**Nuclear Basics**

**Nuclear energy is energy in the core of an atom**

Atoms are tiny particles that make up every object in the universe. Nuclear energy is energy in the nucleus (core) of an atom. There is enormous energy present in the bonds that hold the nucleus together. Energy is released when those bonds are broken. Nuclear energy can be used to make electricity, but it must first be released. Nuclear energy can be released from atoms through 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. Nuclear fusion is the subject of ongoing research, but it is not yet clear whether or not it will be a commercially viable technology for electricity generation.

**Nuclear fuel—uranium**

Uranium is the nonrenewable fuel most widely used by nuclear plants for nuclear fission. Nuclear power plants use a certain kind of uranium, referred to as U-235, because its atoms are easily split apart. During nuclear fission, a neutron hits the uranium atom and splits it, releasing a great amount of energy in the form of heat and radiation. More neutrons are also released when the uranium atom splits. These neutrons go on to bombard other uranium atoms, and the process repeats itself over and over again. This is called a chain reaction.

Although uranium is about 100 times more common than silver, U-235 is relatively rare. Most U.S. uranium is mined in the western United States, but only 17% of the uranium used in American reactors is mined here. Uranium delivered to U.S. reactors in 2013 came from many countries, including Russia, Australia and several Africa countries.

**Nuclear power plants generate about 20% of U.S. electricity**

The United States has 61 operating nuclear power plants with 99 nuclear reactors. There are nuclear power plants in 30 states, and 46 plants are located east of the Mississippi River. Nuclear power has supplied about one-fifth of annual U.S. electricity each year since 1990. Nuclear power provides about as much electricity as the total electricity used in California, New York, and Texas combined.

**Nuclear power comes from nuclear fission**

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

Fission takes place inside the reactor of a nuclear power plant. Nuclear reactors are machines that contain and control nuclear chain reactions while releasing heat at a controlled rate. At the center of the reactor is the core, which contains the uranium fuel. The uranium fuel is formed into ceramic pellets. Each ceramic pellet 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 nuclear fission in the reactor core is used to boil water into steam, which turns the turbine blades. As the turbine blades 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 then be reused.

**Nuclear power reactors do not produce direct carbon dioxide emissions**

Unlike fossil fuel-fired power plants, nuclear reactors do not produce air pollution or carbon dioxide while operating. However, the processes for mining and refining uranium ore and making reactor fuel require large amounts of energy. Nuclear power plants have large amounts of metal and concrete, which also require large amounts of energy to manufacture. If fossil fuels are used for mining and refining uranium ore or in constructing the nuclear plant, then the emissions from burning those fuels could be associated with the electricity that nuclear power plants generate.

**Nuclear energy produces radioactive waste**

The main environmental concern related to nuclear power is the creation of radioactive wastes such as uranium mill tailings, spent (used) reactor fuel, and other radioactive wastes. These materials can remain radioactive and dangerous to human health for thousands of years. They are subject to special regulations that govern their handling, transportation, storage, and disposal to protect human health and the environment. The U.S. Nuclear Regulatory Commission regulates the operation of nuclear power plants.

Radioactive wastes are classified as low-level and high-level. The radioactivity in these wastes can range from just above natural background levels like in mill tailings, to much higher levels like in spent reactor fuel or in the parts inside a nuclear reactor. The radioactivity of nuclear waste decreases with the passage of time through a process called radioactive decay. The amount of time necessary to decrease the radioactivity of radioactive material to half its original level is called the radioactive half-life of the material. Radioactive waste with a short half-life is often stored temporarily before disposal to reduce potential radiation doses to workers who handle and transport the waste, as well as to reduce the radiation levels at disposal sites.

**Spent reactor fuel storage and reactor decommissioning**

Spent reactor fuel assemblies are highly radioactive and must initially be stored in specially designed pools of water, where the water cools the fuel and acts as a radiation shield. Spent reactor fuel assemblies can also be stored 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. There is currently no permanent disposal facility in the United States for high-level nuclear waste.

When a nuclear reactor stops operating, it must be decommissioned. This involves safely removing the reactor and all equipment that has become radioactive from service and reducing radioactivity to a level that permits other uses of the property. The U.S. Nuclear Regulatory Commission has strict rules governing nuclear power plant decommissioning that involve cleanup of radioactively contaminated plant systems and structures, and removal of the radioactive fuel.

**Nuclear reactors and power plants have complex safety and security features**

An uncontrolled nuclear reaction in a nuclear reactor can potentially result in widespread contamination of air and water. The risk of this happening at nuclear power plants in the United States is considered to be very small because of the diverse and redundant barriers and many safety systems in place at nuclear power plants, the training and skills of the reactor operators, testing and maintenance activities, and the regulatory requirements and oversight of the U.S. Nuclear Regulatory Commission. A large area surrounding nuclear power plants is restricted and guarded by armed security teams. U.S. reactors have containment vessels that are designed to withstand extreme weather events and earthquakes.

http://www.eia.gov/kids/energy.cfm?page=nuclear\_home-basics