# 16.1 Natural Resources and Energy

For tens of thousands of years, people have depended on Earth's resources for food, clothing, shelter, energy, medicine, and even entertainment, arts, and riches. What are the basic resources that Earth has to offer?

## Natural resources

### Material resources

A **natural resource** is a feature of Earth that benefits people. Earth's natural *material* resources are things like air, fresh water, and soil. What would happen if any of these resources were missing? Study the scenes below and find the material resources. How does each of these benefit people?


**Energy resources** Some natural resources are used to supply energy to our busy world. Important *energy* resources include:

| | |
|---|---|
| **The sun** | **Tides** |
| **The wind** | **Coal, oil, natural gas** |
| **Moving water** | **Nuclear (radioactivity from uranium)** |
| **Earth's interior heat** | **biomass fuel (such as wood** |

## Energy and daily life

**Energy use** Your alarm clock rings and you wake up for school. You shower, brush your teeth, dress, and grab a quick breakfast before catching a bus. This is how the day starts for hundreds of thousands of students all across the country. What part of that simple morning routine requires electricity and transportation energy? Almost all of it!

**Electricity** The first electric light company in the U.S. was started in 1878. Since then, our use of electricity has grown each year. What do you need to make electricity? You need an energy source. Earth's natural energy sources are used to make electricity. Think of all the ways you use electricity each day. The average American household uses about 10,000 kilowatt-hours of electricity each year. How much energy is that? If your body were able to utilize electricity as
an energy source (rather than food) that much energy could keep you running for almost five months!

**Transportation** Electricity is not the only modern use of natural energy sources. Transportation uses a lot of energy too. In the United States alone, about *130 billion gallons* of gasoline are consumed each year. Where does gasoline come from? Gasoline is made from crude oil,
which is pumped out of the ground, either on land or from the ocean floor.

### Heating and consumer products

In addition to being used for gasoline, oil can be used to heat homes. **Petroleum** is another name for oil, which is often used to heat homes. *Petrochemicals* are compounds made from oil.
Petrochemicals are used to make plastics, medicines, cosmetics, and paints. Look around you and see how many items are made of plastic. It takes petroleum to make all of those things.

# 16.2 Supplying Our Energy Needs

Think of how much you need electricity and how much you rely on motor vehicles every day. Making electricity and driving motor vehicles cause us to use Earth's energy resources.

## Making and transporting electricity

### Starting at the power plant

To find out how electricity is made and transported, let's trace the energy pathway. Look at the diagram below. Electricity is made in a power plant. Most power plants burn fossil fuels (natural resources like coal, oil, or natural gas) to produce heat. Next, this heat is used to boil water. The steam from the boiling water turns a turbine. The turbine turns a generator which produces electricity.

### Electricity is carried by wires

Electricity leaves the power plant and is carried to your house by wires. The fuel energy from the coal, oil, or natural gas changes its form several times on the way to your home. With each change, some energy is converted to heat. In fact, most of the energy that is transferred from fuels like coal, oil, and natural gas will eventually become heat energy. Some will be used, but most will be unusable.

## Electricity from fossil fuels

### What is a nonrenewable resource?

A **nonrenewable resource** is not replaced as it is used. **Fossil fuels** are good examples of nonrenewable resources. Fossil fuels are found within the rocks of Earth's surface. They are called fossil fuels because they were formed hundreds of millions of years ago by processes acting on dead plants and animals. The three major fossil fuels are coal, oil, and natural gas.

### Fossil fuels

Earth's coal, oil, and natural gas deposits took hundreds of millions of years to form. Because it took so long for these resources to form, they are considered nonrenewable resources. Natural gas is pumped out of gas pockets both onshore and offshore. Coal is a solid fossil fuel that is mined from the ground in many places across the United States. Petroleum is drilled out of natural deposits both onshore and offshore. Petroleum deposits are located in many parts of the world, including the United States. Oil, coal, and natural gas can all be used to make electricity.

