Virginia-class nuclear-powered fast-attack submarine USS *North Dakota* transits Thames River as it pulls into homeport on Naval Submarine Base New London, in Groton, Connecticut, January 31, 2019 (U.S. Navy/Jason M. Geddes)

Realizing Energy Independence on U.S. Military Bases

By Timothy Renahan

Politically motivated cyber attacks are now a growing reality, and foreign actors are reconnoitering and developing access to U.S. critical infrastructure systems, which might be quickly exploited for disruption if an adversary's intent became hostile.

—James Clapper,
Director of National Intelligence[1]

Lieutenant Colonel Timothy Renahan, USA, wrote this essay while attending the U.S. Army War College. It won the Strategy Article category of the 2021 Chairman of the Joint Chiefs of Staff Strategic Essay Competition.

The Department of Defense (DOD) is the largest consumer of energy in the U.S. Government, yet it relies on the local electrical distribution systems and grids that surround each military base.[2] The Army has realized that dependence on local energy grids creates a national security concern. Near-peer competitors such as Russia and China are working to exploit our aging infrastructure to gain advantage in possible future conflict and destabilize day-to-day operations.[3] Rogue nations such as Iran and North Korea have undertaken offensive cyber acts to asymmetric benefit, and they have disrupted U.S. ability to continue to pressure them economically.[4] Therefore, military bases should have independent energy production methods to prevent loss of capability and to provide emergency service if the local energy grid is compromised. DOD is currently exploring renewable energy initiatives and nuclear possibilities, such as small modular reactor (SMR) technology, which could offer options for energy independence that are scalable and environmentally friendly. This article focuses on domestic military bases and the energy vulnerabilities associated with local grids; it does not consider forward-deployed locations or military bases overseas. As energy technologies evolve, now is the time to invest future funding to reduce vulnerability of domestic military bases to attack and ensure energy independence.

Risks to National Security

DOD has publicly identified that a significant vulnerability to U.S. military bases is the local energy infrastructure.[5] The military installations themselves are currently positioning physical and cyber security measures, but illicit actors do not need to penetrate the bases.[6] Targeting the external power distribution system that provides a base its electricity is just as damaging as targeting the base itself. In 2019, more than 12 utilities companies across the country were targeted via cyber attack.[7] This pattern of sustained pressure by illicit actors on infrastructure, including electrical nodes, is predicted to continue—if not increase.[8]

The Department of Energy reports that grids have been tested by external threats for years. In 2014 alone, the energy sector reported 46 individual incidents, a significant number of them being advanced persistent threats.[9] Near-peer competitors such as Russia and China seek to manipulate our aging infrastructure to gain advantage in future possible conflict and destabilize day-to-day capability.[10] Nonstate actors, such as terrorist and transnational criminal organizations, are also working to attack grid facilities as a way to challenge perceptions of U.S. governance and stability.[11] Complicating the issue is the way power is managed and regulated: The Federal Energy Regulatory Commission has "jurisdiction over the reliability of the bulk power grid," but the states have responsibility for electrical distribution.[12] Such division of labor creates an issue of security standards across energy platforms and can expose cracks in mutually supporting security strategies.

Energy Consumption and Initiatives

DOD has steadily remained the largest governmental consumer of energy, and it relies heavily on local electrical grid systems to provide that power.[13] Military installations require uninterrupted access to power and other utilities to ensure readiness and maintain critical services. A loss of sustained power could have a significant detrimental effect on a military base and its ability to provide emergency services and support critical missions.[14] External infrastructure support for military bases creates a security concern that has prompted evaluation and testing across the Services.

In conjunction with DOD, the Army has already conducted several energy resilience readiness exercises to deliberately shut off power to a military base and test the reaction and stability under only emergency power capability.[15] So far, Fort Stewart (Georgia), Fort Greely (Alaska), Fort Knox (Kentucky), and Fort Bragg (North Carolina) have been tested using the exercise.[16] The Army has learned numerous lessons, identified gaps, and pinpointed improvements and is moving forward with "resilience" initiatives and Installation Energy and Water Plans.[17]

Several military installations are also experimenting with "microgrids" to provide backup energy in case of emergency and to reduce carbon footprints.[18] Projects in landfill-to-gas, solar, and wind are creating methods to reduce the demand on carbon-based power and local electrical grids.[19] Unfortunately, the current microgrids must be supplemented with diesel and natural gas generators, as the technology for low-emission energy sources alone cannot provide the necessary power. These efforts are developing—and they are important to creating green alternatives for power—but installations must continue to rely on diesel and natural gas in the near term.[20]

