The Heritage Foundation

ISSUE BRIEF
No. 5054 | APRIL 6, 2020

The Pele Program: An Exemplar of Government Nuclear Research and Development

Katie Tubb and Patty-Jane Geller

KEY TAKEAWAYS

Historically, nuclear power has exponentially increased the U.S. military's capabilities, and promising advances have renewed interest in expanding its use.

The Pele Program is a good example of what taxpayer-funded R&D for nuclear innovation should look like, and differs markedly from previous government initiatives.

The U.S. government should support the Pele Program as a military program that focuses on addressing strategic capabilities and battlefield objectives.

With few exceptions, the nuclear energy policy proposals of the past several years can be characterized by a flawed philosophy whereby the U.S. taxpayer has the responsibility to support research, development, demonstration, commercialization, and continued operation of nuclear power plants and advanced reactor technologies. It is a welcome opportunity, then, to highlight a federal program that *appropriately* dedicates taxpayer resources to nuclear research and development (R&D).

The Department of Defense's Strategic Capability Office (SCO) recently announced nearly $40 million for R&D of a nuclear micro-reactor, dubbed the Pele Program. The Pele Program has a clear military application and potential to advance Department of Defense capabilities. Time will tell whether it will succeed in a cost-effective way; however, the Pele

The Heritage Foundation | 214 Massachusetts Avenue, NE | Washington, DC 20002 | (202) 546-4400 | heritage.org

Program is on an early strong footing to do so and provides a strong model for Congress for future federal R&D.

The Pele Program

Historically, nuclear power has exponentially increased the military's capabilities. Famously, the Manhattan Project, and later the Navy's nuclear propulsion program for surface ships and submarines, introduced paradigm-shifting capabilities to military operations, and their success gave rise to the commercial civilian nuclear industry. Military applications of nuclear power have not always been successful. (For example, the Army's portable ML-1 nuclear reactor in the 1960s proved to be costly and unreliable.[1]) However, promising advances in nuclear technology have renewed interest to expand the use of nuclear reactors in the military.[2]

Among these interests is the SCO's Pele Program, which recently took significant steps to advance nuclear micro-reactor technology. In March 2020, the SCO initiated an environmental impact statement and announced $39.7 million in awards to three companies to design a micro-reactor prototype, with the potential for one to progress to a second phase for construction. The program forecasts an aggressive timeline of roughly four years, and will be conducted in collaboration with the Department of Energy and the Nuclear Regulatory Commission (NRC).

A successful nuclear micro-reactor design must meet clear operational requirements: It must have a capacity of 1 megawatt to 10 megawatts; be transportable by truck, ship, and aircraft; install in fewer than 72 hours; pose no net increase in safety; not contribute to nuclear proliferation; be able to be shut down for removal in fewer than seven days; and use high-assay low enriched uranium (HALEU).[3]

Powering the Current and Future U.S. Military

The Pele Program must be viewed in the context of the National Defense Strategy.[4] Preparing the military to face advanced peer threats will require setting new priorities for the Defense Department and divesting from other previous efforts. Lawmakers need to explain to the American people how taxpayer dollars are being allocated to the right priorities, and to hold the executive branch accountable for implementing the strategy. The Pele Program has clear potential to provide an innovative energy capability that can serve as a force multiplier.

The Defense Department currently relies largely on diesel-powered generators to fuel forward and remote operating bases, which require complex logistical supply tails and storage that become easy targets for adversaries.[5] Many permanent military installations connect to the United States' or a host nation's electrical grid, which leaves the installation susceptible to grid interruptions.[6] Nuclear micro-reactors as proposed in the Pele Program could provide the military with options to independently power forward and remote operating bases or military installations, while also freeing up fuel supply and decreasing the logistical footprint for tactical vehicles and aircraft.[7] Making operations self-sustaining for long periods of time with reliable, energy-dense micro-reactors could also provide the military with greater flexibility and independence to operate in a wide range of locations.

Moreover, the Defense Department is developing a next generation of weapons systems that will require dense sources of power as force capabilities become more digital and energy intensive. As summarized by the Defense Science Board's 2016 task force report, "Energy intensive capabilities are under development for which there is no parallel development for power sources."[8] Given the high-energy density of nuclear fuel, micro-reactors could provide solutions for powering directed-energy weapons, railguns, unmanned drones, or homeland missile-defense radars in remote locations like the Kwajalein Atoll, Guam, or Alaska.[9]

Deploying micro-reactors is not without challenges. The operational requirements for a safe and deployable reactor that can withstand attack are themselves challenging. In addition, while sufficient existing resources are available to produce HALEU for the Pele pilot program, the Defense Department will need a long-term source for unobligated HALEU[10] should it decide to pursue extensive micro-reactor deployment. The services would also need to rebuild expertise and provide training to micro-reactor operators. Finally, the United States would need to determine diplomatic, regulatory, and transport requirements to place micro-reactors in foreign nations.

