

## Section 2

# Alternative Energy

**Key Concept** Each alternative energy resource has both benefits and drawbacks.

### What You Will Learn

- Many types of alternative energy resources are used to generate power.
- Alternative energy resources produce less pollution than fossil fuels do.
- The use of alternative energy resources has both advantages and disadvantages.

### Why It Matters

Alternative energy becomes more important as fossil fuels are depleted and as environmental concerns become greater.

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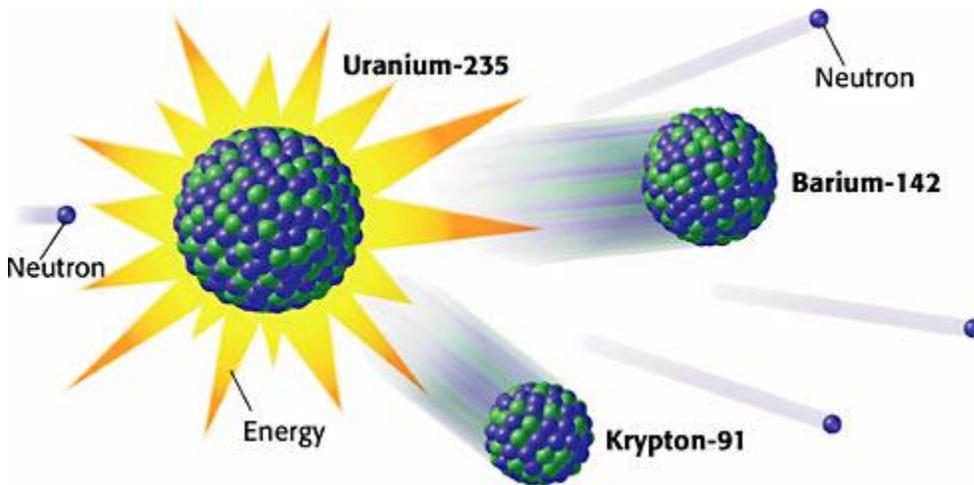
What would your life be like if you couldn't turn on lights, microwave your dinner, take a hot shower, or take the bus to school? Most of your energy needs are met by the use of fossil fuels. However, a variety of technologies have been invented to convert energy from alternative sources. Some alternative energy sources are easily converted into usable forms of energy. Others are unreliable, expensive, or difficult to convert. The energy sources that are easiest and most cost effective to convert are most valuable. In addition, each source of energy has both advantages and disadvantages.

## Nuclear Energy

The energy released when the nuclei of atoms are split or combined is called **nuclear energy**. Nuclear energy can be obtained by two main processes: fission and fusion.

### Splitting the Atom: Fission

*Fission* is a process in which the nuclei of radioactive atoms are split into two or more smaller nuclei, as **Figure 1** shows. When fission takes place, a large amount of energy is released. This energy can be used to generate electrical energy. All nuclear power made by humans is generated by fission.

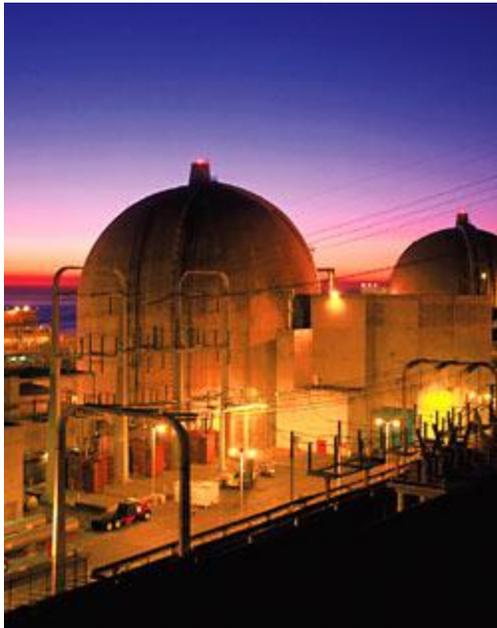


**Figure 1** During nuclear fission, a neutron collides with the nucleus of a uranium-235 atom. The nucleus splits into two smaller nuclei, called fission products, and two or more neutrons.

