hibbs, 2012, p. 9). In the year after the nuclear plant was destroyed, the Japanese government declared plans to phase out nuclear generation by 2040 (Tabuchi, 2012). However, due to the high cost of global energy commodities and the need for a reliable source of electricity, the Japanese government is now seeking to re-open shuttered plants, extend their lifespans, and build new nuclear facilities (Oda, 2023). Similarly, efforts to reduce carbon emissions from electricity generation have spurred global interest in the emissions-free nature of nuclear power.

Figure 2 illustrates the predicted net addition of nuclear power generation under the International Energy Agency's (IEA) "Net Zero by 2050" scenario. Under this scenario, nuclear installation would rapidly expand over the next decade and a half in G7 countries, developing countries, and China.[5]

Figure 2. Net Addition of Nuclear Power Under a 'Net Zero' by 2050 Scenario (Change in capacity each decade in Megawatts).[6]

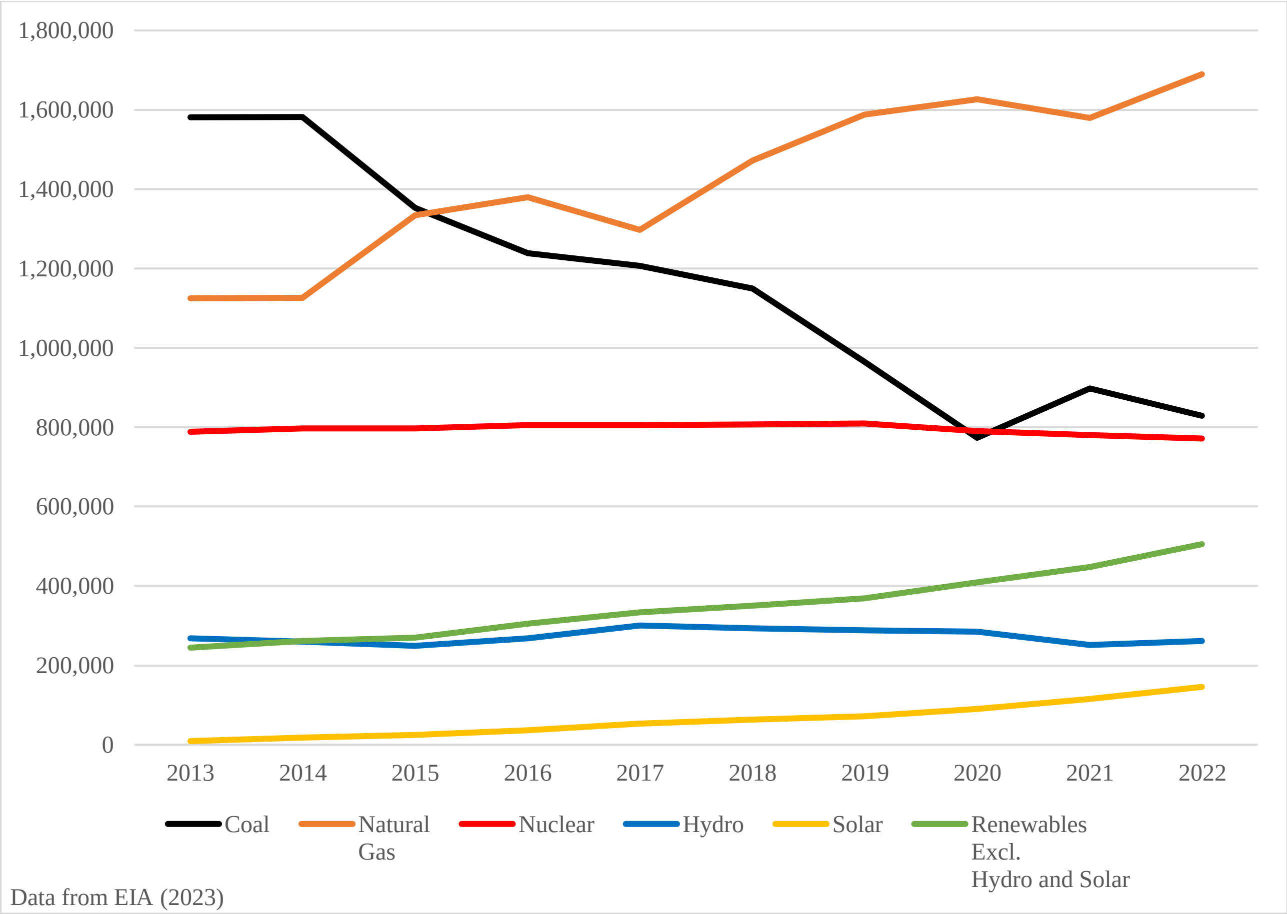


[5] G7 countries include the United States, Canada, United Kingdom, France, Germany, Italy, and Italy.
[6] 'Net addition' refers to new generating capacity less the amount of installed capacity that is retiring within the given timeframe. Data from the International Energy Agency (2022).

From Fuel Supply to Exports: Five Challenges and Solutions

Despite the potential benefits of nuclear power expansion—especially for advanced reactors—the American nuclear industry remains constrained by a variety of outdated federal regulations. And although the United States possesses an abundance of potential nuclear fuel and the world's leading nuclear research facilities, these regulations have helped to inhibit the growth of nuclear-powered electricity—as illustrated in Figure 3.

