Small Modular Nuclear Reactors: Securing American Military Energy in an Era of Vulnerability and Growing Demand

by

Paul Schecklman

Introduction

American military installations are dependent upon an aging, vulnerable civilian grid to perform critical functions. The evolving nature of warfare is placing a higher dependency upon electricity for weapons, vehicles, and advanced computing systems at a time when electricity demand in civilian spheres is expected to grow quickly. This essay discusses the role nuclear energy and Small Modular Reactors (SMRs) can – and, I argue, should – play in enhancing resiliency and servicemember safety, and in reducing emissions while allowing military power generation to keep pace with the demands of modern warfare.

Additionally, I will discuss the potential SMRs can have in expanding American soft-power tools, for such transportable and flexible non-fossil-fuel electricity-generation options also offer great potential in the context of humanitarian and disaster relief operations. Thereafter, I will discuss the vulnerability of the electric grid as a reason to place energy production and transmission to and on U.S. military installations under the purview of the U.S. Department of Defense (DOD) in order to enhance deterrence and credibility while reducing the likelihood of an adversary attacking civilian resources. Finally, I will conclude by describing the role the Pentagon and federal stakeholders should play in ensuring that SMR development continues and that the products of such research and development efforts meet the needs of our national security apparatus.

Background

A sure and abundant supply of energy is a critical enabling component for military operations, and the demand for electrical energy within the U.S. defense establishment is only rising.[1] Ensuring the security and reliability of such a supply, however, represents a complex problem, involving challenges in sourcing, transportation, and grid network vulnerabilities, even as American troops operate around the globe in a wide array of environments under greatly varying conditions and with complex logistics.

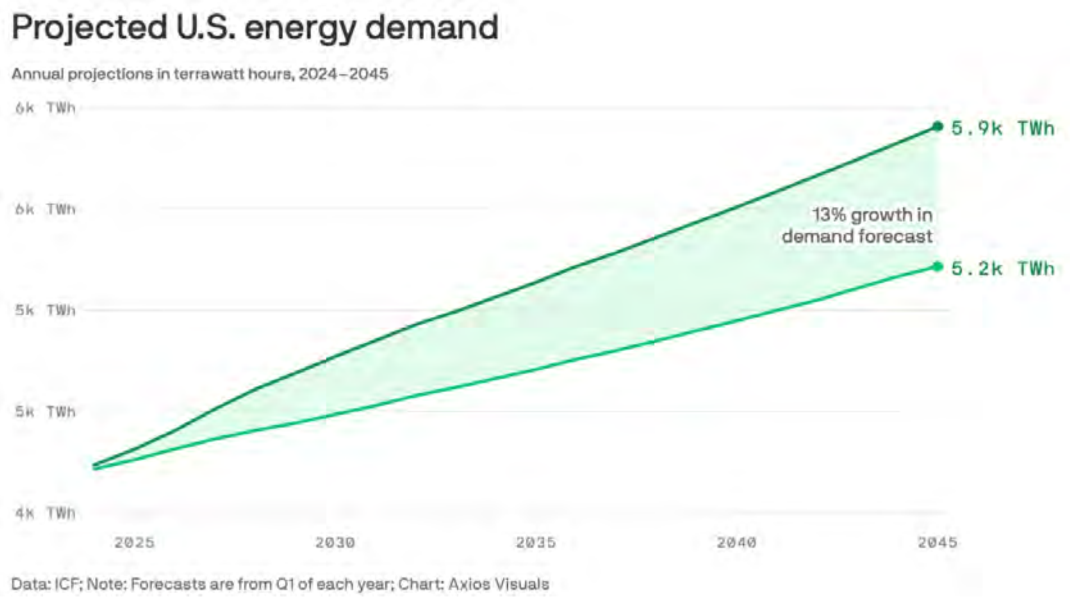
Under the Biden Administration, the DOD was pursuing the goal of becoming carbon-neutral by 2050, a measure adopted in hopes of helping address climate change. While climate change may remain a factor in reevaluating traditional energy sourcing for military operations, however, the Department still has important reasons to focus upon these issues despite the Second Trump Administration's apparent downgrading of addressing climate change as a policy priority.

