

# Energy and Energy Resources

## Energy Resources

### Key Concepts

- What are nonrenewable energy resources?
- What are renewable energy resources?
- Why is it important to conserve energy?

### Study Coach

**Organize Your Notes** Make a table with two columns to contrast different types of energy resources. Label one column *Nonrenewable Resources* and the other column *Renewable Resources*. Complete the table as you read this lesson.

### Reading Check

**1. Identify** Where does the energy in plants and fuels come from?

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### ..... Before You Read .....


**What do you think?** Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	5. Nuclear power plants release many dangerous pollutants into the air as they transform nuclear energy into electric energy.	
	6. Thermal energy from within Earth can be transformed into electric energy at a power plant.	

### ..... Read to Learn .....

## Sources of Energy

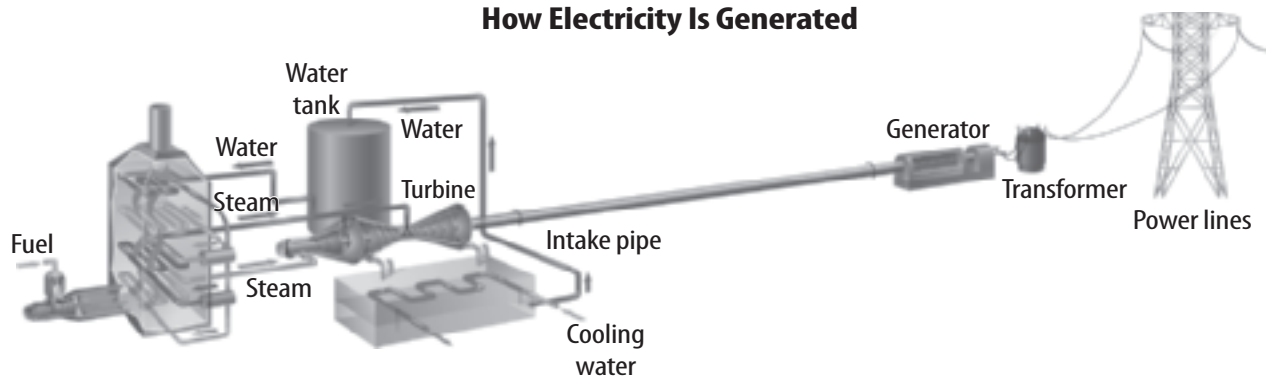
Every day, you use many forms of energy in many different ways. According to the law of conservation of energy, energy cannot be created or destroyed. Energy can only change form. Where does the energy that you use come from?

Most energy you use can be traced back to the Sun. The chemical energy in the food you eat originally came from the Sun. The energy in fuels, such as gasoline, coal, and wood, originally came from the Sun. A small amount of energy that reaches Earth's surface comes from inside Earth. However, the amount of energy that comes from the Sun each day is about 5,000 times greater than the amount of energy that comes from inside Earth. 

## Electric Power Plants

Most of the energy you use every day does not come directly from the Sun. Much of the energy you use is in the form of electric energy. Many of the appliances in your home require electricity. The lights in your classroom are powered by electricity. Most of the electric energy you use comes from electric power plants.

## How Electricity Is Generated




**Energy Sources** An electric power plant transforms the energy in an energy source into electric energy. Power plants use three main energy sources. One source of energy comes from burning fuels, such as coal. The figure above shows a power plant that uses coal as an energy source. Nuclear power plants use nuclear energy contained in uranium. Hydroelectric power plants change the kinetic energy in falling water to electric energy.

**Energy Transformation** The figure above shows how an electric power plant transforms the chemical energy stored in coal into electric energy. When coal burns, some of its chemical energy changes to thermal energy. The thermal energy heats water, producing steam. The steam spins the blades of a turbine, changing thermal energy into mechanical energy. The turbine is connected to a generator which changes mechanical energy into electric energy. The electric energy then travels through power lines.

## Nonrenewable Energy Resources

The coal that a power plant burns is an example of a nonrenewable energy resource. A **nonrenewable energy resource** is an energy resource that is available in limited amounts or that is used faster than it is replaced in nature.

### Fossil Fuels

Fossil fuels are the most commonly used nonrenewable energy resources. **Fossil fuels** are the remains of ancient organisms that can be burned as an energy source. Three types of fossil fuels are coal, natural gas, and petroleum. Petroleum is also often referred to as oil. Coal is a solid fossil fuel. Fossil fuels take millions of years to form. They are being used up much faster than they form. 

