Small Modular Reactors (SMR) Update

By John Benson

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1. Introduction

I just was wondering: (1) how long it has been since I posted a paper on SMRs, and (2) How this technology is coming along. After digging a bit, I found some really good articles on this subject, so I decided to post this update.

2. Why SMRs (and what are they?)

The nuclear industry hopes to launch advanced small reactors by the early 2030s, aiming to meet the deep-pocketed electric utility sector's growing need for electricity to fuel rapidly expanding fleets of data centers.

Nuclear energy has relied largely on the same pressurized-water reactor technology for the past 70 years, but those plants have proven incredibly expensive to build in the U.S. in the 21st century.

Author's comment: See below for the "what are they" part of my Section-title, but the incumbent technology (pressurized water reactors or "PWRs") and their sister-design (boiling water reactors or "BWRs") use a customized design for each plant, and are basically constructed on site.

The first new nuclear plant completed in decades, reactors 3 and 4 at Plant Vogtle in Georgia, infamously cost about $18 billion more than expected and opened seven years behind schedule. Each of those reactors can generate 1,114 megawatts of electricity, enough for more than 800,000 homes.

Despite growing interest in restarting closed reactors, such as Palisades in Michigan and Three Mile Island in Pennsylvania, as a quicker and cheaper near-term solution, there remains "a whole lot of hesitation about brand-new PWR or BWR plants.

The advanced reactors under development (mainly SMRs) promise to have smaller, lighter footprints that could make them cheaper and quicker to build when they are fully commercialized. But the industry is crowded with more than 90 different technologies in various stages of development around the world, per the Nuclear Energy Agency.[1]

Author's comment: SMRs have major components built in a separate factory, and hopefully will ramp up to a high enough volume so they can mass-produce subassemblies and build the major components on an assembly line and ship them to the reactor site using normal road (or other) transport methods.

3. SMR Manufacturers

The utility and tech sectors need to winnow down the field to five or 10 companies with the right technology, said John Ketchum, CEO of NextEra Energy, the largest power company by market capitalization in the U.S.

[1] The NEA Small Modular Reactor Dashboard: Second Edition, July 22, 2025, https://www.oecd-nea.org/jcms/pl_90816/the-nea-small-modular-reactor-dashboard-second-edition

"A lot of them are under-capitalized," Ketchum said of the small nuclear startups designing advanced reactors. "So, we've got to pick out the ones that we really want to get behind and make the bets," the CEO said at the CERAWeek energy conference in Houston earlier this month.

Ketchum sees the first advanced SMR reactor coming online around 2031 in the U.S., with more units potentially on the way around 2035. Technology companies will serve as a catalyst, they are a "huge force" that can drive the industry forward due to their immense demand for electricity coupled with their deep pockets. Alphabet, Amazon, Meta and Microsoft together are worth seven times the value of the entire S&P 500 utility sector.

The following are some of the leading players in the U.S. market to revive nuclear power, the first three are private but with significant financial backing and customers already lined up. There is also a fourth firm below that evolved from an established reactor manufacturer (RM). The fifth firm below is the leading SMR incumbent, and the only firm with an NRC-approved design.

3.1. TerraPower

TerraPower is the first advanced reactor company in the U.S. to move from design to construction, breaking ground on its first plant near a former coal site in Kemmerer, Wyoming in the summer of 2024. The company aims to start dispatching power by the end of 2030 to Warren Buffett's PacifiCorp.

TerraPower's Natrium reactor operates at atmospheric pressure, a feature that should reduce construction costs.

*The U.S. currently relies on BWR and PWR reactors that operate at over 500 degrees Fahrenheit and are cooled by water. These systems operate under high pressure (*water boils at 212°F at atmospheric pressure*) – to keep the coolant liquid, and the plants need heavy, expensive components to contain the pressure.*

TerraPower uses sodium, rather than water, as a coolant. Liquid sodium boils at 900° C, much higher than the Natrium reactor's operating temperature of around 500° Celsius. That means the plant does not need to be pressurized, Levesque said.

Author's comment: The downside with the liquid sodium coolant is that liquid sodium is extremely reactive, and thus they need to use an inert cover gas – ideally Argon. Helium is also inert, but is the second lightest element (after hydrogen) so there could be issues with containment.

Using a low-pressure, lighter plant to avoid high pressure systems reduces tons of steel, tons of concrete, labor hours, numbers of systems. It is estimated that Natrium plants will cost about half as much to build as a traditional nuclear plant, with prices coming down as more are built.

