The Day

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Millstone explores possibility of smaller-scale nuclear reactors

A Holtec associate uses a grinding tool on a HI-Storm overpack in the fabrication process in Camden, N.J. (April Saul)

By **Theresa Sullivan Barger, Special to The Day**

At Holtec International's manufacturing facility in Camden, N.J., welders work to seal stainless steel canisters that will be used by an overseas customer to ship spent nuclear fuel.

To ensure the canisters don't leak, they undergo a series of three tests, including digital radiology to essentially X-ray the welding job, a dye check to discover leaks and a helium leak test because helium will pick up minuscule holes that water or air wouldn't.

The seven-year-old manufacturing facility produces components for existing nuclear energy facilities and is the future site for manufacturing small modular nuclear reactors (SMRs).

SMRs are advanced nuclear reactors that have a power capacity of up to 300 megawatts per unit, which is about one-third of the power-generating capacity of traditional nuclear power reactors like the Millstone III unit in Waterford. Because they are modular, theoretically, systems and components can be built in a factory, transported and assembled relatively quickly on location.

Once the kinks are worked out, proponents say, they will be quicker and cheaper to get up and running than traditional nuclear reactors. But the first few SMRs in the United States have faced cost overruns and construction delays.

Last November, NuScale, the first nuclear company to receive approval for its SMR design from the Nuclear Regulatory Commission, terminated its project with the Utah Associated Municipal Power Systems after rising costs caused local utilities to back out of commitments to buy the energy.

This was after it received millions of dollars from the **U.S. Department of Energy**. So while industry leaders predict SMRs will provide a reliable, clean, financially efficient source of energy once they've reached scale, the costs will be higher in the beginning during the early, developmental stage.

SMRs at Millstone

Holtec has been working on its SMR design for a decade and plans to respond to a request for proposals from Dominion Energy, owner of Millstone Power Station in Waterford, Kelly Trice, president of Holtec International, said in an interview Sept. 23.

"The goal of our reactor is to be able to fit the entire plant on 25 acres," he said.

Holtec built its SMR design and manufacturing facility along the Delaware River, so the company can ship its SMRs via the river when the time comes.

Dominion may launch an SMR at its North Anna, Va., facility in the early to mid-2030s, if it makes business sense, said Tim Eberly, Dominion spokesman.

"We haven't committed to building an SMR down here. We're exploring it," he said. "We don't know if we're going to build. We need to learn a lot more."

Dominion expects to learn about SMRs through its review of the plans submitted in response to its request for proposals, he said.

If Millstone were to add an SMR to its 526-acre site, said Susan Adams, Dominion's state policy director for New England, it wouldn't be built for at least 15 years.

"We are hoping that information gathered through this process will remove some of the risks associated with this new technology and eventually lead to additional SMRs at other Dominion locations," Adams wrote in an email to The Day.

Millstone provides 47% of Connecticut's electricity and 90% of its carbon-free electricity.

Changing attitudes on nuclear power

Since 1979, Connecticut had banned adding new sources of nuclear energy until the U.S. government approved a means for the disposal of "high-level nuclear waste." But in 2022, a bill to allow new nuclear power construction at existing nuclear power generating facilities in the state — which is just Millstone — received bipartisan support to meet the state's plan to reach zero carbon emissions from power plants by 2040.

Gov. Ned Lamont signed House Bill 5202 in May 2022. While other countries move their spent nuclear energy to a storage location, all nuclear facilities in the United States store nuclear waste on-site.

Connecticut's legislators reflect the changing attitude toward nuclear energy among Americans and climate activists. Consider: The **Pew Research Center** reports 56% of U.S. adults support expanding nuclear power to generate electricity, according to a May survey. The previous year's survey was statistically similar.

Author, environmentalist and activist Bill McKibben, co-founder of the climate change movement 350.org, has said nuclear power is essential if the world is going to lessen its dependence on fossil fuels like coal, oil and natural gas.

Swedish climate activist Greta Thunberg argued Germany's decision to shut down its nuclear plants was a mistake because nuclear was preferable to coal. And James Hansen, a former NASA climate scientist and one of the first to warn about climate change, has been advocating for nuclear energy as an alternative to fossil fuels for years.

Several national and international environmental groups still object to nuclear energy. "The Sierra Club is opposed to new nuclear, including SMR," said Samantha Dynowski, state director of the Sierra Club's Connecticut chapter.

"In order to adjust to climate change, we need to lean 100% into renewables, like wind and solar with battery storage. … Nuclear is so costly. It's multiple times the cost of wind and solar to build," she said. "In the amount of time it would take to have new nuclear, we could cover the state with solar at a time when we're trying to eliminate emissions quickly."

No SMRs yet in U.S.

