SECTION 4

Energy Resources

Energy is used to light and warm our homes. It is used to make food, clothing, and other things. It is also used to transport people and products from place to place. Where does all of this energy come from?

An *energy resource* is a natural resource that can be converted into other forms of energy in order to do useful work. In this section, you will learn about several energy resources, including the one that most other energy resources come from—the sun.

What You Will Learn

- Name several energy resources.
- Explain how the sun is the source of most energy on Earth.
- Evaluate the advantages and disadvantages of using various energy resources.

Vocabulary

nonrenewable resource
fossil fuel
renewable resource

READING STRATEGY

Reading Organizer As you read this section, make a table comparing nonrenewable resources and renewable resources.

Nonrenewable Resources

Some energy resources, called **nonrenewable resources,** cannot be replaced or are replaced much more slowly than they are used. Fossil fuels are the most important nonrenewable resources.

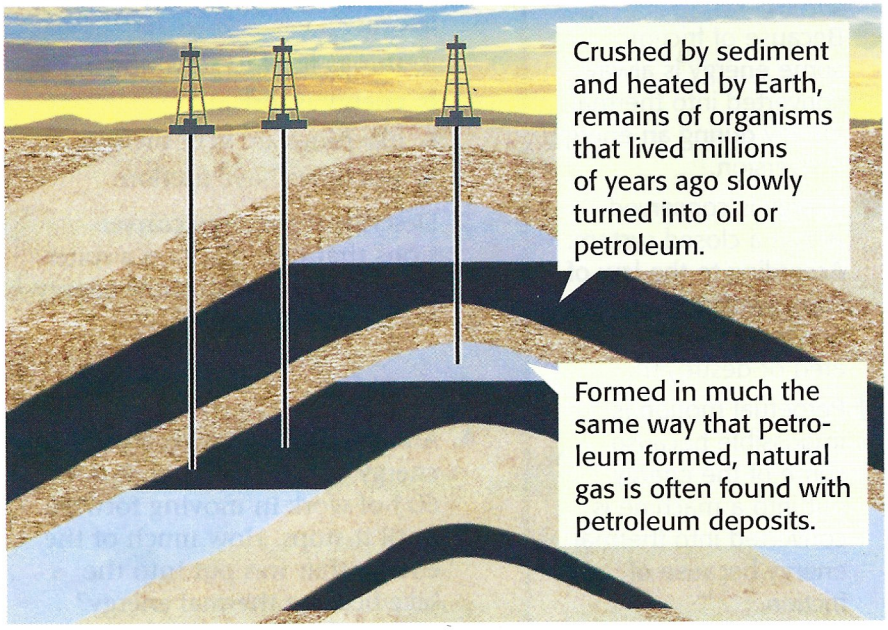
Oil and natural gas, shown in **Figure 1,** as well as coal, are the most common fossil fuels. **Fossil fuels** are energy resources that formed from the buried remains of plants and animals that lived millions of years ago. These plants stored energy from the sun by photosynthesis. Animals used and stored this energy by eating the plants. So, fossil fuels are concentrated forms of the sun's energy. Now, millions of years later, energy from the sun is released when these fossil fuels are burned.

Reading Check **Why are fossil fuels considered nonrenewable resources?** *(See the Appendix for answers to Reading Checks.)*

nonrenewable resource a resource that forms at a rate that is much slower than the rate at which it is consumed

fossil fuel a nonrenewable energy resource formed from the remains of organisms that lived long ago

Figure 1 **Formation of Fossil Fuels**



Uses of Fossil Fuels

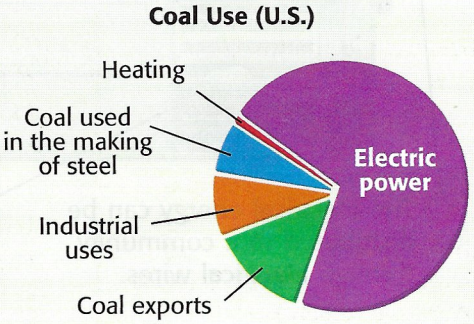
All fossil fuels contain stored energy from the sun, which can be converted into other kinds of energy. **Figure 2** shows some different ways that fossil fuels are used in our society.

People have been getting energy from the burning of coal, a fossil fuel, for hundreds of years. Today, burning coal is still a very common way to generate electrical energy. Many products, such as gasoline, wax, and plastics, are made from petroleum, another fossil fuel. A third kind of fossil fuel, natural gas, is often used in home heating.

