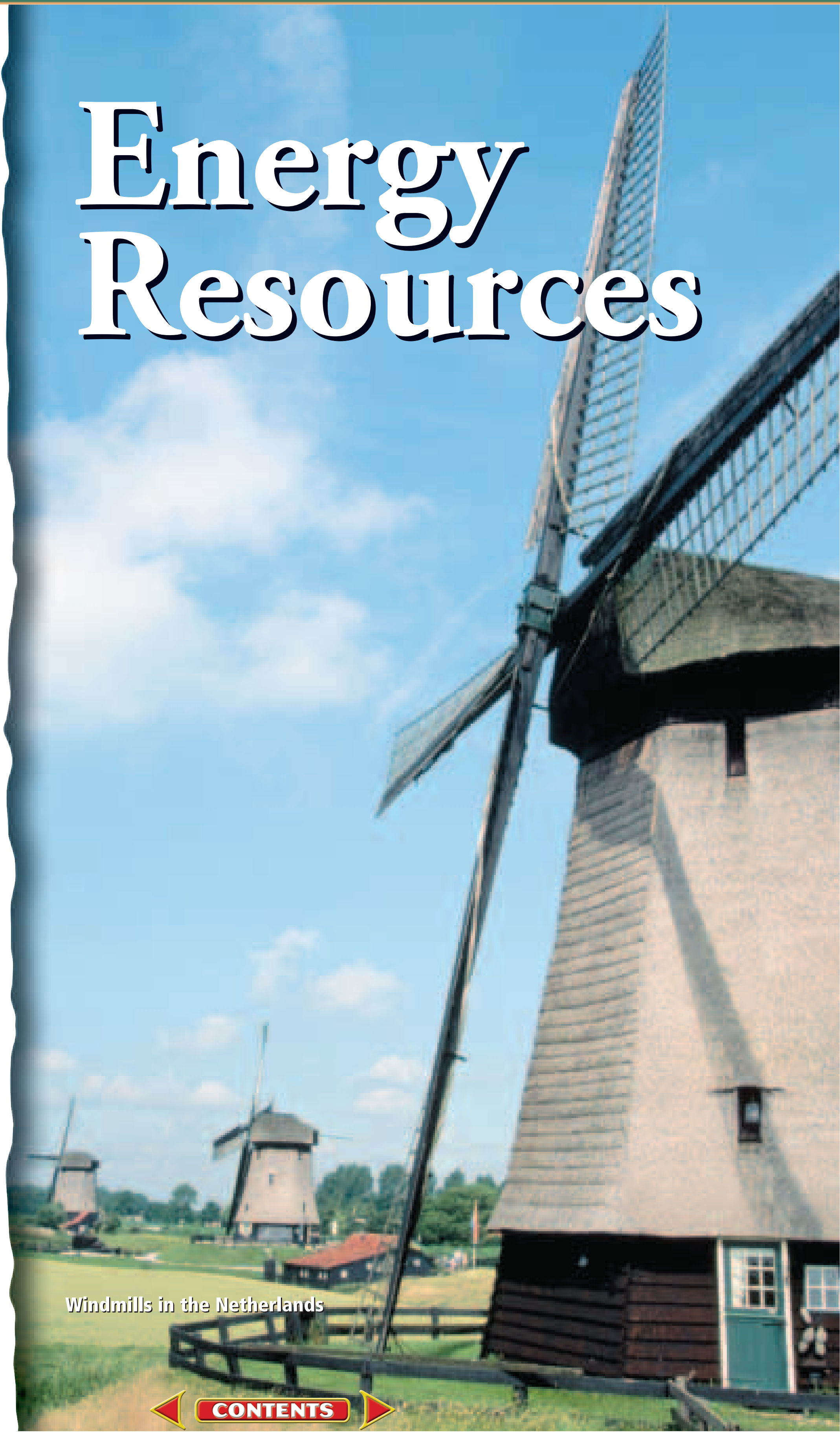
Chapter 26

Energy Resources



Windmills in the Netherlands

What You'll Learn

- What energy resources are found on Earth.
- What alternatives to traditional energy resources exist.
- How conservation can extend both traditional and alternative energy resources.

Why It's Important

Life on Earth could not exist without energy resources. Many commonly used energy resources are nonrenewable; thus, energy conservation and the development of alternative energy resources are necessary to ensure a continuous energy supply.

Earth Science Online

To find out more about energy resources, visit the Earth Science Web Site at earthgeu.com

Discovery Lab

Sources of Energy

Energy cannot be created or destroyed, but it can change form and be transferred. Thus, the same energy can be used over and over again. In this activity, you will observe a type of energy transfer that occurs every day.

1. Add 200 mL of water to a 250-mL glass beaker.
2. Place the beaker on a hot plate.
3. Turn on the hot plate. Observe what happens to the water as it heats up and begins to boil.

CAUTION:* *Always wear safety goggles and an apron in the lab. Allow the beaker to cool before moving it at the end of the activity.

Observe In your science journal, trace the energy source used to bring the water to a boil back to its origin. Describe what happened to the energy as it was used to heat and boil the water. In your description, include an explanation of the source of most energy on Earth. Infer where the energy went when the water began to boil.

SECTION 26.1

Conventional Energy Resources

OBJECTIVES

- **Recognize** *the Sun as the ultimate source of most energy on Earth.*
- **Describe** *how energy changes from one form to another.*
- **Identify** *materials that are used as fuels.*
- **Explain** *how fossil fuels form.*

VOCABULARY

fuel
peat
fossil fuel

What kinds of activities do you engage in each morning? Do you turn on lights or run water for a shower? In the kitchen, you might toast bread or use a microwave oven to heat up your breakfast. You may ride a bus to school or drive a car. All of these activities depend upon energy. Where does most of the energy that you use each morning come from? The energy that humans and all other organisms use comes mostly from the Sun.

TRANSFER OF SOLAR ENERGY

How is solar energy used by organisms? Green plants, protists such as algae, and cyanobacteria are producers that capture the Sun's energy in the process of photosynthesis. In these photosynthetic organisms, solar energy is used for maintenance, growth, and reproduction. Whatever energy is not used right away is stored by the organisms. When consumers eat producers, they use that stored

Figure 26-1 Wheat plants in a field trap the Sun's energy during photosynthesis **(A).** When you eat a breakfast cereal made from wheat **(B),** you are consuming solar energy in another form.

energy for their own life processes. For example, when you eat a breakfast cereal made from grain such as oats or wheat, as illustrated in ***Figure 26-1,*** you are consuming the energy stored by those green plants. In this way, trapped solar energy is transferred through the food chains found in most ecosystems. A food chain is a model that shows how solar energy flows from the Sun to producers and then to consumers in an ecosystem.

Humans also need energy to keep them warm in cold climates, to cook food, to pump water, to grind grain, and to provide light. The energy for all of these purposes also comes primarily from the Sun. Traditional sources of energy, such as wood and peat, are derived from producers such as plants. Even gasoline and kerosene are derived from decayed organisms that first obtained energy from the Sun. When organic materials such as these are burned, the energy stored in them is released.

Figure 26-2 People who live in cold climates require energy to stay warm.

Traditional Sources of Energy

Do you live in an area that has four seasons each year? As you can see in ***Figure 26-2,*** some people live in climates that are very cold for part of the year. Humans have been able to survive in such cold climates primarily because of their ability to alter the environment to meet their needs. Living in cold areas requires humans to use energy to provide heat. Most humans also use energy to provide light and to cook food. The energy for all of these activities is provided by **fuels,** which are materials that are burned to produce heat or power. Probably the earliest use of fuels occurred when humans found pieces of wood that had been struck by lightning and were still burning, and then used them to start fires back at their homesteads. Archaeologists have discovered fire pits in caves that provide evidence that humans burned wood to cook their food many thousands of years ago. Traditional fuels include renewable resources such as wood, dried field crops, and dried fecal material from animals such as cows and bison. In fact, any material that is in good supply and also burns can be used as fuel.

The total amount of living things in an ecosystem is its biomass. Thus, fuels derived from living things are called biomass fuels. In many developing countries, biomass fuels are used to provide energy for cooking and heating. By far, the most commonly used traditional biomass fuel is wood. Today, wood is the primary source of energy for more than half of the world's population.

