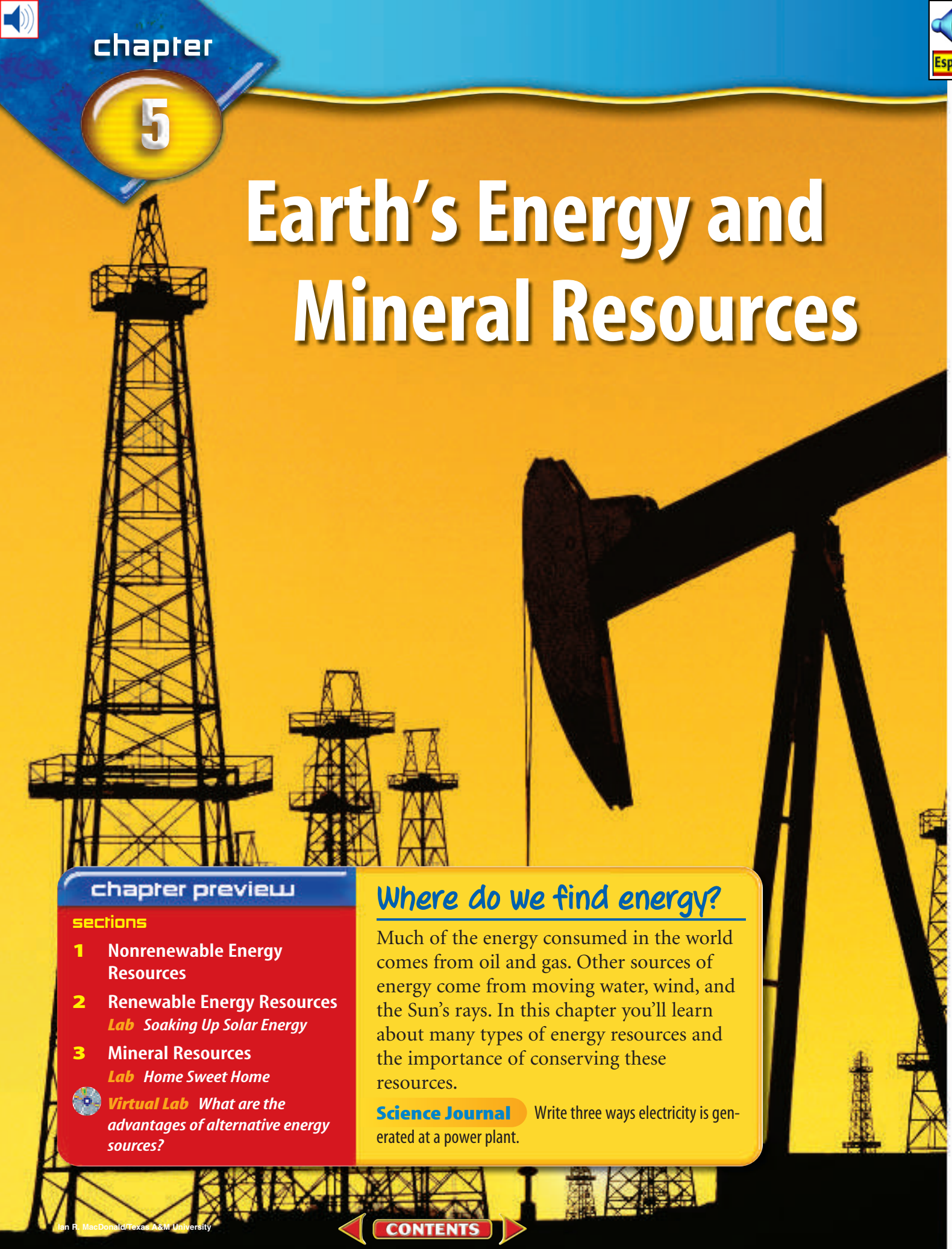
chapter 5

Earth's Energy and Mineral Resources



Ian R. MacDonald/Texas A&M University

chapter preview

sections

1 Nonrenewable Energy Resources

2 Renewable Energy Resources
Lab Soaking Up Solar Energy

3 Mineral Resources
Lab Home Sweet Home

Virtual Lab What are the advantages of alternative energy sources?

Where do we find energy?

Much of the energy consumed in the world comes from oil and gas. Other sources of energy come from moving water, wind, and the Sun's rays. In this chapter you'll learn about many types of energy resources and the importance of conserving these resources.

Science Journal Write three ways electricity is generated at a power plant.

Start-Up Activities

Launch LAB

Finding Energy Reserves

The physical properties of Earth materials determine how easily liquids and gases move through them. Geologists use these properties, in part, to predict where reserves of energy resources like petroleum or natural gas can be found.

1. Obtain a sample of sandstone and a sample of shale from your teacher.
2. Make sure that your samples can be placed on a tabletop so that the sides facing up are reasonably flat and horizontal.
3. Place the two samples side by side in a shallow baking pan.
4. Using a dropper, place three drops of cooking oil on each sample.
5. For ten minutes, observe what happens to the oil on the samples.
6. **Think Critically** Write your observations in your Science Journal. Infer which rock type might be a good reservoir for petroleum.

Science Online

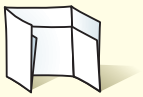
Preview this chapter's content and activities at earth.msscience.com

FOLDABLES™ Study Organizer

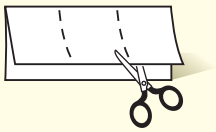
Energy Resources Make the following Foldable to help you identify energy resources.

STEP 1 **Fold** a sheet of paper in half lengthwise. Make the back edge about 1.25 cm longer than the front edge.

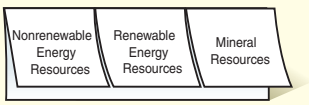
STEP 2 **Turn** lengthwise and **fold** into thirds.



STEP 3 **Unfold and cut** only the top layer along both folds to make three tabs.



STEP 4 **Label** each tab as shown.



Find Main Ideas As you read the chapter, list examples on the front of the tabs and write about each type of resource under the tabs.

CONTENTS

section 1

Nonrenewable Energy Resources

as you read

What You'll Learn

- **Identify** examples of nonrenewable energy resources.
- **Describe** the advantages and disadvantages of using fossil fuels.
- **Explain** the advantages and disadvantages of using nuclear energy.

Why It's Important

Nonrenewable resources should be conserved to ensure their presence for future generations.

Review Vocabulary

fuel: a material that provides useful energy

New Vocabulary

- fossil fuel
- coal
- oil
- natural gas
- reserve
- nuclear energy

Energy

The world's population relies on energy of all kinds. Energy is the ability to cause change. Some energy resources on Earth are being used faster than natural Earth processes can replace them. These resources are referred to as nonrenewable energy resources. Most of the energy resources used to generate electricity are nonrenewable.

Fossil Fuels

Nonrenewable energy resources include fossil fuels. **Fossil fuels** are fuels such as coal, oil, and natural gas that form from the remains of plants and other organisms that were buried and altered over millions of years. Coal is a sedimentary rock formed from the compacted and transformed remains of ancient plant matter. Oil is a liquid hydrocarbon that often is referred to as petroleum. Hydrocarbons are compounds that contain hydrogen and carbon atoms. Other naturally occurring hydrocarbons occur in the gas or semisolid states. Fossil fuels are processed to make gasoline for cars, to heat homes, and for many other uses, as shown in **Table 1.**

Table 1 Uses of Fossil Fuels

Coal	■ To generate electricity
Oil	■ To produce gasoline and other fuels ■ As lubricants ■ To make plastics, home shingles, and other products
Natural Gas	■ To heat buildings ■ As a source of sulfur

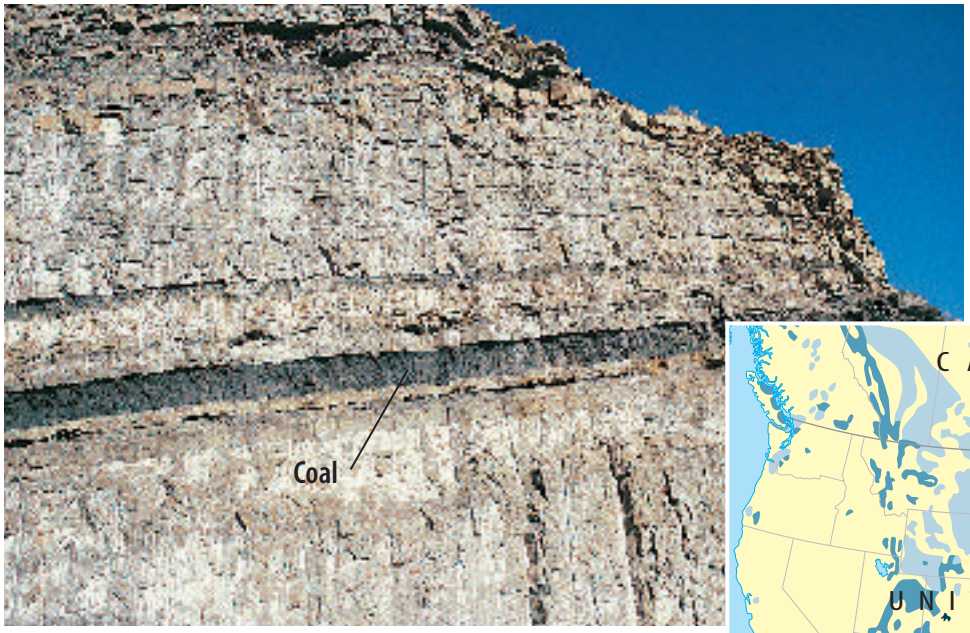


Figure 1 This coal layer is located in Castle Gate, Utah. **Analyze and Conclude** *Using the map and legend below, can you determine what type of coal it is?*

Coal

The most abundant fossil fuel in the world is coal, shown in **Figure 1.** If the consumption of coal continues at the current rate, it is estimated that the coal supply will last for about another 250 years.