### Advantages and Disadvantages of Fission

Nuclear fission produces a large amount of energy. This source of energy does not cause the problems that fossil fuels do. Because no fuel is burned, nuclear power does not cause air pollution. In addition, mining the fuel for nuclear power does not result in massive strip mines or cause the loss of wildlife habitat.

Nuclear power also has drawbacks. For example, nuclear power plants produce dangerous radioactive wastes. These wastes must be stored for a very long period of time where the radiation that they emit cannot harm anyone. Another problem is the potential for releasing harmful radiation into the environment accidentally. In addition, nuclear plants must release extra heat from the fission reaction. The heat may disrupt the local ecosystem. Thus, cooling towers, such as the ones shown in **Figure 2**, must be used to cool water before the water is released into local rivers or the ocean.

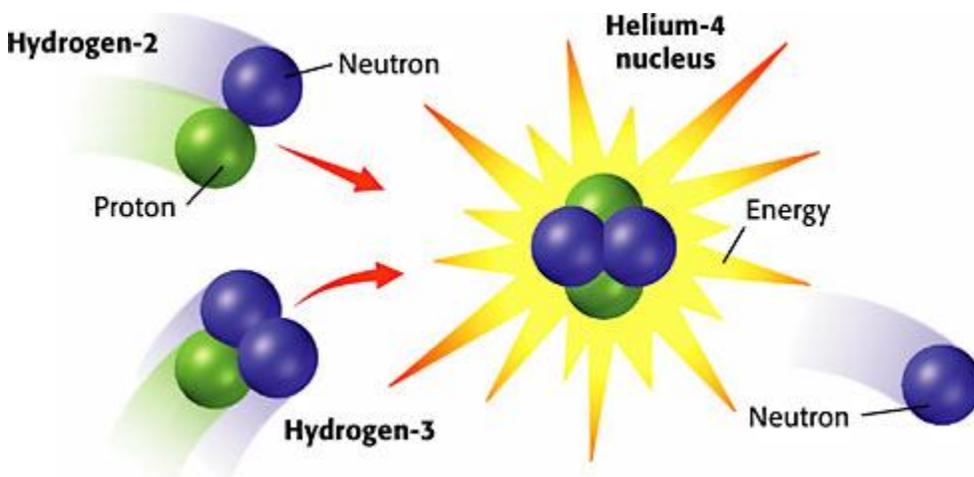


**Figure 2** The San Onofre Nuclear Generating Station in north San Diego County in California provides electrical energy for the surrounding area.

**Standards Check** What are the advantages of producing energy through fission?

**Combining Atoms: Fusion**

Another method of obtaining energy from nuclei is fusion, shown in **Figure 3**. *Fusion* is the joining of two or more nuclei to form a larger nucleus. This process happens naturally in the sun and releases a large amount of energy.



**Figure 3** During nuclear fusion, the nuclei of two forms of hydrogen collide. The two nuclei join to form helium. The joining of nuclei releases large amounts of energy.

### **Advantages and Disadvantages of Fusion**

Fusion has two main advantages. First, fusion produces few dangerous wastes. Second, the fuels for fusion cannot be exhausted, so fusion is a renewable source of energy. The main disadvantage of fusion is that the reaction can take place only at very high temperatures. So, it is difficult to control the reaction and to keep the reaction going. Currently, the technology to make fusion a source of energy is not available.



### **Wind Energy**

Wind is caused indirectly by solar energy because the atmosphere is heated more at middle latitudes than at other latitudes. Because moving air has kinetic energy, energy can be harnessed from wind. Wind power is the use of a windmill to drive an electric generator. Clusters of wind turbines, such as the ones shown in **Figure 4**, can generate a large amount of electrical energy. Wind energy is renewable and does not cause any pollution. But, in many areas, the wind isn't strong enough or frequent enough to generate energy on a large scale.