Figure 3. Major Sources of U.S. Electricity Generation (Annual Totals in Thousand Megawatt Hours)[7]



[7] Data from U.S. Energy Information Administration (2023a).

Unfortunately, these regulatory barriers are not quarantined to one segment of the industry or portion of the supply chain. They challenge the industry's stability and growth in a multitude of ways, correspondingly requiring wide-ranging reform to diminish their deleterious effects. The following five steps each address a unique regulatory challenge and present an actionable solution.

Step 1—Unlock a Domestic Fuel Supply

The process of producing nuclear fuel is complex; uranium is mined, milled, converted, and enriched in discrete steps, all before it is fabricated into fuel that can be used by a reactor. The United States' supply of this fuel is precarious, particularly due to a shortfall of domestic uranium production at the beginning of the process, coupled with a lack of domestic enrichment facilities. According to the Organisation for Economic Co-operation and Development (OECD) and the Nuclear Energy Agency (2022, p. 76), 47,342 metric tonnes of uranium were mined globally in 2020, but just eight tonnes of that amount were mined in the United States. This lack of mining is not because of a domestic shortage of potential deposits; the United States has 112,200 tonnes of identified recoverable resources (OECD, 2022, p. 22). Due to a lack of domestic uranium production, much of American enrichment utilizes foreign-sourced uranium. Currently, only 3% of the fuel loaded into American reactors is from domestically produced uranium (U.S. Energy Information Administration, 2023b, p. 48). In descending order, the leading sources of uranium for American reactors are Canada, Kazakhstan, Russia, Uzbekistan, and Australia (U.S. Energy Information Administration, 2023b, p. 21). While these countries are able to produce raw uranium at globally competitive prices, American producers face onerous permitting challenges that saddle them with additional costs for both the domestic extraction and enrichment of uranium.

The need for a reliable source of nuclear fuel is common across conventional and advanced reactors. Conventional reactors require uranium that is enriched up to 5%, which is known as 'low enriched' uranium. Many advanced reactors require purities of up to 20%, known as 'high assay' low enriched uranium (HALEU). At present, one commercial facility in New Mexico can meet only about one-third of domestic demand for enriched uranium. Consequently, according to the Department of Energy's Assistant Secretary for Nuclear Energy Kathryn Huff (2023, p. 2), "the United States cannot reliably make sufficient low enriched uranium (LEU) or high-assay LEU (HALEU) available to support the needs of today's power reactor fleet, advanced reactors, research reactors, and medical isotope production facilities."

This reliance on imports of raw and enriched uranium—particularly from hostile nations—constitutes a threat to economic and national security. Parallel to the United States' continued critical mineral reliance upon the People's Republic of China, American owners and operators of civilian nuclear facilities purchased about 12% of their uranium products from Russian companies in 2022 (U.S. Energy Information Administration, 2023b, p. 21). The continued trade of enriched uranium with Russia is reportedly worth about $1 billion on an annual basis (Bearak 2023).

Comprehensive permitting reform would help to unlock the domestic supply of nuclear fuel—particularly at the stages in the fuel supply chain when raw uranium is extracted and enriched. Facilitating production of American raw and enriched uranium could lower market prices by increasing supply in the global market. Similarly, centering these crucial steps in the nuclear fuel supply chain within the United States would lower transportation costs. In aggregate, reducing the regulatory burden to lower costs would foster greater competition between nuclear power and other sources of energy.

One potential target for comprehensive reform is the environmental review process, as mandated by the National Environmental Policy Act (NEPA), which constitutes a significant hurdle to natural resource extraction in the United States (McPherson-Smith, 2022). A 2020 report by an inter-agency government working group on the American nuclear supply chain similarly notes that "uranium producers that hope to develop new facilities must navigate complicated licensing and permitting procedures" across several federal agencies (U.S. Department of Energy, 2020, p. 18). Much like raw uranium extraction sites, enrichment facilities can similarly be subject to permitting barriers and litigation. For example, the NRC licensed the first domestic HALEU enrichment facility in Piketon, Ohio in June 2021. Yet, ultimately unsuccessful litigation over whether the NRC's license was compliant with NEPA endured for another 17 months. The rigor of considering the environmental effects of a project—as mandated by NEPA—is not the challenge. Rather, it is the lack of efficiency and predictability in the bureaucratic implementation of the legislation and the potential for frivolous lawsuits that can further delay project development. Environmental protection and bureaucratic efficiency need not be mutually exclusive.