In fact, the DOD today has an opportunity to gain a significant strategic advantage from leveraging nontraditional sources of electric power. Specifically, President Trump's current administration has focused upon American energy dominance and upon achieving deterrence and peace through strength – with a particularly emphasis upon the strength of the U.S. military. The development of small modular reactors and other advanced nuclear reactors, followed by their deployment in support of DOD operations, has the potential to increase resiliency, improve servicemember safety, augment American "soft power," and help meet the growing power demands of new weapon systems.

Today's electrification wave spans all aspects of American life, including military operations. Personal increases in electrical demand stem from the growing prevalence of "smart" homes and vehicles. Commercial power use is increasing with the modern expansion of data centers and artificial intelligence (AI) programs, with electric energy availability (for computation) emerging as a limiting factor in AI development. For its part, the military also needs abundant power for new warfighting tools and weapons.

Even while the United States and other countries have sought to reduce carbon emissions in recent years, stress has been growing on electric grids – grids that also power our military bases. This is increasingly understood to be a national security concern. The 2022 National Defense Authorization Act (NDAA) required the DOD to submit a formal plan to reduce emissions,[2] increasing its reliance upon electricity and energy-efficiency tools. The Biden Administration's 2022 National Security Strategy described climate change as an existential threat to Americans and the world, posing challenges to food, water, health, infrastructure, and security.[3] In response to these policy demands, DOD shifted resources and focus to meet requirements, trying to reduce its fossil fuel and electric energy consumption.

As stresses also grow upon civilian grids, however, the DOD must not allow U.S. military operations to be curtailed, fragmented, or otherwise made vulnerable as a result of energy restrictions – including by forcing them to rely upon expensive and inconsistent renewables such as wind, solar, and battery sources. In January of 2025, President Trump announced a historic investment into AI infrastructure that includes both virtual and hardware investments. This investment focuses not only on the software needs, but the production of data centers, facilities, and computer chips. As both the civilian economy and the U.S. armed services rely increasingly upon computerized systems, DOD activities will require ever larger amounts of reliable energy. To date, however, the government and military have not taken serious steps to address these challenges. As energy demand in America grows, energy availability will be an increasing problem for the DOD.



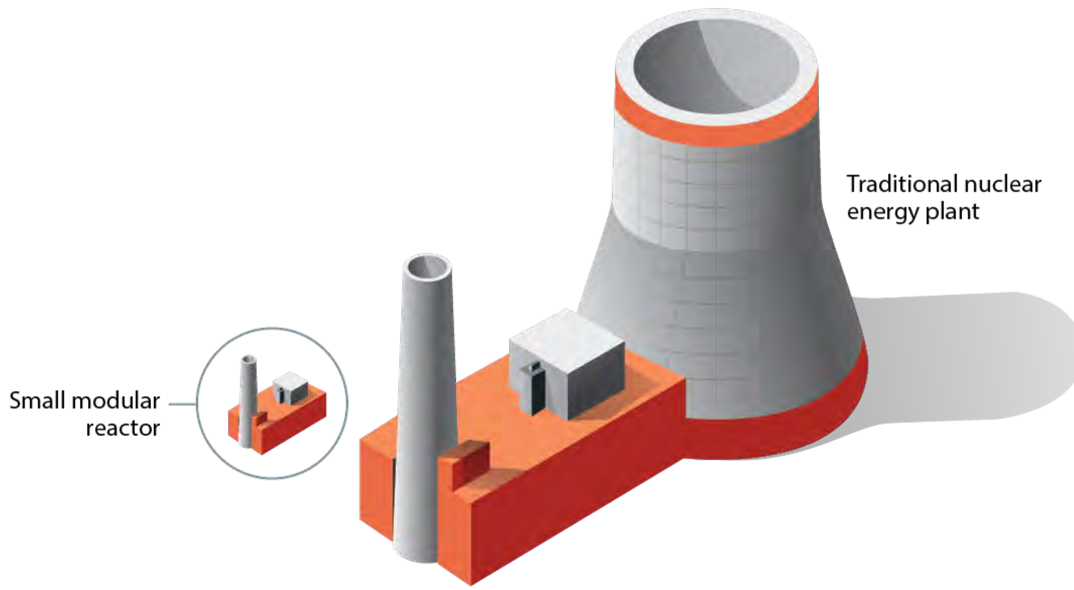
The DOD is already a significant customer of American energy. Currently, the U.S. military manages over 284,000 buildings and facilities that are deemed to be critical to mission assurance.[4] Mission assurance, moreover, can be complex and fragile. The energy systems that power our installations and DOD facilities are directly tied to keeping our nation safe and secure.[5]

