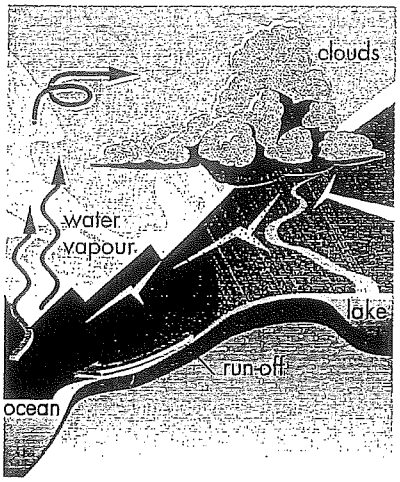
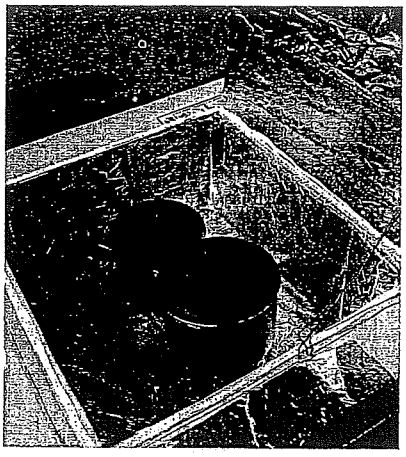


FIGURE 13.7 ▲
Energy from water is renewable because of the water cycle. Water is evaporated from the ocean and other bodies of water by thermal energy from the Sun. This water vapour forms clouds, which release their moisture as precipitation, which falls back to Earth. Rain and the water from melting snow is then pulled downhill by gravity and makes its way back to the ocean via streams and rivers. This water cycle is powered by the Sun, so hydroelectric energy is an indirect form of solar energy. As long as the water cycle continues, there will be hydro energy.



13.2 ENERGY OPTIONS: RENEWABLE ENERGY SOURCES

Fossil fuels and nuclear energy are non-renewable sources, but there are other energy sources that *are* renewable. A **renewable** energy source can be renewed within an average human lifetime (about 75 years) or less. These energy sources are sometimes called alternative energy sources because they have not been used much in the past. Until recently, most of the energy sources we used were non-renewable.

There are several energy sources that are classified as renewable. In British Columbia, we use renewable energy from water to generate hydroelectricity, as you have seen in Chapter 11 (Figure 13.7). Two other commonly used renewable sources are solar energy and wind energy.

SOLAR ENERGY

Solar energy is the cleanest, most inexhaustible source of energy known. The challenge is to find ways to make greater use of solar energy to meet more of our energy needs. At present, there are three basic technologies to use solar energy: reflectors, collectors, and solar cells.

Solar reflectors, such as the one in Figure 13.8, are mirrors, lenses, or curved surfaces that *concentrate* the Sun's rays on one spot. The concentrated heat energy is then used to make steam for electric generators, to melt metals, to cook food, or to improve the efficiency of solar collectors.

Solar collectors, such as the one in Figure 13.9, *absorb* heat energy. You could say your home is a solar collector. Solar energy passes through the windows heating the air and objects inside. One way to increase the usefulness of solar collectors is to use large containers of water to absorb the heat energy. Then, at night or on cloudy days, the water slowly releases heat to the house.

Solar cells, also called photovoltaic cells, *convert* sunlight directly into electrical energy. Many calculators use solar cells to produce the electricity needed to run them. There are even experimental cars, such as the one in Figure 13.10, that use solar cells to produce the electricity they need to move. However, the technology to convert large quantities of solar energy to electrical energy is not yet practical.

FIGURE 13.8 ◀
Solar reflectors can be used to cook food.

