

EXPERT INSIGHT | Energy & the Environment

SMALL MODULAR REACTORS & MICROREACTORS

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TOPLINE POINTS

- ★ SMRs and microreactors are quality energy sources. The U.S. navy has demonstrated their efficacy and breadth of application for decades.
- ★ Modularity and pre-fabrication can help drive down the cost curve for nuclear and de-risk much needed additions to the grid for applications such as AI.
- ★ Small modular reactors (SMRs) and microreactors can provide flexible, firm power where most needed, from industrial hubs to remote and disaster sites.

Introduction

America's power demand is rising again, driven by real economic activity like data centers, manufacturing, and a larger electrified economy. At the same time, grid operators are warning that load growth and the premature retirement of dependable generators are creating mounting reliability risks over the next decade. Nuclear power is already one of America's core reliability assets, supplying about 19% of U.S. electricity from the world's largest commercial fleet. Small modular reactors and microreactors could expand reliable power to more places and more use cases, including behind-the-meter industrial sites and remote installations.

What are small modular reactors (SMRs) and microreactors, and what distinguishes them from traditional nuclear reactors?

SMRs, microreactors, and large, light-water reactors (the type used by the U.S. nuclear fleet) are energy sources powered by nuclear fission. Each letter of the SMR acronym corresponds to a feature that usefully differentiates these reactors (as well as microreactors) from other nuclear units currently operating domestically.

- **Small** (also “micro-”) does not define these reactors as a technological class; the terms refer to taxonomies that describe the size of the unit's thermal or electric output rather than the myriad potential differences in their moderators, fuel types,

coolants, safety features, or overall design. According to [taxonomic guidance](#) from Idaho National Laboratory’s Gateway for Accelerated Innovation in Nuclear (GAIN), SMRs have a threshold of 50-300 MWe, while microreactors generate less than 50 MWe, and often below 10 MWe.¹ In contrast, the large light-water reactors that comprise the current U.S. fleet generate an [average of ~1 GW](#) (1,000 MW).

- **Modularity**, the second term, refers to the more operationally important element of the SMR—that, rather than being built as a bespoke on-site project, the manufacturer pre-fabricates components off-site and then ships them to wherever a power plant is needed. Microreactors are similarly built offsite and are designed to ship as a single, prefabricated unit. Such developments aim to help nuclear reactors benefit from economies of scale: workforce learning across many iterations, bulk orders, and supply-chain efficiencies. Whereas for traditional units, most reactors are inevitably bespoke, first-of-a-kind (FOAK) designs, SMRs and microreactors drive the cost curve down across *nth*-of-a-kind (NOAK) builds. SMRs and microreactors are therefore poised to capture significant cost advantages.

As of December 2025, no commercial SMRs are operating in the United States, though many firms are working alongside public sector partners to deploy them. In 2015, the U.S. Department of Energy (DOE) [launched](#) the Gateway for Accelerated Innovation in Nuclear (GAIN) to provide “access to the technical, regulatory, and financial support necessary to move new or advanced nuclear reactor designs toward commercialization,” among other resources. The DOE’s Advanced Reactor Demonstration Program (ARDP) committed more than [\\$3 billion in cost-shared federal support](#) during the first Trump Administration to a small set of FOAK advanced reactor projects aimed at bringing demonstration units online before the end of this decade. Under the second Trump Administration, the DOE also launched the [Generation III+ Small Modular Reactor Pathway to Deployment](#), a [\\$900 million program](#) to de-risk light-water SMRs. In December 2025, the DOE awarded [\\$400 million each](#) to TVA and Holtec for respective projects at Clinch River (the BWRX-300 reactor) and Palisades (the SMR-300 reactor), with another \$100 million reserved for follow-on work in reactor design, licensing, supply chain issues, and site preparation.

Why are nuclear energy and SMRs important for America’s electric supply?