DOD is also investigating nuclear options for energy on military bases. Two efforts working through the Strategic Capabilities Office and the Under Secretary of Defense for Acquisition and Sustainment have created pilot programs and contracted private energy companies to design small nuclear reactors for use on military installations.[21] Both projects rely on the development and availability of commercial technology and manufacturing support. Although DOD is most interested in microreactor technology, SMRs will be commercially available first, with microreactors lagging and possibly not commercially available until the 2030s.[22]

Solutions for Energy Independence

SMR technology has reached the level of final testing and is expected to be ready for employment by 2026.[23] SMRs can provide on-demand power for a military base if the local energy grid is compromised. These miniaturized nuclear reactors have a smaller footprint compared with a microreactor and are scalable for any energy requirement.[24] Although currently not defined, the cost of producing a SMR could range from 15 percent to 40 percent less than construction of a comparable nuclear plant.[25] SMRs would help the U.S. military increase readiness, reduce its carbon footprint, and lower energy-related waste, while taking up less physical space than other clean energy sources.[26]

Military bases also provide an additional level of safety, security, and support. The U.S. military has had nuclear-powered vessels, with nuclear support on bases, and independent nuclear facilities since the 1950s with no incidents. Currently, the Navy has boasted approximately "5,400 reactor years of accident-free operations."[27] The Army even operated a nuclear facility at Fort Belvoir (Virginia), only miles from Washington, DC, from 1957 through 1973 without incident or fanfare.[28]

Figure. How Do SMRs Work?

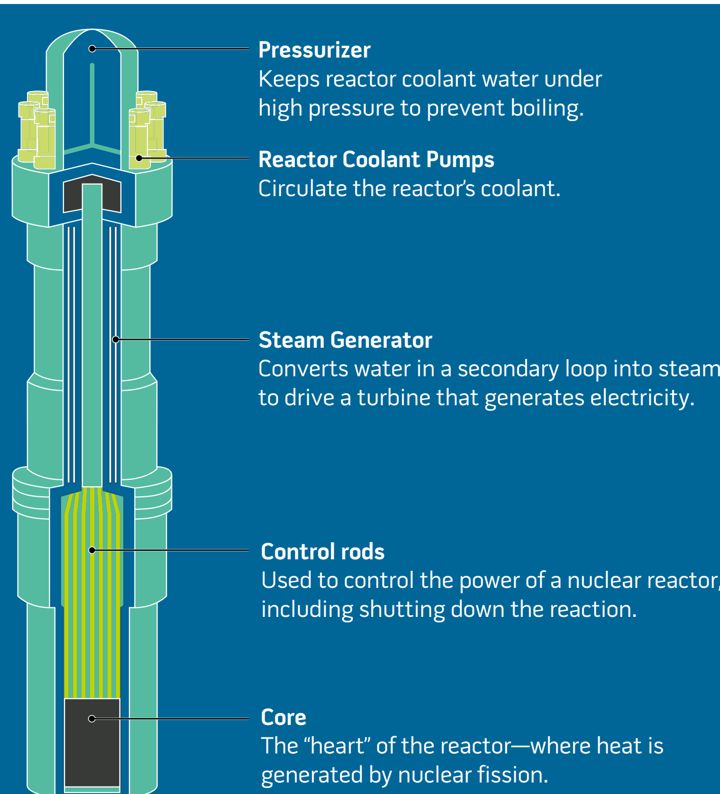
1. Nuclear power plants generate heat through nuclear fission. The proccess begins in the reactor core. Atoms are split apart—releasing energy and producing heat as they separate into smaller atoms. The process repeats again and again through a fully controlled chain reaction.

2. Control rods made of neutron-absorbing material are inserted into the core to regulate the amount of heat generated by the chain reaction.

3. Reactor coolant water picks up heat from the reactor core. Reactor coolant pumps circulate this hot water though a steam generator, which converts water in a secondary loop into steam.

4. The steam is used to drive a turbine, which generates electricity.

5. Throughout the process, the pressurizer keeps the reactor coolant water under high pressure to prevent it from boiling.



Drawbacks and Constraints

The biggest barrier to introducing nuclear power to military bases, besides a potential large initial investment, is the word *nuclear*. Despite the significant rarity of nuclear accidents, the scope and long-term effects of a "Chernobyl" still frighten the population. A 2019 poll showed that Americans were evenly divided, at 49 percent, over the use of nuclear energy as a clean energy alternative—a significant drop from 2010's high of 62 percent in favor.[29] Current political opposition to nuclear power in some states could also be a concern, especially where carbon or natural gas–based enterprises abound.

The potential for terrorist attack and/or cyber attack to a military base is always a threat. But the sheer lack of nuclear incidents in current Navy and Air Force facilities is a direct indication that physical and cyber security measures are in place and being updated.[30] This strong record attests that sound processes are available for transfer within DOD, offering a blueprint for future nuclear additions to facilities. There is the possibility of increased costs to secure and transport nuclear material on the base or to a disposal facility. Current DOD efforts to evaluate nuclear power options should account for those costs in order to inform the overall overhead needed to operate the reactor.