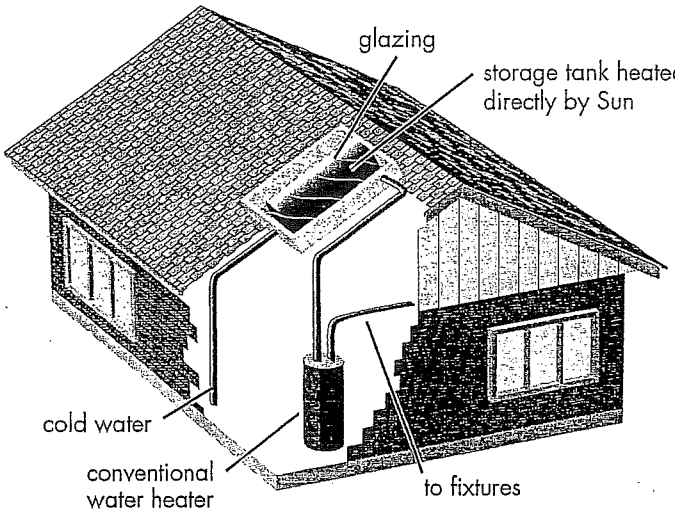


FIGURE 13.9 ◀
These solar collectors collect the Sun's heat and transfer it to water in the tanks.

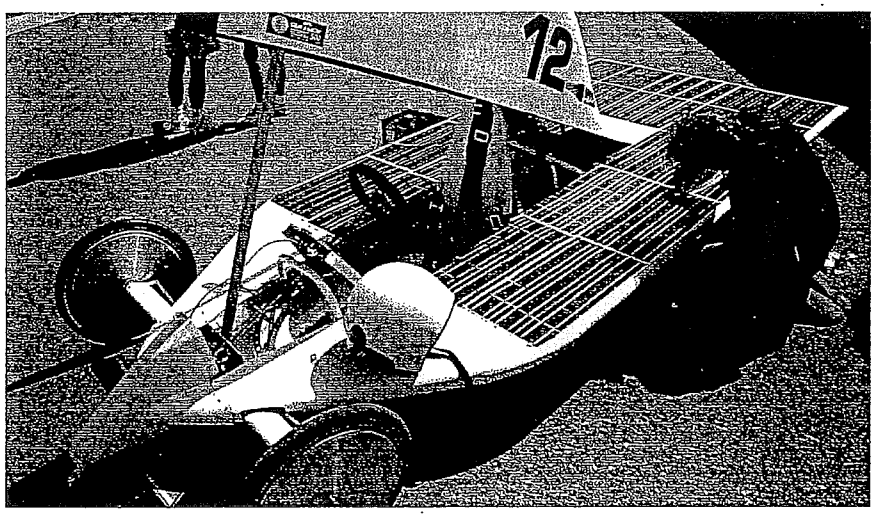


FIGURE 13.10 ◀
This car uses photovoltaic cells to convert solar energy into electrical energy. But what happens on a cloudy day?

It has been estimated that the solar energy received on Earth in just three hours is equal to the total amount of energy humans use each year. Through these three technologies, much greater use could be made of solar energy.

ACTIVITY 13C / HEAT FROM THE SUN

GROUP ACTIVITY

People have used the Sun for centuries to heat water. Today, some people have solar collectors in their homes. A solar collector can be as simple as a shallow box with a clear glass or plastic top. Sunlight passes through the glass and heat is trapped inside the box, much the same as in a greenhouse. This heat can be used to heat water, which in turn can be used to heat swimming pools, the interiors of homes, or even used directly as hot water. Try the following activity to learn more about solar collectors. ➥

WIND ENERGY

The wind is a source of clean, renewable energy. Harnessing wind energy with sails allowed humans to sail the world, and played an important role in the progress of civilization (Figure 13.12). Although humans used wind energy a great deal in the past, this energy source accounts for very little of the total energy used today.

Wind energy is created by solar energy. Solar energy warms air, the oceans, and the surface of Earth at different rates. When air is warmed, it expands and becomes lighter. The lighter, warm air rises and is replaced by heavier, cool air. The combined effects of solar energy, temperature differences, differences in air pressure, and the rotation of Earth cause the winds to blow (Figure 13.13).

The energy in moving air can be harnessed to do work. In the windmill in Figure 13.14, the energy in the wind turns propeller blades. This turns an axle which converts the motion into the mechanical energy of a turning machine. This mechanical energy has been used to grind grain, pump water, and turn generators to produce electricity.