### The future of nonrenewable resources

Nonrenewable resources like coal, oil, and natural gas are not replaced as they are used. This means that someday we will not have enough coal, oil, and natural gas to produce the electricity we need. How are we preparing for the future when these resources are no longer available? Perhaps we can use the energy of atoms, wind, or sunlight. Did you notice the "other" category in the pie chart above? Read on to find out about this category.

## Electricity from nuclear energy

### What is nuclear energy?

The United States gets about 20% of its electricity production from nuclear power plants. The fuel used in nuclear power plants is *uranium*. Uranium is an extremely high-energy source of heat. Uranium atoms split apart in the nuclear reactor and the energy released is used to heat water and make steam. The steam drives a turbine, which spins a generator to produce electricity.

### Advantages and disadvantages of nuclear energy

The main advantage of using nuclear energy to produce electricity is that it doesn't pollute the air like fossil fuel power plants do. We will discuss the problems of pollution in the next section. There are no new nuclear power

plants being built in the United States. In fact, all plants that have been scheduled to be built since 1973 have been canceled. Why is this happening? One reason is that used uranium fuel from a reactor stays dangerously radioactive for a long time. Storage of nuclear waste has always been a major disadvantage of nuclear power plants. When scientists find a way to dispose of spent nuclear fuel safely, nuclear energy will be more widely used to produce electricity.

## Electricity from renewable resources

### Renewable resources

A **renewable resource** can be replaced naturally in a relatively short period of time. The Sun and wind are renewable resources that can be used as energy sources. Figure 16.2 shows that
9 percent of all resources used to make electricity in 2005 were from renewable resources.

### Solar energy

The Sun is our biggest source of light and heat. In fact, 99 percent of the energy used to heat Earth and all of our buildings comes from the Sun. The Sun's energy is often called **solar energy**. A solar cell can convert solar energy to electricity. Solar energy is plentiful and clean. However, two of the biggest challenges with using solar energy to make electricity are:
1. a backup energy source must be used on cloudy days; and
2. solar energy is very spread out, so it must be collected from a huge area to be a significant source of energy.

### Wind energy

A wind energy system captures the energy of motion from moving air (wind) and turns the energy into electrical energy. California was the first U.S. state to build large *wind farms* (areas where wind turbines are located). Today, California produces more electricity from wind energy than any other state in the U.S. In fact, wind is the world's fastest-growing energy source used to
make electricity. Wind is a clean, plentiful fuel source. What disadvantages are there to using wind as an energy source? Well, the wind does not always blow when electricity is needed, and
right now the cost of building a wind farm is greater than the cost of building a power plant that uses fossil fuel to make electricity.

### Other renewable energy sources

It is also possible to use moving water (hydroelectric), hot spots near Earth's surface (geothermal), fuels made from once-living things like wood or corn (biomass), and tides to produce electricity.

## Evaluating resources used to produce electricity in the U.S.

### For discussion

This evaluation chart compares different resources that can be used to make electricity in the U.S. An evaluation chart is a powerful tool used to organize large amounts of information.
According to the chart, which resources will the U.S. be using less and less of in the future? Which resources will be used more as time goes by? Can you explain why?

| | Resource | What is the chance that this source can be used *50 years from now?* | What level of *cost* is involved with using this system? | What level of *impact* does using this resource have on the environment? |
|---|---|---|---|---|
| Nonrenewable resources | Petroleum | Low | High | Medium |
| | Natural gas | Medium | High | Low |
| | Coal | High | Medium | Very high |
| | Nuclear | Medium | Very high | Very high |
| Renewable resources | Hydroelectric (dams) | Low | Medium | Low |
| | Solar | High | High | Low |
| | Wind | High | Medium | Low |
| | Geothermal (using Earth's energy) | Medium | Medium | Medium |
| | Biomass (burning wood and agricultural waste) | Medium | Medium | Medium |

# Transportation and energy sources

## Gasoline use

If you were asked to estimate how many automobiles there are in the United States, what number would you guess? According to the U.S. Department of Transportation, there were *over 132 million automobiles* in the United States in 1997. What is the main energy source used for operating automobiles? If you guessed petroleum, you are correct. Gasoline is made from petroleum. Americans use about 375 million gallons of gasoline *every day.* It is important to know that the U.S. does not produce enough crude oil to make all of the gasoline used by American motorists. The United States produces only about 40 percent of the crude oil it uses. Where does the rest come from? It is imported from other countries.

