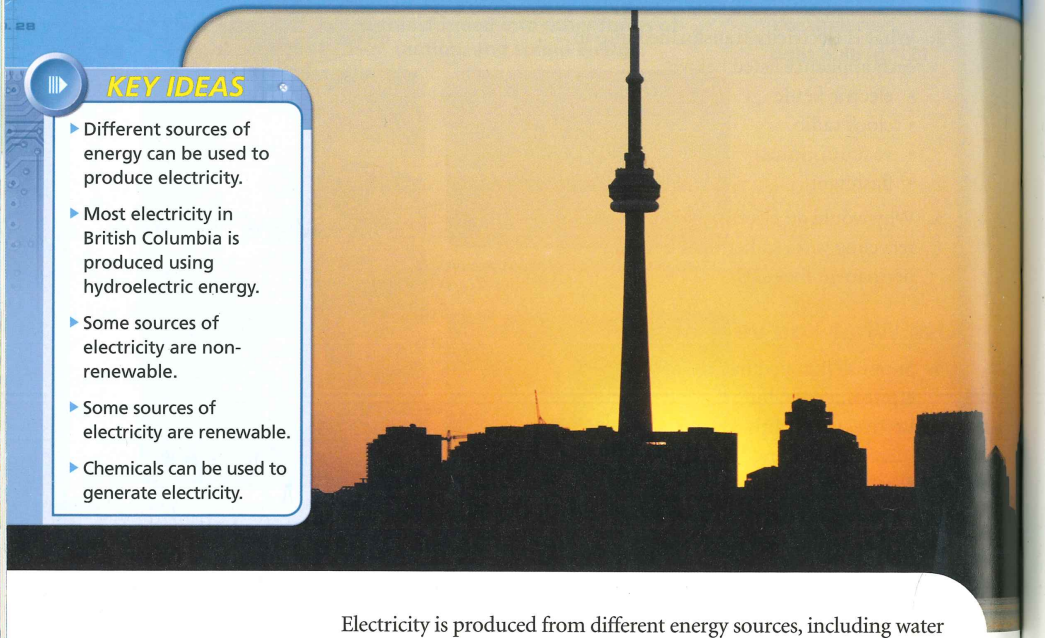
CHAPTER 8

Electricity is produced from renewable and non-renewable resources.



KEY IDEAS

- Different sources of energy can be used to produce electricity.
- Most electricity in British Columbia is produced using hydroelectric energy.
- Some sources of electricity are non-renewable.
- Some sources of electricity are renewable.
- Chemicals can be used to generate electricity.

Electricity is produced from different energy sources, including water and coal. Some energy sources, such as water, are constantly being replaced. Other sources, such as coal, cannot be replaced.

As our demands for electricity increase, there is the possibility that electricity shortages or power blackouts may occur. For example, in August 2003, a massive blackout occurred in Ontario, including Toronto as shown above, and parts of the northeastern United States. Making the best use of the energy sources we have is the only way that we can ensure a plentiful supply of electricity for generations to come.

In this chapter, you will look at how different energy sources are used to generate electricity. You will also look at the production and transmission of electricity in British Columbia.

LEARNING TIP

Before you read this chapter, make a web of what you already know about renewable and non-renewable sources of energy.

How Is Electricity Generated? 8.1

TRY THIS: GENERATE AN ELECTRIC CURRENT

Skills Focus: creating models, observing

You can generate electricity. All you need are two bar magnets, a piece of copper wire, two leads, and a meter for detecting current. Connect the copper wire to two leads (one at each end of the wire). Connect the ends of the leads to a multimeter. Set up the magnets so that the opposite poles are facing. Hold the wire between the magnets as shown in Figure 1. Look at the meter. Now quickly move the wire up and down through the gap.

1. What do you notice on the meter? What does this mean?

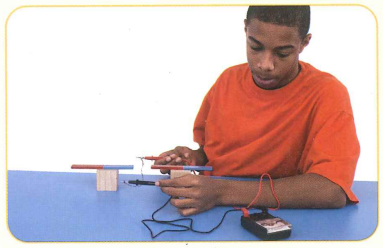


Figure 1

In the 1820s, Michael Faraday produced a current by pushing a magnet in and out of a coil of wire. Unfortunately, he had trouble convincing people that his discovery was useful. Eventually, the generator was developed based on Faraday's discovery. Today, we use the effect of a moving magnet on a coil of wire, or a moving wire on a magnet, to generate electricity (Figure 2).

