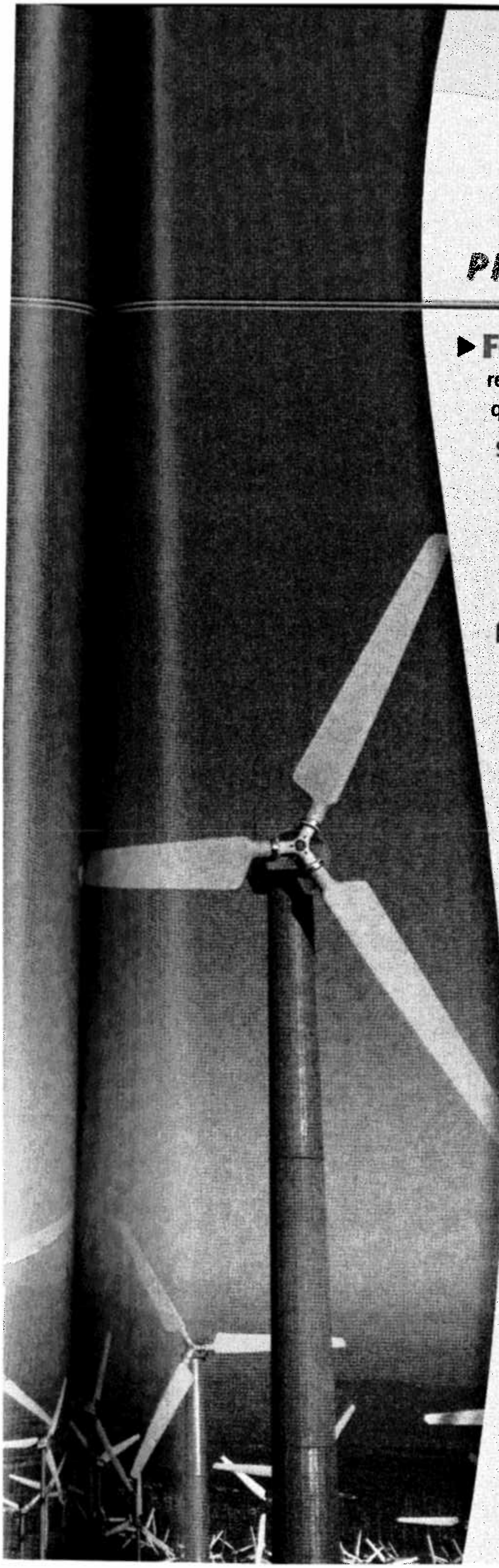
CHAPTER 7

Resources and the Environment

The air that moves the blades of these windmills near Palm Springs, California, is one of Earth's many resources.

What are Earth's resources, and how does the way we use them affect Earth's environment?



CHAPTER 7

PREVIEW

▶ FOCUS QUESTIONS **In this chapter you will study Earth's resources and environment and learn more about the key questions below.**

Section 1 What types of resources are part of Earth's environment, and how are they important to humans?

Section 2 What are nonrenewable and renewable energy resources?

Section 3 How does the use of Earth's resources affect Earth's environment?

▶ REVIEW TOPICS **As you investigate Earth's resources and environment, you will need to use information from earlier chapters.**

- interactions and the four spheres **(p. 11)**
- isotopes and uranium **(pp. 92–93)**
- mineral **(p. 96)**
- rock-forming minerals **(p. 104)**
- mineral groups **(pp. 108–111)**

▶ READING STRATEGY

SET A PURPOSE

Read the key questions listed above. Before you begin reading Chapter 7, write a sentence or two in your science notebook that identifies a purpose for reading each section. Consider what questions about Earth's resources and environment you would like answered by your reading.

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EARTH NEWS

VISUALIZATIONS
- Coal Formation
- Nuclear Fission

LOCAL RESOURCES

CAREERS

INVESTIGATIONS
- What Happens When an Oil Spill Occurs?
- Why Is this Place Protected?
- What Environmental Changes Can We See with Satellites?

7.1

KEY IDEA

Earth has renewable and nonrenewable resources. Humans' demand for and use of resources sometimes exceeds the available supply.

KEY VOCABULARY

- environment
- renewable resource
- nonrenewable resource
- ore mineral
- reserve

Mineral Resources

You've probably heard that it's important to "protect Earth's environment," but what does that phrase mean? Earth's **environment** includes all of the resources, influences, and conditions near Earth's surface. We can make responsible decisions about the use of Earth's resources if we first know the types of resources available and how quickly they are used and renewed.

Renewable or Nonrenewable?

Some of Earth's most important resources, including air, water, land, and sunlight, are basic to life. Other resources have become critical to the world economy only since the 19th century. These include energy resources such as coal and oil and raw materials such as minerals and metal ores.

Earth's resources are classified as renewable and nonrenewable. A **renewable resource** is one that can be replaced in nature at a rate close to its rate of use. Examples are oxygen in the air, trees in a forest, food grown in the soil, and energy from the sun. See the table below.

A **nonrenewable resource** exists in a fixed amount or is used up faster than it can be replaced in nature. Nonrenewable resources include geological resources such as oil, and the metals, nonmetals, and other energy sources listed in the table on the following page. Some geological resources can be reused. Most, especially those used as energy resources, are destroyed once they are used.

Included among nonrenewable resources are the mineral resources mined from Earth's surface. Each United States citizen consumes, on average, about 40,000 pounds of new minerals a year. Minerals provide, for example, stone and cement for building, silicon for fiber optics and computer parts, fertilizers for farming, and aluminum for cars and trucks.

RENEWABLE RESOURCES Sunlight and trees are renewable resources.

SUMMARY Some Common U.S. Renewable Resources

Resource	Type	Some Common Uses
air	nonmineral	respiration in organisms, generation of electricity
water	nonmineral	drinking, growth of crops, generation of electricity, transport
crops	nonmineral	food for humans and livestock, production of fabrics
forests	nonmineral	production of paper, building materials, medicines
sunlight	nonmineral	growth of crops and other plants, home heating, generation of electricity
soil	mixture of minerals and organic matter, water, air, and live organisms	growth of crops, foundation for buildings
ice	mineral based	food storage and preparation, recreation, medical and industrial uses

Earth's Minerals

In Chapter 5 you learned that chemical elements can be divided into two general categories, the metals and the nonmetals. Of the two, the metallic elements are of greater economic importance.

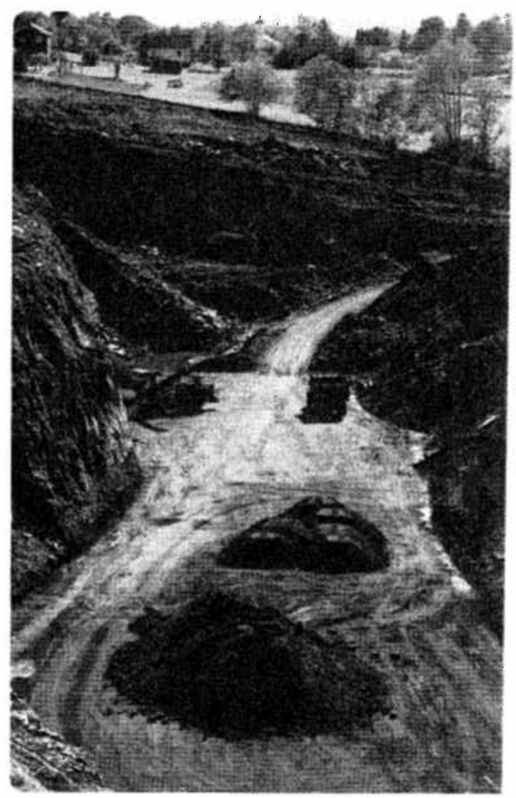
All economically important metallic elements are obtained from minerals. Some of these elements, such as gold and silver, commonly occur as native metals—uncompounded with other elements—and can easily be separated from the rock surrounding them. Often, however, metals are found chemically combined with other elements. A metal must be chemically separated from other elements before it can be used. In either case, the element is often only a small part of the rock in which it occurs.

Rock that contains enough of a metallic element to make separation profitable is called an ore. Iron ore and copper ore are examples of rocks from which metallic elements (iron and copper) can be removed. The valuable mineral, the metallic element, is called an **ore mineral.** The rest of the rock is known as gangue (gang). Quartz, feldspar, and calcite are common gangue minerals.

There are important mineral resources other than those from which metals are extracted. Unlike ores, many of these resources are used in the forms in which they come out of the ground. Others are separated from surrounding materials by means of simple physical processes. Such resources include sand, gravel, building stone, rock salt, talc, and graphite.