To remedy some of these challenges, earlier this year the Fiscal Responsibility Act—known colloquially as the 'debt ceiling bill'—made modest legislative improvements to the implementation of NEPA. Among its many provisions was a mandate that environmental assessments be completed within one year and environmental impact statements within two years. Yet, comprehensive permitting reform remains elusive. For example, the procedure for judicial review of an agency's NEPA compliance could be made more efficient. This could be achieved by mandating the submission of a public comment during the agency's administrative proceedings as a condition for seeking judicial review This would both safeguard community participation and limit opportunistic activist efforts to delay project development through litigation (McPherson-Smith, 2023). Comprehensive permitting reform—including reform of judicial review—is made all the more urgent by advances in uranium extraction. In situ leaching, for example, provides a novel method for obtaining underground uranium by pumping liquids through boreholes to flush the mineral into a pipe. This approach can be both cheaper and significantly less disruptive to the surface environment (U.S. Nuclear Regulatory Commission, 2021). Furthermore, reforming the application of NEPA would not be an exclusive benefit for the nuclear power supply chain. Comprehensive permitting reform would holistically reduce the regulatory barriers faced by myriad large-scale energy developments (Vasquez, 2023), thus further leveling the regulatory playing field across the breadth of the energy industry without prejudice against large projects or those that span states.

Step 2—Update Domestic Licensing Rules

The Office of Nuclear Reactor Regulation within the Nuclear Regulatory Commission (NRC) is the primary federal regulator tasked with "licensing and regulation involving all facilities…associated with the construction and operation of nuclear reactors."[8] Since its creation in 1974, as Nordhaus and Stein (2022) note, the NRC's regulation of reactors has been based upon "prescriptive rules, purpose-built to license large light water reactors." In January 2019, President Donald Trump signed the Nuclear Energy Innovation and Modernization Act (NEIMA) into law, following strong bipartisan support in both the House and Senate. The purpose of the Act is to develop "the expertise and regulatory processes necessary to allow innovation and the commercialization of advanced nuclear reactors."[9] Among its many provisions, NEIMA mandated that "not later than December 31, 2027, the [Nuclear Regulatory] Commission shall complete a rulemaking to establish a technology-inclusive, regulatory framework for optional use by commercial advanced nuclear reactor applicants for new reactor license applications." In theory, this optional regulatory framework would provide an alternative route to permitting advanced reactors that is distinct from the current process for conventional light water reactors. It similarly instructed the NRC to study the potential for structuring the licensing process for advanced reactors across various stages.[10] In March 2023, the NRC published its draft rule to

[8] The Energy Reorganization Act of 1974, Section 203 (b) (1).
[9] See NEIMA, Section 2 (1).
[10] See NEIMA, Section 103 (b) (1)

implement the framework, which included two alternate regulatory processes for advanced reactors.

Despite this step forward, the intent of NEIMA may be hindered by an unwillingness within the NRC to examine its long-held approach to radiation safety. A notable persistence across the existing rules and the NRC's proposed framework is the principle of reducing radiation exposure "As Low As Reasonably Achievable," or ALARA.[11] This principle is the product of a long-held scientific belief that there is a linear relationship between accumulated radiation exposure and adverse health effects, such as cancer. However, there is an ongoing debate over whether ALARA and the associated 'linear no-threshold model' remain applicable for low doses of radiation, particularly in medical science (Siegel, McCollough, and Orton, 2016; Doss, 2018; Oakley and Harrison, 2020).

According to its critics, ALARA replaces a safe limit for radiation exposure with the endless pursuit of lower and lower increments of exposure—so low that they compete with the radiation found naturally in the environment. This pursuit manifests itself in additional compliance costs for nuclear developers, with only marginal benefits for employee or public health. Then-president-elect of the American Nuclear Society, Eric Loewen (2011, p. 6) has argued that the vague objective of ALARA has fostered regulatory drift: "bureaucratic agencies seem to redefine ALARA - without scientific evidence - to meet whatever political or social ends they wish to serve." Loewen (2011, p. 1) has similarly argued that, since ALARA's decades-old origins in the Manhattan Project, the concept has become a "political third rail" that merits reconsideration. Without reexamining the appropriateness of ALARA in light of the latest research, arbitrarily maintaining this extremely rigorous standard poses a potentially costly drag on nuclear deployment.

[11] See page 280 of the proposed rule. https://www.nrc.gov/docs/ML2116/ML21162A102.pdf

There thus appears a yawning gap between Congress' intent to facilitate the deployment of advanced reactors through NEIMA and the NRC's proposed framework to regulate advanced reactors. This distinction has not been lost on Congress. Echoing NEIMA's bipartisan support, in July 2023 a bipartisan and bi-cameral group of lawmakers issued a joint letter to each NRC commissioner.[12] The letter highlighted a variety of shortcomings in the NRC's proposed rule, including "the inclusion of the principle of 'As Low As Reasonably Achievable' (ALARA) as a design requirement." Comprehensive reform of domestic licensing most likely requires further action from Congress. Directing the NRC to study the ongoing debate around the appropriateness of ALARA would help the commission determine whether it remains an appropriate principle.

Further congressional action would also be an opportune moment to tighten the statutory language in NEIMA. The act's definition of a "technology-inclusive regulatory framework" includes "*where appropriate*, the use of risk-informed and performance-based techniques" (emphasis added). These techniques involve actively questioning the best route to achieving a given level of safety by considering the likelihood of the risk and its potential consequences. It differs from the NRC's traditionally *prescriptive* approaches to safety, which rigidly determine what must be done to mitigate a risk. As Lloveras and Stein (2023) note, statutorily mandating the NRC to use risk-informed and performance-based techniques "to the maximum extent possible" would further require the commission to engage with the unique risks of a given reactor. Mandating that bureaucrats embrace this flexibility would fortify the opportunity for innovation, and consequently cost reduction, by allowing developers to devise novel ways to achieve the same level of safety with different materials or more efficient designs.

