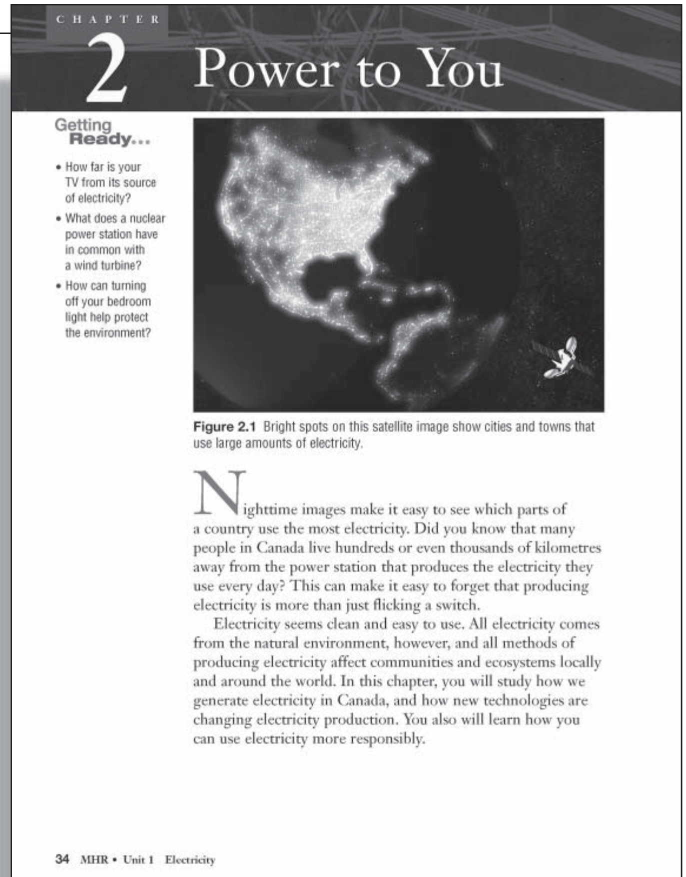
USING THE CHAPTER 2 OPENER

TEACHING STRATEGIES

- **Begin the Lesson**—Ask students to use their logbooks to write and draw what they know about the production of electricity. Then ask students to share their knowledge and brainstorm how different methods of producing electricity could affect communities and ecosystems locally and around the world. Have students suggest which methods of power generation they consider to be environmentally harmful and which are not. Ask students to explain their reasoning and suggest ways we could all use electricity more responsibly.
- Use the Getting Ready questions to assess students' prior knowledge and interests.
- **During Reading**—Read the *What You Will Learn*, *Why It Is Important*, and *Skills You Will Use* sections as a class. Encourage students to express their opinions and prior knowledge about each point.
  - Advise students to create their own definitions of key terms using language that makes sense of their observations. Distribute a copy of BLM 2.1 Key Terms for students to use as a reference throughout the chapter. Alternatively, students could use a graphic organizer for learning new vocabulary in context.
- **After Reading**—*ICT Option:* Discuss methods of power generation in Nova Scotia. The Internet has a variety of sources of information about power generation that students can visit as an introduction to this unit. Have students log onto www.mcgrawhill.ca/links/ns+science6 and follow the links.



CHAPTER 2 Power to You

Getting Ready...

- How far is your TV from its source of electricity?
- What does a nuclear power station have in common with a wind turbine?
- How can turning off your bedroom light help protect the environment?

Figure 2.1 Bright spots on this satellite image show cities and towns that use large amounts of electricity.

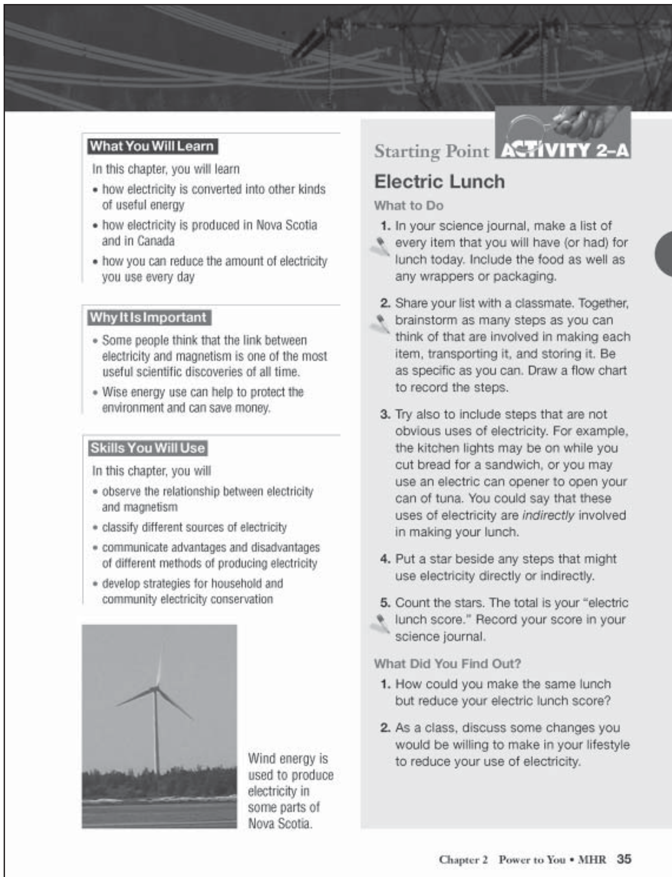
Nighttime images make it easy to see which parts of a country use the most electricity. Did you know that many people in Canada live hundreds or even thousands of kilometres away from the power station that produces the electricity they use every day? This can make it easy to forget that producing electricity is more than just flicking a switch.

Electricity seems clean and easy to use. All electricity comes from the natural environment, however, and all methods of producing electricity affect communities and ecosystems locally and around the world. In this chapter, you will study how we generate electricity in Canada, and how new technologies are changing electricity production. You also will learn how you can use electricity more responsibly.

34 MHR • Unit 1 Electricity

Getting Ready Answers

- **How far is your TV from its source of electricity?** This depends on where a student lives. They may be close to one of the wind turbines in Nova Scotia, near a coal-fired power plant, or close to a hydroelectric station. However, all students should be made aware that Nova Scotia has a centralized grid. This means that all power produced goes to one set of transmission lines and the power coming to a person's house may have been created anywhere in the province.
- **What does a nuclear power station have in common with a wind turbine?** They both use a spinning turbine connected by a shaft to an electric generator, in which a spinning magnet creates an electric current in a coil of wire. The difference is in how the turbine is made to spin. A second similarity is the fact that neither releases gases into the atmosphere as a result of energy production.
- **How can turning off your bedroom light help protect the environment?** If everyone reduces the total amount of energy they use, the need for power generation will decrease. If less power is generated, fewer pollutants are released into the environment as a result of running a power plant.
- **Further question: What forms of power generation are renewable?** Forms of renewable power generation include nuclear, wind, hydroelectric, tidal, biomass, geothermal, and solar power.



What You Will Learn

In this chapter, you will learn

- how electricity is converted into other kinds of useful energy
- how electricity is produced in Nova Scotia and in Canada
- how you can reduce the amount of electricity you use every day

Why It Is Important

- Some people think that the link between electricity and magnetism is one of the most useful scientific discoveries of all time.
- Wise energy use can help to protect the environment and can save money.

Skills You Will Use

In this chapter, you will

- observe the relationship between electricity and magnetism
- classify different sources of electricity
- communicate advantages and disadvantages of different methods of producing electricity
- develop strategies for household and community electricity conservation

Wind energy is used to produce electricity in some parts of Nova Scotia.

Starting Point ACTIVITY 2–A

Electric Lunch

What to Do

1. In your science journal, make a list of every item that you will have (or had) for lunch today. Include the food as well as any wrappers or packaging.
2. Share your list with a classmate. Together, brainstorm as many steps as you can think of that are involved in making each item, transporting it, and storing it. Be as specific as you can. Draw a flow chart to record the steps.
3. Try also to include steps that are not obvious uses of electricity. For example, the kitchen lights may be on while you cut bread for a sandwich, or you may use an electric can opener to open your can of tuna. You could say that these uses of electricity are *indirectly* involved in making your lunch.
4. Put a star beside any steps that might use electricity directly or indirectly.
5. Count the stars. The total is your "electric lunch score." Record your score in your science journal.

What Did You Find Out?

1. How could you make the same lunch but reduce your electric lunch score?
2. As a class, discuss some changes you would be willing to make in your lifestyle to reduce your use of electricity.

Chapter 2 Power to You • MHR 35

STARTING POINT ACTIVITY 2-A ELECTRIC LUNCH

Purpose

- Students will investigate the role of electricity in their daily lives by listing the contents of their lunch, describing how their lunch was prepared and packaged, and indicating which items directly or indirectly involved the use of electricity.

Advance Preparation

- You may wish to photocopy BLM 2.2 Electric Lunch to assist students with the activity.

Suggested Time

- 30 min

HINTS & HELPS

- Instead of having students rank their own lunch, you may ask students to rank their teacher's lunch or items on the cafeteria menu.
- As a class, try to brainstorm a list of some less obvious ways electricity is used to prepare a meal. Students will be trying to come up with ways electricity was indirectly used to make their own lunch, and these ideas will help get them thinking.
- *What Did You Find Out?* questions can be answered in class discussion.

