

NUCLEAR ENERGY IS TYPICALLY OBTAINED from splitting apart atoms in a process called fission. Uranium, a nonrenewable metal found in rocks, is used as a fuel for nuclear fission. In a nuclear reactor, where nuclear energy is used to generate electricity, uranium atoms are bombarded with neutrons that break the bonds holding a uranium nucleus together. The heat released from this process is used to generate electricity.

Nuclear power plants are generally built near large bodies of water because the plants require a great deal of water. Water is used to produce steam from the heat of fission; the steam spins a turbine to generate electricity. Water is also used to absorb waste heat, both during normal operations and in case of an emergency where a reactor overheats. After use, the water is discharged back into the nearby body of water.

Uranium is radioactive and can harm living organisms if it is released into the environment. Radioactivity can cause birth defects, cancer, and even death. Radioactive wastes can remain dangerous for thousands of years. Currently there is no known way to dispose of nuclear waste safely; it must be contained in special storage areas.

There are other safety concerns associated with nuclear energy. Uranium used for nuclear fuel can also be used to create nuclear weapons. Also, the extreme heat created by fission makes reactors susceptible to fires and explosions if safety measures malfunction.

Fission doesn't result in any greenhouse gas emissions. However, greenhouse gases are produced during construction of a nuclear power plant and from mining and transporting uranium.

HYDROPOWER IS THE ENERGY GENERATED by moving water. Fast-flowing water and water that falls a great distance contain much energy. Often a dam is built to harness flowing water and create electricity as needed.

Hydropower is a renewable energy source. Water is renewed naturally through Earth's water cycle. Hydropower is considered a clean energy source because it does not result in any carbon dioxide emissions, air pollution, or water pollution.

Dams have major impacts on environments. Sediments (soil, sand, leaves) can build up in reservoirs—the bodies of water held by dams. That sediment reduces water quality for organisms that live in the water and can choke out the sun's light. Migrating fish, such as salmon, may have trouble swimming around dams. Changing the path of a stream affects any organisms dependent on that stream. It may also cause erosion along riverbanks.

Building dams can also affect human communities. Often, people must be relocated from their homes if they live in an area where a dam and reservoir are to be constructed. On the other hand, some people may benefit from reservoirs, which can serve as resources for recreational activities such as swimming and fishing.

Water is a relatively cheap energy source. The cost of hydropower lies in building and maintaining dams and channels.

COAL IS A BLACK ROCK formed by organic material over millions of years. It is considered a fossil fuel because of the long time required to create it.

Some coal is buried near Earth's surface, but often coal is located hundreds of feet below the surface. Underground mining is required to extract coal buried far below Earth's surface. Mine shafts and elevators allow people to remove deeply buried coal. Coal nearer to the surface can be removed through surface mining. This is cheaper than underground mining. One common type of surface mining is strip mining, which involves removing plants, soil, and rocks to reach the coal below the surface. Another method of surface mining is called mountaintop removal, whereby entire mountain tops are removed to access coal. Mountaintops are blasted with explosives to expose the coal that lies within the mountain. The unwanted rock may be dumped in adjacent valleys, sometimes on top of streams and forests.

Safety concerns related to shaft mining include lung damage to workers and collapse of mine shafts. Mountaintop removal can damage ecosystems and drinking water supplies. Large amounts of water may be used at the mine to remove impurities from coal.

Burning coal releases many air pollutants and creates solid waste called ash. Using coal for electricity production releases more carbon dioxide than other fossil fuels and fossil fuel alternatives. Transporting coal from mines to power plants also relies heavily on fossil fuels to power trains, barges, and trucks. Although transporting coal is expensive, coal is generally affordable for consumers.

SOLAR ENERGY IS THE ENERGY FROM the sun that can be converted into electrical energy. Photovoltaic (PV) cells, which are made of metals and silicon, are often used to convert solar energy into electricity. Space shuttles, watches, and homes and office buildings all use PV cells. Solar-thermal technologies, such as mirrors, can also be used to concentrate the sun's energy.

