Advanced Nuclear Reactors— A Valuable Clean Energy Resource

Nuclear energy provides nearly one-third of low-carbon electricity and about 10% of all electricity globally. As the world seeks to reduce its carbon emissions, embracing a variety of energy technologies is a necessary path forward. For many countries, nuclear energy plays important roles both now and in the future. Like current nuclear power plants, future plants will continue generating emissions-free electricity with 24/7 reliability, providing the opportunity for these plants to be the mainstay of the clean electricity fleet.

Advanced reactors offer new economic and operational models, including new applications. The next generation of reactors will encompass a variety of technologies that are flexible enough to support the unique energy needs of different communities.

Advanced reactors come in all shapes and sizes. They will use a variety of coolants to move heat from the reactor core to where it will be used. Many of these reactors automatically turn off if problems occur, maintain cooling via natural phenomena even without any access to power, restart without offsite power, or use different types of high performance fuels. Advanced reactors include large systems (producing more than 300 megawatts [MW] of electricity per unit), small (10 to 300 MW), and even microreactors (on the order of a few MW per unit). Small and micro systems can be transported and installed to suit the particular needs of a specific community or work site.

Benefits of Advanced Reactors

Advanced reactors will offer several important advantages as sources of carbon-free energy:

- Advanced reactors include multiple automatic safety features that prevent accidents from occurring—without the need for human intervention or offsite power.
- By operating flexibly, and being available 24/7, advanced reactors can work in conjunction with renewables such as wind and solar that vary in energy production.
- Some reactors will be fabricated in factories and shipped to a site for rapid assembly, reducing construction costs.

Advanced reactors could one day power facilities such as large data centers. Image courtesy of Third Way/Gensler.

For more information
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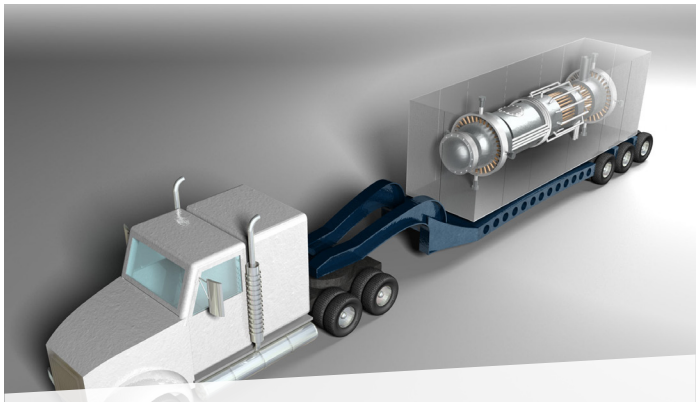

Microreactors could be small enough to be transported to remote sites by truck.

- Some designs will use coolants such as gas, liquid salts, or liquid metal, allowing them to operate at higher temperatures to increase efficiency.
- Some designs will use advanced fuels that provide more power and withstand a greater range of operating conditions.

The flexibility of advanced reactor designs means they are well suited to different energy markets, where they can work with other energy resources to meet a variety of energy demands.

Additional Energy Products

In emerging and rapidly changing energy markets, the most effective use of nuclear energy may be as a source of heat rather than electricity. Advanced reactors will have the flexibility to divert their energy output to other industries once grid demand is met. For example, these reactors can produce hydrogen, which is used in a wide array of industrial processes. They can also provide heat to industries that today rely on fossil fuels to manufacture things like steel or petrochemical products. Advanced reactors could even support decarbonization of transportation by providing electrcity to commercial electric vehicle charging stations, producing cleaner synthetic fuels for planes and ships, or providing direct propulsion for cargo ships.

Remote Locations

In remote communities that rely on fossil fuel for electricity, fuel transportation costs mean high prices for consumers, and fuel supplies can be vulnerable to disruption. In these areas, advanced nuclear power plants may provide reliable electricity at a lowest cost.

Humanitarian Needs

Earthquakes, floods, hurricanes, or tsunamis can affect electricity grids and fossil fuel supplies. Microreactors, along with other technologies such as batteries and renewables, are being designed to work in tandem as islanded microgrids. These power systems can be transported to hospitals, shelters, or city blocks to provide electricity and security where it is most needed in a disaster. These systems could even restore clean water supplies through coupled desalination units.

No one knows the future, but by planning and designing for possible scenarios, advanced reactors coupled to other energy sources can allow critical services to operate during low-probability but devastating natural weather events.

INL's Thermal Energy Distribution System is helping researchers develop the technology to more efficiently use the energy produced by advanced reactors

ADVANCED NUCLEAR AT A GLANCE

Power generation
From a few to hundreds of megawatts, depending on reactor type and community need

Fuel
Advanced, accident-tolerant fuel such as TRISO, recycled fuel and other options under development

Availability
The first commercial advanced reactors are expected to be operational by 2030