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BACKGROUNDER

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The Nuclear Energy Leadership Act: A Missed Opportunity for Leadership

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KEY TAKEAWAYS

The main NELA proposals are a mandatory long-term power purchase agreement; a nuclear research, development, and demonstration agenda; and a nuclear fuel program.

NELA should not be evaluated in a vacuum; Congress already extensively subsidizes nuclear reactor research, development, and demonstration.

Subsidies create new vulnerabilities, overstep the government's role, and ignore underlying policy problems: over-regulation and nuclear waste mismanagement.

With the apparent collapse of the nuclear renaissance of the early 2000s, many are looking to advanced nuclear-reactor technologies to reinvigorate the domestic nuclear industry. Advanced nuclear technologies enjoy favor from a diverse political set motivated by the prospect of deploying nuclear technology into new industries, competition from Russia and China, perceived national security opportunities and threats, reduction of carbon dioxide emissions, and the glamour of Silicon Valley start-ups.

In late 2018 and early 2019, Congress passed the Nuclear Energy Innovation Capabilities Act (NEICA) and the Nuclear Energy Innovation and Modernization Act (NEIMA)—in an effort to improve access to federal labs and to modernize the regulatory pathway for advanced nuclear reactor technologies, respectively. While imperfect, these acts began to address government-imposed barriers to market entry for new nuclear technologies.

A third bill, the Nuclear Energy Leadership Act (NELA), is being proposed as the next necessary policy step for launching an advanced nuclear industry in the U.S. But NELA is a bridge too far. NELA proposes an extensive federally funded and directed research, development, and demonstration program for advanced nuclear technologies through the Department of Energy (DOE). Rather than improving private sector access to federal assets, reducing regulatory barriers, and addressing the political risks that nuclear energy faces, NELA quite literally proposes that the government do the work of private companies for them—to improve their product, acquire financing, and find potential customers. Not only is such a program outside the responsibility of the federal government and federal taxpayer; it could also erect new barriers for companies that do not go through the DOE program. It further makes the nuclear industry politically dependent, and consequently politically vulnerable.

There are changes that could perhaps make NELA less egregious and invasive. Even then, NELA is poor policy. Congress should instead turn its attention to government-imposed risks that are immanently the responsibility of the federal government to address, and which haunt the current and future nuclear industry. In doing so, Congress would provide sorely needed leadership for the nuclear energy industry in the United States.

NELA in Three Parts

Nuclear energy provides 19 percent of the electricity that Americans use today from 97 commercial nuclear reactors, more than in any other country. These reactors are designed with light-water reactor technology, which is the most commonly used reactor around the world. While America has tested and demonstrated a variety of other nuclear reactor technologies since the 1950s, none took hold in the civilian commercial sector. In the past decade, advanced reactor companies building on these older concepts have cropped up and scores of reactor projects are now underway in the United States.[1] These designs aim to provide a variety of options—smaller, more efficient, safer, less waste, different fuels, and the potential for applications beyond power generation.[2]

The Nuclear Energy Leadership Act (S. 903 and H.R. 3306) aims to marshal this private-sector activity into an aggressive government strategy that puts America in a position of global leadership for advanced nuclear technologies. There are three major components of NELA: (1) a government power purchase agreement project, (2) an extensive government research agenda and accompanying government-backed reactor demonstration program, and (3) an advanced nuclear fuel program.[3]

1. Power Purchase Agreements. Current law limits government power purchase agreements for utilities to 10-year contracts. NELA amends this law to allow agreements of up to 40 years (for electricity services only), to enable government agencies to sign long-term contracts with nuclear power plants, which recover construction costs over several decades. Generally speaking, this change increases options and potential opportunities for contracts that best meet government needs and objectives.

While there could be good reasons for a multi-decade contract for electricity services, there are also good reasons not to commit taxpayers to such extensive contracts. Looking retrospectively, electricity use has changed drastically in the past 40 years. In 1979, electricity deregulation and the hydraulic fracking boom had yet to occur, and the make-up of electricity generation looked quite different with more than half of electricity being generated from coal. Today, coal provides 27 percent of electricity, and natural gas has boomed to 35 percent.[4] A long contract could force government into using expensive, inefficient energy.

