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We were promised smaller nuclear reactors. Where are they?

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9–11 minutes

Small modular reactors could be quicker and cheaper to build. Now, they've reached a major milestone.

Stephanie Arnett/MITTR | Envato

For over a decade, we've heard that small reactors could be a big part of nuclear power's future.

Because of their size, small modular reactors (SMRs) could solve some of the major challenges of traditional nuclear power, making plants quicker and cheaper to build and safer to operate.

That future may have just gotten a little closer. In the past month, Oregon-based NuScale has reached several major milestones for its planned SMRs, most recently receiving a final approval from the US federal government for its reactor design. Other companies, including Kairos Power and GE Hitachi Nuclear Energy, are also pursuing commercial SMRs, but NuScale's reactor is the first to reach this stage, clearing one of the final regulatory hurdles before the company can build its reactors in the US.

SMRs like NuScale's planned reactors could provide power when and where it's needed in easy-to-build, easy-to-manage plants. The technology could help curb climate change by replacing plants powered by fossil fuels, including coal.

But even as SMRs promise to speed up construction timelines for nuclear power, the path to this point has been full of delays and cost hikes. And the road ahead for NuScale still stretches years into the future, revealing just how much streamlining there still is to go before this form of nuclear power could be built quickly and efficiently.

Going smaller

NuScale's SMR generates electricity by a process similar to the one used in today's nuclear plants: the reactor splits atoms in a pressurized core, giving off heat. That heat can be used to turn water into steam that powers a turbine, generating electricity. The biggest difference is the size of the reactors.

In the past, nuclear plants have been gigantic undertakings—so-called megaprojects, costing billions of dollars. "If it's over a billion dollars, the wheels tend to fall off on a project," says Patrick White, a project manager at the Nuclear Innovation Alliance, a nuclear-focused think tank.

For example, construction is currently underway in Georgia to install two additional units at the existing Vogtle power plant. Each of the two planned units will have a capacity of over 1,000 megawatts, enough to power over a million homes. The reactors were supposed to start up in 2017. They still haven't, and the project's total cost has doubled, to over $30 billion, since construction began a decade ago.

By contrast, NuScale plans to build reactor modules that have a capacity of less than 100 megawatts. When these modules are combined in power plants, they'll add up to a few hundred megawatts, smaller than even a single unit in the Vogtle plant. SMR plants with a capacity of a few hundred megawatts would power several hundred thousand homes—similar to an average-size coal-fired power plant in the US.

And while the Vogtle plant sits on a site that covers more than 3,000 acres, NuScale's SMR project should require about 65 acres of land.

Smaller nuclear power facilities could be easier to build and might help cut costs as companies standardize designs for reactors. "That's the benefit—it becomes more of a routine, more of a cookie-cutter project," says Jacopo Buongiorno, director of the Center for Advanced Nuclear Energy Systems at MIT.

These reactors might also be safer, since the systems needed to keep them cool, as well as those needed to shut them down in an emergency, could be simpler.

Untangling the red tape

The problem with all these potential benefits is that so far, they're still mostly potential. Demonstration projects have started up in some parts of the world, with China being the first to connect an SMR to the electrical grid in 2021. Last month, GE Hitachi Nuclear Energy signed commercial contracts for a plant in Ontario, which could come online in the mid-2030s. NuScale, too, is pursuing projects in Romania and Poland.

There are no SMRs running in the US yet, partly because of the lengthy regulatory process run by the Nuclear Regulatory Commission (NRC), an independent federal agency.

Nuclear is the only power source to have its own dedicated regulatory agency in the US. That extra oversight means no detail goes unnoticed, and it can take a while to get nuclear projects moving. “These are big, complicated projects,” says Kathryn Huff, assistant secretary in the office of nuclear energy at the US Department of Energy. The DOE helps fund SMR projects and support research, but it doesn’t oversee nuclear regulations.

NuScale started working toward regulatory approval in 2008 and submitted its official application to the NRC in 2016. In 2020, when it received a design approval for its reactor, the company said the regulatory process had cost half a billion dollars, and that it had provided about 2 million pages of supporting documents to the NRC.

After more than two years of finalizing details and a vote by the agency, the NRC released its final ruling on NuScale’s reactor design last month. The final ruling goes into effect on February 21 and certifies a NuScale design for a reactor module that generates 50 MW of electricity.

Receiving a final ruling for the design means that NuScale would only have to get approval for a reactor site and complete final safety reviews before beginning construction. So in theory, NuScale has already cleared the hardest regulatory steps required before building a reactor.

“It is a big deal and should be celebrated as a milestone,” Buongiorno says. However, he says, minimizing what’s still to come would be a mistake: “Nothing is easy and nothing is quick when it comes to the NRC.”

There’s an additional wrinkle: NuScale wants to tweak its reactor modules. While the company was going through the lengthy regulatory process, researchers were still working on reactor design. During the process of submission and planning, the company discovered that its reactors could achieve better performance.

“We found that we could actually produce more power with the same reactor, the same exact size,” says Jose Reyes, cofounder and chief technology officer at NuScale. Instead of 50 MW, the company found that each module could produce 77 MW.

So the company changed course. For its first power plant, which will be built at the Idaho National Laboratory, NuScale is planning to package six of the higher-capacity reactors together, making the plant capacity 462 MW in total.

The upgraded power rating requires some adjustments, but the module design is fundamentally the same. Still, it means that the company needed to resubmit updated plans to the NRC, which it did last month. It could take up to two years before the altered plans are approved by the agency and the company can move on to site approval, Reyes says.

The long road ahead

Back in 2017, NuScale planned to have its first power plant in Idaho running and generating electricity for the grid by 2026. That timeline has been pushed back to 2029.

Meanwhile, costs are higher than when the regulatory process first kicked off. In January, NuScale announced that its planned price of electricity from the Idaho plant project had increased, from $58 per megawatt-hour to $89. That's more expensive than most other sources of electricity today, including solar and wind power and most natural-gas plants.

The price hikes would be even higher if not for substantial federal investment. The Department of Energy has already pitched in over $1 billion to the project, and the Inflation Reduction Act passed last year includes $30/MWh in credits for nuclear power plants.

Costs have gone up for many large construction projects, as inflation has affected the price of steel and other building materials while interest rates have risen. But the increases also illustrate what often happens with first-of-their-kind engineering projects, Buongiorno says: companies may try to promise quick results and cheap power, but "these initial units will always be a little bit behind schedule and a little bit above budget."

If price hikes continue, there's a chance that participants could back out of NuScale's project, which could spell danger. For SMRs in the works, "I'm not going to believe it's for real until I see them operating," Buongiorno says.

The true promise of SMRs will be realized only when it's time to build the second, the third, the fifth, and the hundredth reactor, DOE's Huff says, and both companies and regulators are learning how to speed up the process to get there. But the benefits of SMRs are all theoretical until reactors are running, supplying electricity without the need for fossil fuels.

"It becomes truly real when electrons go on the grid," Huff says.

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