SUMMARY Some Common U.S. Nonrenewable Resources

Resource	Type	Some Common Uses
coal	nonmineral	generation of electricity
petroleum	nonmineral	production of gasoline, kerosene, fuel oil, lubricants, plastics, fertilizers, dyes, and medicines
natural gas	nonmineral	fuel; production of plastics, fertilizers, dyes, and medicines
sand, gravel, building stone, crushed stone	mineral based	construction of roads and buildings
salt	mineral based	production of chemicals, clearing road ice, food preservation
talc	mineral based	talcum powder, filler in paints and rubber
graphite	mineral based	dry cells, lubricants
sulfur	mineral based	soil conditioner, fungicides, production of sulfuric acid
gypsum	mineral based	plasterboard, plaster products
uranium	mineral based	generation of electricity, medical and industrial uses
phosphate rock, potash, nitrates	mineral based	fertilizers



NONRENEWABLE RESOURCES Coal, shown being mined at a Pennsylvania strip mine, is used faster than it can be replaced in nature.

Supply and Demand

Stores operate on the principle of supply and demand. That is, they try to provide supplies of products to meet the needs (demand) of the shoppers who want to buy the products. Similarly, the use of mineral resources is a matter of supply and demand. Unlike manufactured goods, however, minerals are not replaced as fast as or faster than they are used.

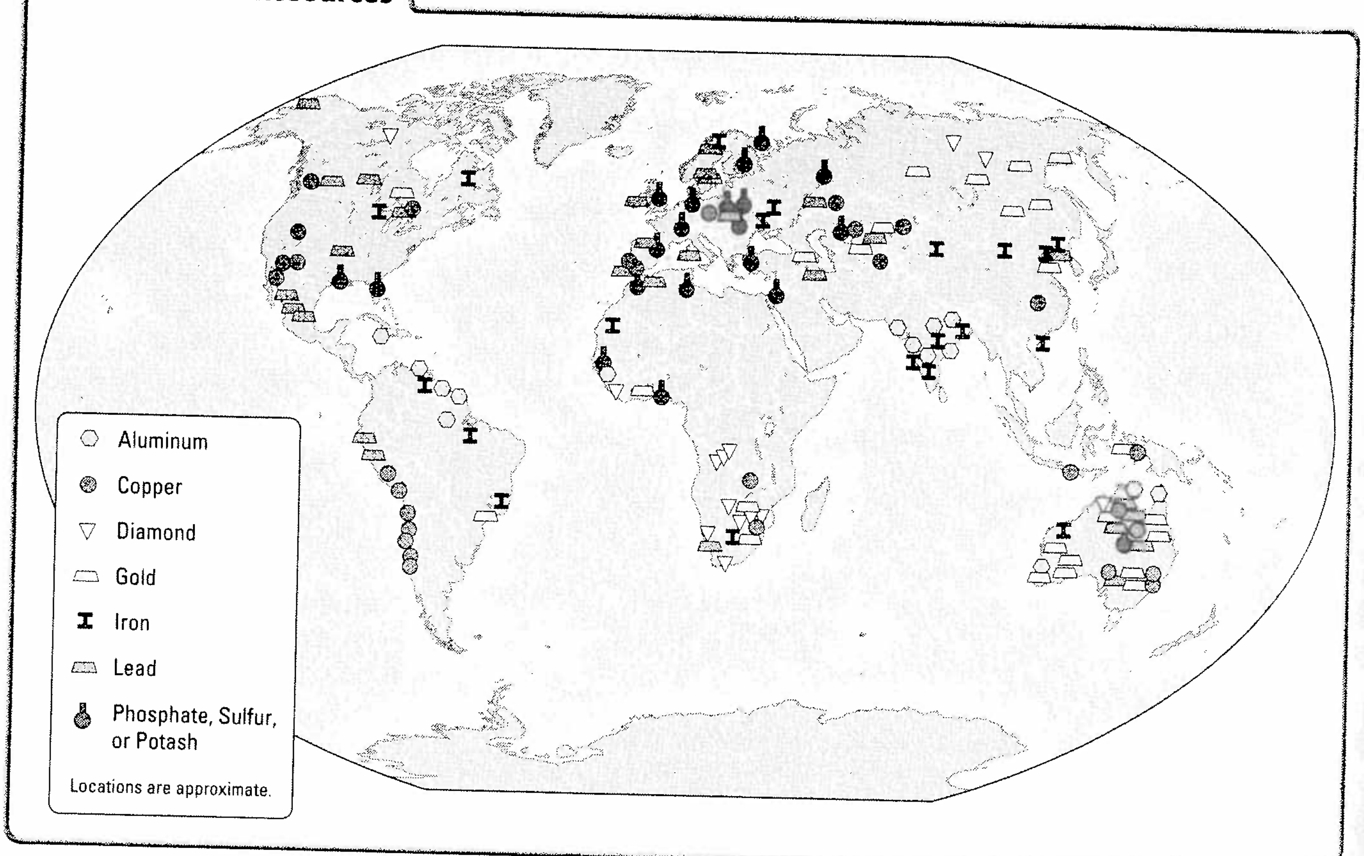
Availability of Minerals

Estimating the world's supply of a particular resource and the amount of it that should be used is a complex and controversial process. Reliable estimates of the total available amounts of minerals are hard to make because the entire world has not been explored for each resource. Most estimates of minerals' available supplies refer to reserves. A mineral **reserve** is the known deposits of a mineral in ores that are worth mining. The cost of mining and processing a mineral must also be considered. A high demand often means that an expensive mining operation can still be profitable.

Minerals are nonrenewable. Knowing the size of the reserve of a particular mineral and the rate at which it is being used makes it possible to estimate how long the reserve will last. The more of a mineral we demand, the faster it will be used up.

The map below shows the locations of some major mineral deposits. As you know from earlier chapters in this unit, Earth's mantle and crust are composed mostly of lighter minerals. However, metals exist in the crust in

World Mineral Resources



localized concentrations. It is not always easy to find and remove these metals. Ores deep in the ground are usually removed in underground mines reached by tunnels. Ores close to the surface are removed by digging great holes, called open-pit mines. Both types of mining can be costly, requiring the use of expensive machines and technologies as well as the labor and knowledge of many people.

Use of Minerals

The United States has some of the world's largest deposits of mineral resources. However, it is also one of the greatest consumers of these resources. If present rates of use continue, the world reserves of these and other elements could be used up within the next 60 years. Some metals, such as platinum, magnesium, cobalt, chromium, tin, and nickel, are scarce in the United States, and must be entirely imported.

Why are metals so desirable? Societies around the world depend on metals in a variety of ways. The metal iron, alloyed with elements such as carbon, nickel, chromium, or tungsten, is essential to steel production. Steel is used to make skyscrapers, bridges, tunnels, ships, planes, and trains. Steel also is used to make objects as small as pins, as well as utensils and tools. Another metal, copper, is used in electrical wiring and is combined with zinc to make brass. Zinc is also used as a protective coating to prevent rust. Cans, cookware, and bicycle frames are made with aluminum. Car batteries and the protective shielding around radioactive materials are made with lead.

Nonmetals such as sand, gravel, and crushed stone are taken from quarries (small open-pit mines). The construction industry has many uses for these resources, including the making of concrete and the construction of asphalt-gravel roofs. Phosphate rock, potash, and nitrates are used in fertilizers. All are mined or produced in the United States.

Because mineral resources are nonrenewable, all consumers must plan for the day when these resources disappear. If we can reduce the demand for them, we will increase the length of time that they will be available. A reduction in demand will also help reduce the creation of hazardous wastes, thus making Earth's environment safer for living organisms, including humans.

7.1 Section Review

1. **Distinguish between a renewable and a nonrenewable resource.**
2. **What characteristics make a mineral an ore mineral?**
3. **In what ways is a mineral reserve different from a mineral resource?**
4. **CRITICAL THINKING Review the uses of mineral resources. Identify three such resources that you encounter daily and describe how life in your community might change if those mineral reserves were exhausted.**

7.2

KEY IDEA

Humans depend on a variety of energy resources, both renewable and nonrenewable, to meet their energy needs.

KEY VOCABULARY

- fossil fuel

Energy Resources

Water, wind, and even humans can supply energy for work. Fuels also provide energy. In the past, the major source of energy was wood, a fuel burned to provide heat and light. However, the sources of energy and the demand for it have changed dramatically in the past 150 years.