However, NELA goes too far in requiring the DOE to enter into a power purchase agreement of at least 10 years with a nuclear energy company, with special consideration for service to the Departments of Defense or Homeland Security. Presumably, the DOE would have to find another customer if either department declines.[5] NELA further permits the agreement to be set at above-market rates if the selected nuclear company meets certain national security objectives. Acquiring defense assets often does require paying a premium. However, what NELA describes as a national defense capability or as being in the national interest, and therefore permissible for above-market rates, is so broad that it is hard to envision an arrangement that could not in some way fit the description.

Such a pilot program is reminiscent of the renewable energy mandates required by Congress and the Obama Administration, or initiatives like the Great Green Fleet. Both used the military as a customer to stimulate private-sector supply and demand for biofuels, adding additional costs without improving capabilities.[6] Similarly, NELA borrows national security language for what is otherwise a program to subsidize the private nuclear industry.

Recommendations. Advanced nuclear technologies could meet unique defense needs, and there has been interest in exploring those possibilities.[7] However, the Departments of Defense and Homeland Security should not be used as stimulus programs, and procurement of energy and technology should clearly meet actual needs for defense capabilities. Congress should reduce legal barriers for the government to use nuclear energy (and other technologies), as NELA does by redefining the scope of power purchase

agreements. Congress further should eliminate renewable energy mandates for government agencies, which unnecessarily restrict energy options and bias against nuclear energy as a source of greenhouse gas emissions free power, the presumed goal of these mandates. Similarly, Congress should not create new barriers to energy choices by requiring the use of nuclear power. At a minimum, Congress should make the DOE pilot long-term power purchase agreement optional where it is currently mandatory.

2. Nuclear Energy Strategic Plan. The real substance of NELA is in sections four and five, which outline a 10-year nuclear energy strategic plan for an all-encompassing DOE research plan and demonstration reactor program. NELA requires the DOE's plan to improve access to federal research facilities and data, identify further research areas, and develop accompanying goals with industry to cover the full spectrum of nuclear energy, from materials testing and modeling to nuclear waste management processes.

Further, the DOE must complete between two and five advanced reactor demonstration projects by 2035 under cost-sharing agreements in which up to 50 percent of costs can by covered by the taxpayer unless the DOE determines that a higher percentage of federal aid is necessary.[8] These demonstration reactors are intended to meet perceived private-sector needs. For example, two such objectives identified in NELA are to produce heat for industrial processes and to generate carbon dioxide free electricity at $60 per megawatt hour or less. For reference, a theoretical conventional natural gas plant produces electricity at roughly $46 per megawatt hour, and unsubsidized onshore wind at $56 per megawatt hour.[9]

To determine demonstration projects, companies would be evaluated for technological readiness by the DOE and an external review board of private sector companies representing prospective customers. For candidates that are not ready by the initial deadline of 2025, the DOE must identify their technology challenges and support research and development to help them overcome these challenges. Finally, the DOE is to collaborate with the private sector to find reactor sites.

In other words, NELA directs the DOE to literally do the work of a private company for the company—from improving a product to financing and finding a customer and site. Rather than improving private sector access to federal resources at national labs, NELA directs the DOE to cater to the nuclear industry such that it proposes nothing short of the federal government co-opting the advanced nuclear industry.

While many advanced nuclear technologies are exciting and promising, such a research and demonstration agenda is far outside the constitutional scope of the federal government. The federal government simply should

not intervene in energy markets to make better commercial nuclear power reactors, or any number of other activities aimed at jump-starting energy technologies. Doing so has negative consequences for taxpayers and the very nuclear industry that Congress purports to help. These consequences include:

- **Cronyism.** The opportunities for cronyism through NELA are many, as it all but invites companies to direct taxpayer resources to their own benefit. While well intentioned, NELA opens this door via the various advisory and review panels staffed by advanced reactor companies and their potential customers to both help define the DOE's research agenda and select demonstration projects. The results may not align with actual market needs and preferences.