At present, however, the U.S. electrical grid is too fragile for the DOD to rely upon – not to mentioned being an attractive target for cyber disruption by America's adversaries. The North American Electric Reliability Corp has warned of elevated risks of blackouts across the country while numerous national security community members have assessed the grid to be unreliable.[6] The U.S. power grid is highly complex, with over 3,000 utility companies working together to deliver power through hundreds of thousands of miles of transmission lines and 55,000 substations.[7] To further complicate matters, the grid and its energy services are outside the purview of the DOD for its continental bases, which means that they and their critical operations are subject to the same outages as civilian consumers, with inherently limited and temporary emergency capabilities for on-site backup generator power.

At present, roughly 6.5 percent of electricity the DOD consumes comes from renewables. Wind and solar have some utility, but are often limited by location, weather, time of year, storage capacity, and available land or constructability.[8] Additionally, solar installations and wind farms are also both fragile and highly visible targets for enemies. Furthermore, much of the storage and transmission components for solar and wind power are sourced from our primary adversary. (China is now the world's top supplier of advanced grid components and lithium batteries.) Together, these represent a significant cyber vulnerability.

As noted, the U.S. electric power grid has long been considered a logical target for a major cyberattack.[9] Then-FBI Director Christopher Wray warned of such threats in 2024, specifically from the People's Republic of China (PRC). Vulnerabilities exist through multiple points of entry of our electrical grid, which could allow attackers to exploit and access system networks.[10] And indeed the American grid has indeed already been exploited in the past by both adversaries and "hacktivists" (those breaking into systems for social or political reasons);[11] it will surely remain a target in the future.

Solar and wind power sourcing cannot adequately meet the energy demands of the DOD,[12] especially in time of crisis or war – that is, exactly when we would *need* to rely upon DOD most. The American grid, which supplies military assets on the continental United States, is too fragile, overloaded, and subject to cyber and other forms of attacks. While most bases do have backup power that can sometimes function for a few days, military assets taken offline in response to power outages would be unavailable to both domestic and international operations, and on-site supplies of diesel fuel are unavoidably finite. While energy efficiency measures can help, decreased consumption cannot meet the goal of insulating these bases from energy risk.[13] The only available technology that can meet the needs of the DOD and increase U.S. energy security, I submit, is nuclear power[14] – especially in the form of new "microgrids" fueled by modular nuclear reactors.



SMR comparison courtesy of Idaho National Laboratory

Small Modular Reactors

Nuclear energy capabilities are the "all the above" option to meet DOD needs[15] and are not new a new concept the United States military. The U.S. Navy is well known for its use of nuclear energy production on ships and submarines. For the past 70 years, the Naval Nuclear Propulsion Program has operated over 500 reactor cores, with 98 in service today,[16] while never experiencing an accident. From 1954 to 1977, the U.S. Army Nuclear Power Program also operated eight reactors, five of which were portable.[17]

Recent technological advances and signals from the commercial market have spurred a renewed investment into nuclear energy production with a variety of sizes and capabilities. Large, conventional reactors already provide robust energy solutions for civilian grids. However, Small Modular Reactors (SMRs) can provide the DOD the opportunity to right-size energy production to its energy requirements. DOD interest in SMRs originated from two vulnerabilities outlined in a decade-old report: dependence of U.S. military bases on fragile civilian grids, and the challenge of safely and reliably supplying energy to service members in forward operating locations.[18]

SMRs can generate roughly one-third the capacity of traditional reactors but their smaller footprint can be sited on locations not suitable for large plants.[19] Moreover, they can be built in waves, or incrementally, to match the changing needs of an installation. SMRs weigh 20-40 tons, can be transported by truck or plane, and can be installed in under 72 hours.[20] More importantly, they can safely, efficiently, and cleanly power military bases entirely independently of any public grids vulnerable to attack or outage.