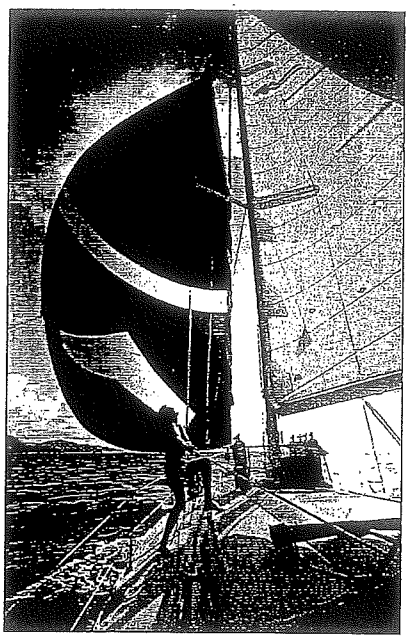
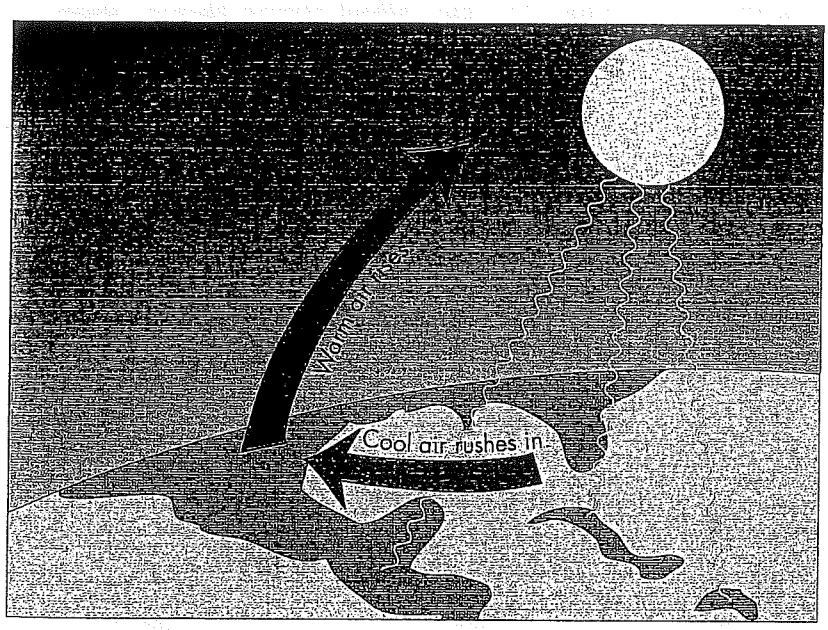


FIGURE 13.12 ▲
Wind energy powers this sailboat.

FIGURE 13.13 ▼
The Sun warms some parts of Earth's surface more than others. The warm air near Earth rises and is replaced by heavier cool air. The air starts to circulate, creating winds. Since the process begins with the Sun, wind energy is an indirect form of solar energy.



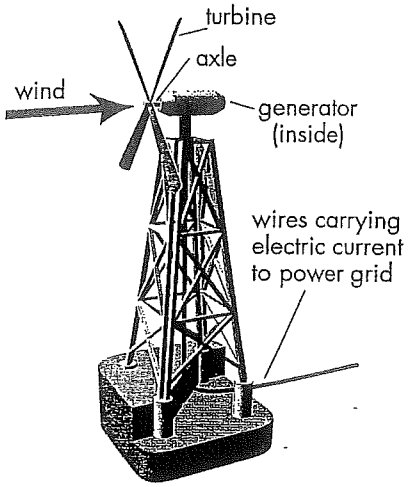


FIGURE 13.14 ▲
A windmill converts the energy in moving air into electricity.