Wood Humans have been using wood as an energy source for thousands of years. While wood is currently the primary source of energy for only about four percent of households in the United States, roughly 1.5 billion people throughout the world use wood as their primary source of fuel for heating and cooking. Many of these people live in developing countries, which use half of the world's wood supply. Unfortunately, the need to use wood as a fuel has led to deforestation in many areas of the world. As the forests near villages are cut down for fuel, people travel farther and farther away to gather the wood they need. In some parts of the world, this demand for wood has led to the complete removal of forests, which, in turn, has resulted in erosion and the loss of topsoil. In industrialized countries such as the United States and Canada, trees are cut down for lumber and paper production rather than fuel. However, these uses of forest resources can have the same negative impact on the environment.

Field Crops When wood is scarce, humans use other materials, including field crops, as fuel. The simplest way to use field crops, such as corn, hay, and straw, is to burn them directly. Crop residues left after harvest, including the stalks, hulls, pits, and shells from corn, oats, rice, wheat, and nuts, are other sources of energy. All of these can be burned to provide heat. Crops and their residues are most commonly burned for fuel on farms and in homes.

Fecal Material Feces are the solid wastes of animals. In many cases, dried feces contain undigested pieces of grass that help the material to burn. Fecal material from cows often meets the energy needs of people in developing countries that have limited forest resources. People who live in villages in India, Pakistan, and Afghanistan collect animal dung for fuel and dry it on the outside walls of their stables or compounds, as illustrated in ***Figure 26-3.***

Figure 26-3 Traditional energy sources usually are those available locally. Where wood is scarce, people rely on other resources for fuel, such as dried fecal material from cows.

Figure 26-4 Peat is cut into blocks, dried in the Sun, and then burned in stoves and furnaces to provide heat for homes. When it burns, peat has an earthy smell that many people enjoy.

Peat Bogs are poorly drained areas with spongy, wet ground that is composed mainly of dead and decaying plant matter. Plants in bogs include *Sphagnum* moss, which forms large mats on top of the water. When plants in a bog die, they fall into the water. Bog water is acidic and has low levels of oxygen; these conditions slow down or stop the growth of the bacteria that decompose dead organic matter, including plants. As a result, dead and partially decayed plant material builds up on the bottom of the bog. Over time, as the plant material is compressed by the weight of water and by other sediments that accumulate above, it becomes a light, spongy material called **peat,** shown in ***Figure 26-4.*** Most of the peat used as fuel today is several thousands of years old.

Peat has been used as a low-cost fuel for centuries because it can easily be cut out of a bog, dried in the sun, and then burned directly in a stove or furnace to produce heat. Highly decomposed peat burns with greater fuel efficiency than wood. Today, peat is still used to heat homes in Ireland, England, parts of northern Europe, and the United States.

Fossil Fuels

Peat is one of the **fossil fuels,** which are energy sources that formed over geologic time as a result of the compression and partial decomposition of plants and other organic matter. Although peat and all fossil fuels originally formed from once-living things, these energy sources are considered to be nonrenewable because their formation occurred over thousands or even millions of years. The formation of peat is the first step in the development of coal.

Fossil fuels also include coal, natural gas, and petroleum. The high concentration of carbon and hydrogen in fossil fuels makes them very efficient energy sources. Most industrialized countries of the world today, including the United States, depend primarily on coal, natural gas, and petroleum to fuel power plants that provide electricity and to fuel vehicles. You can find out how one oil company preserves the environment while prospecting for fossil fuels in the *Science & the Environment* feature at the end of this chapter. Although fossil fuels are diverse, all of them originated from organic matter trapped in sedimentary rock.

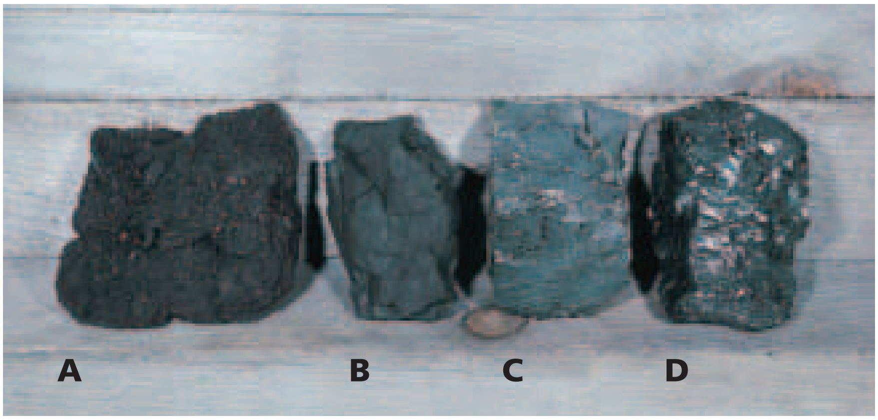


Figure 26-5 Peat **(A)** is light and spongy. Lignite **(B)** is a soft, brown coal. Bituminous coal **(C)** and anthracite **(D)** differ mainly in hardness, color, and carbon content.

Coal During periods of coal formation, tectonic plate movements caused some landmasses to move near Earth's equator. As a result, these areas experienced humid, tropical conditions that supported abundant plant growth. Generations of swamp plants, such as ferns and sedges, grew in the warm, tropical swamps. As each generation died, the organic material settled to the bottom of the swamp and became covered with subsequent generations of dead plants. The limited supply of oxygen was used up quickly, which resulted in a slow rate of decay. Over time, oxygen and hydrogen were lost from the organic matter, and the concentration of remaining carbon increased. Eventually, this compressed organic matter became coal.

Coal can be classified according to the amount of pressure under which it formed and the amount of time involved. ***Figure 26-5*** shows types of coal. When peat continues to be compressed, it becomes a type of coal called lignite, a soft, brown, low-grade coal. Over time, and under increasing pressure, lignite develops into higher grades of coal as it changes from soft bituminous coal to hard anthracite, the highest grade of coal. Carbon concentrations in lignite are generally around 40 percent. In bituminous coal, carbon concentrations can be as high as 85 percent, and in anthracite, these concentrations reach 90 to 95 percent. The higher the carbon concentration, the hotter and cleaner the coal burns.

Anthracite is the most efficient and most cleanly burning coal. However, less than one percent of the coal reserves in the United States are anthracite. Most coal reserves in the United States are bituminous coal; thus, many of the electric power plants in the United States burn this type of coal. When bituminous coal burns, it releases carbon and sulfur and nitrogen oxides into the air, causing air pollution. Although lignite has a low sulfur content—less than 1 percent—and is less expensive than bituminous coal, lignite is a less-efficient fuel; more of it must be burned than other types of coal to provide the same amount of energy.

Earth Science Online

Topic: Fossil Fuels
To find out more about fossil fuels, visit the Earth Science Web Site at earthgeu.com

Activity: World Reserves
Research the amount of petroleum that geologists think is left in the world (reserves). How many barrels are left? How many years will it last?

MiniLab

Oil Migration

Model the migration of oil and natural gas upward through layers of porous rocks.

Procedure

1. Pour 20-mL of cooking oil into a 100-mL graduated cylinder.
2. Carefully pour sand into the graduated cylinder until the sand-oil mixture reaches the 40-mL mark.
3. Now add a layer of colored aquarium gravel above the sand until the gravel reaches the 70-mL mark.
4. Pour tap water into the graduated cylinder until the water reaches the 100-mL mark.
5. Let stand and observe for 5 minutes.

Analyze and Conclude

1. What does the cooking oil represent? What do the sand and aquarium gravel represent?
2. What happens when water is added to the mixture in the graduated cylinder? Why does adding water cause this change?
3. Predict what might occur in the graduated cylinder if a carbonated soft drink was added to the mixture instead of water. What would the bubbles represent?

Petroleum and Natural Gas The word *petroleum* comes from the Greek word *petra,* meaning "rock," and the Latin word *oleum,* meaning "oil"; thus, petroleum was originally known as rock oil. Today, the term *petroleum* is used to refer to the natural crude oil found underground and on Earth's surface in natural seeps, which are areas on Earth's surface where shallow deposits of crude oil ooze upward into pits or creeks, or along beaches. One such seep is illustrated in ***Figure 26-6.*** Crude oil is a mixture of compounds of hydrogen and carbon called hydrocarbons, which can be burned to release energy. Crude oil that is collected on Earth's surface or pumped out of the ground is refined into a wide variety of petroleum products, such as gasoline and kerosene.

