

ADVANCED NUCLEAR ENERGY

Frequently Asked Questions for Community Stakeholders

TABLE OF CONTENTS

- 1. [What is nuclear energy’s role in the future of electricity?](#)3
- 2. [What are the benefits of nuclear energy?](#)3
- 3. [What is an advanced nuclear reactor? Are there different types of reactors?](#)3
- 4. [How does nuclear work with other sources of energy like wind, solar, geothermal and hydropower?](#)4
- 5. [Is it safe to live near an advanced nuclear plant?](#).....5
- 6. [Will these plants generate nuclear waste? What is done with it?](#)6
- 7. [Are advanced nuclear plants expensive?](#)7
- 8. [How does the nuclear industry manage uncertainty associated with construction of new nuclear plants?](#)7
- 9. [When will advanced nuclear be ready?](#)8
- 10. [What can I do if I’m interested in advanced nuclear energy in my community?](#)9
- 11. [What policies would help my community host an advanced nuclear plant?](#)9
- 12. [Where can I find more information?](#)10



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1. What is nuclear energy's role in the future of electricity?

Across the U.S. and the world, there is a growing need for electricity, and many parts of daily life are transitioning to be powered by electricity. In the coming years, home heating and cooling, cooking stoves, our personal vehicles, and commercial vehicles, to name a few, will increasingly be powered by electricity. The U.S. Energy Information Administration predicts that worldwide demand for electricity will grow by 50% by 2050. Other forecasts project global electricity demand could double by that date.

While we expect a growing need for electricity, we are also seeking to find sources of electricity that protect the environment and do not emit pollution. As this energy transition takes place, interested groups like communities, utilities and governments are seeking sources of electricity that will provide abundant energy and keep our air clean.

Nuclear energy is one option for communities that want to add new electricity production or replace a plant that is retiring. Nuclear energy is the largest carbon-free energy source that is available 24/7/365. If you're looking for carbon-free, reliable electricity, nuclear energy may be a good solution.

2. What are the benefits of nuclear energy?

Nuclear energy facilities are emissions-free. They do not release pollution into the air, which keeps our climate and environment clean. Governments and scientists agree that we need to speed up the deployment of carbon-free power to address challenges with our climate, so building a nuclear facility can help your local environment and make a difference on a worldwide scale.

Nuclear facilities produce reliable electricity around the clock, regardless of the weather. They use uranium fuel and are able to store many months of fuel on site within the reactor, so they have everything they need to provide power over a long stretch of time. This means your community [will have energy when it is needed](#).

Nuclear facilities help the economy in the surrounding area. They create hundreds of well-paying, long-term jobs, both working at the facility and by supporting community businesses. The nuclear facilities also pay local and state taxes based on their financial activity, which helps support education and public services in the community. Many nuclear facilities are the largest taxpayer in their locality. Nuclear facilities operate for many decades, making them a reliable source of jobs and tax revenue.

Nuclear reactors only require a [small amount of land](#) to generate large amounts of power. In addition, the companies that own nuclear facilities take good care of the surrounding land, maintaining green space which is often home to wildlife.

While clean air, reliable electricity and a thriving economy are some of the main benefits of nuclear energy, there are [many other advantages](#) that may help your community.

3. What is an advanced nuclear reactor? Are there different types of reactors?

Advanced nuclear reactors are a new class of nuclear energy, a technology that has been around since the 1950s. Advanced nuclear reactors are being designed to meet the growing need for small and mid-size energy facilities that offer more opportunities for flexibility and

versatility. With [dozens of advanced nuclear designs being developed](#), the nuclear industry is creating a portfolio of nuclear reactors that will be able to meet a diverse set of market and customer needs. Nuclear energy may be used by smaller electric cooperatives and municipal utilities or by traditional large utilities, and even for hydrogen and process heat applications.

Advanced nuclear energy is an overarching term for these newer designs, which fit into several categories:

- Small modular reactors, or SMRs, are nuclear plants that typically produce up to 300 megawatts of electric power per reactor, or module. Modules can be combined to produce more energy, which allows communities and utilities to customize the plants for the amount of energy they need. The plants are mostly built in a factory and finished at their final location.
- Micro-reactors typically produce less than 50 megawatts of electric power. They are capable of operating independently from the electric grid, so do not need to be connected to long-distance power lines. Therefore, they are well-suited to serve the energy needs for locations that currently do not have access to clean, reliable, resilient and affordable energy. Micro-reactors can be thought of as replacements for diesel generators and are best suited for remote applications, such as arctic communities, islands, mines, defense installations and microgrids.