Nonrenewable Energy Resources

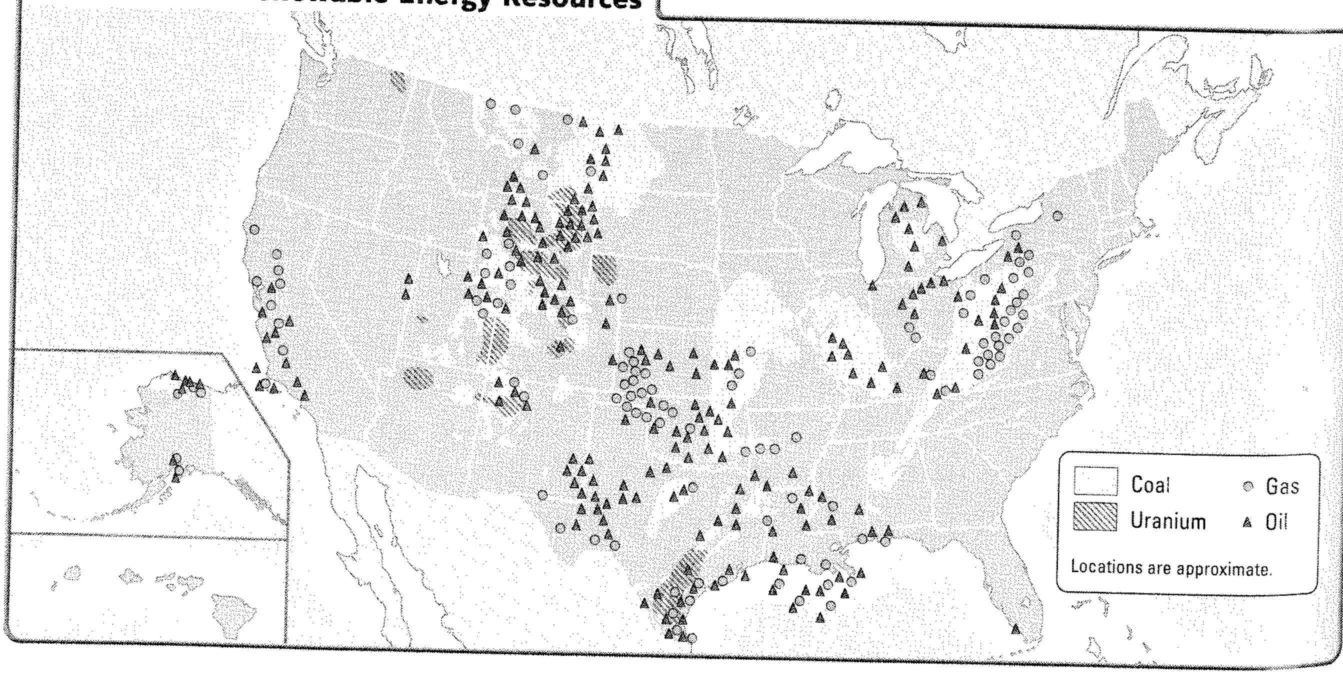
Today the world's use of energy is greater than ever. About 7 percent of that energy comes from renewable sources. The rest comes from nonrenewable sources of energy, such as coal, petroleum, natural gas, and nuclear fission.

Fossil Fuels

In Chapter 6 you learned that a fossil is evidence of life preserved in rock. Coal, petroleum, and natural gas are called **fossil fuels** because they formed from the remains of organisms that lived millions of years ago. The burning of coal, petroleum, and natural gas, like that of other fuels, releases the energy stored in them. Fossil fuels are nonrenewable because they are being used up millions of times faster than they are forming. In the United States today, coal is used primarily in power plants to generate electricity, but it is also important in the manufacture of steel and as a raw material in chemical processes. Deep coal deposits are worked in underground mines. Coal in shallow deposits is dug up in surface mines called strip mines.

Most coal is considered an organic sedimentary rock formed from materials such as ferns, mosses, and parts of trees. These and all other organic materials include the element carbon. Some also include hydrogen and oxygen. When organic remains are buried in swamp waters—often

Some U.S. Nonrenewable Energy Resources



under sand or clay—they decay slowly, gradually losing hydrogen and oxygen. The physical properties of the sediment change as it ages and is compacted.

The lightly compressed mass of plant remains is called peat. Over time, peat is compressed and more hydrogen and oxygen are lost. Eventually, a soft brown coal called lignite forms. Some types of lignite contain about 40 percent carbon. After millions of years of compression, lignite may become bituminous, or soft, coal. Bituminous coal is up to 85 percent carbon. Through regional metamorphism, bituminous coal may become anthracite, or hard coal. Anthracite is about 90 to 95 percent carbon. The higher the percentage of carbon, the greater the amount of energy released when the coal is burned.

VISUALIZATIONS
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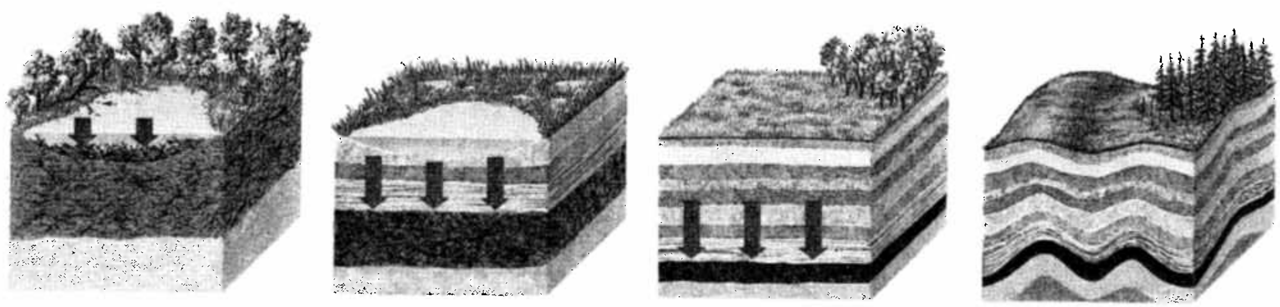
Observe an animation showing coal formation.
Keycode: ES0701

Formation of Coal



1 Swamp matter decays and is compacted over time, becoming peat. Close examination of peat can reveal leaves, sticks, and twigs.

2 Sedimentation and compaction of the peat force out water and gases. The resulting lignite has a higher carbon content than peat.

3 Over millions of years, more sediments cover the lignite. It becomes harder, sedimentary bituminous coal.

4 Anthracite, a metamorphic coal, takes the longest to form and has been exposed to the most heat and pressure.

Unlike coal, petroleum is a liquid. However, both are sedimentary materials of organic origin. Petroleum, or oil, is mainly a mixture of liquid hydrocarbons (compounds of hydrogen and carbon). Petroleum is recovered by drilling wells into oil-bearing rock. Natural gas, a mixture of methane and other hydrocarbon gases, often occurs with petroleum—although it may exist in great deposits by itself. The pressure of natural gas overlying oil deposits helps bring the oil to the surface. The drilling must be carefully controlled, or the high pressure causes wasteful gushers. Even with modern technology, only about 60 percent of the oil in a given well can be pumped out of it.

VOCABULARY STRATEGY

The word *petroleum* (puh-TROH-lee-uhm) comes from the Latin words *petra,* meaning "rock," and *ōleum,* meaning "oil."

25-Minute

MiniLAB

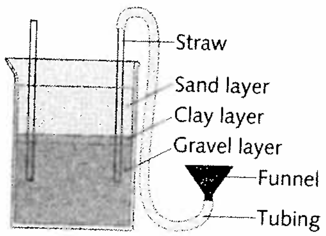
Oil Well

Materials

- gravel
- clear beaker
- 2 straws
- modeling clay
- sand
- plastic tubing
- funnel
- water

Procedure

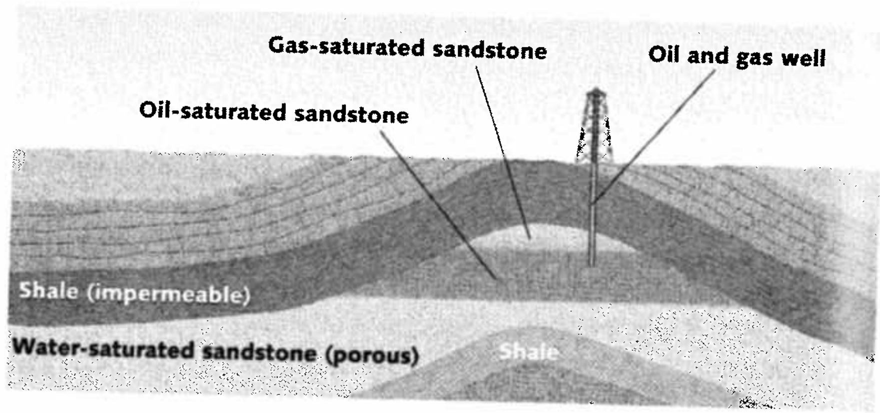
1. Place 10 cm of gravel in the bottom of the beaker. Stand the straws inside the beaker, on opposite sides. Pack 1 cm of modeling clay to seal around each straw and the beaker's sides. Add 6 cm of sand on top of the clay. Use more clay to seal the plastic tubing and funnel to one of the straws.