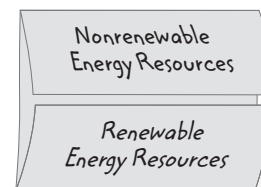
### Visual Check

**2. Specify** What form of energy changes water into steam?

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### FOLDABLES<sup>®</sup>

Make a shutter fold to organize your notes on nonrenewable and renewable energy resources.



### Key Concept Check

**3. Explain** Why are fossil fuels considered a nonrenewable energy resource?

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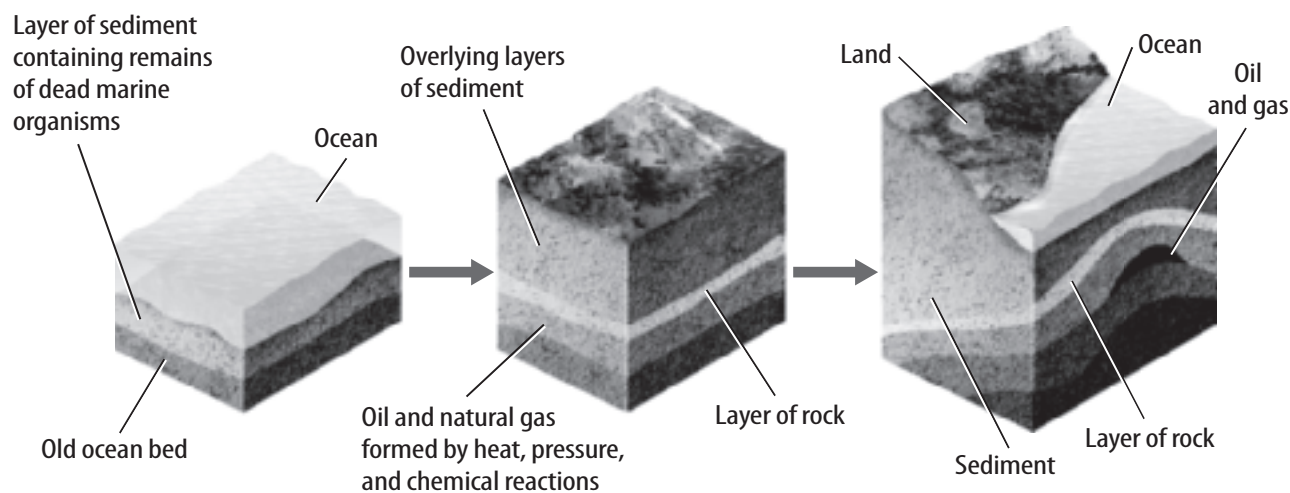
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## The Formation of Fossil Fuels

The processes that formed fossil fuels began at Earth's surface. Petroleum and natural gas formed from microscopic ocean organisms that died and sank to the ocean floor, as shown in the figure below. These organisms were gradually buried under layers of sediment—sand and mud—and rock.

Over millions of years, the weight of the sediment and rock layers increased the temperature and pressure on the dead organisms underground. This heat and pressure changed the dead organisms into petroleum and natural gas.

Coal formed on land from plants that died millions of years ago. The dead plants were buried under thick layers of sediment and rock.



### Visual Check

**4. Identify** What forces act on the dead organisms in sediment, transforming these materials into oil and gas?

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### Reading Check

**5. Specify** What percentage of the coal used in the United States is burned in electric power plants?

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## Using Fossil Fuels

Fossil fuels formed from organisms that changed radiant energy from the Sun to chemical potential energy. The chemical potential energy stored in fossil fuels changes to thermal energy when the fossil fuels burn.

**Using Petroleum** Gasoline, fuel oil, diesel, and kerosene are made from petroleum. These fuels are burned mainly to power vehicles and to heat buildings. Petroleum is also used as a raw material in making plastics and other materials.

**Using Coal** Electric power plants burn about 90 percent of the coal used in the United States. Some coal is burned to heat buildings. Coal is also used to produce steel and concrete.

Burning coal produces more pollution than burning other fossil fuels. In some places, these pollutants react with water vapor in the air and create acid rain. Acid rain can harm organisms, such as trees and fish. ✓

**Using Natural Gas** About half of all homes in the United States use natural gas for heating. Electric power plants burn about 30 percent of the natural gas used in the United States. Burning natural gas produces less pollution than burning other fossil fuels.

