Twenty-First-Century US Nuclear Power: A National Security Imperative

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Abstract

America's twentieth-century policy on the peaceful uses of nuclear power was original US strategic thinking. It was a policy founded on a rules-based liberal international order shaped by personal experiences and aligned with comprehensive, long-term national security objectives. However, in the twenty-first century, the US is embroiled in a national discussion as to whether it should advance its civilian nuclear power enterprise or abandon it altogether. This disposition conflicts with America's original nuclear power policy and does not align with twenty-first-century realities. Nuclear power generation is not merely a domestic energy issue subject to popular opinion or the volatility of energy markets. Competing powers are leveraging civilian nuclear collaborations to meet strategic geopolitical objectives. If America retreats from the civilian nuclear field, revisionist powers will become the global leaders in nuclear science, nuclear engineering, and nuclear technology in the twenty-first-century with adverse implications for US national security. Thus, the civilian nuclear power enterprise should be included as a strategic sector within the US national security industrial base and deliberated as a foreign policy issue within a global alliance.

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In a globalized, interdependent world, energy is among a country's most important natural resources. Abundant supplies of marketable energy such as coal, oil, and natural gas afford resource-rich countries with geopolitical opportunities and advantages that resource-poor countries lack. The historical trend in energy has been toward resources of greater energy density coupled with the development of technologies to harness and channel energy into the human endeavor. Energy animates a country's economy and underpins the technological capacity to protect itself and defend its interests. It has a value proposition beyond that of a

market commodity as it defines and shapes geopolitical relationships and international stature.

Nuclear energy is arguably the most complex energy resource because of its dual utility for civilian power and military weaponry, both of which have distinct strategic roles. Because of this dual utility, it should not be reduced to a mere domestic energy policy issue. Nuclear power is of such strategic importance that it must be viewed as an instrument of US national security and foreign policy. This article first reviews the original principles of US nuclear power policy and evaluates the disposition of twenty-first-century US nuclear power policy. Next, it identifies domestic and international issues that are challenging the US nuclear enterprise. Finally, the article recommends two core actions for aligning twenty-first-century US nuclear power policy with national security and foreign policy.

The twentieth century and the bipolar Cold War that threatened it have given way to a globalized, multipolar twenty-first century with nations turning to nuclear power to meet economic development needs.[1] At the same time, the twenty-first century faces the specter of climate change—a global issue that is complicating US energy discussions. When international control of nuclear energy, competition for global nuclear technology leadership, and climate change are combined, these challenges of twenty-first-century US nuclear power policy appear more complex than those of the twentieth century.[2] It might, then, be considered hubris for the US to conclude it can sustain its global leadership role in nuclear science and technology, uphold its commitment to international control of nuclear energy, maintain a reliable electric grid, and meet the additional challenge of climate change while unilaterally disengaging from civilian nuclear power. In all, America is facing a perfect storm of twenty-first-century domestic and international challenges to its nuclear power enterprise. We contend that the legacy principles of US nuclear power policy established in the twentieth century remain sound and valid and that actions are required to operationalize those principles to meet this century's national security challenges.

US Nuclear Power Policy: First Principles

With the discovery of the neutron in 1932 and fission in 1938, enough was understood about the energy available in the nucleus of a uranium atom that scientists and engineers were understandably concerned that this energy could be channeled into the construction of an explosive. In 1944, and with the atomic bomb close to reality, some scientists and engineers working on the Manhattan Project, along with key officials from the

State and War Departments, were already thinking of postwar US nuclear policy and the impact atomic energy would have on a yet-to-be-constructed world order.[3] Knowing that scientific discovery could not be monopolized long term and that technological advantages are similarly temporary, the US convened numerous proceedings from 1945 to 1953 focused on America's nuclear power policy. Among these was the Acheson-Lilienthal Committee and its board of consultants, which concluded, among other key points, that the US was "not dealing simply with a military or scientific problem but with a problem in statecraft and the ways of the human spirit."[4] The committee realized that America's nuclear power policy and its engagement in a global effort to control atomic energy would require a brand of statecraft aligned with twentieth-century international arrangements that were unfolding and unpredictable. What became evident was that nuclear power had become a political issue "in the context of the great contest between Western freedom and Soviet totalitarianism" and would require candor, trust, and confidence with the American public and with US allies in an emerging world order.[5]

Subsequently, in December of 1953, President Eisenhower delivered his "Atoms for Peace" speech to the United Nations. He proposed that atomic energy "be allocated to serve the peaceful pursuits of mankind"—particularly to "provide abundant electrical energy in the power-starved areas of the world"—thus dedicating strength to "serve the needs rather than the fears of mankind." President Eisenhower essentially framed the first US nuclear power policy.[6] Consequently, the Atomic Energy Act of 1954 liberalized the US nuclear enterprise by allowing private companies to develop and construct nuclear reactors domestically under the regulatory authority of the federal government and to engage internationally in the sharing of nuclear science and technology for peaceful civilian uses. Pursuant to President Eisenhower's policy declaration, in 1955 the National Security Council (NSC) produced a Statement of Policy on Peaceful Uses of Atomic Energy. It specified that in the interests of national security, US programs for development of the peaceful uses of atomic energy should be directed toward the following:

- "Maintaining U.S. leadership in the field, particularly in the development and application of atomic power.
- Using such U.S. leadership to promote cohesion within the free world and to forestall successful Soviet exploitation of the peaceful uses of atomic energy to attract the allegiance of the uncommitted peoples of the world.