2. Fill the funnel with water while holding it below the top of the gravel layer. Observe the flow of water as you slowly raise the funnel above the sand, adding more water as needed.
3. Blow directly into the funnel.

Analysis

Explain your observations. On the basis of your results, describe methods that can be used to pump oil from below ground.



OIL TRAP

Petroleum is thought to have been formed by slow chemical changes in organic materials buried under sand and clay in shallow coastal waters. As the sediments were compacted, liquid and gaseous hydrocarbons were forced into pores and cracks of nearby sandstones or limestones. The pores and other spaces may have been filled with seawater; but the lighter petroleum rose above the water, and the natural gas collected above the petroleum.

Why haven't the petroleum and gas escaped from the rock during the millions of years that followed their formation? Probably large amounts have. The deposits found today are ones that were sealed underground by layers of virtually impermeable rock, such as shale, in structures called oil traps. The illustration above shows the most common type of trap—an anticline, or upfold.

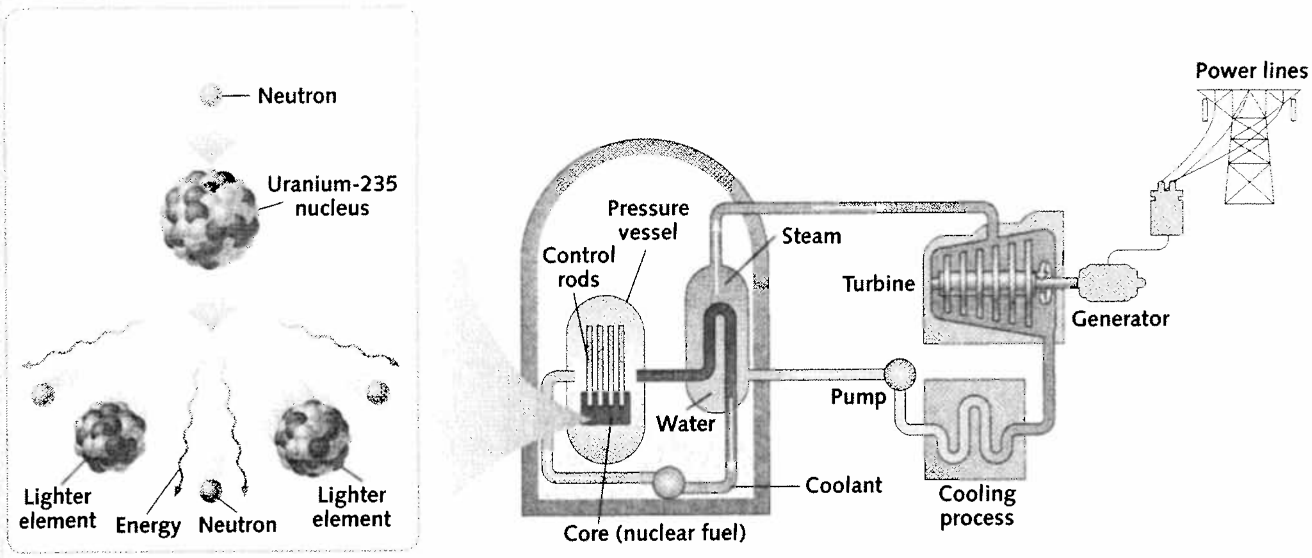
Other sources of fossil fuels include oil shales and tar sands. When heated, oil shales release a petroleum vapor that can be condensed into liquid oil. The spaces between the grains of tar sands are filled with what may be the dried residue of petroleum. Oil can be removed from these sands. The amount of oil in Earth's oil shales and tar sands is estimated to be 50 percent greater than Earth's remaining oil reserves. However, the recovery processes for both are too expensive at present for either to compete with oil from wells. Coal is currently the least expensive fossil fuel.

Uranium

The metallic element most commonly used as a fuel is uranium. When atoms of a certain isotope of uranium are hit with neutrons, a reaction called atomic fission occurs, releasing much energy. The newly released neutrons cause the fission of other nuclei. This process, modeled on page 151, takes place in the nuclear reactor of a nuclear power plant. A coolant pumped through the reactor is heated by the energy released by fission. The hot coolant is used to convert water to steam. The steam moves turbines, which generate electricity.

Uranium is recovered primarily from the black mineral uraninite and the yellow mineral carnotite. The fission of one gram of uranium releases as much energy as the burning of nearly 3 tons of coal or 14 barrels of oil. Today, uranium is the fifth most important source of energy in the world, behind oil, natural gas, coal, and water power.

Nuclear Power



1 Fission occurs when the nucleus of a uranium isotope absorbs a neutron. Lighter elements form and much energy is released.

2 The energy produced by fission heats the nuclear reactor's coolant.

3 The hot coolant converts water to steam. The steam is used to generate electricity.

Renewable Energy Resources

Four of the most widely used sources of renewable energy are water, wind, the sun, and geothermal energy.

Water

The major use of water power today is to produce electricity. Electricity so produced is called hydroelectric power. Water power is the most efficient way of producing electricity because the turbines that power the electrical generators are turned directly by moving water. When coal or uranium is used, the energy they produce must first be used to convert water to steam. It is the steam that turns the turbines.

Tides, the rise and fall of Earth's oceans, can also be used to generate electricity. Water is trapped behind a barrier at high tide and then slowly released at low tide. As the water drops to the lower level, it spins a turbine. Currently, several large-scale tidal power plants are in operation. One has been operating in France since 1966.

VISUALIZATIONS
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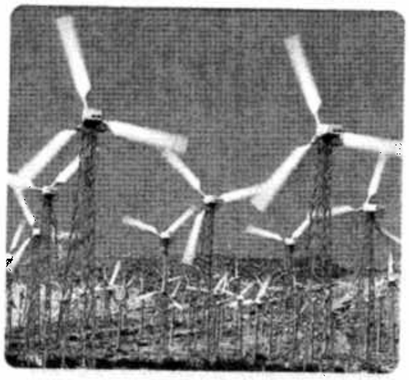
Observe an animation of nuclear fission.
Keycode: ES0702

HYDROELECTRIC POWER The Dallas Dam in Oregon generates electricity by using the force of the Columbia River's moving water to power turbines.



WIND POWER This windmill farm in Palm Springs, California, generates electricity by capturing the power of the wind with hundreds of windmills.

Wind

Wind power—the force of moving air—can be captured by a windmill, which can be used to generate electricity. The amount of power produced can vary greatly, depending on the speed of the wind, the length of the windmill's blades, and the efficiency of the windmill. In order for wind power to provide electricity to large numbers of homes, windmill farms must be built. A windmill farm is an array of up to several hundred windmills. Windmill farms in the United States are located in Hawaii, California, and New Hampshire. Occasionally, homeowners in remote areas use individual windmills to power small electrical generators.

Wind power is not the most efficient way of producing electricity, but better windmills are being developed. Since 1991, the number of windmills in California has dropped, yet the amount of electricity generated has remained about the same. In 1999, California windmills produced over 1650 megawatts of electricity, about the same amount produced by a medium-sized nuclear power plant.

The Sun

Solar power—energy from the sun—can be used to provide heat and electricity. "Passive" or "active" systems may be used. A building with a passive solar heating system is designed to collect and store solar energy. For example, a special type of window might let light into a house but not let heat escape. An outside wall might be made of a material that heats easily in sunshine and then transfers its heat to the inside of the house.

An active solar heating system has three parts. A solar collector facing the sun absorbs heat, which is transferred to a storage area. There the heat energy is stored until it is needed. Finally, a system distributes the heat throughout the building. The same system can also be used to heat water.