### Fossil Fuels and Global Warming

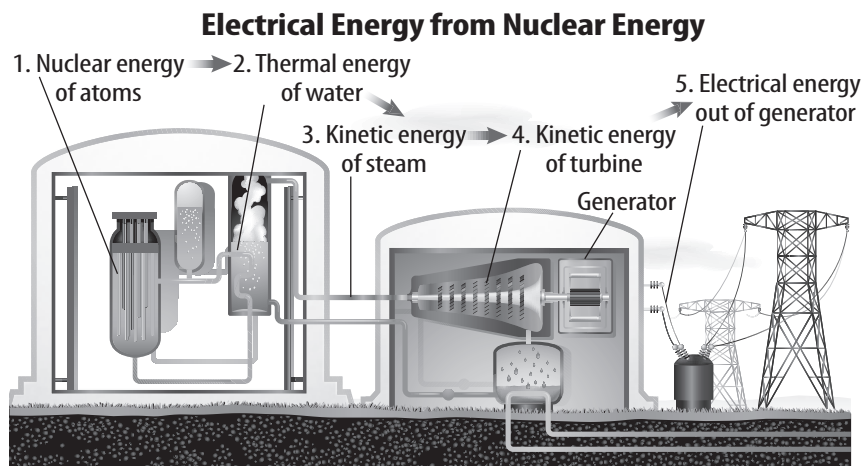
Burning fossil fuels releases carbon dioxide gas into Earth’s atmosphere. Carbon dioxide is one of the gases that helps keep Earth’s surface warm. However, over the past 100 years, Earth’s surface has warmed by about 0.7°C. Some of this warming is a result of the increasing amount of carbon dioxide produced by burning fossil fuels.

### Nuclear Energy

People can transform nuclear energy into thermal energy. Nuclear energy is energy that is released when the nuclei of uranium atoms break apart. Certain minerals contain uranium, but significant amounts of uranium are no longer being formed inside Earth. As a result, nuclear energy from uranium is a nonrenewable energy resource. ✓

**Nuclear Power Plants** The figure below shows the energy changes that occur inside a nuclear power plant. Breaking apart uranium nuclei transforms nuclear energy into thermal energy. This thermal energy changes water into steam. The steam spins a turbine, changing thermal energy into mechanical energy. The turbine spins a generator, changing mechanical energy into electric energy.

Unlike a fossil fuel power plant, a nuclear power plant does not release pollutants into the air. However, a nuclear power plant produces harmful nuclear waste.



### Math Skills

Electric energy is often measured in units called *kilowatt-hours* (kWh). To calculate the electric energy used by an appliance in kWh, use this equation:

$$\text{kWh} = \left(\frac{\text{watts}}{1,000}\right) \times \text{hours}$$

Appliances typically have a power rating measured in watts.

**6. Solve a One-Step Equation** A hair dryer is rated at 1,200 watts. If you use the dryer for 0.25 hours, how much electric energy do you use?

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### Reading Check

**7. Explain** Why is nuclear energy released from uranium nuclei considered a nonrenewable energy resource?

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### Visual Check

**8. Sequence** Describe the energy changes that take place to make electricity from nuclear energy.

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**Storing Nuclear Waste** Nuclear waste contains radioactive materials that can harm living organisms. Some of these materials can remain radioactive for thousands of years. Almost all nuclear waste in the United States is currently stored at the nuclear power plants that produce the waste.

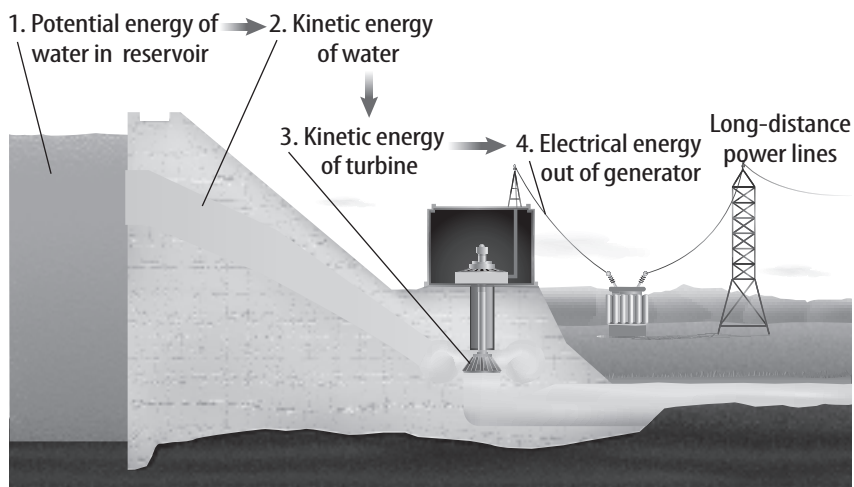
## Renewable Energy Resources

Fossil fuels and uranium are being used up faster than they are being replaced. However, other energy resources are not being used up. These energy resources are called renewable resources. A **renewable energy resource** is an energy resource that is replaced as fast as, or faster than, it is used. Renewable energy resources include water, sunlight, geothermal energy, wind, and biomass.