Currently, for instance, the DOD is pursuing a pilot program in SMR technology called "Project Pele." This reactor model is designed to be resilient to external hazards such as weather and kinetic attack, and resilient against nuclear weapons proliferation in unauthorized hands.[21] (Members of the National Guard and Army Corps of Engineers will be charged with assembling, moving, and operating the reactor.) A decade in the making, the Project Pele reactor is not intended for forward use on the battlefield.[22] It is well-secured and utilizes spent fuel or low-enriched uranium, making it less likely to cause proliferation because such material would require further enrichment in order to be usable in a nuclear weapon.

While the DOD should be commended for moving forward with a potentially critical program, however, regulatory timelines and costs for licensing are still causing uncertainty.[23] Despite the U.S. having operated modular nuclear reactors in the past, and the Navy's resounding success in nuclear propulsion, the regulatory process in this industry can require up to 15 years for approvals, construction, and completion.[24] Under its new leadership, the DOD should focus on streamlining operations to ensure opportunity for key strategic advantages are not missed.

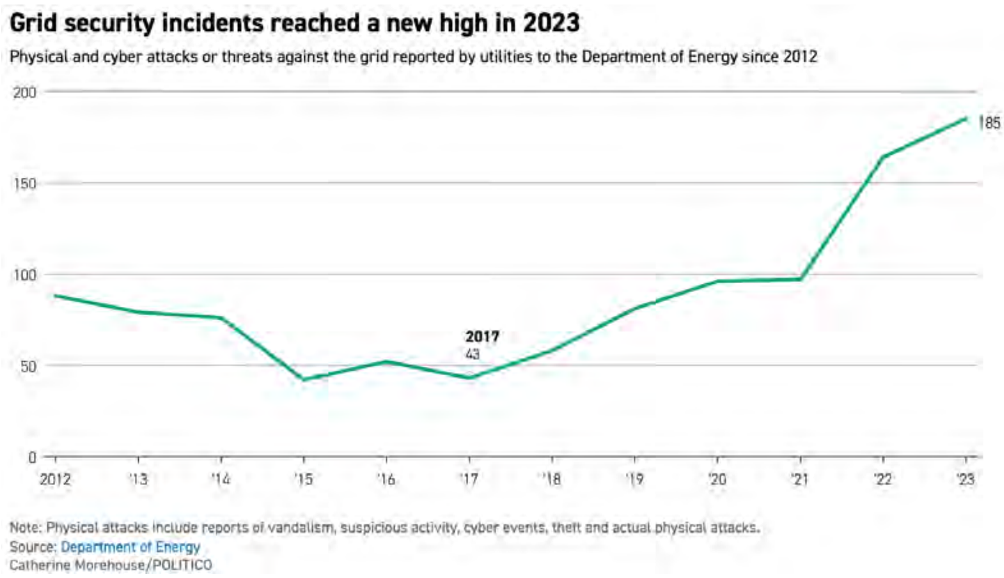
The U.S. is not alone in this quest. France, China, South Korea, and Russia are all pursuing similar technology. In fact, China is currently developing 16 non-naval SMR-type power reactor designs and Russia four, while the U.S. is producing only one.[25] If the DOD and U.S. government fail to lead (or at least to keep up) in this sector, we risk the standards being set by adversaries and the industry being largely controlled overseas, not to mention our failing to ensure adequate power sourcing for U.S. military installations. Foreign domination of this arena would mean that designs might not be optimal for U.S. military applications – or that foreign suppliers might prohibit sales to U.S. military end-users – and that expertise will be dominated by foreign companies.[26] The DOD is on the right track with Project Pele, but its programs should expand to include not just SMRs but also very-small modular reactors (vSMRs) for use on forward, remote, or expeditionary bases, as well as larger modular reactors for permanent, large military bases in the United States.