For a decade, energy use in the United States has [remained flat](#), as energy efficiency gains and other factors offset modest demand increases. However, the U.S. set a new record for

¹ Some variance exists on definitions. The Department of Energy’s [Pathways to Liftoff](#) report describes an upper range of ~350 MW for SMRs; the NRC [defines](#) SMRs as having a “power generating capacity of 300 MWe or less per module.” The Code of Federal Regulations does not define “microreactor” but NRC staff have “described [anticipated characteristics](#) of microreactors, which include ... thermal power levels of a few megawatts to several tens of megawatts.”



consumption in 2024, and the U.S. Energy Information Agency’s (EIA) December 2025 [Short-Term Energy Outlook](#) expects consumption to rise by 68 billion kilowatt-hours in 2026 alone as energy demands for artificial intelligence, manufacturing, and consumer electrification intensify. Such growth, driven by real-world applications rather than fanciful “net zero” targets, puts America on a strong footing, but it is essential that we have the power supply to match it.

Concerningly, the electric grid is already strained in advance of projected growth: Federal Energy Regulatory Commission (FERC) Commissioners [Danly](#) and [Christie](#) have both testified to such concerns, with the latter referring to an incoming “reliability crisis.” Similarly, the North American Electric Reliability Corporation’s (NERC) [2024 Long-Term Reliability Assessment](#) indicates mounting reliability challenges over the next ten years as loads grow and dispatchable generators are being retired faster than firm replacement come online. In many regions, interconnection queues are [littered](#) with proposed wind and solar projects that are insufficient to meet the demand for reliable power, if they ever get built at all.²

Against such a backdrop, the U.S. nuclear fleet has become one of our most valuable strategic assets: 94 reactors totaling 97 gigawatts of capacity and providing 19% of U.S. electricity at a median [91% capacity factor](#), the [largest and most energetic](#) commercial nuclear fleet in the world. But large-scale nuclear plants have been retired without sufficient reliable replacements. SMRs, for reasons discussed below, may be able to overcome some of the regulatory and political friction that has so far stymied the development of additional nuclear power.

What novel advantages could SMRs and microreactors provide?

Foremost among their benefits, SMRs and microreactors offer considerable amounts of firm power. A single 300-megawatt module can power as many as 300,000 homes, a large data-center campus, or a cluster of industrial facilities. But the size of SMRs and microreactors offers key flexibility and, therefore, distinct advantages. Because the units are smaller, they can often be sited at retired coal or nuclear plants or other brownfield sites, thereby reusing existing grid connections, infrastructure, and skilled workforces. Companies such as Holtec aim to do this at the Palisades plant in Michigan, where the proposed restart of the large light-water reactor and the [addition of SMRs](#) would convert a retired plant into a nuclear hub. SMRs can also be placed behind the meter to serve manufacturers or data center hyperscalers that need firm power onsite.

Additionally, SMR and microreactor designs should be able to efficiently serve an application that has seen [low market penetration](#) from large reactors: industrial process heat. Some units may provide process heat, either alone or alongside electric generating capacity, thus making them a

² [Forbes](#) quotes study authors at Enverus Intelligence Research as noting that for developers of wind, solar, and stationary battery projects, “based on our gradient-boosting machine learning model, we predict that only ~10% of projects will successfully come online in the next three years.”



natural, co-located partner for refineries, petrochemical plants, steel and fertilizer producers, and other heat-intensive industries. Similarly, they might also support [desalination projects](#) in regions subject to drought. Furthermore, while nuclear power is often thought of as baseload, some experts have [proposed](#) that SMRs or microreactors could be load-following resources in certain locales.

In turn, microreactors' small size may enable them to serve a variety of [novel use cases](#) that were previously unavailable to nuclear power, in part due to their lower materials intensity [and lighter land/water use](#) requirements. For example, remote locations such as military bases, rural communities, and mining operations may benefit from their reliability and resilience; their transportability by planes, trains, or even trucks will allow them to deploy quickly to natural or other disaster situations. Furthermore, the inherent safety features possessed by advanced nuclear technologies provide operators [greater flexibility](#) to prepare for potential emergency situations.