Most geologists hypothesize that oil originated organically, in a manner similar to the formation of coal. Millions of years ago, much of Earth's land surface was covered by shallow seas. Rivers carrying mud and silt, along with other sediments, emptied into these seas. Organisms that died in or near the water became part of the sediment load and fell to the bottom of the seas. As layers of sediment accumulated, they were pressed down by the weight of overlaying layers and eventually became sedimentary rocks.

Figure 26-6 La Brea Tar Pits in Hancock Park, Los Angeles, California, are fossil-bearing seeps that ooze crude oil.

Most scientists hypothesize that crude oil and natural gas originated with once-living organisms partly because sedimentary rocks associated with oil deposits, such as sandstone and shale, contain fossils of ancient organisms. Also, because little oxygen could reach the layers of organic matter at the bottom of the seas, bacteria that do not require oxygen partially decomposed the accumulated organisms, and released a waste product called methane, which is one of the components of natural gas.

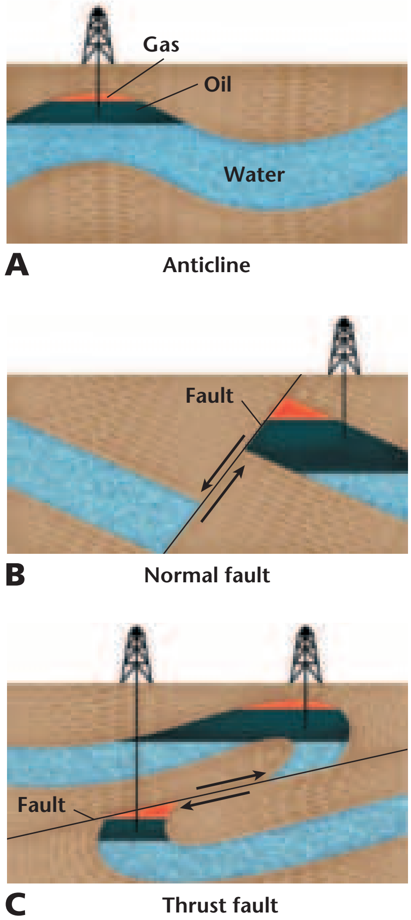


Figure 26-7 These diagrams show typical structural traps for oil and gas deposits.

Migration Crude oil and natural gas migrate sideways and upward from their place of formation. As they migrate, they move through the pores of permeable sedimentary rocks such as limestone and sandstone. These pores in permeable rocks are the reservoirs in which crude oil and gas accumulate. As the oil and gas rise upward, they displace some, but not all, of the water that originally filled the pores. You can find out how oil migrates in the *MiniLab* on the previous page. Oil and gas continue to rise until they reach a barrier of impermeable rock, such as slate or shale, that prevents their continued upward movement. This barrier effectively seals the reservoir and creates a trap for the petroleum. In some petroleum traps, the natural gas forms a gas cap above the oil, but at high pressures, the gas may form a layer below the crude oil. Geologic formations such as faults and anticlines can trap petroleum deposits, as shown in ***Figure 26-7.*** Because most geologists accept the hypothesis that oil and natural gas originated with the sedimentation of once-living organisms, the search for crude oil and natural gas often begins in areas with thick beds of sedimentary rocks. Today, geologists search for oil deposits using remote sensors, magnetometers, and seismographic equipment that create subsurface maps.

SECTION ASSESSMENT

1. What is the primary source of energy on Earth?
2. How does coal form?
3. How does petroleum form?
4. **Thinking Critically** Explain how the energy released by a burning candle originated from the Sun.

Skill Review

5. **Comparing and Contrasting** Compare and contrast the formation of peat and the formation of crude oil. How are these two energy sources alike? How are they different? For more help, refer to the *Skill Handbook.*

earthgeu.com/self_check_quiz

SECTION 26.2 *Alternative Energy Resources*

OBJECTIVES

- **Identify** *alternative energy resources.*
- **Compare** *the advantages and disadvantages of the various alternative energy resources.*

VOCABULARY

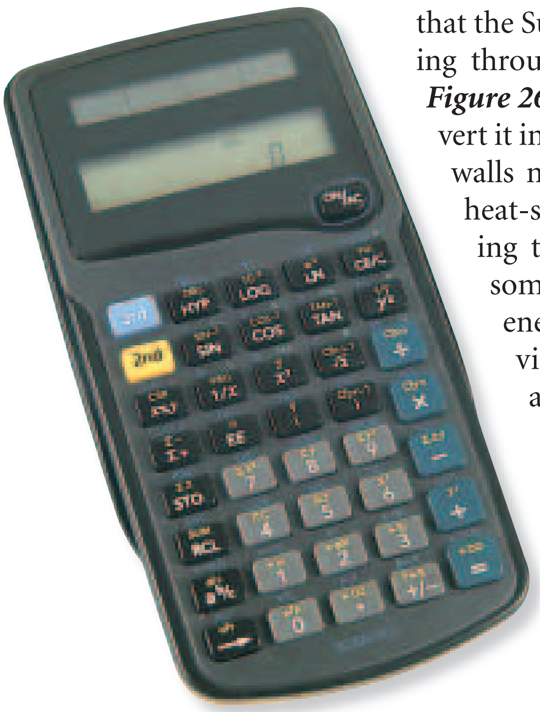
photovoltaic cell
geothermal energy
biogas
gasohol

As you have learned, many of the fuels used today are renewable resources, including wood. Most people, however, rely on nonrenewable fossil fuels for their energy needs. Recently, it has become clear that humans are using up nonrenewable fuels at an alarming rate. Even though there are known reserves of fossil fuels around the world, development of such reserves may be too dangerous, too expensive, or too damaging to the environment to be practical. Some experts estimate that petroleum resources may be used up within the next 60 years. Scientists, private companies, and government agencies are all studying renewable alternatives to traditional energy resources. These alternative energy resources include solar energy, wind, water, geothermal energy, nuclear energy, and biomass.

SOLAR ENERGY

Have you ever used a calculator like the one shown in ***Figure 26-8?*** This calculator has batteries, but it also has a solar collector that uses the Sun's energy to provide power. As you have learned, the Sun is the ultimate source of most energy on Earth. The main advantages of solar energy are that it is free and it doesn't cause any kind of pollution.

Figure 26-8 This hand-held calculator uses solar energy for power.



Passive Solar Heating Have you ever sat on the vinyl seat of a car that had been in direct sunlight for a few hours? If so, you know that the Sun can heat up the inside of a car or a building just by shining through the windows. The sunporch of the house shown in ***Figure 26-9*** uses this principle to capture sunlight directly and convert it into heat. The Sun's energy also can be captured in floors and walls made of concrete, adobe, brick, stone, or tile, which have heat-storing capacities. These materials collect solar energy during the daytime and slowly release it during the evening. In some warm climates, these materials alone provide enough energy to keep a house warm. Passive solar designs can provide up to 70 percent of the energy needed to heat a house, as well as up to 60 percent of the energy needed to cool it. Although a passive solar house can be slightly more expensive to build than a traditional home, the cost of operating such a house is 30 to 40 percent lower.

Active Solar Heating Even in areas that do not receive consistent sunlight, the Sun's energy can still be used for heating. Active solar-heating systems include collectors such as solar panels that absorb solar energy and fans or pumps that distribute that energy throughout the house. Solar panels mounted on the roof, as shown in the house in ***Figure 26-9,*** have unobstructed exposure to the Sun. Heat collected by these solar panels can be used to heat a house directly, or it can be stored for later use in insulated tanks that contain rocks, water, or a heat-absorbing chemical. Solar panels mounted on a roof can heat water up to 65°C (149°F), which is hot enough to wash dishes and clothing.

Figure 26-9 This house incorporates both passive and active solar heating in its design. Deciduous trees help block the Sun in the summer to keep the house cool. In the winter trees lose their leaves, allowing the Sun to warm the house directly.