Implementing the Activity

- Encourage divergent thinking in students. For example, were the tomatoes grown in a hothouse, field, or using hydroponics? Students might not know the answers, but consideration of the questions should help broaden their thinking.
- Encourage students to compare the energy consumption of home-cooked meals to the energy consumption of a fast-food meal.
- Prepare a poster about lunch to use as a demonstration with the class.

Adaptations

- Encourage students who are not confident in general class activities to be active in this activity.
- Distribute BLM 2.2 Electric Lunch to students who may need assistance in this activity.
- This activity can be completed as a focussed discussion that everyone can participate in. Visual aids such as a poster, flowcharts, or other graphic organizers may be used to organize the discussion responses.

Activity Wrap-Up

- Highlight the instances of energy use that occurred most frequently and those that occurred least frequently. Discuss the reasons for these differences.

What Did You Find Out? Answers

1. Answers may include not using electric can openers, not including heated liquids such as soup, limiting packaging, and using reusable lunch containers. Accept all reasonable answers.
2. Answers may include watching less television, using computers and CD players less, turning off lights or "instant on" features, and setting the house thermostat lower.

SECTION 2.1 USING ELECTRICITY

What Students Do in Section 2.1

- discover that electric devices are loads that convert electrical energy into another form of useful energy
- compare the function of incandescent and compact fluorescent light bulbs
- learn how an electric heating device works
- construct and investigate the function of an electromagnet

TEACHING STRATEGIES

- **Begin the Lesson**—Have students continue using and sharing their science logbooks.
  – Have students define the key terms in their own words before beginning the section.
- **During Reading**—Some explanation may be necessary to help students grasp the concept of energy conversion. Analogies may be useful, such as a windmill changing wind energy to mechanical energy or the conversion of kinetic energy to heat energy as we rub cold hands together.
- **After Reading**—Have students brainstorm a list of other types of electrical energy conversions that they use in their daily lives, such as electricity to motion (a fan) and information storage (computer).

ELECTRICITY TO LIGHT

BACKGROUND INFORMATION

- Although similar in function, incandescent and compact fluorescent bulbs operate quite differently. In an incandescent bulb, the current heats the tungsten filament to an extremely high temperature, between 2000K and 3300K. The heated filament gives off both visible light and infrared radiation (heat). In a compact fluorescent bulb, electrical energy collides with mercury vapour, which becomes excited. The energy the vapour gives off causes the coating of the bulb to glow, producing light.
- Inside an incandescent bulb, an inert gas (argon) allows particles that evaporate off the hot filament to be captured and restored back to the filament. Argon is useful in this function because it does not readily react with other compounds.

CHAPTER 2

Section 2.1 **Using Electricity**

Key Terms
light bulb
incandescent bulb
compact fluorescent bulb
electromagnetism
electromagnet

For an electric circuit to be useful, it must change electrical energy into another form of energy such as light, sound, or motion. You learned in Chapter 1 that electricity flows in a circuit and produces a response in loads connected to the circuit. As charges pass through a load, electrical energy is converted into other forms of energy. But why does the electric current produce a different response in different kinds of loads? In the next few pages, you will learn how some loads convert electrical energy.

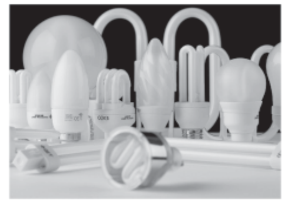


Figure 2.2 Compact fluorescent bulbs such as these use only one quarter to one third of the energy used by similar incandescent bulbs to produce the same amount of light. They are made to fit in the same light sockets as incandescent bulbs.

Electricity to Light

A **light bulb** is a device that turns electrical energy into heat and light energy. Traditional light bulbs, or **incandescent bulbs**, produce light by passing charges through a very thin wire, called a filament, inside the bulb. As charges pass through the wire, their electrical energy is given off as heat. As the wire heats up, it glows and produces light. As much as 95 percent of the energy used by an incandescent bulb is lost as heat. **Compact fluorescent bulbs** are designed in a different way. Charges pass through a tube containing mercury gas. As the charges collide with the gas, the mercury gives off energy that causes the coating of the tube to give off visible light. Only about 30 percent of the energy used by a compact fluorescent bulb is lost as heat.

36 MHR • Unit 1 Electricity

- A light bulb is usually said to "burn out" after a time. This suggests combustion has taken place, which is not strictly true, since there is no oxygen present to allow combustion. In actual fact, at high temperatures, tungsten atoms evaporate from the surface of the tungsten, even though argon atoms tend to get in the way. Some parts of the wire evaporate at a faster rate. These points get thinner and offer a higher resistance to charge flow. This in turn causes greater heating and more evaporation. Eventually the wire melts in this location.

TEACHING STRATEGIES

- **Begin the Lesson**—Ask the students to explain the terms "convert" and "transform" in their own words. Have them describe what each term means both in terms of electricity and other aspects of life.
- **After Reading**—*ICT Option:* Refer students to web sites that show how light bulbs work. Links can be found at www.mcgrawhill.ca/links/ns+science6.

Electricity to Heat

Inside a traditional light bulb, electricity is converted into heat. When the filament gets very hot, it glows, producing light. Many appliances produce heat alone, or with only a little light (think of the glow of the wires in a toaster). These loads work like the light bulb but use different materials so that the right amount of heat or light is produced. The heating filament in a toaster or hair dryer is made of a metal that becomes hot when an electric current runs through it.

Figure 2.3 A traditional light bulb and a hair dryer work in a similar way. Electricity is converted to heat in both devices. However, in a light bulb we use the light produced by the glowing filament, and in a hair dryer we use the heat.

Electricity to Magnetic Effects

An electric current creates magnetic energy. The magnetic energy that surrounds a wire carrying a current is called a *magnetic field*. Magnets are objects that can attract some metals. You can use a small magnet to pick up paper clips or pins. You can create the same kind of magnetism in some metal objects by using electricity.

Electromagnetism is the name given to magnetism produced by electricity. An **electromagnet** is a temporary magnet created by an electric current (Figure 2.4). In your next activity you will build your own electromagnet.

Figure 2.4 Electromagnets are used at scrap yards and recycling centres to pick up metals and separate them from other materials.

Chapter 2 Power to You • MHR 37

Common Misconceptions

- Students may think that using compact fluorescent bulbs is expensive. The initial purchase price is higher than that of incandescent bulbs, but since they are more efficient, they are cheaper to operate. Also, because they have no metal filament, they do not "burn out" as quickly.
- Some students may believe that because compact fluorescent bulbs last so much longer, they do not have to continue to conserve energy in other ways if they use these bulbs. Discuss the importance of working to make overall total reductions in the use of energy rather than simply cutting back in one area so another area of energy use can be expanded.
- Compact fluorescent bulbs help the environment by requiring less energy, but they contain a small amount of toxic mercury that introduces another environmental problem into the equation. Broken compact fluorescent bulbs release mercury vapour. If a bulb breaks, open a window to ventilate the room for a few minutes. Wear gloves as you clean up broken glass and dispose of it as suggested in your local area.

ELECTRICITY TO HEAT/ELECTRICITY TO MAGNETIC EFFECTS

BACKGROUND INFORMATION

- The Nichrome™ wire used in heating filaments (for example, in a toaster, blow dryer, or electric blanket) has two advantages. First, it does not combine with oxygen so it does not oxidize. Second, it has a very high electrical resistance and heats up easily when an electric current passes through it.
- When electric current magnetizes a metal, all the atoms line up in the same direction due to the attraction and repulsion of charged particles. This creates an effect similar to having several bar magnets working together.
- Electromagnets are widely used in daily life. They are used in such common devices as loudspeakers and electric motors. They also have more exotic uses, such as in anti-shoplifting devices, particle accelerators, and maglev trains. Maglev (short for magnetic levitation) trains use electric fields in the track and in the walls alongside the track (the guideway) to propel the train forward. The electromagnets in the track levitate the train, while alternating polarity in the electromagnets in the guideway alternately push and pull the train forward.

TEACHING STRATEGIES

- **During Reading**—Examine Figure 2.4 and discuss potential uses of electromagnets, such as those listed in the Background Information above.
- **After Reading**—Discuss with students the reasons why different metals would be used for hair dryers and other heating devices than in incandescent bulbs. The filament in a bulb (tungsten) produces dangerous amounts of heat compared to that in a hair dryer (Nichrome™).

CONDUCT AN INVESTIGATION 2-B WHAT'S THE BIG ATTRACTION?

Purpose

- Students will construct a simple circuit to discover the basic properties of an electromagnet.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 days before	– Collect enough equipment for each group in the class. – Ask students to bring as much of the material as possible. – Complete the activity yourself to ensure its success.
1 day before (optional)	– Photocopy BLM 2.3 Electromagnetism on acetate to use as an overhead.

