Clean, Reliable Energy in Small Packages: Micro- and Small Modular Reactors

Advanced nuclear technologies offer new options for generating reliable, carbon-free heat and electricity. Advanced reactors can provide operational flexibility in response to grid demands, and they're designed with next-generation materials, fuels and systems to enhance safety and performance.

Advanced nuclear reactors come in a variety of sizes. While some advanced reactors are designed for conventional larger-scale systems that meet centralized energy needs, other smaller-scale reactors offer more options for deployment.

Smaller-scale reactors

Small-scale reactor options under development range in size from a few megawatts (i.e., microreactors) to a few hundred megawatts (i.e., small modular reactors) to support distributed energy demands.

These technologies open the door for nuclear energy to power a wide range of applications — from providing electricity and heat to remote towns or small grids, to managing fluctuating electricity and heat demand for a large city, to supplying energy for disaster relief.

Many microreactors and small modular reactors would work seamlessly with energy storage and variable renewable energy sources such as wind and solar, making them ideal for small or isolated grids.

High temperature heat

Size isn't the only way these reactors are flexible. Many advanced reactors use advanced technologies including coolants such as liquid metal, molten salt or gas. They would operate at between about 500 C and 900 C—hot enough to power a wide range of industrial applications such as water purification, hydrogen production and steel manufacturing, as well as everyday applications like residential heat.

When demand for electricity is low, or when ample electricity is available from renewables, those reactors could divert excess energy to industry in the form of heat, steam or electricity. By including energy storage, both grid and heat demands can be met at all times.

Simplicity is the key

Most micro- and small modular reactor designs include automatic safety features that rely on the laws of physics instead of electrical pumps and valves. That means the reactors automatically shut down in case of an emergency, and many allow restart without off-site power.

Because these designs are small and incorporate advanced safety features, they require fewer on-site safety measures and substantially reduce expensive building materials such as concrete.

Further, many micro- and small modular reactor designs rely on fuels and materials that essentially eliminate the possibility of a meltdown. Some also use core designs that provide an additional layer of security against external threats.

The simple and secure nature of these designs makes them suitable for deployment to nations with less developed infrastructure or nuclear energy experience. Further, their relatively low capital and operating costs make

Microreactors could supply energy to remote towns

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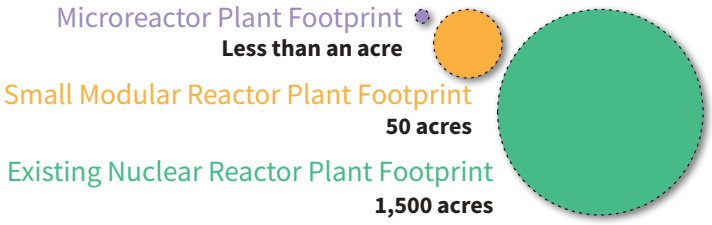
them a good option for smaller utilities and companies looking for a long-term source of clean energy that might not otherwise secure financing for a nuclear project.



MICROREACTORS

Microreactors are well suited for small applications away from the centralized electric grid — remote communities, disaster relief, military bases and mining operations, to name a few.

Most microreactors would be built in a factory — assembly line style — which simplifies quality control processes and reduces costs. These plants would require minimal site preparation and are small enough to be shipped in cargo containers to most locations around the globe.

When they arrive, these microreactors could be located on less than an acre of land, operated closer to populated areas than typical large plants, and could plug into the existing power grid with very few infrastructure upgrades. Most designs are flexible enough to provide electricity for an isolated microgrid and high temperature heat for industry.

These units would then operate for 10 or more years with minimal maintenance needs and fewer onsite staff relative to large-scale systems. At the end of their fuel life, most microreactor developers would simply replace the entire reactor, eliminating the need for onsite refueling or used fuel storage.

Microreactor Stats

Power output: up to 20 megawatts electric
Footprint: potentially less than an acre
Availability: mid- to late 2020s
Temperature range: 500 C to more than 900 C, depending on the reactor type
Applications: energy to remote communities, disaster relief, military bases and mining operations

SMALL MODULAR REACTORS

Like microreactors, small modular reactors (SMRs) would be mostly built in a factory and shipped to the site for assembly.

SMR plants could include one or many reactor modules to meet energy demand, and modules can be added as needed. For example, a 750-megawatt plant might be powered by 10 75-megawatt modules built over several years.

Further, SMR power plants could be configured to accommodate additional modules as energy needs of the community grow. The modular approach could also allow for some modules to be fully dedicated to electricity production, while others might support heat demands full time.

Ready for commercialization

While many SMRs adopt high-temperature reactor technologies, others build on decades of experience using light water for cooling. Water-cooled SMRs introduce advanced operational approaches to support modern electric grids and advanced safety features such as passive cooling to keep the reactor cool without pumps during normal or accident conditions. These water-cooled designs offer many of the same benefits as their higher temperature counterparts, including the potential to support industrial processes that operate at lower temperatures or incorporating heat augmentation approaches to support higher temperature applications, while potentially offering a faster path to commercialization.

Small Modular Reactor Stats

Power output: 20 to 300 megawatts electric
Footprint: about 50 acres
Availability: mid- to late 2020s
Temperature range: 300 C to more than 900 C, depending on the reactor type
Applications: base load, demand response and industrial electricity; industrial processes such as hydrogen production, crop drying and water purification; district heating

For more information, see *Advanced Nuclear Reactors—A Valuable Energy Resource*.

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