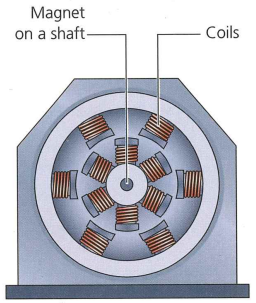


Figure 2
Most power stations generate electricity by turning giant electromagnets within stationary coils of wire.

The electricity that you use in your home comes from different energy sources. Some energy sources, like water, wind, and energy from the Sun, are **renewable** resources. This means that these sources are constantly being replaced and are always there to use. Other energy sources, like fossil fuels, are **non-renewable** resources. Once non-renewable resources are used up, they cannot be replaced.

Different energy sources are used to turn a turbine [TER-bine], which is attached to a generator. As the turbine turns, the generator produces electricity. In a hydroelectric generator, falling water turns the turbine. Fossils fuels, nuclear energy, wind, the Sun, and even tides also turn a turbine.

CHECK YOUR UNDERSTANDING

1. What are some energy sources that are used to generate electricity?
2. What energy sources are used to generate electricity where you live?

8.2 How Does Electricity Get to Your Home?

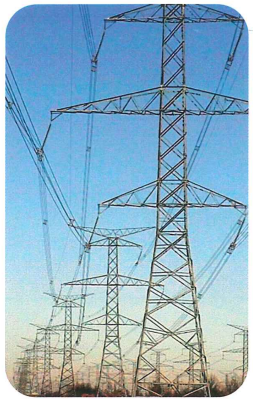


Figure 1
Transmission lines, supported by tall metal towers, carry high voltage electricity over long distances.

Once electricity has been generated, how does it get to you? When the electricity leaves the generator of a power plant, devices called transformers change it to a much higher voltage. The increase in voltage means that less electricity is lost as the current flows along the transmission lines.

The electricity is carried by transmission lines to your community (Figure 1). It is then transformed to a low voltage that is suitable to be used in homes. It is transmitted along the street to your home through transmission lines on poles. The voltage of the electricity flowing through your home is at least 110 V, and can be as high as 220 V. This voltage is dangerous, so you should be careful when using plugs and electrical outlets. You should also be careful around transmission lines. People have been **electrocuted,** or killed with electricity, when ladders or equipment they were using touched transmission lines.

The company that provides your electricity needs to know your **consumption,** or how much electricity your family uses. To do this, the company puts a meter on the line that comes into your home (Figure 2). Each time you turn on a television or use a hair dryer, the meter records how much electricity you have used. This way, the company knows how much to charge your family.

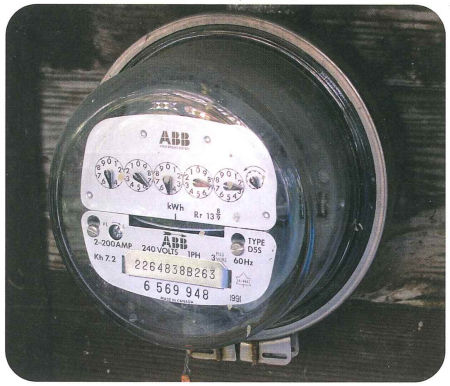


Figure 2
You can measure how much electricity your family uses by reading dials on the household electrical meter.

TRY THIS: BE POWER SMART

Skills Focus: observing, communicating

How does your family use electricity? Observe your family's electrical consumption habits for two or three days. Look at how you and your family are conserving electricity. For example, you may use a hand-held toothbrush rather than an electric toothbrush (Figure 3). Your family may use a clothesline to dry clothes or use energy-efficient light bulbs in lamps.

Also look at ways that electricity is being wasted in your home, such as lights being left on in empty rooms.

1. Write down your observations for both conserving electricity and wasting electricity.
2. Create a poster that describes, in words and pictures, different ways to conserve electricity.

Figure 3

The amount of electricity that your family uses can change from day to day. For example, in the winter, when it gets dark early, you might need more electricity for lighting. In the summer, when it is very hot, you might use a lot of electricity to run a fan or air conditioner.