DID YOU KNOW

■ A Green Walkman may soon be available. With the Green Walkman, you'll never have to buy batteries again. It is powered by a large, wind-up spring that converts the elastic energy in the spring into mechanical energy. Then the mechanical energy is used to produce the electrical energy to play your favourite tunes. The designers of this "wind-and-play" technology are Anie Galipeau and Paul Brown, engineering students at the University of Ottawa. They call their invention "green" because there are no batteries containing harmful chemicals such as mercury, lead, zinc, and cadmium that will end up in the environment. Can you think of another product that produces energy without harming the environment?

NUCLEAR ENERGY

Another non-renewable energy source is **nuclear energy**. There are no nuclear power plants in British Columbia. However, there are nuclear plants in Ontario and in the state of Washington, just to the south of us.

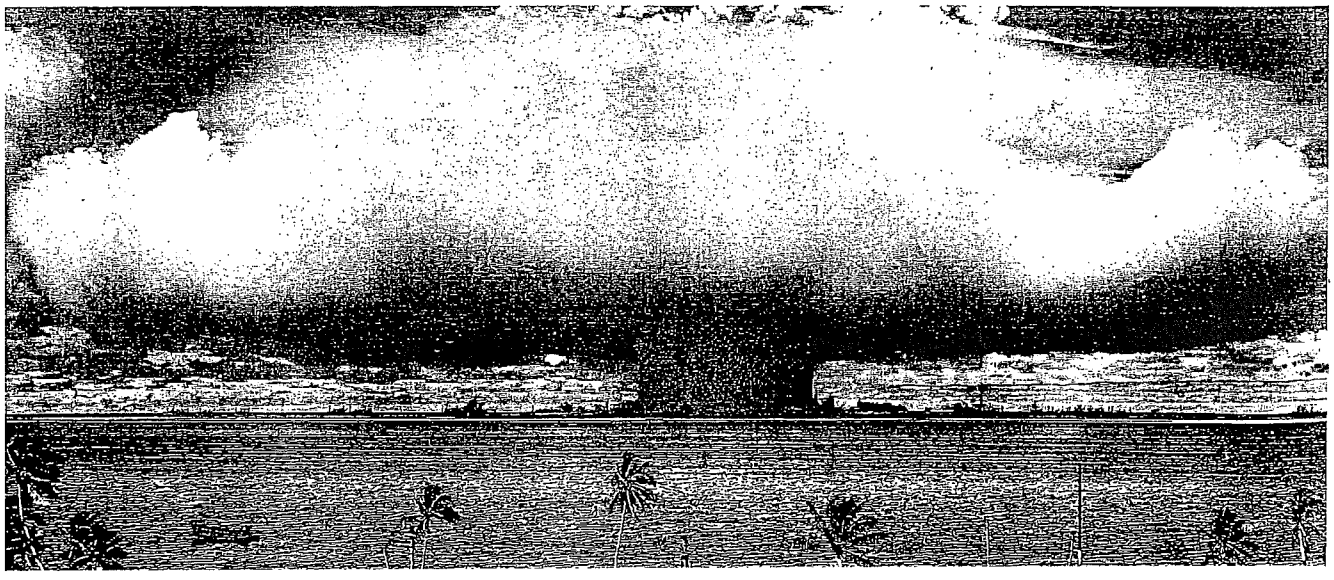
Nuclear energy is the energy stored in the central part of an atom, called the nucleus. Scientists knew about nuclear energy for many years before they understood how to convert it into other forms. Unfortunately, this knowledge was first used to develop the atomic bomb. It converted the nuclear energy of uranium atoms into intense heat, sound, light, and several other forms of energy. The result was a massive, uncontrolled, and deadly explosion (Figure 13.4).

Since then, scientists have also developed the **nuclear reactor**. This technology makes it possible to control the transformation of nuclear energy into heat (thermal energy). The transformation process is called nuclear fission. See Figure 13.5 for a comparison of a fossil fuel power plant and a nuclear power plant.

Nuclear power plants are efficient generators of electricity. However, some people feel nuclear power is too dangerous. They identify several problems that can affect living things, even when the power plant is operating normally:

- Harmful radiation. Not all of the nuclear energy in uranium is converted into heat. Nuclear fission also produces harmful radiation that can damage human health and even cause death. For this reason, nuclear reactors must be built from very thick concrete and other materials that help block radiation.