What barriers could delay or halt the incoming small-scale fleet?

To convert the potential of SMRs and microreactors into steel and concrete, outdated regulations must be updated to match new technologies, and broad-based [moratoria on new nuclear](#) must be repealed. Many regulations and frameworks unnecessarily inhibit new nuclear, including the “as low as reasonably achievable” (ALARA) framework and the National Environmental Policy Act (NEPA). This analysis will focus on licensing issues for SMRs and microreactors.

The Nuclear Regulatory Commission's traditional licensing frameworks, Parts 50 and 52, were written with large, light-water reactors in mind. But as the Vogtle experience demonstrates, they are already inadequate to the task of building nuclear power safely, efficiently, and at scale. Congress recognized that, and, through the Nuclear Energy Innovation and Modernization Act (NEIMA), instructed the NRC to create a new framework for advanced designs (including SMRs and microreactors), which is now taking shape as the [proposed 10 CFR Part 53](#).

Part 53's premise has been to be “risk-informed” and “technology-inclusive,” meaning that regulatory requirements and reviews would be calibrated to each design's actual risk, rely on performance-based assessment, and apply to both light-water and non-light-water reactors without requiring a new rule for every design. That effort is a step in the right direction, but the current draft has drawn concerns from [developers](#), [lawmakers](#), and [other experts](#) who argue that it layers new complexity on top of old rules instead of creating a genuinely simpler path and fails to adequately deal with burdensome frameworks such as ALARA. Furthermore, the current draft of Part 53 does not provide a clear path for projects already moving ahead under the existing



licensing frameworks³ to transition to the newer one, should it prove in the end to be a streamlined path.

How should small-scale nuclear be considered relative to the existing nuclear fleet?

America's backbone of large, light-water reactors should be treated as a vital national asset. As identified in [Executive Order 14302](#), we should keep as many units online as safely possible, extend their licenses, pursue uprates where feasible, and add new large reactors, especially at proven sites. The opportunity for traditional reactors is significant: analysis from GAIN and Idaho National Labs suggests that existing nuclear plants could host [60-95 gigawatts](#) of additional capacity and that repowering or co-siting reactors at coal plants could add an [additional 128-174 gigawatts](#).

In addition to capturing the significant opportunities for new large reactors, America should seek to expand the footprint of SMRs and microreactors. Their presence on and behind the grid will be important as developers seek to meet the growing demands of artificial intelligence, industrial sites, and other communities that cannot wait many years for a single gigawatt-scale project. They are an innovation-driven solution that aims to beat the regulatory gridlock and construction timelines that have slowed large nuclear projects, serving communities or sites that are hard to reach today while reinforcing the existing system.

How can SMRs and microreactors support American families?

Today's nuclear sector already directly employs [more than 70,000](#) Americans in high-quality, long-term jobs and supports [over 250,000 jobs](#) when suppliers and downstream economic activity are included. Studies by the OECD Nuclear Energy Agency find that each gigawatt of nuclear capacity generates around [200,000 labor-years](#) of employment over its life cycle when direct, indirect, and induced jobs are added together.

More relevant to individual communities, U.S. experience shows a new nuclear plant can employ up to 9,000 workers at construction's peak. Once in service, each plant supports the order of 500 to 800 highly skilled, long-term jobs with a 2023 median annual industry-wide wage of [~\\$120,000](#). SMRs and microreactors can significantly enhance those job benefits. At a time when many communities are rightly skeptical of short-term "[green jobs](#)" promises, large and small nuclear plants offer job stability and the well-paying jobs that can support growing families and communities.

³ Plants including Kairos Power's Hermes and Hermes-2 demonstration reactors in Tennessee, TerraPower's Sodium demonstration plant in Wyoming, and X-energy's Xe-100 project in Texas are proceeding under 10 CFR Part 50.