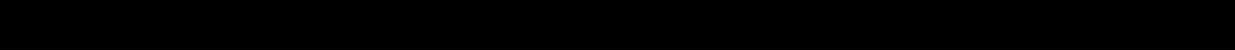
**Figure 4** These wind turbines are at a wind farm in Altamont Pass near Livermore, California. Notice the white pick-up truck, which shows how large the turbines are. **What can you conclude about the space needed for wind power?**

**Standards Check** Why is wind a useful energy source in some locations, but not in others?

### **Chemical Energy from Fuel Cells**

When you think of fuel for a car, you most likely think of gasoline. However, not all vehicles are fueled by gasoline. Some vehicles are powered by energy that is generated by fuel cells. Fuel cells power automobiles by converting **chemical energy** into electrical energy. This conversion happens when hydrogen and oxygen react to form water. One advantage of using fuel cells as energy sources is that fuel cells do not create pollution. The only byproduct of fuel cells is water. In addition, cars that use fuel cells are more efficient than cars that use gasoline.

The United States has been using fuel cells in space travel since the 1960s. Fuel cells have provided space crews with electrical energy and drinking water. Today, fuel-cell technology is used to generate electrical energy in some buildings, ships, and submarines.



## Solar Energy

Almost all forms of energy, such as wind energy and the energy of fossil fuels, come from the sun. The energy received by Earth from the sun in the form of radiation is [solar energy](#). Earth receives more than enough solar energy to meet all of our energy needs. Because Earth continuously receives solar energy, this energy is a renewable resource.

**Standards Check** Why is solar energy a renewable resource?

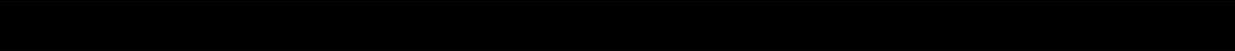


### Uses of Solar Energy

Sunlight can be changed into electrical energy through the use of solar cells or photovoltaic cells. You may have used a calculator powered by solar cells. Solar energy can also be used directly to heat buildings and to generate electrical energy. However, the technology that is used to generate electrical energy from solar energy is very expensive.

### Advantages and Disadvantages of Solar Energy

One of the best things about solar energy is that it doesn't produce pollution. Because it comes from the sun, solar energy is renewable. But some climates don't have enough sunny days to benefit from solar energy. And despite the fact that solar energy is free, solar cells and solar collectors are more expensive to make than other energy systems.



## Hydroelectric Energy

Humans have used the energy of falling water for thousands of years. Water wheels have been around since ancient times. Today, the energy of falling water is used to turn turbines that generate electrical energy. Electrical energy produced by moving

water is called [hydroelectric energy](#).

### Advantages of Hydroelectric Energy

After a dam and a hydroelectric power plant are built, generating hydroelectric energy is inexpensive. In addition, hydroelectric energy causes no air pollution and little other pollution. Hydroelectric energy is renewable because it is driven by the water cycle, which is driven by solar energy.

### Disadvantages of Hydroelectric Energy

Like wind energy, hydroelectric energy is not available everywhere. It can be produced only where large volumes of moving water can be harnessed. Huge dams, such as the one in **Figure 5**, must be built on major rivers to capture enough water to generate large amounts of electrical energy.



**Figure 5** Large amounts of water allow this California dam to generate electrical energy.

Building a large dam necessary for a hydroelectric power plant has many costs other than the financial costs. The habitats of wildlife living in the river are disrupted. Fish cannot migrate. Water trapped upstream of a dam may flood farmland and wildlife habitats. Downstream, the amount of sediment that reaches beaches and other sites is reduced. In addition, a dam can decrease water quality and can cause erosion. A dam also may cause flooding disasters if the dam is damaged or collapses.

**Standards Check** What are six potential costs of building a dam for a hydroelectric power plant?

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### Energy from Living Things

Plants absorb energy from the sun and store this energy for later use. Leaves, wood, and other parts of plants contain stored energy. Even the dung of plant-grazing animals has a lot of stored energy. These sources of energy are called biomass. **Biomass** is organic matter that can be a source of energy.

Biomass is most commonly used in its solid form. **Figure 6** shows a woman who is preparing cow dung that will be dried and used for fuel. Biomass can also be changed into liquid fuel. Plants that contain sugar or starch can be made into alcohol. The alcohol can be used as a fuel. Alcohol can also be mixed with gasoline to make a fuel called **gasohol**.



**Figure 6** In many parts of the world where firewood is scarce, people burn animal dung for energy.

### **Burning Biomass**

The most common way to release biomass energy is to burn biomass. When biomass is burned, energy is released as heat. This heat can be used to cook food, to heat a house, or to drive an engine. Scientists estimate that 14% of the energy used in the world comes from the burning of wood and animal dung.

