The NuScale SMR: Now Nuclear Goes 'Off the Grid'

Small modular reactors, or SMRs, have a lot of obvious strengths. They can be factory-assembled, cutting costs and construction time and improving quality. And they can be added to the grid in increments as needed.

But NuScale Power's design has an additional characteristic that deserves attention, and will allow it to fill new roles: uniquely among power reactors, it does not have to be on a grid. Nuclear reactors in service today add stability to the grid, but this new model will go a step beyond that. These reactors would be among the first generators to re-start in an emergency, and could sustain critical loads for extended periods if the recovery time were drawn out.

The ability to operate without outside electricity is important because nuclear reactors now in service must shut down if the power on the surrounding power grid is lost, and they cannot start up again until the grid is running. But special features in the design of NuScale Power's SMR will let it continue operating smoothly even if an outside event like a storm, an earthquake or human error takes transmission lines out of service. And if a NuScale plant comprising several SMRs does shut down, it can start up independently of the grid and take the lead in helping to re-establish normal grid operations.

Many plants running on natural gas can start up independently, but these operate mostly with a "just-in-time" fuel delivery system, and weather or other events can disrupt fuel supplies. Some natural gas units have oil backup, but not for very long.

Generators running on solar and wind can run without fuel supplies, of course. Wind and solar advocates talk about going off the grid with those resources, although hardly any do, because those sources are intermittent and

batteries are expensive. But small modular reactors can change their output to meet varying levels of demand. And in normal operation on the grid, this capability will help them mesh well with intermittent renewables.

In addition, a NuScale plant is less likely to shut down in the first place, because many of the components of a conventional reactor that could malfunction and cause a “trip,” or automatic shutdown, do not exist in the NuScale design. Nearly three quarters of the trips that occur in existing reactors simply could not happen in a NuScale plant, the company says.

Current reactors don’t shut down for unscheduled reasons very often, less than once a year per plant, on average. But conventional nuclear reactors use outside power to run certain critical pumps and valves, so that those components can be available to the plant operators even if the plant trips. One consequence is that those plants must shut if there is a wide-scale regional blackout.

But NuScale reactors are designed to operate safely without any emergency-grade electricity, so they do not require power from outside the plant. Even if the load they serve suddenly disappeared, because, for example, a transmission line failed, the NuScale reactor could keep running, because the reactor, producing a rock-steady flow of steam, can disconnect itself from its turbine-generator, which in normal operation takes the steam and converts it to mechanical energy and then to electricity. The reactor simply routes the steam into a different part of the plant, to be turned back into water for another trip to the reactor.

These are important advances that will give the NuScale reactors a special sort of versatility and flexibility never seen before in power reactors. Since the NuScale reactors are ordinarily refueled only once a year, and since the typical NuScale plant will be a cluster of 12 small reactors, if a catastrophic event knocked out the grid for an extended period, the NuScale plant could run a micro-grid and provide power to first responders following a natural disaster, or provide critical community services, or power a military base that

must maintain operations for national security, for several years without outside support.

NuScale plans to deploy a commercial-scale plant at the Idaho National Laboratory by 2026. Part of the project will be a demonstration of the technology, and the Department of Energy says it would like to show how a NuScale reactor could run a microgrid. Conventional nuclear plants contribute to national security by keeping the grid as a whole resilient and strong; small modular reactors can maintain operations of critical functions even if the broader grid goes down.