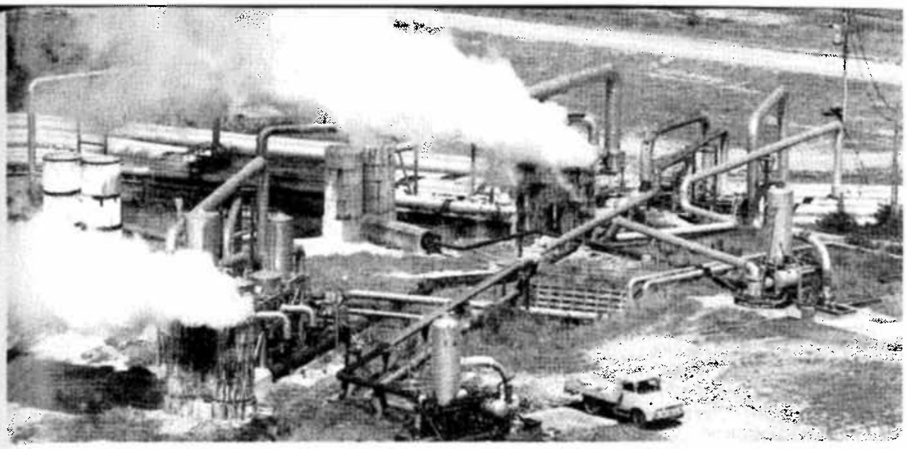
Most active solar heating systems are privately owned. Engineers, however, have developed solar power plants that can deliver electricity to thousands of homes. Throughout the day, mirrors focus sunlight on a large collector, heating molten salt to over 500°C. The salt stores heat so well it can make steam to turn turbines even at night or during cloudy days.

Solar cells, also known as photovoltaic cells, have been used to generate electricity in spacecraft since the start of the space age. These cells convert light into electricity. Advances in the design of solar cells may eventually lead to power plants that can produce millions of watts of electrical power.

SOLAR POWER The Natatorium has harnessed solar power since it was built as the swimming facility for the 1996 Olympics in Atlanta. Its solar energy system uses thermal panels (black) to absorb the sun's warmth, and photovoltaic panels (blue) to convert sunlight into electricity.

Geothermal Energy

Heat from Earth's interior is called geothermal energy. In some areas, highly pressurized steam rises naturally out of deep hot rock. Most geothermal sources, however, are drilled and controlled like oil wells. The geothermal energy is converted to electrical energy when steam or hot water from below Earth's surface is piped into a power plant to run a generator. Hot water from geothermal areas can also be piped into homes for heating and cooking.



GEOTHERMAL POWER Geothermal resources provide direct heating and generate electricity. This power plant in Wairakei, New Zealand, has operated since the 1950s.

Areas of volcanic activity have the greatest potential as geothermal energy sources. In the United States, geothermal sources generate enough energy to provide electricity for nearly 3.5 million homes. The Geysers, California, is the largest source of geothermal power in the world. As of 1999, geothermal power plants in 22 countries around the world provided electricity to over 60 million people.

Because hot rock can be found in all parts of Earth's crust at various depths, scientists have experimented with ways to use geothermal energy at any location. The United States, France, Australia, and Japan have experimented with "hot-dry-rock" projects. In such a project, cold water is pumped into an underground reservoir in hot rock. The water warms underground, then is pumped back to the surface to generate electricity and heat homes.

Ground-source heat pumps are another direct use of geothermal energy. Regardless of climate, Earth's ground temperature remains constant about 150 centimeters below the surface. As a result, the ground is warmer than the air in the winter and cooler in the summer. In winter, a heat pump moves fluid through pipes in the ground, transferring heat from the Earth to the fluid. The warm fluid is then circulated through a house, warming it. Similarly, the ground can cool the house in the summer. Ground pumps will work in nearly all parts of the United States.

Scientific Thinking

COMPARE AND CONTRAST

As some power plants use coal or uranium to generate electricity, a waste-to-energy plant burns solid waste. Although pollution from the resulting ash is a concern, this method not only provides energy but gets rid of mountains of solid waste that would otherwise be buried in landfills. Landfills can also cause pollution and take up valuable space.

What risks and benefits might a small, densely populated country consider when choosing among energy sources—traditional fuels, such as coal, oil, and uranium, and renewable resources such as solid waste as a means of producing energy?

7.2 *Section Review*

1. **List four nonrenewable energy resources used today. Which one is not a fossil fuel?**
2. **What is a renewable energy resource? Name two and tell why they are considered renewable.**
3. **CRITICAL THINKING Compare peat and the three types of coal. Which might be preferred as a fuel for power plants? Why?**
4. **GEOGRAPHY Locate Iceland on a world map and on the plate tectonic map in the Appendix. Most of that country's energy comes from geothermal sources. What other countries might make similar use of geothermal energy? What geological characteristics or features must be present in these countries?**

7.3

KEY IDEA

Human use of Earth's resources affects the living and nonliving parts of the environment.

KEY VOCABULARY

- conservation
- recycle

Environmental Issues

Human beings' use of Earth's resources often damages the environment that enables us to live. If Earth's environment is severely damaged, life as we know it will be changed.

Risks and Disadvantages

Our current use of nonrenewable resources can pollute land, water, and air and contribute to global warming. While renewable resources cause less pollution, they also have disadvantages.

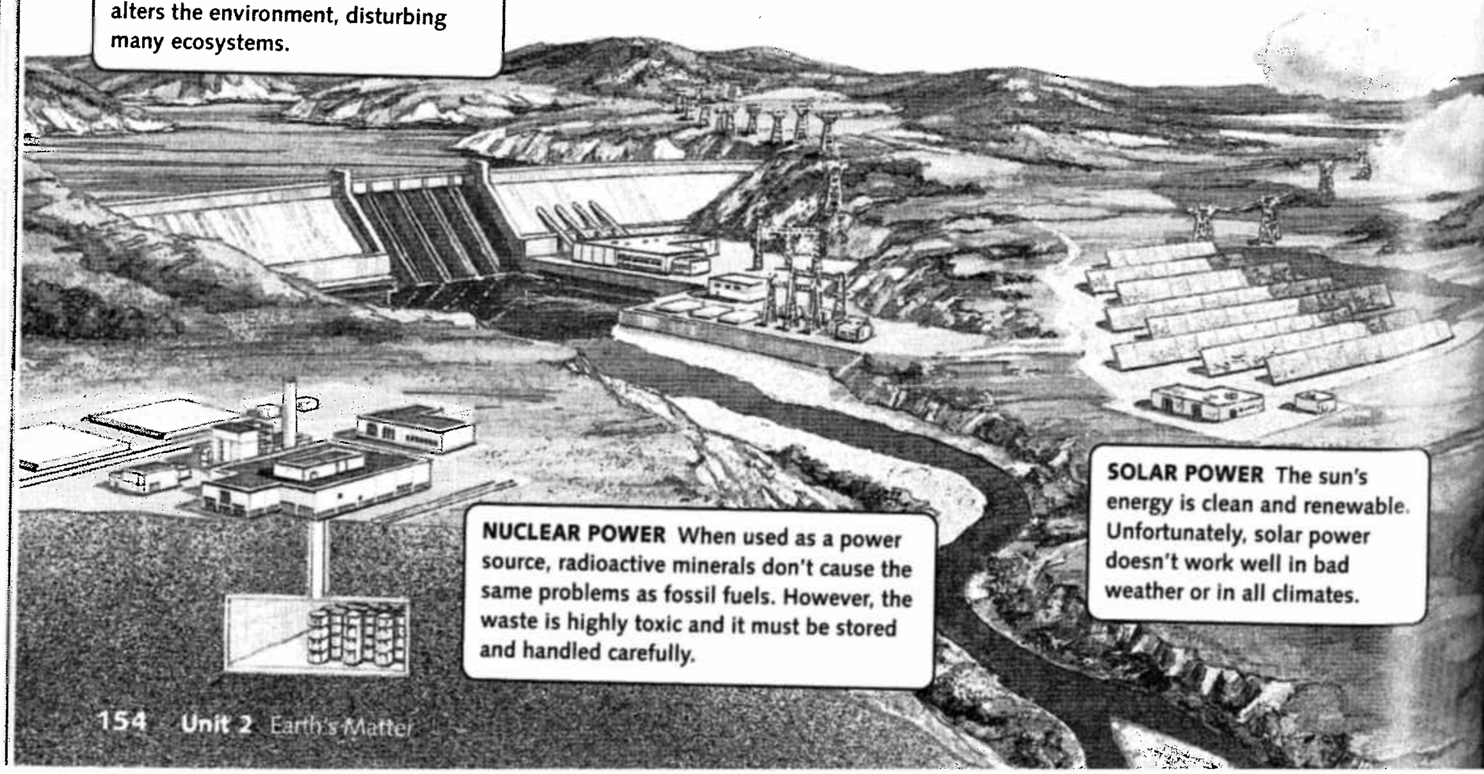
Mining for Minerals

Surface mining can remove tons of soil, ore, or rock, often creating a rocky waste that supports little life. Although topsoil is a renewable resource, it is renewed naturally at a rate of only a few inches every thousand years. Strip-mined land can take decades to recover.