### **Advantages and Disadvantages of Biomass**

Biomass is inexpensive and can be replaced quickly. Therefore, it can be considered a renewable resource. However, biomass is renewable only when the rate at which the fuel is used does not exceed the rate at which the fuel is replaced. If biomass is used too quickly, habitats may be destroyed and species may become extinct. In that case, the biomass may be considered a nonrenewable resource. Some types of biomass production can require land that could be used for growing food. If that land is not protected, it may become unusable in the future.



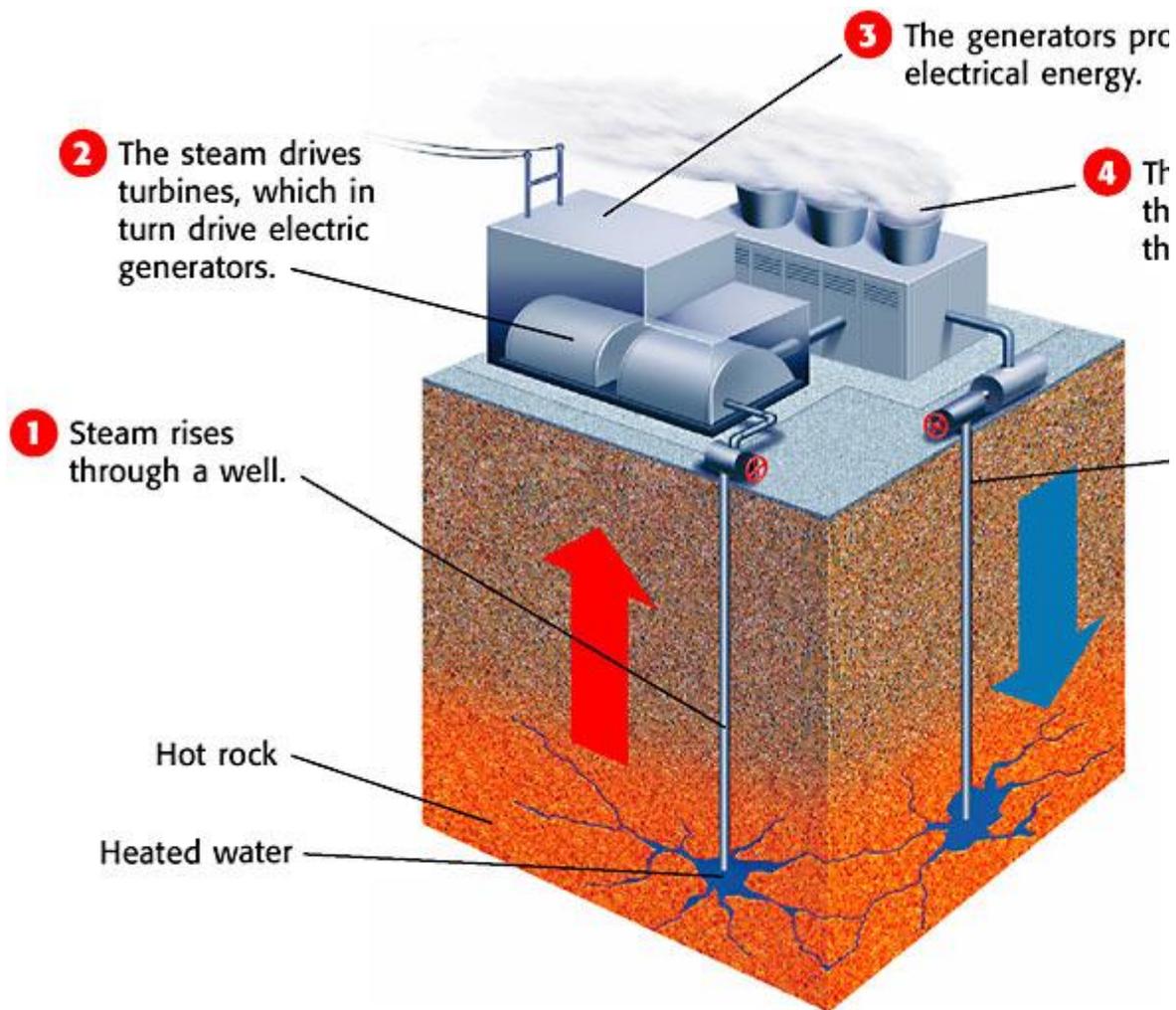
### **Energy from Within Earth**

When *magma*, or melted rock, contacts solid rock, the solid rock heats up. If the solid rock contains groundwater, the water is heated, too. The energy in the hot water can be used to generate electrical energy. The energy produced by the heat within Earth is called **geothermal energy**.