MATERIALS	
– 1 D-cell battery (1.5 V)	– iron filings
– 2 copper wires with alligator clips	– white paper
– 1 iron rod (5 cm)	– rubber gloves
– 1 piece of copper wire (15-20 cm)	

Suggested Time

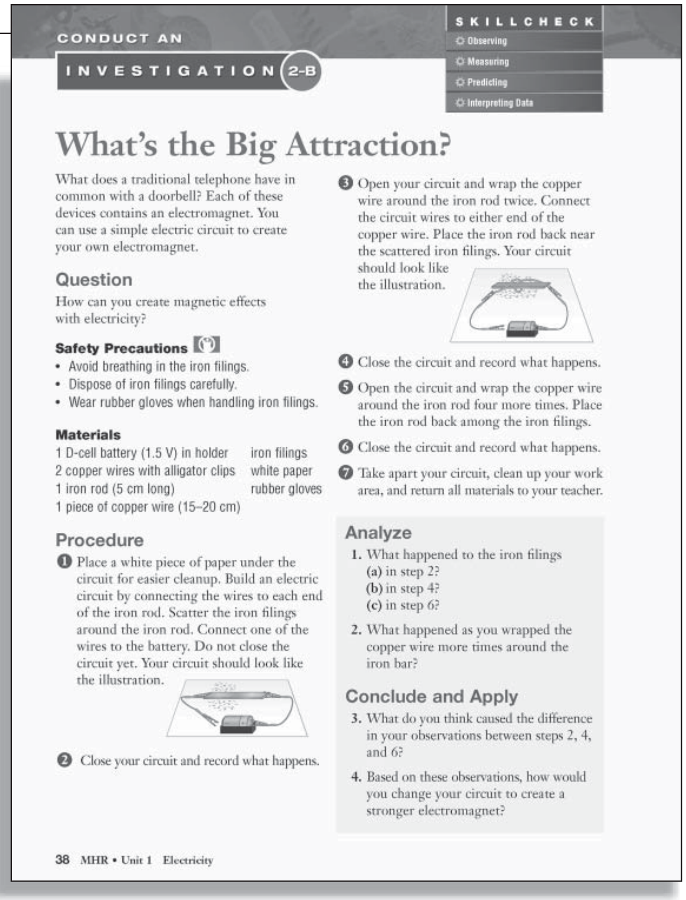
- 40 min

Safety Precautions

- Students should wear rubber gloves when handling iron filings and possibly a dust mask. Remind students to avoid breathing in the filings and to dispose of them carefully.
- Review the safety precautions for dealing with electric circuits. Remind students that as the power supply increases, the bar and wires can become very hot.

HINTS & HELPS

- Students will find it easier to clean up iron filings if they wrap the iron bar in a plastic sandwich bag before wrapping the wire around it or putting iron filings near it.
- The wire used to wrap around the iron bar must be insulated so that it doesn't "short" on the bar.
- Students may need to gently tap the paper to see the iron filings line up. The effect is most noticeable when many turns of wire are used.
- A magnetic field demonstrator may be used in place of the iron filings.



CONDUCT AN INVESTIGATION 2-B

SKILLCHECK
- Observing
- Measuring
- Predicting
- Interpreting Data

What's the Big Attraction?

What does a traditional telephone have in common with a doorbell? Each of these devices contains an electromagnet. You can use a simple electric circuit to create your own electromagnet.

Question

How can you create magnetic effects with electricity?

Safety Precautions
- Avoid breathing in the iron filings.
- Dispose of iron filings carefully.
- Wear rubber gloves when handling iron filings.

Materials

1 D-cell battery (1.5 V) in holder
2 copper wires with alligator clips
1 iron rod (5 cm long)
1 piece of copper wire (15–20 cm)
iron filings
white paper
rubber gloves

Procedure

1. Place a white piece of paper under the circuit for easier cleanup. Build an electric circuit by connecting the wires to each end of the iron rod. Scatter the iron filings around the iron rod. Connect one of the wires to the battery. Do not close the circuit yet. Your circuit should look like the illustration.
2. Close your circuit and record what happens.
3. Open your circuit and wrap the copper wire around the iron rod twice. Connect the circuit wires to either end of the copper wire. Place the iron rod back near the scattered iron filings. Your circuit should look like the illustration.
4. Close the circuit and record what happens.
5. Open the circuit and wrap the copper wire around the iron rod four more times. Place the iron rod back among the iron filings.
6. Close the circuit and record what happens.
7. Take apart your circuit, clean up your work area, and return all materials to your teacher.

Analyze

1. What happened to the iron filings
(a) in step 2?
(b) in step 4?
(c) in step 6?
2. What happened as you wrapped the copper wire more times around the iron bar?

Conclude and Apply

3. What do you think caused the difference in your observations between steps 2, 4, and 6?
4. Based on these observations, how would you change your circuit to create a stronger electromagnet?

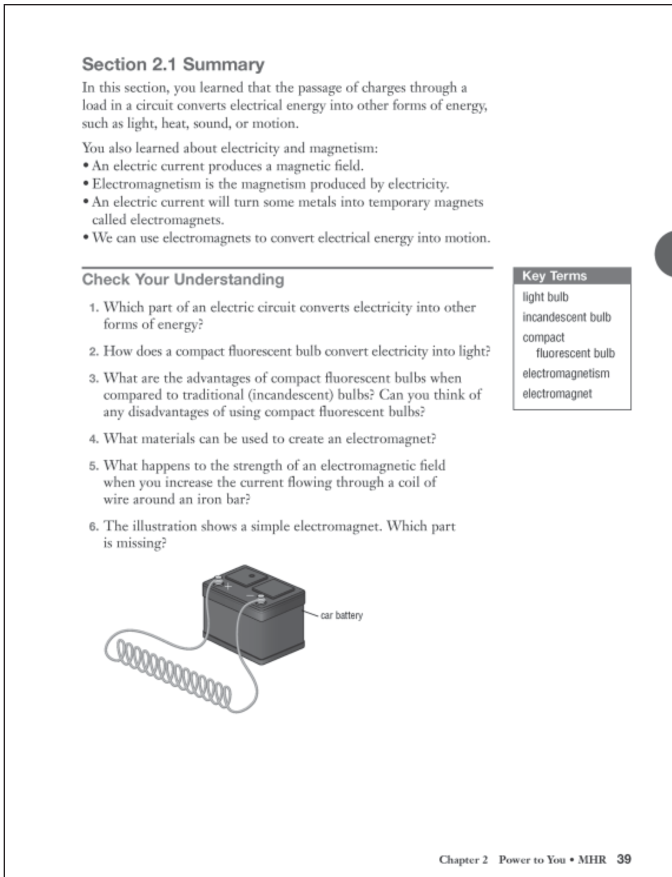
38 MHR • Unit 1 Electricity

Implementing the Investigation

- Keep an extra supply of batteries on hand. Students may need to replace or double up batteries to see the magnetic field.
- Have students carefully examine the pattern in the iron filings all the way around the bar. The magnetic field should be more pronounced and its shape more visible at the poles of the electromagnet. Ask students to draw the pattern.

Adaptations

- Students with fine-motor difficulties should be provided with a nearly complete set-up to safely and easily view the magnetic field. They may also use a small compass to detect the field, rather than iron filings.
- Students with literacy difficulties should be paired with good readers to ensure they know what the instructions mean.
- You may wish to show BLM 2.3 Electromagnetism as an overhead to reinforce the results of the activity or show students how to draw what they have seen.
- Students with an advanced interest in this subject could be encouraged to investigate the relationship between simple electric motors and electromagnets. Consider providing a simple motor for these students to take apart and examine.



Section 2.1 Summary

In this section, you learned that the passage of charges through a load in a circuit converts electrical energy into other forms of energy, such as light, heat, sound, or motion.

You also learned about electricity and magnetism:
- An electric current produces a magnetic field.
- Electromagnetism is the magnetism produced by electricity.
- An electric current will turn some metals into temporary magnets called electromagnets.
- We can use electromagnets to convert electrical energy into motion.

Check Your Understanding

1. Which part of an electric circuit converts electricity into other forms of energy?
2. How does a compact fluorescent bulb convert electricity into light?
3. What are the advantages of compact fluorescent bulbs when compared to traditional (incandescent) bulbs? Can you think of any disadvantages of using compact fluorescent bulbs?
4. What materials can be used to create an electromagnet?
5. What happens to the strength of an electromagnetic field when you increase the current flowing through a coil of wire around an iron bar?
6. The illustration shows a simple electromagnet. Which part is missing?

Key Terms
light bulb
incandescent bulb
compact fluorescent bulb
electromagnetism
electromagnet

Chapter 2 Power to You • MHR 39

Investigation Wrap-Up
- Sketch or prepare a poster to show students what the magnetic field looks like.
- Perform a teacher demonstration using a 6 V lantern battery connected to 100 turns of copper wire wrapped tightly around a cardboard tube filled with large spiking nails. Either use iron filings to display the pattern or pick up a pile of small finishing nails.
- Discuss the use of electromagnets in daily life (see Background Information for this section).

Assessment Option
- Use Science Skills Rubric 19, Conduct an Investigation to assess student work.

Analyze Answers

1. (a) No evident movement of the iron filings was observed.
   (b) The iron filings seemed to "jiggle" a bit.
   (c) The iron filings formed lines along the length of the bar. They seemed to turn in towards the ends of the iron bar.
2. As students increased the number of times they wrapped the copper wire around the iron bar, they should have observed that the iron filings became more attracted to the bar. Some students may state that the magnet became stronger.