While traditional reactors use water as a coolant, some advanced nuclear designs use different materials, such as molten salt or gas, as coolants. These non-water-cooled designs are able to achieve higher temperatures, important for some heat applications. The Nuclear Innovation Alliance offers a [detailed guide](#) to different types of nuclear reactors.

4. How does nuclear work with other sources of energy like wind, solar, geothermal and hydropower?

All carbon-free sources of electricity have an important role to play in meeting our future need for power and addressing a changing climate. [Nuclear energy complements other carbon-free sources](#) like wind and solar. We will need a balanced mix of all technologies to reach a future where we have plentiful electricity and clean air. And a wide variety of studies, from academia, think-tanks and electric system operators, have found that having a diverse variety of electricity sources available is the best way to keep our grid strong and to keep costs low for consumers. Wind and solar produce electricity while the wind blows and the sun shines, and nuclear ensures there is a firm source of electricity that is available all the time.

Some new nuclear plants are designed specifically with wind and solar in mind. These plants can scale their output up and down based on the variable production from wind and solar, which helps balance the electric grid and ensures communities have power when it is needed.



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5. Is it safe to live near an advanced nuclear plant?

When people think of safety in relation to nuclear plants, questions most often arise around radiation, so it is helpful to understand the process that produces radiation. Advanced nuclear plants are powered by uranium fuel that undergoes a reaction, called fission, which produces heat. The heat is used to turn water into steam, which turns a turbine. Radiation also results from the reaction. Advanced nuclear plants are designed to seal off radiation from the outside world using barriers that radiation cannot travel through. Each nuclear plant is protected by multiple backup safety systems.

The industry takes [accidents](#) that happened at Three Mile Island, Chernobyl and Fukushima very seriously. This is why nuclear plant workers monitor radiation with extremely sensitive tools that can detect problems before they occur.

Advanced nuclear designers have built on the lessons learned from these incidents and have incorporated innovations to further enhance the safety of advanced nuclear energy. Advanced reactors incorporate a multitude of factors, from their location below ground to the use of natural physics that reduce the reliance on pumps and valves. In fact, most advanced reactor designs are able to maintain a safe configuration without the need for operator actions, power or water, which have been factors in previous incidents. Of course, plants will always be staffed by operators who are trained to respond in the case of an emergency.

If your community decides to host a nuclear reactor, there will be discussions and studies involving community members, technology developers and government regulators to discuss the safety features specific to the design being considered. For every design, the plant will be protected by multiple safety features and your community will be involved in establishing the appropriate emergency planning so that community members know what to do in the very unlikely case of an accident.

6. Will these plants generate nuclear waste? What is done with it?

When considering the management of waste from any technology, there are three things that must be in place: 1) the ability to manage it safely, 2) the ability to pay for it, and 3) a place to put it.

The uranium fuel that powers nuclear plants eventually gives off enough energy that it is removed from the plant and stored – this is also called nuclear waste, used fuel or spent fuel. Used fuel is a solid material, and because uranium contains a lot of energy in a small package, the volume of spent fuel is very small – the spent fuel from seventy years of nuclear energy in the U.S. would fill a football field to a height of ten yards.

Used fuel has been stored safely at nuclear plants for decades. When it is removed from the reactor, the spent fuel initially goes into an isolated, sealed pool of water to cool down and is then moved to steel and concrete containers for longer-term storage. While there may be some differences in the materials and shapes of advanced reactor used fuel, this same technology can be used to store it safely, fortified against extreme events like earthquakes, fires and hurricanes.

Advanced nuclear plants will set aside funding for the management of used fuel, and decommissioning, starting on day one of operations. In fact, the government ensures that the funding that is set aside during operations will be sufficient to pay for the management of used fuel and decommissioning. In terms of funding the final disposal of used fuel from all of the nation's nuclear plants, there is a government trust fund with over \$40 billion to pay for the disposal of nuclear waste.

There is a location designated by law for the final disposal of used fuel, and the Yucca Mountain site has been studied to ensure it can keep used fuel safe for thousands of years. It is in the hands of the Nuclear Regulatory Commission to independently verify the location. Discussions continue at the federal level on whether Yucca Mountain should be the site for final disposal or whether another site should be pursued through a consent-based siting process, so it is unclear when the Department of Energy, which has contractual obligations to dispose of the nation's commercial used fuel, will begin removing used fuel from nuclear plants. In the meantime, there are efforts underway in the private sector to establish consolidated storage sites, and the technology has been proven to provide safe long-term storage until a repository is available. Other countries have made further progress in designating a disposal location for their used fuel. Finland will build the first permanent disposal site for used fuel after conducting a siting and licensing process. The facility, which will utilize multiple barriers to seal in the fuel, is slated to begin operations in 2024. Canada is also conducting a siting process for its used fuel disposal facility and is currently considering two host communities, selected from 22 communities that indicated interest in hosting the facility.

