



These windmills at Tehachapi Pass in California use the energy of the wind to produce electricity. Would windmills be good to use where you live? Why or why not?

Learning Objectives

- Identify five different sources of energy.
- Describe how people use different energy sources.
- Explain the benefits and problems of using different energy sources.
- LAB ACTIVITY: Compare how different surfaces absorb solar energy.
- ON-THE-JOB SCIENCE: Read and interpret gauges in a nuclear power plant.

Words to Know

nuclear reactor	a device that splits atoms to release energy
radioactive	giving off radiation, or harmful rays
solar collector	a device with a dark surface that absorbs sunlight and changes it into heat energy
hydroelectric energy	the electrical energy from moving water
turbine	a machine with blades that can be turned; used to run an electric generator
geothermal energy	the heat contained in rock deep inside the Earth
geyser	a hot spring that shoots steam and hot water into the air

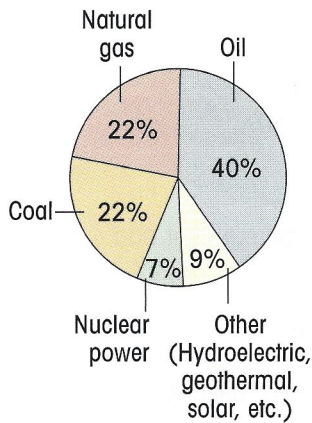


Figure 20-1 This pie chart shows energy use in the United States.

Remember

A fossil fuel is a fuel made of organisms that died millions of years ago.

Power of the Past

We get energy from many sources. An explosion releases a lot of energy. Ocean waves and strong winds are full of energy, too. The sun has an almost unlimited supply of energy. Even tiny atoms hold huge amounts of energy.

You already know a lot about energy. You know the forms it can take: heat, sound, light, electricity, chemical forms, and mechanical forms.

You learned that burning fossil fuels releases energy. Coal, oil, and natural gas are fossil fuels. Over 80 percent of all the energy used in the United States comes from burning fossil fuels. Fossil fuels are used to run cars, heat homes, and provide power for factories. Many plastics also come from fossil fuels.

✓ Where does most of the energy that Americans use come from?

Problems With Fossil Fuels

There are two serious problems with burning fossil fuels for energy. First, there is only so much fossil fuel in existence. Fossil fuels take millions of years and just the right conditions to form. People cannot make more. When fossil fuels run out, they are gone for good. Another problem with fossil fuels is that they cause air pollution when they burn. Their waste products are poisonous and very harmful to the environment.

People can help with these problems. The less often fossil fuels are used, the longer the supply will last. Gasoline can be saved by riding a bike, walking, or taking a bus instead of a car. These ways of getting around also help to keep the air cleaner.

Insulation in homes helps, too. Using insulation means less energy is needed to heat the homes.

✓ What are two problems with fossil fuels?

Lesson Review

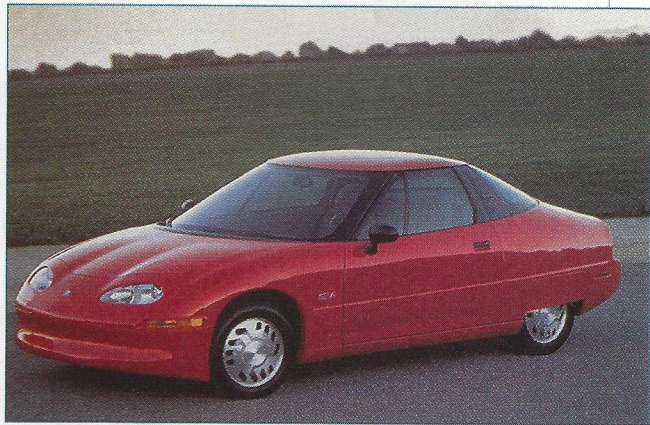
1. What percent of energy used in the United States comes from fossil fuels?
2. How do people use fossil fuels?
3. How can people use less of fossil fuels?
4. **CRITICAL THINKING** How can recycling products made from plastic help us use less of fossil fuels?

