Nuclear power as an energy source has its pros and cons

About 450 nuclear reactors, including this one in Germany, provide about 11 percent of the world's electricity. Photo by: RelaxFoto.de/Getty Images

By National Geographic Society, adapted by Newsela staff

Nuclear power is generated by splitting atoms. These are the tiny particles that are the building blocks of all matter. All atoms have a central core called a nucleus that consists of protons and neutrons. Splitting atoms releases the energy held in the nucleus. This process, called nuclear fission, generates heat that is then directed to a cooling agent, which is usually water. This creates steam. The steam spins a turbine connected to a generator, producing electricity.

About 450 nuclear reactors provide about 11 percent of the planet's electricity. The countries that generate the most nuclear power are the United States, France, China, Russia, and South Korea.

The Role Of Uranium In A Nuclear Reaction

Nuclear fuel is the fuel that is used in a reactor to help sustain a nuclear reaction. The most common fuel for nuclear power is an element called uranium. This is used as fuel in nuclear reactors because its atoms can be split apart easily. Uranium is an abundant metal found throughout the world. It can be mined and processed into a version known as U-235.

During a nuclear reaction, neutrons, which are subatomic particles that have no electric charge, collide with atoms and cause them to split. That nuclear fission releases more neutrons that react with more atoms, creating a chain reaction. During the reaction, a byproduct called plutonium is produced. Plutonium is a radioactive chemical element that can also be used as nuclear fuel.

Two types of nuclear reactors are commonly used in the United States: boiling water reactors and pressurized water reactors. Both types of reactors produce steam. In boiling water reactors, the water is heated to the boiling point to release steam. In pressurized water reactors, pressurized water does not boil, but funnels heat to a secondary water supply for steam generation. Other types of nuclear power reactors include gas-cooled reactors and fast neutron reactors. Gas-cooled reactors use carbon dioxide as the cooling agent. These are used often in the U.K. Fast neutron reactors are cooled by liquid sodium.

Competing With Wind And Solar Energy

The idea of nuclear power began in the 1930s, when physicist Enrico Fermi first showed that neutrons could split atoms. Fermi led a team that achieved the first nuclear chain reaction,

under a stadium at the University of Chicago, in 1942. The first electricity from atomic energy was produced at Idaho's Experimental Breeder Reactor I in 1951. The first nuclear power plant was built in the city of Obninsk, part of the former Soviet Union, in 1954. The first commercial nuclear power plant was built in Shippingport, Pennsylvania in 1957.

Nuclear power isn't considered renewable energy because it is dependent on uranium. This element is a mined, limited resource. However, operating reactors do not release any of the greenhouse gases that contribute to global warming. This is why supporters say it should be considered a climate change solution. Leslie Dewan is an engineer who works with National Geographic. She wants to bring back the molten salt reactor. This type of reactor uses liquid uranium dissolved in molten salt as fuel. Dewan argues molten salt reactors could be safer and less costly than reactors in use today.

Other people are working on smaller reactors that could be portable and easier to build. Inventions like those are aimed at saving the nuclear power industry, which is in trouble. The nuclear plants in operation today are getting older. New ones are more expensive than other energy options, like natural gas and renewable resources such as wind and solar.

The best bet for the future of nuclear power involves nuclear fusion. While nuclear fission splits the nucleus, nuclear fusion does the opposite. Nuclear fusion generates energy when two light nuclei smash together to form a single, heavier nucleus. Fusion could deliver more energy more safely and with far less harmful radioactive waste than fission. However, only a small number of people have managed to build working nuclear fusion reactors. One of those people is a 14-year-old from Arkansas. Organizations such as ITER in France and Max Planck Institute of Plasma Physics in Germany are working on commercially affordable versions. So far, however, that goal has been difficult to achieve.

Nuclear Power Not The Safest Option

When arguing against nuclear power, opponents often point to two problems. The first is long-lived nuclear waste, and the second is rare but devastating nuclear accidents. Two such accidents were Chernobyl in 1986 and Fukushima Daiichi in 2011. The deadly Chernobyl disaster occurred in Ukraine, a country in eastern Europe. The accident happened when flawed reactor design and human error caused a power surge and explosion at one of the reactors. A large amount of radioactivity was released into the air, and hundreds of thousands of people were forced from their homes. Today, the area surrounding the plant, which is known as the Exclusion Zone, is open to tourists. However, it is only inhabited by various wildlife species such as gray wolves.

In the case of Japan's Fukushima Daiichi, the Tohoku earthquake and tsunami caused the accident. The surrounding towns still have not recovered. Evacuees remain afraid to return and public mistrust has slowed the recovery effort.

There was also a partial meltdown at Pennsylvania's Three Mile Island in 1979. These accidents remain terrifying examples of nuclear power's radioactive risks. The Fukushima disaster in particular raised questions about the safety of power plants in earthquake zones. One such questionably-placed reactor is the Metsamor power station in Armenia, a small country in eastern Europe.

Another issue related to nuclear power is where and how to store the spent fuel, or nuclear waste. This waste remains dangerously radioactive for thousands of years. Many nuclear power plants are located on or near coasts because of the closeness to water for cooling. However, this means they must face rising sea levels and extreme storms due to climate change.