Coal is a rock that contains at least 50 percent plant remains. Coal begins to form when plants die in a swampy area. The dead plants are covered by more plants, water, and sediment, preventing atmospheric oxygen from coming into contact with the plant matter. The lack of atmospheric oxygen prevents the plant matter from decaying rapidly. Bacterial growth within the plant material causes a gradual breakdown of molecules in the plant tissue, leaving carbon and some impurities behind. This is the material that eventually will become coal after millions of years. Bacteria also cause the release of methane gas, carbon dioxide, ammonia, and water as the original plant matter breaks down.

Reading Check ***What happens to begin the formation of coal in a swampy area?***

Synthetic Fuels

Unlike gasoline, which is refined from petroleum, other fuels called synthetic fuels are extracted from solid organic material. Synthetic fuels can be created from coal—a sedimentary rock containing hydrocarbons. The hydrocarbons are extracted from coal to form liquid and gaseous synthetic fuels. Liquid synthetic fuels can be processed to produce gasoline for automobiles and fuel oil for home heating. Gaseous synthetic fuels are used to generate electricity and heat buildings.

INTEGRATE Life Science

Coal Formation The coal found in the eastern and midwestern United States formed from plants that lived in great swamps about 300 million years ago during the Pennsylvanian Period of geologic time. Research the Pennsylvanian Period to find out what types of plants lived in these swamps. Describe the plants in your Science Journal.

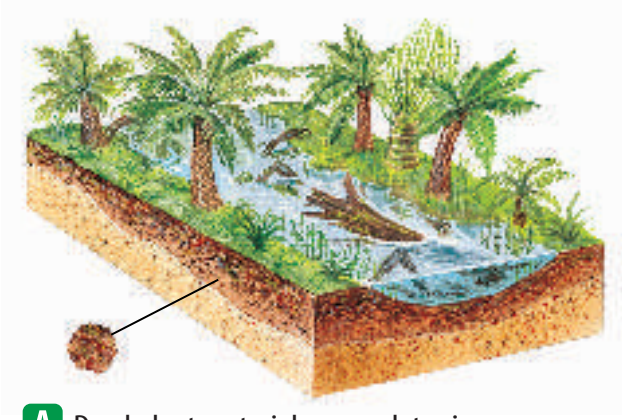
Stages of Coal Formation As decaying plant material loses gas and moisture, the concentration of carbon increases. The first step in this process, shown in Figure 2, results in the formation of peat. Peat is a layer of organic sediment. When peat burns, it releases large amounts of smoke because it has a high concentration of water and impurities.

As peat is buried under more sediment, it changes into lignite, which is a soft, brown coal with much less moisture. Heat and pressure produced by burial force water out of peat and concentrate carbon in the lignite. Lignite releases more energy and less smoke than peat when it is burned.

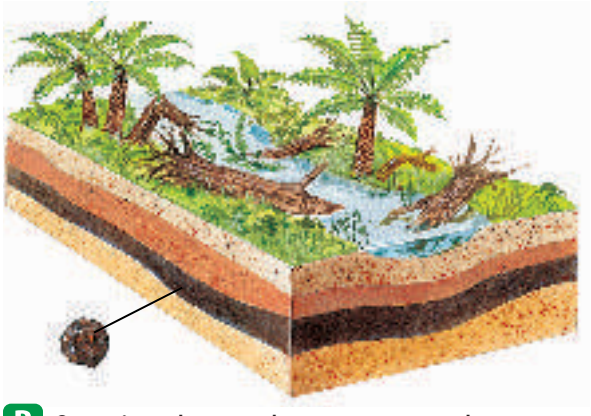
As the layers are buried deeper, bituminous coal, or soft coal, forms. Bituminous coal is compact, black, and brittle. It provides lots of heat energy when burned. Bituminous coal contains various levels of sulfur, which can pollute the environment.

If enough heat and pressure are applied to buried layers of bituminous coal, anthracite coal forms. Anthracite coal contains the highest amount of carbon of all forms of coal. Therefore, anthracite coal is the cleanest burning of all coals.

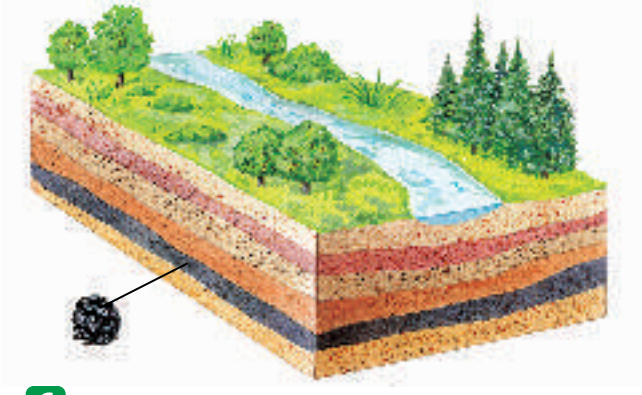
Figure 2 Coal is formed in four basic stages.



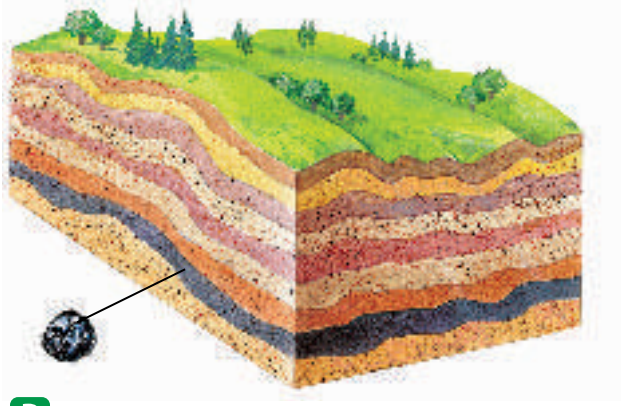
A Dead plant material accumulates in swamps and eventually forms a layer of peat.



B Over time, heat and pressure cause the peat to change into lignite coal.



C As the lignite coal becomes buried by more sediments, heat and pressure change it into bituminous coal.



D When bituminous coal is heated and squeezed during metamorphism, anthracite coal forms.

Oil and Natural Gas

Coal isn't the only fossil fuel used to obtain energy. Two other fossil fuels that provide large quantities of the energy used today are oil and natural gas. **Oil** is a thick, black liquid formed from the buried remains of microscopic marine organisms. **Natural gas** forms under similar conditions and often with oil, but it forms in a gaseous state. Oil and natural gas are hydrocarbons. However, natural gas is composed of hydrocarbon molecules that are lighter than those in oil.

Residents of the United States burn vast quantities of oil and natural gas for daily energy requirements. As shown in **Figure 3,** Americans obtain most of their energy from these sources. Natural gas is used mostly for heating and cooking. Oil is used in many ways, including as heating oil, gasoline, lubricants, and in the manufacture of plastics and other important compounds.

Energy Use in the United States, 2002

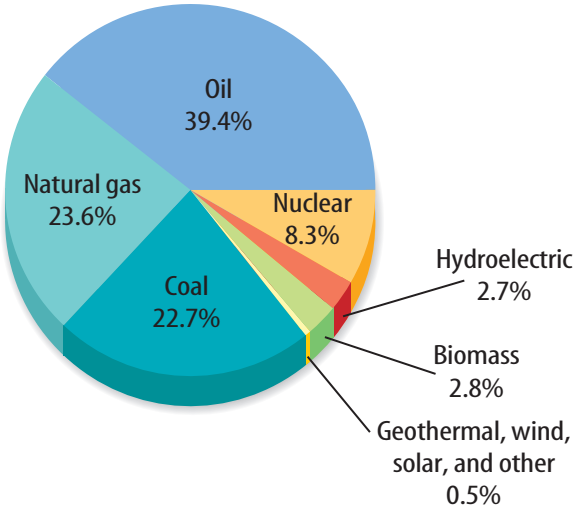


Figure 3 This circle graph shows the percentages of energy that the United States derives from various energy resources.
Calculate *What percentage is from nonrenewable energy resources?*

Formation of Oil and Natural Gas

Most geologists agree that petroleum forms over millions of years from the remains of tiny marine organisms in ocean sediment. The process begins when marine organisms called plankton die and fall to the seafloor. Similar to the way that coal is buried, sediment is deposited over them. The temperature rises with depth in Earth, and increased heat eventually causes the dead plankton to change to oil and gas after they have been buried deeply by sediment.

Oil and natural gas often are found in layers of rock that have become tilted or folded. Because they are less dense than water, oil and natural gas are forced upward. Rock layers that are impermeable, such as shale, stop this upward movement. When this happens, a folded shale layer can trap the oil and natural gas below it. Such a trap for oil and gas is shown in **Figure 4.** The rock layer beneath the shale in which the petroleum and natural gas accumulate is called a reservoir rock.

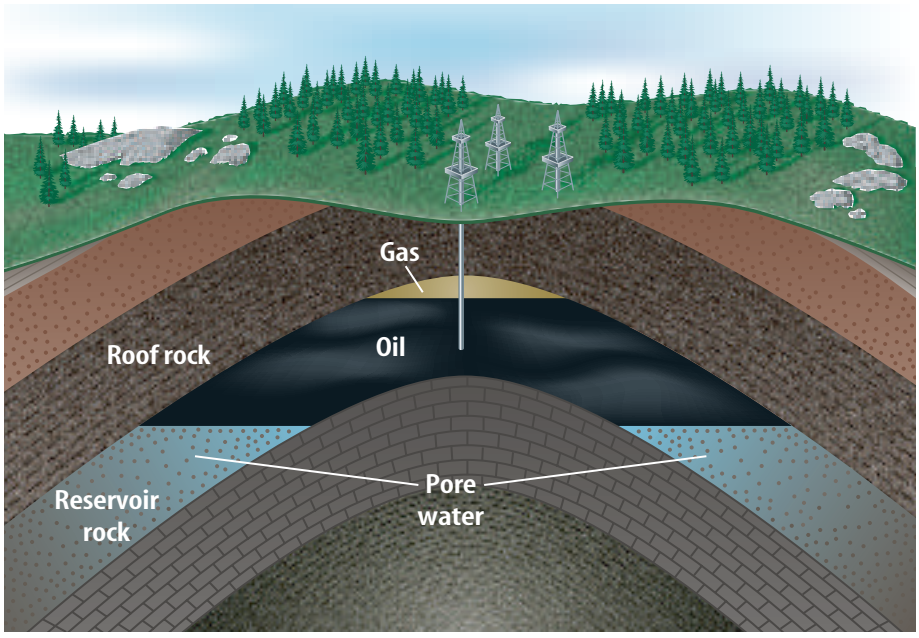


Figure 4 Oil and natural gas are fossil fuels formed by the burial of marine organisms. These fuels can be trapped and accumulate beneath Earth's surface.