### Hydroelectric Power Plants

The most widely used renewable energy resource is falling water. The figure below shows a hydroelectric power plant. The power plant changes the kinetic energy in falling water into electric energy. First, a dam is built across a river. This forms a large pool of water called a reservoir (REH zuh vvor) behind the dam. The water stored behind the dam has potential energy. As this water falls through tunnels in the dam, the water's potential energy changes into kinetic energy. The kinetic energy of the flowing water spins a turbine. The turbine spins a generator, changing kinetic energy into electric energy.

Hydroelectric power plants do not produce pollutants. However, in some places, the dams can disturb the life cycle of some wildlife, such as fish.



### Key Concept Check

**9. Contrast** renewable and nonrenewable energy resources.

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### Think it Over

**10. Define** What is hydroelectric power? (Circle the correct answer.)

- a. energy from wind
- b. energy from falling water
- c. energy from the Sun

### Visual Check

**11. Infer** what would happen to the turbine if the river stopped flowing.

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## Solar Energy

Another renewable energy source is radiant energy from the Sun—solar energy. Because the Sun will produce energy for billions of years, solar energy is an inexhaustible energy resource. An **inexhaustible energy resource** is an energy resource that cannot be used up.

Solar energy is converted directly into electric energy by solar cells. When sunlight strikes solar cells, materials in the solar cells transform radiant energy into electric energy. Solar cells can be placed on rooftops to provide electric energy for buildings.

## Wind Energy

Wind energy is another inexhaustible energy resource. Modern wind turbines, like those shown below, change the kinetic energy in wind to electric energy. Wind spins a propeller that is connected to an electric generator.

Wind turbines produce no pollution. However, wind turbines are practical only in regions where the average wind speed is more than about 5 m/s. Also, many wind turbines covering a large area are needed to obtain as much electric energy as one fossil fuel-burning power plant.



## Biomass

Materials such as wood, dried peat moss, and manure are often used as fuels. These materials come from plants and animals and are called biomass. Biomass can be replaced as fast as it is used. It is a renewable energy resource.

Some biomass can be converted into fuels that can be burned in the engines of cars and other vehicles. Fuels made from biomass are often called biofuels. Using biofuels in vehicles can reduce the use of gasoline and make the supply of petroleum last longer.



### Think it Over

**12. Explain** What might be a disadvantage of solar cells?

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### Visual Check

**13. Infer** Why are most wind turbines placed on the tops of hills and mountains?

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### Think it Over

**14. Apply** Should coal be considered a type of biomass? Why or why not?

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### ✓ Reading Check

**15. Describe** What are geothermal reservoirs?

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## Geothermal Energy

Thermal energy from inside Earth is called geothermal energy. This energy comes from the decay of radioactive nuclei deep inside Earth. In some places, geothermal energy produces underground pockets of hot water and steam. These pockets are called geothermal reservoirs. ✓

In a few places, wells can be drilled to reach geothermal reservoirs. The hot water and steam in the reservoir are piped to the surface, where they spin a turbine attached to an electric generator. The steam cools in cooling towers and condenses into water. The water is pumped back down into the geothermal reservoir.

## Conserving Energy Resources

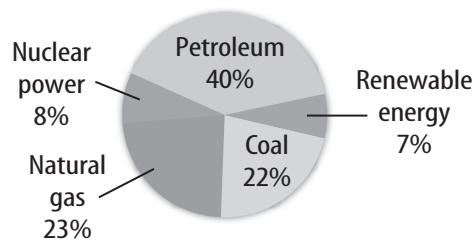
The graph below shows that fossil fuels provide about 85 percent of the energy used in the United States. Because fossil fuels are a nonrenewable resource, the supply, or the amount remaining, decreases as they are used. Nuclear power is also a nonrenewable energy source. When added to the usage of fossil fuels, you can see that 93 percent of energy used in the United States comes from nonrenewable sources.