Resiliency

The threats facing the U.S. military are substantial. Moreover, the number of military installations that are tied to civilian critical infrastructure creates not only direct vulnerabilities for the DOD, but may also place civilians at risk as a sort of "collateral damage" if and when adversaries seek to impede operations at military facilities by crashing U.S. civilian grids.[27] Adversaries such as Russia, China, Iran, and North Korea seem to view U.S. electrical grid vulnerabilities as offering them a potential asymmetric advantage in time of crisis or conflict, and they have offensive cyber and other capabilities that could be used against those grids. They might, for instance, calculate that a war of critical infrastructure attacks would impede us more than it would impede them, that we would be unwilling to attack *their* civilian electric grids in response, or simply that causing domestic confusion and disruption in the United States is their best way to hobble U.S. military mobilization against them overseas. Attacks on American critical infrastructure might be felt likely to discredit the U.S. Government, distract the public and military from military operations, or simply represent an easy means of retaliation.[28] Removing DOD installations from the public grid would thus lessen the national security impact of such disruptions if they were to occur, and would help protect American civilians from being caught up in such problems by reducing the incentive for an opponent to attack civilian electricity sources in the first place.[29]

Enhancing electrical resiliency for military operations might also contribute not merely to disincentivizing adversary aggression against

U.S. civilian infrastructure, but also to *deterring* it. By removing military functions from the civilian grid, the United States would be signaling to adversaries that hampering U.S. civilian grids would thereafter be viewed as a direct attack on American civilians that has no military rationale – and hence as a dramatic escalation, even a war crime. Additionally, building a capable energy resource for DOD facilities that has robust cyber defenses would make clear that any adversary that did attack the U.S. civilian grid would face an American military unimpeded by any loss of electrical power at its most important facilities. The U.S. would thus be in better position to "deter by denial" (because grid attacks would be less effective in achieving their goals) as well as to "deter by punishment" (because civilian grid attacks would elicit a more effective military response).



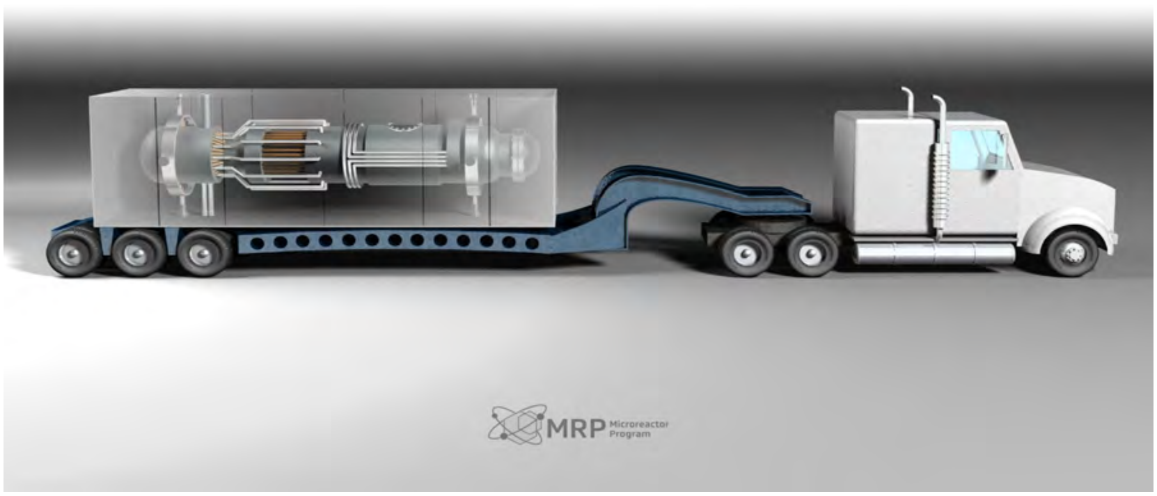
Servicemember Safety

SMR-based electric power security for DOD installations would have an additional benefit as well. American military assets and servicemembers are today deployed in a variety of distant and frequently austere environments. Our ability to project force globally is a unique and decisive advantage for the United States.[30] This ability is not without risk, however. The DOD's liquid, fossil-fuel-based energy supply lines extend from oil fields to refineries, and from U.S. Merchant Marine transports and ports of entry over sometimes enormous distances before reaching the end user. Supply chain reliability is thus not a guaranteed proposition today, and was a driving reason for the Navy's adoption of nuclear power in the 1950s.[31]