Step 3—Reform Fees for Start-Ups

[12] See "Letter to The Honorable Christopher T. Hanson," dated July 14, 2023. https://d1dth6e84htgma.cloudfront.net/Chairman_Hanson_Commission_Review_of_Part_53_Rulemaking_Letter_FINAL_79792c48e7.pdf

The NRC's approach to regulation is shaped by its history of regulating large companies seeking to design and build large facilities using technology first developed for nuclear submarines. Companies that apply for a license to build and operate commercial reactors pay both annual fees, as well as hourly fees for inspections and assessments. Due to concerns that the NRC's billing structure was opaque for licensees, NEIMA offered additional federal oversight of the NRC's fee structure, notably by requiring annual fees to be only "reasonably related to the cost of providing regulatory services."[13]

Despite this step toward transparency, the NRC's approach to charging annual fees for small companies remains inflexible and outdated. The NRC establishes caps on annual fees for each category of license for smaller companies. For fiscal year 2023, there are two categories of non-manufacturing 'small' companies, based on their average gross receipts over the past 5 years: those that receive less than $555,000 and those that received between $555,000 and $8 million (U.S. Nuclear Regulatory Commission, 2023a, p. 4). For a research- and capital-intensive industry like nuclear power generation, these thresholds are low. For reference, the Small Business Administration considers a sewage treatment facility to be "small" if its annual receipts are less than $35 million and an oil and gas pipeline construction company to be "small" if its annual receipts are less than $45 million.[14]

Congress has the power to reform how the NRC charges small companies for these annual fees. Raising the annual fee caps in line with comparable industries—such as oil and gas pipeline builders—would provide financial relief for start-up companies seeking to enter the nuclear power industry. Lifting the "small entity" annual fee cap would not give businesses a free ride; the NRC would still be able to charge companies the hourly fees associated with inspecting and assessing license applications.

[13] See NEIMA, Section 102 (b) (3) (c) (ii) (I)
[14] See 13 CFR Part 121, subpart A.

Moreover, the current two tiers of caps could be broken down further into a sliding scale cap. At present, a company with annual receipts of $8 million enjoys the same fee cap as a company earning just 7% of that figure—$555,001. A proportional scale would increase the burden on companies commensurate with their growth.

Step 4—Increase the NRC's Industry Engagement

As the primary federal regulator, the NRC serves as the gatekeeper to domestic nuclear expansion. The domestic regulations that govern the domestic nuclear industry are only as good as their administrator; in practice, depending on how the NRC's staff approach their mandate, this position gives the commission the ability to encourage the growth of the nuclear industry or to inhibit it. In the founding legislation of the NRC—the Energy Reorganization Act of 1974—Congress declared that "the general welfare and the common defense and security require effective action to develop, and increase the efficiency and reliability of use of, all energy sources."[15] The text of the legislation also details the specific licensing and regulation duties of the NRC. However, the NRC's self-professed mandate exclusively focuses on its important licensing and regulation duties, albeit with no consideration of Congress' broader intent. The NRC currently seeks "to license and regulate the Nation's civilian use of radioactive materials, to provide reasonable assurance of adequate protection of public health and safety, to promote the common defense and security, and to protect the environment" (U.S. Nuclear Regulatory Commission, 2022, p. 1). Yet, this does not reflect the proactive approach embodied in Congress' intent for "effective action to develop…all energy sources."

A tangible symptom of the distance between Congress' intent and the current NRC mandate is the way the NRC engages with the private sector. The testimony of Jeffrey S. Merrifield, a former NRC commissioner and chairman of the Advanced Nuclear Working

[15] The Energy Reorganization Act of 1974, Section 2 (a).

Group of the U.S. Nuclear Industry Council, provides an illustrative anecdote.[16] According to Merrifield (2023):

> I have heard from many licensees that the NRC staff states that it is limited in what it can say to applicants seeking clarification of Agency rules and guidance, as the NRC cannot "promote" nuclear energy or act as a "consultant" due to its independent safety mission… There is absolutely nothing wrong with the Agency providing clarifications and assistance to licensees who are attempting to understand and meet the complex, difficult and sometimes inscrutable guidance and rules of the NRC. Responding to questions and engaging with licensed entities and the public with direct and fulsome responses is the responsibility of the Agency, and the NRC should not hide behind its role as an "independent" safety regulator. (p. 2)

Maintaining safety and supporting the development of the industry—consistent with Congress' stated intent—are not mutually exclusive objectives. Congress can reiterate its intent by legislating the explicit mandate and mission of the NRC. This can be enhanced by legislating the creation of an office of public and private engagement with the mandate to engage with both the general public and licensees in support of nuclear expansion.