- **Selection of winners and creation of barriers.** No matter how diligent or transparent an Administration is, federal funding for research and development beyond meeting discrete government needs (that is, where government is the direct customer) inherently picks winners and losers among companies and technologies. This narrows the scope of innovation to the few companies and technologies that win DOE approval. Competition to develop a technology, informing and winning investors, and finding customers should winnow down the well-populated field of advanced nuclear companies. But NELA rigs the game, putting many of those decisions in the hands of bureaucrats and advisory boards whose actions cannot help but sway private investment and define the advanced nuclear market.[10] Unfortunately, this rewards companies with better lobbying teams and political connections, and builds new barriers for companies that choose not to, or do not, meet the parameters of the DOE's demonstration program. Regardless of their technical merit, the companies left out may appear riskier to potential investors and customers simply because they do not have the DOE stamp of approval or interest.

- **Poor incentives.** Government intervention in the development, demonstration, and commercialization of new technologies muddles important market signals that are critical to the long-term success of any technology. This is especially the case when there is already investment by the private sector, as indeed there is in advanced nuclear technology. Further, the direct and indirect subsidies proposed act as a disincentive for discipline and efficiency in costs, research, operations, and investments within the nuclear industry.

- **Poor government track record.** Except where government is the customer, Congress and the DOE lack the very commitment that NELA claims the private sector does not have to complete a nuclear power project. For example, in the recent past, Congress authorized $1.25 billion in the Energy Policy Act of 2005 for a public–private partnership, the Next Generation Nuclear Power Plant. Congress spent $528 million through 2010 on this very-high-temperature gas reactor, only to abandon it in 2011 during the pre-licensing process.[11] There are other such quasi-commercial examples of government failure: the MOX reprocessing facility at the Savannah River Site; the costly oscillation in policy regarding reprocessing among Presidents Jimmy Carter, Ronald Reagan, George H. W. Bush, and Bill Clinton; and the expensive failure of a sodium-cooled fast reactor at Clinch River with the Tennessee Valley Authority. Staff turnover, leadership changes, federal budgets, and unanticipated shifts in political priorities historically have made the federal government an unreliable partner (no matter how artfully proponents relate a project to national security or federal objectives).

Recommendations. Taxpayers should not subsidize energy technology research and development, nuclear or otherwise, except where the government is the customer seeking to fulfill a specific federal objective. Congress largely stayed within those bounds while improving the nuclear industry's access to DOE infrastructure in NEICA. Congress should allow NEICA to play out (in addition to its regulatory counterpart, NEIMA) and pivot to addressing other regulatory issues that plague the nuclear industry.

Relatedly, the DOE should make the national labs more accessible as resources to the private sector, not just to industry but to potential investors. Advanced reactor companies routinely mention the challenge to educate venture capitalists and other potential investors unfamiliar with nuclear energy technology. Rather than promoting any one technology, the national labs could be a more visible resource in the education process. National labs could modify a program like the Lab Partnering Service to make existing resources and personnel available to investors seeking to understand different reactor concepts.

If Congress is determined to spend taxpayer money to further subsidize the commercial nuclear sector, it should make changes to diminish NELA's consequences for the private sector. For example, rather than selecting companies to participate in NELA's government-funded demonstration reactor program, NELA could implement reverse auctions or offer prizes

for performance or successful demonstration of certain technological benchmarks. While ideally companies should be working to win customers, these approaches would at least better incentivize productivity, allow better technologies and business models to rise to the top, better protect taxpayers, and not have the effect of the government implicitly down-selecting technologies and companies.