On the Cutting Edge

ELECTRIC CARS

One of the problems with using gasoline in cars is that it causes air pollution. Scientists are looking for ways to cut down on air pollution. One way is for people to drive electric cars.

Electric cars run on rechargeable batteries instead of gasoline. They can travel about 100 miles (160 kilometers) before their batteries need to be recharged. It takes about 3 hours to recharge the battery. Unlike cars that use gasoline, electric cars do not pollute the air. They also produce less noise.



An electric car runs on a rechargeable battery.

CRITICAL THINKING What is an advantage and a disadvantage of using an electric car?

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Nuclear Energy

You learned earlier that scientists know how to split the nucleus of an atom. This process is nuclear fission. It releases a tremendous amount of energy.

Nuclear Fission

Nuclear power plants use nuclear reactors. A **nuclear reactor** is a device that splits atoms to release energy. In a nuclear reactor, millions of atomic nuclei are split every second. This process releases a great deal of heat. The heat is used to change water into steam. The steam is then used to power electric generators. The generators change the heat energy into electricity.

Remember

Radiation is energy that comes from the sun or is released by the breakdown of atomic nuclei.

However, nuclear fission has some serious problems. For one thing, the fission process produces **radioactive** wastes. Radioactive means giving off radiation, or harmful rays.

Radioactive wastes give off large amounts of rays that can be very dangerous to living things. These wastes may remain dangerous for millions of years. No one is sure what to do with them. If the wastes are buried, they may pollute the groundwater and soil. Scientists are looking for places where nuclear wastes can be buried safely. These sites must be dry so that the containers of wastes do not come into contact with water. Also, there can be no earthquakes near the burial sites. An earthquake could damage and break open the containers.

Accidents inside nuclear power plants are a problem. Harmful substances have leaked out of a few power plants. Many people think nuclear energy is not worth the risks.

Nuclear Fusion

Scientists are looking for ways to use the energy released by nuclear fusion. Nuclear fusion is the process the sun uses to release heat and light energy.

Nuclear fusion is a very clean process. The fuel used in nuclear fusion is hydrogen. Hydrogen is easy to get from seawater. The wastes from nuclear fusion are water and other safe substances. However, scientists still do not know how to control the nuclear fusion process.

Remember

Nuclear fusion joins atoms together. Energy is released in this process, just as it is when atoms are split apart.

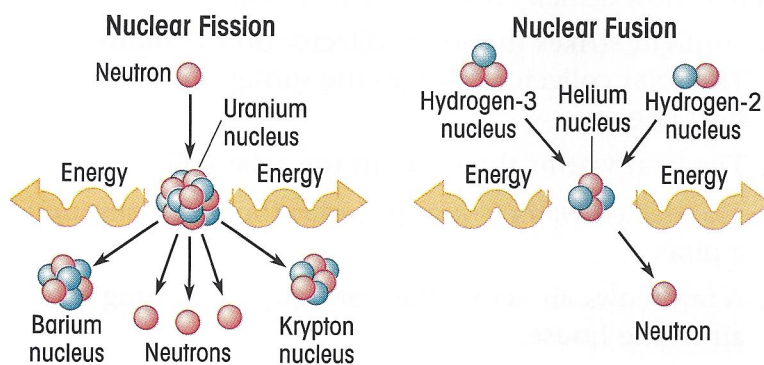


Figure 20-2 In nuclear fission, one large nucleus splits to form two smaller nuclei. In nuclear fusion, small nuclei join to form a larger nucleus.

✓ What are the problems with using nuclear fission and nuclear fusion to produce electricity?

Solar Energy

Remember

Solar energy is energy given off by the sun. It reaches us mostly in the form of light energy.