FIGURE 13.4 ▼
This mushroom-shaped cloud is evidence of nuclear fission. Although nuclear energy has been peacefully used to create electricity, it has also been used to create devastating weapons.



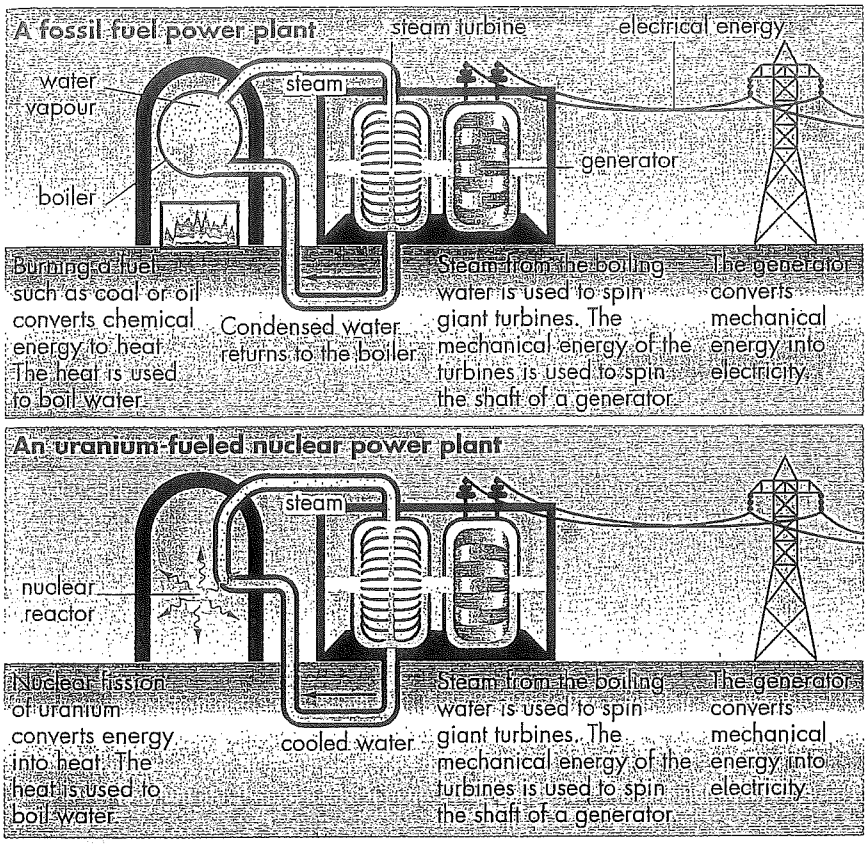


FIGURE 13.5 ◀
Both the fossil fuel power plant and the nuclear power plant produce electricity through a series of energy transformations. Only the heat-producing first step differs.

- Thermal pollution. In a nuclear power plant, heat from nuclear fission is used to produce steam. After the steam has been used to turn the turbines, it must be cooled to condense it into liquid water. In some reactors, water from a nearby lake or river is used in the cooling process. This cooling water absorbs energy from the steam and becomes very hot. When this hot water is dumped back into nearby lakes or rivers, it affects plants, animals, and micro-organisms. A nuclear power plant usually produces more waste heat than a coal-fired or oil-fired power plant of the same size.
- Storage problems. Uranium is naturally radioactive, so it must be shipped to a power plant in radiation-proof containers. And it must be handled and stored with care until it is placed in the reactor. After nuclear fission has occurred, only a very small part of the uranium's mass is converted into energy. The rest becomes solid nuclear waste, which remains dangerously radioactive for a very long time. Critics of nuclear power say the storage difficulties are so great that no more plants should be built. Supporters of nuclear power believe that safe disposal technology can be developed.

DID YOU KNOW

■ Radiation is usually considered harmful to human health. But radiation therapy is used to treat some forms of cancer. In one type of treatment, beams of gamma rays from the radioactive element cobalt are focused on the cancerous growth. The gamma rays destroy the cancer cells.