### **Geothermal Energy**

Geothermal power plants pump steam and hot water from rock beneath Earth's surface, as shown in **Figure 7**. The hot water and steam turn turbines that generate electricity. Geothermal energy can also be used to heat buildings. In this process, hot water and steam are used to heat a fluid. Then, the fluid is pumped through a building. Energy from the fluid escapes into the building and heats the building.

### **Figure 7 Using Geothermal Energy**



### Advantages and Disadvantages of Geothermal Energy

Geothermal energy is renewable. It comes from water heated by magma in Earth's interior. Because Earth's core will be very hot for billions of years, geothermal energy will be available for a long time. It adds few pollutants to the air or the land. However, this energy can be used only where magma is near Earth's surface.

## Section Summary

- The usefulness of a resource depends on how easy converting the resource into energy is, how expensive the resource is, and how much of the resource is available.
- Fission and fusion are processes that release nuclear energy. The byproducts of fission are heat and radioactive waste.
- Wind power, solar energy, hydroelectric energy, biomass, and geothermal energy are renewable resources that emit very little pollution.
- Not all alternative energy resources can be generated in all areas. Some alternative energy resources are very expensive.
- Every energy resource has advantages and disadvantages.



## Chapter Summary

### The Big Idea

Sources of energy differ in quantity, distribution, usefulness, and the time required for formation.

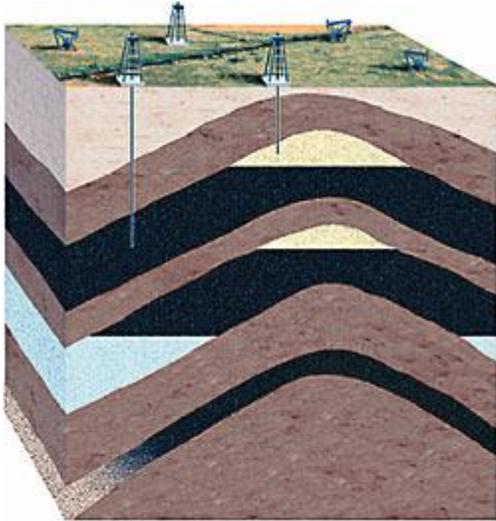
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### Section 1 Fossil Fuels

**Key Concept** Most of the energy used by humans comes from fossil fuels, which are made up of ancient plant and animal matter that stored energy from the sun.

- Fossil fuels are important energy resources.

- Fossil fuels form slowly over very long periods of time.
- Fossil fuels are found and obtained in different ways.
- Fossil fuels are nonrenewable and create pollution when burned.



Wells reach reservoirs of natural gas and petroleum deep in the ground.

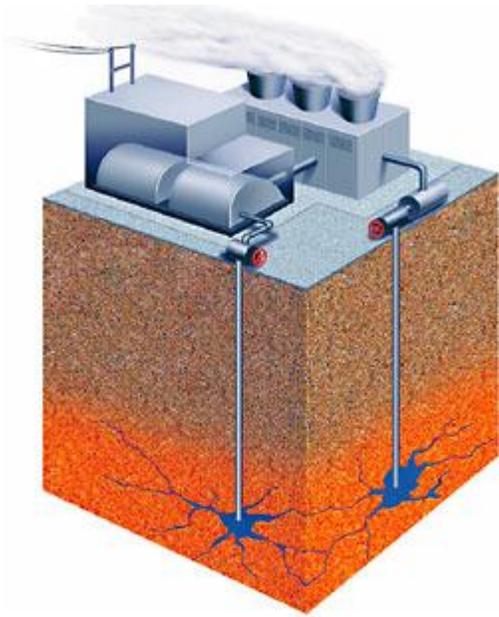
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Geothermal power plants use heat from Earth's interior to generate electricity.

