energy KIDS
Energy Information Administration

Did You Know?

All nuclear power in the United States is used to generate electricity.

Did You Know?

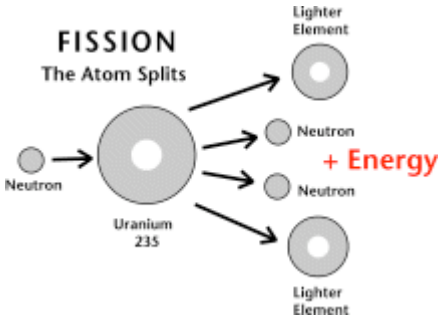
Steam coming out of the nuclear cooling towers is just hot water.

Nonrenewable

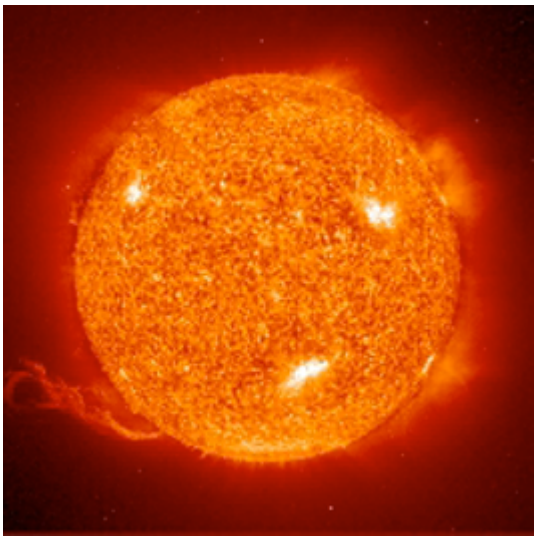
Uranium (nuclear)

Uranium (nuclear) Basics

Drawing of How Fission Splits the Uranium Atom



The sun is basically a giant ball of hydrogen gas undergoing fusion into helium gas and giving off vast amounts of energy in the process.



Source: NASA

Nuclear Energy Is Energy from Atoms

Nuclear energy is energy in the nucleus (core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together.

Nuclear energy can be used to make electricity. But first the energy must be

released. It can be released from atoms in two ways: nuclear fusion and nuclear fission.

In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use this energy to produce electricity.

In nuclear fusion, energy is released when atoms are combined or fused together to form a larger atom. This is how the sun produces energy. Fusion is the subject of ongoing research, but it is not yet clear that it will ever be a commercially viable technology for electricity generation.

Nuclear Fuel — Uranium

The fuel most widely used by nuclear plants for nuclear fission is uranium. Uranium is nonrenewable, though it is a common metal found in rocks all over the world. Nuclear plants use a certain kind of uranium, referred to as U-235. This kind of uranium is used as fuel because its atoms are easily split apart. Though uranium is quite common, about 100 times more common than silver, U-235 is relatively rare.

Most U.S. uranium is mined in the Western United States. Once uranium is mined, the U-235 must be extracted and processed before it can be used as a fuel.

During nuclear fission, a small particle called a neutron hits the uranium atom and splits it, releasing a great amount of energy as heat and radiation. More neutrons are also released. These neutrons go on to bombard other uranium atoms, and the process repeats itself over and over again. This is called a chain reaction.

Nuclear Power Plants

Nuclear Power Plants Generate About One-Fifth of U.S. Electricity

Nuclear power accounted for about 20% of the total net electricity generated in the United States in 2008, about as much as the electricity used in California,

Texas, and New York, the three States with the most people. In 2008, there were 66 nuclear power plants (composed of 104 licensed nuclear reactors) throughout the United States. Most of the reactors are east of the Mississippi. The last new reactor to enter commercial service in the United States was the Tennessee Valley Authority's Watts Bar 1 in Tennessee in 1996.

In 2008, TVA resumed construction on Watts Bar 2, which was about 80% complete when its construction was stopped in 1988. It is now expected to be completed in 2012.

Nuclear Power Comes from Fission

Nuclear reactors look like large concrete domes from the outside. Not all nuclear power plants have cooling towers.