The modern computerized and sensor-swept battlefield has amplified the need for electrical power, and energy has become a substantial vulnerability or limitation on our freedom of action.[32] The U.S. operates a variety of forward operating bases (FOBs), remote operating bases (ROBs), and expeditionary forces. In Iraq and Afghanistan, the DOD learned quickly that operations to deliver the supplies needed for combat operations could quickly become combat missions themselves, requiring the diversion of ground and air combat resources to protect fuel convoys.[33] Because mechanized armies can to essentially nothing without energy, fuel convoys became prime targets for our adversaries.

SMRs and the use of microgrids that are not reliant upon liquid fuels can thus become a key enabler for operations at these bases without the requirement to divert combat resources and risk the lives of the service members who would otherwise be needed to protect such convoys. The military has already used microgrids in austere locations that lack centralized power sources, typically diesel generators, in the past.[34] The difference now would be removing the need for fuel convoys by utilizing vSMRs at these forward locations. Such nuclear systems would be transportable, deployable, compact, safe, secure and reliable.

The use of vSMRs for local power could assure communications for troops, water treatment on site, spare-parts production through additive manufacturing, systems maintenance, and power necessities including heating, cooling and plumbing for service members.[35] These SMR systems would meet the needs of various operating environments so that energy itself remains an advantage, not a limitation. In an era in which warfare seems increasingly to involve the ubiquitous use of aerial drones for both sensing and attack missions – and in which the U.S. military has been working to expand its use of quiet electric vehicles in tactical operations – having forward-deployed vSMPR-based battery-recharging capabilities would also be a significant benefit.



vSMR/microreactor illustration courtesy of Idaho National Laboratory

Soft Power Potential

Nuclear energy production and transportability would also provide the United States another key advantage during a time of rising global competition with the People's Republic of China. With SMRs promising to be cheaper, more rapidly available, and more grid-appropriate than huge traditional reactor designs, many developing countries have expressed interest in this new technology. Energy has long been associated with human prosperity, with some 1.18 billion people reportedly facing "energy poverty" in the developing world and with some 773 million people lacking electricity connection *at all* in 2020. SMRs and vSMRs, however, could provide transportable nuclear-energy to support responses to natural disasters, to stabilize local grids in other nations, and to sustain partner nations experiencing energy blockades or embargos.[36] As Hurricane Maria in 2017 highlighted, the DOD currently has a gap in its ability to provide transportable power generation to areas that experienced substantial natural disasters. As disaster intensity increases worldwide due to population growth, coastal development, and climate change, the need for such capabilities will only grow.[37]

In the 1960s, the United States converted the WWII Liberty Ship *USS Sturgis* into a floating nuclear power plant. (This vessel provided power for operations in Panama regularly, for example.) The idea of using deployable nuclear power source for humanitarian support and other emergency civilian uses is thus not a new concept for DOD, but rather one that with renewed focus and development could prove invaluable. The capability to ensure reliable energy at disaster sites, both foreign and domestic, would be a great asset to U.S. "soft power" in the world. The ability of such reactor systems to help circumvent energy embargos might be of considerable use in supporting U.S. allies and other partner nations as well, helping them resist coercion from our adversaries in time of crisis or conflict.