Figure 2 **Everyday Uses of Some Fossil Fuels**

Coal

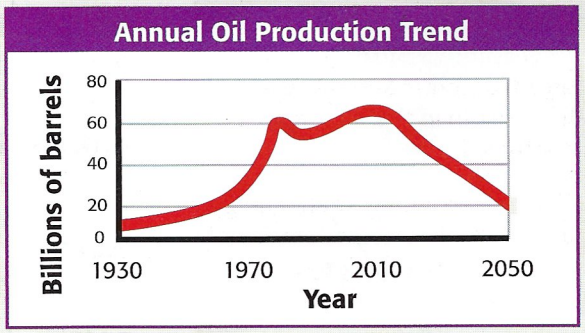
Most coal used in the United States is burned to produce steam to run electric generators.



Petroleum

Gasoline, kerosene, wax, and petrochemicals come from petroleum.

Finding alternative energy resources will become more important in years to come.



Natural Gas

Natural gas is used in heating systems, stoves, ovens, and vehicles.

Compared to other fossil fuels, natural gas has very low emission levels when burned.

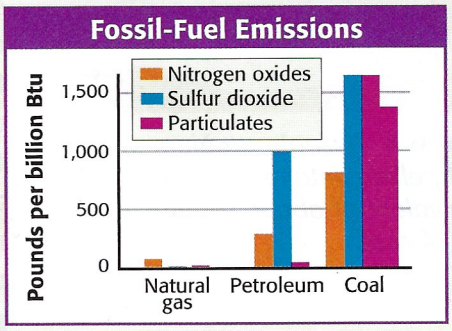
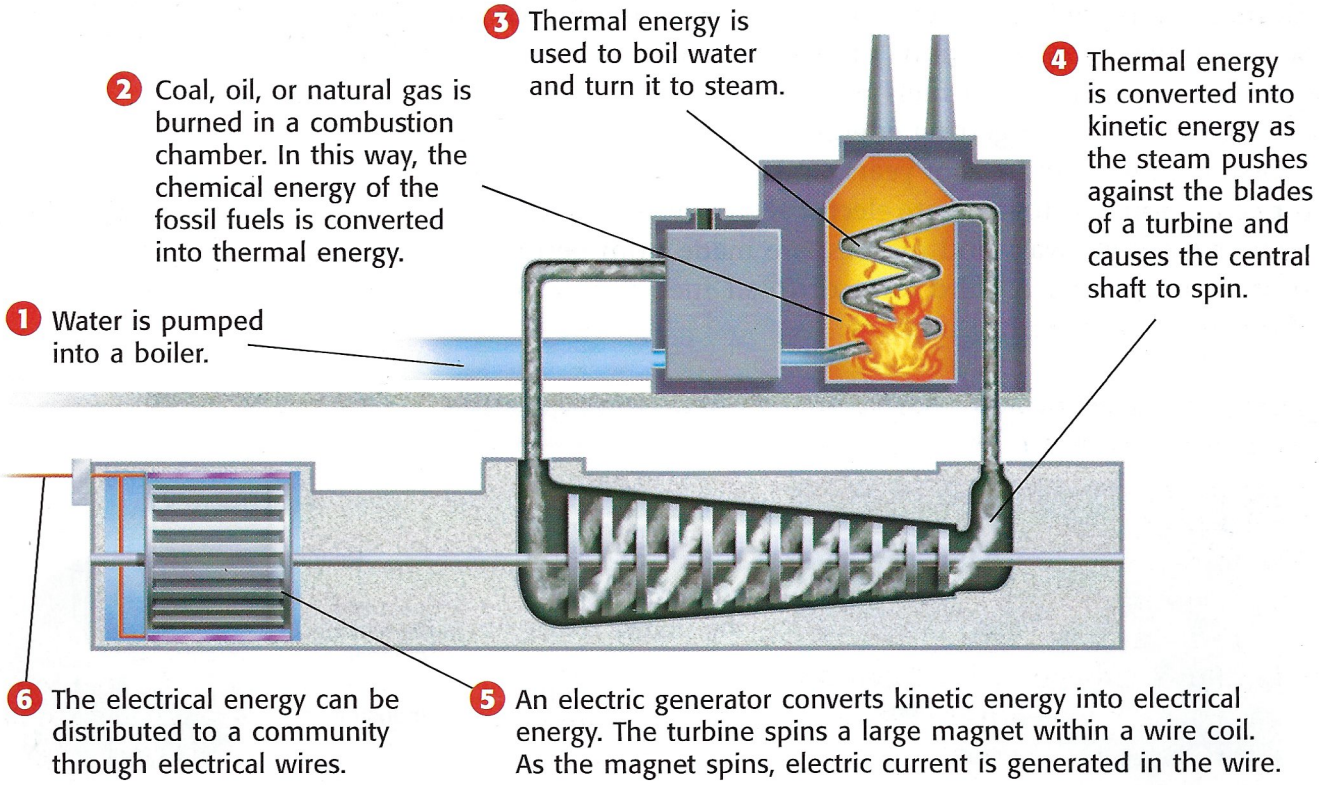


