

Chapter 12 Energy and Material Resources - Section 1 Summary**Fossil Fuels****Key Concepts**

- How do fuels provide energy?
- What are the three major fossil fuels?
- Why are fossil fuels considered nonrenewable resources?

A **fuel** is a substance that provides a form of energy—such as heat, light, electricity, or motion—as the result of a chemical change. This change from one form of energy to another is called **energy transformation**. **When fuels are burned, chemical energy is released as heat and light. These forms of energy can be used to generate other forms of energy, such as motion or electricity.** The process of burning a fuel is called **combustion**.

Most of the energy used today comes from fossil fuels. **Fossil fuels** are the energy-rich substances formed from the remains of once-living organisms. Layers of sand, rock, and mud buried the dead organisms. Over millions of years, heat and pressure changed the materials into fossil fuels. **The three major fossil fuels are coal, oil, and natural gas.** Fossil fuels are made of hydrocarbons. **Hydrocarbons** are energy-rich chemical compounds that contain carbon and hydrogen.

Coal is a solid fossil fuel formed from decaying plant matter. Known deposits of coal and other fossil fuels that can be obtained using current technology are called reserves. Coal is the most plentiful fossil fuel in the United States. It is fairly easy to transport and provides a lot of energy when it is burned. However, coal mining can cause erosion and water pollution. When burned, most types of coal cause more air pollution than other fossil fuels. In addition, coal mining can be a dangerous job.

Oil is a thick, black liquid fossil fuel. **Petroleum** is another name for oil. Oil is formed from the remains of small ocean-living organisms. Most oil deposits are located deep below Earth's surface. Oil that is pumped out of the ground is called crude oil. A factory where crude oil is separated into fuels and other products by heating is called a **refinery**. **Petrochemicals** are compounds that are made from oil.

Natural gas is a mixture of methane and other gases. Natural gas forms from the same organisms as oil. Because it is less dense than oil, natural gas often rises above an oil deposit, forming a pocket. Natural gas produces lower levels of many air pollutants than coal or oil and is fairly easy to transport. However, natural gas is highly flammable. A gas leak can cause a violent explosion and fire.

People currently rely very heavily on fossil fuels. **But since fossil fuels take hundreds of millions of years to form, they are considered nonrenewable resources.** Fossil fuels are being used at a faster rate than they are formed. New sources of energy are needed to replace the decreasing fossil fuel reserves.

Chapter 12 Energy and Material Resources ■ Section 2 Summary**Renewable Sources of Energy****Key Concepts**

- What forms of energy does the sun provide?
- What are some renewable sources of energy?

Solar energy is energy from the sun. **The sun constantly gives off energy in the forms of light and heat.** Solar energy is the source, directly or indirectly, of most other renewable energy

resources. In a solar power plant, giant mirrors focus the sun's rays to boil water. The steam can be used to generate electricity. Solar energy also can be converted directly into electricity in a solar cell. Solar energy can be used to heat homes and other buildings. A passive solar system converts sunlight into thermal energy without using pumps or fans. An active solar system captures the sun's energy, then uses fans and pumps to distribute the heat.

Other renewable sources of energy include water, the wind, biomass fuels, geothermal energy, and the tides. Solar energy is also the indirect source of water power. The sun drives the water cycle. Flowing water can turn a turbine and generate electricity. Electricity produced by flowing water is called **hydroelectric power**. Once the dam and power plant are built, hydroelectric power is inexpensive and clean. However, in the United States, most suitable rivers have already been dammed. Also, dams can have negative effects on the environment.

Wind power is also a renewable energy resource. Large wind farms contain many wind turbines. The turbines turn to generate electricity. Wind power causes no pollution and is renewable. It is possibly the fastest-growing energy resource. Drawbacks of using wind power include the need for steady strong winds and opposition to the building of wind farms in scenic areas.

Fuels made from material that was once part of a living thing are called **biomass fuels**. Examples include wood, leaves, food wastes, and manure. Burning these fuels releases energy. Biomass materials can also be converted into other fuels, such as alcohol. Adding the alcohol to gasoline forms a mixture called **gasohol**. Currently it is expensive to produce biomass fuels in large quantities.

The intense heat from Earth's interior that warms magma is called **geothermal energy**. The magma heats underground water, and the steam can be used to heat homes and generate electricity. However, magma is close to Earth's surface in only a few places. In other areas, expensive deep wells would be needed to tap this energy.

Another source of moving water is the tides. **Tides** are the regular rise and fall of Earth's waters along its shores. Along coastlines, water flows into and out of bays as tides come in and go out. Tidal power plants use this regular flow to turn turbines and generate electricity. However, only a few places on Earth are suitable for tidal power plants.

Chapter 12 Energy and Material Resources - Section 3 Summary

Nuclear Energy

Key Concepts

- What happens during a nuclear fission reaction?
- How does a nuclear power plant produce electricity?
- How does a nuclear fusion reaction occur?