The **U.S. Department of Energy** (DOE) has been funding research into SMRs since 2000. There are no SMRs in operation in the United States. The first SMR began commercial operation in late 2019 at Russia's Akademik Lomonosov, according to the International Atomic Energy Agency. SMRs also operate in China and India.

While the largest SMR could produce 300 MW of energy, the two in Russia produce 35 MWs. There are SMRs in the licensing stage or under construction in Argentina, Canada, China, Russia, South Korea and the United States.

"More than **80 commercial SMR** designs being developed around the world target varied outputs and different applications, such as electricity, hybrid energy systems, heating, water desalinization and steam for industrial applications. Though SMRs have lower upfront capital cost per unit, their economic competitiveness is still to be proven in practice once they are deployed," according to the **International Atomic Energy Agency** (IAEA).

Some SMRs, especially those using coolants other than water, may generate new forms of radioactive waste, the IAEA reported. Therefore, countries planning to deploy SMRs must plan to manage these new types of waste.

Holtec, a privately held company with more than 200 patents, has been designing its SMR for the past decade with input from the NRC along the way.

“Our goal is to have a plant be able to start construction and be on the grid in 36 months,” Trice said. “Our first one will probably be slower. We design them all the same and manufacture them in a factory in a novel concept called an assembly line.”

Traditional, large nuclear plants take more than a decade to get up and running before they start generating income. The company plans to have its first SMR approved, assembled and operational by 2030 at the site of a nuclear power plant in Palisades, Mich.

The customers who buy the SMRs will prepare the site and lay the concrete and the SMR will be shipped in pieces “to the field with as little work on-site as possible. Even the walls of the structure would come from the factory,” Thrice said.

The modular method of construction will keep building costs down in order to keep the cost for power output lower than with traditional, full-size reactors, said proponents such as Katie Austgen, project manager for new nuclear with the Nuclear Energy Institute.

“Advanced nuclear reactors are small enough that they can be part of integrated energy systems, for example, where their waste heat can be used to meet local heating requirements,” she said.

SMRs have had a rocky start in the U.S. In NuScale’s case, the company initially estimated that it would charge $58 per megawatt, but when it raised its target price to $89 per megawatt, the community-owned utility companies in the western U.S. decided against subscribing to purchase energy.

And yet, a **Bank of America Global Research** report from May 2023 concluded that when analyzing the life of nuclear power stations and their outputs, “industry research suggests that, after accounting for efficiency, storage needs, the cost of transmission, and other costs, nuclear power plants are one of the least expensive sources of energy.”

Safety measures

SMRs are intended to be simpler so that fewer people are needed to operate them, Trice said. SMR manufacturers have studied what went wrong with the world’s three major nuclear accidents to learn from them, Austgen said.

“The goal is a 100% passive safety system. No human operator has to do anything in the event of an accident for the plant to be able to make itself safe. If that’s the case, you would be able to operate with far fewer people,” Thrice said.

The system would rely on natural properties such as gravity so there would be no need for human intervention, he said.

“For instance, the main plant loop is a closed water cycle, and it’s designed for natural circulation, which means when the reactor shuts down, it can shut itself down. It still gives off heat, and that heat needs to be discharged, and so essentially what would happen is the water would circulate between the steam generator and the reactor in perpetuity until the plant no longer gave off sufficient heat to matter,” he said.

One of the selling features of SMRs is that they do not need to be located next to a body of water to supply water for cooling the reactor. They could be placed in the middle of the desert, Trice said. Holtec is designing its SMR to be either air-cooled, water-cooled or a combination of both.

“In our case, what we’re proposing, the cooling tower sucks water in and discharges water out. Our thesis is you can use air cooling. Water inside the plant gets hot when it’s in the reactor; it turns the turbine and makes steam. After the steam is done, it’s still got some hot residue that has to be dealt with. You can ‘reject’ that heat to the air,” he said. ‘Rejecting’ is the term used for getting rid of heat.

It works like a convection oven, with fans pushing air through the pipes to cool them, he said. It’s like what happens to the water when someone takes a shower. The water comes out of the faucet warm and cools as it hits the body, and as the water cools, it gives off steam, he said.

Nuclear industry leaders are well aware of public concern about safety, given the accidents at Three Mile Island in Pennsylvania in 1979, at Chernobyl in Ukraine in 1986 and at Fukushima in Japan in 2011.

Despite public perception, nuclear energy is safer than coal, oil, natural gas, wind and solar when comparing deaths from energy-related accidents per unit of electricity, according to the **World Nuclear Association**. **Our World in Data**, a project of the nonprofit Global Change Data Lab, **reports** that when factoring deaths from accidents and air pollution, solar is the only form of energy safer than nuclear, per terawatt hour of electricity production.