Figure 3 Converting Fossil Fuels into Electrical Energy



Electrical Energy from Fossil Fuels

One way to generate electrical energy is to burn fossil fuels. In fact, fossil fuels are the main source of electrical energy generated in the United States. *Electric generators* convert the chemical energy in fossil fuels into electrical energy by the process shown in **Figure 3.** The chemical energy in fossil fuels is changed into the electrical energy that you use every day.

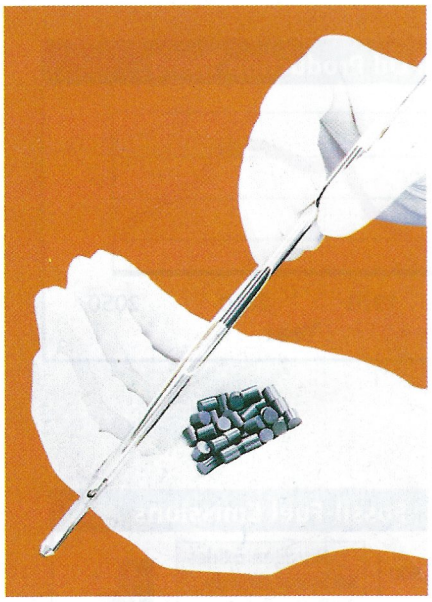


Figure 4 *A single uranium fuel pellet contains the energy equivalent of about 1 metric ton of coal.*

Nuclear Energy

Another way to generate electrical energy is to use nuclear energy. Like fossil-fuel power plants, a nuclear power plant generates thermal energy that boils water to make steam. The steam then turns a turbine, which runs a generator. The spinning generator changes kinetic energy into electrical energy. However, the fuels used in nuclear power plants differ from fossil fuels. Nuclear energy is generated from radioactive elements, such as uranium, shown in **Figure 4.** In a process called *nuclear fission* (NOO klee uhr FISH uhn), the nucleus of a uranium atom is split into two smaller nuclei, which releases nuclear energy. Because the supply of these elements is limited, nuclear energy is a nonrenewable resource.

Reading Check **Where does nuclear energy come from?**

Renewable Resources

Some energy resources, called **renewable resources,** are naturally replaced more quickly than they are used. Some renewable resources, such as solar energy and wind energy, are considered practically limitless.

renewable resource a natural resource that can be replaced at the same rate at which the resource is consumed

Solar Energy

Sunlight can be changed into electrical energy through solar cells. These cells can be used in devices such as calculators. Solar cells can also be placed on the roof of a house to provide electrical energy. Some houses can use solar energy by allowing sunlight into the house through large windows. The sun's energy can then be used to heat the house.

Energy from Water

The sun causes water to evaporate and fall again as rain that flows through rivers. The potential energy of water in a reservoir can be changed into kinetic energy as the water flows through a dam. **Figure 5** shows a hydroelectric dam. Falling water turns turbines in a dam. The turbines are connected to a generator that changes kinetic energy into electrical energy.

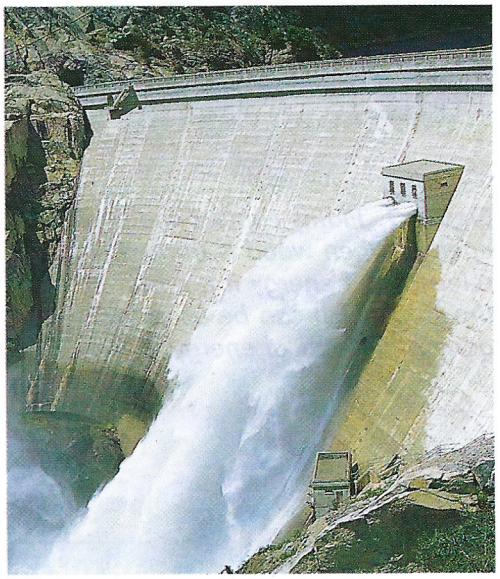


Figure 5 *This dam converts the energy from water going downstream into electrical energy.*

Wind Energy

Wind is caused by the sun's heating of Earth's surface. Because Earth's surface is not heated evenly, wind is created. The kinetic energy of wind can turn the blades of a windmill. Wind turbines are shown in **Figure 6.** A wind turbine changes the kinetic energy of the air into electrical energy by turning a generator.