- Increasing progress in developing and applying the peaceful uses of atomic energy in free nations abroad.
- Assuring continued U.S. access to foreign uranium and thorium supplies.
- Preventing the diversion to non-peaceful uses of any fissionable materials provided to other countries."[7]

The foundational NSC discussions of America's nuclear power policy were carried out at the dawn of a new liberal international order but in the shadow of a rising Communist power. Communist intentions, which were at that time unknown, had to be anticipated and incorporated into America's foreign policy calculus to ensure US national security and global stability in Europe and Asia. The life experiences of the individuals involved were as central to their deliberations of the postwar world as was the science behind nuclear fission. It was the undercurrent of these experiences that motivated the NSC to establish an international system to safeguard the US and the world from future great power conflicts by controlling atomic energy in all its various pathways that could offer peaceful applications and prevent military extensions.

The potential implications of atomic energy came into focus as the key discussants realized they were not dealing with just another domestic energy issue or simply a science and technology issue. Rather, they were ushering in a new era of energy statecraft that would require a level of technological capacity within the US industrial complex and the US diplomatic corps fundamentally different from that associated with traditional energy commodities such as oil and natural gas. They recognized the importance of US technological primacy in the nuclear space, underpinned by a vigorous nuclear research and development enterprise. Primacy would sustain America's early technological lead and its credibility as a nation of experts capable of engaging authoritatively, competently, and competitively in a global network of ever-evolving developments in the nuclear field.[8] Moreover, they perceived the strategic imperative of crafting US nuclear power policy as an extension of US foreign and security policy.[9]

From these proceedings emerged the most robust civilian nuclear power program in the world today—one that includes 95 US reactors and 25 Section 123 agreements with other nations.[10] The US monopoly on nuclear science and engineering was short-lived as Russia, the UK, France, and China developed nuclear weapons by 1964. They were followed by India, Pakistan, and North Korea with declared nuclear weapons and Israel with undeclared nuclear capabilities.[11] As for civilian applications,

since 1954, 38 countries have engaged in the construction and operation of nuclear reactors, much of which has been through international partnerships to ensure international control, safety, and security within the global nuclear materials cycle.[12] However, while in the twentieth century the US was the global leader and international authority for the development and deployment of civilian nuclear science, engineering, and technology, the twenty-first century is unfolding differently—domestically and internationally—and with many challenges.

Twenty-First-Century Nuclear Power Challenges and Implications

According to Ambassador Thomas Graham Jr., a former senior US diplomat, and Adm Richard W. Mies, retired, "The recent struggles of the U.S. nuclear energy industry may appear to be no more than the usual economic disruption caused by competition among technologies. But from our experience in diplomacy and the armed forces, we understand that a declining domestic civil nuclear industry has other ramifications. Critical U.S. national security interests are at risk."[13]

The first principles of US nuclear power policy clearly convey the national security imperatives of nuclear energy and technology. However, most of the original principles are not being fulfilled. Policy makers today must understand the challenges confronting America's civilian nuclear power sector and the national security implications of a declining US nuclear enterprise—both domestic and international in nature. Despite the ever-expanding field of international players, the national security implications of US nuclear power policy are rarely included in America's domestic energy debate.

Domestic Challenges and Implications

The domestic debate on US nuclear power policy is fragmented into several issues that precipitate the decline of the US civilian nuclear enterprise, three of which are briefly discussed here.[14] First, atomic energy has long been controversial within the public domain due in part to concerns about reactor safety and the security of nuclear materials and technologies that could be misused for nuclear weaponry.[15] To this end, it is not uncommon for the civilian use of nuclear power to be conflated with military applications.[16] The Acheson-Lilienthal Committee noted that "one of the most serious dangers to the promotion of effective international action is . . . that our natural preoccupation with the destructive aspects of atomic

energy may blind us to its useful aspects."[17] Today, that conflation continues with calls for the US to opt out of the nuclear industry altogether based in part on waste and proliferation concerns.[18]

Second, within America's overall energy policy debate there is a call to move the US away from all traditional fuels—meaning fossil fuels and nuclear resources—and transition the country to 100 percent renewable energy, in part to address the impacts of global climate change.[19] This is an ongoing issue with considerable political overtones, not only in the US but globally as well.[20] The underlying theory is that the US and the world can meet all energy needs with renewable energy alone, with no need for fossil fuels or nuclear power.[21] The rationale is that renewable energy will improve energy security by displacing imported energy with a domestic resource that poses near-zero risk, whereas fossil fuels and nuclear energy have import/export dependencies, emissions issues, waste, and proliferation risks. The push for 100 percent renewable energy in the US is likely to remain part of the national energy policy debate well into the future as global climate change concerns are elevated in the national energy conversation and renewable energy is promoted as the lowest-risk pathway to address those climate concerns.[22] It is important to note that global climate change has been identified as a national security issue by the US Department of Defense and the US Office of the Director of National Intelligence. Since US climate policy influences US energy policy, US climate policy will influence the trajectory of US energy technology—including nuclear power. Consequently, US energy and climate policy are entangled with US nuclear power policy and national security.[23]