To reduce the amount of money that your family spends on electricity, you should use electricity as carefully and responsibly as possible. As a society, we need to use the available sources of energy to produce electricity carefully and responsibly. This is what energy **conservation** means—taking care of our energy resources in a knowledgeable and responsible way.

CHECK YOUR UNDERSTANDING

1. How does electricity get to your home? What happens to it along the way?
2. How can you reduce the amount of electricity that you and your family use?

8.3 Generating Electricity from Water

In British Columbia, the most commonly used source for generating electricity is moving water. About 85% of all British Columbia's electricity is generated using hydroelectric energy, or **hydro.** Water is a renewable resource because it is constantly recycled on Earth.

Hydroelectric dams, like the one shown in Figure 1, are used to change the energy of moving water into electricity. These plants are usually built on large rivers. British Columbians are fortunate to have many fast-flowing rivers that can be used to generate electricity. The first hydroelectric dam in British Columbia was built in 1897 at Bonnington Falls, near Nelson.

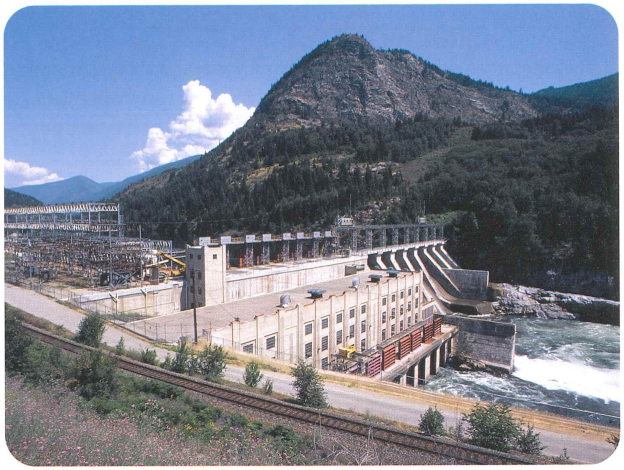


Figure 1
Brilliant Dam, near Castlegar, British Columbia, is located on the Kootenay River.

Figure 2 shows a cross section of a hydroelectric dam. A dam stops the flow of water on a river. This creates a large storage lake, called a reservoir. When electricity is needed, water from the reservoir is allowed to flow through a tube, called a penstock, in the dam. At the bottom of the penstock, the water spins a turbine. The turbine drives the generator, which produces electricity.

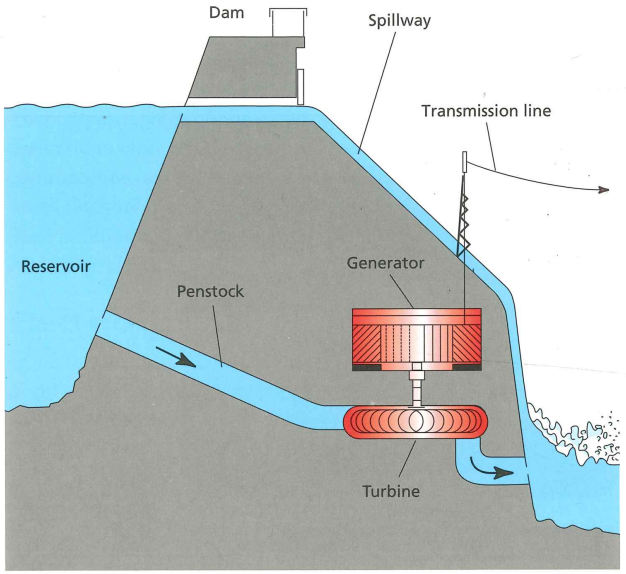


Figure 2
The electricity that is generated at a dam is sent along transmission lines to businesses and homes.

LEARNING TIP

As you read about how a hydroelectric dam works, use the labels on the diagram in Figure 2 to follow the explanation.

Hydroelectric energy is generated without polluting the air. However, the generation of hydroelectric energy creates other environmental problems. For example, large amounts of land are flooded to create a reservoir. The dam itself changes the natural flow of the water. The result is a loss of habitat for many animals and plants, both upstream and downstream from the dam.

