



# Energy

**Scientists use the term energy to mean the ability to do work. Many people use the term power to mean the same thing as energy. But when scientists use the term power, they mean the rate at which work is done or the rate at which energy is used up.**

There are three main forms of energy: kinetic, potential, and latent. Kinetic energy is the energy of motion. For example, windmills use the moving energy of air to perform mechanical tasks, such as grinding corn. A bullet shot from a gun also possesses kinetic energy. This energy is "given up," or transferred, when the bullet hits the target. At rest, the bullet does not possess this energy.

Potential energy is sometimes called the energy of position. For example, if any mass, such as a book, is raised, it possesses potential energy, because it has the "potential" to move or fall. If allowed to fall, the mass has the ability to do work. Potential energy can be used to do something; for example, a hammer can push a pile into the ground to support the foundations of a building.

Kinetic and potential energy are both forms of stored energy. A drum of oil possesses latent (undeveloped) energy, because the oil can be used to run an engine. Similarly, burning liquid fuel in a rocket can provide the energy to launch a missile.

## Units of energy

One way of measuring work is the foot-pound system. A foot-pound is the amount of energy required to lift 1 pound (0.45 kilograms) through a height of 1 foot (0.3 meters). For example, a 10-pound (4.5-kilogram) weight on a table that is 3 feet (0.9 meters) high has a 30 foot-pound potential energy. The metric system, however, uses such units as kilogram-meters. Today, a single basic unit called a joule is widely used, while power is measured in watts.

## Potential energy

Gravity is one example of the fields of force found in nature. Every time something is lifted, it is moved through the field of gravity, against a force that is pushing down on it. This gives the object potential energy. The heavier the object, and the higher it is lifted, the more potential energy it has.

To lift a chair, for example, energy must be used, or "work" done, to overcome the force that is present due to gravity. The energy is then transferred to, and stored in, the chair. This energy is called potential energy. If you release the energy by dropping the chair, it changes into kinetic energy, the energy of motion.

## Coal, oil, and gas

The fossil fuels coal, oil, and natural gas are sources of latent energy. They are called fossil fuels because they consist of once-living matter. When fossil fuels burn, they provide energy in the form of heat.

Oil and natural gas are the leading sources of heat energy. Oil is particularly versatile, being used to make engine gasoline, for example. Coal is more expensive to extract, more difficult to transport, and less heat-efficient, and it is used primarily in power stations and in heavy industry. Because of the high rate at which fossil fuels are being used, they will soon start to run out. Oil reserves may start to run out by 2010, and coal reserves may start to run out by the end of the twenty-first century. There are various other sources of energy, however.

## Solar energy

Of all the sources of energy, solar power is the most attractive. It is clean, plentiful, and free. Sunlight arriving at Earth carries about 15,000 times our energy needs. Solar energy can be thought of as kinetic energy—the motion being on an atomic level rather than a visible one.

Solar energy can be turned into electricity in two ways. One is to use a large number of mirrors to concentrate solar energy onto a boiler to raise steam. This steam drives a turbine and generator. More commonly, solar cells are used. These cells convert sunlight falling on them into electricity.

It is no use having power only when and where the Sun shines, however, and it is not yet possible to store enough solar electricity to supply the world's needs. One solution, however, could be to use hydrogen as a fuel, instead of fossil fuels. Water can be converted to hydrogen and oxygen by passing electrical current through it. This could be done using solar-generated electricity where sunlight is plentiful. The hydrogen could then be taken to where it is needed and used as a clean-burning fuel.

## Nuclear energy

Scientists have now learned how to use the energy that binds together atomic nuclei (*singular*, nucleus). This discovery has made possible the generation of nuclear energy. The conversion of nuclear mass into energy was made possible by the work of the German-born U.S. physicist Albert Einstein (1879–1955).

Einstein produced a famous equation:  $E = mc^2$ . This equation means that energy (E) is equal to the product of the mass (m) and the square of the speed of light ( $c^2$ ). The square of the speed of light is a very large number and so, even if the mass is small, the amount of energy (E) is still very large. This equation, called the "mass-energy equivalence equation," explains why a

very great amount of energy can be obtained from an extremely small mass, as in nuclear weapons and nuclear power stations. It also accounts for the great quantities of radiant energy given off by stars such as the Sun.

## Nuclear power

Nuclear reactors split radioactive fuels, such as uranium or plutonium, in a process called nuclear fission. The enormous kinetic energy released produces heat, which is then used to make electricity. A major drawback of nuclear fission is the amount of radioactive waste produced. This waste is being produced in increasing amounts, and takes several hundred years to fall to a safe level, so it has to be stored carefully. The safe transport of fuel elements between reactors and fuel-processing plants is another serious problem. Yet in some industrial nations, including Britain and the United States, nuclear reactors already produce more than 10 percent of the total electricity supply.

## The promise of fusion

Nuclear power by fusion could provide the answer to the world's energy needs. Fusion is the source that powers the Sun and the hydrogen bomb. In both cases, the centers of hydrogen atoms are fused, or joined together, to create helium. Fusion can release much more energy than fission, and it is cleaner, with less danger of pollution.

The fuels used in nuclear fusion are deuterium and tritium, heavy forms of hydrogen. Waste products are not radioactive, although the reactor itself may be. Teams around the world are working to find ways of controlling nuclear fusion and making it viable for electricity generation. This is proving to be a great challenge, however, and it may not be until the middle of the twenty-first century that fusion power plays a part in our everyday lives.

## Water energy

Because of the water cycle, there is a constant supply of water to mountain streams and lakes. The kinetic energy of this water is used by allowing it to fall under gravity through turbines that drive electricity generators. This source of energy is called hydroelectric power. While the building of hydroelectric power stations is costly, the production of electricity is cheap and clean. In mountainous countries, hydroelectric power stations produce a high proportion of the national electrical supply. But, overall, only about 7 percent of the world capacity is being used, because many unused sources are far from cities, and transmission costs are high.

Another form of water power comes from the daily rise and fall of tides. As the tide rises, water is allowed to flow inland through a dam. When a large enough head of water has collected, the dam is closed, and water is allowed to flow back through turbines. Wave energy can also be harnessed by rows of moving float generators, but again, the amount of electricity generated is small. Tidal and wave energy can make only a small contribution to world requirements.

## Other sources of energy

In volcanic regions, such as Iceland and New Zealand, heat from naturally occurring hot springs is being used to generate electricity. Cold water is pumped through pipes into the hot ground, and the hot water that is pumped back to the surface is used to produce electricity. This geothermal energy is not a global energy solution, however.

Finally, wind energy is another visible form of kinetic energy that can be harnessed to generate electricity. Giant windmills are now a common sight in many countries. These take up a lot of space, however, and can only be used on a small scale.

**See also:** [EINSTEIN, ALBERT](#); [ELECTRICITY](#); [FISSION, NUCLEAR](#); [FUSION, NUCLEAR](#); [GRAVITY](#); [HYDROELECTRIC POWER](#); [MOTION](#); [PHOTOELECTRIC CELL](#); [SUN](#).

**Citation:**

"Energy." *Growing Up with Science*. Marshall Cavendish Digital. 2009. 21 July 2009  
<<http://www.marshallcavendishdigital.com/articledisplay/6/2908/29098>>.