Figure 6 *These wind turbines are converting wind energy into electrical energy.*

Geothermal Energy

Thermal energy caused by the heating of Earth's crust is called *geothermal energy*. Some geothermal power plants pump water underground next to hot rock. The water returns to the surface as steam, which can then turn the turbine of a generator.

Reading Check **Where does geothermal energy come from?**

Figure 7 *Plants capture the sun's energy. When wood is burned, it releases the energy it got from the sun, which can be used to generate electrical energy.*

Biomass

Plants use and store energy from the sun. Organic matter, such as plants, wood, and waste, that can be burned to release energy is called *biomass*. **Figure 7** shows an example. Some countries depend on biomass for energy.

The Two Sides to Energy Resources

All energy resources have advantages and disadvantages. How can you decide which energy resource to use? **Table 1** compares several energy resources. Depending on where you live, what you need energy for, and how much energy you need, one energy resource may be a better choice than another.

Table 1 **Advantages and Disadvantages of Energy Resources**

Energy Resource	Advantages	Disadvantages
Fossil fuels	• provide a large amount of thermal energy per unit of mass • are easy to get and transport • can be used to generate electricity and to make products such as plastic	• are nonrenewable • produce smog • release substances that can cause acid precipitation • create a risk of oil spills
Nuclear	• is a very concentrated form of energy • does not produce air pollution	• produces radioactive waste • is nonrenewable
Solar	• is an almost limitless source of energy • does not produce pollution	• is expensive to use for large-scale energy production • is practical only in sunny areas
Water	• is renewable • does not produce air pollution	• requires dams, which disrupt a river's ecosystem • is available only where there are rivers
Wind	• is renewable • is relatively inexpensive to generate • does not produce air pollution	• is practical only in windy areas
Geothermal	• is an almost limitless source of energy • power plants require little land	• is practical only in areas near hot spots • produces wastewater, which can damage soil
Biomass	• is renewable • is inexpensive	• requires large areas of farmland • produces smoke

Choosing the Right Energy Resource

As **Table 1** shows, each source of energy that we know about on Earth has advantages and disadvantages. For example, you have probably heard that fossil fuels pollute the air. They will also run out after they are used up. Even renewable resources have their drawbacks. Generating lots of energy from solar energy is difficult. So it cannot be used to meet the energy needs of large cities. Geothermal energy is limited to the "hot spots" in the world where it is available. Hydroelectric energy requires large dams, which can affect the ecology of river life. Energy planning in all parts of the world requires careful consideration of energy needs and the availability and responsible use of resources.

CONNECTION TO Social Studies

WRITING SKILL **Earth's Energy Resources** Find examples of places in the world where the various energy resources mentioned in this chapter are used. List them in your **science journal.** Discuss any patterns that you notice, such as which regions of the world use certain energy resources.

SECTION Review

Summary

- An energy resource is a natural resource that can be converted into other forms of energy in order to do useful work.
- Nonrenewable resources cannot be replaced after they are used or can be replaced only after long periods of time. They include fossil fuels and nuclear energy.
- Renewable resources can be replaced in nature over a relatively short period of time. They include energy from the sun, wind, and water; geothermal energy; and biomass.
- The sun is the source of most energy on Earth.
- Choices about energy resources depend on where you live and what you need energy for.

Using Key Terms

1. In your own words, write a definition for the term *fossil fuel*.

Complete each of the following sentences by choosing the correct term from the word bank.

nonrenewable resources
renewable resources

2. There is a practically limitless supply of ___.
3. ___ are used up more quickly than they are being replaced.

Understanding Key Ideas

4. Which of the following is a renewable resource?
   - **a.** wind
   - **b.** coal
   - **c.** nuclear energy
   - **d.** petroleum
5. Compare fossil fuels and biomass as energy resources.
6. Trace electrical energy back to the sun.