Conclude and Apply Answers

3. The magnetic field became stronger as more turns of wire were used.
4. A stronger electromagnet can be created by using more turns of wire around the iron bar. Some students may suggest that using more batteries will strengthen the field, which is also correct.

SECTION 2.1 SUMMARY

Read the section summary together and discuss questions that the students still have with respect to the conversion of electricity. Have the students update their science logbooks and key terms lists.

Check Your Understanding Answers

1. A load converts electrical energy into other forms of energy.
2. Compact fluorescent bulbs convert energy into light as follows: Charges pass through a tube containing mercury gas. As the charges collide with the gas, the mercury gives off energy that causes the coating of the tube to give off visible light.
3. Student answers should state that compact fluorescent bulbs use less energy than incandescent bulbs. Some students may recognize that they last longer because they have no metal filament to "burn out." Accept any reasonable disadvantages. One disadvantage of compact fluorescent bulbs is that they contain toxic mercury. If they break, they release this gas into the environment.
4. To build an electromagnet, a source of electricity, a conducting wire, and an iron bar are required. A switch is also helpful.
5. The strength of a magnetic field increases as the current around the iron bar increases.
6. The iron bar is missing from the diagram of the simple electromagnet.

✓ ASSESSMENT OPTIONS FOR SECTION 2.1

- Assign some or all of the Check Your Understanding questions on page 39 as a quiz to review the section.
- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook as a guide to evaluation.

SECTION 2.2 USING THE ELECTROMAGNETIC CONNECTION TO GENERATE ELECTRICITY

What Students Do in Section 2.2

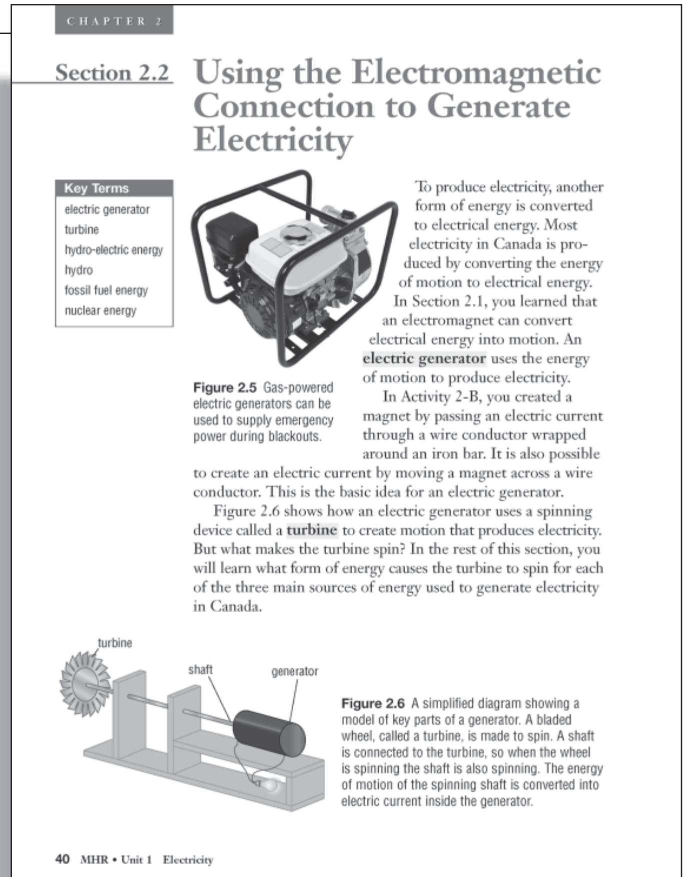
- describe the basic function of a power-generation turbine
- investigate the types of electrical power generation currently used in Nova Scotia
- compare and contrast how energy is generated by nuclear, fossil fuel, and hydroelectric power-generation stations

BACKGROUND INFORMATION

- Most large-scale power generation is a result of the rotation of a turbine by an external force. The force can be created by moving steam, as in generation with nuclear and fossil fuels; by moving water, as in hydroelectric generation; or by moving air, as in wind turbines. All methods generate electricity by using the rotation of a turbine to rotate a magnet in a coil of wire.
- Electrical energy can also be produced directly through the use of chemical reactions in batteries or from the Sun in photovoltaic cells.

TEACHING STRATEGIES

- **Begin the Lesson**—Have students define the key terms in their own words before beginning the section.
  - Various models of turbine function will assist with the instruction of this section. Small hand-crank radios or flashlights, as well as model generators, are all available to help students visualize the function of generators.
- **During Reading**—Figure 2.7 in the student textbook has been reproduced as an overhead, BLM 2.4 Generating Stations, for your use.
- **After Reading**—Have a group discussion or debate over the expanded or reduced use of fossil fuels and other non-renewable resources for power generation in Nova Scotia.



CHAPTER 2

Section 2.2 Using the Electromagnetic Connection to Generate Electricity

Key Terms
electric generator
turbine
hydro-electric energy
hydro
fossil fuel energy
nuclear energy

To produce electricity, another form of energy is converted to electrical energy. Most electricity in Canada is produced by converting the energy of motion to electrical energy. In Section 2.1, you learned that an electromagnet can convert electrical energy into motion. An **electric generator** uses the energy of motion to produce electricity.

In Activity 2-B, you created a magnet by passing an electric current through a wire conductor wrapped around an iron bar. It is also possible to create an electric current by moving a magnet across a wire conductor. This is the basic idea for an electric generator.

Figure 2.6 shows how an electric generator uses a spinning device called a **turbine** to create motion that produces electricity. But what makes the turbine spin? In the rest of this section, you will learn what form of energy causes the turbine to spin for each of the three main sources of energy used to generate electricity in Canada.

Figure 2.5 Gas-powered electric generators can be used to supply emergency power during blackouts.

Figure 2.6 A simplified diagram showing a model of key parts of a generator. A bladed wheel, called a turbine, is made to spin. A shaft is connected to the turbine, so when the wheel is spinning the shaft is also spinning. The energy of motion of the spinning shaft is converted into electric current inside the generator.

40 MHR • Unit 1 Electricity

Common Misconceptions

- It is sometimes believed that turbines create electricity. In fact, a turbine is just a device that transforms one form of energy, such as heat, into the motion of a spinning axle. (In Nova Scotia, an early popular type of turbine was a waterwheel.) The energy of motion is then transferred to wire coils that spin inside a magnetic field, inducing an electric current.

FIND OUT ACTIVITY 2-C WHAT'S YOUR SOURCE?

Purpose

- Students will investigate the main methods of power generation in Nova Scotia and across the country. They will discover the factors that determine the key types of power generation in different areas of the country.

Find Out ACTIVITY 2–C

What's Your Source?

The energy needed to power an electric generator can come from a variety of sources. Which sources are used most commonly across Canada?

This station generates electricity by burning fossil fuels (coal, oil, or gas).

What to Do

1. Your teacher will assign your group one province or territory to research. Use library or Internet resources to find the sources of energy used for generation of electricity in that province. What are the top two sources in the province?
2. Share your findings with the other groups in the class.
3. Arrange the information you have collected for all of the provinces into a table. Give your table a descriptive title.
4. Use the Internet, your school library, or community resources to locate the electricity-generating station closest to your community. What source of energy does it use?

What Did You Find Out?

1. What are the top two sources for electricity generation in Nova Scotia? Does the electricity-generating station near your community use one of these sources?
2. What factors might explain why the electricity-generating station was built or placed in this particular location near your community?
3. What are the most common sources of electricity across Canada? Are the top sources of electricity the same for all of the provinces? How do they compare with the top sources in Nova Scotia? Explain any differences. (Hint: What factors could make a source suitable for a particular province?)

Energy from the ocean tides can be used to generate electricity. Which provinces have tidal generating stations?

Chapter 2 Power to You • MHR 41

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 month before	– Collect books, articles, and web sites to assist with the investigation.
1 week before	– Secure access to the necessary computers, library resources, and other materials to complete the activity. – Have students prepare a data table for their data collection or photocopy BLM 2.5 What's Your Source? – Visit useful web sites at school before beginning the activity to ensure they are not blocked by web-filtering software.

Suggested Time

- 60 min for data collection
- 30 min for discussion, table preparation, and completion of questions

HINTS & HELPS

- You may wish to collect relevant information about power generation in your area (through Nova Scotia Power or other research) to assist students.
- Discuss different methods of presenting data. Histograms, pie charts, and other visual displays will assist with the conclusion of the activity.
- *ICT Option:* Use the Nova Scotia Power web page as a starting point for this activity. It can assist with identifying power-generation station locations and types. Statistics Canada also has a large collection of information related to energy use across the country. Links can be found at www.mcgrawhill.ca/links/ns+science6.

Implementing the Activity

- Group students prior to the activity.

Adaptations

- Pair students with literacy difficulties with strong readers to deal with the text-based nature of the research. As alternatives, consider the use of text-reading software, scan text and increase the font size, or use the accessibility feature of various search engines.
- You may wish to distribute BLM 2.5 What's Your Source? to assist students with the organization of their information.
- Encourage multiple methods of presentation. Students should be encouraged to share their discoveries in the method that they believe best presents their results.