Creating a public and private engagement office need not expand the NRC's budget. Speaking at the NRC's annual Regulatory Information Conference, NRC Commissioner Annie Caputo (2023, p. 9) summarized the commission's fiscal bloat. According to Commissioner Caputo, the commission's inspections and licensing work in 2023 will require only 15% of its employees and 21% of its budget. She also noted that "the agency will spend 46 percent more on corporate support activities than on inspection and licensing work." NEIMA mandated limits on overhead spending at NRC, with a gradually

[16] At the time of his testimony, Merrifield was a partner in the nuclear energy practice at Pillsbury Winthrop Shaw Pittman.

decreasing cap on corporate support down to 28% by 2025.[17] Yet, the commission still spends an inordinate amount of its resources on everything but regulating nuclear facilities. As Commissioner Caputo notes, the NRC had a $92 million surplus in 2022—"roughly $58 million dollars from licensees and $34 million from taxpayers." Coupled with an even higher budget request for 2024, the entirety of the commission's inspections and licensing work could almost be doubled "and still fit under the 2024 budget request."

The NRC presents the worst of both worlds—most of its budget and staff are not actively engaged in licensing and inspection, and those who are remain reluctant to help private sector customers for fear of promoting nuclear energy. Congressional action, including reiterating the NRC's nuclear promotion mandate and using targeted appropriations, could reduce this fiscal bloat on net. This can be done while mandating an office of public and private engagement to fulfill Congress' original intent of promoting the use of "all energy resources."

Step 5—Cut Outdated Red Tape Around Nuclear Exports

While the United States remains the world's largest and most dynamic economy, it is a simple fact that the majority of global energy use occurs beyond our borders. The rationale for further nuclear deployment in the United States also applies to countries abroad; reliable, safe, and affordable baseload electricity is an essential component of economic prosperity. The United States exports a variety of energy products and technology to meet this demand—both sharing America's energy abundance and providing a greater market for American energy companies. For example, American companies played a crucial role in supplying liquified natural gas (LNG) to allies in Europe following a halt to Russian gas exports in 2022. Exporting advanced nuclear reactor technology abroad would similarly provide economic benefits to American partners, while offering American innovators economies of scale through a larger market.

[17] See the Nuclear Energy Innovation and Modernization Act of 2019, Section 102 (a) (3).

The international market for nuclear exports is fiercely competitive. In addition to supplying fuel to reactors in 15 countries (Liu, 2022), Russia's state-owned Rosatom is the world's largest exporter of nuclear reactors (Schepers, 2019). Similarly, since 2013, the Chinese Communist Party (CCP) has sought to export nuclear technology as part of its Belt and Road Initiative (BRI). With the ability to now offer various turn-key nuclear plants and generous financial support from the Chinese state, the CCP seeks to dominate the global nuclear industry within 30 years (Bing-Ming, 2021, pp. 3-6).

The ability of American companies to compete in this international market is shaped by the variety of parallel regulations that govern civilian nuclear exports. For example, the Department of Energy approves or denies whether an American company can bid on a foreign nuclear project when the tender would involve disclosing proprietary or sensitive information.[18] Furthermore, the export of nuclear technology or components is largely governed by the NRC's own export licensing regime.[19] The export of nuclear technology that may be used for weapons purposes is further regulated by the Department of Commerce's Bureau of Industry and Security.[20]

In addition to complying with these regulatory safeguards, American nuclear exports must comply with section 123 of the Atomic Energy Act of 1954, which requires a formal agreement for nuclear cooperation between the United States and a partner country before nuclear materials or technology may be exported. These international accords—known as 123 agreements—confirm the existence of robust nuclear weapons non-proliferation procedures, including the right for the United States to revoke any material or equipment if a non-nuclear weapon state independently detonates a nuclear weapon.[21] In effect, this

[18] See 10 CFR 810.
[19] See 10 CFR 110.
[20] See 15 CFR 730-46.
[21] See the Atomic Energy Act of 1954, Section 123 (4).

self-imposed restriction assumes that all nations are potential proliferators of nuclear weapons, unless proven otherwise.

While this framework was sensible for the era of its enactment, section 123's effectiveness in inhibiting nuclear proliferation is heavily undercut in the contemporary era by the ready availability of Chinese and Russian nuclear technology and fuel. Moreover, its implementation over several decades has led it astray from the rest of American foreign policy. At present, 47 countries are covered by 123 agreements. However, these agreements have no relation to the United States' broader diplomacy or international relations. Russia and China both enjoy 123 agreements. India, despite not having signed or ratified the Nuclear Non-Proliferation Treaty, also enjoys a 123 agreement. Yet Macedonia, Albania, Iceland, and the Philippines—which are all mutual defense treaty allies of the United States—lack 123 agreements. And 11 more countries that enjoy the formal designation of a "major non-NATO (MNNA) ally" of the United States lack a 123 agreement.[22] This disparity is counter-intuitive because both treaty ally and MNNA countries enjoy close cooperation with the United States and access to American military technology. Additionally, in light of the United States' long-held opposition to nuclear weapons proliferation, it is inconsistent that a country would be both a formally designated American ally and a new developer of nuclear weapons.[23]

Congress can rectify this inconsistency by amending the Foreign Assistance Act of 1961, of which section 517 concerns the designation of MMNA status. This status should automatically confer authorization to receive civilian nuclear exports along the lines of a generic 123 agreement, unless specified otherwise by Congress or the president, for as long