At a minimum, Congress should limit taxpayer liability under NELA's current approach. NELA requires the DOE "to seek to ensure that...the selected demonstration projects can meet deadline[s]" of 2025 or 2035 and, as part of that determination, "consider" a project's "capacity to meet cost-share requirements."[12] Such flexible language gives the DOE too much room for discretion to ignore costs to taxpayers, in addition to the already low bar set in the Energy Policy Act of 2005 permitting the DOE to exceed federal cost-share maximums. Rather, NELA should explicitly state priority for demonstration reactors that do not request any federal funds. Any project requesting federal funding should not be considered for the first deadline of 2025. Subsequently, NELA should stipulate that the DOE prioritize demonstration projects requesting the least amount of taxpayer cost-sharing funds.

3. Advanced Nuclear Fuel Security Program. NELA directs the DOE to develop a program to produce high-assay low-enriched uranium (HALEU) for use in advanced nuclear reactors, made available "through contracts for sale, resale, transfer, or lease."[13] (See Textbox 1 for more information on HALEU and the nuclear fuel market.)

According to NELA, the DOE must make two metric tons of HALEU available by 2022, and at least 10 metric tons by 2025 for commercial, civilian use. While NELA does not mandate where the DOE sources HALEU, it requires the DOE to consider the stockpile of uranium maintained by the DOE and National Nuclear Security Administration. The program would end in 2035 or once a domestic supplier can offer HALEU (whichever comes first), and so is intended as a stop gap to provide advanced reactor companies a source of fuel. NELA also requires the DOE to deliver a report to Congress on how it plans to create such a program.

The DOE has several sources of enriched uranium that could be processed for use as HALEU, namely spent fuel from Navy reactors, previous weapons production, and EBR-II, a government demonstration fast reactor that closed in 1994. Idaho National Lab (INL) will continue down-blending and storing roughly 25 metric tons of spent fuel from EBR-II.[14]

Because the DOE houses resources that currently cost taxpayers to store and are of market interest, a program to make these resources available

to the private sector makes sense. However, such fuel should be offered at a market price and at no cost to the taxpayer in order to send accurate market signals to customers and private-sector fuel suppliers. Indeed, this is the point of the NELA program—to send a market signal for the private sector to build out infrastructure for HALEU, *not* to supplant private-sector participation.

Beyond this, though, NELA begins to tread into questionable territory with its discussion of defense and civilian uses of enriched uranium. Unlike defense uses, the advanced nuclear industry's needs for enriched uranium can be sourced domestically *or* internationally. This distinction is obscured in NELA, which unhelpfully conflates the military's need for domestic-only enrichment with industry's general and less restrictive need for HALEU.

While some may balk at U.S. companies purchasing HALEU from Russian company Tenex, for example, they ignore the fact that the American fuel services company Centrus has been contracting with Tenex for years. Or again, the New Mexico–based subsidiary of European company Urenco has announced that it is capable of producing HALEU pending Nuclear Regulatory Commission (NRC) licensing and market demand. Both are legitimate options for the civilian nuclear industry.

The DOE has one responsibility in providing for domestic enrichment services, and that is to meet national security requirements for enriched uranium. It is fundamentally not the responsibility of the DOE, and thus the taxpayer, to provide fuel for a commercial civilian industry whether explicitly or under the pretext of national security. Further, DOE participation could harm private-sector endeavors to offer competitive enrichment services.[15] In fact, the DOE historically has done a very poor job of justifying defense enrichment infrastructure costs with private-sector demand, let alone anticipating and responding to private-sector needs.[16] Consequently, any DOE program for HALEU must be strictly limited.

Recommendations. Defense-related needs and timelines for domestic enrichment capabilities are well-known and should be addressed in time. However, NELA is not an appropriate or sufficient place to address those needs, which deserve far more coherent and careful attention from Congress. "National security" is not a catch-all phrase that obligates taxpayers to carry the entire nuclear industry. In keeping with this, NELA should clarify the distinction between defense and commercial needs for enriched uranium.

Any DOE program for civilian uses of HALEU should be limited. NELA should stipulate that any uranium used should be from existing DOE resources in excess of what is set aside for defense needs. Resources and services should be made available under contracts with the nuclear

TEXT BOX 1

HALEU and Uranium Enrichment: What Are They, and What Do They Mean?