Third, the free market historically has been a dominant driver of the US energy portfolio, and some contend that market forces alone should determine the fate of America's nuclear industry.[24] Currently, those market forces are moving the US electric power sector toward natural gas because it is abundant and inexpensive and because large nuclear construction projects, by comparison, are more capital intensive and require a long-term investment perspective. Consequently, about 20 percent of US civilian nuclear power reactors are under threat of premature closure.[25] Moreover, domestic nuclear construction waned toward the end of the twentieth century. New construction has been largely dormant in the twenty-first century with only two reactors under construction at Plant Vogtle in Georgia—the first new US nuclear construction project in over 30 years.[26]

Further complicating America's nuclear power policy debate is that, in spite of the twenty-first-century emergence of China and Russia and bipartisan agreement in Washington of this emergence, recent polling indi-

cates that great power competition is not a top priority with the American public.[27] By extension, the national security implications of US civilian nuclear power policy within the context of the strategic geopolitical objectives of these two revisionist powers are even less likely to be a priority. The US debate over the fate of its nuclear enterprise has been generally reduced to that of a domestic energy policy issue within the overall debate of global climate change—a debate that includes considering whether the US should retain its nuclear enterprise or abandon it altogether. This disconnect between nuclear power as a national security issue, as understood by policy makers post–World War II, and nuclear power as only a commodity in the energy market may reflect what Hal Brands and Charles Edel characterize as contemporary amnesia with the United States "losing the tragic sensibility that impelled it to do great things."[28]

The debates over waste and proliferation concerns, renewable energy, and the role of markets are creating strong domestic headwinds for the future of US nuclear power and have the potential to bring the civilian US nuclear industry to a close. Moreover, the domestic challenges to America's nuclear enterprise raise an even more pointed question: Does the US see any value in retaining its twentieth-century nuclear leadership into the twenty-first century? At the same time, international forces are presenting additional challenges to America's nuclear enterprise and global leadership in nuclear power—challenges that are more strategic and have broader implications for US national security.

International Challenges and Implications

The greatest national security challenge to the original principles seems to emanate from international actors, particularly through geopolitical exploitation. The decline in US domestic nuclear construction over the past 30-plus years—relative to the growth of nuclear power development in other regions of the world—has created opportunities for revisionist powers China and Russia to aggressively engage in expanding nuclear power collaborations. Since 2000, 96 nuclear reactors have been connected to the grid in 13 countries. Of these, 45 were constructed in China and 12 in Russia. An additional four Chinese-designed reactors and seven Russian-designed reactors were deployed in five other countries, meaning 71 percent of reactor deployment is associated with China or Russia either by domestic location or by reactor design. Currently, 54 reactors are under construction in 20 countries. Of these, 13 are Chinese designed (11 in China, 2 outside of China), and 16 are Russian designed (4 in Russia, 12

outside of Russia). Thus, 54 percent of reactors under construction are associated with China or Russia.

In all, since 2000, 150 nuclear reactors have been connected to the grid or are under construction in 22 countries. Of these, 97 are associated with China or Russia in 11 of those countries. Thus, for the past 20 years, China and Russia are associated with 65 percent of reactor construction in half of the countries where nuclear power has been or is being deployed.[29] Much of the new reactor construction can be attributed to the practical need for electricity in developing economies in Eurasia and the Asia-Pacific region.

China and Russia are deftly leveraging their nuclear expertise for strategic geopolitical gain and are on track to displace America as the reliable global partner in nuclear technology and international nuclear collaborations.[30] From planning to construction, operation, and decommissioning, nuclear collaborations span decades, affording China and Russia the ability to project their respective geopolitical influence in countries that will be dependent on them for nuclear technology and services. Both nations are positioned to assume global leadership in civilian nuclear technology and services and are outcompeting other states on the global stage to the extent that "the nuclear industry in a few decades is likely to be decidedly non-Western."[31] China is a particularly adept competitor as it is taking an "integrated approach to innovation" as well as a "whole-of-nation implementation of military-civil fusion" to "leverage synergies between defense and commercial developments" including global nuclear commerce, which is embedded within its Belt and Road Initiative.[32] This status isn't a reflection of superiority in nuclear expertise or capabilities so much as how each country views nuclear power—as an energy technology subject to popular opinion and political leanings or as a geopolitical tool subject to the will of the state. It also indicates that China and Russia are exploiting nuclear energy to attract allegiance.