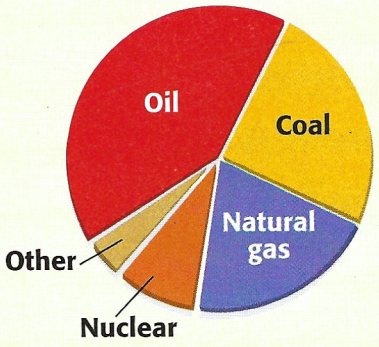
Critical Thinking

7. **Making Comparisons** Describe the similarities and differences between transforming energy in a hydroelectric dam and a wind turbine.
8. **Analyzing Ideas** Name an energy resource that does NOT depend on the sun.

Interpreting Graphics

9. Use the pie chart below to explain why renewable resources are becoming more important to the United States.

U.S. Energy Sources



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Chapter Review

USING KEY TERMS

For each pair of terms, explain how the meanings of the terms differ.

1. *potential energy* and *kinetic energy*
2. *mechanical energy* and *energy conversion*
3. *friction* and *the law of conservation of energy*
4. *renewable resources* and *nonrenewable resources*
5. *energy resources* and *fossil fuels*

UNDERSTANDING KEY IDEAS

Multiple Choice

6. Kinetic energy depends on
   - **a.** mass and volume.
   - **b.** velocity and weight.
   - **c.** weight and height.
   - **d.** velocity and mass.
7. Gravitational potential energy depends on
   - **a.** mass and velocity.
   - **b.** weight and height.
   - **c.** mass and weight.
   - **d.** height and distance.
8. Which of the following types of energy is not a renewable resource?
   - **a.** wind energy
   - **b.** nuclear energy
   - **c.** solar energy
   - **d.** geothermal energy

9. Which of the following sentences describes a conversion from chemical energy to thermal energy?
   - **a.** Food is digested and used to regulate body temperature.
   - **b.** Charcoal is burned in a barbecue pit.
   - **c.** Coal is burned to produce steam.
   - **d.** All of the above
10. When energy changes from one form to another, some of the energy always changes into
    - **a.** kinetic energy.
    - **b.** potential energy.
    - **c.** thermal energy.
    - **d.** mechanical energy.

Short Answer

11. Name two forms of energy, and relate them to kinetic or potential energy.
12. Give three examples of one form of energy being converted into another form.
13. Explain what a closed system is, and how energy is conserved within it.
14. How are fossil fuels formed?

Math Skills

15. A box has 400 J of gravitational potential energy.
    - **a.** How much work had to be done to give the box that energy?
    - **b.** If the box weighs 100 N, how far above the ground is it?

CRITICAL THINKING

16 **Concept Mapping** Use the following terms to create a concept map: *energy, machines, sound energy, hair dryer, electrical energy, energy conversions, thermal energy,* and *kinetic energy*.

17 **Applying Concepts** Describe what happens in terms of energy when you blow up a balloon and release it.

18 **Identifying Relationships** After you coast down a hill on your bike, you will eventually come to a complete stop. Use this fact to explain why perpetual motion is impossible.

19 **Predicting Consequences** Imagine that the sun ran out of energy. What would happen to our energy resources on Earth?

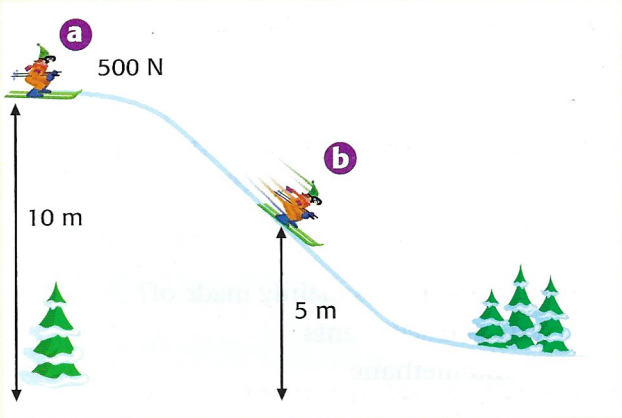
20 **Analyzing Processes** Look at the photo below. Beginning with the pole vaulter's breakfast, trace the energy conversions necessary for the event shown to take place.

21 **Forming Hypotheses** Imagine two cars, one of which is more efficient than the other. Suggest two possible reasons one car is more efficient.

22 **Evaluating Hypotheses** Describe how you would test the two hypotheses you proposed in item 21. How would you determine whether one, both, or neither hypothesis is a factor in the car's efficiency?

INTERPRETING GRAPHICS

Use the graphic below to answer the questions that follow.



23 What is the skier's gravitational potential energy at point *a*?

24 What is the skier's gravitational potential energy at point *b*?

25 What is the skier's kinetic energy at point *b*? (Hint: mechanical energy = potential energy + kinetic energy)