Removing Fossil Fuels from the Ground

Coal is removed from the ground using one of several methods of excavation. The two most common methods are strip mining, also called open-pit mining, and underground mining, shown in **Figure 5.** Oil and natural gas are removed by pumping them out of the ground.

Coal Mining During strip mining, as shown in **Figure 5,** layers of soil and rock above coal are removed and piled to one side. The exposed coal then is removed and loaded into trucks or trains and transported elsewhere. After the coal has been removed, mining companies often return the soil and rock to the open pit and cover it with topsoil. Trees and grass are planted in a process called land reclamation. If possible, animals native to the area are reintroduced. Strip mining is used only when the coal deposits are close to the surface.

In one method of underground coal mining, tunnels are dug and pillars of rock are left to support the rocks surrounding the tunnels. Two types of underground coal mines are drift mines and slope mines. Drift mining, shown in the **Figure 5** inset photo, is the removal of coal that is not close to Earth's surface through a horizontal opening in the side of a hill or mountain. In slope mining, an angled opening and air shaft are made in the side of a mountain to remove coal.

Figure 5 Coal is a fossil fuel that can be removed from Earth in many different ways.

During strip mining, coal is accessed by removing the soil and rock above it.

During drift mining, tunnels are made into Earth.

Explain *how you think the coal is removed from these tunnels.*

CONTENTS

Drilling for Oil and Gas Oil and natural gas are fossil fuels that can be pumped from underground deposits. Geologists and engineers drill wells through rocks where these resources might be trapped, as shown in **Figure 6.** As the well is being drilled, it is lined with pipe to prevent it from caving in. When the drill bit reaches the rock layer containing oil, drilling is stopped. Equipment is installed to control the flow of oil. The surrounding rock then is fractured to allow oil and gas to flow into the well. The oil and gas are pumped to the surface.

Reading Check *How are oil and natural gas brought to Earth's surface?*

Figure 6 Oil and natural gas are recovered from Earth by drilling deep wells.

Fossil Fuel Reserves

The amount of a fossil fuel that can be extracted at a profit using current technology is known as a **reserve.** This is not the same as a fossil fuel resource. A fossil fuel resource has fossil fuels that are concentrated enough that they can be extracted from Earth in useful amounts. However, a resource is not classified as a reserve unless the fuel can be extracted economically. What might cause a known fossil fuel resource to become classified as a reserve?

Methane Hydrates You have learned that current reserves of coal will last about 250 years. Enough natural gas is located in the United States to last about 60 more years. However, recent studies indicate that a new source of methane, which is the main component of natural gas, might be located beneath the seafloor. Icelike substances known as methane hydrates could provide tremendous reserves of methane.

Methane hydrates are stable molecules found hundreds of meters below sea level in ocean floor sediment. They form under conditions of relatively low temperatures and high pressures. The hydrocarbons are trapped within the cagelike structure of ice, as described in **Figure 7.** Scientists estimate that more carbon is contained in methane hydrates than in all current fossil fuel deposits combined. Large accumulations of methane hydrates are estimated to exist off the eastern coast of the United States. Can you imagine what it would mean to the world's energy supply if relatively clean-burning methane could be extracted economically from methane hydrates?

Science Online

Topic: Methane Hydrates

Visit earth.msscience.com for Web links to information about methane hydrates.

Activity Identify which oceans might contain significant amounts of methane hydrates.

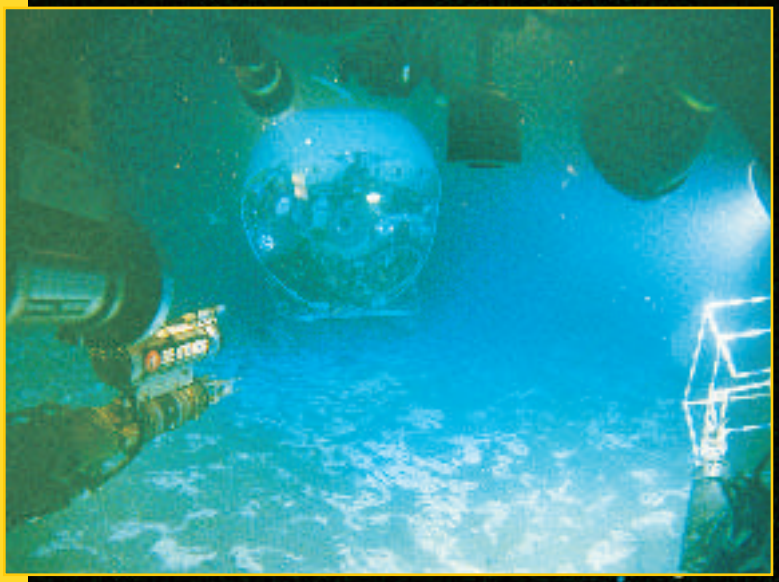
CONTENTS

NATIONAL GEOGRAPHIC

VISUALIZING METHANE HYDRATES

Figure 7

Reserves of fossil fuels—such as oil, coal, and natural gas—are limited and will one day be used up. Methane hydrates could be an alternative energy source. This icelike substance, background, has been discovered in ocean floor sediments and in permafrost regions worldwide. If scientists can harness this energy, the world's gas supply could be met for years to come.



In the photo above, a Russian submersible explores a site in the North Atlantic that contains methane hydrate deposits.

Methane hydrates are highly flammable compounds made up of methane—the main component of natural gas—trapped in a cage of frozen water. Methane hydrates represent an enormous source of potential energy. However, they contain a greenhouse gas that might intensify global warming. More research is needed to determine how to safely extract them from the seafloor.

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Conserving Fossil Fuels Do you sometimes forget to turn off the lights when you walk out of a room? Wasteful habits might mean that electricity to run homes and industries will not always be as plentiful and cheap as it is today. Fossil fuels take millions of years to form and are used much faster than Earth processes can replenish them.

Today, coal provides about 25 percent of the energy that is used worldwide and 22 percent of the energy used in the United States. Oil and natural gas provide almost 61 percent of the world's energy and about 65 percent of the U.S. energy supply. At the rate these fuels are being used, they could run out someday. How can this be avoided?

By remembering to turn off lights and appliances, you can avoid wasting fossil fuels. Another way to conserve fossil fuels is to make sure doors and windows are shut tightly during cold weather so heat doesn't leak out of your home. If you have air-conditioning, run it as little as possible. Ask the adults you live with if more insulation could be added to your home or if an insulated jacket could be put on the water heater.

Energy from Atoms

Most electricity in the United States is generated in power plants that use fossil fuels. However, alternate sources of energy exist. **Nuclear energy** is an alternate energy source produced from atomic reactions. When the nucleus of a heavy element is split, lighter elements form and energy is released. This energy can be used to light a home or power the submarines shown in **Figure 8.**

The splitting of heavy elements to produce energy is called nuclear fission. Nuclear fission is carried out in nuclear power plants using a type of uranium as fuel.

Mini LAB

Practicing Energy Conservation

Procedure

1. Have an adult help you find the **electric meter** for your home and record the reading in your **Science Journal.**
2. Do this for several days, taking your meter readings at about the same time each day.
3. List things you and your family can do to reduce your electricity use.
4. Encourage your family to try some of the listed ideas for several days.

Analysis

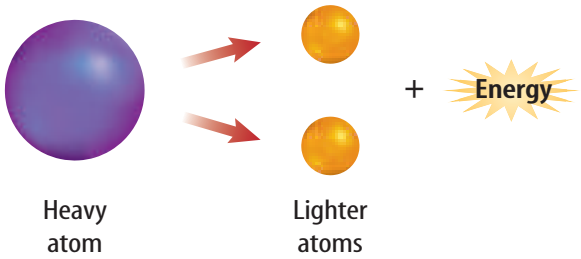
1. Keep taking meter readings and infer whether the changes make any difference.
2. Have you and your family helped conserve energy?

Try at Home

Figure 8 Atoms can be a source of energy.

These submarines are powered by nuclear fission.

During nuclear fission, energy is given off when a heavy atom, like uranium, splits into lighter atoms.