China has developed a three-phase strategy to transition from its current light-water-reactor technology to nuclear fusion.[33] It has also structured a deal to establish a nuclear industry university for advanced study.[34] Lin Boqiang, director of the China Center for Energy Economics Research at Xiamen University, emphasizes that "China is the fastest-expanding nuclear power generator in the world . . . at a time when traditional giants like the US are retreating." He characterizes China's state-owned nuclear sector as an "incomparable advantage" of the Chinese system as it offers "long-term stability and rich financing sources to support research and development."[35] This advantage is unique compared with the US capitalist-based nuclear sector. China is leveraging that ad-

vantage, having identified advanced nuclear technologies in its Thirteenth Five-Year Plan as a strategic industry for development.[36] With its state-owned nuclear enterprise, Russia has its own strategic build-own-operate plan for international nuclear agreements, has deployed its BN-800 fast breeder reactor, and is working on closing its fuel cycle.[37]

The nuclear power enterprises of China and Russia are state-owned enterprises (SOE) and are being leveraged as extensions of the state to meet strategic foreign policy and geopolitical objectives. This structure stands in contrast to the privatized US civilian nuclear power industry that, while regulated by a centralized federal authority, is driven by competition and is not supported by national financing to achieve foreign policy or geopolitical objectives. This is not a military competition—rather it is a strategic competition wherein China and Russia are deploying civilian nuclear technologies and services with high geopolitical stakes.

While unilateral efforts by China and Russia are concerning enough, those concerns are heightened given that "the two countries have significantly expanded their cooperation, especially in the energy, military, and technology spheres, since 2014 . . . as the overall US lead in science and technology shrinks."[38] The geopolitical synergism of Chinese and Russian nuclear enterprises raises questions as to whether the US is positioned to maintain its nuclear leadership role and warrants attention to issues contributing to the US decline relative to the rest of the world.[39]

Aligning US Nuclear Power with National Security Objectives

Henry DeWolf Smyth, a US physicist who played a key role in the early development of atomic energy and US nuclear policy, posed a question in 1956 that still reverberates today: "Are the aims of our foreign policy consistent with the aims of our domestic policy as far as nuclear power is concerned?"[40] Global leadership in the twenty-first-century landscape of civilian nuclear power will belong to the country that not only sustains its existing nuclear plants, an issue the US is dealing with currently, but also has a long-term vision for growth and expansion of its nuclear enterprise. Further, it must have a strategy to operationalize that vision—a vision and strategy the US currently is not projecting. Such a strategy will require research and development programs for advanced reactors, advanced and alternative nuclear fuels, spent fuel management, and technologies for closing the nuclear fuel cycle.[41] The strategy must also show evidence of a long-term commitment to nuclear power technologies and peripheral services that attract developing economies looking to establish long-term

cooperative nuclear power relationships—as was the custom in the early years of nuclear power programs.

Currently, the US is facing two national-level issues affecting the fate of the US civilian nuclear power enterprise. Those two issues are global climate change and the reemergence of long-term, strategic competition by revisionist powers.[42] It is imperative to ensure that any policies engendered by these issues align US nuclear power policy with the objectives of US foreign policy and national security. To that end, we propose two core actions—one domestic and one international. First, expand the scope of nuclear science, engineering, and technology within the national security industrial base to include US civilian nuclear power as a strategic sector, and conduct a whole-of-government industrial base review of the US civilian nuclear enterprise. Second, marshal US allies having core nuclear expertise and capabilities into a twenty-first-century coalition capable of doing collectively what each nation is not doing individually—outcompete illiberal, authoritarian powers in global nuclear partnerships.[43]

Civilian Nuclear Power as Part of the National Security Industrial Base

US and allied nations generally approach nuclear power from an economic feasibility basis, be that in domestic projects or bilateral cooperation. China and Russia, on the other hand, approach it with a strong emphasis on geopolitical gains and not economic feasibility alone. As long as it does not include the national security value of nuclear power, economic feasibility of itself will not compete with the geopolitics of a state. Given that the twentieth-century liberal international order was constructed with America's nuclear power policy aligned with national security objectives, this potential shift in civilian nuclear primacy from democratic to authoritarian nations raises a broader question as to the geopolitical arrangements of the twenty-first century. Specifically, can the US, without world-class civilian nuclear power expertise in its industrial base, sustain in a more geopolitically complex twenty-first century what it established in the twentieth century with the world's premier civilian nuclear power expertise? This question demands a response as a decline in the US civilian nuclear industry translates to a decline in US nuclear expertise, which is acutely problematic if that decline is countered by an increase in nuclear expertise in competing great powers.

While the overarching role of nuclear capabilities in US foreign policy unquestionably will be to maintain America's military superiority, the full scope of twenty-first-century great power competition will not be re-

stricted to military means. Twenty-first-century great power competition is a strategic competition where "technological advances and an economic rebalancing" are leveraged as "low-cost and relatively low-risk opportunities to weaken the United States and the Western alliance."[44] Given that authoritarian powers are leveraging civilian nuclear technology as extensions of the state in this contest for technological superiority, concerns regarding America's national security industrial base should extend to the US civilian nuclear power industry.