Activity Wrap-Up

- Discuss the students' conceptions of the benefits and drawbacks of each of the types of energy sources in terms of function, environmental impact, and safety and cost factors.

Assessment Option

- Adapt Learning Skills Rubric 5, Research Project to assess student work in this activity.

What Did You Find Out? Answers

1. The top two sources of energy generation in Nova Scotia are coal/fossil-fuel-fired power plants and hydroelectric plants. The use of wind turbines is growing rapidly across the province.
2. Factors that determine where an electricity-generating station is built include availability and proximity of fuel sources, environmental conditions and impact, and rail and road access.
3. The most common forms of electricity generation across Canada are hydroelectric, fossil-fuel turbines, and nuclear-power stations. The top source varies from province to province, depending upon local requirements, resources, and technology. Nova Scotia primarily uses fossil fuels to generate electricity. The long history of coal mining made coal a cheap and available source for power creation across the province. Wind power is gaining acceptance as an alternative source.

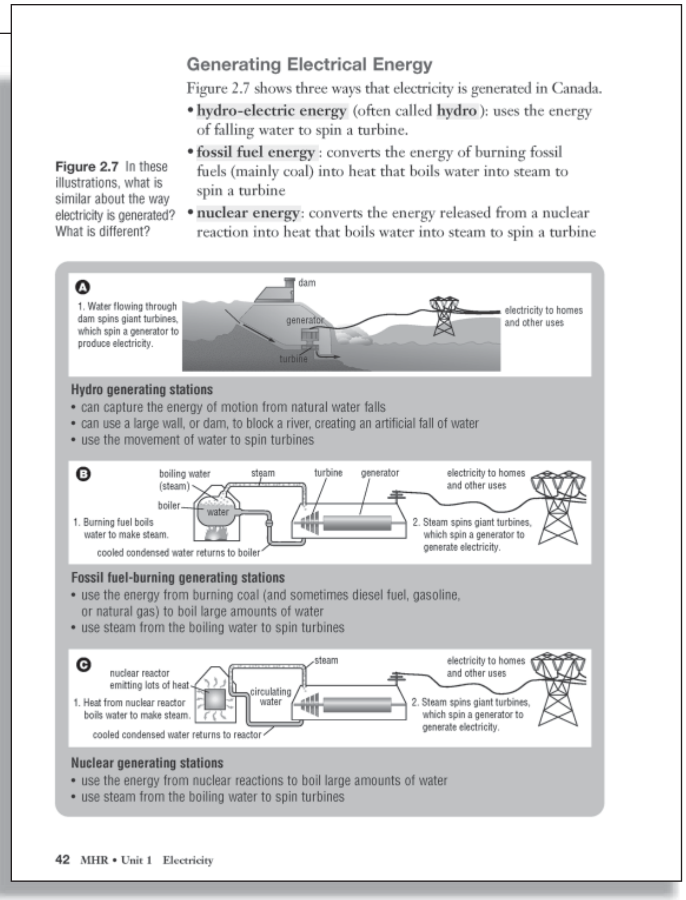
GENERATING ELECTRICAL ENERGY

BACKGROUND INFORMATION

- Hydroelectric power generators can be (1) traditional large-scale generators where large dams provide gravity-controlled movement of water and (2) micro-hydro generators that divert a portion of the total flow of a river through a small turbine and then back into the waterway.
- Thermochemical plants traditionally have used coal as a main source of generating electricity. The pollutants given off by these plants have been an environmental issue for some time. Thermochemical plants can now use *clean* coal (minerals and impurities such as sulphur dioxide have been removed), natural gas, and wood biomass to reduce the effects of pollutants. However, carbon-dioxide emissions are still an issue.
- Thermonuclear (nuclear reactions creating heat) plants use the heat energy given off by controlled nuclear fission to create energy. The basis for this energy is the fact that the mass of the products is slightly less than the mass of the initial chemicals in the reaction. This small mass gives off large amounts of energy (as predicted in the famous equation $E = mc^2$).

TEACHING STRATEGIES

- **During Reading**—Examine Figure 2.7 and discuss what features each of the stations have in common and which are different. Have students focus on the fact that all involve the rotation of a turbine that in turn rotates a magnet inside of a copper-wire conductor.
- **After Reading**—Discuss the environmental effects of each of the types of power generation covered in the student textbook. All have benefits. Nuclear and hydroelectric power produce no air pollution, fossil fuels do not require the creation of large lakes that destroy habitat (hydroelectric power does), hydroelectric power and fossil fuels do not produce radioactive waste, nuclear power does create radioactive waste that takes thousands of years to degrade.



Generating Electrical Energy

Figure 2.7 shows three ways that electricity is generated in Canada.

- **hydro-electric energy** (often called **hydro**): uses the energy of falling water to spin a turbine.
- **fossil fuel energy**: converts the energy of burning fossil fuels (mainly coal) into heat that boils water into steam to spin a turbine
- **nuclear energy**: converts the energy released from a nuclear reaction into heat that boils water into steam to spin a turbine

Figure 2.7 In these illustrations, what is similar about the way electricity is generated? What is different?

Hydro generating stations
- can capture the energy of motion from natural water falls
- can use a large wall, or dam, to block a river, creating an artificial fall of water
- use the movement of water to spin turbines

Fossil fuel-burning generating stations
- use the energy from burning coal (and sometimes diesel fuel, gasoline, or natural gas) to boil large amounts of water
- use steam from the boiling water to spin turbines

Nuclear generating stations
- use the energy from nuclear reactions to boil large amounts of water
- use steam from the boiling water to spin turbines

42 MHR • Unit 1 Electricity

Common Misconceptions

- Students may believe that Nova Scotia uses coal that comes only from local sources. Nova Scotia Power imports coal from all over the world to generate power. One reason for this is that the sulphur content of local coal is high compared to other coal sources. A reduced-sulphur content decreases air pollution from fossil fuels.
- Many people believe that nuclear power is created by uncontrolled, nuclear-bomb-type reactions. Nuclear-power stations use a number of controls to regulate the rate of the nuclear reaction and keep the reactor safe. CANDU® reactors are made in Canada and sold around the world. They have an excellent safety record.

Figure 2.7

1. All three types of power generation use a turbine to rotate a magnet inside a coil of wire. All three types also involve the conversion of one form of energy (chemical, gravitational, nuclear) to rotational energy to electrical energy.
2. The difference between the three types of power generation is what causes the rotation. Fossil fuels and nuclear use chemical reactions to generate heat that boils water to create steam and turn a turbine. Hydroelectric power uses the flow of water due to gravity to turn the turbine.

Section 2.2 Summary

In this section, you learned the following:

- An electric generator uses energy from motion to spin a turbine.
- The turbine spins a wire coil inside a magnet or a magnet inside a wire coil.
- The magnet produces an electric current in the coil.
- The sources of energy used for electricity production change from province to province.

Most of Canada's electricity comes from three energy sources:

- hydro-electric energy
- burning fossil fuels
- nuclear reactions

INTERNET CONNECT

www.mcgrawhill.ca/links/ns+science6

What are motors, and how do they use electromagnets? Go to the web site above and click on **Web Links** to find out about the role of motors in your life.

Check Your Understanding

1. What source of energy supplies most of Nova Scotia's electricity?
2. How does an electric generator produce electricity?
3. What are the three main ways that electricity is generated?
4. What do the energy sources listed in question 3 have in common, in terms of how they produce electricity?
5. In the next section, you will learn about some other ways that electricity can be generated. One of these ways involves the use of wind. Make a sketch with labels to show how you think the wind could be used at a power plant to generate electricity. (Hint: Think about what the three methods in Figure 2.7 have in common.)
6. The provinces of Newfoundland, British Columbia, and Ontario use a lot of hydro-electric energy to generate electricity. The province of Alberta and the territory of Nunavut do not. Explain why some places can use only certain kinds of energy to generate electricity.

Key Terms

electric generator
turbine
hydro-electric energy
hydro
fossil fuel energy
nuclear energy

SECTION 2.2 SUMMARY

Read the section summary together and discuss questions that the students still have related to the generation of electricity. Have the students update their science logbooks and key terms list. Ask students to share their ideas about the future of power generation in Nova Scotia. What types of power generation do they think are expanding? What types are being reduced? What issues arise when a new type of power generation is used?

✓ ASSESSMENT OPTIONS FOR SECTION 2.2

- Assign some or all of the Check Your Understanding questions on page 43 as a quiz to review the section.
- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook as a guide to evaluation.

INTERNET CONNECT In an electric motor, current is used to generate magnetic fields. The attraction and repulsion generated is translated into rotational motion, causing the armature of the motor to spin.

Check Your Understanding Answers

1. Fossil fuel power generation provides most of Nova Scotia's electricity.
2. An electric generator produces electricity as follows: an energy source rotates a turbine, which rotates a magnet inside of a large coil of wire. The rotation of the magnet causes electric current to be created in the wire.
3. The three main ways electricity is generated are burning fossil fuels, nuclear reactions, and hydroelectric energy.
4. All three forms of power generation use a source of energy to rotate a turbine, which causes the rotation of a magnet in a coil of wire, generating electric current.
5. All sketches should show the rotation of the blades of the wind turbine, which rotate a turbine, which in turn rotates a magnet inside a coil of wire.
6. The type of power generation in a given area depends on its local geography and natural resources. Areas with large river systems are good for hydroelectric generation. Areas like Nova Scotia, with large deposits of coal, use fossil fuels to generate energy.