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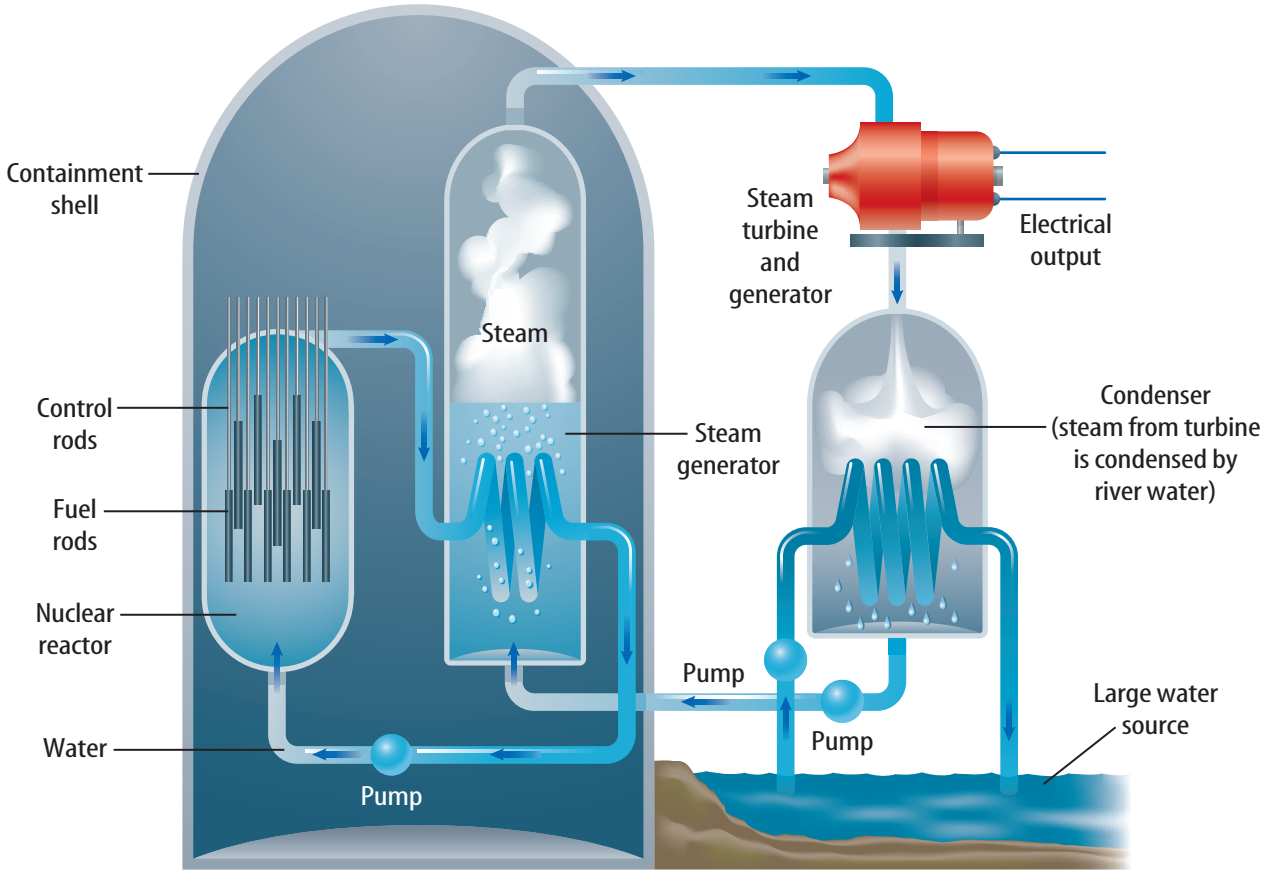


Figure 9 Heat released in nuclear reactors produces steam, which in turn is used to produce electricity. This is an example of transforming nuclear energy into electrical energy.

Infer *Why do you think nuclear power plants are located near rivers and lakes?*

Electricity from Nuclear Energy

A nuclear power plant, shown in **Figure 9,** has a large chamber called a nuclear reactor. Within the nuclear reactor, uranium fuel rods sit in a pool of cooling water. Neutrons are fired into the fuel rods. When the uranium-235 atoms are hit, they break apart and fire out neutrons that hit other atoms, beginning a chain reaction. As each atom splits, it not only fires neutrons but also releases heat that is used to boil water to make steam. The steam drives a turbine, which turns a generator that produces electricity.

Reading Check ***How is nuclear energy used to produce electricity?***

Nuclear energy from fission is considered to be a nonrenewable energy resource because it uses uranium-235 as fuel. A limited amount of uranium-235 is available for use. Another problem with nuclear energy is the waste material that it produces. Nuclear waste from power plants consists of highly radioactive elements formed by the fission process. Some of this waste will remain radioactive for thousands of years. The Environmental Protection Agency (EPA) has determined that nuclear waste must be stored safely and contained for at least 10,000 years before reentering the environment.

Fusion Environmental problems related to nuclear power could be eliminated if usable energy could be obtained from fusion. The Sun is a natural fusion power plant that provides energy for Earth and the solar system. Someday fusion also might provide energy for your home.

During fusion, materials of low mass are fused together to form a substance of higher mass. No fuel problem exists if the low-mass material is a commonly occurring substance. Also, if the end product is not radioactive, storing nuclear waste is not a problem. In fact, fusion of hydrogen into helium would satisfy both of these conditions. However, technologies do not currently exist to enable humans to fuse hydrogen into helium at reasonably low temperatures in a controlled manner. But research is being conducted, as shown in **Figure 10.** If this is accomplished, nuclear energy could be considered an inexhaustible fuel resource. You will learn the importance of inexhaustible and renewable energy resources in the next section.

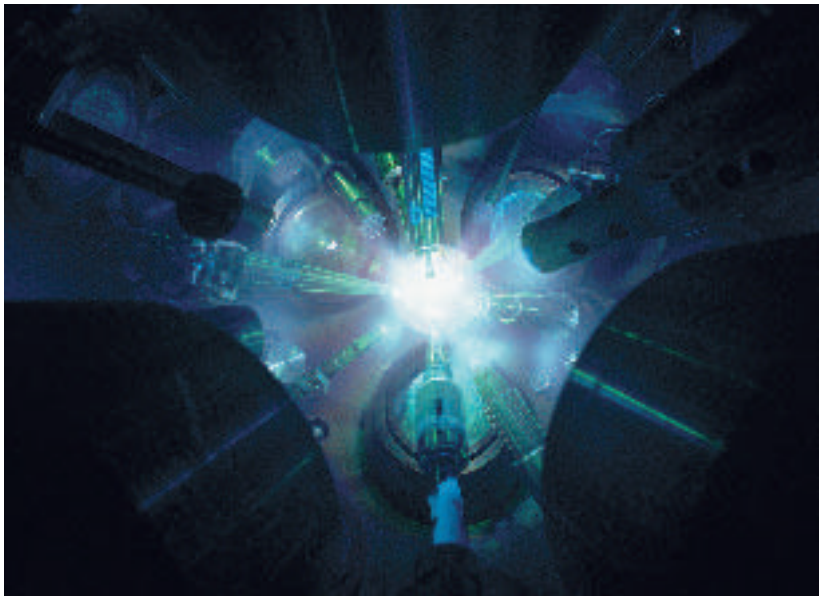


Figure 10 Lasers are used in research facilities to help people understand and control fusion.

section 1 review

Summary

Fossil Fuels

- Coal, natural gas, and oil are all nonrenewable energy sources.
- Synthetic fuels are human-made fuels that can be derived from coal.
- The four stages of coal formation are peat, lignite, bituminous coal, and anthracite coal.
- Oil and gas are made from the decay of ancient marine organisms.
- Strip mining and underground mining are two common methods that are used to extract coal reserves.

Energy from Atoms

- Energy is released during a fission reaction when a heavy atom is split into lighter atoms.
- Fusion occurs when two atoms come together to form a single atom.

Self Check

1. **Explain** why coal, oil, and natural gas are fossil fuels.
2. **Explain** why fossil fuels are considered to be nonrenewable energy resources.
3. **Describe** two disadvantages of nuclear energy.
4. **Think Critically** Why are you likely to find natural gas and oil deposits in the same location, but less likely to find coal and petroleum deposits at the same location?

Applying Math

5. **Design a Graph** Current energy consumption by source in the U.S. is as follows: oil, 39%; natural gas, 24%; coal, 23%; nuclear energy, 8%; renewable resources, 6%. Design a bar graph to show the energy consumption by source in the U.S. Display the sources from greatest to least.

section 2

Renewable Energy Resources

as you read

What You'll Learn

- **Compare and contrast** inexhaustible and renewable energy resources.
- **Explain** why inexhaustible and renewable resources are used less than nonrenewable resources.

Why It's Important

As fossil fuel reserves continue to diminish, alternate energy resources will be needed.

Review Vocabulary

energy: the ability to cause change

New Vocabulary

- solar energy
- wind farm
- hydroelectric energy
- geothermal energy
- biomass energy

Inexhaustible Energy Resources

How soon the world runs out of fossil fuels depends on how they are used and conserved. Fortunately, there are inexhaustible energy resources. These sources of renewable energy are constant and will not run out in the future. Inexhaustible energy resources include the Sun, wind, water, and geothermal energy.

Energy from the Sun When you sit in the Sun, walk into the wind, or sail against an ocean current, you are experiencing the power of solar energy. **Solar energy** is energy from the Sun. You already know that the Sun's energy heats Earth, and it causes circulation in Earth's atmosphere and oceans. Global winds and ocean currents are examples of nature's use of solar energy. Thus, solar energy is used indirectly when the wind and some types of moving water are used to do work.

People can use solar energy in a passive way or in an active way. South-facing windows on buildings act as passive solar collectors, warming exposed rooms. Solar cells actively collect energy from the Sun and transform it into electricity. Solar cells were invented to generate electricity for satellites. Now they also are used to power calculators, streetlights, and experimental cars. Some people have installed solar energy cells on their roofs, as shown in **Figure 11.**

Figure 11 Solar panels, such as on this home in Laguna Niguel, California, can be used to collect inexhaustible solar energy to power appliances and heat water.

Spencer Grant/PhotoEdit, Inc.

Figure 12 Wind farms are used to produce electricity.
Evaluate *Some people might argue that windmills produce visual pollution. Why do you think this is?*

Disadvantages of Solar Energy Solar energy is clean and inexhaustible, but it does have some disadvantages. Solar cells work less efficiently on cloudy days and cannot work at all at night. Some systems use batteries to store solar energy for use at night or on cloudy days, but it is difficult to store large amounts of energy in batteries. Worn out batteries also must be discarded. This can pollute the environment if not done properly.

Energy from Wind What is better to do on a warm, windy day than fly a kite? A strong wind can lift a kite high in the sky and whip it around. The pull of the wind is so great that you wonder if it will whip the kite right out of your hands. Wind is a source of energy. It was and still is used to power sailing ships. Windmills have used wind energy to grind corn and pump water. Today, windmills can be used to generate electricity. When a large number of windmills are placed in one area for the purpose of generating electricity, the area is called a **wind farm,** as shown in **Figure 12.**

Wind energy has advantages and disadvantages. Wind is nonpolluting and free. It does little harm to the environment and produces no waste. However, only a few regions of the world have winds strong enough to generate electricity. Also, wind isn't steady. Sometimes it blows too hard and at other times it is too weak or stops entirely. For an area to use wind energy consistently, the area must have a persistent wind that blows at an appropriate speed.

Reading Check ***Why are some regions better suited for wind farms than others?***

Physicists The optimal speed of wind needed to rotate blades on a windmill is something a physicist would study. They can calculate the energy produced based on the speed at which the blades turn. Some areas in the country are better suited for wind farms than others. Find out which areas utilize wind farms and report in your Science Journal how much electric-ity is produced and what it is used for. What kinds of organizations would a physicist work for in these locations?