Most power plants, including nuclear plants, use heat to produce electricity. They rely on steam from heated water to spin large turbines, which generate electricity. Instead of burning fossil fuels to produce the steam, nuclear plants use heat given off during fission.

In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Fission takes place inside the reactor of a nuclear power plant. At the center of the reactor is the core, which contains the uranium fuel.

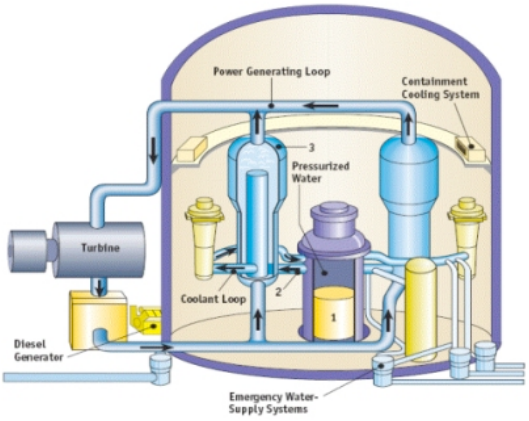
The uranium fuel is formed into ceramic pellets. The pellets are about the size of your fingertip, but each one produces roughly the same amount of energy as 150 gallons of oil. These energy-rich pellets are stacked end-to-end in 12-foot metal fuel rods. A bundle of fuel rods, sometimes hundreds, is called a fuel assembly. A reactor core contains many fuel assemblies.

The heat given off during fission in the reactor core is used to boil water into steam, which turns the turbine blades. As they turn, they drive generators that make electricity. Afterward, the steam is cooled back into water in a separate

structure at the power plant called a cooling tower. The water can be used again and again.

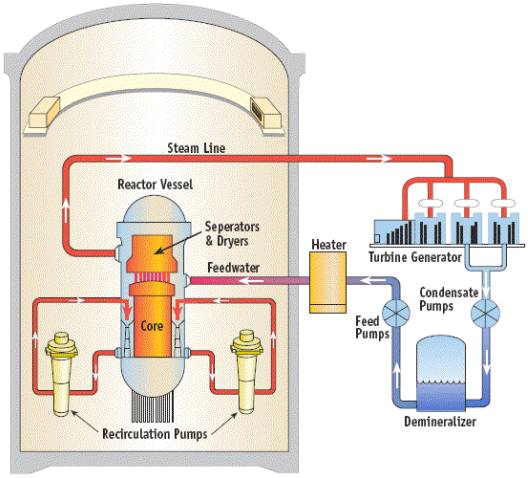
Types of Nuclear Reactors

Diagram of a Pressurized Nuclear Reactor System



Source: U.S. Nuclear Regulatory Commission

Diagram of a Boiling Water Nuclear Reactor



Source: U.S. Nuclear Regulatory Commission

Nuclear reactors are large machines that contain and control nuclear chain reactions, while releasing heat at a controlled rate.

A nuclear power plant uses the heat supplied by the nuclear reactor to turn water into steam, which drives turbine-generators that generate electricity.

There Are Two Types of U.S. Reactors

Just as there are different approaches to designing and building airplanes and automobiles, engineers have developed different types of nuclear power plants. Two types are used in the United States: boiling-water reactors and pressurized-water reactors.

Boiling-Water Reactors

In a boiling-water reactor, the water heated by the reactor core turns directly into steam in the reactor vessel and is then used to power the turbine-generator.

Pressurized-Water Reactors

In a pressurized-water reactor, the water heated by the reactor core is kept under pressure so that it does not turn to steam at all — it remains liquid. This hot radioactive water flows through a piece of equipment called a steam generator.

A steam generator is a giant cylinder with thousands of tubes in it that the hot radioactive water can flow through and heat up. Outside these hot tubes in the steam generator is nonradioactive water (or clean water), which eventually boils and turns to steam .

The radioactive water flows back to the reactor core, where it is reheated and then sent back to the steam generator. The clean water may come from one of several sources including oceans, lakes, or rivers.