Solar Cookers Have you ever heard a weather forecaster say that temperatures will be hot enough to cook eggs on a sidewalk? The Sun's energy can cook food when it is focused correctly. Solar cookers can be used effectively where fuels are scarce or expensive, as in countries that have cut down most of their forests. A solar cooker can be as simple as an enclosed box with reflectors to direct the Sun's rays inside the box. More-sophisticated types of solar cookers, such as the parabolic cooker shown in ***Figure 26-10,*** can provide enough heat to boil water by focusing sunlight on one point. When the Sun's rays are focused in this way, however, they can damage eyesight, and therefore dark glasses must be worn when solar cookers are used.

Photovoltaic Cells All of the uses of solar energy described so far rely on direct sunlight. Using direct sunlight is relatively easy, but energy is also needed during hours of darkness and on cloudy days. On overcast days and in areas that don't get much direct sunlight, solar energy cannot be used directly. In addition, solar energy is difficult to store. An economical and practical method of storing large amounts of solar energy for long periods of time has not yet been developed. If such a method were to be developed, there might be no need for any other energy resources.

Until such a method is developed, solar energy is converted into electrical energy by **photovoltaic cells,** which are thin, transparent wafers made up of layers of boron- and phosphorus-enriched silicon. When sunlight falls on a photovoltaic cell, it releases a flow of electrons that creates an electrical current. Although a photovoltaic cell produces only a small amount of electricity, many such cells can be wired together in a panel that provides 30 to 100 W of power. In the same way, several panels wired together increase the amount of power produced. The electricity produced by photovoltaic cells can be stored in batteries.

Figure 26-10 This parabolic solar cooker focuses sunlight on the spot where the cooking pot is placed.

Figure 26-11 A power tower is surrounded by banks of solar panels that reflect and concentrate sunlight onto the tower, where the sunlight is collected and stored in batteries.

Photovoltaic cells are reliable, quiet, and typically should last more than 30 years. They can be installed quickly and can be moved easily. Large-scale groups of cell panels can be set up in deserts and in other land areas that are not useful for other purposes. Today, more than 20 public utility companies in the United States use photovoltaic cells in their operations. Power towers are being used to collect solar energy and produce electricity, as shown in ***Figure 26-11.*** Some scientists estimate that power towers may someday supply 30 percent of the electric power used worldwide.

Energy from Water

Are you familiar with the waterfall pictured in ***Figure 26-12?*** This is Niagara Falls, a waterfall in the Niagara River that straddles the border between the United States and Canada. This waterfall produces electricity for both countries. Water from the falls is diverted into massive turbines. As water falls over the turbines, they turn, producing mechanical energy that drives a generator and produces electrical energy. Energy produced in this way is called hydroelectric power.

The power of falling water also can be harnessed to produce electricity when a dam is built across a large river to create a reservoir. The water stored in the reservoir flows through huge pipes at controlled rates and causes turbines to spin to produce electricity. Today, hydroelectric power provides about 20 percent of the world's electricity and 6 percent of its total energy. Approximately 10 percent of the electricity used in the United States is generated by water, while Canada obtains more than 70 percent of its electricity from this source. Many of the hydroelectric power resources of North America and Europe have already been developed, but in Africa, Latin America, and Asia, many potential sites for hydroelectric power plants have not yet been explored.

One advantage of hydroelectric power is that it is nonpolluting. Dams built to harness hydroelectric energy provide additional

Figure 26-12 The water diverted from Niagara Falls powers huge turbines. Hydroelectric power presently provides 26 percent of the electricity needs of Upstate New York.

benefits in the form of recreational opportunities, drinking water, flood control, and water for irrigation. Dams also have negative impacts, however. When the reservoirs behind dams fill, they flood large areas and force people to move, destroy wildlife habitats, interrupt migration routes for fish, and change the natural pattern of water flow. This causes sediments to accumulate in the reservoir, streambeds downstream to erode, and water quality to degrade.

Energy from the Oceans Ocean water is another potential source of energy. The kinetic energy in waves, which is created primarily by wind, can be used to generate electricity. Barriers built across estuaries or inlets can capture the energy associated with the ebb and flow of tides for use in tidal power plants. One such plant exists at the mouth of La Rance River in France. While power from moving ocean water is renewable and nonpolluting, barriers in the ocean can change the water level and may disrupt coastal and marine ecosystems.

NATIONAL GEOGRAPHIC

To learn more about water, go to the **National Geographic Expedition** on page 898.

GEOTHERMAL ENERGY

Most of the energy sources you have studied in this chapter so far came from the Sun. However, one energy source used today originates from Earth's own internal heat. Some of the hot springs at Yellowstone National Park, in the western United States, regularly shoot out geysers, tall fountains of steam mixed with hot water. Old Faithful is one of the best-known geysers in the world. What causes geysers? Water trapped underground in fractures or in porous rock is heated by Earth's internal heat. Some of the water becomes steam. When the heated water and steam escape through cracks in Earth's crust, they explode upwards in spectacular displays. Energy produced by naturally occurring steam and hot water is called **geothermal energy.** While some geothermal energy escapes from Earth in such small amounts that it is barely noticeable, large amounts of geothermal energy are released at other surface locations. In these areas, which usually coincide with plate boundaries, geothermal energy can be harnessed to heat homes and businesses, used in power plants to produce electricity, and even used to provide recreational opportunities, as illustrated in ***Figure 26-13.***

The U.S. Department of Energy estimates that if the geothermal reservoirs in the United States were developed, they could provide up to 30 times as much energy as the country currently uses.

Figure 26-13 Geothermal reservoirs are most common in areas of high volcanic and seismic activity. In Reykjavik, Iceland, almost 80 percent of the buildings are heated by power plants that draw hot water directly from geothermal wells underneath the city.

Advantages and Disadvantages of Geothermal Energy

One advantage of geothermal energy is that it is abundant and reliable at the sites where it occurs. However, as the water heated by geothermal energy is tapped, cooler water replaces it. To provide continuous power, geothermal energy reservoirs must be managed carefully. For example, in Rotorua, New Zealand, homes are heated with geothermal energy, but the availability of water is decreasing and restrictions are now being placed on its use. Geothermal steam is generally pollution-free, but water heated by geothermal energy frequently contains large amounts of minerals that can clog pipes and pollute surface water. These problems can be eliminated with systems that hold hot water and steam from geothermal reservoirs in closed containers. A greater disadvantage of geothermal energy is that its development can disrupt ecosystems and can cause local air and water pollution. Also, geothermal energy is useful only near sites where it exists, because transporting it is not practical.

Earth Science Online

Topic: Alternative Energy
To find out more about alternative energy sources, visit the Earth Science Web Site at earthgeu.com

Activity: Fuel Cells
Research fuel cells as alternatives to petroleum to power automobiles. What issues must be resolved to make fuel cells practical?

Wind Energy

Have you ever seen a windmill? Windmills in the Netherlands have been capturing wind power for human use for more than 2000 years. Today, wind farms, such as the one shown in ***Figure 26-14,*** are replacing the more traditional windmills that farmers once used to pump water from underground wells. The windmills on a wind farm are more properly called wind turbines, because they convert the energy of the wind to mechanical energy, which is then used to produce electrical energy. Wind energy increases with the cube of the wind speed. For example, when wind velocity doubles, the wind's capacity to generate power increases 8 times.

Figure 26-14 Wind farms such as this one in California produce one percent of the state's electricity.

Most of the wind farms in the United States are in California, yet nearly all of the energy needs of the country could be met if wind farms were built in just three states that experience consistent, steady winds: North Dakota, South Dakota, and Texas. Wind turbines currently provide three percent of the electricity used in Denmark. Experts suggest that wind power could supply more than 10 percent of the world's electricity by the year 2050.

Advantages and Disadvantages of Wind Energy

Wind is a virtually unlimited energy resource at favorable sites worldwide. Locations at high altitudes generally produce the strongest, most consistent winds. Another advantage of using wind energy is that wind farms can be built quickly and expanded as needed. They are nonpolluting and do not require water for cooling purposes, and the land underneath wind turbines can be used for cattle grazing or other farming activities. As a result, wind energy is one of the least expensive ways to produce electricity.