The building of dams is a major concern for many Aboriginal peoples in Canada. Dams affect traditional hunting and migration routes. Some hydroelectric energy companies realize the importance of working with Aboriginal peoples and have invited Aboriginal representatives to provide advice. Since many Aboriginal peoples have lived for generations in particular areas, they know a lot about the local ecosystems. This means that they understand the impact of hydroelectric dams on the environment. Some Aboriginal peoples actively protest the construction of dams to protect their traditional lands.

The building of dams is also a concern for the fishing industry. Dams may present a barrier to migrating fish, such as salmon. Fish ladders, like the one shown in Figure 3, can be built to help salmon get around dams. Some people feel that this is not enough, however, and that the fishing industry is being damaged by the building of dams.

Figure 3
This fish ladder allows fish to get around dams.

TRY THIS: MAKE A MODEL OF A WATER WHEEL

Skills Focus: creating models, communicating

Water wheels use flowing water to do work. The first water wheels were used to grind grain. Today, water wheels called turbines are used to produce electricity. Can you make a working model of a water wheel using common materials? Figure 4 shows a model that was made with plastic spoons, a Styrofoam ball, and a wooden skewer. To make your model, consider using paper cups, empty creamer containers, wire, foil plates, egg cartons, thread spools, plastic straws, string, and elastics. Pour water over your model to test how it works.

Compare your model with the dam in Figure 2. How is your model similar to a dam?

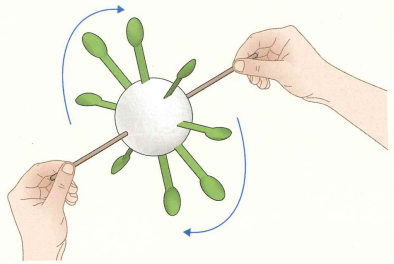


Figure 4
Your model of a water wheel could look like this.

CHECK YOUR UNDERSTANDING

1. Why does most of British Columbia's electricity come from hydroelectric energy?
2. What does BC Hydro do? Why is "BC Hydro" a good name for this company?
3. Why is water considered to be a renewable resource?

Producing Electricity from Non-renewable Resources

8.4

There are two types of non-renewable sources of energy: fossil fuels and nuclear [NOO-klee-uhr] fuels. **Fossil fuels** are the most common non-renewable resource used to produce electricity. Fossil fuels are made from the remains of dead organisms that lived millions of years ago. There are three kinds of fossil fuels: coal, natural gas, and oil.

LEARNING TIP

Scan the subheadings in this section. How many types of non-renewable sources of energy do you think you will learn about?

Electricity from Fossil Fuels

In a fossil-fuel generating station, the fuel—either coal, natural gas, or oil—is used to heat water to produce steam. The steam is then used to turn turbines in a generator to produce electricity (Figure 1).

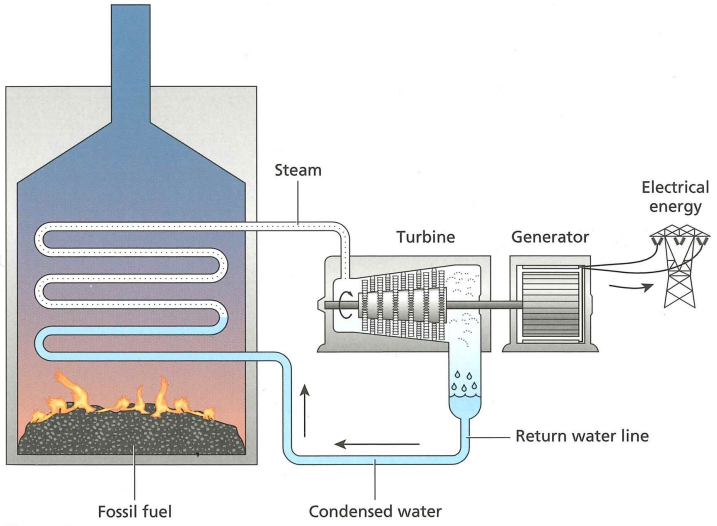


Figure 1
A cross section of a fossil-fuel generating station

Coal is a hard fossil fuel, made of ancient plants such as trees and ferns. Most of the coal that is used in Canada is mined from coal deposits in Saskatchewan, Alberta, and British Columbia.