A landscape can be destroyed when mining leaves hills barren, levels mountains, or forms enormous craters. Mining produces huge piles of waste rock. Water that collects in open pits or runs off from piles of waste rock can be dangerous. Surface compounds in the waste can react with the water to form sulfuric acid. Ore processing can contaminate the waste chemically. Heavy metals dangerous to living things can be weathered out of waste rock. All these substances can pollute water, damaging or killing life in streams and lakes.

Nonrenewable Energy

One problem with the use of nuclear reactors is that fission produces dangerously radioactive byproducts. Radioactive waste must be stored away from living things for thousands of years. No satisfactory way of safely



HYDROELECTRIC DAM Water is a renewable and nonpolluting energy resource. However, few sites are available for new dams. Also, a dam alters the environment, disturbing many ecosystems.

NUCLEAR POWER When used as a power source, radioactive minerals don't cause the same problems as fossil fuels. However, the waste is highly toxic and it must be stored and handled carefully.

SOLAR POWER The sun's energy is clean and renewable. Unfortunately, solar power doesn't work well in bad weather or in all climates.

storing or disposing of nuclear waste has been found. Also, accidents can happen. In 1986, workers caused a deadly accident at the Chernobyl nuclear power plant in the Soviet Union. Thirty-two people were killed immediately, thousands became ill, and millions of acres were contaminated with radiation. Fortunately, mechanical safeguards and extensive training of nuclear technicians make such accidents rare.

The burning of fossil fuels, especially coal and oil, releases pollutants into the air. Some of these pollutants can irritate the nose, throat, and lungs. Others contribute to acid rain, which you will read more about in later chapters. Acid rain can damage buildings, reduce forest growth, harm crops, and kill or injure plant and animal life in lakes and streams.

The increasing demand for fossil fuels threatens protected lands and wildlife. As fossil fuels have become harder to find, oil companies have sought permission to search for petroleum and natural gas in protected land such as wildlife refuges. Oil spills there or anywhere else on land can pollute soil and drinking water. Spills at sea can damage miles of coastline and kill thousands of organisms.

INVESTIGATIONS
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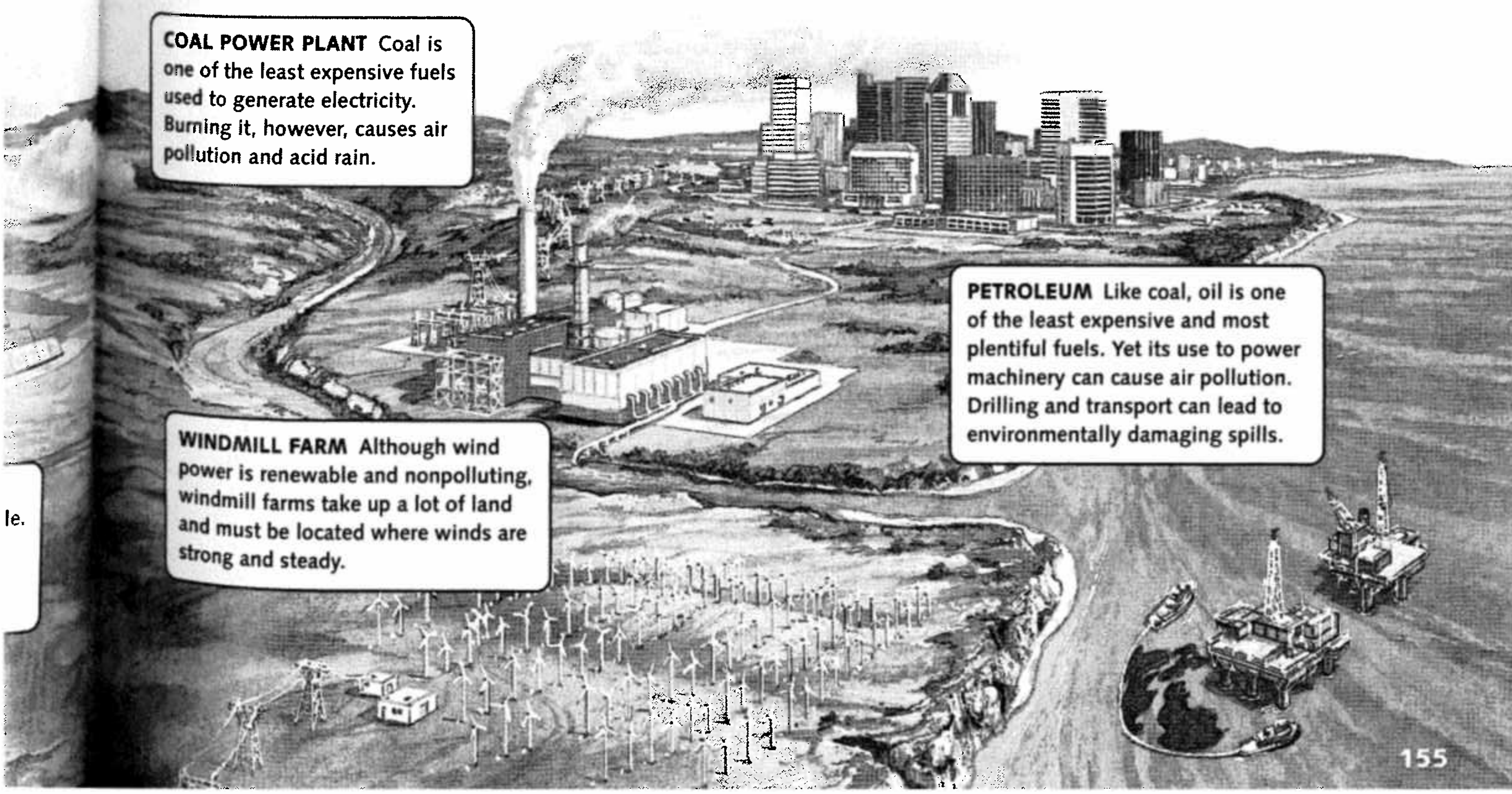
What Happens When an Oil Spill Occurs? Examine the affects of an oil spill on the surrounding environment. *Keycode:* ES0703

Renewable Energy

In general, renewable energy resources have a less damaging impact on the environment than nonrenewable energy resources. However, each type is limited in some way. None is usable everywhere. For example, water power can be used only in areas where dams can be built for water storage. In the United States, only about 10 percent of the electricity used is hydroelectric.

Wind power can be used only in areas with strong, steady winds. Windmills can interfere with television and radio reception. Windmill farms need a lot of land and can interfere with bird migration. There is also the problem of energy storage. Scientists have not found a reliable and efficient



INVESTIGATIONS
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Why Is This Place Protected? Explore the unique features of national parks and monuments and decide if another place is worth protecting.
Keycode: ES0705

method of storing the energy produced during strong winds for use during calms. Similar problems of storage and reliability affect solar power.

Geothermal energy provides little of the world's total energy supply. Few areas have hot bedrock near the surface. Those areas that do may not be near large population centers. The chemical-rich, superheated water can pollute lakes and streams. Cave-ins can occur when hot water drawn from the ground is not returned.

Using Resources Wisely

How can we slow the depletion of minerals, rock resources, and energy resources? Conservation and the development of efficient and reliable renewable energy resources are important. Likewise, recycling and legislation can help slow the rate at which resources are used and help protect the environment.

Conservation and Recycling

Think of **conservation** as the protection, restoration, and management of natural resources. Geological resources can be conserved, but because industrial societies are dependent on mined resources, it isn't likely that mining will stop completely. Conservation may include research that improves the efficiency of people's use of resources, so that reserves last longer. We can also find better ways of controlling the environmental impact of mining. For example, topsoil can be removed prior to mining and replaced and replanted after the mine is closed. Although the land will not be perfectly restored, the amount of damage can be kept to a minimum. Controlling erosion and preventing runoff that pollutes water can also limit environmental damage.

Reducing gasoline consumption can conserve oil resources. Fuel mixtures are one conservation measure. Gasohol is a mix of gasoline (usually 90 percent) and alcohol made from grain crops. Gasoline can also be conserved through the development of hybrid cars that run on both gasoline and electricity.