SECTION 2.3 RENEWABLE SOURCES OF ELECTRICITY

What Students Do in Section 2.3

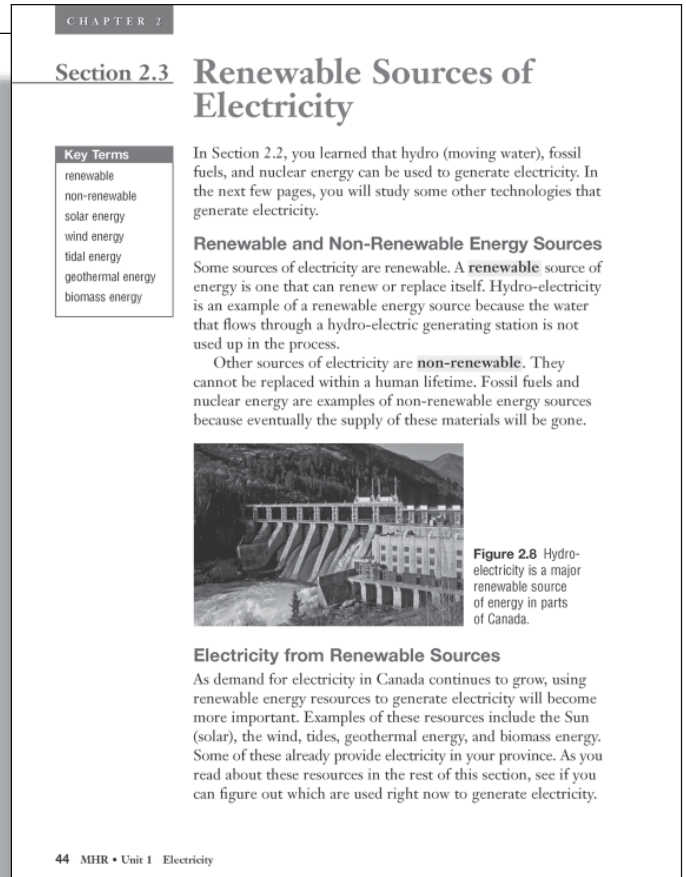
- investigate a variety of forms of renewable power generation
- identify the similarities and differences between renewable and non-renewable energy sources
- discuss the type of power generation that would be best for their local area, based on available resources and environmental concerns
- describe the advantages and disadvantages of a variety of types of power generation

BACKGROUND INFORMATION

- The economic and environmental costs and the diminishing availability of non-renewable resources cause governments to seek ways of generating electricity through renewable sources. In 2006, renewable resources generated 18 percent of global energy, with 13 percent coming from biomass burning and 3 percent coming from hydroelectric power generation. The European Union has reached an agreement that 20 percent of the Union's energy will come from renewable sources by 2020.

TEACHING STRATEGIES

- **Begin the Lesson**—Introduce the section with a group discussion about what the term "renewable" means to the students. Ask students to make notes in their science logbooks about what they know about renewable and non-renewable sources of energy. Ask them to tell what they know of the use of renewable sources in Nova Scotia and what they think are the best methods for power generation in the future.
- **During Reading**—Try the following approach to information sharing when reading the five file cards on different types of renewable energy on the student textbook pages 45 to 47. Arrange students into groups of five. Have a different student in each group silently read a different file card. Ask students to share what they have read with the other group members.
- **After Reading**—*ICT Option:* The U.S. Department of Energy has details about each of the forms of renewable energy. Links can be found at www.mcgrawhill.ca/links/ns+science6.



CHAPTER 2

Section 2.3 **Renewable Sources of Electricity**

Key Terms
renewable
non-renewable
solar energy
wind energy
tidal energy
geothermal energy
biomass energy

In Section 2.2, you learned that hydro (moving water), fossil fuels, and nuclear energy can be used to generate electricity. In the next few pages, you will study some other technologies that generate electricity.

Renewable and Non-Renewable Energy Sources

Some sources of electricity are renewable. A **renewable** source of energy is one that can renew or replace itself. Hydro-electricity is an example of a renewable energy source because the water that flows through a hydro-electric generating station is not used up in the process.

Other sources of electricity are **non-renewable**. They cannot be replaced within a human lifetime. Fossil fuels and nuclear energy are examples of non-renewable energy sources because eventually the supply of these materials will be gone.

Figure 2.8 Hydro-electricity is a major renewable source of energy in parts of Canada.

Electricity from Renewable Sources

As demand for electricity in Canada continues to grow, using renewable energy resources to generate electricity will become more important. Examples of these resources include the Sun (solar), the wind, tides, geothermal energy, and biomass energy. Some of these already provide electricity in your province. As you read about these resources in the rest of this section, see if you can figure out which are used right now to generate electricity.

44 MHR • Unit 1 Electricity

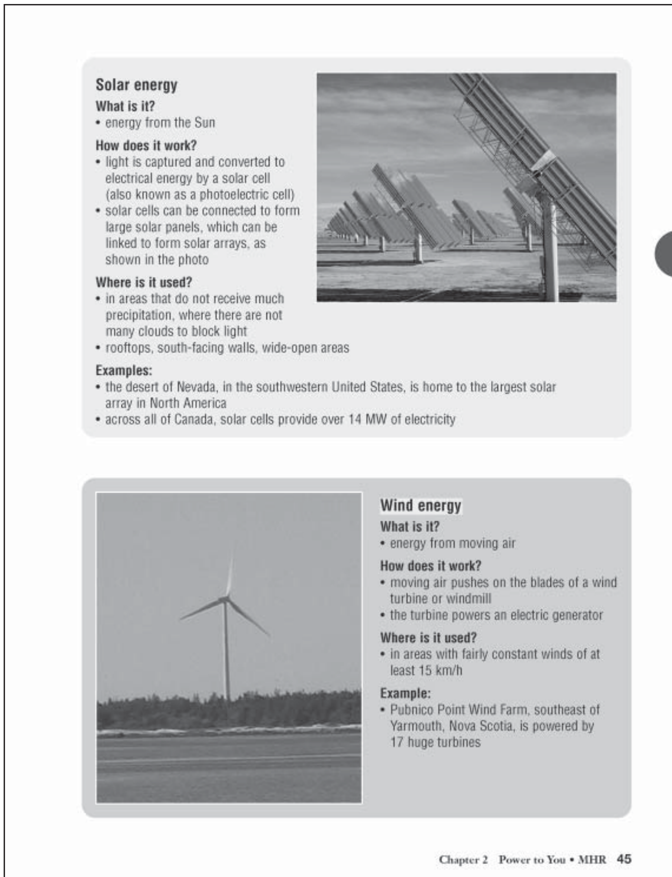
Common Misconceptions

- Many students may believe that only solar power and wind power can replace today's forms of power generation. They may not be aware of the vast array of power generation methods introduced in this section.

RENEWABLE AND NON-RENEWABLE ENERGY SOURCES/ELECTRICITY FROM RENEWABLE SOURCES

BACKGROUND INFORMATION

- The demand for energy is using up Earth's fossil-fuel reserves, making it more and more important to develop alternative forms of energy. In the 1960s, an estimated 40 billion tonnes of fossil fuel had not yet been harvested. In the 1990s, new reserves were found; however, the rate of use increased simultaneously. It is currently estimated that at the current rate of use, Earth's fossil-fuel reserves will last no longer than 70 years, unless new reserves are found.



Solar energy

What is it?

- energy from the Sun

How does it work?

- light is captured and converted to electrical energy by a solar cell (also known as a photoelectric cell)
- solar cells can be connected to form large solar panels, which can be linked to form solar arrays, as shown in the photo

Where is it used?

- in areas that do not receive much precipitation, where there are not many clouds to block light
- rooftops, south-facing walls, wide-open areas

Examples:

- the desert of Nevada, in the southwestern United States, is home to the largest solar array in North America
- across all of Canada, solar cells provide over 14 MW of electricity

Wind energy

What is it?

- energy from moving air

How does it work?

- moving air pushes on the blades of a wind turbine or windmill
- the turbine powers an electric generator

Where is it used?

- in areas with fairly constant winds of at least 15 km/h

Example:

- Pubnico Point Wind Farm, southeast of Yarmouth, Nova Scotia, is powered by 17 huge turbines

Chapter 2 Power to You • MHR 45

TEACHING STRATEGIES

- **Begin the Lesson**—Discuss the role of the Sun in most electricity production. It is responsible for fossil fuels (long term), winds, biomass, solar, and hydroelectric generation.
- **After Reading**—Canadians consume more energy per person compared to other nations. Ask students to suggest what might account for these differences in energy consumption.

Common Misconceptions

- With the prevalence of oil and natural-gas exploration across Nova Scotia and Canada, some students may see these sources as limitless or renewable over time. Students should be reminded that it takes millions of years to convert energy from decaying matter into oil and gas.