Energy from Water For a long time, waterwheels steadily spun next to streams and rivers. The energy in the flowing water powered the wheels that ground grain or cut lumber. More than a pretty picture, using a waterwheel in this way is an example of microhydropower. Microhydropower has been used throughout the world to do work.

Running water also can be used to generate electricity. Electricity produced by waterpower is called **hydroelectric energy.** To generate electricity from water running in a river, a large concrete dam is built to retain water, as illustrated in **Figure 13.** A lake forms behind the dam. As water is released, its force turns turbines at the base of the dam. The turbines then turn generators that make electricity.

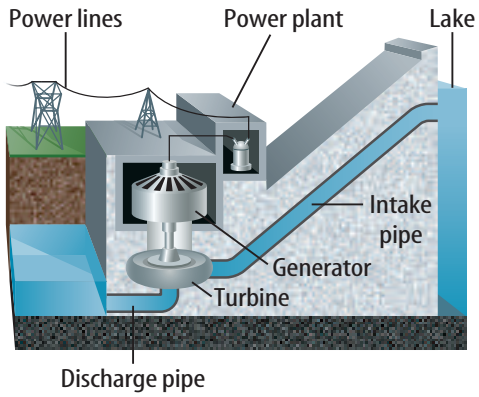
At first it might appear that hydroelectric energy doesn't create any environmental problems and that the water is used with little additional cost. However, when dams are built, upstream lakes fill with sediment and downstream erosion increases. Land above the dam is flooded, and wildlife habitats are damaged.

Energy from Earth Erupting volcanoes and geysers like Old Faithful are examples of geothermal energy in action. The energy that causes volcanoes to erupt or water to shoot up as a geyser also can be used to generate electricity. Energy obtained by using hot magma or hot, dry rocks inside Earth is called **geothermal energy.**

Bodies of magma can heat large reservoirs of groundwater. Geothermal power plants use steam from the reservoirs to produce electricity, as shown in **Figure 14.** In a developing method, water becomes steam when it is pumped through broken, hot, dry rocks. The steam then is used to turn turbines that run generators to make electricity. The advantage of using hot, dry rocks is that they are found just about everywhere. Geothermal energy presently is being used in Hawaii and in parts of the western United States.

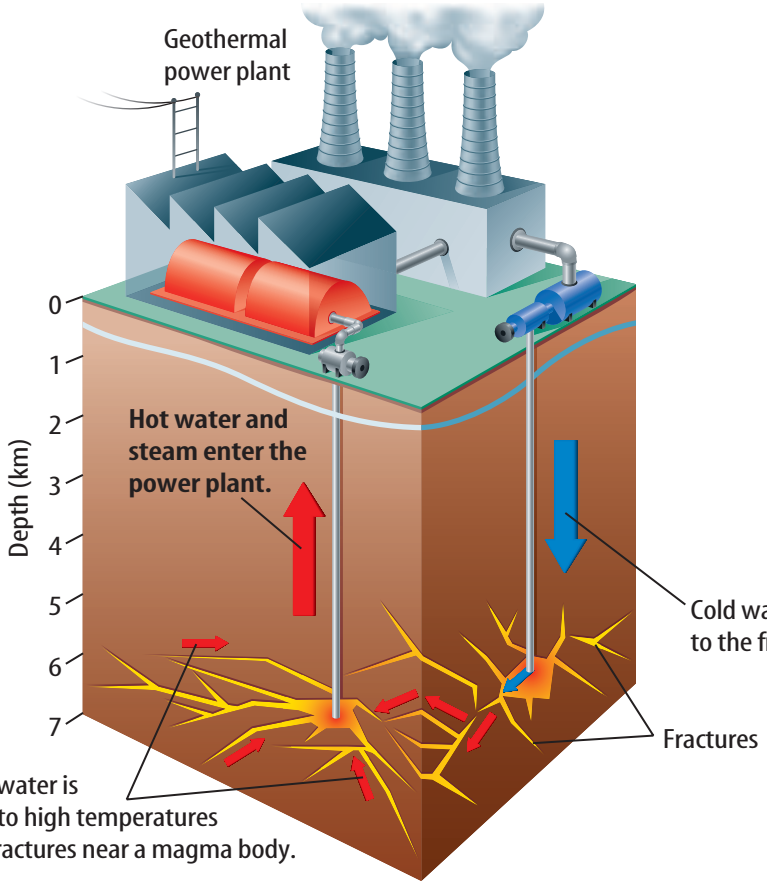
Robert Cameron/Stone/Getty Images

Figure 13 Hydroelectric power is important in many regions of the United States. Hoover Dam was built on the Colorado River to supply electricity for a large area.



The power of running water is converted to usable energy in a hydroelectric power plant.

Figure 14 Geothermal energy is used to supply electricity to industries and homes.



What by-product is produced in this geothermal plant in California? Is it considered a pollutant?

Renewable Energy Resources

Energy resources that can be replaced in nature or by humans within a relatively short period of time are referred to as renewable energy resources. This short period of time is defined generally as being within a human life span. For example, trees can be considered a renewable energy resource. As one tree is cut down, another can be planted in its place. The new tree might be left untouched or harvested.

You have learned that most energy used in the United States—about 90 percent—comes from fossil fuels, which are nonrenewable energy resources. Next, you'll look at some renewable energy resources and how they might fit into the world's total energy needs now and in the future.

Biomass Energy

A major renewable energy resource is biomass materials. **Biomass energy** is energy derived from burning organic material such as wood, alcohol, and garbage. The term *biomass* is derived from the words *biological* and *mass*.

Science Online

Topic: Biomass Energy

Visit earth.msscience.com for Web links to information about biomass energy.

Activity List three new technologies that turn biomass into useable energy. Give two examples of each type of biomass and its energy technology.

CONTENTS

Figure 15 These campers are using wood, a renewable energy resource, to produce heat and light.
Discuss *Why do you think wood is the most commonly used biomass fuel?*

Energy from Wood

If you've ever sat around a campfire, like the campers shown in **Figure 15,** or close to a wood-burning fireplace to keep warm, you have used energy from wood. The burning wood is releasing stored solar energy as heat energy. Humans have long used wood as an energy resource. Much of the world still cooks with wood. In fact, firewood is used more widely today than any other type of biomass fuel.

Using wood as a biomass fuel has its problems. Gases and small particles are released when wood is burned. These materials can pollute the air. When trees are cut down for firewood, natural habitats are destroyed. However, if proper conservation methods are employed or if tree farms are maintained specifically for use as fuel, energy from wood can be a part of future energy resources.

Figure 16 Gasohol sometimes is used to reduce dependence on fossil fuels.

Energy from Alcohol

Biomass fuel can be burned directly, such as when wood or peat is used for heating and cooking. However, it also can be transformed into other materials that might provide cleaner, more efficient fuels.

For example, during distillation, biomass fuel, such as corn, is changed to an alcohol such as ethanol. Ethanol then can be mixed with another fuel. When the other fuel is gasoline, the mixture is called gasohol. Gasohol can be used in the same way as gasoline, as shown in **Figure 16,** but it cuts down on the amount of fossil fuel needed to produce gasoline. Fluid biomass fuels are more efficient and have more uses than solid biomass fuels do.

The problem with this process is that presently, growing the corn and distilling the ethanol often uses more energy from burning fossil fuels than the amount of energy that is derived from burning ethanol. At present, biomass fuel is best used locally.

Reading Check ***What are the drawbacks of biomass fuels?***

CONTENTS

Energy from Garbage Every day humans throw away a tremendous amount of burnable garbage. As much as two thirds of what is thrown away could be burned. If more garbage were used for fuel, as shown in **Figure 17,** human dependence on fossil fuels would decrease. Burning garbage is a cheap source of energy and also helps reduce the amount of material that must be dumped into landfills.

Compared to other nations, the United States lags in the use of municipal waste as a renewable energy resource. For example, in some countries in Western Europe, as much as half of the waste generated is used for biomass fuel. When the garbage is burned, heat is produced, which turns water to steam. The steam turns turbines that run generators to produce electricity.

Unfortunately, some problems can be associated with using energy from garbage. Burning municipal waste can produce toxic ash residue and air pollution. Substances such as heavy metals could find their way into the smoke from garbage and thus into the atmosphere.

Figure 17 Garbage can be burned to produce electricity at trash-burning power plants such as this one in Virginia.

section 2 review

Summary

Inexhaustible Energy Resources

- Solar cells are used to collect the Sun's energy.
- Wind energy produces no waste or pollution, however only a few areas are conducive for creating significant energy supplies.
- Dams are used to help provide running water, which is used to produce electricity.
- Energy obtained by using heat from inside Earth is called geothermal energy.

Renewable Energy Resources

- Biomass energy is produced when organic material such as wood, alcohol, or garbage is burned.
- Trash-burning power plants convert waste into electricty by burning garbage.

Self Check

1. **List** three advantages and disadvantages of using solar energy, wind energy, and hydroelectric energy.
2. **Explain** the difference between inexhaustible and renewable energy resources. Give two examples of each.
3. **Describe** how geothermal energy is used to create electricity.
4. **Infer** why nonrenewable resources are used more than inexhaustible and renewable resources.
5. **Think Critically** How could nuclear energy, which normally is classified as a nonrenewable energy resource, be reclassified as an inexhaustible energy resource?

Applying Skills

6. **Use a Spreadsheet** Make a table of energy resources. Include an example of how each resource is used. Then describe how you could reduce the use of energy resources at home.

LAB

Soaking Up Solar Energy

Winter clothing tends to be darker in color than summer clothing. The color of the material used in the clothing affects its ability to absorb energy. In this lab, you will use different colors of soil to study this effect.

Real-World Question

How does color affect the absorption of energy?

Goals

- **Determine** whether color has an effect on the absorption of solar energy.
- **Relate** the concept of whether color affects absorption to other applications.