Previous task force studies have anticipated challenges, and the Pele Program reflects acknowledgment to accommodate some of them. For instance, a pilot reactor must employ improvements being developed for advanced reactors, including automatic shutdown, passive safety and defense, and tri-structural isotropic fuel[11] to contain radiation in the event of a meltdown.[12] Opponents may argue that micro-reactors present dangerous new targets for adversaries,[13] but the threat of targeting a hardened, perhaps even underground, reactor must be weighed against the current challenges and costs of protecting vulnerable logistical tails for diesel and oil fuel supplies. While the U.S. government faces hurdles to operationalize micro-reactors long-term, these hurdles should not deter funding and support for the Pele Program to explore this concept.

Productive Model for Congress

The Pele Program is a good example of what taxpayer-funded R&D for nuclear innovation should look like, and contrasts markedly with previous initiatives in Congress and by previous Administrations. First, rather than an end in itself, micro-reactor innovation has a clear objective to be a force multiplier to support complex military operations.[14] While the question remains whether micro-reactors can deliver, years of study and analysis demonstrate a sufficient case to test. This approach differs qualitatively from, for example, the Obama Administration's Great Green Fleet and related biofuel initiatives. These programs were intended to reduce military greenhouse gas emissions, at best a tertiary, if not irrelevant, objective for the military that distracted from the development of strategic capabilities.[15] A clear mission need is essential to long-term success of a program.

Second, measured taxpayer support for the Pele Program is justified. Its mission supports a constitutionally appropriate federal function to provide for defense, which taxpayers should pay for as beneficiaries of that mission. In contrast, Congress has passed many programs to subsidize civilian reactor technology research and commercialization, which chiefly or entirely benefits a handful of private companies.[16] The Trump Administration's attempt to subsidize electricity in the mid-Atlantic region by using federal emergency powers was similarly problematic, though ultimately rejected.[17] Instead, taxpayer-funded R&D should meet a public need or create benefits for the general public health or welfare.

Finally, the government is the direct, self-interested customer of the Pele Program. Federally directed nuclear innovation has largely failed where the government tries to play market investor, leading to a predictable path of failure.[18] The political landscape, nuclear sector, and broader energy market are far more dynamic and unpredictable than any government plan to jump-start the private sector.[19] By contrast, federally funded research, development, and deployment of nuclear innovation for the government has produced successful outcomes, such as early nuclear enrichment technology and naval and spacecraft reactors.

Recommendations for the U.S. Government

1. **Congress and the Administration should support the Pele Program as a military program.** While the program will likely produce

spin-off applications for the civilian commercial industry (the NRC's involvement acknowledges that possibility), the objective should never be inverted to subsidize private-sector desires. The Pele Program should not serve as a domestic stimulus program. Rather, the program must remain focused on addressing strategic capabilities and battlefield objectives. Accordingly, appropriations for this program should remain with the Defense Department, and not move to Energy and Water appropriations.

2. **The Defense Department must not hide or camouflage the costs of the program.** Acquiring defense assets often does require paying a premium; however, cost is not an irrelevant factor in advancing strategic capabilities. Micro-reactors will provide little use to the military if they are cost-prohibitive, and hiding costs will only create political rejection of the program.

3. **The Administration must strategically promote the Pele Program to Congress and the public as it progresses.** Any nuclear program provokes political opposition, but given its safety goals and strategic use, Pele should not be one of them. While nuclear opponents may characterize the program as dangerous, the Administration should promote the program for what it is: a pilot to explore long-term strategic uses of nuclear micro-reactors developed based on strict safety requirements.

4. **Congress must address nuclear waste disposal needs.** While spent nuclear fuel can be safely stored locally for decades, a deep geologic repository will be necessary for safe and permanent disposal. Congress has failed to make any policy progress since the Obama Administration dismantled the Yucca Mountain program in 2010. Deep geologic disposal is already necessary for spent Naval reactor fuel and decommissioning of Cold War weapons production sites. It will become only more necessary as the military increases its use of nuclear technology.

Katie Tubb is Senior Policy Analyst for Energy and the Environment in the Thomas A. Roe Institute for Economic Policy Studies, of the Institute for Economic Freedom, at The Heritage Foundation. **Patty-Jane Geller** is Policy Analyst for Nuclear Deterrence and Missile Defense in the Center for National Defense, of the Kathryn and Shelby Cullom Davis Institute for National Security and Foreign Policy, at The Heritage Foundation.