We propose expanding the scope of nuclear science, engineering, and technology within the US national security industrial base to include US civilian nuclear power as a strategic sector. This will shift US civilian nuclear power from an issue debated predominantly as a domestic energy and climate policy issue to a core foreign policy issue deliberated within the national security space. Doing so will serve to ameliorate much of the political volatility associated with populist energy policies as well as some of the inherent fluctuations in domestic energy markets. It will also provide grounds for conducting a whole-of-government nuclear industrial base review—led by the Department of Defense and the intelligence community—to evaluate risks, identify impacts, and make recommendations for strengthening, reorganizing, and reconstituting the US nuclear sector's domestic and global manufacturing and supply chain. The US nuclear sector is currently working from a twentieth-century model wherein the US had substantial momentum from its post–World War II monopoly and its great power competition in the nuclear space was military competition with the USSR. The twenty-first century is far different, and the US must evaluate how its nuclear enterprise should be structured and organized to efficiently and effectively compete on a global scale with Chinese and Russian SOEs and how to out-innovate state-backed R&D programs in advanced nuclear technologies.

The domestic challenges previously noted are fundamentally misaligned with the foundational principles of US nuclear power policy that considered nuclear power strategy to be first and foremost a foreign policy and national security issue—not merely a domestic energy policy issue. Moreover, relegating the future of US nuclear power to markets alone, particularly a global market without fair market signals, is a gamble that will not pay dividends on the national security value of nuclear power. Smyth emphasized that "decisions about the peacetime development of nuclear energy have not, cannot and probably should not be made on the basis of strict economic realism."[45] Smyth's opinion was echoed by Thomas E. Murray, Jr., businessman and commissioner of the Atomic Energy Com-

mission, who considered attaining economical nuclear power to be as vital to national security as US preeminence in nuclear weapons.[46] Affordability matters, of course, and the competition inherent in free market capitalism is critical to innovation in next-generation nuclear reactors. However, national security is not an emergent property of capitalism and free markets because the national security benefits of nuclear power are non-monetized benefits. As the US has witnessed, if left to markets alone, America's nuclear power policy and its nuclear legacy would be overly influenced by near-term profits and marginal costs of energy. Therefore, the free market's invisible hand should be allowed limited pull on the levers of foreign policy and national security or on any market approach that marginalizes or precludes nuclear science, engineering, and technology from the US industrial base.

The robustness of the US industrial base and supply chain in a highly interdependent globalized economy recently triggered concerns pertaining to America's industrial capacity to respond to contemporary threats. This was evidenced by President Trump's issuance of Executive Order 13806 directing "the Secretary of Defense to conduct a whole-of-government effort to assess risk, identify impacts and propose recommendations in support of a healthy manufacturing and defense industrial base—a critical aspect of economic and national security."[47] This order can serve as the model for a similar industrial base review of America's civilian nuclear enterprise to evaluate how the US should "transform, organize, sustain, and leverage [its] national security technology and innovation community to prevail in a long-term competition against an authoritarian regime that has centralized, long-range national plans to dominate the critical dual-use technologies central to future economic and military competitiveness."[48] This inherently will include an evaluation of the various sectors of the US nuclear enterprise, including plant operation, fuel services, safety, security, and project management, to name a few, as well as a reevaluation of the US public-private nuclear partnership that prevailed throughout the twentieth century. Moreover, since this evaluation is oriented toward restructuring the US nuclear sector for twenty-first-century international arrangements, consideration should be given to engaging allied nations in a broader contingent, which prompts the second proposed core action.

A US-Led Global Alliance

While the US deliberates the fate of its nuclear industry, Japan, South Korea, France, and the UK—all US allies—are having domestic issues over the future of their respective nuclear power enterprises. Following the

Fukushima incident and the shutting down of its nuclear reactors, Japan has announced plans to construct 22 new coal-fired power plants.[49] South Korea has proposed a nuclear phase-out policy that is creating domestic concerns of an exodus of nuclear expertise from the ROK and a collapse within its nuclear supply chain.[50] France will soon face the uncertainty of whether nuclear power is considered clean enough to meet the green energy objectives of a post-Brexit European Union and has embarked on a path of reducing its dependency on nuclear power.[51] Meanwhile, the UK has faced numerous challenges in the construction of new nuclear capacity at Hinkley Point C. Exacerbating these challenges is UK collaboration with China as an investment partner in the project, triggering security concerns among UK policy makers questioning the decision to engage China in its civilian nuclear industry.[52]

International control of atomic energy in the twentieth century was accomplished by a US-led coalition of nations to prevent proliferation of nuclear weapons, which will remain the paramount objective for all activities related to nuclear power. However, additional proliferation concerns have emerged in the twenty-first century—the propagation of ideologies from authoritarian powers leveraging technologies such as nuclear power to project soft power and advance their respective geopolitical interests. Since bilateral nuclear cooperation translates to decades-long relationships, a US response must be geopolitically strategic with long-term objectives, not merely transactional as if nuclear power is only an energy commodity. We propose that it is incumbent upon the US as chief signatory of the twentieth-century liberal international order to reassert its leadership and unite its allies into a twenty-first-century coalition of civilian nuclear power partners. This coalition must be capable of competing with China and Russia in the deployment of nuclear technology, fuel, and services in emerging economies where energy demand is increasing rapidly and countries are seeking partnerships.