The Natrium reactor has a power capacity of 345 megawatts, enough for more than 250,000 homes. A plant will have the ability to ramp up to 500 megawatts for several hours by storing heat in a thermal battery made of molten salt. The idea is to be able to dispatch power on demand to the grid when renewable solar and wind power fade because the sun isn't shinning or winds are slack.

TerraPower has the financial backing of its key founder Bill Gates, SK Group, one of South Korea's largest energy providers, and ArcelorMittal, a steelmaker. Gates and SK Group led TerraPower's $830 million funding round in 2022. The Wyoming project is backed by $2 billion from the Department of Energy, which TerraPower says it will match dollar for dollar.

TerraPower filed its construction license application with the Nuclear Regulatory Commission in 2024 and expects the regulator will issue a permit in December 2026.

3.2. X-Energy

Of all the advanced reactor companies, X-Energy is the first to win a direct investment from a tech company, securing hundreds of millions of dollars from Amazon to build its Xe-100 reactor.

"What this sector needs is risk-capital to invest in plants because U.S. utilities aren't doing it today," X-Energy CEO Clay Sell told CNBC.

X-Energy's most recent financing round raised $700 million, led by Amazon and with additional capital from Citadel founder Ken Griffin, Ares Management, Segra Capital Management, Jane Street Capital and the University of Michigan, among others.

"One of the largest corporations in America, a company that is in size larger than the entirety of the investor-owned utility sector in the U.S., was stepping forward and saying we want to facilitate the new nuclear future in the United States," Sell said.

The cash will largely go to completing the reactor design so it's ready for construction, and finishing the first phase of X-Energy's fuel facility, Sell said.

The Xe-100 is an 80-megawatt reactor sold in a pack of four units to construct 320 megawatts in total, the CEO said. The multiple units create redundancy and the small size allows the biggest component, the reactor vessel, to ship from a factory via road to the construction site, Sell said.

The reactor uses helium gas as a coolant rather than water. X-Energy has its own proprietary fuel made of graphite pebbles that contain uranium kernels encased in ceramic. Sell said the graphite can't melt, which makes the plant "intrinsically safe."

Amazon's investment will finance four Xe-100 reactors in Washington state that will be built, owned and operated by Energy Northwest, a utility, with plants coming online in the early 2030s. The intent is to scale up to a dozen Xe-100s in Washington (total of 960 MW), Sell said.

X-Energy is also working with Dow Inc. to deploy four reactors at the chemical company's manufacturing facility in Seadrift, Texas. The Department of Energy has awarded X-Energy up to $1.2 billion to develop and deploy its technology.

X-Energy aims to become the first company to commission an operational advanced reactor in the U.S., Sell said.

3.3. Kairos Power

Kairos Power signed a contract with Alphabet's Google unit last year (2024)[2] to deploy multiple, advanced reactors, aiming to supply the YouTube company with 500 megawatts of power. The first reactor is expected to come online in 2030, with additional deployments through 2035.

[2] https://kairospower.com/external_updates/google-and-kairos-power-partner-to-deploy-500-mw-of-clean-electricity-generation/

Financial terms of the deal weren't disclosed, but the Google contract is "immensely important," allowing Kairos to "plan the infrastructure not just for one project but for a series of projects," CEO Mike Laufer told CNBC.

"It allows us to scale our infrastructure, production — our manufacturing capabilities," Laufer said.

The 75-megawatt Kairos' reactor will be deployed in pairs to provide 150 megawatts of total power. Similar to TerraPower, Kairos' reactor operates at near atmospheric pressure using molten fluoride salt instead of water as coolant. Like X-Energy, Kairos uses fuel that encases uranium kernels in ceramic and graphite pebbles that can't melt in high-temperature reactors, according to the company.[3]

Kairos is building a low-power, demonstration reactor in Oak Ridge, Tennessee to showcase its ability "to deliver clean, safe, and affordable nuclear heat." Oak Ridge, site of a national laboratory about 25 miles west of Knoxville, was where uranium was enriched as part of the Manhattan Project to build the first atomic bombs.

Today, there will be a "natural thinning" in the number of advance reactor companies, Kairos CEO Laufer said: "It's going to be driven by who can actually be in a position to execute projects," he said.

3.4. Hitachi GE Vernova Nuclear Energy

Author's comment: Reference 1 only summarized the above three SMR-Builders, but I couldn't complete this paper without covering this and this subsection's title RM. GE Nuclear was not only my former employer, but they played an important role in the development of power reactors, and NuScale (next subsection) was a pioneer of the SMR concept. Thus, I found other recent references that covered Hitachi GE Vernova and NuScale.

This company evolved from GE Nuclear Energy Division over the last decade or two. They offer an SMR Designed as described (and referenced) below.