Endnotes

1. Juan A. Vitali et al., "Study on the Use of Mobile Nuclear Power Plants for Ground Operations," U.S. Army, October 26, 2018, p. 18, https://apps.dtic.mil/dtic/tr/fulltext/u2/1064604.pdf (accessed March 23, 2020).
2. See fiscal year (FY) 2009 NDAA § 334 and FY 2014 NDAA. The resulting studies: James T. Bartis and Lawrence Van Bibber, "Alternative Fuels for Military Applications," RAND Corporation, 2011, https://www.rand.org/pubs/monographs/MG969.html (accessed March 24, 2020), and U.S. Department of Defense, Defense Science Board, "Task Force on Energy Systems for Forward/Remote Operating Bases," August 1, 2016, https://apps.dtic.mil/dtic/tr/fulltext/u2/1022571.pdf (accessed March 24, 2020).
3. A conventional, commercial reactor has a capacity of around 1,000 megawatts and uses 3 percent to 5 percent enriched fuel. HALEU is enriched up to 19.75 percent. See U.S. Department of Defense, Strategic Capabilities Office, "Pele Program Phase I, Request for Solutions Amendment No. 1," May 20, 2019, p. 20, https://govtribe.com/opportunity/federal-contract-opportunity/request-for-solutions-pele-requestforsolutionspele (accessed March 24, 2020).
4. Frederico Bartels, ed., "How the 2021 National Defense Authorization Act and the Defense Appropriations Act Can Prepare the U.S. for Great Power Competition," Heritage Foundation *Special Report* No. 222, March 23, 2020, https://www.heritage.org/sites/default/files/2020-03/SR222.pdf.
5. Vitali et al., "Study on the Use of Mobile Nuclear Power Plants," p. 1.3, and Andrew Holland, "Micro Nuclear Reactors: Prospects for Deploying Land-Based Nuclear Energy for the US Military," American Security Project, October 2019, p. 6, https://www.americansecurityproject.org/wp-content/uploads/2019/10/Ref-0231-Micro-Nuclear-Reactors.pdf (accessed March 24, 2020).
6. Holland, "Micro Nuclear Reactors," p. 2.
7. Vitali et al., "Study on the Use of Mobile Nuclear Power Plants," p. 1.5.
8. U.S. Department of Defense, Defense Science Board, "Task Force on Energy Systems for Forward/Remote Operating Bases," p. 1.
9. U.S. Department of Defense, Strategic Capability Office, "Pele Program Phase I," p. 4, and Vitali et al., "Study on the Use of Mobile Nuclear Power Plants," p. C.8-9.
10. Katie Tubb, "The Nuclear Energy Leadership Act: A Missed Opportunity for Leadership," Heritage Foundation *Backgrounder* No. 3435, September 11, 2019, p. 9, https://www.heritage.org/sites/default/files/2019-09/BG3435.pdf.
11. Tri-structural Isotropic (TRISO) particle fuel is made of uranium fuel "kernels" that are triple coated to provide a containment system for each particle, increasing resistance to extreme temperatures and preventing the release of radioactive fission products that would occur during a nuclear meltdown. U.S. Department of Energy, "TRISO Particles: The Most Robust Nuclear Fuel on Earth," July 9, 2019, https://www.energy.gov/ne/articles/triso-particles-most-robust-nuclear-fuel-earth (accessed March 25, 2020).
12. U.S. Department of Defense, Strategic Capability Office, "Pele Program Phase I," p. 25.
13. Edwin Lyman, "The Pentagon Wants to Boldly Go Where No Nuclear Reactor Has Gone Before. It Won't Work," *Bulletin of the Atomic Scientists*, February 22, 2019, https://thebulletin.org/2019/02/the-pentagon-wants-to-boldly-go-where-no-nuclear-reactor-has-gone-before-it-wont-work/ (accessed March 24, 2020).
14. U.S. Department of Defense, Defense Science Board, "Task Force on Energy Systems for Forward/Remote Operating Bases," p. 2.
15. Bartis and Van Bibber, "Alternative Fuels for Military Applications."
16. Tubb, "The Nuclear Energy Leadership Act."
17. Katie Tubb, Nicolas Loris, and Rachel Zissimos, "Taking the Long View: How to Empower the Coal and Nuclear Industries to Compete and Innovate," Heritage Foundation *Backgrounder* No. 3341, September 5, 2018, https://www.heritage.org/energy-economics/report/taking-the-long-view-how-empower-the-coal-and-nuclear-industries-compete.
18. 18Jack Spencer, "Competitive Nuclear Energy Investment: Avoiding Past Policy Mistakes," Heritage Foundation *Backgrounder* No. 2086, November 15, 2007, https://www.heritage.org/environment/report/competitive-nuclear-energy-investment-avoiding-past-policy-mistakes.
19. This is not to say that government has no role in advancing civilian nuclear power innovation. Regulatory reform, export markets, nonproliferation, and access to the national laboratories are effective and productive roles for government.