Enrichment is an essential part of turning uranium into a usable fuel. Once uranium is mined and purified in the milling process (from which "yellowcake" is produced), it is processed at a conversion facility and enriched. Enrichment essentially separates and concentrates the desired fissionable isotope uranium-235 from the more stable uranium-238. From there, enriched uranium is then packaged as fuel according to the design and use for which it is intended.

HALEU is uranium enriched between 5 percent and just below 20 percent, and is the nuclear fuel needed by many advanced reactor concepts. Enrichment grades beyond 20 percent are considered weapons-usable material. Today's commercial nuclear power reactors generally use uranium fuel enriched to 5 percent or less; consequently, most enrichment services are outfitted and licensed to meet these market needs rather than the nascent advanced nuclear technologies. However, HALEU currently is available internationally through Russian company Tenex. Urenco USA, a subsidiary of a European consortium and the sole domestic enrichment facility, announced it is capable of producing HALEU up to 19.75 percent and is considering making investments for a dedicated HALEU unit in New Mexico.[1] It is currently licensed by the Nuclear Regulatory Commission to enrich uranium up to 5 percent.

The nuclear industry can and does shop internationally for fuel services (and is generally itself now an inherently international industry). In 2018, American nuclear power operators purchased the majority of their uranium within the U.S. and from six countries: Australia, Canada, Kazakhstan, Namibia, Russia, and Uzbekistan. Enrichment services are also sourced globally: 52 percent of enrichment services came from international providers and 48 percent from domestic providers.[2]

In contrast, the U.S. military requires uranium to be enriched to grades upwards of 90 percent for use in weapons, aircraft carriers, and submarines.[3] Unlike civilian uses, defense uses require domestically sourced uranium, processing, and enrichment facilities that are not "obligated" or "encumbered" by international nonproliferation agreements or peaceful-use restrictions. Most of these needs are met through the stockpile of highly enriched uranium managed by the National Nuclear Security Administration and the DOE. There currently are no domestically owned enrichment facilities that meet defense restrictions; however, anticipated defense-related needs are well-known and understood by the responsible departments.[4]

1. News release, "Urenco USA Inc. Announces Nest-Step HALEU Activities," Urenco, February 5, 2019, https://urenco.com/news/articles/urenco-usa-inc-announces-next-step-haleu-activities (accessed July 23, 2019).
2. U.S. Energy Information Administration, "2018 Uranium Marketing Annual Report," May 2019, https://www.eia.gov/uranium/marketing/pdf/umar2018.pdf (accessed July 23, 2019).
3. Lance Larson, "The Front End of the Nuclear Fuel Cycle: Current Issues," Congressional Research Service *Report for Congress*, June 6, 2019, https://fas.org/sgp/crs/nuke/R45753.pdf (accessed July 23, 2019).
4. U.S. Department of Energy, "Tritium and Enriched Uranium Management Plan Through 2020," *Report to Congress*, October 2015, http://fissilematerials.org/library/doe15b.pdf (accessed July 23, 2019).

industry at zero cost to the taxpayer and at rates that do not underbid the market. Further, Congress should clarify that any DOE material should be introduced at volumes that do not distort the market. Finally, NELA encroaches too far into the private sector by directing the DOE to establish a research, development, demonstration, and grant program for HALEU

transportation packages. The only role of the government is in licensing and regulating packaging.

An Embarrassment of Riches: The Abundance of Taxpayer Aid for Advanced Nuclear Technology

NELA should not be weighed in a vacuum. Congress is already dedicating significant resources to advanced nuclear technologies: 23 percent of the DOE's fiscal year 2019 energy research and development funding in the Offices of Science and Nuclear Energy went to advanced nuclear technologies, second only to energy efficiency, according to the Congressional Research Service.[17] Current federal support for research, development, demonstration, and commercialization of advanced nuclear technology include the following:

- On May 31, 2019, the DOE announced a no-bid contract award for uranium enrichment as part of a "HALEU Demonstration Project," which Congress did not authorize.[18] The contract was awarded under the stated premise of meeting national security needs, yet is being funded through the DOE's civilian nuclear energy programs and is clearly designed for civilian advanced reactors.