### 🌐 Visual Check

**16. Examine** Look at the graph. What percent of the energy needs in the United States are met with petroleum?

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**Sources of Energy  
Used in the U.S. in 2006**



Because the supply of fossil fuels is decreasing, there could be a shortage of fossil fuels in the future. Conserving energy is one way to reduce the rate at which all energy resources are used. Conserving energy means avoiding the wasting of energy. For example, turning off lights when no one is in a room is one way to conserve energy. ✓

### 🔑 Key Concept Check

**17. Summarize** How does conserving energy affect the rate at which energy resources are used?

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## Advantages and Disadvantages of Energy Resources

Energy Resource	Advantages	Disadvantages
<b>Nonrenewable Energy Resources</b>		
Fossil Fuels	<ul style="list-style-type: none"> <li>• Easy to transport</li> <li>• Widely available</li> <li>• Relatively inexpensive</li> <li>• Fossil fuel power plants are relatively inexpensive to operate.</li> </ul>	<ul style="list-style-type: none"> <li>• Drilling and surface mining may damage land and wildlife habitats.</li> <li>• Oil spills and leaks can harm wildlife.</li> <li>• Burning fossil fuels can produce air pollution.</li> <li>• Burning fossil fuels produces carbon dioxide that can cause global warming.</li> </ul>
Nuclear Energy	<ul style="list-style-type: none"> <li>• Nuclear power plants are relatively inexpensive to operate.</li> <li>• Does not produce air pollution</li> </ul>	<ul style="list-style-type: none"> <li>• Produces radioactive waste that is difficult to store</li> <li>• Accidents can result in dangerous leaks of radiation.</li> <li>• Nuclear power plants are relatively expensive to build.</li> </ul>
<b>Renewable Energy Resources</b>		
Hydroelectric	<ul style="list-style-type: none"> <li>• Does not pollute the air or water</li> <li>• Hydroelectric power plants are relatively inexpensive to operate.</li> </ul>	<ul style="list-style-type: none"> <li>• Dams damage wildlife habitats.</li> <li>• Dams can affect water quality and reduce the flow of water downstream.</li> <li>• Droughts can affect hydroelectric power plants.</li> </ul>
Solar	<ul style="list-style-type: none"> <li>• Does not pollute the air or water</li> <li>• Theoretically inexhaustible supply</li> </ul>	<ul style="list-style-type: none"> <li>• The amount of solar energy that reaches Earth's surface varies, depending on the location, time of day, season, and weather conditions.</li> <li>• A large area is needed to collect enough solar energy for a solar power plant to be viable.</li> </ul>
Wind	<ul style="list-style-type: none"> <li>• Does not pollute the air or water</li> <li>• Can be used in remote areas where electricity is unavailable</li> </ul>	<ul style="list-style-type: none"> <li>• Wind turbines can be noisy.</li> <li>• Can disrupt wildlife</li> <li>• Generates electricity only when the wind is blowing</li> </ul>
Geothermal	<ul style="list-style-type: none"> <li>• Does not pollute the air</li> <li>• Geothermal power plants are relatively inexpensive to operate.</li> </ul>	<ul style="list-style-type: none"> <li>• Geothermal reservoirs are located mostly in the western United States, Alaska, and Hawaii.</li> <li>• Some geothermal plants produce solid wastes that require careful disposal.</li> </ul>
Biomass	<ul style="list-style-type: none"> <li>• Biofuels could replace petroleum fuels in most vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>• Energy from fossil fuels is used to grow biomass.</li> <li>• Some farm land is used to grow biomass instead of food crops.</li> <li>• Burning biomass produces pollutants, such as smoke.</li> </ul>

### Visual Check

**18. Point Out** Highlight one advantage of nuclear energy that fossil fuels do not have.



## ..... After You Read .....

### Mini Glossary

**fossil fuel:** the remains of ancient organisms that can be burned as an energy source

**inexhaustible energy resource:** an energy resource that cannot be used up

**nonrenewable energy resource:** an energy resource that is available in limited amounts or that is used faster than it is replaced in nature

**renewable energy resource:** an energy resource that is replaced as fast as, or faster than, it is used

1. Review the terms and their definitions in the Mini Glossary. Write an original sentence using the term *fossil fuel*.

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2. Write examples in the chart of renewable, nonrenewable, and inexhaustible energy resources.

Renewable Resources	Nonrenewable Resources	Inexhaustible Resources

3. How did making a table help you understand what you read about renewable and nonrenewable resources?

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### What do you think **NOW?**

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?



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