Materials

dry, black soil
dry, brown soil
dry, sandy, white soil
thermometers (3)
ring stand
graph paper
colored pencils (3)
metric ruler
clear-glass or plastic dishes (3)
200-watt gooseneck lamp
**200-watt lamp with reflector and clamp*
watch or clock with second hand
**stopwatch*
**Alternate materials*

Safety Precautions

WARNING: *Handle glass with care so as not to break it. Wear thermal mitts when handling the light source.*

Procedure

1. Fill each dish with a different color of soil to a depth of 2.5 cm.
2. Arrange the dishes close together on your desk and place a thermometer in each dish. Be sure to cover the thermometer bulb in each dish completely with the soil.
3. Position the lamp over all three dishes.
4. **Design** a data table for your observations similar to the sample table above. You will need to read the temperature of each dish every 30 s for 20 min after the light is turned on.
5. Turn on the light and begin your experiment.
6. Use the data to construct a graph. Time should be plotted on the horizontal axis and temperature on the vertical axis. Use a different colored pencil to plot the data for each type of soil, or use a computer to design a graph that illustrates your data.

Time and Temperature

Time (min)	Temperature Dish A (°C)	Temperature Dish B (°C)	Temperature Dish C (°C)
0.0			
0.5			
1.0			
1.5			

Conclude and Apply

1. **Observe** which soil had the greatest temperature change. The least?
2. **Explain** why the curves on the graph flatten.
3. **Infer** Why do flat-plate solar collectors have black plates behind the water pipes?
4. **Explain** how the color of a material affects its ability to absorb energy.
5. **Infer** Why is most winter clothing darker in color than summer clothing?

section 3

Mineral Resources

Metallic Mineral Resources

If your room at home is anything like the one shown in **Figure 18,** you will find many metal items. Metals are obtained from Earth materials called metallic mineral resources. A **mineral resource** is a deposit of useful minerals. See how many metals you can find. Is there anything in your room that contains iron? What about the metal in the frame of your bed? Is it made of iron? If so, the iron might have come from the mineral hematite. What about the framing around the windows in your room? Is it aluminum? Aluminum, like that in a soft-drink can, comes from a mixture of minerals known as bauxite. Many minerals contain these and other useful elements. Which minerals are mined as sources for the materials you use every day?

Ores Deposits in which a mineral or minerals exist in large enough amounts to be mined at a profit are called **ores.** Generally, the term ore is used for metallic deposits, but this is not always the case. The hematite that was mentioned earlier as an iron ore and the bauxite that was mentioned earlier as an aluminum ore are metallic ores.

Reading Check *What is an ore?*

as you read

What You'll Learn

- **Explain** the conditions needed for a mineral to be classified as an ore.
- **Describe** how market conditions can cause a mineral to lose its value as an ore.
- **Compare and contrast** metallic and nonmetallic mineral resources.

Why It's Important

Many products you use are made from mineral resources.

Review Vocabulary

metal: a solid material that is generally hard, shiny, pliable and a good electrical conductor

New Vocabulary

- mineral resource
- ore
- recycling

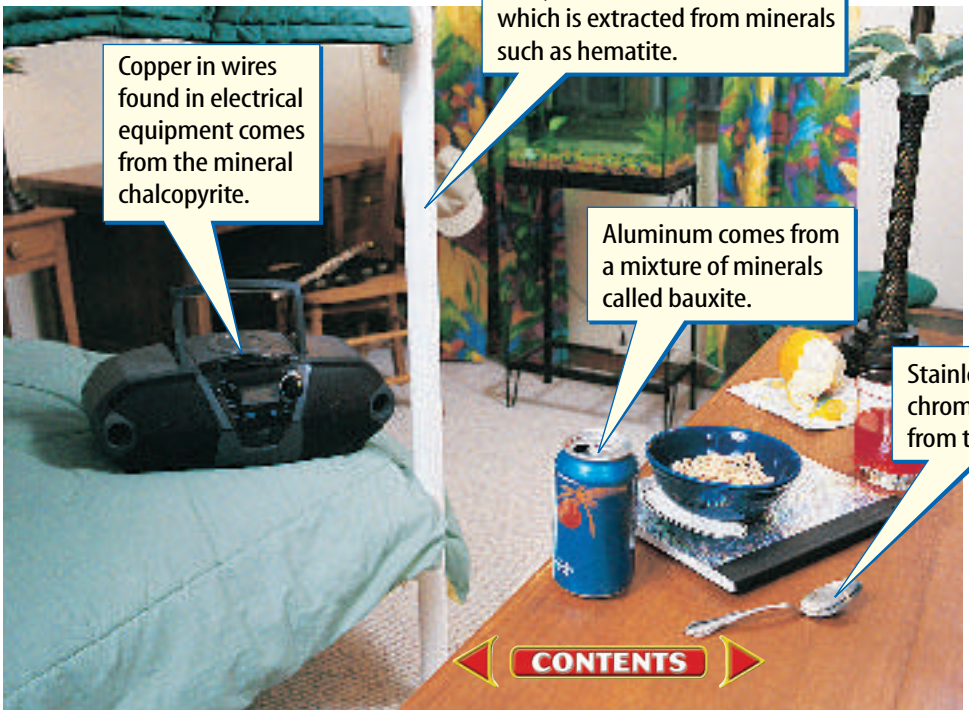


Figure 18 Many items in your home are made from metals obtained from metallic mineral resources.

CONTENTS

Aaron Haupt

Figure 19 Iron ores are smelted to produce nearly pure iron. **List** *three examples of what this iron could be used for.*

Economic Effects When is a mineral deposit considered an ore? The mineral in question must be in demand. Enough of it must be present in the deposit to make it worth removing. Some mining operations are profitable only if a large amount of the mineral is needed. It also must be fairly easy to separate the mineral from the material in which it is found. If any one of these conditions isn't met, the deposit might not be considered an ore.

Supply and demand is an important part of life. You might have noticed that when the supply of fresh fruit is down, the price you pay for it at the store goes up. Economic factors largely determine what an ore is.

Refining Ore The process of extracting a useful substance from an ore involves two operations—concentrating and refining. After a metallic ore is mined from Earth's crust, it is crushed and the waste rock is removed. The waste rock that must be removed before a mineral can be used is called gangue (GANG).

Refining produces a pure or nearly pure substance from ore. For example, iron can be concentrated from the ore hematite, which is composed of iron oxide. The concentrated ore then is refined to be as close to pure iron as possible. One method of refining is smelting, illustrated in **Figure 19.** Smelting is a chemical process that removes unwanted elements from the metal that is being processed. During one smelting process, a concentrated ore of iron is heated with a specific chemical. The chemical combines with oxygen in the iron oxide, resulting in pure iron. Note that one resource, fossil fuel, is burned to produce the heat that is needed to obtain the finished product of another resource, in this case iron.

Nonmetallic Mineral Resources

Any mineral resources not used as fuels or as sources of metals are nonmetallic mineral resources. These resources are mined for the nonmetallic elements contained in them and for the specific physical and chemical properties they have. Generally, nonmetallic mineral resources can be divided into two different groups—industrial minerals and building materials. Some materials, such as limestone, belong to both groups of nonmetallic mineral resources, and others are specific to one group or the other.

CONTENTS

Industrial Minerals Many useful chemicals are obtained from industrial minerals. Sandstone is a source of silica (SiO_2), which is a compound that is used to make glass. Some industrial minerals are processed to make fertilizers for farms and gardens. For example, sylvite, a mineral that forms when seawater evaporates, is used to make potassium fertilizer.

Many people enjoy a little sprinkle of salt on french fries and pretzels. Table salt is a product derived from halite, a nonmetallic mineral resource. Halite also is used to help melt ice on roads and sidewalks during winter and to help soften water.

Other industrial minerals are useful because of their characteristic physical properties. For example, abrasives are made from deposits of corundum and garnet. Both of these minerals are hard and able to scratch most other materials they come into contact with. Small particles of garnet can be glued onto a sheet of heavy paper to make abrasive sandpaper. **Figure 20** illustrates just a few ways in which nonmetallic mineral resources help make your life more convenient.

Mini LAB

Observing the Effects of Insulation

Procedure

1. Pour **warm water** into a **thermos bottle.** Cap it and set it aside.
2. Pour **cold water** with **ice** into a **glass** surrounded by a **thermal cup holder.**
3. Pour warm water—the same temperature as in step 1—into an **uncovered cup.** Pour cold water with ice into a glass container that is not surrounded by a thermal cup holder.
4. After 2 h, measure the temperature of each of the liquids.

Analysis

1. Infer how the insulation affected the temperature of each liquid.
2. Relate the usefulness of insulation in a thermos bottle to the usefulness of fiberglass insulation in a home.

Figure 20 You benefit from the use of industrial minerals every day.

Road salt melts ice on streets.

Many important chemicals are made from industrial minerals.

An industrial mineral called trona is important for making glass.

CONTENTS

Building Materials One of the most important nonmetallic mineral resources is aggregate. Aggregate is composed of crushed stone or a mixture of gravel and sand and has many uses in the building industry. For example, aggregates can be mixed with cement and water to form concrete. Quality concrete is vital to the building industry. Limestone also has industrial uses. It is used as paving stone and as part of concrete mixtures. Have you ever seen the crushed rock in a walking path or driveway? The individual pieces might be crushed limestone. Gypsum, a mineral that forms when seawater evaporates, is soft and lightweight and is used in the production of plaster and wallboard. If you handle a piece of broken plaster or wallboard, note its appearance, which is similar to the mineral gypsum.

Rock also is used as building stone. You might know of buildings in your region that are made from granite, limestone, or sandstone. These rocks and others are quarried and cut into blocks and sheets. The pieces then can be used to construct buildings. Some rock also is used to sculpt statues and other pieces of art.

Reading Check *What are some important nonmetallic mineral resources?*

Applying Science

Why should you recycle?

Recycling in the United States has become a way of life. In 2000, 88 percent of Americans participated in recycling. Recycling is important because it saves precious raw materials and energy. Recycling aluminum saves 95 percent of the energy required to obtain it from its ore. Recycling steel saves up to 74 percent in energy costs, and recycling glass saves up to 22 percent.

Identifying the Problem

The following table includes materials that currently are being recycled and rates of recycling for the years 1995, 1997, and 2001. Examine the table to determine materials for which recycling increased or decreased between 1995 and 2001.