GE Vernova Hitachi's (GVH) BWRX-300 is not a concept, a plan, or a PowerPoint. It's now under construction. Its configuration, based on proven technologies, has been selected for the leading project in the Western world with construction underway in Canada on the first BWRX-300. Construction of the first unit is estimated to be completed by the end of 2029 and in commercial operation by the end of 2030.[4]

With more than 65 years of nuclear industry experience and a rich legacy of excellence and quality, GE Vernova Hitachi has the energy technologies to change the world—and the BWRX-300 is a key part of that mission.

[3] Both the X-Energy and Kairos reactor designs are commonly called "Pebble-Bed Reactors."
[4] GE Vernova Hitachi Nuclear Energy, "BWRX-300," 2025, https://www.gevernova.com/nuclear/carbon-free-power/bwrx-300-small-modular-reactor

Author's comment: Your author was employed by GE Nuclear from 1977 to 1980.

Ontario will be home to the Western world's first SMR. Working in collaboration with Ontario Power Generation (OPG) and others, construction began in May 2025 and is estimated to be completed in late 2029.

The BWRX-300 is a source of electricity generation capable of powering communities across the globe with the energy they rely on to thrive.

The BWRX-300 uses modern construction methods and advanced concrete solutions, inspired by proven techniques from Hitachi GE Vernova's long history of nuclear expertise as well as oil, gas, and other power industries.

By using modular construction, the BWRX-300 can be built in just ~24-36 months and boasts a compact configuration, reducing the overall plant site by about 90% and using ~50% less concrete per unit of energy produced. That means faster, more cost-effective construction and a smaller environmental footprint.

3.5. NuScale

NuScale (SMR) shares soared 15% on Wednesday after the U.S. Army launched the "Janus Program" – a new initiative aimed at accelerating the development and commercialization of small nuclear reactors.[5]

The U.S. Army has partnered with the Defense Innovation Unit to fast-track advanced reactor tech, an effort aligned with President Donald Trump's directive to have operational reactors at military bases by 2028.

Including today's rally, NuScale stock is up more than 375% versus its year-to-date low in April.

The Janus Program signals policy momentum that creates a lucrative, derisked opportunity for the likes of Corvallis-headquartered NuScale Power.

As a leader in small modular reactors (SMR), and the only one with a design approved by the U.S. Nuclear Regulatory Commission, NuScale is strongly positioned to secure valuable, high-profile government contracts.

This could boost the company's revenue, scale its production, and validate its technology for wider commercial markets.

In short, the U.S. Army's announcement boosts investor confidence in SMR stock and could drive both retail and institutional capital into the NYSE-listed firm over the next few months.

[5] Wajeeh Khan, Barchart via MSN, "The U.S. Army Is Betting on Small Nuclear Reactors. Should You Buy NuScale Power Stock?" October 15, 2025, https://www.msn.com/en-us/money/markets/the-u-s-army-is-betting-on-small-nuclear-reactors-should-you-buy-nuscale-power-stock/ar-AA1Oxtud?ocid=BingNewsSerp

3.5.1. Why the Valuation Isn't Too Concerning for this SMR Stock

NuScale shares sure aren't inexpensive to own at a price-sales (P/S) multiple of 346x at the time of writing.

But there are several reasons beyond the Army's support that warrant owning them for the long term. For example, it's the only American firm that already has regulatory approval for its SMR design.

Plus, renewed trade tensions between the U.S. and China are increasing interest in domestic energy solutions, which also stands to benefit SMR shares.

More broadly, nuclear power outperforms renewables like solar and wind in terms of reliability as well, further strengthening the overall bull case for NuScale.

Author's comment: Nuclear is a reasonable match for solar and wind. First of all, it's fully and flexibly dispatchable and available 24x7. Second, although reactors can hold fuel for several years operation, it is more convenient to have yearly-scheduled refueling, in order to (1) coordinate maintenance with other major plant components, (2) move the fuel elements to different locations in the reactor core to provide 100% fuel-utilization, and (3) avoid refueling (and other maintenance) during peak demand periods.

A reactor can be refueled in as little as 10 days. However, when a unit goes down for refueling, the outage lasts an average of about two months. Reactor operators typically defer much of their non-critical maintenance work until a refueling outage. They conduct this maintenance work in parallel with the refueling. By minimizing the number of times that the reactor powers down, operators maximize their reactor's online time and profitability even though it extends the refueling outage. The NRC data yield an annual average capacity factor for the U.S. nuclear industry from 2007 to 2010 of about 90%.[6]

[6] EIA, Today in Energy, May 23, 2011, "Nuclear power plants undergo seasonal scheduled outages"