The National Technology and Industrial Base (NTIB) focuses on defense applications. Its creation stems from the priority of "retaining access to global technology and industrial capabilities" and the need for industrial cooperation between the US and other nations—particularly Canada, the UK, and Australia.[53] The NTIB could be paralleled with a Civilian Nuclear Technology and Industrial Base (CNTIB) to facilitate US nuclear power cooperation with Canada, the UK, Australia, France, South Korea, and Japan—each having nuclear expertise or resources critical to the global nuclear ecosystem (fig. 1). The CNTIB would be fundamentally informed by the afore-proposed nuclear industrial base review and then used as the

framework for organizing a US-led coalition of allied nuclear collaborators (fig. 2). Each country could contribute unique, specialized services in a best-of-practice arrangement capable of doing collectively what isn't being done individually—respond strategically to China's and Russia's efforts to be the trusted, reliable partner in nuclear power.

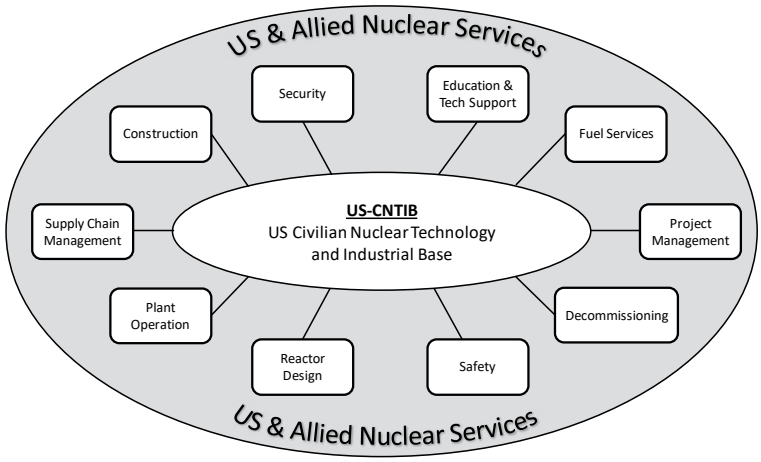

Figure 1. A proposed US Civilian Nuclear Technology and Industrial Base that leverages allied nuclear expertise within a global network of services and technologies

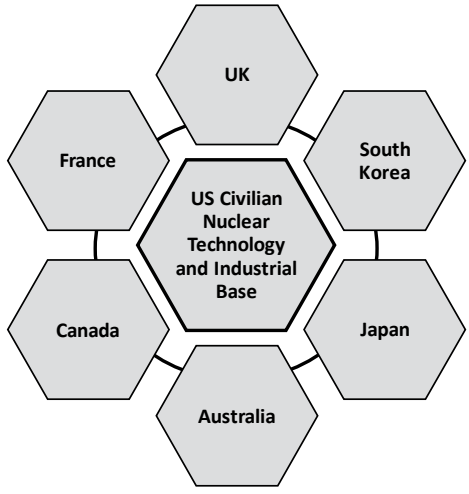

Figure 2. US-led allied coalition of nuclear collaborators capable of competing with China and Russia

As nuclear construction is capital intensive and presents financial and investment challenges on the domestic front, this allied arrangement provides a shared risk environment for new nuclear projects as well as for research and development into advanced nuclear science, engineering, and

technology. As such, it will position the US and allied partners with the organizational capacity to compete with Chinese and Russian SOEs to be the preferred nuclear power partner for meeting global energy demands under low-carbon constraints of global climate change. It also will shift the purview of nuclear power from one that is predominantly focused on nuclear energy as a transactional commodity issue at the domestic level to one of a strategic geopolitical issue at the international level. This transactional to geostrategic shift, in keeping with the shift proposed in the first core action, will project an allied show of force that democratic nations are willing and capable of responding to the challenge of twenty-first-century great power competition for superiority and dominance in nuclear technology and services.

A US-led international arrangement will facilitate a transition of the US civilian nuclear enterprise from a model aligned with twentieth-century foreign policy and national security challenges to one that aligns with foreign policy and national security objectives of the twenty-first century. It will refurbish America's nuclear brand while adhering to the original principles of US nuclear power policy. Such a move will foster "maintaining U.S. leadership . . . [,] using such U.S. leadership to promote cohesion within the free world . . . [,] increasing progress in developing and applying peaceful uses of atomic energy . . . [,] assuring continued U.S. access to foreign . . . supplies[, and] preventing the diversion to non-peaceful uses."[54]