Holtec, like others designing SMRs, is “designing a plant that doesn’t need an offsite response beyond the plant boundary. So essentially the plant is on about 25 acres or so,” he said. “Today if you were to look at nuclear plants, they have emergency exclusion zones, which means if there’s some sort of safety incident in the plant, the towns have to shelter and have drills and things like that. In our case, we’re designing a plant where that won’t be necessary. So, in theory, you could put it into the center of a population and be just fine because the accident scenarios postulated would not create a safety problem” for the nearby community.

The bottom line

The state Department of Energy and Environmental Protection (DEEP) studied SMRs and advanced nuclear reactors and, in a **report** released in April, it concluded that cost remains the single largest barrier to deployment of SMRs in New England.

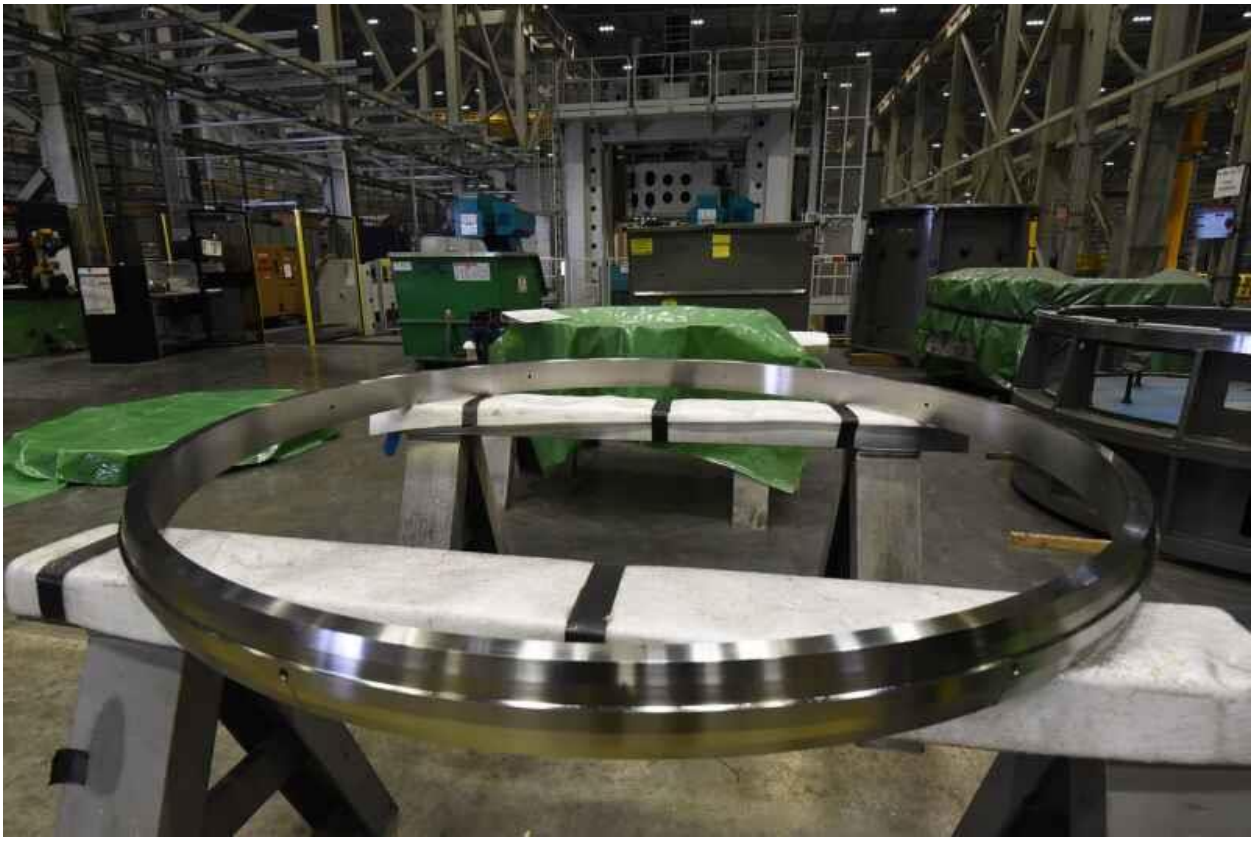
“Cost risk poses a particularly high barrier to deployment for first-of-a-kind and subsequent early projects in a deregulated regional electric market like Connecticut and New England. State policy tools to mitigate and equitably distribute this risk are more limited in such markets. Studies from the federal DOE and others suggest that advanced nuclear technologies may become cost-competitive in the future. However, this cost competitiveness has not yet been demonstrated and is unlikely to be realized until these technologies move beyond initial projects and are deployed at scale,” the report said.

The authors wrote, “Advanced reactors and their associated fuel cycles can reduce carbon emissions, improve economic competitiveness, reduce environmental impacts, and enhance nuclear safety and proliferation resistance.” They have the potential to help meet decarbonization mandates and, because they operate 24/7/365, they can help meet winter reliability needs, the report continued.