Recommendation

As energy technologies continue to evolve, now is the time to earmark future defense funding to create energy-independent military bases. SMRs would be the first commercially available technology that could support the critical energy needs of a military base.[31] Current data indicate that they would be less expensive to implement compared with microreactors or other nuclear options, although both options present a significant initial cost for purchase and infrastructure. DOD should continue to develop and research renewable energy capabilities (solar, wind, water) but should prioritize a nuclear solution to deliver to military bases energy that is independent of a local grid.

Investing in SMRs will provide a quicker and more cost-efficient option for independent power to reduce vulnerability on domestic military bases. SMRs create enough energy to run critical infrastructure and maintain readiness levels; they will be commercially available almost a decade before microreactor technology will.[32] Placing a smaller and scalable SMR on a military base would also allow DOD to effectively map on-base energy infrastructure specific to each installation. DOD, in coordination with the Department of Energy, should prioritize military installations for fielding and testing; work with local installations to educate and plan; and include research, development, and acquisition funding in the Program Objective Memorandum and/or request funding as part of potential upcoming environmental legislation for purchase and installation of a few SMRs on select installations.[33] **JFQ**

Notes

[1] James R. Clapper, *Statement for the Record: Worldwide Cyber Threats, Before the House Permanent Select Committee on Intelligence*, 114th Cong., 1st sess., September 10, 2015, 3, available at <https://www.dni.gov/index.php/newsroom/congressional-testimonies/congressional-testimonies-2015/item/1251-dni-clapper-statement-for-the-record-worldwide-cyber-threats-before-the-house-permanent-select-committee-on-intelligence>.

[2] Department of Energy, "Comprehensive Annual Energy Data and Sustainability Performance," June 1, 2020, available at <https://ctsedwweb.ee.doe.gov/Annual/Report/TotalSiteDeliveredEnergyUseInAllEndUseSectorsByFederalAgencyBillionBtu.aspx>.

[3] Mission Support Center, *Cyber Threat and Vulnerability Analysis of the U.S. Electric Sector* (Idaho Falls: Idaho National Laboratory, August 2016), 22, available at <https://www.energy.gov/sites/prod/files/2017/01/f34/Cyber%20Threat%20and%20Vulnerability%20Analysis%20of%20the%20U.S.%20Electric%20Sector.pdf>.

[4] Ibid., 22–23.

[5] Aaron Mehta, "Pentagon Weighs New Requirements to Secure Military's Vulnerable Power Grid," *Defense News*, November 29, 2017, available at <https://www.defensenews.com/pentagon/2017/11/29/pentagon-weighs-new-requirements-to-secure-militarys-vulnerable-power-grid/>.

[6] Don Snyder et al., *Improving the Cybersecurity of U.S. Air Force Military Systems Throughout Their Life Cycles* (Santa Monica, CA: RAND, 2015), available at <https://www.rand.org/content/dam/rand/pubs/research_reports/RR1000/RR1007/RAND_RR1007.pdf>.

[7] Rebecca Smith and Rob Barry, "Utilities Targeted in Cyberattacks Identified," *Wall Street Journal*, November 24, 2019.

[8] Robert Walton, "U.S. Electric Grid More Vulnerable to Cyberattacks as DERs Increase Potential Targets, GAO Finds," *Utility Dive*, September 27, 2019, available at <https://www.utilitydive.com/news/us-electric-grid-more-vulnerable-to-cyberattacks-as-ders-increase-potential/563860/>.

[9] The 46 incidents include advanced persistent threats and "sophisticated actors." See Mission Support Center, *Cyber Threat and Vulnerability Analysis*, 2.

[10] Ibid., 22.

[11] Including cyber attacks to undermine existing protocols. See ibid., ii.

[12] Daniel Shea, *Cybersecurity and the Electric Grid: The State Role in Protecting Critical Infrastructure* (Denver: National Conference of State Legislators, January 2020), available at <https://www.ncsl.org/research/energy/cybersecurity-and-the-electric-grid-the-state-role-in-protecting-critical-infrastructure.aspx>.

[13] Department of Energy, "Comprehensive Annual Energy Data and Sustainability Performance."

[14] Alex Beehler and J.E. Jack Surash, "Cutting the Cord to Test Energy Resilience," *U.S. Army* blog, April 13, 2020, available at <https://www.army.mil/article/234514/cutting_the_cord_to_test_energy_resilience>.

[15] Ibid.

[16] Ibid.