STURGIS: US Army Corps of Engineers

Modern Warfare

Modern advances in warfighting have resulted in a higher demand for reliable energy. The Pentagon is already examining more uses for electricity in battle to include vehicles, tanks, ships and planes,[38] and our military will continue to expand its reliance upon electricity-consuming communications technologies, sophisticated intelligence, surveillance, and reconnaissance (ISR) systems, and on-base necessities such as HVAC systems. Emerging warfighting technologies will increase electrical demand further, such as with AI, directed energy weapons, electromagnetic pulse weapons, railguns, autonomous systems, and even additive manufacturing.[39]

By raising the energy requirements of deployed military forces, such new technologies will further increase the complexity and challenge of providing reliable fuel shipments, but assured fuel convoys or airlift shipments probably cannot be taken for granted in a high-intensity modern combat environment. (The logistics alone are challenging, but given the capabilities of our primary adversaries in this era of renewed great power competition, enhanced adversary anti-access/area-denial [A2/AD] capacities could make such deliveries impossible.) SMRs and vSMRs could provide a critical microgrid capability that removed many of the negative tradeoffs of security convoy travel. In this new era of global competition, there is a competition to develop and deploy technologies that will transform our security,[40] and this is one of them. To utilize these technologies of modern warfare, we must also *power them* in locations around the world – and SMRs/vSMRs offer a good way to do so.

Conclusion

The United States military thus faces an era of opportunity. The DOD now has the chance to take a path that reduces fossil fuel emissions while also gaining and exploiting a strategic advantage in utilizing SMR and vSMR technology for concrete operational and broader "soft power" purposes. SMRs therefore represent an "all of the above" solution for the Pentagon's energy needs.

Moving energy production and transmission for military installations under the purview of the DOD – and thus getting them off the civilian grid – would improve the reliability of electricity for defense functions and meet the military's expanding power needs, while reducing the benefits an adversary may expect by attacking civilian grids. (There would also be more civilian power available for the growing needs of America's private sector.) Such a move would also make DOD a more important stakeholder in the energy sector, giving it somewhat more leverage influencing industry technical standards in order to ensure national security needs are met in this emerging market with less danger of ceding technological design and manufacturing dominance to our adversaries as we have done with batteries.

Developing an SMR-based energy security for the DOD will ensure American military operations are credible and reliable at home and abroad. This resource would broaden America's ability to operate in remote and austere environments without risk of combat over fuel convoys or a reduction in capabilities. The DOD should thus lead on militarily-applicable SMR development and work with other government agencies to explore adding SMRs to their own civilian nuclear portfolios, as well as using them as a transportable system for disasters or conflict.

The Pentagon should work with stakeholders in Congress, the Department of Energy, and the Nuclear Regulatory Commission (NRC) to streamline overly burdensome regulations and remove unnecessary bureaucratic hurdles to SMR development. (These federal stakeholders must also engage states individually to remove duplicative or restrictive permitting processes that exceed federal environmental and construction regulations. SMR development should *not* take ten years. Sending such positive signals to industry would also likely accelerate research and development.) The DOD must also impress upon policymakers and the public that nuclear energy is safe, clean, and reliable – and that DOD energy needs are increasing at a rate with which renewables are unable to keep pace. Securing funding for SMR projects to ensure survivability of emerging firms is integral to success. Lastly, the DOD must work with these federal stakeholders to secure relevant supply chains and material production while increasing the pool of sufficient labor talent.

Given the Second Trump Administration's emphasis on U.S. "energy dominance," commitment to investing in future warfighting systems, and commitment to a strong military, the Department of Defense has a unique window of opportunity in which to advance the energy infrastructure that serves military operations while enhancing deterrence at home.

*   *   *

About the Author

Paul Schecklman *is a doctoral student in the School of Defense and Strategic Studies at Missouri State University. The views expressed herein are entirely his own, and do not necessarily represent those of anyone else.*

Notes

1 Michael Anastasio & Paul Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," Office of the Secretary of Defense, August 1, 2016, 9.

2 Jessica Yllemo & Martha Christino, "Enabling Factors for Achieving U.S. Army Microgrid Goals," *American Security Project*, September 5, 2023, 3, https://www.americansecurityproject.org/perspective-enabling-factors-for-achieving-u-s-army-microgrid-goals/.

3 President Joseph Biden, *National Security Strategy*, The White House, 2022, 7, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.pdf.