DEEP officials are staying abreast of SMRs’ progress.

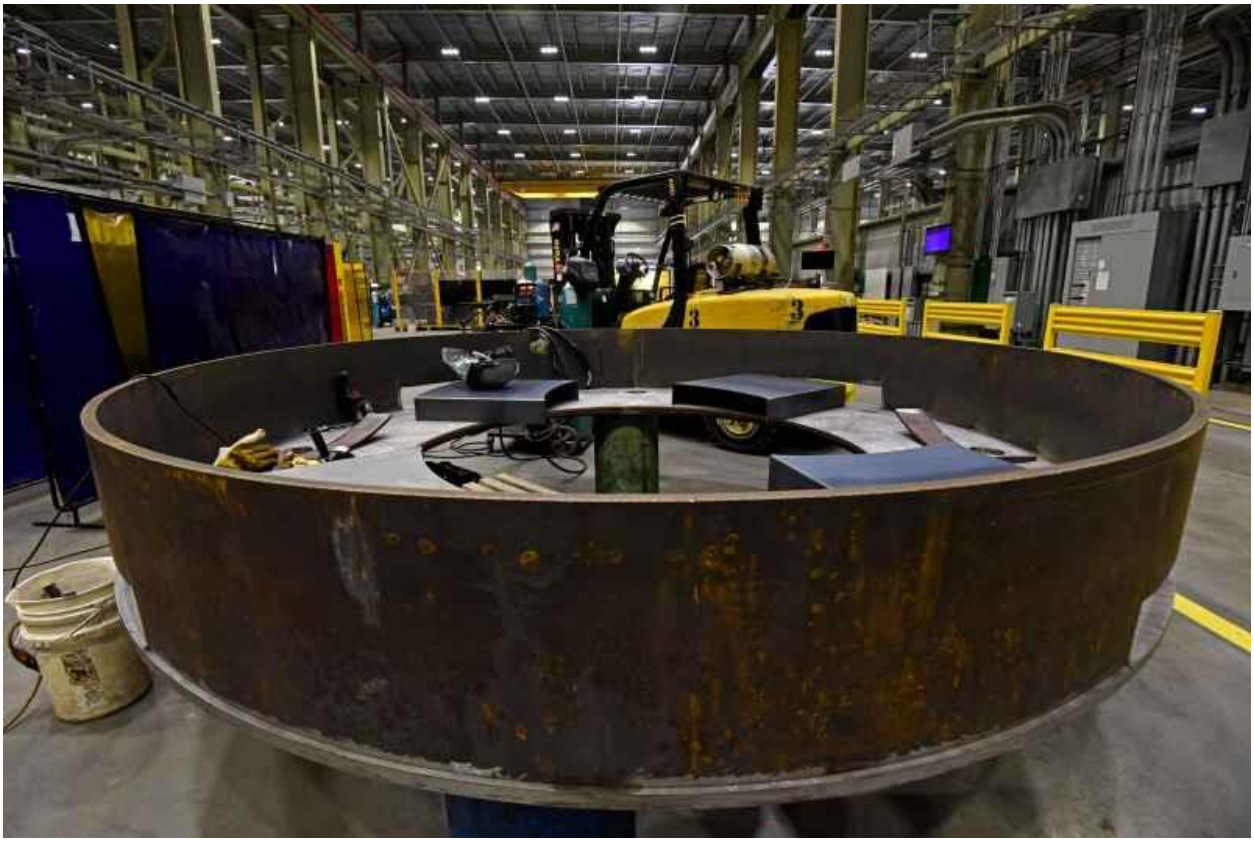
"Connecticut is always looking at diverse energy options to meet our climate and energy goals,” said DEEP Commissioner Katie Dykes. “Small modular reactor technology continues to make progress. DEEP

is monitoring deployments in other regions, and exploring local feasibility studies and investment strategies that can help make SMRs an option for New England in the future."



A stainless-steel ring in fabrication process at Holtec in Camden, N.J. (April Saul)

A transport cask in a milling machine at Holtec in Camden, N.J. (April Saul)



The lower section of a HI-storm overpack in the early fabrication and welding process at Holtec in Camden, N.J. (April Saul)

Multi-purpose canister internal spacers at Holtec in Camden, N.J. (April Saul)

A Holtec associate welding the interior of a HI-Storm overpack dry fuel storage system at Holtec in Camden, N.J. (April Saul)

A wall of patents held by Holtec and CEO Dr. Kris Singh at the Camden Technology Campus. (April Saul)

Holtec president Kelly Trice with a nuclear fuel bundle model at Holtec in Camden, N.J. (April Saul)

A Holtec associate maneuvering a man-lift inside the Advanced Manufacturing factory in Camden, N.J. (April Saul)

HI-Storm overpack systems in the fabrication process stored at the Holtec factory in Camden, N.J. (April Saul)

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