Conclusion

America's twentieth-century nuclear legacy was established through strategic public-private research and development collaborations. This basis gave the privatized US nuclear industry the momentum to engage the world in civilian nuclear power partnerships as the US nuclear brand was accepted as the technology, safety, and security standard to which other nations ascribed—a nuclear brand that can be characterized as mutualistic and nonpredatory. America's initial advantage of having a monopoly on nuclear science, engineering, and technology was not exploited to subject defeated nations to US rule. Instead, the US leveraged its initial advantage in a strategic global effort to establish nonproliferation-focused international control over atomic energy, to share the science and technology for peaceful purposes, and to project security guarantees for allies against the inevitable development of atomic weaponry by illiberal, authoritarian nations. In essence, the US established international protocol to safeguard the world from the very science it had discovered and the technology it had developed. To that end, America's nuclear policy has

been mutualistic, not predatory, providing benefits to both the US and Section 123 partners. However, abandoning or severely reducing peaceful applications of nuclear energy will tarnish this brand and shift the culture of US nuclear applications to predominantly military. Such a reframing does not reflect the first principles of nuclear power policy articulated in the National Security Council's 1955 Statement of Policy on Peaceful Uses of Atomic Energy and the dual-use applications of atomic energy.[55]

The twentieth-century liberal international order was arranged under US leadership, with US nuclear power policy aligned with US foreign policy and national security objectives to sustain and extend the benefits of that liberal order throughout the world. This framework was accomplished during a time when great power competition was largely a bipolar struggle for military superiority, when global climate change had not been elevated as a national and international security concern, and when the US was the dominant, most reliable partner for global civilian nuclear technology and services. The twentieth century gave way to a much different, more complex, and more globally interconnected twenty-first century with great powers seeking to, at a minimum, erode US influence globally and regionally and using technology as one of the eroding forces. This includes civilian nuclear technology. However, as the US is engaged in a national debate over the fate of its nuclear power enterprise, authoritarian powers China and Russia are having no such debate. Rather, they are embedding nuclear power partnerships into their respective geopolitical strategies—including designs for dominating the global market in civilian nuclear technology and services—thereby occupying in the twenty-first century the nuclear technology space occupied by America in the twentieth century.

Given America's legacy of commitment to global leadership in nuclear science, the conversation is not aligned with twenty-first-century challenges—thus the need for sober discussion within America's security and foreign policy community. America's nuclear power enterprise is at a strategic crossroads for decision-making that original policy makers likely would have never imagined—one that could set the US on a trajectory toward unilateral disengagement from civilian nuclear power. If the US disengages from civilian nuclear power, whether by the hidden hand of economics, fear of waste, proliferation, misplaced confidence in the potential of renewable energy, or a lack of political resolve, it will signal America's abandonment of its foundational principles of nuclear power. SSQ

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Notes

1. "Plans for New Reactors Worldwide," World Nuclear Association, updated June 2020, https://www.world-nuclear.org/.

2. David K. Gattie, "Testimony of David Gattie Before the Energy and Commerce Committee, Subcommittee on Environment and Climate Change," US House of Representatives, 5 December 2019, https://energycommerce.house.gov/. See also David K. Gattie, "US Energy, Climate and Nuclear Power Policy in the 21st Century: The Primacy Of National Security," *Electricity Journal* 33, no. 1 (January–February 2020): 106690, https://doi.org/10.1016/j.tej.2019.106690.

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4. Department of State, *A Report on the International Control of Atomic Energy: Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants*, Dept. of State pub. 2498 (Washington, DC: US Government Printing Office, 1946), 15, https://www.cia.gov/.

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6. President Dwight D. Eisenhower, "Atoms for Peace Speech" (address, 470th Plenary Meeting of the United Nations General Assembly, New York City, 8 December 1953), International Atomic Energy Agency, https://www.iaea.org/.

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8. It was broadly agreed upon that the US nuclear enterprise must appeal to the scientific imagination to attract the ablest and best minds. Robert Oppenheimer was adamant that "only a unit that was organic and alive could keep abreast of the changing technology

and attract an able, imaginative staff." Richard G. Hewlett and Oscar E. Anderson Jr., *The New World*, vol. 1, *History of the United States Atomic Energy Commission*, *1939–1946* (University Park, PA: Pennsylvania State University Press, 1962), 536, https://www.energy.gov/. The Acheson-Lilienthal Report specifically pointed out the following:

> One cannot look intelligently for a factor of whose principle of design and operation one has never heard. It therefore becomes absolutely essential that any international agency seeking to safeguard the security of the world against warlike uses of atomic energy should be in the very forefront of technical competence in this field. If the international agency is simply a police activity for only negative and repressive functions, inevitably and within a very short period of time the enforcement agency will not know enough to be able to recognize new elements of danger, new possibilities of evasion or the beginnings of a course of development having dangerous and warlike ends in view.

Department of State, *International Control of Atomic Energy*, 13, 27.

9. Henry DeWolf Smyth, physicist, author of a landmark report on the wartime atomic energy program and an early member of the Atomic Energy Commission, contended that America's "knowledge of atomic energy should be used as a major instrument to promote our foreign policy of universal peace and freedom" and that the US had "a great obligation to maintain leadership in the development of this new technology of nuclear power" with "a specific obligation to back up our foreign policy gestures in this field with growing technological strength" and "a vigorous program of reactor development." Henry DeWolf Smyth, "Nuclear Power and Foreign Policy," *Foreign Affairs* 35, no. 1 (October 1956): 1–16.