Although the sun releases much energy, it is difficult to use all of this energy because the sun's energy is not concentrated into a single beam. Currently, PV cells are not very efficient. They lose the majority of their collected energy in the process of converting light into electrical power.

Although a solar cell itself doesn't release greenhouse gases, the process of creating the solar cell does. The silicon used to make PV cells can be extracted from sand. The process of removing silicon from sand and processing it for use in a PV cell is energy intensive, which can release greenhouse gases.

PV cells can be costly for energy consumers, at least initially. However, because the sun's energy is free and people who get energy from PV cells don't have to pay an electric company for solar energy, solar power can be cost-effective long-term. A PV cell will not last forever, and the resulting waste must be dealt with at the end of its life.

WIND IS PRODUCED because the sun heats Earth's surface unevenly, causing air to circulate. This moving air is a renewable form of energy that can be converted into electricity. Generating electricity from wind power is most efficient when wind blows consistently. Production of wind-generated electricity may not be possible in locations that have low wind speeds.

Converting wind energy into electricity requires wind turbines (sometimes called windmills). These are made primarily of steel. Steel is made of iron and other metals; mining and processing these metals requires energy and produces greenhouse gases. The operation of wind turbines does not produce any pollution, including greenhouse gases. Wind turbines can be installed on land or offshore.

Some people don't like wind turbines because they can harm birds and bats that might get caught in the blades. Others don't like the way they look or the noise that large wind farms can create.

Costs of wind power have varied from year to year. Although costs of wind power have been relatively low at times in the past, high demand for wind turbines has pushed up prices. Building and maintaining wind turbines are the major costs associated with wind power. Some farmers and ranchers have installed wind turbines on their land to make extra money.

NATURAL GAS IS A COLORLESS, odorless gas. The main component of natural gas is methane, a greenhouse gas. Natural gas is considered a fossil fuel because it is composed of ancient organic material. It takes millions of years to turn organic material into fossil fuels.

Natural gas, which can be found in reservoirs between rocks, can be drilled from thousands of feet below Earth's surface. In a process called hydraulic fracturing (a.k.a. "fracking"), a high pressure mixture of water, sand, and chemicals is pumped into rock to release the gas trapped by the rock. Pipelines bring the gas up to Earth's surface, where it is stored or transported elsewhere to create electricity.

Concerns about natural gas center around human and environmental safety. Drilling below Earth's surface for natural gas can cause erosion and landslides. Fracking can destabilize land, in some cases triggering earthquakes. Fracking has also been known to harm groundwater reservoirs, and toxic wastewater is produced as a byproduct of the process. Natural gas is very flammable and can cause explosions if it leaks from pipes or storage containers.

Burning natural gas to create electricity produces carbon dioxide and nitrous oxide emissions. Natural gas burns "cleaner" than coal and oil because it produces fewer greenhouse gas emissions and other air pollution emissions.

GEOHERMAL ENERGY IS HEAT THAT originates within the earth. Extremely high temperatures are continuously produced inside the earth by the slow decay of radioactive particles, a process that happens naturally in rocks. Reservoirs of hot water, steam, and hot dry rocks can be used to generate electricity.

Geothermal energy can be experienced near Earth's surface (think of hot springs). The shallow ground of the earth provides geothermal energy that can be accessed almost anywhere to heat or cool buildings. For most areas in the world, temperatures in the upper 20 feet of Earth's crust are usually warmer than the air in the winter and cooler than the air in the summer, kind of like a cave. Geothermal heat pumps transfer heat from the ground into buildings in the winter and reverse the process in the summer, transferring heat from the air into the cooler ground.

Geothermal power may also be obtained from great depths. Pipes can be drilled 1-2 miles below Earth's surface to reach reservoirs of thermal energy. Such geothermal reservoirs are more difficult to access in places where they are not as close to Earth's surface.

Construction of geothermal power plants that drill pipes deep into the ground can affect land stability in the surrounding region. However, after a power plant has been constructed, geothermal energy has lower environmental impacts than fossil fuels. Geothermal power plants release less than 1% of the CO₂ emissions of a fossil fuel plant.

Geothermal energy is constantly available and is unaffected by weather.