## Efficiency

What does it mean to say that a machine or a process is efficient? If a machine is *efficient*, the machine is able to use most of its energy source to do a job. For efficient machines, very little of the energy source is converted to unusable energy like heat. Efficiency is a very important concept to understand when you are learning about how we use different energy sources. A bicycle is a very efficient machine (Figure 16.3). When you ride a bicycle, almost 80 percent of the energy you put into pedaling the bike is converted to motion. Automobiles, however, have a low efficiency. Only about 20 percent of the gasoline energy is converted to motion. Most of the energy is lost as unusable heat.

## Usefulness and trade-offs

If bicycles are so efficient, why don't we use them more, instead of automobiles, when we travel? You know the answer to that question! Cars can take us where we want to go much faster and more conveniently than bicycles can. Bicycles aren't as useful to us as cars are. Useful energy sources are sources that meet our needs *and* have the right balance of cost and efficiency.

# Comparing notes

## For discussion

Compare gasoline-powered cars to cars of the future. What will cars of the future use for energy sources? What type of car will you drive some day?

# 16.3 Resources and Conservation

In this chapter you have been learning about Earth's material and energy resources. Natural resources benefit people, and it is important to think about how we can take care of Earth's resources. **Resource conservation** happens when people protect, preserve, and manage Earth's natural resources.

## Air—an important resource

### Air is everywhere

Air is a very important natural resource, even though you may forget that it is all around you. Air is a mixture of nitrogen, oxygen, carbon dioxide, water vapor, and other gases. We do not need to worry that the air will get "used up," because there are natural cycles that keep the supply steady. However, these natural cycles can't always keep the air clean.

### Air pollution

**Pollution** is a change to the environment (air, water, or soil) that is harmful to humans or other living things. Some changes to the air can have harmful effects on humans and other living organisms. Air pollution (Figure 16.4) is caused by tiny particles and gases called **emissions** that are released into the air. Some things that produce emissions and pollute the air include:

- power plants that use fossil fuels to make electricity
- motor vehicles (trucks, cars, airplanes, etc.)
- factories
- erupting volcanoes

### Reducing pollution

The United States government has passed laws to control the levels of emissions from power plants, factories, and motor vehicles. If you use less electricity, you can help keep the air clean too.

## Conserving the water supply

### Earth is a watery planet

The amount of water on Earth today is about the same as it was during the age of dinosaurs, 65 to 220 million years ago. About 70 percent of Earth's surface is covered by water. That's a lot of water! However, only a small amount of this water is useful to humans. Why can't humans use more than a small part of Earth's water supply? About 97 percent of Earth's water is salt water. That leaves only 3% as fresh water. About 70 percent of this fresh water is frozen, and the rest is found in rivers, streams, lakes, ponds, and even below the ground in layers of soil and rock (Figure 16.5). If this is true, and Earth has been around for such a long time, why haven't we run out of water? The answer is that Earth's water is recycled by natural processes.

### Water pollution

Earth's water supply will stay steady, but the water that humans can actually use is a precious resource which we must use with care. Water can be polluted by changes that are harmful to people or other living things. How does water get polluted?

- Towns and cities can pollute the fresh water supply with wastes that are washed down sinks, toilets, and showers.
- Industries like factories and power plants produce wastes that can pollute water.
- Pesticides and fertilizers from farms can end up in the water supply.
- Oil spills from large ships that transport oil across the oceans can cause serious pollution problems.