The **nucleus** is the central core of an atom that contains the protons and neutrons. **Nuclear fission** is the splitting of an atom's nucleus into two smaller nuclei. The fuel for the reaction is a large atom that has an unstable nucleus, such as uranium-235. A neutron is shot at the U-235 atom at high speed. **When the neutron hits the U-235 nucleus, the nucleus splits apart into two smaller nuclei and two or more neutrons.** The total mass of all these particles is a bit less than the mass of the original nucleus. The small amount of mass that makes up the difference has been converted into energy. The process continues over and over in a chain reaction. If a nuclear chain reaction is not controlled, the released energy produces a huge explosion. If the chain reaction is controlled, the energy is released as heat, which can be used to generate electricity.

In a nuclear power plant, the heat energy released from fission is used to change water into steam.

The steam then turns the blades of a turbine to generate electricity. The **reactor vessel** is the section of a nuclear reactor where nuclear fission occurs. The reactor contains rods of uranium, called **fuel rods**. The chain reaction is controlled by placing **control rods** made of the metal cadmium between the fuel rods. The heat that is produced is used to boil water to produce steam, which runs the electrical generator.

Nuclear power plants have some problems. If the fuel rods generate too much heat, they start to melt, a condition called a **meltdown**. This can cause an explosion. Also, radioactive wastes produced by nuclear power plants remain dangerous for thousands of years. Finding a place to safely store these wastes is very difficult. Nuclear power plants emit large amounts of heat. However, they don't pollute the air.

A second type of nuclear reaction is fusion. **Nuclear fusion** is the combining of two atomic nuclei to produce a single larger nucleus. **In nuclear fusion, two hydrogen nuclei combine to create a helium nucleus, which has slightly less mass than the two hydrogen nuclei. The lost mass is converted to large amounts of energy.**

Nuclear fusion is a promising future energy source. The fuel for a fusion reaction could be obtained from water. Fusion would not produce air pollution or long-lived radioactive wastes. But fusion can take place only at extremely high temperatures and pressures. Scientists have not yet found a way to build a large-scale fusion reactor.

Chapter 12 Energy and Material Resources ■ Section 4 Summary

Energy Conservation

Key Concept

- What are two ways to preserve our current energy sources?

Fossil fuels will not last forever. Most people think that it makes sense to start planning now to avoid possible fuel shortages in the future. **One way to preserve energy resources is to increase the efficiency of energy use. Another way is to conserve energy whenever possible.**

One way to get as much work as possible out of fuels is to use them efficiently. **Efficiency** is the percentage of energy that is actually used to perform work. The rest of the energy is "lost" to the surroundings, usually as heat. For example, an incandescent light bulb converts only about 10 percent of the electricity it uses into light. The rest is given off as heat. In contrast, a compact fluorescent bulb uses only about one fourth as much energy to provide the same amount of light.

One method of increasing the efficiency of heating and cooling systems is insulation. **Insulation** is a layer of material that traps air to help block the transfer of heat between the air inside and outside a building.

Engineers have improved the efficiency of cars by designing better engines and tires. Another way to save energy is to use public transit systems and carpool. In the future, cars that run on electricity may provide the most energy savings of all.

Reducing energy use is called **energy conservation**. For example, walking to the store instead of driving a car conserves gasoline. You can even reduce your personal energy use. Instead of turning up the heat, put on a sweater. When the weather is hot, use fans instead of air conditioners.

Chapter 12 Energy and Material Resources ■ Section 5 Summary

Recycling Material Resources

Key Concepts

- What are three methods of handling solid waste?
- What can people do to help control the solid waste problem?

The waste materials produced in homes, businesses, schools, and other places in a community are called **municipal solid waste**. Other sources of solid waste include construction debris and certain agricultural and industrial wastes. **Three methods of handling solid waste are burning, burying, and recycling. Each method has advantages and disadvantages.**

The burning of solid waste is called **incineration**. The advantages are that incinerators do not take up much space, and the heat produced by burning solid waste can be used to generate electricity. The disadvantages are that incinerators do release some pollution into the air, some waste still remains after incineration, and incinerators are expensive to build.

Disposing of solid waste in open dumps is dangerous because rainwater dissolves chemicals from the waste. This polluted liquid, called **leachate**, can run off into streams and rivers or trickle down into the groundwater. Today, much solid waste is buried in landfills that hold the waste more safely. A **sanitary landfill** holds municipal solid waste, construction debris, and some types of agricultural and industrial waste. Even well-designed landfills can pose a risk of polluting groundwater.

The process of reclaiming raw materials and reusing them to create new products is called **recycling**. Recycling reduces the volume of solid waste by enabling people to use the materials in wastes again. Any material that can be broken down and recycled by bacteria and other decomposers is **biodegradable**. Unfortunately, many of the products people use today are not biodegradable. Instead, people have developed techniques to recycle the raw materials in these products. Most recycling focuses on four major categories of products: metal, plastic, glass, and paper.

There are ways individuals can help control the solid waste problem. **These are sometimes called the "three R's"—reduce, reuse, and recycle.** *Reduce* refers to creating less waste in the first place. *Reuse* refers to finding another use for an object rather than discarding it. *Recycle* refers to reclaiming raw materials to create new products. Another way to reduce the amount of solid waste is by composting. **Composting** is the process of helping biodegradable wastes to decompose naturally.