Why isn't wind power used to provide more of the world's electricity? Wind power is economical only in areas with steady winds. When the wind dies down, people have to rely on backup systems for power, including traditional fossil fuel-burning power plants. Other disadvantages of wind farms are that they are not very attractive and they have been shown to interfere with and even kill migrating birds, as well as birds of prey. Windmills also can be noisy and interfere with radio and television reception.

Using Math

Calculating Wind Speed Wind energy increases with the cube of the wind speed. What increase in wind energy would occur if the wind speed quadrupled?

Nuclear Energy

As you learned in Chapter 3, atoms lose particles in the process of radioactive decay. One process by which atomic particles are given off is called nuclear fission. Nuclear fission is the process in which a heavy nucleus (mass number greater than 200) divides to form smaller nuclei and one or two neutrons. This process releases a large amount of energy. Radioactive elements consist of atoms that have a natural tendency to undergo nuclear fission. Uranium is one such radioactive element that is commonly used in the production of nuclear energy. Nuclear energy is one other energy source that does not come directly from the Sun.

In the late 1950s, power companies in the United States began developing nuclear power plants because scientists suggested that nuclear power could produce electricity at a much lower cost than coal and other types of fossil fuels. Another advantage was that nuclear power plants do not produce carbon dioxide or any other greenhouse gases. After 50 years of development, however, 424 nuclear reactors in 25 countries currently are producing only 17 percent of the world's electricity. Construction of new nuclear power plants in Europe has come to a halt, and no new nuclear plants have been built in the United States since 1978.

What happened to the promise of nuclear power? Poor management, high operating costs, poor reactor designs, and public concerns about safety and disposal of radioactive wastes contributed to the decline of nuclear power. In addition, nuclear accidents such as those at Three Mile Island, shown in ***Figure 26-15,*** and at

Figure 26-15 The nuclear power plant at Three Mile Island near Harrisburg, Pennsylvania, lost its coolant water as a result of mechanical failure and human error in 1979. About 70 percent of the core was damaged, and unknown amounts of radioactive materials escaped into the atmosphere.

Figure 26-16 Bales of bagasse are burned to produce the energy that powers this steam locomotive in Java, Indonesia.

Chernobyl, Ukraine, in 1986, alerted people worldwide about the hazards of nuclear power plants. Because of its hazards, nuclear power is no longer considered to be the solution to providing for the world's energy needs, although nuclear power plants continue to provide energy in many countries.

Biomass

Biomass is a renewable energy resource as long as the organisms that provide the biomass are replaced. Biomass fuels include wood, dried field crops, and dried fecal materials from animals. One way to produce biomass fuel is to plant large numbers of rapidly growing plants, such as cottonwood trees, in biomass plantations. After harvest, these plants can be burned directly, converted into gas, or fermented into alcohol fuel.

Bagasse, which is the residue of sugar cane after the juice has been extracted, is another source of biomass that is burned to produce power as illustrated in ***Figure 26-16.*** The burning of bagasse produces approximately 10 percent of Hawaii's electricity supply, and thus, it eliminates the need for approximately 2.7 million barrels of oil each year. Other types of biomass fuels are produced when bacteria and chemical processes are used to convert solid biomass into gaseous and liquid biofuels, such as biogas, liquid ethanol, and liquid methanol. A disadvantage of biomass fuels is that when they are burned, they release carbon dioxide and particulate matter into the atmosphere. Biomass is the main source of energy for more than half of the world's population.

Biogas **Biogas** is a mixture of gases that includes 50 to 70 percent methane gas and 30 to 48 percent carbon-dioxide gas. Plant and animal wastes can be converted into methane gas in simple containers, called digesters, by the action of bacteria. In China, more than 8 million biogas digesters are in use in individual households. In a biogas digester the gas is separated from the solid wastes and piped into homes for use as a cooking fuel. The leftover solid wastes then can be used as fertilizer on food crops, because the high temperatures inside the digester destroy harmful bacteria.

Ethanol and Methanol Liquid ethanol is another name for grain alcohol. Ethanol can be made from sugar and grain crops, including sugar cane, sugar beets, sorghum, and corn. Currently, ethanol produced from corn is used in gasoline mixtures around the world. Gasoline mixed with ethanol makes **gasohol,** which can be burned in conventional gasoline engines. The use of gasohol can extend gasoline supplies and reduce dependency on foreign petroleum reserves. Ethanol fuels burn more cleanly than pure gasoline. Liquid methanol, which is wood alcohol, is made mostly from natural gas, but it can also be made from wood, wood wastes, agricultural wastes, sewage sludge, garbage, or coal.

Figure 26-17 Shale oil is extracted from oil shale, a fine-grained rock. Some oil shale can actually ignite and burn on its own, as this photo shows.

ENERGY FROM OIL SHALE AND TAR SAND

You have learned that crude oil and natural gas can be found in porous sedimentary rocks. Sometimes, other hydrocarbon mixtures become trapped in different types of rocks. For example, oil shale, shown in ***Figure 26-17,*** is a fine-grained rock that contains a solid, waxy mixture of hydrocarbon compounds called kerogen. Oil shale can be mined, then crushed and heated until the kerogen vaporizes. The kerogen vapor can then be condensed to form a heavy, slow-flowing, dark-brown oil known as shale oil. Shale oil is processed to remove nitrogen, sulfur, and other impurities before it can be sent through pipelines to a refinery. At present, the cost of processing oil shale is higher than the cost of crude oil sold by countries that have abundant oil supplies.

Tar sand is a mixture of clay, sand, water, and bitumen, which is a heavy, black, high-sulfur oil. Tar sand also can be mined, then heated until the bitumen fluid softens and floats to the top. Bitumen can be purified and upgraded into a type of crude oil. However, the processing of oil shale and tar sand requires large amounts of energy and produces air and water pollution.

SECTION ASSESSMENT

1. Identify one alternative energy resource that is associated with each of Earth's systems: the atmosphere, hydrosphere, biosphere, and lithosphere.
2. Compare passive and active solar energy.
3. What is gasohol?
4. What alternative energy source would be the least damaging to the environment if the required technology could be developed to harness and use it? Explain.
5. **Thinking Critically** Although solar energy could supply all of the world's energy needs, why isn't it used to do so?

SKILL REVIEW

6. **Making Tables** Prepare a table that compares the advantages and disadvantages of alternative energy resources, including solar energy, hydroelectric energy, geothermal energy, wind, nuclear energy, and biomass. In your table, include the following headings: Location, Limits to Use, Health Hazards, Affordability, Major Advantage, and Major Disadvantage. For more help, refer to the *Skill Handbook*.

earthgeu.com/self_check_quiz

SECTION 26.3

Conservation of Energy Resources

OBJECTIVES

- **Recognize** *the need for the conservation of energy resources.*
- **Identify** *ways to conserve energy resources.*

VOCABULARY

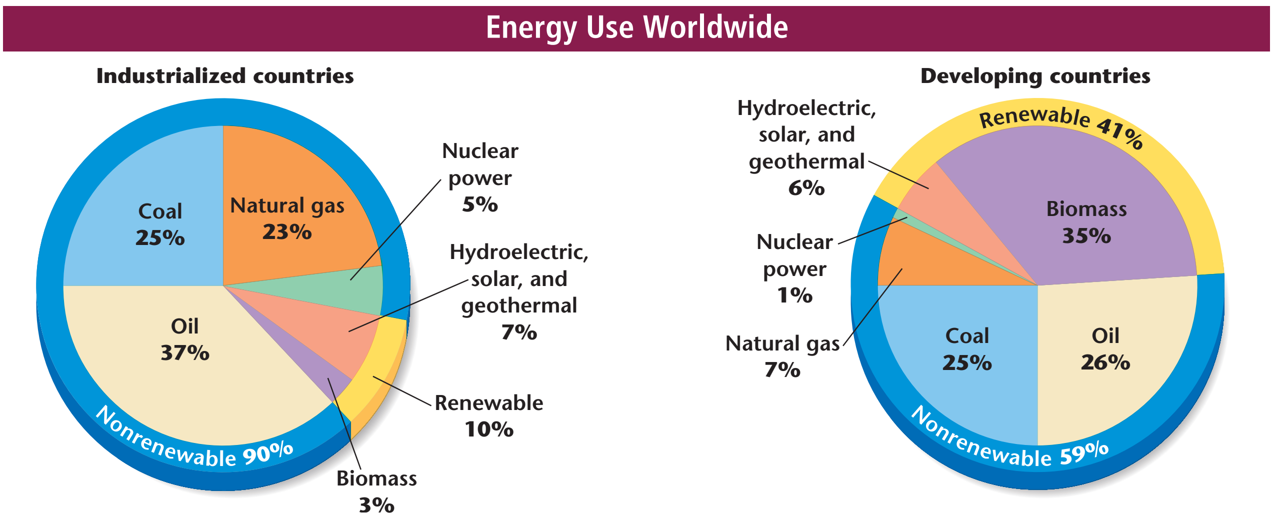
energy efficiency
cogeneration
sustainable energy