CONSERVATION By bicycling rather than driving cars, these commuters in Shanghai, China, conserve petroleum and reduce air pollution.

Individuals can practice energy conservation by reducing energy consumption and changing energy-wasting habits. They can, for example, walk or ride a bicycle for short trips, use carpools, adjust clothing instead of the thermostat, and turn off unneeded lights. Insulating a home means less energy is needed to cool and heat it. A well-maintained car pollutes less. Energy-efficient cars, houses, and appliances also help save energy. How can we conserve nonenergy resources? We can buy only the products we really need and plan on using. Avoiding waste is an important conservation method.

Reducing use and recycling can help make metal and nonmetal mineral resources last longer. To **recycle** is to collect and reuse materials from waste. Scrap iron, aluminum cans, and gold in computer chips are examples of metals that can be reused. Recycling glass bottles helps conserve sand and the other materials needed to make glass. Copper can be conserved by using glass-fiber cables rather than copper wires to carry telephone conversations and digital data. Many communities now have

SCIENCE & Technology

Harnessing the Power of the Sun

Is active solar power the only "real" solar power? Can passive solar technology also help to conserve Earth's fossil fuels and protect our environment? Researchers are investigating many ways of making use of the sun's energy.

How can a simple change to a common building material help to reduce the demand for electricity?

DEBBY TEWA is a solar energy expert. She tours throughout the United States, lecturing about the advantages of solar energy.

Engineers are working hard to perfect solar power plants. Ideally, active solar power would replace coal or nuclear power. Yet the development of such complex systems can be expensive, and it may be decades before they are widely used. A low-tech, less expensive approach to solar energy offers improved prospects for its widespread and immediate use.

Traditionally, a passive solar heating system includes a thermal mass that stores heat—a thick concrete wall, for example, or barrels of water. Such materials can take up space and limit the design and location of a building, but these bulky systems may soon be obsolete. Researchers have been testing thermal-mass materials that are up to 14 times more efficient at storing and transferring heat. They've used these materials to make a new product, phase-change wallboard.

A phase change occurs when the state, or phase, of matter—solid, liquid, or gas—changes. Researchers have incorporated materials such as paraffin wax into normal gypsum drywall. When the outside temperature rises, the material in the wallboard slowly melts but remains at a constant temperature until it is entirely melted. This way it absorbs the sun's energy without getting hotter. At night, when the outside air cools, the material radiates heat while returning to its solid state. Phase-change wallboard can keep inside temperatures comfortable in summer and in winter.

Widespread use of this product could significantly reduce the demand for coal and nuclear power plants. Simulations indicate that its use could shift 90 percent of the air conditioning in Dallas to off-peak hours. Parts of California might even be able to eliminate air conditioning altogether. ■

Extension

SCIENCE NOTEBOOK

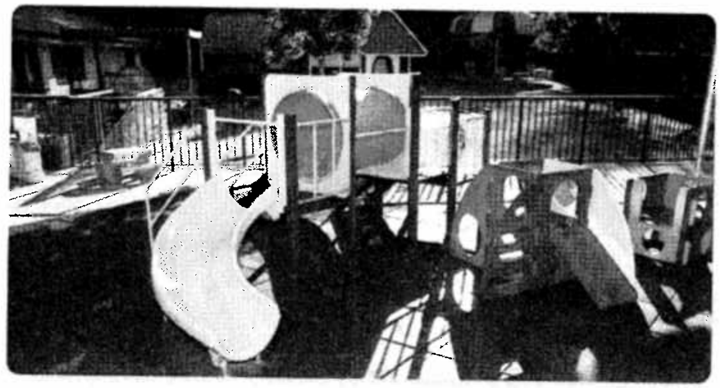
Consider the many ways fossil fuels are used. What other simple changes to commonly used materials or products might help reduce the demand for fossil fuels?

DATA CENTER
CLASSZONE.COM

Learn more about solar power.
Keycode: ES0704

PASSIVE SOLAR ENERGY systems, such as the one in this Chicago, Illinois, home, use the renewable energy of the sun, helping to conserve nonrenewable natural resources.

RECYCLING Manufacturers used recycled plastics to make this playground equipment in Laguna Niguel, California.



pilot recovery programs for recycling (or properly disposing of) the materials in old televisions and computers.

Legislation

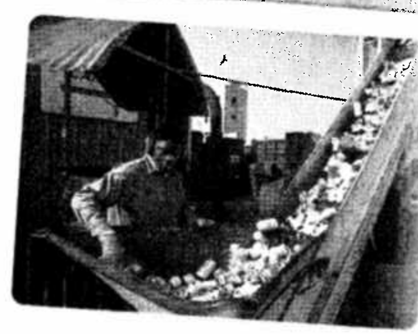
Since the 1870s, federal and state laws have been passed that have enabled government agencies to protect the environment and conserve resources. More recently, federal laws have allowed the Environmental Protection Agency (EPA) to monitor and set standards for drinking-water and air quality. Current laws control the production and disposal of toxic industrial chemicals and hazardous waste. The Pollution Prevention Act of 1990 was designed to control pollution and to encourage the conservation of energy,

CAREER

Recycling Technician

When you sort paper, aluminum cans, and glass to be recycled, do you ever wonder what happens after the materials are taken to the recycling center? Recycling technicians work to ensure that the recycled materials are properly processed so they can be sold and reused. These materials include not only the consumer waste that you are familiar with but also industrial waste, such as scrap metal. In order to carry out their work, recycling technicians operate trucks, loaders, and other heavy equipment. Recycling technicians also identify, report, and remove hazardous waste found in the materials to be recycled. Periodically, they sample groundwater and monitor chemical levels to ensure that the environment is not being harmed by the recycling process.

Since most recycling technicians receive on-the-job training, a high school diploma and a valid driver's license are usually sufficient. Recycling technicians often find that organizational skills come in handy when collecting sampling data. Physical fitness and good coordination are also necessary, since the job requires heavy lifting and the operation of industrial equipment. Recycling technicians are dedicated to their jobs, since they must sometimes work in severe weather conditions. Although their career is challenging, recycling technicians take pride in knowing that community recycling and conservation efforts would not be possible without their work.



RECYCLING TECHNICIANS at the Alcoa Recycling Center in Tennessee sort thousands of aluminum cans.

CAREERS CLASSZONE.COM

Find out more about a career in recycling.
Keycode: ES0706

water, and other natural resources. The act promotes recycling, reduction of resource use, and sustainable agriculture. Many states have laws requiring manufacturers to use a minimum amount of recycled material in their products. Several states require lower levels of certain automobile exhaust gases than federal regulations demand.

Concerned individuals have joined or formed environmental and conservation organizations. These have influenced state, federal, and corporate agencies to adopt policies that help conserve resources and protect the environment. Locally, residents may work to make their communities more conservation-minded. Many communities rely on landfills to get rid of solid wastes. Because landfills can pollute soil and water and take up valuable land, some communities now encourage conservation to reduce the need for landfills. They require recycling, thereby conserving aluminum, trees, and other resources. They fine those who throw out recyclable materials and charge residents for landfill-bound garbage by weight. Some communities have cut their waste by 50 percent by recycling a variety of materials and composting food waste and yard debris.

LEGISLATION Voicing your opinion about environmental issues can influence legislation that affects Earth's environment and its resources.

7.3 *Section Review*

1. What are the advantages and disadvantages of using nuclear energy?
2. Although renewable energy resources cause few environmental problems, why is the use of nonrenewable energy resources not more common?
3. Name three ways of conserving nonrenewable energy resources. Be specific.
4. **CRITICAL THINKING** The United States currently recycles between 10 percent and 25 percent of its garbage. Propose two or three ideas for getting people in this country to recycle more.

CHAPTER 7 LAB Activity

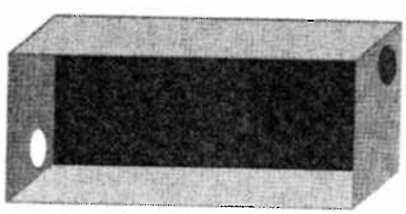
Passive and Active Solar Heating

Skills and Objectives

- ***Construct models*** of passive and active solar collectors.
- ***Compare*** the operation and effectiveness of solar collectors.

