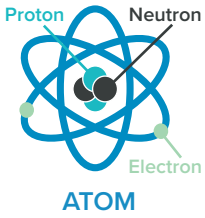
NUCLEAR ENERGY 101

Of the various types of energy used to power our cities and heat or cool our homes, nuclear is perhaps the most misunderstood. Fortunately, you don't need to be a physicist to **understand how nuclear energy works**.

THE BASICS

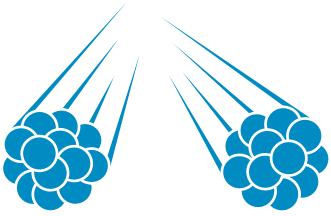


ATOM

ATOMS ARE THE **MOST BASIC** UNIT OF MATTER.

Every solid, liquid, and gas is made up of atoms. At the center of an atom is a nucleus, which consists of even smaller things called protons and neutrons. Protons and neutrons are tightly bound to each other by a really strong force.

Atoms come in different sizes; some are "small" and have only one neutron and one proton, while others are "big" and have more than 200 protons and neutrons. These different-sized atoms are what make up the Earth's elements, which are then combined in different ways to **CREATE EVERYTHING IN THE ENTIRE WORLD.**



NUCLEAR ENERGY IS CREATED BY SPLITTING APART THE NUCLEUS OF AN ATOM INTO SEPARATE PIECES.

This is a process called **nuclear fission**. To split the nucleus apart, it must absorb a very fast-moving, high-energy neutron that is propelled toward the nucleus. Some of the intense energy that was being used to bind the proton and the neutron is then released as the nucleus splits apart. Fission also produces more high-energy neutrons. These neutrons cause a controllable chain reaction in which other nearby nuclei are also split apart, adding to the magnitude of the energy that is being created.

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CREATING NUCLEAR POWER

The first nuclear reactor was invented by Enrico Fermi and his colleagues, and the first-ever, human-made self-sustaining nuclear chain reaction was successfully initiated in December 1942. After scientists split atoms apart and discovered that the splitting produced significant amounts of energy, they wondered how it could be possible to harness that massive energy to help create electricity. Nuclear reactors are facilities that allow scientists to split apart those atoms on a large scale, creating energy.

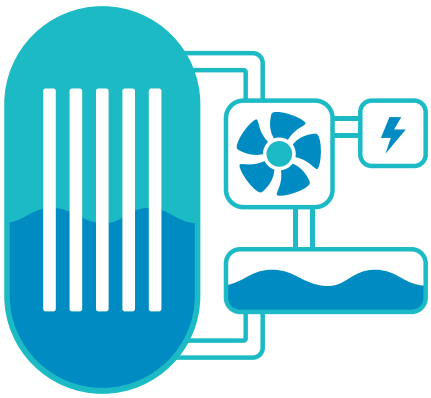
A NUCLEAR REACTOR IS A LARGE STRUCTURE WHERE **NUCLEAR FISSION** CAN OCCUR IN A HIGHLY CONTROLLED MANNER.

Inside the reactor, there are thousands of 12–foot–long metal tubes, or "fuel rods," that are surrounded by water. Each fuel rod holds hundreds of fuel pellets, which are made from an element called uranium (more on that later). There are currently two main types of reactors used at nuclear power plants, and different types of advanced nuclear reactors are being developed, which shows how nuclear technology is constantly evolving and moving forward.

Once nuclear fission has begun inside the fuel rods, the energy that is released by the atoms being split apart heats up the water inside the reactor to produce steam. The steam is then routed out of the nuclear reactor through a series of pipes to a turbine. **The turbine is a large fan-like machine that is rotated by the steam.**

The rotating turbine, when combined with another component called a "generator," is what produces electricity. This electricity then makes its way to us. **Nuclear energy is on 24/7 because the fuel is inside the reactor and doesn't need to be replaced except every 18 to 24 months. This also means that the reactor's fuel supply cannot be disrupted, even in severe weather, enabling the reactor to continually operate.**

Other sources of energy that create electricity use different processes to create steam for the turbine. Whereas nuclear energy heats water to create steam, other products such as natural gas and coal are burned to create the heat and steam that eventually moves the turbine. When you burn fossil fuels, emissions like sulfur dioxide or carbon dioxide are released. **With nuclear energy, the white plume you might see coming out of the tall cooling towers located near reactors is water vapor**, not smoke or any carbon-based emission.



NUCLEAR REACTOR

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WHY URANIUM?

SCIENTISTS CHOSE TO USE A FORM OF THE ELEMENT
URANIUM CALLED URANIUM 235 (U-235)
in the fuel pellets that make nuclear energy because it is one of the biggest naturally occurring elements on Earth and will fission more easily than other materials. One atom of uranium 235 has 92 protons and 143 neutrons. In general, the more protons and neutrons an element has (or the "bigger" it is), the easier it is to split the atoms apart to release the energy binding them. On average, nuclear reactors get new fuel every 18-24 months.

As you can see, the fundamentals of nuclear energy are straightforward. **Nuclear energy is clean energy**, which means it does not release harmful pollutants into the air. Other examples of clean energy are wind, solar, and hydro, all of which are renewable. Unlike some renewable and other non-renewable energy sources, **nuclear is carbon-free, available 24/7 regardless of weather, and generates an immense amount of electricity**. Understanding the science behind nuclear power is the first step to understanding its important role in our clean energy future.