You have probably at some time sat in a car in the sunshine. You may have started to feel warm. Sunlight hitting your car was turned into heat energy and trapped inside. This is how a **solar collector** works. A solar collector is a device with a dark surface that absorbs sunlight and changes it into heat energy.

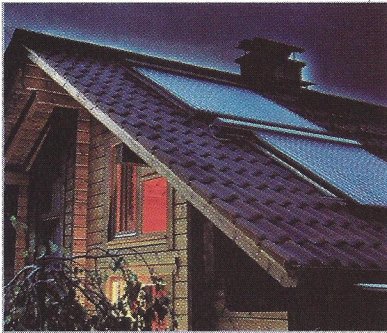
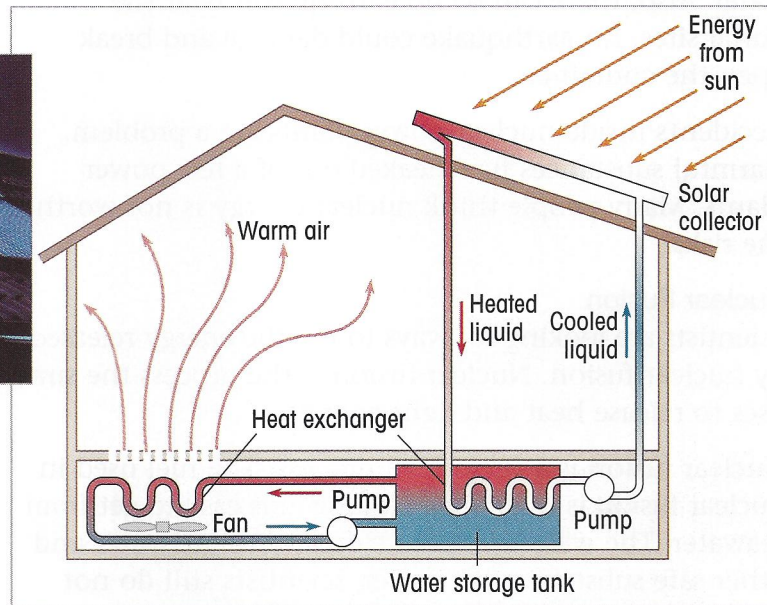


Figure 20-3 The solar collectors on a house face the direction that gets the most sunlight.



Here is how a solar collector heats a house:

1. Sunlight strikes the solar collector on the house. The solar collector changes the sunlight into heat energy.
2. The heat warms the water in the solar collector.
3. The heated water is pumped into the house through a pipe.
4. A fan blows air across the warm pipe, warming the air in the house.

Solar energy can also be used to produce electricity. A *solar cell* changes sunlight into electricity. However, this technology can be very expensive.

Another problem with solar energy is that the sun's light is spread out over wide areas. Scientists must find better ways to collect and store it.

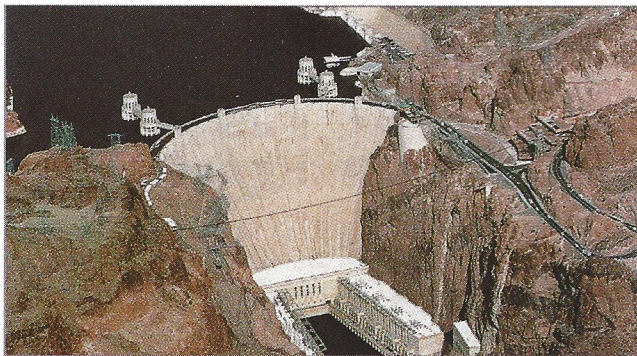
Energy from the sun is clean, there is a lot of it, and it is free. Scientists hope that solar energy will provide much of the world's energy in the future.

✓ What does a solar collector do?

Hydroelectric Energy

Hydroelectric energy is electrical energy from moving water. A dam traps the water in a river. The water behind the dam is released a little at a time, often by opening its flood gates. The moving water strikes a **turbine**. A turbine is a machine with blades that can be turned. When the moving water hits the turbine, it turns the blades. This motion runs an electric generator, which changes the mechanical energy of the blades into electrical energy.