Materials

- 2 shoeboxes of the same size
- 1 brick
- 2 thermometers
- 1 sheet of aluminum foil
- 2 paper cups
- 2 pieces of plastic wrap
- masking tape
- black paint
- rubber cement
- 1 sheet of graph paper
- scissors
- hole punch
- colored pencils



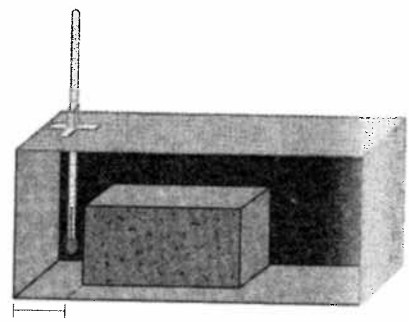
STEP 3

Two kinds of solar collectors are used for heating buildings. One is a passive solar collector, which uses the building itself to collect and store heat from the sun. The other is an active solar collector, which uses a system to collect, store, and transfer heat. The two collectors absorb and release heat at different rates. In this experiment, you will construct models of passive and active solar collectors and observe the differences between them.

Procedure

1. Place the brick inside a shoebox 1 cm from the end as shown in the diagram below. Use rubber cement to glue the brick to the bottom of the box. Paint the brick and the inside of the box black.

2. Make a hole in the side of the shoebox. Position the hole so that you can center the bulb of the thermometer in the 1-cm space between the box and the brick, as shown in the diagram to the right. Use masking tape to secure the thermometer at the hole and to prevent air from escaping. You now have a passive solar collector.



STEPS 1 AND 2

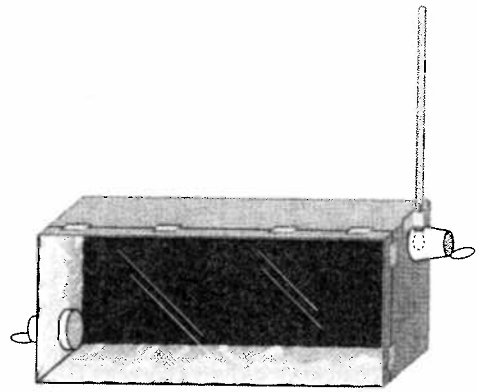
3. On the outside of the second shoebox, use the open end of a paper cup to trace two circles diagonally opposite each other. The circles should be in the bottom corners of the short sides of the box, as in the diagram to the left. Cut out the two circles with scissors.

4. Use the bottom of a paper cup to make a flap that can be opened and closed. Cut around the bottoms of two cups, but leave one-eighth of the circumference still attached.

5. From the inside of the box, insert the narrow end of one cup into one of the holes. Pull gently until the lip of the cup is even with the side of the box. Tape the cup in place. Repeat the procedure for the second cup.

6. Punch a hole in the side of one of the paper cups at the point at which it joins the box. Insert a thermometer in the hole and position the bulb of the thermometer in the center of the cup. Tape the thermometer to the outside of the box, as shown in the diagram on the next page. Make sure that you can read the entire thermometer scale.

7. Line the inner sides of the box with aluminum foil and glue the foil in place. Cut the foil from the holes in the box. Paint the bottom of the box black. Cover the top of the box with plastic wrap and tape to the outside of the box. You now have an active solar collector.



STEPS 5–7

8. Place the collectors in full sunlight. Tilt each collector so it faces the sun. The collectors will be at the correct angle when a pencil held perpendicular to the plastic cover has no shadow. Prop up the collectors with books and allow them to heat for 3 minutes.

9. Read the temperatures on both thermometers. Copy the table below and record the data. Open the flaps on the active solar collector. For the next 16 minutes, read and record the temperatures on both thermometers every 2 minutes.

	Heating Phase									Cooling Phase							
Minutes	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Temperature (°C), passive collector																	
Temperature (°C), active collector																	

10. Remove the collectors from the sunlight. As the collectors cool, read and record the temperatures every 2 minutes for 16 minutes.

11. Make a graph of your data by plotting time on the x-axis and temperature on the y-axis. Begin numbering the y-axis with the lowest temperature you recorded. Use two different colors to plot the data for the two collectors.

Analysis and Conclusions

1. Which collector reached the higher temperature? Which collector stayed warm longer?

2. If you were building a passive–solar-heated house, what features would you include in the design to help the house hold heat?

3. There are three parts to an active solar collector. Which one is missing from the model you built? Explain why the missing part is needed.

4. Your collectors were painted black. Design an experiment that determines whether black is the most efficient color.

5. Do you think it would be wise to invest in research to improve the efficiency and reliability of solar energy? Explain your answer.

CHAPTER 7 REVIEW

Summary of Key Ideas

7.1 Earth's environment includes all the renewable and nonrenewable resources, influences, and conditions at Earth's surface. Renewable resources are replaced by nature at a rate close to their rate of use. Nonrenewable resources, which include minerals, exist in fixed amounts. A resource can be exhausted if the demand for and use of it is greater than the amount that exists in nature.

7.2 Humans use a variety of renewable and nonrenewable energy resources to meet their energy needs. Nonrenewable energy resources include uranium and fossil fuels such as coal, petroleum, and natural gas. Water, wind, the sun, and geothermal energy are types of renewable energy sources.

7.3 The recovery and use of resources affects both the living and nonliving parts of the environment. Mining minerals and rocks can harm soil, water, and living organisms. Nonrenewable resources are limited and their use can cause pollution. Renewable energy sources use no fuel and do not pollute but can be more expensive to use than fossil fuels. Conservation, recycling, and environmental legislation can help protect resources and the environment.

KEY VOCABULARY

conservation (p. 156)
environment (p. 144)
fossil fuel (p. 148)
nonrenewable resource (p. 144)
ore mineral (p. 145)
recycle (p. 156)
renewable resource (p. 144)
reserve (p. 146)

Vocabulary Review

Write the term from the key vocabulary list that best completes the sentence.

1. Nonrenewable ___?___ forms from the remains of plants and animals.
2. A(n) ___?___ , such as water power, wind power, solar energy, and geothermal energy, uses no fuel and does not pollute.
3. All the living and nonliving things at Earth's surface are part of the ___?___ .
4. Natural resources can be protected and managed through ___?___ .
5. Knowing Earth's ___?___ allows scientists to predict how long resources will last.

Concept Review

6. Of gold, oxygen, iron, and sulfur, which is a renewable resource? Explain.
7. Identify a metallic mineral resource. Summarize how it might be recovered, processed, and used.
8. Compare and contrast uranium and petroleum. How do they differ? How are they similar?
9. Compare and contrast a coal-burning power plant and a hydroelectric dam. List advantages and disadvantages of each.
10. List three ways an individual can help protect the environment.
11. **Graphic Organizer** Copy and complete the flow chart below.

dead organisms in huge freshwater swamps
form
?
becomes
?
becomes
?
becomes
?

Critical Thinking

12. Evaluate Forests have been called America's renewable resource. Under what circumstances might wood, trees, or forests be a nonrenewable resource? Describe a process for preserving forests as a renewable resource.

13. Predict What types of problems would result if everyone heated their home with coal? Explain your reasoning.

14. Communicate Make a presentation describing ways in which technology could affect mineral reserves. Explain why it is possible to increase reserves of a mineral but not resources of a mineral.

15. Draw Conclusions Which produces more energy, burning peat or burning an equal mass of anthracite? Explain. Keeping in mind your answer to the first question, explain why peat is still a popular fuel in some countries.

Internet Extension

INVESTIGATIONS CLASSZONE.COM

What Environmental Changes Can We See with Satellites? Use images taken from space to investigate cases of environmental change through time.

Keycode: ES0707

Writing About the Earth System

SCIENCE NOTEBOOK Your home state probably has its own interesting rock formations or geologic history. Use a variety of resources to find information about the rocks in your region. Try to identify which particular type of rock—igneous, sedimentary, or metamorphic—is more common than others. Describe any environmental changes—biological, water, or atmospheric events—that have helped shape the geologic features you see today.

Interpreting Graphs

The graph shows the hourly averages of fine particulates in the air at an Austin, Texas, collection station. These pollutants, measured in micrograms per cubic meter of air, generally come from vehicle exhaust and industrial and residential activities.

16. How does the concentration of pollutants at 6 A.M. Tuesday compare with the concentration of pollutants at 6 A.M. Wednesday?

17. Air pollution can worsen the health of people with lung disease. According to the graph, when is the best time for such a person to run errands?

18. At what time does the concentration of pollutants peak on both days?

19. What could be the cause of the peaks in the amounts of pollution on the two days?

20. Falling rain tends to clean pollutants from the air. What evidence is there that no rain fell Tuesday morning before 6 A.M.?

21. Assume these trends continue into Thursday, June 21. Predict the time on that day when the amount of pollutants is most likely to be greatest.