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37. Fast nuclear reactors can potentially extract 60 times more energy from uranium than standard light-water reactors and have the capability of significantly reducing the levels of radioactive waste, including plutonium, by consuming the waste for fuel, thus closing the nuclear fuel cycle. Russia deployed its fast breeder reactor, the BN-800, in 2016. The US had made substantial progress in the development of its Integral Fast Reactor (IFR), but the IFR program—characterized by President Clinton as "no longer needed"—was eliminated in 1993. Combined with Russia's aggressive efforts to provide nuclear services to other countries, the deployment of fast reactor technology projects Russia advancing its nuclear enterprise. See President Bill Clinton (address, Joint Session of Congress, 17 February 1993), Miller Center, https://millercenter.org/; James L. Tyson, "Clinton Gives Breeder Reactor Ax, Many Scientists Lined Up Against It," *Christian Science Monitor*, 16 February 1994, https://www.csmonitor.com/; Sonal Patel, "Rapid Advancement for Fast Nuclear Reactors," *Power Magazine*, 28 February 2019, https://www.powermag.com/; and Nick Gallucci and Michael Shellenberger, "Will the West Let Russia Dominate the Nuclear Market?," *Foreign Affairs*, 3 August 2017, https://www.foreignaffairs.com/.

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41. The nuclear fuel cycle is the industrial process that supports the production of electricity from uranium in nuclear power reactors. The process is characterized as having a "front end" and a "back end." The front end includes uranium mining, enrichment, fuel fabrication, and the service period of the reactor. The back end refers to the safe management of spent fuel from the reactor. In the US, fissile uranium-235 (U-235) is the fuel for light-water reactors (LWR)—the US industry standard. The enrichment process increases the concentration of U-235 from naturally occurring levels of 0.7 percent to reactor-grade levels of 3–5 percent for nuclear fuel rods. Throughout the service period, fission products and transuranic elements, including fissile plutonium-239 (Pu-239), accumulate in the fuel rods, along with residual U-235. This results in spent fuel that must be either permanently stored for safety and security reasons or reprocessed for reuse in a reactor. While Yucca Mountain has been set aside as a long-term geological repository for spent fuel in the US, it is in a political stalemate. Consequently, spent fuel is being stored on-site at nuclear power plants. Closing the nuclear fuel cycle means reprocessing and reusing spent fuel in reactors designed to accommodate reprocessed fuels. Since weapons-grade levels for uranium and plutonium are at least 90 percent, enrichment and reprocessing technologies represent security issues. Advanced reactors are a broad class of reactor designs, some of which can consume not only U-235 and Pu-239 but also transuranics (elements

having a higher atomic number than uranium). Thus, these reactors can serve to reduce or eliminate fissile materials such as U-235 and Pu-239 from spent fuel. Other advanced reactor designs use molten salts rather than solid fuel assemblies, providing enhanced safety features compared with LWRs, while other designs use thorium as the nuclear fuel source rather than uranium. In general, advanced nuclear reactors focus on improving safety and security within the nuclear fuel cycle through proliferation-resistant technologies to recover more energy and reduce waste. Currently, the US has no comprehensive strategy for its nuclear fuel cycle. For further reference, see Mark Holt, *Advanced Nuclear Power and Fuel Cycle Technologies: Outlook and Policy Options*, CRS Report RL34579 (Washington, DC: Congressional Research Service, 2008), https://fas.org/; The World Nuclear Association, "The Nuclear Fuel Cycle," accessed July 2020, https://www.world-nuclear.org/; United States Nuclear Regulatory Commission, "Backgrounder on Licensing Yucca Mountain," fact sheet, accessed July 2020, https://www.nrc.gov/; United States Nuclear Regulatory Commission, "Stages of the Nuclear Fuel Cycle," accessed July 2020, https://www.nrc.gov/; and World Nuclear Association, "Advanced Nuclear Power Reactors," accessed February 2020, https://www.world-nuclear.org/.

42. James Mattis, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, January 2018), 2. See also Office of the Under Secretary of Defense for Acquisition and Sustainment, *Report on Effects of a Changing Climate to the Department of Defense* (Washington, DC: Department of Defense, January 2019), 2, https://media.defense.gov/.

43. In the twentieth century, the phrase "arsenal of democracy" signified more than mere World War II propaganda. America's industrial base—and the science, technology, engineering, and education capabilities that undergirded it—became the distinguishing source of its superpower status as well as its economic vitality. Today, the industrial base as a whole is experiencing changes perhaps as never before. While individual firms and programs continue to rise and fall, the overall US national security marketplace (now extending beyond traditional defense issues) is wrestling with revolutions in technology, new modes of warfare, and uncertainty in everything from its labor pool to trade policy to budgetary resources. Many believe that the industry is at a strategic inflection point where its future can sharply change for better or for worse. Yet despite this combination of importance and uncertainty, the topic is too frequently approached in a short-term manner, too frequently defined by consideration of a single program authorization decision rather than broad trends, and too frequently discussed in mere bumper sticker terms." Brookings, Center for 21st Century Security and Intelligence, "About the National Security Industrial Base," accessed July 2020, https://www.brookings.edu/.

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