SOLAR ENERGY

BACKGROUND INFORMATION

- There are two ways of generating electricity from solar radiation: (1) Photovoltaic cells (or solar cells) generate electricity by absorbing the energy from the Sun using a semi-conducting surface, such as silicon. The absorbed energy excites electrons on the surface causing them to move freely and generate a current; or (2) a solar furnace uses mirrors to focus the Sun's energy on a boiler, which generates steam to rotate a turbine, generating electricity as well.
- The space program uses solar cells extensively to power parts of the international space station, telescopes, and various satellites.

TEACHING STRATEGIES

- **After Reading**—A small, solar-powered calculator or simple solar cell can be used to demonstrate how solar power varies with changing light conditions.

WIND ENERGY

BACKGROUND INFORMATION

- Wind turbines use blades that rotate in the wind to turn a turbine. Wind turbines generally have a sophisticated computer system that successfully rotates them towards the wind and stops their operation if wind speeds become too high or too low.
- There has been some discussion about the possibility of using the wind-tunnel effect of major highways, such as Highway 401 in Toronto, to power wind turbines.

TEACHING STRATEGIES

- **After Reading**—*ICT Option:* Visit www.mcgrawhill.ca/links/ns+science6 for links to an animation showing the components of a wind turbine.

Common Misconceptions

- Originally, wind power was described as producing no pollution. However, altering the landscape, the noise from the wind turbines, and the threat to birds may be considered forms of pollution.

TIDAL ENERGY

BACKGROUND INFORMATION

- The Moon is mainly responsible for the tides on Earth; however, the Sun also plays a small role in the rising and falling of the oceans each day.
- Nova Scotia currently has one of the few operational tidal power stations in the world. The high tides in the Bay of Fundy make Nova Scotia one of the best possible sites for tidal generation.
- Students may be interested to learn that waves can also be harnessed for their energy. Portugal is currently developing the world's first commercial wave farm, and several are being planned in the U.K.

TEACHING STRATEGIES

- **During Reading**—Ask students to think of reasons people would support or be opposed to a tidal power generation station. Discuss student ideas after reading the section.
- **After Reading**—*ICT Option:* The Canadian company Blue Energy Canada has a web site describing its vertical tidal generator. Links can be found at www.mcgrawhill.ca/links/ns+science6.

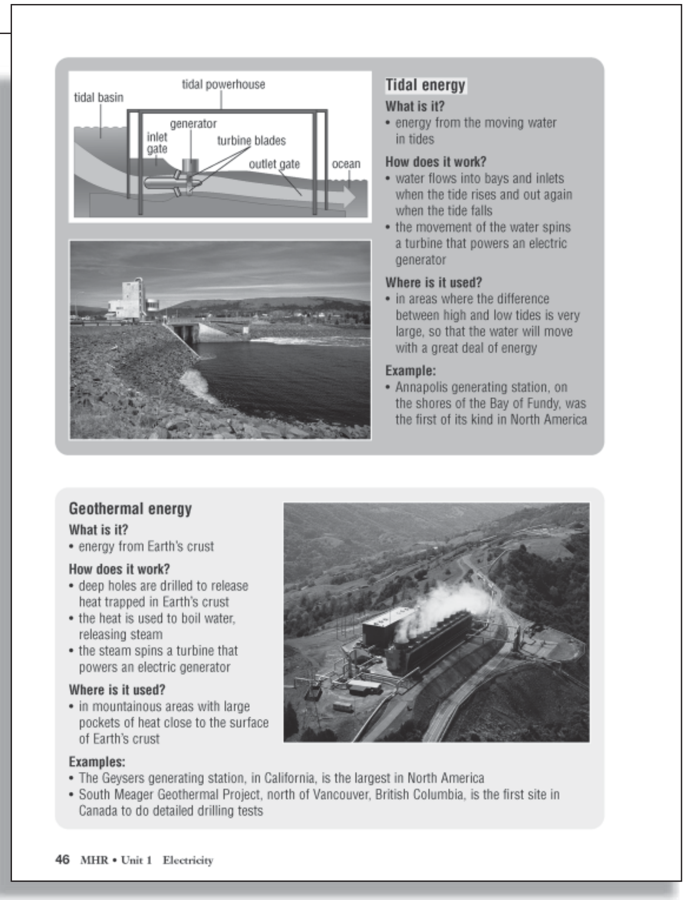
Common Misconceptions

- The tidal method of generating electric power has been thought to be pollution-free. However, it does have a negative effect on aquatic and shoreline ecosystems, due to reduced tidal flow and the build-up of silt.

GEOTHERMAL ENERGY

BACKGROUND INFORMATION

- Earth's core transfers heat to the surrounding rock layer, called the mantle. Under sufficient pressure, mantle rock melts into a liquid magma. Because it is less dense than the surrounding rock, convection currents carry magma upward towards Earth's surface. If molten magma breaks through Earth's surface, it is called lava. More commonly, the magma remains trapped and heats the water and rock below the surface. Sometimes the hot water reaches Earth's surface as hot springs or geysers. Otherwise it remains underground and collects as a geothermal reservoir, which is accessed to generate electricity.
- Iceland is a world leader in geothermal energy. The nation has five geothermal power plants that supply 26 percent of the country's energy. The majority of their electricity comes from hydroelectric resources. Only 0.1 percent comes from fossil fuels.



Tidal energy

What is it?
- energy from the moving water in tides

How does it work?
- water flows into bays and inlets when the tide rises and out again when the tide falls
- the movement of the water spins a turbine that powers an electric generator

Where is it used?
- in areas where the difference between high and low tides is very large, so that the water will move with a great deal of energy

Example:
- Annapolis generating station, on the shores of the Bay of Fundy, was the first of its kind in North America

Geothermal energy

What is it?
- energy from Earth's crust

How does it work?
- deep holes are drilled to release heat trapped in Earth's crust
- the heat is used to boil water, releasing steam
- the steam spins a turbine that powers an electric generator

Where is it used?
- in mountainous areas with large pockets of heat close to the surface of Earth's crust

Examples:
- The Geysers generating station, in California, is the largest in North America
- South Meager Geothermal Project, north of Vancouver, British Columbia, is the first site in Canada to do detailed drilling tests

46 MHR • Unit 1 Electricity

- In Nova Scotia, abandoned coal mines could be a source of geothermal energy. Water can be pumped into the tunnels, where it will be heated to 15ºC by the air down there. It can then be brought to the surface and run through heat pumps.

TEACHING STRATEGIES

- **After Reading**—*ICT Option:* Students with an interest in geology may be encouraged to explore the differences between the various types of geothermal power plants. You may also want to use a multimedia projector to show a presentation about geothermal energy. Links to presentations can be found at www.mcgrawhill.ca/links/ns+science6.

BIOMASS ENERGY

BACKGROUND INFORMATION

- To create energy from biomass, any type of plant material (such as waste wood) is dumped into hoppers and fed into a furnace. Heat generated from combustion boils water in a boiler, and the resulting steam drives a turbine. Alternatively, biomass, such as corn and sugar cane, is fermented and distilled into ethyl alcohol (ethanol). Ethanol

Biomass energy

What is it?
- energy stored in plant and animal tissues

How does it work?
1. plant tissues, such as wood, wood pulp, or straw, are burned to release heat
   - the heat is used to boil water, producing steam
   - the steam spins a turbine that powers an electric generator
2. animal or plant tissues are fed to micro-organisms
   - the micro-organisms produce a form of natural gas called biogas
   - the biogas is burned to boil water, producing steam
   - the steam spins turbines that power an electric generator

Where is it used?
- in forested areas where waste wood chips or pulp from logging operations are available
- in areas where large crops such as wheat or corn are grown

Example:
- Brooklyn Energy Centre, in Brooklyn, Nova Scotia, produces 21 MW of power from wood energy

Find Out **ACTIVITY 2–D**

Comparing Energy Sources

How can we decide which sources or technologies to use?

What to Do

Part 1

1. Conduct research using Internet or library resources on two sources of electricity from the following list:
   - Hydro
   - Coal
   - Wind
   - Solar
   - Natural gas and diesel
   - Tidal
   - Nuclear
   - Biomass
   - Geothermal
2. Answer the following questions about these two sources:
   - Is it necessary to develop new technology to harvest this source of electricity?
   - How expensive is it to develop the technology?
   - How might the use of this source affect the environment?
   - How might the use of this source affect people and communities?

Part 2

3. Have a class debate to decide which source of electricity the class, as a whole, would choose to support based on the information everyone has collected.

What Did You Find Out?

1. Based on your classroom debate, decide which arguments were most convincing. In your science journal, explain which energy source would be best for a generating station in your community. Justify your answer.

Chapter 2 Power to You • MHR 47

can be used as a fuel to boil water and drive a steam turbine to generate electricity. Biomass can also be used as a supplementary fuel in coal-burning power plants. Biofuels derived from plant materials that could feed people have been implicated in rising food prices and shortages.

- Animals use micro-organisms to digest food. This process produces biogas, usually methane. In a similar process, plant and animal tissue and waste is fed to these micro-organisms (bacteria) in a controlled environment. The biogas is collected and used as a fuel to boil water. The steam drives a turbine in an electric generator.