Recycling Rates in the United States

Material	1995 (%)	1997 (%)	2001 (%)
Glass	24.5	24.3	27.2
Steel	36.5	38.4	43.5 (est.)
Aluminum	34.6	31.2	33.0
Plastics	5.3	5.2	7.0

Solving the Problem

1. Has the recycling of materials increased or decreased over time? Which materials are recycled most? Which materials are recycled least? Discuss why some materials might be recycled more than others.
2. How can recycling benefit society? Explain your answer.

Recycling Mineral Resources

Mineral resources are nonrenewable. You've learned that nonrenewable resources are those that Earth processes cannot replace within an average human's lifetime. Most mineral resources take millions of years to form. Have you ever thrown away an empty soft-drink can? Many people do. These cans become solid waste. Wouldn't it be better if these cans and other items made from mineral resources were recycled into new items?

Recycling is using old materials to make new ones. Recycling has many advantages. It reduces the demand for new mineral resources. The recycling process often uses less energy than it takes to obtain new material. Because supplies of some minerals might become limited in the future, recycling could be required to meet needs for certain materials, as shown in **Figure 21.**

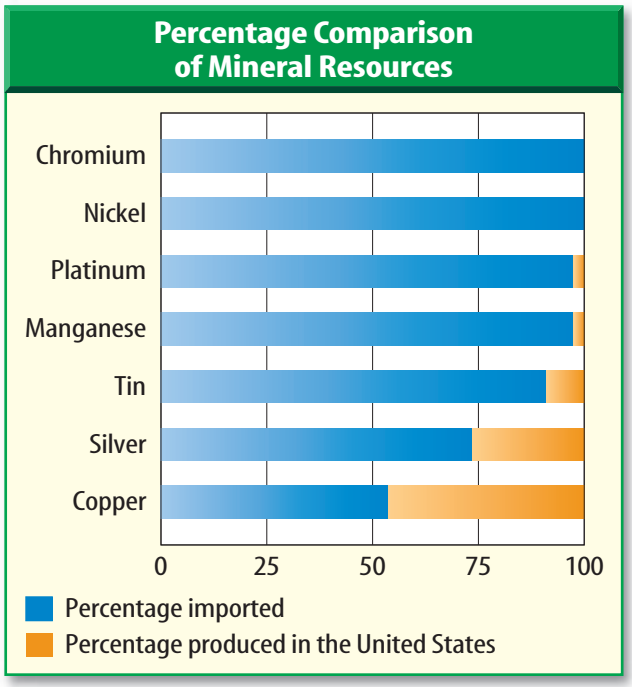


Figure 21 The United States produces only a small percentage of the metallic resources it consumes.

Recycling also can be a profitable experience. Some companies purchase scrap metal and empty soft-drink cans for the aluminum and tin content. The seller receives a small amount of money for turning in the material. Schools and other groups earn money by recycling soft-drink cans.

section 3 review

Summary

Metallic Mineral Resources

- Minerals found in rocks that can be mined for an economic profit are called ores.

Nonmetallic Mineral Resources

- Nonmetallic mineral resources can be classified into groups: industrial minerals and building materials.
- Sedimentary rocks such as limestone and sandstone can be used as building materials to make things like buildings and statues.

Recycling Mineral Resources

- Recycling materials helps to preserve Earth's resources by reusing old or used materials without extracting new resources from Earth.
- The recycling process may use fewer resources than it takes to obtain new material.

Self Check

1. **Explain** how metals obtained from metallic mineral resources are used in your home and school. Which of these products could be recycled easily?
2. **List** two industrial uses for nonmetallic mineral resources.
3. **Explain** how supply and demand of a material can cause a mineral to become an ore.
4. **Think Critically** Gangue is waste rock remaining after a mineral ore is removed. Why is gangue sometimes reprocessed?

Applying Skills

5. **Classify** the following mineral resources as metallic or nonmetallic: *hematite, limestone, bauxite, sandstone, garnet,* and *chalcopyrite.* Explain why you classified each one as you did.

LAB

Model and Invent

Home Sweet Home

Goals

- **Research** various inexhaustible and other energy resources available to use in the home.
- **Design** blueprints for an energy-efficient home and/or design and build a model of an energy-efficient home.

Possible Materials

paper
ruler
pencils
cardboard
glue
aluminum foil

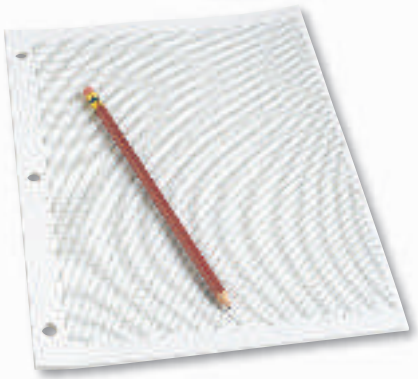
Real-World Question

As fossil fuel supplies continue to be depleted, an increasing U. S. population has recognized the need for alternative energy sources. United States residents might be forced to consider using inexhaustible and other renewable energy resources to meet some of their energy needs. The need for energy-efficient housing is more relevant now than ever before. A designer of energy-efficient homes considers proper design and structure, a well chosen building site with wise material selection, and selection of efficient energy generation systems to power the home. Energy-efficient housing uses less energy and produces fewer pollutants. What does the floor plan, building plan, or a model of an energy efficient home look like? How and where should your house be designed and built to efficiently use the alternative energy resources you've chosen?

CONTENTS

Make a Model

Plan



1. **Research** current information about energy-efficient homes.
2. **Research** inexhaustible energy resources such as wind, hydroelectric power, or solar power, as well as energy conservation. Decide which energy resources are most efficient for your home design.
3. Decide where your house should be built to use energy efficiently.
4. Decide how your house will be laid out and draw mock blueprints for your home. Highlight energy issues such as where solar panels can be placed.
5. Build a model of your energy-efficient home.

Do

1. Ask your peers for input on your home. As you research, become an expert in one area of alternative energy generation and share your information with your classmates.
2. **Compare** your home's design to energy-efficient homes you learn about through your research.

Test Your Model

1. Think about how most of the energy in a home is used. Remember as you plan your home that energy-efficient homes not only generate energy—they also use it more efficiently.
2. Carefully consider where your home should be built. For instance, if you plan to use wind power, will your house be built in an area that receives adequate wind?
3. Be sure to plan for backup energy generation. For instance, if you plan to use mostly solar energy, what will you do if it's a cloudy day?

Analyze Your Data

Devise a budget for building your home. Could your energy-efficient home be built at a reasonable price? Could anyone afford to build it?

Conclude and Apply

Create a list of pro and con statements about the use of energy-efficient homes. Why aren't inexhaustible and other renewable energy sources widely used in homes today?

Communicating Your Data

Present your model to the class. Explain which energy resources you chose to use in your home and why. Have an open house. Take prospective home owners/classmates on a tour of your home and sell it.

Aaron Haupt

BLACK GOLD!

What if you went out to your backyard, started digging a hole, and all of the sudden oil spurted out of the ground? Dollar signs might flash before your eyes.

It wasn't quite that exciting for Charles Tripp. Tripp, a Canadian, is credited with being the first person to strike oil. And he wasn't even looking for what has become known as "black gold."

In 1851, Tripp built a factory in Ontario, Canada, not far from Lake Erie. He used a natural, black, thick, sticky substance that could be found nearby to make asphalt for paving roads and to construct buildings.

In 1855, Tripp dug a well looking for fresh-water for his factory. After digging just 2 m or so, he unexpectedly came upon liquid. It wasn't clear, clean, and delicious; it was smelly thick, and black. You guessed it—oil! Tripp didn't understand the importance of his find. Two years after his accidental discovery, Tripp sold his company to James Williams. In 1858,

The Titusville, Pennsylvania, oil well drilled by Edwin Drake. This photo was taken in 1864.

Some people used TNT to search for oil. This photo was taken in 1943.

Williams continued to search for water for the factory, but, as luck would have it, diggers kept finding oil.

Some people argue that the first oil well in North America was in Titusville, Pennsylvania, when Edwin Drake hit oil in 1859. However, most historians agree that Williams was first in 1858. But they also agree that it was Edwin Drake's discovery that led to the growth of the oil industry. So, Drake and Williams can share the credit!

Today, many oil companies are drilling beneath the sea for oil.

Make a Graph Research the leading oil-producing nations and make a bar graph of the top five producers. Research how prices of crude oil affect the U.S. and world economies. Share your findings with your class.

ScienceOnline
For more information, visit earth.msscience.com/oops

Reviewing Main Ideas

Section 1 Nonrenewable Energy Resources

1. Fossil fuels are considered to be non-renewable energy resources.
2. The higher the concentration of carbon in coal is, the cleaner it burns.
3. Oil and natural gas form from altered and buried marine organisms and often are found near one another.
4. Nuclear energy is obtained from the fission of heavy isotopes.

Section 2 Renewable Energy Resources

1. Inexhaustible energy resources—solar energy, wind energy, hydroelectric energy, and geothermal energy—are constant and will not run out.
2. Renewable energy resources are replaced within a relatively short period of time.
3. Biomass energy is derived from organic material such as wood and corn.

Section 3 Mineral Resources

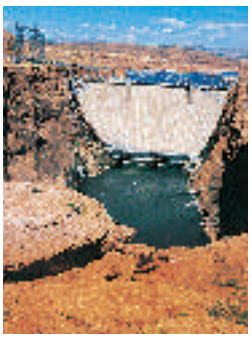
1. Metallic mineral resources provide metals.
2. Ores are mineral resources that can be mined at a profit.
3. Smelting is a chemical process that removes unwanted elements from a metal that is being processed.
4. Nonmetallic mineral resources are classified as industrial minerals or building materials.

Visualizing Main Ideas

Copy and complete the following table that lists advantages and disadvantages of energy resources.

Energy Resources

Resource	Advantages	Disadvantages
Fossil fuels		
Nuclear energy		
Solar energy		
Wind energy		
Geothermal energy		
Biomass fuel		



chapter 5 Review

Using Vocabulary

biomass energy p. 133
coal p. 121
fossil fuel p. 120
geothermal energy p. 132
hydroelectric energy p. 132
mineral resource p. 137
natural gas p. 123
nuclear energy p. 127
oil p. 123
ore p. 137
recycling p. 141
reserve p. 125
solar energy p. 130
wind farm p. 131

Each phrase below describes a vocabulary word from the list. Write the word that matches the phrase describing it.