[22] These countries are Bahrain, Columbia, Egypt, Israel, Jordan, Kuwait, New Zealand, Pakistan, Qatar, Thailand, and Tunisia.
[23] The State of Israel is the sole exception to this rule, due to the historic and enduring hostility of neighboring and near-by countries to modern Israel's existence. Despite Israel's official position of ambiguity, it is widely suspected that the country possesses nuclear weapons. The United States' tacit acceptance of this reality is consistent with America's interests.

as they enjoy this designation. Such legislation could outline the terms of the generic 123 agreement and detail the situations under which access to American nuclear technology or material would be denied—such as in the case of a unilateral nuclear weapons test. The amendment should also make eligible countries that maintain a mutual defense treaty with the United States. As an issue of domestic economic regulation, this statutory change would not redefine the terms of any treaty. This benefit should not automatically apply to the member states of the Rio Treaty of 1947 which, while technically a mutual defense treaty, includes countries such as Nicaragua and Venezuela. Nonetheless, this exclusion should not prejudice the ability of the Rio Treaty member states to seek 123 agreements or additional treaties with the United States or to be designated as MMNA countries. Amendments to this effect would maintain the integrity of the 123 agreement system and the United States' ability to sign them with other countries. Moreover, it would better align the United States' nuclear regulation with its foreign policy by establishing an implicit presumption that a formally designated ally of the United States is not a likely proliferator of nuclear weapons. It would also not affect the NRC's licensing authority[24]—nor that of the Departments of Energy and Commerce—that regulates how American companies bid and export nuclear technology, fuel, and components. Yet, this harmonization of American foreign policy and nuclear security would, in short order, dramatically expand the number of potential national markets for American advanced nuclear innovators.

Conclusion

The United States' energy policy is at a crossroads. There is an increasingly dire need for reliable and affordable baseload electricity generation to power the nation's grid. Yet, because of the United States' diverse climatic conditions and dispersion of natural resources, a one-size-fits-all approach to electricity generation will not achieve this goal. Rather, competition between energy technologies on a level regulatory playing field would produce the most efficient energy mix. Leveling the regulatory playing field requires a

[24] See the Atomic Energy Act of 1954, Sections 126-128.

close study of the policies, rules, and laws that inhibit the growth and competitiveness of each specific form of energy technology.

By virtue of its stability and increasing flexibility, nuclear power has the potential to credibly rival other sources of electricity generation. This is particularly the case for advanced reactors. Yet, at every stage of its supply chain and development, the American nuclear industry is subject to various federal regulations that challenge its growth. This report details five such regulations—ranging from the domestic procurement of nuclear fuel to international exports—and provides five corresponding actionable policy solutions.

The first of these regulatory challenges is the onerous regulation of domestic mineral extraction, which could be remedied through comprehensive permitting reform. The second is the persistence of inflexible approaches to reactor safety regulation, which merits a re-examination in light of the latest science. The third is the disproportionate financial burden placed on nuclear startup companies, which could be made more accommodating and flexible based on the company's size. The fourth is the NRC's narrow, self-professed mandate that does not reflect Congress' original intent to "to develop, and increase the efficiency and reliability of use of, all energy sources." This could be remedied by restating Congress' holistic objective and creating an office of public and private engagement using the NRC's existing budget surplus. The fifth is the distinction between America's close relations with its allies and the persistent presumption that all countries are potential weapons proliferators. This inconsistency could be harmonized by removing unnecessary regulatory barriers to importing American nuclear technology and materials. While these policy solutions will not guarantee the success of the American nuclear industry, they would nonetheless help to level the regulatory playing field and harness American innovation to advance five steps toward an American nuclear renaissance.

Works Cited:

Acton, J. M. and Hibbs, M. (2012). *Why Fukushima was Preventable*. The Carnegie Endowment for International Peace (March 2012). https://carnegieendowment.org/files/fukushima.pdf

Bearak, M. (2023). The U.S. Is Paying Billions to Russia's Nuclear Agency. Here's Why. *The New York Times* (June 14, 2023). https://www.nytimes.com/2023/06/14/climate/enriched-uranium-nuclear-russia-ohio.html

Bing-Ming, C. (2021). *China's "Nuclear Dragon" Goes Abroad: Exporting Nuclear Power Infrastructure through the Belt and Road Initiative*. Center for International Private Enterprise (May 18, 2021). https://www.cipe.org/wp-content/uploads/2021/05/Nuclear-Dragon-Goes-Abroad.pdf

Caputo, A. (2023, March 15). "THERE IS NO BETTER TIME THAN THE PRESENT…" Address delivered at the NRC Regulatory Information Conference.. https://www.nrc.gov/about-nrc/organization/commission/comm-annie-caputo/caputo-03152023-ric.pdf

Christie, M. C (2023). *Opening Statement of Mark C. Christie Commissioner Federal Energy Regulatory Commission (FERC) House Committee on Energy and Commerce Subcommittee on Energy, Climate and Grid Security* (2023, June 13). https://d1dth6e84htgma.cloudfront.net/06_13_23_Testimony_Christie_661473d44f.pdf?updated_at=2023-06-12T13:52:57.733Z