As you have learned, traditional energy resources such as fossil fuels are nonrenewable and in limited supply. Yet industrialized countries continue to consume these resources at ever increasing rates. ***Figure 26-18*** compares the energy resources used in industrialized countries to those used in developing countries. The graphs in ***Figure 26-18*** show that renewable resources account for 41 percent of the energy used in developing countries, in comparison to industrialized countries where renewable resources account for only 10 percent of the energy used. Experts have concluded that the best way to meet energy needs is a combination of improved energy efficiency and increased use of locally available, renewable energy resources. This means that it is better to use a variety of energy resources at all times than to depend upon a single, nonrenewable energy resource such as oil, coal, or natural gas. For example, a community that has hydroelectric energy resources may also use solar energy to generate electricity in months when water levels are low.

ENERGY EFFICIENCY

Energy efficiency is the use of energy resources in the ways that are most productive. This means using the same amount of a resource but getting more from it. To find ways to use resources more efficiently, scientists study exactly how energy resources are used and where improvements are needed. Using resources more efficiently is a type of conservation.

Figure 26-18 This graph shows the relative amounts of energy used by industrialized and developing countries worldwide.



How can energy efficiency be improved? Energy analysts have suggested several ways of doing so. People can recycle old appliances and vehicles, and purchase newer, more energy-efficient models. They also can improve the energy efficiency of older homes by adding insulation, installing solar panels, or by installing new windows, or they may purchase newer, energy-efficient homes. Local power companies can use energy from alternative resources in areas where they are available to decrease their dependence on petroleum. Governments also can help by offering tax savings to people who buy more-efficient vehicles and appliances, and by funding research and development projects related to energy efficiency.

Conservation of Energy Resources Do you wet your toothbrush, then turn off the water while you brush your teeth? When you leave an empty room, do you turn off the lights? You can probably think of many other ways that you could conserve energy at home, at school, and in the workplace. Conserving energy is, in the long run, less expensive than finding new energy sources. You can find out how energy use has changed in the *Problem-Solving Lab* on this page.

Problem-Solving Lab

Changes in Energy Resource Use

Analyze how the use of energy resources has changed Many types of energy resources are used throughout the world. Over time, fluctuations occur in the amount of each resource used. The data in the table show the changes that have occurred in world energy use between 1900 and 1997. Are these changes good or bad?

Analysis

1. Plot the data in the table on a graph. Use a different color for each year.

Thinking Critically

2. Of all the energy used between 1900 and 1997, what percentage was nonrenewable?
3. What trend in the use of renewable energy sources is evident?
4. What concerns are reflected by the data? How can these concerns be addressed?

World Energy Use

Energy Source	Percent of Total Energy Provided	
	1900	1997
Coal	55	22
Oil	2	30
Natural gas	1	23
Nuclear power	0	6
Alternatives (biomass, hydroelectric energy, wind, solar energy, geothermal energy)	42	19

Getting More for Less

The usual approach to energy use in industrialized countries has been to spend more to get more. Higher demand requires a greater supply and results in higher costs. The price that people in these countries pay for energy is high. This is especially true of electrical energy. Electricity is costly to produce and it is not efficiently used in homes or industry. In the United States, approximately 43 percent of the energy used by motor vehicles and to heat homes and businesses is wasted. One solution is to shift to the more efficient use of energy rather than the search for more energy. If this became the norm, less energy would be needed, thus helping the total cost of energy to go down.

Figure 26-19 Fluorescent lightbulbs like this one can be used in most lamps to save energy.

One example of this concept involves merely changing the type of lightbulb in a lamp. Replacing an incandescent lightbulb with a compact fluorescent lightbulb, shown in ***Figure 26-19,*** would save the consumer $35 to $50 over the 10-year life of the lightbulb. Replacing just 25 incandescent lightbulbs in a house with fluorescent ones could save between $87 to $125 each year in electricity costs. Use of fluorescent lightbulbs or other energy-efficient lighting could save businesses in the United States alone billions of dollars per year in the cost of electricity. In addition, less energy would be used. This would help to reduce the amount of coal or other fossil fuels needed for generation of electricity, which could in turn decrease the amount of carbon dioxide and sulfur dioxide emitted into the atmosphere. The net effect would be a reduction in air pollution.

Cogeneration When power plants generate electricity, waste heat is given off during the process. However, it is possible to recover this waste heat and use it to produce another form of energy. The production of two usable forms of energy, such as steam and electricity, at the same time from the same process is called **cogeneration.** Cogeneration can produce income and reduce the need for additional energy resources. One secondary use of the heat given off by the generation of electricity is the warming of buildings or water. Another is the operation of electrical devices in the power plant, such as scrubbers, which remove sulfur from the air emitted from smokestacks. Cogeneration has enabled Central Florida to operate the nation's cleanest coal-powered electric facility. Sweden has achieved an 85-percent energy efficiency rating while releasing only a fraction of the nitrogen-oxide and sulfur-oxide emissions that are permitted for coal-powered facilities in the United States.

Figure 26-20 Electric cars generally are smaller than gasoline-powered vehicles, and they have a limited range. However, for trips close to home at moderate speeds, these vehicles are extremely efficient and nonpolluting.

Improving Efficiency in Transportation Transportation is necessary to move food and other goods from one place to another, and to move people from their homes to workplaces, schools, stores, and other places. Although transportation requires the use of fuel, conservation practices can help reduce dependency on the fuel resources used for transportation.

The use of fuel-efficient vehicles is one way to reduce the amount of petroleum resources consumed. Automobile manufacturers now have the ability to build vehicles that achieve high rates of fuel efficiency without sacrificing performance. Laws that lower speed limits help improve fuel efficiency, because engines burn fuel more completely at lower speeds. The future of this industry looks especially promising as hybrid and electric cars, such as the one shown in ***Figure 26-20,*** begin to reach the consumer market.

People who live in metropolitan areas can improve energy efficiency by using public transportation. When it is necessary to drive private automobiles, carpooling can reduce the number of vehicles on the highways and reduce gasoline consumption. Carpooling also eases congestion on major highways in and around large cities. Some metropolitan areas, such as Washington, DC, encourage carpooling by providing express lanes for cars with multiple passengers, as illustrated in ***Figure 26-21.*** In Europe, mass transportation includes long-distance rail systems, as well as electric trams and trolleys in the major cities.

People who live in rural areas are often dependent on automobiles. In many rural areas, modes of transportation other than the automobile are limited or nonexistent. However, with the increasing importance

Figure 26-21 Special lanes for car pools encourage people to leave their cars at home and travel with a friend or two to work each day, thus reducing total vehicle emissions.

of computers and access to the Internet, more jobs can be performed from home. The use of bicycles for short distances is another option in some places. In China, a country of 1.3 billion people, approximately 300 million bicycles are in use.

Improving Efficiency in Industry While industries use one-third of all energy produced in the United States, cogeneration has allowed some industries to increase production while leveling off their energy use. This has been accomplished in part by the use of more efficient machinery. Industries can further improve their energy efficiency by making greater efforts to reduce their use of both materials and the energy used to produce those materials. For example, packaging can be reduced overall, and unnecessary packaging can be eliminated. These efforts would cut down on resource use, lower costs, and also reduce the amount of solid waste.

Increasing Efficiency at Home People can do many things in their own homes to conserve energy. For example, fluorescent lights last longer than incandescent bulbs and need to be replaced less frequently. The use of energy-efficient appliances can also make a significant difference in energy consumption. This is especially true of appliances that consume large amounts of energy, such as refrigerators, water heaters, and ovens.