- Congress indefinitely renewed a production tax credit of 1.8 cents per kilowatt hour to advanced nuclear power plants. The credit will apply to at least two reactors currently being built at the Alvin W. Vogtle Electric Generating Plant in Georgia, but is estimated to be worth billions of dollars in deferred tax burden to taxpayers.[19]

- $8.8 billion in DOE loan guarantees remain available for advanced nuclear reactors, with another $12 billion having already been dedicated to the Vogtle reactor construction project.

- In December 2018, the DOE entered into a memorandum of understanding to enter into a power purchase agreement with NuScale to service Idaho National Lab.[20] NuScale is a small modular reactor company that uses simplified light-water reactor technology. The DOE also intends to use another NuScale reactor for research to demonstrate non-electrical uses of nuclear reactors. The DOE has partially funded NuScale's research, development, siting, and licensing activities intermittently since 2000.[21]

- The Office of Nuclear Energy houses a variety of advanced nuclear research and development programs and cost-sharing opportunities. It also supports the DOE's Gateway for Accelerated Innovation in Nuclear (GAIN) initiative, which has a voucher program to fund work at national laboratories for advanced nuclear companies and a 20 percent to 50 percent cost-share program for development, demonstration, and regulatory assistance. The Office of Nuclear Energy also offers technical and financial support for licensing activities of advanced nuclear technology.

    - The DOE is funding a GE Hitachi advanced reactor which, assuming further funding from Congress as NELA designs, will be used as a national "versatile test reactor" and will, to a degree, also serve to demonstrate GE Hitachi's PRISM reactor. The PRISM reactor is itself a vestige of a 1980s DOE program ended in 1993 and resurrected in the early 2000s as part of the DOE's Global Nuclear Energy Partnership program.[22]

- The Office of Science houses DOE research and development of fusion technologies, in addition to funding of fusion research at the International Thermonuclear Experimental Reactor (ITER) project in France.

- The DOE's Advanced Research Projects Agency-Energy (ARPA-E) funds research in advanced modeling and materials science for advanced nuclear technology as part of its Modeling-Enhanced Innovations Trailblazing Nuclear Energy Reinvigoration (MEITNER) program.

In addition to existing support, a historical perspective shows that NELA recommends little that is new and untried. Under the George W. Bush Administration, Congress funded "an aggressive effort to move beyond [light-water reactor] technology into advanced reactors and fuel cycles."[23] If anything, this advanced reactor effort was better justified as an appropriately *federal* program under the auspices of nonproliferation to catalyze proliferation resistant reactor and spent-fuel technologies.

The resulting Global Nuclear Energy Partnership, the Generation IV Initiative, and the Advanced Fuel Cycle Initiative under the Bush Administration employed a strategic technology "roadmap,"[24] federal research and development, advanced reactor loan guarantees, cost-sharing programs for licensing activities, and a public–private partnership to construct the Next

Generation Nuclear Plant at Idaho National Lab for research, development, and demonstration of electricity production and non-electrical uses of an advanced nuclear reactor.

These programs remain largely unfulfilled or abandoned. Congress should learn from this experience that the nuclear sector and broader energy market are far more dynamic and unpredictable than any detailed government plan to jump-start the private sector. Indeed, politics are just as, if not more, unpredictable.

Where Congress Needs to Pivot

Government has focused on "making nuclear cool again"[25] and mitigating the cost of nuclear energy through subsidies, leading down a predictable path of failure. While subsidies may spur some amount of commercial activity, it is limited only to what is subsidized.

Congress and the Administration would provide better leadership toward a sustainable future for the nuclear industry by addressing underlying policy problems.[26] Poorly rationalized regulations and nuclear waste policy are two of the biggest issues facing conventional and advanced nuclear companies alike, and both are uniquely within the domain of the federal government.