Dams provide energy to many cities. People do not want to dam up too many rivers, though. Dams can affect fish and other wildlife found in or near rivers by changing the ecology of the area.



Hydroelectric energy from dams is used to turn turbines and to store water for future use.

✓ How is moving water used to power an electric generator?



Geysers carry geothermal energy up from under the ground.

Geothermal Energy

The heat contained in rock deep inside the Earth is called **geothermal energy**. This heat is produced by radioactivity and the movements of rock below the surface of the Earth. Geothermal energy heats rock and any water that trickles through cracks in the rock. Sometimes the heat is released in geysers and hot springs. A geyser is a hot spring that shoots steam and hot water into the air.

Scientists have learned how to use geothermal energy to heat homes and produce electricity. Wells are drilled into the ground. Hot water is pumped out to heat buildings. If the rock is hot enough, steam rises to the surface and is used to run an electric generator. There are only a few places on Earth where hot rock is close enough to the surface to make drilling worthwhile. These places include Iceland, New Zealand, and parts of Italy, Japan, and California.

✓ **What causes geothermal energy?**

Winds and Tides

People have used the energy of the wind for many centuries. All over the world, windmills pump water, grind grain, and make electrical energy. Of course, windmills work best where there is a lot of wind. The picture on page 296 shows a wind farm in a windy mountain pass. Rows of windmills operate electric generators.

There is a lot of energy in ocean waves and tides. Power plants can use the energy in waves and tides to produce electrical energy. However, such power plants have to be built near oceans. Even there, conditions must be just right for setting up a power plant.

✓ **How is the energy in wind and in waves and tides used?**

Lesson Review

Match each energy source with its problem.

Energy Source

1. fossil fuels
2. nuclear fission
3. sun
4. hydroelectric
5. geothermal
6. wind
7. nuclear fusion

Problem

- a. produces radioactive wastes
- b. hard to store its energy
- c. needs many windy days
- d. heated rock too deep
- e. limited amounts
- f. harmful to river wildlife
- g. cannot yet be controlled

8. **CRITICAL THINKING** What are two advantages of using wind energy?

A Closer Look

ENERGY FROM GARBAGE

Every year, people in the United States produce millions of tons of garbage. Most of the garbage is buried in areas called *landfills*. However, instead of being buried, some food and paper wastes are being burned to release their stored energy. The wastes are burned in electric power plants. The energy that is released is used to heat water and produce steam. The steam powers electric generators.

The garbage in landfills is also a source of energy. The buried garbage produces a gas called methane. The methane is taken from the landfill and mixed with natural gas, which is a fossil fuel. Mixing the two fuels helps the supply of natural gas last longer.

CRITICAL THINKING Burning garbage and burning fossil fuels both pollute the air. What is the advantage of burning garbage instead of fossil fuels?



Some power plants burn garbage to make steam and produce electricity.



LAB ACTIVITY

Absorbing Solar Energy

BACKGROUND

Solar collectors are placed on the roofs of houses to absorb the sun's energy and change it into heat energy. The collectors have a dark surface.

PURPOSE

You will compare how well different-color surfaces absorb the sun's energy and change it into heat energy.

MATERIALS

paper; pencil; 4 thermometers; 1 sheet each of black, white, red, and yellow construction paper; clock or watch

WHAT TO DO

1. Copy the chart below.

	Color of Paper			
	Black	White	Red	Yellow
Temperature Reading				

2. Place four thermometers in sunlight.
3. Cover each thermometer with a different color sheet of construction paper.
4. Leave the thermometers in the sunlight for 15 minutes.
5. After 15 minutes have passed, record in the chart the temperature reading of each thermometer.

DRAW CONCLUSIONS

- Which paper absorbed the most solar energy? How do you know?
- Why do you think solar collectors on a house have a dark surface?