Getting (Producing) Uranium

The fuel most widely used by nuclear plants for nuclear fission is uranium. In nuclear fission atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use the heat from nuclear fission to produce electricity.

Uranium Is Found in Nature but Must Be Processed into Fuel

Uranium is nonrenewable, though it is a common metal found in rocks all over the world. Uranium occurs in nature in combination with small amounts of other elements.

Nuclear plants use a certain kind of uranium, U-235, as fuel because its atoms are easily split apart. Though uranium is quite common, about 100 times more common than silver, U-235 is relatively rare.

Economically recoverable uranium deposits have been discovered principally in the western United States, Australia, Canada, Africa, and South America. Once uranium is mined, the U-235 must be extracted and processed before it can be used as a fuel. Mined uranium ore typically yields one to four pounds of uranium concentrate (U_3O_8 or "yellowcake") per ton, or 0.05% to 0.20% U_3O_8. The Nuclear Fuel Cycle describes uranium processing in more detail.

Most of Our Uranium Is Imported

Owners and operators of U.S. civilian nuclear power reactors purchased the equivalent of 53 million pounds of uranium during 2008. Uranium delivered to U.S. reactors in 2008 came from six continents:

- 14% of delivered uranium came from the United States
- 86% of delivered uranium was of foreign-origin:
    - 42% was from Australia and Canada
    - 33% originated in Kazakhstan, Russia and Uzbekistan
    - 11% came from Brazil, Czech Republic, Namibia, Niger, South Africa, and the United Kingdom

Nuclear Power & the Environment

Nuclear Power Plants Produce No Carbon Dioxide

Dry Storage Cask

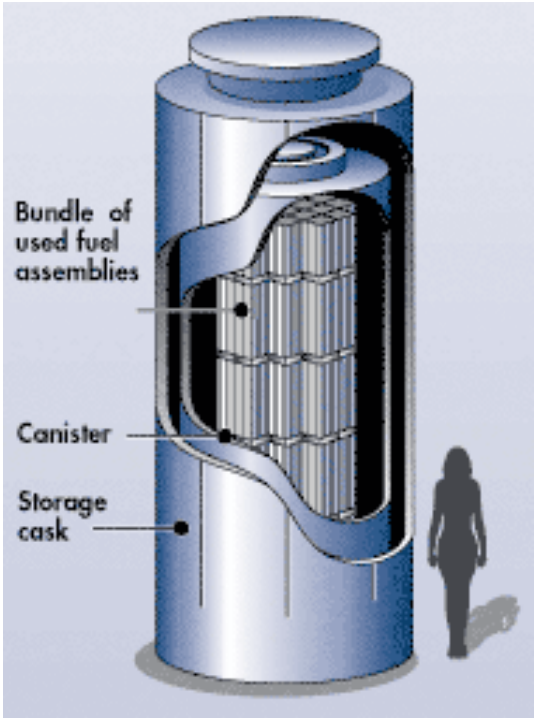
Unlike fossil fuel-fired power plants, nuclear power plants produce no air pollution or carbon dioxide. However, a small amount of emissions result from processing the uranium that is used in nuclear reactors.

Nuclear Energy Produces

Radioactive Waste

Like all industrial processes, nuclear power generation has by-product wastes: spent (used) fuels, other radioactive waste, and heat. Spent fuel and other radioactive wastes are the principal environmental concerns for nuclear power.

Most nuclear waste is low-level radioactive waste. It consists of ordinary tools, protective clothing, wiping cloths, and disposable items that have been contaminated with small amounts of radioactive dust or particles. These materials are subject to special regulation that govern their disposal so they will not come in contact with the outside environment.



Some canisters are designed to be placed vertically in robust above-ground concrete or steel structures.

Source: U.S. Nuclear Regulatory Commission

Spent Fuel Must Be Stored

The spent fuel assemblies, on the other hand, are highly radioactive and must initially be stored in specially designed pools resembling large swimming pools (water cools the fuel and acts as a radiation shield) or in specially designed dry storage containers. An increasing number of reactor operators now store their older spent fuel in dry storage facilities using special outdoor concrete or steel containers with air cooling.