Do SMRs stand to benefit the U.S. on the world stage?

Globally, there are [more than 30 countries](#) that operate nuclear reactors; virtually all are traditional light- or heavy-water models, thus demonstrating a significant existing demand for nuclear power. These countries, in a time of rising energy demand, may wish to increase their capacity for reliable nuclear power but may struggle to take on the financing demands of a larger plant. Smaller units built to U.S. standards and with lower cost thresholds should be naturally attractive to such partners and would help cement American dominance in global nuclear markets. SMR exports would allow us to offer partners reliable, affordable power, deepen long-term industrial ties, and open multi-decade markets for American services and high-tech equipment.

Of course, the competition is not standing still. [Russian](#) and Chinese state-owned enterprises are already building and exporting reactors, including smaller designs, and [have been explicit](#) about plans to use nuclear exports as a strategic tool to expand their share of global nuclear capacity and influence, including at America's expense. If we hesitate, other suppliers are likely to fill the gap, consequently locking in long-term business relationships and building leverage over fuel supply, standards, and political relationships.

If we act, U.S. designs for large reactors and SMRs can set the safety, non-proliferation, and market rules for the next generation of nuclear power, thereby complementing America's [growing exports of oil, gas, and coal](#). The current administration has sought to capture this opportunity through [Executive Order 14299](#), "Deploying Advanced Nuclear Reactor Technologies for National Security," which, in part, aims to "position American nuclear companies as the partners of choice for future energy growth throughout the world." This plan involves securing "123 Agreements," which target peaceful nuclear cooperation with other nations, and leveraging tools such as the U.S. International Development Finance Corporation, the U.S. Trade and Development Agency, and the Export-Import Bank.

Can small reactors be cost-effective?

Yes, nuclear energy is and can be cost-effective. Clear, easy-to-comply-with rules, repetition, and scale provide a strong path forward to increase cost-effectiveness for all reactor types, large and small. SMRs, which are already inherently well-positioned to capture the gains from repetition and scale, represent a promising, innovation-led path to drive down the cost of nuclear energy in the United States.

While some critics point to the recently finished Vogtle Units 3 and 4 as [proof](#) that new nuclear is destined to be late and over budget, others say that the failure to build Vogtle on time and under budget means that SMRs represent the only economically viable path forward for the nuclear industry. Both views are misguided. Instead, the experience of Vogtle and



other recent projects should inform our view of the challenges facing the nuclear industry, the best practices for driving down costs, and illustrate how regulatory reform should be approached, as well as the ways that modularity in reactor design may overcome these problems.

Vogtle's expansion, by all accounts a FOAK facility, [suffered through](#) mid-project regulatory changes, which prompted major redesigns, and ultimately contributed to costs far beyond the scope of initial estimates, around [\\$16,000 per kilowatt](#). And while Vogtle is a recent and painful example, it fits the overall trend of U.S. nuclear costs being driven up by heavy regulatory and litigation pressures: a [2025 study](#) found that the average costs for U.S. nuclear plants today can be as high as \$15/watt, while the latest French plants costs over \$4/watt and Chinese plants cost about \$2/watt. Nevertheless, the experience of Vogtle need not be the destiny of future projects. South Korea's APR-1400 program, including the four units at the Barakah plant in the United Arab Emirates, has delivered large reactors at [under \\$5,000 per kilowatt](#) in nominal costs and close to schedule by using standardized designs, an experienced builder, and a stable regulatory framework.