### What can you do?

Using less water at home and at school can certainly help by putting less demand on the water supply. Also, never pour things like paint, paint thinner, motor oil, or garden chemicals on the ground or down the drain. Your town or city probably has a special collection area for these hazardous substances.

# Land, forests, and wildlife resources

### Land and soil

Earth's land and soil are used to benefit people in many ways, and everyone must share these nonrenewable resources. How is land used to benefit people?

• Mining minerals: A *mineral* is a solid, naturally occurring substance with a defined chemical composition that is found in Earth's crust. A rock is made of one or more minerals. Gold, silver, diamond, aluminum, iron, and tin are important minerals that you have heard of.

• Development: People use land to build houses, schools, and industries.

• Agriculture: Growing crops and raising animals for food are important land uses.

### Forests and fisheries

Think of all the products we use that come from forests. Maple syrup, rubber, fruits, and nuts come from living trees. Lumber for constructing buildings and furniture comes from trees that have been cut down. Paper is another important forest product. Don't forget that trees and other plants produce oxygen that humans and other organisms need to survive. Fish are also valuable resources. Both trees and fish are renewable resources, but we cannot use them up faster than they are replenished, or the supply will decrease quickly.

### What can you do?

Do you recycle paper, metal, and plastic in your home and school? Recycling programs all over the country have been put in place to help reduce the solid waste that takes up so much of our landfills by finding ways to reuse products instead of producing new ones.

# A resource conservation issue: global warming

### Global warming

Have you ever heard the phrase "global warming"? This is an important concern that has received a lot of attention in recent years. *Global warming* refers to an increase in the temperature of Earth's climate due to increasing amounts of certain gases in the atmosphere—mostly carbon dioxide.

### Carbon dioxide and global warming

There is very little carbon dioxide in the atmosphere, compared to the amounts of nitrogen and oxygen (Figure 16.6). Does this surprise you? The amount of carbon dioxide in Earth's atmosphere is just enough to trap heat from the Sun to make Earth warm and comfortable. Earth would be too warm with too much carbon dioxide, and too cold if the carbon dioxide level was too low. When we use fossil fuels, we add more carbon dioxide to the atmosphere. Increased levels of carbon dioxide can contribute to global warming. Using public transportation, using less electricity (turn out the lights!), and driving hybrid vehicles can all help reduce carbon dioxide levels.

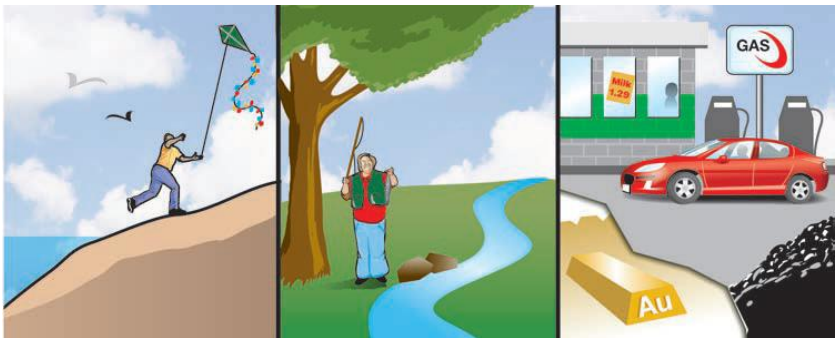
**Consequences** The amount of carbon dioxide in the atmosphere has increased by about 30 percent since the 1800s. Also, Earth's average surface temperature has increased 0.6 to 1.2 degrees Fahrenheit over that same time period. These increases are not huge, but they are enough to have warmed the North Pole and caused the sea level to rise 4 to 10 inches. Have you heard about any other consequences of global warming?

### Trees and air quality

One acre of trees can provide oxygen for about 20 people each day. This same acre of trees can also absorb emissions, including carbon dioxide (Figure 16.7). Trees are not the solution to the problem of increased carbon dioxide levels, but they can certainly help!