Some advanced reactor designs are even looking into the potential to utilize used fuel or recycled fuel as a means to produce an even smaller amount of used fuel, as is currently done in nations such as France. But no matter what path forward we take for management of spent nuclear fuel in the U.S., the technology and the know-how exist to continue managing this material safely for the long-term.

7. Are advanced nuclear plants expensive?

Typically, when considering which type of technology to build for new electricity generation, costs for each option are compared against each other, and the lowest cost is chosen. As with other novel technologies, the first advanced nuclear plants will initially have a higher cost than alternatives. However, a wide range of recent studies have shown that a diverse portfolio of generating technologies, which includes nuclear energy, results in the lowest costs of energy.

To understand this, we can begin by comparing generation costs. Generation cost is typically measured in dollars per megawatt hour, averaging the total cost of a plant over all the electricity sent out from a nuclear plant over its lifetime. Though nuclear plants require a large initial investment to build, their operating costs are predictable and relatively low, and they can operate for 80 years or longer. Since nuclear plants can generate electricity 24 hours a day, 7 days a week, for many decades, this cost is on par with other sources of electricity that may require a smaller initial investment but cost more to operate or have shorter lifetimes.

A [report](#) by SMR Start concluded that after initial SMRs are built, costs should be between \$44.3/MWh and \$65.1/MWh, compared to estimated costs of wind and solar between \$33.5/MWh and \$51.7/MWh. While wind and solar are generally less than advanced nuclear, the costs are competitive. When we consider attributes of a generation source, like reliability, the costs look very different. The same SMR Start report found that when reliable and dispatchable energy is required, the costs for SMRs are \$71.57/MWh to \$79.73/MWh, and the costs of wind and solar range from \$87.8/MWh to \$274.2/MWh. Therefore, the determination of the lowest cost generation source is very situation specific. The key takeaway is that we need all clean energy options to achieve a reliable and affordable energy supply.

Aside from electricity, nuclear energy also provides a lot of additional value to our electricity system – it is carbon-free, runs 24/7 and improves life in the communities where it is located. Having nuclear energy in the U.S. helps us remain the innovative, inventive society that has made us a world leader, and having a reliable source of energy also contributes to our national security.

8. How does the nuclear industry manage uncertainty associated with construction of new nuclear plants?

Some have expressed concerns that advanced nuclear technology is unproven and risky. As with all technologies, the first-of-a-kind is typically more expensive than the lowest-cost alternative in the market. For example, electricity sold from a wind farm built in 2010 cost more than 3 times what electricity costs from a wind farm constructed today. As more and more of the technology is built, the costs come down. Thus, the government has traditionally invested in the deployment of new technologies by covering these unique first-of-a-kind costs.

Currently, the U.S. government is supporting innovation by investing in the first-time construction of several nuclear plants. The federal government has established tools such as cost-share programs, production tax credits and loan guarantees, similar to those that helped wind and solar when they were first introduced. These government investments cover the upfront costs to make first-of-a-kind advanced nuclear plants competitive. State governments are also establishing or considering the implementation of policies, ranging from feasibility studies to tax incentives, that would support advanced nuclear plants.

While there have been nuclear plants that exceeded initial budget and schedule estimates, there have also been nuclear reactors built on-time and on-budget. The nuclear industry is serious about building advanced reactors on-time and on-budget and is actively working on understanding and implementing the lessons learned and best practices from previous projects. As more advanced nuclear reactors are built, the learnings will be used to make future plants less expensive – you can think of this like the latest TV technology that is pricy when it is first released, but gets cheaper over time as more TVs are produced.

The costs and financial risks of any new generation project is a case-by-case consideration. If a utility proposes to build an advanced nuclear plant, it will go through reviews to ensure that such investment risk is appropriate. For example, regulated utilities will need to get approval from their Utility Commission and municipal utilities will need to get approval from their elected officials.



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9. When will advanced nuclear be ready?

The first advanced nuclear plants in North America are expected to begin operations before 2030, although there are some advanced reactors already operating in other parts of the world. Across the country and the world, many communities are integrating advanced nuclear energy into their energy planning. In fact, there are over 20 advanced nuclear plants being planned or considered to build domestically, with most having target dates for operations in 2032 or sooner.

Of these plans for advanced nuclear plants, the following are leading the way toward first commercial operations by 2030:

- The UAMPS Carbon Free Power Project in Idaho will provide power to dozens of cities across the Intermountain West, predominantly in Utah. This project will use six NuScale VOYGR SMRs. Though the planned reactors are not directly replacing another plant, they will make up for the electricity lost when coal plants retire in the late 2020s. The project will serve increased customer demand and provide a carbon-free energy.