[17] Installation Energy and Water Plans are working plans that "outline critical mission requirements, assess energy and water baseline conditions, and develop a prioritized approach for both projects and operations-and-maintenance activities that improve energy and water resilience." See ibid.

[18] The move to renewable energies is based on law and executive order to improve energy security and energy sustainability and to increase renewable energy sources to meet government-wide goals. See *DOD Renewable Energy Projects: Improved Guidance Needed for Analyzing and Documenting Costs and Benefits*, GAO-16-487 (Washington, DC: Government Accountability Office, September 2016), available at <https://www.gao.gov/assets/gao-16-487.pdf>.

[19] Emma Foehringer Merchant, "U.S. Military Microgrids Are Using More Renewables and Batteries," *Greentech Media*, November 9, 2018, available at <https://www.greentechmedia.com/articles/read/for-the-u-s-military-energy-resilience-has-long-been-a-priority>.

[20] The green projects are not robust enough to provide the level of energy necessary to operate the bases or provide a sustainable backup at this time. See ibid.

[21] The Strategic Capabilities Office project is focused on a microreactor that could be deployed to forward locations outside of the United States, and the Under Secretary of Defense for Acquisition and Sustainment project is focused on a small nuclear reactor for a "permanent domestic military installation by 2027." See Aaron Mehta, "Pentagon Awards Contracts to Design Mobile Nuclear Reactor," *Defense News*, March 9, 2020, available at <https://www.defensenews.com/smr/nuclear-arsenal/2020/03/09/pentagon-to-award-mobile-nuclear-reactor-contracts-this-week/>.

[22] Ibid.

[23] David Roberts, "A Beginner's Guide to the Debate over Nuclear Power and Climate Change," *Vox*, updated December 19, 2019, available at <https://www.vox.com/energy-and-environment/2019/9/6/20852313/december-democratic-debate-nuclear-power-energy>.

[24] Meaning that two or more could work in unison if additional capability is needed. See Office of Nuclear Energy, "Four Key Benefits of Advanced Small Modular Reactors," Department of Energy, May 28, 2020, available at <https://www.energy.gov/ne/articles/4-key-benefits-advanced-small-modular-reactors>.

[25] Piotr Dobrzyński, "Estimating the Cost of Small Modular Reactors" (master's thesis, Paul Scherrer Institute, 2017), available at <https://www.psi.ch/sites/default/files/import/ta/PublicationTab/MSc_Piotr_Dobrzynski_2017.pdf>.

[26] Moving to a nuclear option for power generation would also reduce the environmental impact caused by military bases. See Office of Nuclear Energy, "Three Reasons Why Nuclear Is Clean and Sustainable," Department of Energy, March 31, 2020, available at <https://www.energy.gov/ne/articles/3-reasons-why-nuclear-clean-and-sustainable>.

[27] James Conca, "How the U.S. Navy Remains the Masters of Modular Nuclear Reactors," *Forbes*, December 23, 2019, available at <https://www.forbes.com/sites/jamesconca/2019/12/23/americas-nuclear-navy-still-the-masters-of-nuclear-power/#2a222f106bcd>.

[28] Army Corps of Engineers, "Army Nuclear Power Program—SM-1 at Fort Belvoir," n.d., available at <https://www.usace.army.mil/About/History/Exhibits/Nuclear-Power-Program/Fort-Belvoir/>.

[29] "U.S. Public Opinion Evenly Split on Nuclear," *World Nuclear News*, April 1, 2019, available at <https://world-nuclear-news.org/Articles/US-public-opinion-evenly-split-on-nuclear>.

[30] Conca, "Masters of Modular Nuclear Reactors."

[31] DOD has already reached out to private industry for recommendations on how to effectively and efficiently add nuclear power to military bases. See Mehta, "Pentagon Awards Contracts."

[32] Ibid.

[33] President Joe Biden's Plan for Climate Change and Environmental Justice, released after the 2020 Presidential campaign, and the current American Jobs Plan being discussed in Congress both contain significant emphasis and funding for clean energy infrastructure. DOD has the ability to use its history of success in funding dual-use technology (technology that is created with a military intent/use but can be used in commercial/private sector as well) to fund or request funding for small modular reactor technology. Internally programming or requesting funding in environmentally focused legislation will allow DOD to create energy-independent installations, support national climate change goals, and propel immature nuclear technology for future commercial use. Supporting research and development into modular nuclear technology defends against environmental national security challenges and hedges against potential energy use cuts or taxes to DOD. See "The Biden Plan to Secure Environmental Justice and Equitable Economic Opportunity," *JoeBiden.com*, 2021, available at <https://joebiden.com/environmental-justice-plan/>; and *Fact Sheet: The American Jobs Plan* (Washington, DC: The White House, March 31, 2021), available at <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>.