Natural gas and oil come from plankton (tiny plants and animals) that lived in ancient seas and lakes. Natural gas and oil are usually found together, often in deep wells. Most of Canada's natural gas and oil are found in western Canada. British Columbia has a very large reserve of natural gas and oil that has not yet been developed. Oil wells pump the deposits of natural gas and oil to the surface. Pipelines are used to deliver the fuels to storage basins and refineries (Figure 2).

Figure 2
Pipelines are used to transport natural gas and oil. Some pipelines interfere with the annual migration of caribou.

There are many problems with using fossil fuels to create electricity. One problem is that once the fossil fuels are used, they are gone forever. Another problem is that burning fossil fuels puts dangerous gases and particles into the air. As well, there are concerns about coal mining damaging the surrounding environment, and the possibility of oil spills destroying ecosystems.

Electricity from Nuclear Fuel

Most nuclear generating stations use uranium [yoo-RAY-knee-um] as a fuel to create **nuclear energy.** As in a fossil-fuel generating station, the fuel heats water and produces steam. The steam turns a turbine to produce electricity. Although there are no nuclear generating stations in British Columbia, just over 10% of Canada's supply of electricity is provided by nuclear energy. Figure 3 shows a nuclear generating station in Ontario.

Figure 3
The Pickering Nuclear Generating Station, in Ontario, is one of the largest nuclear generating stations in the world.

Nuclear generating stations are very efficient producers of electricity, and they do not create air pollution. However, many people feel that nuclear energy is not safe. In other parts of the world, accidents at nuclear generating stations have occurred. Harmful radiation [RAY-dee-AY-shun] has leaked and caused serious damage and death. Uranium is radioactive and must be handled very carefully. After it has been used, the waste remains dangerously radioactive for thousands of years. It must be stored carefully, where it cannot leak and pollute the land or air.

CHECK YOUR UNDERSTANDING

1. What are non-renewable resources? Give examples.
2. Why are fossil fuels considered to be non-renewable resources?
3. What are some of the drawbacks associated with using coal to produce electricity?
4. What are some of the drawbacks associated with using uranium to produce electricity?

8.5 Producing Electricity from Renewable Resources

LEARNING TIP

Check for understanding as you read. Turn each of the headings in this section into a question and see if you can answer it.

There are many renewable resources—other than water—that can be used to produce electricity. These renewable resources include sunlight, steam from underground, wind, tides, and biomass.

Electricity from the Sun

You have probably seen or used a solar-powered calculator. Have you ever seen a solar-powered car, like the one shown in Figure 1? Both of these devices have solar cells, or photoelectric cells, that use sunlight to produce a small amount of electricity. Energy from the Sun is called **solar energy.** Solar energy can also be used to produce larger amounts of electricity. At a solar-powered station, mirrors are used to focus sunlight on water tanks and heat the water. The steam that is produced turns the turbines to generate electricity.

Figure 1
This car uses solar cells to change solar energy into electricity.

The major benefit to using solar energy is that the supply seems endless to us. As well, solar energy does not create any pollution. However, the amount of sunlight varies with the time of day, the season, and the weather. It is very hard to use solar energy on a dark, stormy day! Solar-powered stations need not only a lot of sunlight, but also a lot of land on which to set up solar collectors and mirrors.

Electricity from Earth

Deep inside Earth is a large amount of energy. This energy is called **geothermal energy.** Geothermal [JEE-oh-THUR-muhl] energy heats water and produces steam. The hot water and steam either reach the surface through cracks or are brought to the surface by drilling.

Geothermal energy can be used to produce electricity. The hot water or steam is used to turn turbines to produce electricity. A power plant that uses hot water or steam is called a geothermal power plant.

There are advantages to using geothermal energy. It does not create pollution, and it is a reliable source of energy. The disadvantage to geothermal energy is that only certain places on Earth have the right geology for this energy. Fortunately, many areas of British Columbia have the right geology (Figure 2).

LEARNING TIP

The word "geothermal" combines the Greek word "geo," which means "Earth" with the Greek word "thermal," which means "producing heat or warmth." So "geothermal" refers to heat from Earth.