Regulations. In NEIMA, Congress endeavored to address the muddled regulatory pathway to license unconventional, non-light-water reactor designs. The nonexistent licensing pathway drove some companies (such as Advanced Reactor Concepts) to pursue licensing in Canada. Further, the process is exorbitantly expensive; for example, NuScale reportedly expects to pay $85 million in NRC fees for the licensing process, and internally to spend $2 for every dollar the NRC charges.[27] Currently, eight advanced or small modular reactor companies are progressing through the NRC's pre-application and design certification regime, even as the NRC begins to execute NEIMA.[28] Congress needs to provide oversight and hold the NRC accountable as it implements NEIMA.

Congress and the Administration should also continue this leadership by re-evaluating at least two additional areas of regulation, namely those related to radiation exposure standards and exports. First and briefly, radiation exposure standards have lagged woefully behind scientific advances. Excessively conservative standards have increased cost and complexity of nuclear reactor design and operation—for little or no public health and safety benefit. The implications are much larger than the nuclear industry, however: Deficient standards dangerously misinform the public about the

actual risk. Though the Environmental Protection Agency (EPA) is responsible for setting baseline standards, radiation exposure standards thereafter are inconsistent across federal agencies. As the Government Accountability Office concluded in 2000: "EPA- and NRC-preferred protection levels...are both well below the range where radiation effects have been conclusively verified. In this regard, the disagreement essentially involves policy judgments—not strictly scientific judgments."[29]

Second, the likely market for nuclear energy is overseas, given growing electricity demand in the developing world.[30] However, American nuclear companies face an inefficient export regime that neither advances the intended purpose of achieving security and nonproliferation benefits, nor enables nuclear energy companies in the U.S. to be competitive abroad. For example, a 2017 report by the Clean Air Task Force found that it takes the DOE, State Department, and interagency process an average of 400 days to review an export application under the DOE's Part 810[31] specific authorization regulations. It took fewer than 150 days in the 1990s.[32] The DOE has also used export regulations to close markets to American companies. Most notably, the DOE delayed export authorization for two years and ultimately amended its policy in early 2018 to deny nuclear technology exports to China for small modular reactors and advanced nuclear concepts.[33] This has all but closed the door for advanced nuclear companies, such as NuScale and TerraPower, the latter of which initially chose to license its design in China. This policy change occurred despite the recent completion of four Westinghouse reactors in China as part of an earlier contract.

Nuclear Waste. The Nuclear Waste Policy Act of 1982 requires industry to be responsible for the *costs* of nuclear waste management, but makes the federal government responsible for actual *siting, constructing, transporting, and operating* nuclear waste disposal. This has created at least two overarching problems for the current and future nuclear industry.

First, America's government-centric approach has created risk for industry even amongst nuclear friendly communities. Though the DOE was required by law to begin collecting nuclear waste from commercial nuclear reactors by 1998, Congress and presidential Administrations have failed to do so. This failure halted otherwise legitimate licensing activities at the NRC during the hailed nuclear renaissance of the early 2000s.[34] Some states have banned or conditioned construction of nuclear power plants on a proved nuclear waste disposal or reprocessing pathway.[35] Even communities willing to build new nuclear power plants face the nuclear waste question. For example, Rebecca Casper, the mayor of Idaho Falls, which will purchase electricity from NuScale's small modular reactor, aptly expressed

these frustrations at an event promoting advanced nuclear technologies: "We've got to deal with, at some point, the nuclear waste stream that comes from commercial nuclear. There's a part of me as a local that...resents the fact that I have to answer to that, as I'm trying to sell something that's very good for my community, my state, my nation, and my world."[36]

The nuclear industry cannot grow without a clear pathway for waste management. Yet political interference has indefinitely deferred solutions and cast doubt on nuclear energy as a viable option for communities.

Second, the federal government has little incentive to manage waste it did not produce, let alone pursue innovative waste solutions that could work in sync with advanced nuclear technology. Given an intricate web of laws, federal budgeting rules, contracts between industry and the DOE, fees, and litigation, the only pathways for nuclear waste management currently available seem to be the proposed permanent repository at Yucca Mountain in Nevada and the occasional DOE pet research, development, and demonstration project (such as deep borehole disposal attempted during the Obama Administration or the now-cancelled MOX reprocessing facility in South Carolina).