The use of more-efficient insulation on existing homes can result in dramatic savings on heating costs, especially in climates with cold winters. As warm air rises, heat escapes through windows, chimneys, and roofs. Weather-stripping around doorways and caulking around older windows can help keep cold air outside and warm air inside. Insulating pipes and water heaters also reduces energy consumption.

Building materials and windows are rated according to their insulation abilities. Construction materials are labeled with these ratings, known as R-values, as shown in ***Figure 26-22.*** The use of materials with high insulation values can significantly reduce energy consumption. Replacing older windows can save so much money in reduced energy costs that the windows pay for themselves in just a few years.

When new structures are built, the use of energy-efficient materials and windows can have a major impact on future energy needs. Designs for new buildings that incorporate

Figure 26-22 Insulation is rated by its R-value, which is the resistance to heat flow. An R-value of 18 indicates that this insulation is more efficient at retaining energy than insulation with an R-value of 3.

passive and active solar heating also can reduce the need for the consumption of traditional energy resources. Find out more about solar heating in the *Design Your Own GeoLab* at the end of this chapter. Some window manufacturers now triple-glaze their windows, as shown in ***Figure 26-23,*** or place an inert gas between the panes to reduce energy loss. Superinsulation and air barriers in new homes built in Minnesota recently resulted in heating savings of 68 percent. Newly constructed buildings that are designed to save energy cost more initially, but they can save money and resources in the long run.

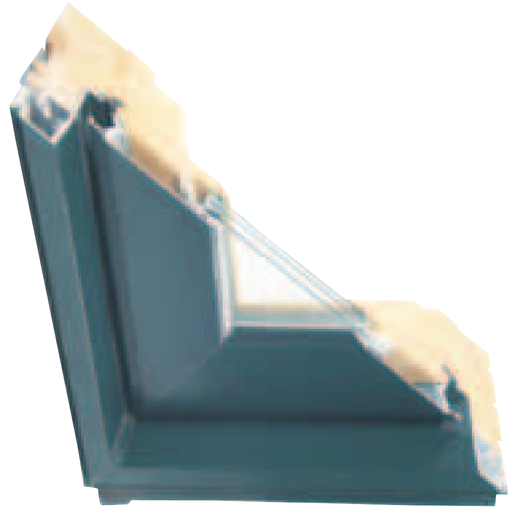


Figure 26-23 A triple-glazed window is one that has either three panes of glass or two panes of glass with a middle layer of plastic film. Some triple-glazed windows also have an inert gas, such as argon or krypton, between the layers to improve the insulating ability of the windows.

Sustainable Energy

All humans have needs for energy, but these needs vary. Energy resources on Earth are interrelated, and they affect one another. **Sustainable energy** involves the global management of Earth's natural resources to meet current and future energy needs without causing environmental damage. A good management plan incorporates both conservation and energy efficiency. The development of new technology to extend current resources and provide additional energy resources is a vital part of such a plan. Global cooperation can help ensure the necessary balance between protection of the environment and economic growth. The achievement of these goals will depend on the commitment made by all to ensure that future generations have access to the energy resources required to maintain a high quality of life on Earth.

Section Assessment

1. Why should you be concerned about energy efficiency?
2. Describe three ways in which you could conserve electrical energy in your home.
3. How does cogeneration save energy resources?
4. Why is it important to conserve resources instead of seeking new sources of energy?
5. **Thinking Critically** Why is there such a difference in energy consumption among different countries, such as the United States and India?

Skill Review

6. **Concept Mapping** Use the following terms to construct a concept map of the major concepts in this section. For more help, refer to the *Skill Handbook.*

conservation, cogeneration, energy efficiency, natural resources

DESIGN YOUR OWN GeoLab

Designing an Energy-Efficient Building

Buildings can be designed to conserve heat energy. Some considerations involved in the design of a building that conserves heat include the materials that will be used in construction, the materials that will store heat, and the overall layout of the building.

Preparation

Problem

How can a building be designed to conserve energy? What building materials will work best, and what other factors need to be considered?

Possible Materials

glass or clear plastic
sturdy cardboard boxes
scissors
tape
glue
thermometers
paints of various colors
materials to cover the building (paper, aluminum foil, foamboard, and so on)
interior materials (stones, mirrors, fabric, and so on)
light source

Hypothesis

Brainstorm a list of design features that might contribute to the energy efficiency of a building. Hypothesize how you could incorporate some of these features into an energy-efficient building. Find out what materials are used in heat-efficient homes and research local sources of materials for your design.

Decide how you will determine the heat efficiency of the building you construct. Be sure to plan for a control building for comparison.

Objectives

In this Geolab, you will:

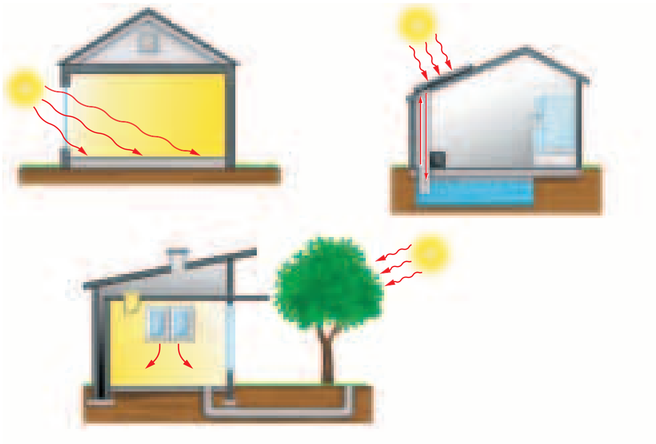
- **Research** what materials are used in the construction of energy-efficient buildings.
- **Design** a building that is energy efficient.
- **Construct** the building that you design.
- **Determine** the heat efficiency of the building by comparing it to a control building.
- **Interpret** the data that you collect to determine your success in developing an energy-efficient building.

Safety Precautions

Be careful when you are using scissors. Make sure to handle the light source carefully when it is hot. Always wear safety goggles and an apron in the lab.

Plan the Experiment

1. Review the data that you collected about building energy-efficient buildings. Also review your list of possible design features.
2. Design your building. Make a list of the heat-conserving issues that you addressed.
3. Decide on the materials that you will use to build your house. Collect those materials.
4. Construct the building and a control building for comparison.
5. Devise a way to test the heat-holding ability of each building.
6. Proceed with the test on each building. To test the buildings' heat energy efficiency, it may be necessary to heat the buildings and determine how long heat is conserved within each one. ***CAUTION:*** *Make sure the heat source is far enough away from the building materials so that they do not burn or melt.*
7. Record your data in a table. Then, make a graph of your data.
8. Make modifications to the design to improve the building's efficiency.



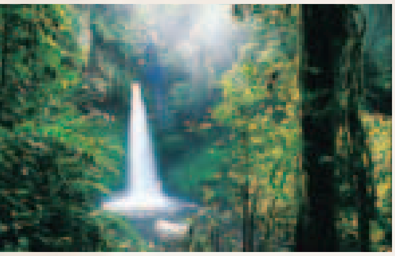
Analyze

1. **Checking Your Hypothesis** Was the building that you designed more energy-efficient than the control building? Why did you construct a control building?
2. **Interpreting Observations** What problems did you encounter, and how did you solve them?
3. **Observing and Inferring** How did your observations affect decisions that you might make if you were to repeat this lab? Why do you think your design worked or did not work?
4. **Comparing and Contrasting** Compare and contrast the building you designed and the control building. Compare and contrast your design and the designs of your classmates.
5. **Thinking Critically** Suppose you could use only naturally occurring materials. Would that limit your design? Explain your answer.

Conclude & Apply

1. How could you incorporate some of your design elements in your own home?
2. How could your design be improved?
3. How could using different energy sources affect your results?

Science & the Environment



Preserving the Rain Forest

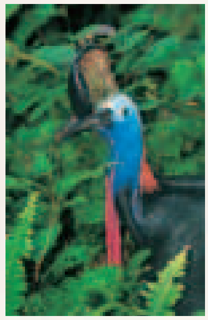
Papua New Guinea's rain forest is home to a diverse population of living things. Huge butterflies glide through the air along with more than 700 species of tropical birds. This paradise also contains extinct volcanoes and beautiful waterfalls.