Danly, J. P (2023). *Written Testimony of James P. Danly Commissioner, Federal Energy Regulatory Commission Before the Subcommittee Committee on Energy, Climate, & Grid Security Committee on Energy and Commerce United States House of Representatives* (June 13, 2023). https://d1dth6e84htgma.cloudfront.net/06_13_23_Testimony_Danly_f91eb20bb8.pdf?updated_at=2023-06-12T13:57:23.833Z

U.S. Department of Energy (2020). *Restoring America's Competitive Nuclear Energy Advantage*. https://www.energy.gov/articles/restoring-americas-competitive-nuclear-energy-advantage

U.S. Department of Energy, Office of Nuclear Energy (2021). *3 Advanced Reactor Systems to Watch by 2030*. https://www.energy.gov/ne/articles/3-advanced-reactor-systems-watch-2030

Doss, M. (2018). Are We Approaching the End of the Linear No-Threshold Era? *Journal of Nuclear Medicine*. Volume 59, Issue 12. Pages 1786-1793:

doi.org/10.2967/jnumed.118.217182

Ellis Jr., J. O. and Shultz, G. P. (2017). Foreword. In Carl, Jeremy and Fedor, David (Eds.). *Keeping the Lights on at America's Nuclear Power Plants* (pp. X). Hoover Institution Press: Stanford, CA. ISBN 9780817920951.

U.S. Energy Information Administration. (2013, April 24). *Lower Wholesale Power Prices Reduce Quark Spreads Available to Nuclear Plant Operators*.. https://www.eia.gov/todayinenergy/detail.php?id=10971

U.S. Energy Information Administration. (2022). *How Much Electricity Does an American Home Use?* https://www.eia.gov/tools/faqs/faq.php?id=97&t=3

U.S. Energy Information Administration. (2023a). *Electric Power Monthly: Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2013-March 2023*. (May 24, 2023). https://www.eia.gov/electricity/monthly/current_month/may2023.pdf

U.S. Energy Information Administration. (2023b, June). *2022 Uranium Marketing Annual Report*. . https://www.eia.gov/uranium/marketing/pdf/2022%20UMAR.pdf

U.S. Energy Information Administration. (2023c, June 21). *As solar capacity grows, duck curves are getting deeper in California*.. https://www.eia.gov/todayinenergy/detail.php?id=56880

Federal Energy Regulatory Commission, North American Electric Reliability Corporation, and Regional Entity Staff (2021). *The February 2021 Cold Weather Outages in Texas and the South Central United States*. Federal Energy Regulatory Commission (November, 2021). https://www.ferc.gov/media/february-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and

Gasparotto, J. and Martinello, Kátia Da Boit (2021, April). Coal as an Energy Source and its Impacts on Human Health. *Energy Geoscience*: Volume 2, Issue 2, Pages 113-120. https://doi.org/10.1016/j.engeos.2020.07.003

Golding, G., Kumar, A., and Mertens, K. (2021, April 15). *Cost of Texas' 2021 Deep Freeze Justifies Weatherization*, Federal Reserve Bank of Dallas. https://www.dallasfed.org/research/economics/2021/0415

Huff, K. (2023). *Testimony of Dr. Kathryn Huff Assistant Secretary for Nuclear Energy U.S. Department of Energy Before the Committee on Energy and Natural Resources U.S. Senate* (March 9, 2023). https://www.energy.senate.gov/services/files/EE5F975E-30A7-4075-9177-3A220627CC36

International Energy Agency (2022). Nuclear Power and Secure Energy Transitions, IEA, Paris. https://www.iea.org/reports/nuclear-power-and-secure-energy-transitions

Jenkins, J.D; Zhou, Z; Ponciroli, R; Vilim, R.B; Ganda, F; de Sisternes, F; and Botterud, A (2018, July 15). The Benefits of Nuclear Flexibility in Power System Operations with Renewable Energy. *Applied Energy*: Volume 222, Pages 872-884. https://www.sciencedirect.com/science/article/abs/pii/S0306261918303180

Kenley, C.R.; Klingler, R.D; Plowman, C.M; Soto, R; Turk, R.J; Baker, R.L; Close, S.A; McDonnell, V.L; Paul, S.W; Rabideau, L.R; Rao, S.S; and Reilly, B.P (2009, November). Job creation due to nuclear power resurgence in the United States. *Energy Policy*: Volume 37, Issue 11, Pages 4894-4900.

Liou, J. (2021). *What are Small Modular Reactors (SMRs)?* International Atomic Energy Agency. https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs

Liu, Z. Z. (2022, June). *Renewing America's Leadership in the Global Civil Nuclear Energy Market*. Council on Foreign Relations. https://www.cfr.org/blog/renewing-americas-leadership-global-civil-nuclear-energy-market

Lloveras, L. A. and Stein, A. (2023). Congress Tries Again on Advanced Nuclear Energy. The Breakthrough Institute. https://thebreakthrough.org/issues/energy/congress-tries-again-on-advanced-nuclear-energy

Loewen, E. P (2011). *Is ALARA reform needed?* Address to both Eastern Washington and Trinity Sections of the American Nuclear Society. https://wx1.ans.org/about/officers/docs/alara-reform-rev-9.pdf

Mari, C. (2014). *Hedging Electricity Price Volatility using Nuclear Power*. Applied Energy: Volume 113, Pages 615-621 (January 2014).