- The Department of Energy's [Advanced Reactor Demonstration Program](#) is enabling two new projects to be built:
 - Terrapower will build its sodium-cooled Natrium reactor in Kemmerer, Wyoming in partnership with PacifiCorp. It will directly replace a retiring coal plant. There were a number of communities in Wyoming that hoped to host this plant because it will provide benefits – cleaning up the air and supporting good jobs that would have been lost when the coal plant closed.
 - As part of the TRi Energy Partnership, an X-Energy Xe-100 reactor will be built in South Central Washington. The carbon-free power from the reactor will help Washington state meet its goal of 100% carbon-free electricity. It will help serve increasing demand for electricity in the region.
- GE Hitachi will build its BWR X-300 at Darlington Ontario, Canada, owned by Ontario Power Generation (OPG). This will help OPG achieve net-zero emissions by 2040.
- Tennessee Valley Authority has announced that it is establishing a New Nuclear Program to examine advanced reactor technologies for its Clinch River Site near Knoxville, Tennessee.
- There are also several micro-reactor plants moving forward:
 - Oklo will build its Aurora 1.5 MWe plant, a micro-reactor, at Idaho National Laboratory.
 - Ultra Safe Nuclear Corporation is working with Global First Power to build its first plant at Chalk River and working with the University of Illinois to build a second plant.
 - The U.S. Department of Defense is also working on two separate projects for micro-reactors which could power remote bases. The first is on a mobile micro-reactor demonstration of either the X-energy or BWXT design. The second is plans for a micro-reactor at Eielson Air Force Base near Fairbanks, Alaska.

10. What can I do if I'm interested in advanced nuclear energy in my community?

If a community would like a nuclear power plant, discussions will occur between community members, local, regional and state governments, the utility and reactor developers to determine what reactor technology is the best fit for the location, geography, power grid and electricity needs of the area. You can work with your local and state government officials to encourage them to support nuclear energy – some specific policies are highlighted below. You can also sign up for [Nuclear Matters](#), a grassroots advocacy group, to be notified of relevant nuclear policy issues in your area.

SMR Start has also published a guide for considering advanced reactors in [Integrated Resource Planning](#).

11. What policies would help my community host an advanced nuclear plant?

There are several energy and nuclear related policies that are gaining momentum as our energy transition progresses. Many cities and states have pledged or enacted legislation committing them to obtain 100% emission-free electricity by a set date. When these mandates or goals were initially introduced, some localities envisioned that they would rely totally on renewable energy like wind and solar, but many of these standards are now being updated to allow for all carbon-free sources of electricity, including nuclear energy.

In addition, some states have restrictions on new nuclear facilities. These conditions around new construction vary by state, with some states requiring demonstrable technology or means for high-level waste disposal, while other states require approval by the state legislature or voters before new construction can occur. Now that there is a high demand for carbon-free energy, and nuclear waste is well-managed, a number of states have repealed or revised their bans. Just this year, states like West Virginia and Connecticut have revisited their nuclear bans.

Many states are also adopting legislation that will allow them to more closely explore advanced nuclear energy by creating commissions and task forces that bring together diverse stakeholders (including government officials, academia, industry and others) to explore policy options and ways to support advanced reactor technologies. In addition, states are requiring new feasibility studies that examine the economic impact of nuclear; potential job creation and workforce transition; streamlining the siting and permitting of advanced reactors, and cost savings for electricity customers, among other topics. These commissions and studies can serve as useful tools for local communities exploring the benefits of hosting an advanced reactor.

For more information, SMR Start has published [options](#) for state policies to support advanced reactors or read NEI's summary of state [legislation and regulations supporting nuclear energy](#), which covers many of these policy ideas. The Nuclear Innovation Alliance has also published a briefing paper, [Advanced Reactors for State Policymakers](#).

12. Where can I find more information?

- [U.S. Energy Information Administration: Nuclear Explained](#)
- [Nuclear Energy Institute: Advanced Nuclear](#)
- [Advancing Nuclear Technologies: Explainer from Dr. Everett Redmond](#)
- [Ask an Expert: Nuclear's World-Class Safety Standards](#)
- [Nuclear Innovation Alliance: Advanced Nuclear](#)
- [Energy Communities Alliance: New Nuclear Initiative](#)
- [Advanced Nuclear Reactor Technology: A Primer](#)
- [SMR Start: Small Modular Reactor Technology](#)
- [What will new nuclear plants look like?](#)
- [Careers in Nuclear Energy](#)



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