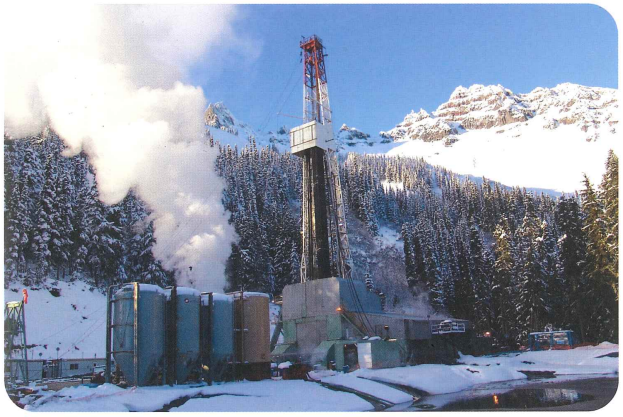


Figure 2
The South Meager geothermal area is located 170 km north of Vancouver. Research indicates that this geothermal project has the potential to supply 80 000 homes with electricity.

Electricity from the Wind

Wind is another source of energy. **Wind power** has been used for centuries to sail boats and to pump water using windmills. Wind energy can also be used to produce electricity (Figure 3). Wind pushes against the blades of a wind turbine and turns them. This turns a magnet that generates electricity.

Figure 3
Wind turbines can change the energy in moving air into electricity.

Several sites are being studied for future wind farms in British Columbia. Most of these sites are located on Vancouver Island and on the northern costal areas of the mainland. In these areas, strong wind flows come off the Pacific Ocean. Most wind turbines need a wind speed of 20 km/h to be useful.

The wind is a source of clean, renewable energy. Because the wind does not blow steadily, however, it is not a reliable source of electricity. As well, some people think that wind turbines are unattractive, noisy, and dangerous to flying birds.

TRY THIS: BUILD AN ANEMOMETER

Skills Focus: creating models, communicating

A windmill needs steady winds of at least 11 km/h to work. An anemometer [AN-uh-MOM-ih-tuhr] is a device that is used to find out the speed of the wind. Design a simple anemometer to determine the wind patterns at your school. Your anemometer could look something like the anemometer shown in Figure 4. Place your anemometer in different areas around your schoolyard, and at different times.

1. What time of day does the wind blow the hardest?
2. Where in your schoolyard is the wind the strongest? Why do you think this happens?
3. Where does the wind blow most consistently? Why do you think this happens?
4. Where in your schoolyard would you build a windmill? Explain why you would choose that location.

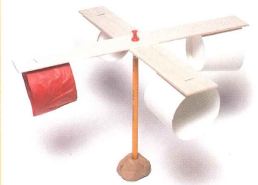


Figure 4

Electricity from the Tides

One very powerful renewable source of energy is the moving ocean. The problem is capturing this energy. One way of capturing this energy involves filling a reservoir with ocean water at high tide and later releasing the water through hydroelectric turbines as the tide goes back out. This is called **tidal energy.** There are only a few tidal power plants around the world. The second largest tidal power plant in the world is the Annapolis Tidal Generation Station in Nova Scotia (Figure 5). British Columbia has a number of locations on the coast that are ideal for using tidal energy to produce electricity.

Figure 5
This tidal power plant near Annapolis Royal, Nova Scotia, uses the power of the tides to produce electricity.

While tidal energy is widely available and does not create pollution, it does have drawbacks. Like geothermal energy, tidal energy is only available in certain places on Earth. As well, many people are concerned about how tidal power plants affect the environment. Tidal power plants can harm coastlines and can also affect marine life. For example, in August 2004, a young humpback whale nicknamed Sluice became trapped in the Annapolis River for two weeks. Sluice had entered the river through the gates next to the tidal plant (Figure 6). The power plant was shut down to ensure the safety of the whale.