# 16.1 Section Review

1. Define the term *natural resource*, and list all of the natural resources that exist in the area directly around your school.




2. List at least four major natural resources that you see in *each* scene above.

3. What two things in our modern lives require a lot of Earth's natural energy sources?

4. What is gasoline made from?

5. What is a petrochemical? What types of products can be made from petrochemicals?

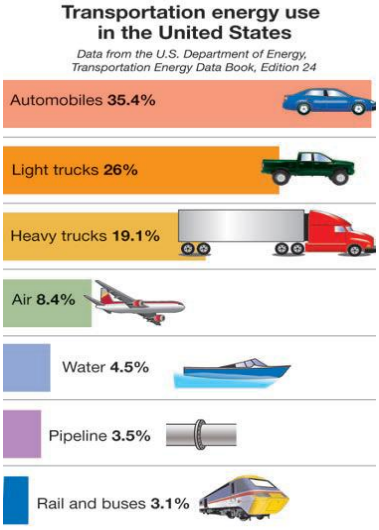
6. What natural resource is plastic made from?

7. Study the bar graph in Figure 16.1 and answer the following questions.

a. What type of information does this graph give you?

b. How would the graph look if many more people in the United States used public transportation?

c. "Americans love their cars." Does this graph support that statement? Why or why not?



# 16.2 Section Review

1. Some of the energy that comes from burning a fossil fuel can be turned into electricity, but most of the energy is lost. Explain why this is a true statement and identify the unusable or lost energy.

2. Define *nonrenewable resources* and list three that are used for making electricity.

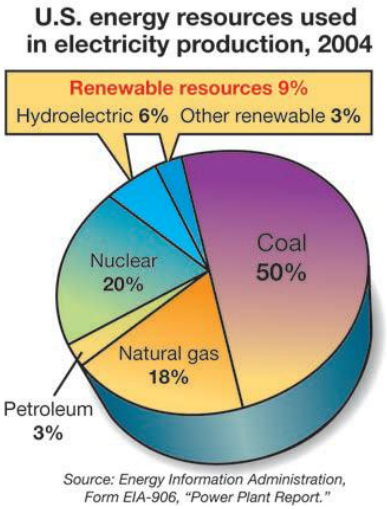
3. Define *renewable resources* and list three that can be used for making electricity.

4. List one major advantage and one disadvantage of making electricity in a nuclear power plant.

5. List two advantages and two disadvantages of using solar energy to make electricity.

6. List two advantages and two disadvantages of using wind energy to make electricity.

7. Study the pie chart below. Redraw your own version of this pie chart as it will most likely look *fifty years from now*. Use the evaluation table in this section that compares energy resources to help you decide how to draw your graph.



# 16.3 Section Review

1. What does it mean to conserve Earth's natural resources?

2. Why is air an important natural resource?

3. List four possible causes of air pollution.

4. Why can humans only use a small part of Earth's water supply for drinking, cleaning, and other daily needs?

5. Why is water an important natural resource?

6. List four possible causes of water pollution.

7. Describe two things you can do to help conserve Earth's water resources.

8. Study the fresh-water pie chart in Figure 16.5. What percentage of fresh water can readily be used for drinking water and other needs? Why?

9. Make your own illustration of natural resources provided by trees. Draw a living tree and show on your diagram all of the different products that can come from different kinds of living trees. Draw a tree that has been cut down and show on your diagram all the different products that can come from trees that have been harvested. Be creative!

10. Why are fish considered a natural resource? Is this a nonrenewable or a renewable resource? Explain your answer.

11. Land is a natural resource. List at least three ways that land and soil are used to benefit humans.

12. How can global warming cause the ocean levels to rise? What problems could increased ocean levels cause?

13. Do some research to find at least two consequences of global warming, in addition to rising ocean levels.