However, advanced nuclear reactors offer interesting answers to nuclear waste management, as some are designed to produce less waste, or to use waste as fuel. If the nuclear industry were responsible for waste management, it also would inherently be incentivized to consider options that minimize waste production and simplify management—not just at the back end of waste disposal, but also in decisions about fuel and reactor technology that influence waste streams. For instance, there is no legal barrier in the United States to reprocessing or recycling spent fuel, which are useful or essential for some advanced reactor concepts. However there is little incentive to pursue these when the nuclear industry has no skin in the game except to pay a flat fee for the government to someday permanently dispose of waste. Instilling private-sector ownership would open up a market for nuclear waste use and management.

Conclusion

There will always be believers in nuclear technology—and for good reason. Nuclear energy is arguably the safest, most energy dense, environmental option available today. It has unlocked opportunities unfathomable 50 years ago, in industries as diverse as power generation, defense, medicine, space exploration, and food safety. But until nuclear energy can also prove to the skeptic that it is affordable and can be built on schedule, nuclear power will struggle to succeed in the marketplace.

The government indeed plays a role, but that role is not to do the work of industry for industry through a well-meaning subsidy, plan, or program (always designed better than the last time). Taxpayers are not responsible for leading the civilian nuclear industry out of the doldrums, nor are they able to. While subsidies may make nuclear appear more economic, they further tie the nuclear industry to politics and create new vulnerabilities. The illusion of having "done something" to help the nuclear industry leaves unaddressed underlying policies that provoke unnecessary risk, uncertainty, and costs. These become all the more apparent again when subsidies run out and the next industry crisis arises. Advanced reactors are not an escape from many of those underlying policy challenges facing the conventional nuclear industry.

If Congress desires a strong civilian nuclear industry, it needs to turn its attention and leadership to these policy issues, chief among them the regulatory burden and nuclear waste management. Unlike research, development, demonstration, and financing, which the private sector can also do and do better, the federal government is uniquely situated to address nuclear energy policy. Only industries rooted in free markets, supported by predictable and efficient regulation, can yield competitive and innovative nuclear energy that will be a critical part of America's energy future. Congress and the Trump Administration must have the discipline to address the many government-erected barriers thwarting the American nuclear industry and develop a modern regulatory system. *That* will require true congressional leadership.

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Endnotes

1. John Milko, Todd Allen, and Ryan Fitzpatrick, "Keeping Up with the Advanced Nuclear Industry," Third Way, February 8, 2018, https://www.thirdway.org/graphic/keeping-up-with-the-advanced-nuclear-industry (accessed July 23, 2019).
2. There are eight general categories of advanced reactor technology: (1) light-water small modular reactor, (2) supercritical water-cooled reactor, (3) high-temperature gas reactor, (4) gas-cooled fast reactor, (5) sodium-cooled fast reactor, (6) lead-cooled fast reactor, (7) molten salt reactor, and (8) fusion. For more information on each category, see Josh Freed et al., "Advanced Nuclear 101," Third Way, December 1, 2015, https://www.thirdway.org/report/advanced-nuclear-101 (accessed July 23, 2019).
3. NELA also renews an existing university scholarship, fellowship, research, and development program not discussed here. Nuclear Energy Leadership Act, S. 903, 166th Cong., 1st Sess., https://www.congress.gov/116/bills/s903/BILLS-116s903is.pdf (accessed August 14, 2019).
4. U.S. Energy Information Administration, "Electricity," *Monthly Energy Review* (June 2019), Table 7.2a, https://www.eia.gov/totalenergy/data/monthly/pdf/sec7.pdf (accessed July 23, 2019).
5. NELA does not tamper with the Defense Department's ability to exempt itself, for purposes of national security, from general service agreements as stipulated in 40 U.S. Code § 640(c)(1).
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