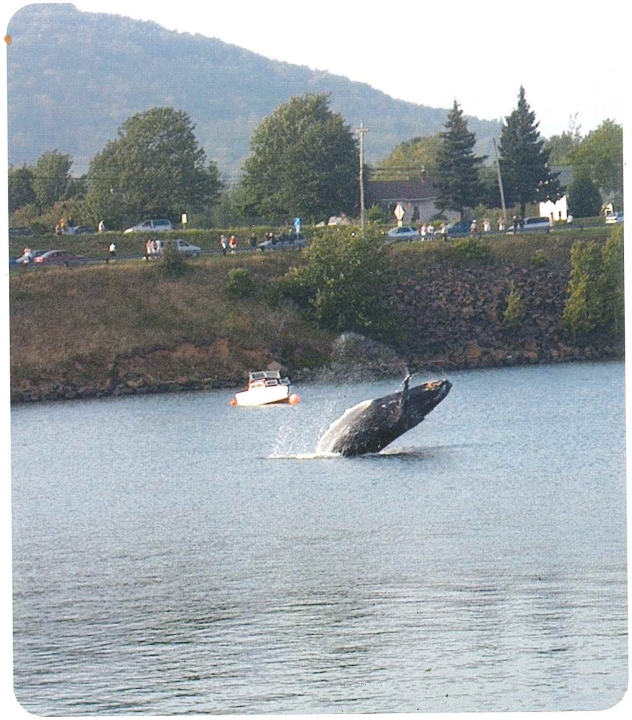


Figure 6
Sluice, the humpback whale, breaches in the Annapolis River as tourists watch. Sluice lived in the river for two weeks before returning to the ocean.

Energy from Living Things

When you burn wood in a campfire, you are using biomass to create heat. The term **biomass** refers to any type of plant or animal tissue, such as wood and wood chips, straw, manure, and crop waste. Biomass can be burned to heat water and create steam to turn turbines and generate electricity (Figure 7).

Figure 7
Williams Lake Power Plant is the largest wood-waste-fuelled electric generating plant in North America.

The wood waste from sawmills is the most common source of biomass in British Columbia. In fact, did you know that most pulp and paper mills produce much of the energy they need by burning wood waste?

Although there is a large supply of biomass in Canada, little is used as an energy source. This is because the burning of biomass produces pollution. Scientists are currently developing new non-polluting ways to generate electricity from biomass.

CHECK YOUR UNDERSTANDING

1. Explain why each source of energy discussed in this section is considered to be renewable.
2. Which renewable energy sources could be used in British Columbia? Explain your answer.

8.7 Producing Electricity from Chemicals

LEARNING TIP

As you read this section, think about your use of batteries. How many batteries do you use? What type of batteries do you use? How do you dispose of the batteries you use?

What devices do you own that run on batteries? We rely on batteries to run many of our electrical devices. A battery creates an electric current from a chemical reaction. Energy can be stored in batteries until it is needed to power electrical devices. As you discovered when you created circuits, batteries only conduct electricity when they are connected to a complete circuit. The best thing about batteries is that they can be taken anywhere (Figure 1).

Figure 1
Batteries are convenient sources of electricity.

Alessandro Volta (1745–1827) developed the first electric cell in the 1790s. The cell was made of copper and zinc discs, separated by a thick paper disc that had been soaked in salt water. The zinc and copper discs acted as the electrodes, and the soaked paper disc acted as the electrolyte.

There are different types of batteries (Figure 2), but they all work by transforming chemical energy into electricity. Rechargeable batteries can be recharged and used again. A disposable battery is a one-use battery. When the stored energy is used up, the battery cannot be used again. Rechargeable batteries are more expensive than disposable batteries because they cost more to make.

Figure 2
There are many types of batteries.

Batteries are convenient, but they are not problem free. Some batteries contain dangerous materials, such as acids and poisonous metals, including lead and mercury. These batteries are usually thrown away and end up in landfill sites. Over time, the dangerous materials can leak into the ground and contaminate it. Also, some materials that are used to make batteries are quite rare. They are found only in specific deposits on Earth.

Today, some manufacturers produce batteries that contain less poisonous metals. Many communities encourage people to take used batteries to recycling facilities that dispose of the batteries safely. Unfortunately, only a very small percentage of batteries are being recycled. Can you think of a way that you could use batteries more responsibly?

CHECK YOUR UNDERSTANDING

1. What is the difference between a rechargeable battery and a disposable battery?
2. Why is it important to recycle batteries properly or to use rechargeable batteries? Think of ways that you could encourage people to recycle batteries.
3. Copy and complete the following chart in your notebook. Is it better to buy an expensive rechargeable battery or a cheaper disposable battery?

Type of battery	Pros	Cons
rechargeable battery		
disposable battery		