4 Yllemo & Christino, "Enabling Factors for Achieving U.S. Army Microgrid Goals," 1.

5 Ibid.

6 Robert Walton, "As US Defense Facilities Face Rising Outage Risks, Regional Transmission Could Help," Utility Dive, December 6, 2023, https://www.utilitydive.com/news/grid-reliability-issues-threaten-national-defense/701674/.

7 Robert Knake, "A Cyberattack on the U.S. Power Grid," *Council on Foreign Relations*, April 2017, https://backend-live.cfr.org/sites/default/files/pdf/2017/03/ContingencyPlanningMemo31_Knake.pdf.

8 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," 25.

9 Knake, "A Cyberattack on the U.S. Power Grid."

10 Mission Support Center, "Cyber Threat and Vulnerability Analysis of the U.S. Electric Sector Mission Support Center Analysis Report," 9, 2016, https://www.energy.gov/policy/articles/cyber-threat-and-vulnerability-analysis-us-electric-sector.

11 Laura Kearney, "US electric grid growing more vulnerable to cyberattacks, regulator says," *Reuters*, April 4, 2024, https://www.reuters.com/technology/cybersecurity/us-electric-grid-growing-more-vulnerable-cyberattacks-regulator-says-2024-04-04/.

12 Aaron Horwood, Juan Vitali, Andrew Theume, Rudie Ibanez, & Travis W. Knight, "DOD's Need for a Transportable Energy Solution," *Joint Forces Quarterly*, no.113, 2nd Quarter 2024, 60-68, https://digitalcommons.ndu.edu/cgi/viewcontent.cgi?article=1009&context=joint-force-quarterly

13 Richard B. Andres & Hanna L Brett, "Small Nuclear Reactors for Military Installations: Capabilities, Costs, and Technological Implications," *Institute for National Strategic Studies: Strategic Forum*, no. 262, February 2011, 4.

14 Horwood et al., "DOD's Need for a Transportable Energy Solution."

15 Jeff Waksman, "Project PELE Mobile Nuclear Reactor – DoD Research & Engineering, OUSD(R&E)," Cto.mil Strategic Capabilities Office, 2017, https://www.cto.mil/pele_eis/.

16 Horwood et al., "DOD's Need for a Transportable Energy Solution."

17 Waksman, "Project PELE Mobile Nuclear Reactor."

18 Andres & Brett, "Small Nuclear Reactors for Military Installations," 1.

19 Joanne Liou, "What Are Small Modular Reactors?," International Atomic Energy Agency, September 13, 2023, https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs.

20 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," 34.

21 Waksman, "Project PELE Mobile Nuclear Reactor ."

22 Horwood et al., "DOD's Need for a Transportable Energy Solution."

23 Andres & Brett, "Small Nuclear Reactors for Military Installations," 7.

24 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," 40.

25 Waksman, "Project PELE Mobile Nuclear Reactor."

26 Andres & Brett, "Small Nuclear Reactors for Military Installations," 9.

27 Ibid., 3.

28 Knake, "A Cyberattack on the U.S. Power Grid."

29 Andres & Brett, "Small Nuclear Reactors for Military Installations," 4.

30 Horwood et al., "DOD's Need for a Transportable Energy Solution."

31 Ibid.

32 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," 4.

33 Ibid., 7.

34 Jessica Yllemo & Martha Christino, "Enabling Factors for Achieving U.S. Army Microgrid Goals," American Security Project, September 5, 2023, 2, https://www.americansecurityproject.org/perspective-enabling-factors-for-achieving-u-s-army-microgrid-goals.

35 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases."

36 Horwood et al., "DOD's Need for a Transportable Energy Solution."

37 Ibid.

38 Brenda Shaffer & Alan Howard, "The Hidden Dangers of a Carbon-Neutral Military," *Foreign Policy*, August 13, 2021, https://foreignpolicy.com/2021/08/12/the-hidden-dangers-of-a-carbon-neutral-military/.

39 Anastasio & Kern, "Final Report of the Defense Science Board Ad Hoc Committee on Energy Systems for Forward/Remote Operating Bases," 9.

40 Biden, *National Security Strategy*, 7.