Imagine the distress the people of Papua New Guinea must have felt when a multinational petroleum company announced that it had plans to search for oil in their rain forest home. Plans to begin drilling for oil in the Kikori area of Papua New Guinea met with local opposition immediately. The oil company responded by teaming up with the government of Papua New Guinea to develop a comprehensive environmental plan. This plan called for the study of archaeological, cultural, and socioeconomic impacts that the extraction of oil would have on the rain forest. In addition, the company enlisted the help of an international wildlife organization to study the environmental impacts of oil extraction. The Kikori Integrated Conservation and Development Plan is the result of that study. It includes a major biodiversity survey of the area, experimental projects in ecotourism and ecoforestry, and training of personnel in conservation management. The project has now become a model for development in Papua New Guinea.

Protecting the Ecosystem

Since the beginning of oil drilling in the Kikori area, most of the rain forest has been left intact. The clearings for oil drilling equipment are small; only as much room as is needed has been cleared of vegetation. When crews are finished working in an area, it is reseeded with native plants. Only essential roads have been built; most roads are narrow and hard to see from above. Supplies are brought in by boats or seaplanes.

Birds Tell the Tale



Once oil drilling operations in tropical rain forests begin, wildlife often leave. However, in the Kikori area, tropical birds such as the bird of paradise remain. Bird watchers are amazed to see that many endangered species of birds still call the rain forest home. These include the double-wattled cassowary, shown in the photograph above, a flightless bird that is related to emus.

Other Benefits

The oil company has built schools and trained local residents in health and sanitation methods. In addition, the company has donated money to a fund that protects tropical birds. In these ways, oil companies can continue to search for and extract oil while preserving the environment.

Activity

Research the endangered bird species found in Papua New Guinea. Choose one bird species and report on how it nests, what it eats, what part of the rain forest it lives in, and so on. Find a photograph of the bird in a book or go to earthgeu.com and make a drawing of the bird to include in your report.

CHAPTER 26

Study Guide

Summary

SECTION 26.1

Conventional Energy Resources

Main Ideas

- The Sun is the ultimate source of most energy on Earth. The Sun's energy is transferred from photosynthetic organisms to all other living things.
- Materials derived from living things, known as biomass, have been used as renewable fuels by humans for thousands of years.
- Wood continues to serve as a fuel for over half of the world's population.
- Fossil fuels, such as natural gas, coal, and petroleum, formed from organisms that lived millions of years ago. The burning of these fossil fuels releases sulfur into the atmosphere, and thus contributes to air pollution.

Vocabulary

fossil fuel (p. 686)
fuel (p. 684)
peat (p. 686)

SECTION 26.2

Alternative Energy Resources

Main Ideas

- Alternative energy resources, such as solar energy, water, geothermal energy, wind, nuclear energy, and biomass, can supplement dwindling conventional energy resources.
- Solar energy is unlimited, but technological advances are needed to find practical solutions to collect and store it.
- Hydroelectric power is derived from the energy of moving water and is commonly used in the production of electricity. Geothermal energy is a product of Earth's internal heat. Its usefulness is limited to areas where it is found near Earth's surface. Wind is a source of energy in areas that have consistently strong winds.
- Nuclear energy results when atoms of radioactive elements emit particles in the process known as fission.
- Oil shale and tar sand contain secondary oil resources that are expensive to extract.

Vocabulary

biogas (p. 696)
gasohol (p. 696)
geothermal energy (p. 693)
photovoltaic cell (p. 691)

SECTION 26.3

Conservation of Energy Resources

Main Ideas

- Energy resources will last longer if conservation and energy efficiency measures are developed and used. Energy efficiency results in the use of fewer resources to provide more usable energy.
- Cogeneration, in which two usable forms of energy are produced at the same time from the same process, saves resources in the long run.
- The achievement of sustainable energy use will ensure that current and future energy needs are met while maintaining standards of living and at the same time protecting the environment.

Vocabulary

cogeneration (p. 700)
energy efficiency (p. 698)
sustainable energy (p. 703)

CHAPTER 26

Assessment

Understanding Main Ideas

1. What is the ultimate source of most energy on Earth?
   a. tides c. the Sun
   b. radioactivity d. the mantle

2. Which product can be made from crude oil?
   a. kerosene c. cornmeal
   b. peat d. biogas

3. Which is NOT derived from living things?
   a. petroleum c. peat
   b. coal d. photovoltaic cells

4. Which is NOT a biomass energy resource?
   a. wood c. fecal material
   b. sugar cane d. wind

5. In which process is the Sun's energy captured and used for food production in living things?
   a. photosynthesis c. radioactivity
   b. respiration d. combustion

6. What organic fuel is derived from moss and other bog plants?
   a. bagasse c. biogas
   b. peat d. oil shale

7. Which is NOT a fossil fuel?
   a. crude oil c. lignite
   b. bituminous coal d. biogas

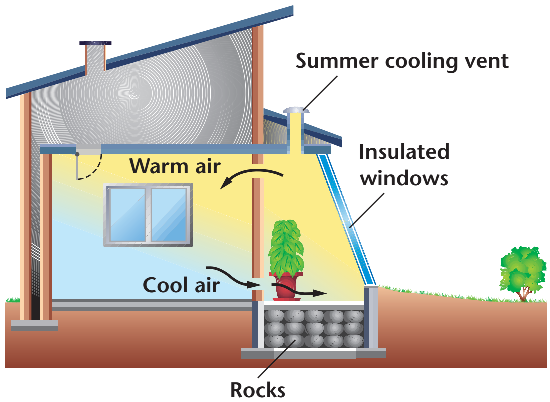
8. What percentage of the world's electricity is provided by falling water?
   a. 50 percent c. 30 percent
   b. 20 percent d. 60 percent

9. How many nuclear reactors are producing electricity in the world today?
   a. 25 c. 17
   b. 50 d. 424

10. Which is NOT a type of fuel?
   a. wood c. the Sun
   b. kerosene d. coal

Use the diagram to answer questions 11, 12, and 13.

11. The diagram represents a house in New York with a glass-enclosed porch. Which direction should the porch be facing to take advantage of passive solar heating?
   a. north c. east
   b. south d. west



12. What material should be used as flooring in the porch to reduce the need for a furnace to heat the room?
   a. wall-to-wall carpeting c. oak
   b. slate d. vinyl tile

Test-Taking Tip

DIAGRAMS If a test question requires you to understand a diagram, check the labels carefully. Then test yourself by mentally explaining the diagram.

Assessment

13. To make full use of the energy-conservation abilities of this house, what landscape plants should be planted in front of the porch?
    a. tall deciduous trees
    b. short evergreen bushes
    c. short evergreen trees
    d. ornamental grasses

Applying Main Ideas

14. Why isn't wind energy used to provide electricity in most parts of the northeastern United States?
15. What are two problems associated with the use of solar energy?
16. How is the production of oil from oil shale similar to coal mining?
17. Describe five ways in which you could improve energy efficiency in your home.
18. Explain why nuclear energy is no longer considered to be a solution to providing for the world's energy needs.

Thinking Critically

19. How can a household that uses only electricity be responsible for depleting fossil fuel reserves?
20. Why is the deforestation of tropical rain forests a global concern?
21. What might be some negative consequences of a nation being dependent on foreign energy resources?
22. Explain how using closed containers in geothermal reservoirs is similar to saving energy in cogeneration.

Standardized Test Practice

INTERPRETING SCIENTIFIC ILLUSTRATIONS

Use the illustration below to answer questions 1 and 2.

1. How could this kitchen be made more energy efficient?
    a. by maintaining older appliances instead of replacing them with newer ones
    b. by replacing the fluorescent light bulb with an incandescent one
    c. by washing the dishes in the dishwasher instead of the sink
    d. by replacing the old windows with newer ones

2. If this kitchen was located in a house in China, which alternative energy source would most likely be used in it?
    a. bagasse
    b. biogas
    c. gasohol
    d. oil shale

3. Which type of coal is the most efficient and burns most cleanly?
    a. peat
    b. lignite
    c. bituminous coal
    d. anthracite

4. Which is NOT a good way to conserve transportation energy?
    a. drive at a lower speed
    b. make frequent stops
    c. work from home
    d. use a hybrid or electric car