McPherson-Smith, O. (2022). *Restoring America's Critical Mineral Supply Chains*. The America First Policy Institute. https://americafirstpolicy.com/latest/20221128-restoring-americas-critical-mineral-supply-chains

McPherson-Smith, O. (2023). *Revisiting Judicial Review: The Next Step for Permitting Reform*. America First Policy Institute. https://americafirstpolicy.com/latest/expert-insight-revisiting-judicial-review-the-next-step-for-permitting-reform

Merrifield, J. S (2023). *Legislative Hearing on Securing America's Energy Future*. U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Energy and Power. https://d1dth6e84htgma.cloudfront.net/07_18_23_Testimony_Merrifield_3a621dd892.pdf

Montgomery, S. L. (2018). *The Nuclear Industry is Making a Big Bet on Small Power Plants*. The Conversation. https://theconversation.com/the-nuclear-industry-is-making-a-big-bet-on-small-power-plants-94795

The National Academies of Sciences, Engineering, and Medicine (2023). *Merits and Viability of Different Nuclear Fuel Cycles and Technology Options and the Waste Aspects of Advanced Nuclear Reactors*. National Academies of Sciences, Engineering, and Medicine. Washington, DC. https://doi.org/10.17226/26500

Nordhaus, T. and Stein, A. (2022). *NRC Staff Whiffs on Nuclear Licensing Modernization*. The Breakthrough Institute. https://thebreakthrough.org/blog/nrc-staff-whiffs-on-nuclear-licensing-modernization

Nuclear Innovation Alliance (2022). *Advanced Nuclear Reactor Technology: A Primer.* https://nuclearinnovationalliance.org/sites/default/files/2022-07/ANRT-APrimer-July2022.pdf

U.S. Nuclear Regulatory Commission (2021). *In Situ Recovery Facilities.* https://www.nrc.gov/materials/uranium-recovery/extraction-methods/isl-recovery-facilities.html

U.S. Nuclear Regulatory Commission (2022). *STRATEGIC PLAN Fiscal Years 2022–2026*. NUREG-1614, Vol. 8. https://www.nrc.gov/docs/ML2206/ML22067A170.pdf.

U.S. Nuclear Regulatory Commission (2023a). *Fiscal Year 2023 Small Entity Compliance Guide*. https://www.nrc.gov/docs/ML2234/ML22347A247.pdf

U.S. Nuclear Regulatory Commission (2023b). *Revision of Fee Schedules; Fee Recovery for Fiscal Year 2023*. U.S. Nuclear Regulatory Commission. [NRC–2021–0024] RIN 3150–AK58.
https://www.govinfo.gov/content/pkg/FR-2023-06-15/pdf/2023-12696.pdf

Oakley, P. A. and Harrison, D. E. (2020). *Death of the ALARA Radiation Protection Principle as Used in the Medical Sector*. Dose Response. Volume 18, Issue 2. Pages 1-12: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7218317/pdf/10.1177_1559325820921641.pdf

Oda, S. (2023, March 6). *Nuclear Power Revival Reaches Japan, Home of the Last Meltdown*. The Japan Times.
https://www.japantimes.co.jp/news/2023/03/06/national/nuclear-power-revival/

Organisation for Economic Co-operation and Development and the Nuclear Energy Agency (2022). *Uranium 2022: Resources, Production and Demand*. https://doi.org/10.1787/2c4e111b-en

Rodríguez-Penalonga, L. and Soria, B. Yolanda Moratilla (2017). *A Review of the Nuclear Fuel Cycle Strategies and the Spent Nuclear Fuel Management Technologies*. Energies Volume 10, Issue 8: 1235-1251. https://doi.org/10.3390/en10081235

Schepers, N. (2019). *Russia's Nuclear Energy Exports: Status, Prospects and Implications*. EU Non-Proliferation and Disarmament Consortium (February 2019). https://www.sipri.org/sites/default/files/2019-02/eunpdc_no_61_final.pdf

Siegel, J. A.; McCollough, C. H.; and Orton, Colin, G. (2016). Advocating for use of the ALARA principle in the context of medical imaging fails to recognize that the risk is hypothetical and so serves to reinforce patients' fears of radiation. *Medical Physics*. Volume 44, Issue 1: https://doi.org/10.1002/mp.12012

Tabuchi, H. (2012, September 14)). Japan Sets Policy to Phase Out Nuclear Power Plants by 2040. *The New York Times*.
https://www.nytimes.com/2012/09/15/world/asia/japan-will-try-to-halt-nuclear-power-by-the-end-of-the-2030s.html

Vasquez, D. (2023). *The Economic Benefits of Natural Gas: The Mountain Valley Pipeline and the Need for Further Pipeline Expansion*. America First Policy Institute. https://americafirstpolicy.com/latest/fact-sheet-the-economic-benefits-of-natural-gas-the-mountain-valley-pipeline-and-the-need-for-further-pipeline-expansion

Vasquez, D. and McPherson-Smith, O. (2023). *Hydrogen Fuel: Background, Applications, and Challenges*. America First Policy Institute. https://americafirstpolicy.com/latest/fact-sheet-hydrogen-fuel-background-applications-and-challenges