Elsewhere, Orr and Rolling [find](#) in a 2022 study that for the South Korean APR-1400, "the cost of serving load was \$69 per MWh. Small modular reactors (SMRs), based on EIA cost estimates, were modeled to generate electricity for \$213 per MWh if used as peaking resources and \$120 per MWh if used in a baseload capacity." The authors find this compares very favorably to the "all-in" cost of battery-backed wind facilities at \$272 per MWh and solar facilities at \$471 per MWh. It is worth noting on the operational side that although FOAK SMRs have an uncertain price point in practice, the longevity of nuclear plants and fission power's low fuel costs contribute to falling input prices and additional cost savings over time, though this may [vary by reactor design](#).

What are potential military applications for SMRs and microreactors?

Forward bases need electricity that holds up under stress. In the Indo-Pacific, the United States operates across a [large, dispersed posture](#) (more than 375,000 personnel across at least 66 defense sites). Many of those locations sit in island environments where dispatchable, dependable power is limited, and where outages, cyber threats, and supply disruptions can quickly become operational problems. Defenses to power may threaten communications, maintenance, air defense, medical support, and sustained operations.

Microreactors are designed around the logistics reality of remote operations. Look no further than the U.S. nuclear navy, which has steamed [more than 177,000,000 miles](#) under small-scale nuclear propulsion, [accident-free](#). On land, microreactor concepts are designed to be small enough to be transported, in whole or in part, [by truck, rail, or aircraft](#) such as the C-130 or C-17—meaning that the same lift capacity that sustains a base can, in principle,



deliver a firm power source to that base. The underlying advantage is energy density: a [U.S. Army report](#) notes that nuclear fuel can support forward and remote power generation without continuous fuel resupply. Such energy density helps solve for one of the hardest problems in austere environments: keeping generators running when fuel deliveries are contested or delayed.

Guam shows why energy mobility and independence are critical for the U.S. military. According to the [EIA](#), the civilian grid has a roughly 464 MW capacity, while the military accounts for roughly 20% of the island's electricity use. Significantly, the [planned retirement](#) of ~132 MW at Cabras 1 and 2 comes on top of heavy reliance on imported fuels. A set of microreactors dispatched to handle on-base loads could lower fuel exposure and reduce the risk that a civilian grid failure becomes a mission failure. And while [Executive Order 14299](#) and the [Janus Program](#) are driving near-term deployment on domestic installations by September 30, 2028, the strategic logic for extending that posture to select overseas and island sites is at least as strong, because those are the places where grid fragility and fuel dependence are not hypothetical—they are daily constraints.

Policy Recommendations

To ensure that America takes full advantage of the opportunities that SMRs and microreactors present, policymakers should consider the following:

- Ensuring that the Nuclear Regulatory Commission's (NRC) upcoming final rule for the upcoming Part 53 framework should be technology-neutral with respect to different fuel systems, safety features, and reactor capacity; should be performance-based rather than requiring specific design elements; and should be risk-informed to allow innovators and entrepreneurs to experiment and discover the safety approaches that are most effective at the lowest cost. If it is not, Congress should pass legislation to further define and improve the licensing process for advanced reactors. ([America First Policy Institute](#))
- The NRC should revisit the decades-old ALARA standard for radiological risk and assess, in light of the latest research, whether ALARA is the appropriate radiological risk mitigation standard for nuclear energy and propose a new alternative standard, or set of standards, if it is found to no longer be appropriate. Here, too, further Congressional action may be warranted. ([America First Policy Institute](#))

Conclusion

SMRs and microreactors are a promising tool for achieving an American energy revival. They can give utilities, data-center operators, and industrial customers more ways to add firm, emissions-free power in more locations, therefore closely matching real-time demand.

The technology is entering serious testing phases, the demand is already here, and the jobs and exports are tangible. Physics is not what stands in the way—regulations and



muscle memory are. If America chooses to unleash them, SMRs and microreactors can pair with life extensions and uprates for the existing fleet, new large reactors where they make economic sense, and leadership that keeps reliable coal and gas plants from being driven off the grid by politics. This will bring the energy dominance agenda to life and create a better reality for workers, for industry, and for families who simply want the lights to stay on and the bills to stay low.