Safety Alert

Be careful when working with glass thermometers to avoid breaking them.

ON-THE-JOB SCIENCE

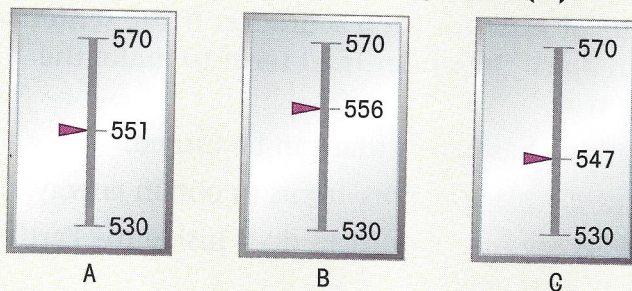
Nuclear Reactor Operator

Julio works in a nuclear power plant. He is a nuclear reactor operator. He spends most of his time in the control room. Here, he keeps close watch on the many gauges. They show that all the parts of the power plant are working right.

Some of the gauges measure the amount of fission occurring in the reactor. This is the reactor power. Other gauges measure the temperature of the water that cools the reactor. Julio checks the amount of steam flow in the steam generator. He also checks the amount of electricity produced at the power plant. If there is a problem, he shuts down the reactor.

These three gauges show different temperatures of the reactor coolant system. For this reactor, the temperature ranges from 530°F at 0 percent power to 570°F at 100 percent power.

Reactor Coolant System: Temperature (°F)



Use the gauges above to answer the questions.

1. What is the correct order of the gauges from the lowest power to the highest power?
2. Which gauge shows the reactor operating at about 50 percent?
3. Which gauge shows the reactor operating at about 65 percent?



Julio sometimes trains other nuclear reactor operators.

Critical Thinking

Draw two temperature gauges. One should show that the reactor is at 0 percent power. The other should show that the reactor is at 100 percent power.

Summary

People use various sources of energy. These include fossil fuels, nuclear fission, the sun, moving water, hot rocks deep underground, wind, ocean waves, and tides.

Lesson 20.1

Fossil fuels are the most commonly used source of energy. However, there are limited amounts of fossil fuels on Earth. Another problem is that fossil fuels cause air pollution.

Lesson 20.2

Nuclear fission and nuclear fusion both release energy from the nuclei of atoms. Solar energy is energy from the sun. Hydroelectric energy uses moving water as its energy source. Geothermal energy is energy from hot rocks underground.

Vocabulary Review

Write *true* or *false* for each sentence. If the sentence is false, replace the underlined term to make the sentence true.

1. A turbine has blades that can be turned.
2. A nuclear reactor splits atoms to obtain energy.
3. The energy from hot rocks deep inside the Earth is called solar energy.
4. A radioactive substance gives off harmful rays.
5. A windmill has a dark surface that absorbs sunlight and changes it into heat energy.
6. A fossil fuel is a hot spring that shoots steam and hot water into the air.
7. Hydroelectric energy comes from moving water.

Chapter Quiz

Write your answers on a separate sheet of paper.

1. What three fossil fuels are good sources of energy?
2. How do people get energy from fossil fuels?
3. How is using fossil fuels harmful to the environment?
4. What two processes release energy from the nuclei of atoms?
5. Which one of the two processes in Question 4 above produces radioactive wastes?
6. Why is solar energy a good energy source to use?
7. How do we get hydroelectric energy?
8. How is geothermal energy changed to electricity?
9. What are three ways in which people use wind energy?
10. What is the problem with using the energy of ocean waves and tides to produce electricity?

Test Tip

Before taking a chapter test, use the summary questions and the questions in each Lesson Review to help you review the chapter.

Research Project

Research how one of the following energy sources is changed to electricity: hydroelectric energy, geothermal energy, wind, ocean tides, and waves. Find out where in the world that energy source is used. Write a report. Then make a diagram and a map that shows what you learned.