

Are these tiny, 'inherently safe' nuclear reactors the path to a carbon-free future?

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In the six decades since the Shippingport Atomic Power Station near Pittsburgh began operating as the nation's first commercial nuclear reactor, the industry has built ever larger plants to improve the economies of scale. A typical commercial reactor now produces about 20 times as much electricity as the first Shippingport unit in 1958.

So it may seem counterintuitive that the industry sees the future not in building gargantuan plants, but in small modular reactors, or SMRs—factory-built units with fewer parts, designed to be installed underground with passive cooling systems that the industry says are "inherently safe."

Unlike large nuclear units, which are designed to operate full-tilt all year, SMR designers say the small units are flexible enough to be cranked up as needed to fill gaps in production from wind and solar-powered plants—a critical role as some see [nuclear power](#) as a carbon-free bridge between fossil fuels and [renewable energy](#). The worldwide market for such reactors is expected to reach \$100 billion by 2035, according to the Nuclear Energy Agency, an intergovernmental organization based in Paris.

Among U.S. developers, NuScale Power of Corvallis, Ore., has surpassed its competitors—including Holtec International of Camden—to advance its design closer to the finish line. Supported with \$275 million in U.S. Energy Department grants, NuScale has invested about \$800 million to design a 75-foot-tall cylindrical reactor that the

Nuclear Regulatory Commission is expected to approve next year. NuScale aims to begin producing [power](#) at its first plant in 2026.

"There's a good case for SMRs in a lot of markets, both in the U.S. and throughout the world," said John Kotek, vice president of policy development and public affairs for the Nuclear Energy Institute, an industry trade group.

But not everyone is sold on their promise.

"SMRs seem to be a fad, as far as I can tell," said Edwin Lyman, a senior scientist with the Union of Concerned Scientists, who wrote a widely cited paper questioning the economics of small reactors. "There's very really little substance to its motivation, other than the private sector can't afford ordinary sized reactors."

'SAFER, COST-EFFECTIVE'

Each NuScale reactor would produce 60 megawatts of power—the same as the original Shippingport reactor, which was decommissioned in 1989. The company says its units can be installed individually, or in groups. The initial plant at the Department of Energy's Idaho National Laboratory would contain 12 reactors. Utah Associated Municipal Power Systems is the primary customer.

The smaller reactors will be cost-effective because they can be mass-produced at existing U.S. manufacturing facilities, dramatically reducing onsite construction costs and times, said Tom Mundy, NuScale's chief commercial officer.

SMR designers say the plants will need fewer operators, and because the design is safer, they have also asked the NRC to reduce the 10-mile emergency planning zones now required for larger commercial reactors

to an area confined to the plant site. Critics such as the Union of Concerned Scientists have opposed the request, saying the plants and their accumulated on-site spent fuel still pose a significant risk.

"They argue the reactors are so safe that terrorists won't be able to effectively cause a massive radiological contamination event, and I beg to differ," said Lyman.

The initial markets for SMRs are expected to be primarily overseas, where electricity costs are higher and nuclear energy can compete, NuScale says. Some water-starved Middle Eastern countries have expressed interest because some units can be configured to produce steam, rather than electricity, to power a nearby water desalinization plant.

ANTIDOTE TO CLIMATE CHANGE

The industry is also positioning carbon-free nuclear plants as an antidote to climate change. They cite a recent study by Massachusetts Institute of Technology that found that it would cost less to deploy nuclear power along with renewable energy to reduce carbon emissions, than it would to rely solely upon wind, solar and battery storage to cut emissions.

"Both domestically and internationally, there's a realization by many that in order to achieve carbon climate objectives that are being set, nuclear has to be part of the equation," said Mundy, who worked for Exelon Generation in Kennett Square before joining NuScale in 2012. He lives in Chester County.

Despite the climate benefits, many environmental advocates fiercely oppose any expansion of nuclear energy's role, including skeptics who cite safety issues exposed by the accident 40 years ago this month at Three Mile Island Unit 2 in Pennsylvania, which put the brakes on the

industry's growth in the 1980s. In the last 20 years, just one new commercial plant has begun operations in the United States, and only two are currently under construction.

Lyman said the industry would need to produce "hundreds or thousands" of units in order to cut costs and reduce the need for government assistance.

But NuScale says it will need to produce only 12 reactor units, and build three power plants, to develop the experience needed to bring down costs. "Clearly, we're not talking about hundreds, and clearly not thousands," said Mundy. "There's nothing complicated about its construction, compared to large gigawatt plants."

Nuclear power's cost is at the heart of a debate that officially launched in Pennsylvania last week with the introduction of a proposal to give the nuclear industry \$500 million in annual subsidies, paid by electric customers. Nuclear operators have threatened to shut down several Pennsylvania reactors because they are unable to compete in low-price electricity markets awash in cheap power from natural gas plants.

Exelon Generation says it will shut down Three Mile Island Unit 2, located next to the partly dismantled Unit 1, unless state lawmakers come to the rescue by June. TMI employs 675 people and produces more carbon-free power than all the state's solar, wind, and hydroelectric plants combined. First Energy Corp., which operates two reactors at the Beaver Valley Power Station in Western Pennsylvania, has also announced plans to retire the reactors in 2021.

While the industry is contracting, hope springs eternal among nuclear advocates, whose true believers are driven by the promise of harnessing the vast amount of energy locked in radioactive fuel.

LOCAL CONNECTIONS

Dozens of companies are working to develop new nuclear reactors, including so-called Generation IV reactors that are cooled with such materials as molten salts, inert gases, or even liquid metals.

Several companies have focused on developing SMR designs. Holtec International, a private company in Camden whose core business is managing spent fuel at nuclear reactors and decommissioning old reactors, has developed a 160-megawatt reactor design it calls the SMR-160. The project's status is unclear, and Holtec did not respond to written questions.

"I haven't seen evidence of it really advancing," said Lyman, of the Union of Concerned Scientists.

Westinghouse and BWX Technologies Inc., which both have long histories of building reactors, abandoned their SMR projects.

NuScale in September chose BWXT to build its SMR. BWXT, which built many of the small reactors used to power U.S. Navy ships and submarines, plans to subcontract component manufacturing to Precision Custom Components of York, Pa.

Mundy said by outsourcing the manufacturing to existing plants, NuScale can keep costs down compared with building a new factory. NuScale's majority owner is the giant contractor Fluor Corp.

Mundy says the NuScale design is not a smaller version of a larger reactor.

"We have features that are different, that you're not going to find in the competition, and we have very strong customer interest in our

technology," he said.

DISASTER-PROOF DESIGN

Each reactor vessel is surrounded by its own high-pressure steel containment, and immersed in an eight-million-gallon pool of water, so there is no need for a hardened containment building.

The 2011 Fukushima nuclear disaster in Japan was triggered when the six plants lost off-site power after an earthquake, and the on-site emergency generators that powered the plant's cooling water pumps failed because they had been inundated by a tsunami. The operators were unable to restore cooling water before four reactors melted down, spewing radioactive contamination over the countryside.

"Our technology doesn't require the need for offsite power," Mundy said. "In an event where the station loses all power, our reactors will automatically shut down, and they will self-cool for an indefinite period of time without the need to add any water, without the need to have the operators take any additional action, or for the need to restore AC or DC power."

Lyman said that he is worried that multiple modular reactors would fail in NuScale plant, but that the NRC will accept more risk because it is under pressure to not impede the licensing process.

"If everything works just right, the [reactor](#) will be safely cooled," he said. "There are a number of ways that picture could end up not so pretty."

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