1. mineral resource mined at a profit
2. fuel that is composed mainly of the remains of dead plants
3. method of conservation in which items are processed to be used again
4. inexhaustible energy resource that is used to power the *Hubble Space Telescope*
5. energy resource that is based on fission
6. liquid from remains of marine organisms

Checking Concepts

Choose the word or phrase that best answers the question.

7. Which has the highest content of carbon?
   A) peat **C)** bituminous coal
   B) lignite **D)** anthracite coal

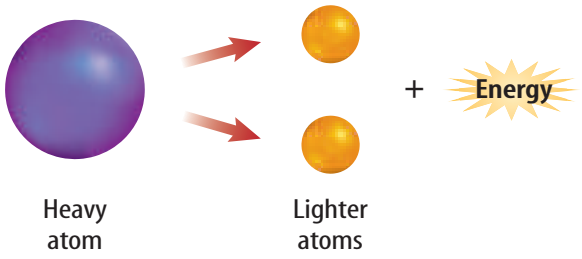
8. Which is the first step in coal formation?
   A) peat **C)** bituminous coal
   B) lignite **D)** anthracite

9. Which of the following is an example of a fossil fuel?
   A) wind **C)** natural gas
   B) water **D)** uranium-235

10. What is the waste material that must be separated from an ore?
    A) smelter **C)** mineral resource
    B) gangue **D)** petroleum

11. What common rock structure can trap oil and natural gas under it?
    A) folded rock **C)** porous rock
    B) sandstone rock **D)** permeable rock

Use the figure below to answer question 12.



12. What other particles are released in the reaction above?
    A) protons **C)** uranium atoms
    B) neutrons **D)** heavy atoms

13. What is a region where many windmills are located in order to generate electricity from wind called?
    A) wind farm
    B) hydroelectric dam
    C) oil well
    D) steam-driven turbine

14. Which of the following is a deposit of hematite that can be mined at a profit?
    A) ore **C)** gangue
    B) anthracite **D)** energy resource

15. What is an important use of petroleum?
    A) making plaster **C)** as abrasives
    B) making glass **D)** making gasoline

16. Which of the following is a nonrenewable energy resource?
    A) water **C)** geothermal
    B) wind **D)** petroleum

Thinking Critically

17. **Describe** the major problems associated with generating electricity using nuclear power plants.

18. **Explain** why wind is considered to be an inexhaustible energy resource.

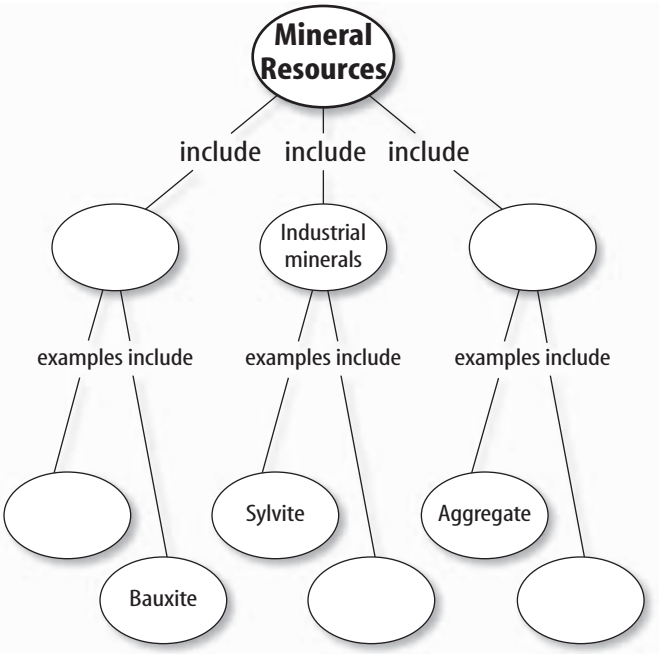
19. **Determine** which type of energy resources are considered to be biomass fuels. List three biomass fuels.

20. **Discuss** two conditions which could occur to cause gangue to be reclassified as an ore.

21. **Predict** If a well were drilled into a rock layer containing petroleum, natural gas, and water, which substance would be encountered first? Illustrate your answer with a labeled diagram.

22. **Compare and contrast** solar energy and wind energy by creating a table.

23. **Concept Map** Copy and complete the following concept map about mineral resources.



Performance Activities

24. **Make Models** Make a blueprint of a house that has been built to use passive solar energy. Which side of the house will face the sun?

25. **Letter** Write a letter to the Department of Energy asking how usable energy might be obtained from methane hydrates in the future. Also inquire about methods to extract methane hydrates.

Applying Math

Use the table below to answer questions 26–28.

Big Canyon Mine

Ore Mineral	Metal	Percent Composition	Value (dollars/kg)
Bauxite	Aluminum	5	1.00
Hematite	Iron	2	4.00
Chalcopyrite	Copper	1	6.00
Galena	Lead	7	1.00

26. **Ore Composition** If 100 kg of rock are extracted from this mine, what percentage of the rock is gangue?

A. 15% **C.** 74%

B. 26% **D.** 85%

27. **Total Composition** Graph the total composition of the extracted rock using a circle graph. Label each component clearly. Provide a title for your graph.

28. **Economic Geology** Of that 100 kg of extracted rock, determine how many kilograms of each ore mineral is extracted. List the total dollar value for each metal after the gangue has been eliminated and the ore mineral extracted.

Part 1 Multiple Choice

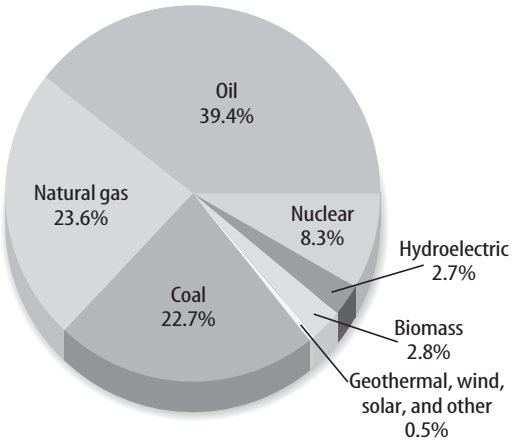
Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. Which is a sedimentary rock formed from decayed plant matter?

A. biomass **C.** natural gas
B. coal **D.** oil

Use the graph below to answer questions 2 and 3.

Energy Use in the United States, 2002



2. What percentage of the energy used in the United States comes from fossils fuels?

A. 6% **C.** 47%
B. 24% **D.** 86%

3. What percentage of our energy sources would be lost if coal runs out?

A. 6% **C.** 23%
B. 8% **D.** 39%

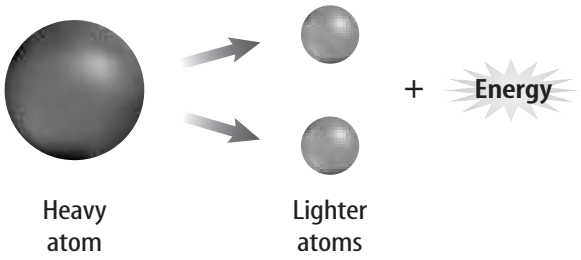
4. Which is a new potential source of methane?

A. coal **C.** hydrocarbons
B. hydrates **D.** petroleum

5. Which is an inexhaustible resource?

A. coal
B. nuclear
C. oil
D. solar

Use the illustration below to answer questions 6 and 7.



6. Which type of energy source is shown in this diagram?

A. coal **C.** fusion
B. fission **D.** natural gas

7. What is produced that drives a turbine, which turns a generator?

A. atoms **C.** steam
B. neutrons **D.** waste

8. Which type of energy uses magma or hot dry rocks to generate electricity?

A. geothermal
B. hydroelectric
C. nuclear
D. solar

9. What is combined to make gasohol?

A. ethanol and gasoline
B. oil and gasoline
C. oil and petroleum
D. wood and gasoline

10. Which helps to reduce the demand for new mineral resources?

A. generating **C.** recycling
B. mining **D.** refining

Test-Taking Tip

Circle Graphs If the question asks about the sum of multiple segments of a circle graph, do your addition on scratch paper and double-check your math before selecting an answer.

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

11. What are two advantages of burning garbage for fuel?

12. What conditions are necessary for a wind farm?

13. Contrast methods used to remove coal with methods used to remove oil and natural gas.

14. How are bacteria involved in the formation of coal?

15. Why are methane hydrates so difficult to extract from the seafloor?

16. List two advantages of using fusion as an energy source.

17. Compare and contrast a mineral resource and an ore. How could a mineral resource become an ore? Is it possible for an ore to become just a mineral resource? Explain your answers.

Use the photo below to answer question 18.

18. What type of nonmetallic mineral resource is being used in this picture? List two other uses for this nonmetallic mineral.

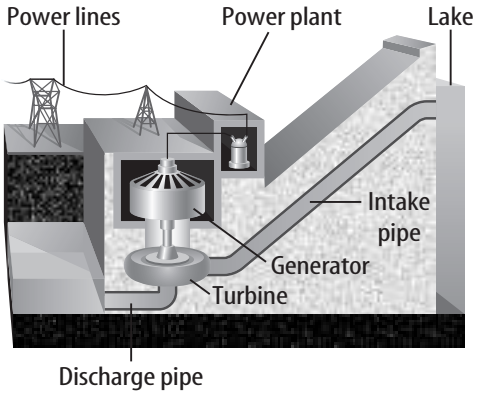
Part 3 Open Ended

Record your answers on a sheet of paper.

19. Contrast the amount of heat released and smoke produced when burning peat, lignite, bituminous coal, and anthracite coal.

20. What are some household ways to help conserve fossil fuels?

Use the illustration below to answer question 21.



21. How is energy to run the turbine being produced? Discuss environmental issues associated with this energy source.

22. Design a 4-part, time-lapse illustration to show the path of iron from the hematite mine to pure iron.

23. How do population growth and technology affect the use of nonrenewable resources?

24. Some sources describe the Sun, wind, water, and geothermal energy as inexhaustible energy resources. What might be some limitations to these resources?

25. Are mineral resources considered to be renewable or nonrenewable? Explain your answer.