TEACHING STRATEGIES

- **During Reading**—Ask students to use their knowledge of the local environment to consider what type of biomass energy would be the best possible fuel source for their area.

FIND OUT ACTIVITY 2-D COMPARING ENERGY SOURCES

Purpose

- Students will conduct research using a variety of sources to compare the strengths and weaknesses of each type of electrical energy production. Students will then use their discoveries to debate which type of energy production they believe the class should support.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 month before	– Collect books, articles, and web sites to assist with the investigation.
1 week before	– Secure access to the necessary computers, library resources, and other materials to complete the activity. – Have students prepare a data table for their data collection or photocopy BLM 2.6 Comparing Energy Sources. – Check the web sites at school before beginning the activity.

Suggested Time

- 60 min for data collection
- 30 min for discussion/debate with classmates

HINTS & HELPS

- Information related to power generation in your area is available from Nova Scotia Power.
- Discuss some advantages and disadvantages of each type of energy production before the activity to give students some information to start with when beginning their research.
- Identify web sites that use appropriate language for students.
- Assign the sources of electricity that groups will be researching so that each type of energy production is researched.
- Review the guidelines for a proper debate.

Implementing the Activity

- Review the types of energy production used in Nova Scotia before students begin their research and have students think about how the type of energy production they are researching could be used where they live.

Adaptations

- Pair students with literacy difficulties with strong readers to deal with the text-based research.
- You may wish to distribute BLM 2.6 Comparing Energy Sources to assist students.
- Provide visual aids or software to assist students with speaking difficulties.

(continued) ➜

Activity Wrap-Up

- Review strong and weak points of the debates and as a class come to a conclusion about which type of energy production is the best for Nova Scotia.

Assessment Option

- Develop a rubric to assess classroom debate using Process Skills Rubric 18, Rubric Template or use Learning Skills Checklist 3, Oral Presentation.

What Did You Find Out? Answers

1. Students should justify their choices. They may refer to the cost of constructing or running the generating plant, the affordability of the electricity, the environmental impact of electricity production, the availability and proximity of resources, or public opinion.

SECTION 2.3 SUMMARY

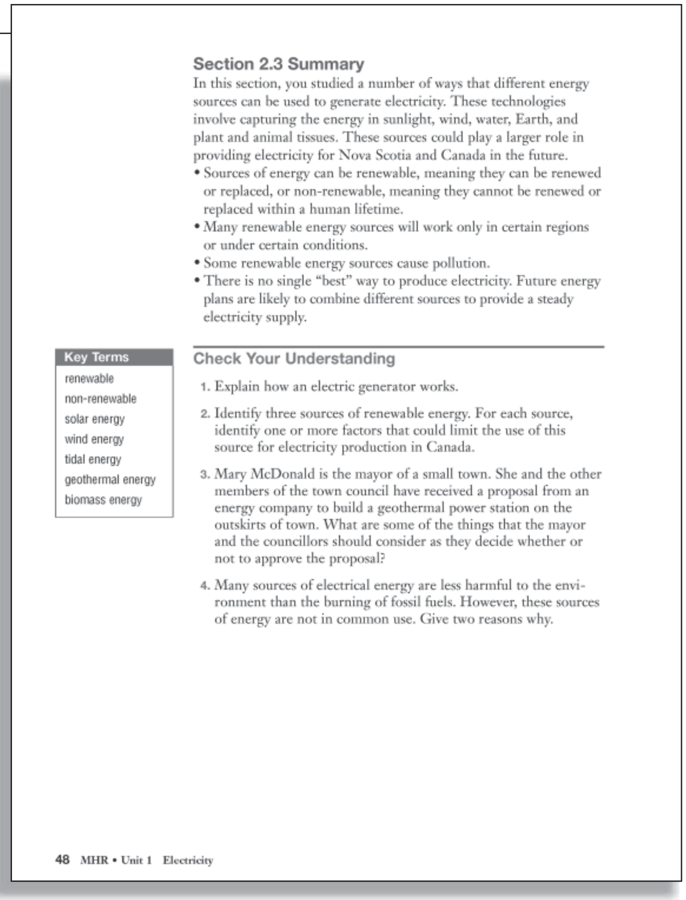
Read the section summary together and discuss remaining questions related to renewable electricity. Ask the students to update their science logbooks and key terms list. Have students create a short quiz that addresses one type of renewable energy introduced in Section 2.3. Students can exchange quizzes with a partner and try to answer the questions.

✓ ASSESSMENT OPTIONS FOR SECTION 2.3

- Assign some or all of the Check Your Understanding questions on page 48 as a quiz to review the section.
- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook as a guide to evaluation.
- Review student quiz questions.

Check Your Understanding Answers

1. An electric generator works by rotating a turbine that in turn rotates a magnet inside a copper coil, producing an electric current.
2. Any three of the following:
   (a) Solar—limited due to Canada's higher latitude and lower solar intensity
   (b) Wind—limited by availability of steady winds of sufficient strength
   (c) Tidal—limited to the coast and by the availability of suitable tidal inlets
   (d) Geothermal—limited to those locations where heat pockets are accessible from the surface
   (e) Biomass—the forests and agricultural lands must be carefully managed to ensure an ongoing supply



Section 2.3 Summary

In this section, you studied a number of ways that different energy sources can be used to generate electricity. These technologies involve capturing the energy in sunlight, wind, water, Earth, and plant and animal tissues. These sources could play a larger role in providing electricity for Nova Scotia and Canada in the future.

- Sources of energy can be renewable, meaning they can be renewed or replaced, or non-renewable, meaning they cannot be renewed or replaced within a human lifetime.
- Many renewable energy sources will work only in certain regions or under certain conditions.
- Some renewable energy sources cause pollution.
- There is no single "best" way to produce electricity. Future energy plans are likely to combine different sources to provide a steady electricity supply.

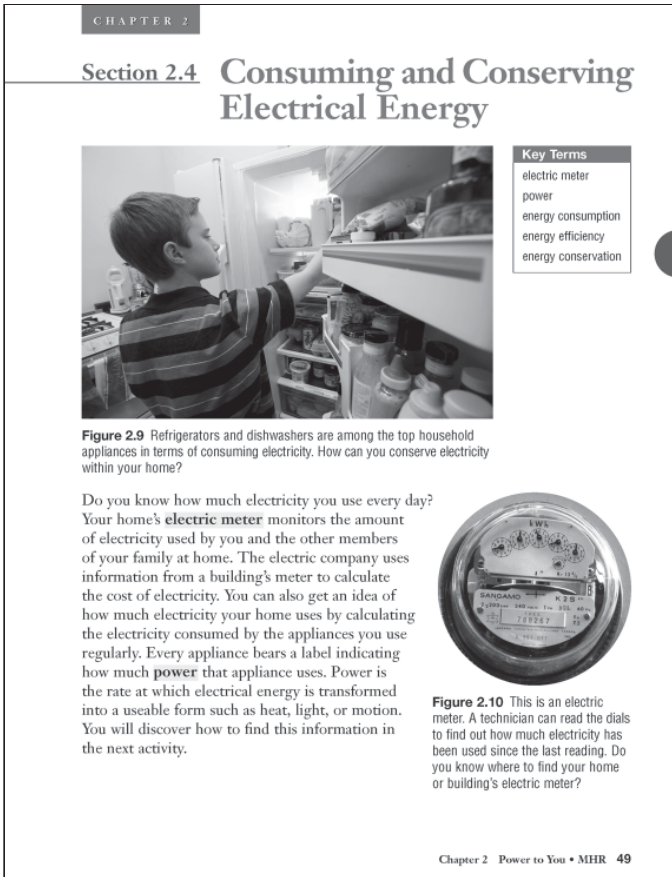
Key Terms
renewable
non-renewable
solar energy
wind energy
tidal energy
geothermal energy
biomass energy

Check Your Understanding

1. Explain how an electric generator works.
2. Identify three sources of renewable energy. For each source, identify one or more factors that could limit the use of this source for electricity production in Canada.
3. Mary McDonald is the mayor of a small town. She and the other members of the town council have received a proposal from an energy company to build a geothermal power station on the outskirts of town. What are some of the things that the mayor and the councillors should consider as they decide whether or not to approve the proposal?
4. Many sources of electrical energy are less harmful to the environment than the burning of fossil fuels. However, these sources of energy are not in common use. Give two reasons why.

48 MHR • Unit 1 Electricity

3. *Sample answer:* Mrs. McDonald and the town council need to consider (a) how the construction of the plant will affect the people who live in the area and their surrounding ecosystem; (b) how reliable the source of energy will be and how long it will last; (c) how the cost of building the plant compares with the amount of electrical energy generated by the plant; (d) what the cost of the electricity will be to the consumer; and (e) what hazardous materials may be released into the environment.
4. Sample answer:
   (a) The cost of initiating electricity production through less harmful sources may be quite high, while fossil-fuel plants are already established. This cost will be transferred to the consumer who may not want to pay more for electricity.
   (b) Other sources of energy are not always as consistent or predictable as fossil fuels.
   (c) Consumers do not always embrace change, especially if it involves something they are not familiar with.
   (d) Consumers may have incorrect beliefs about the new source of electricity (e.g., nuclear power is unsafe or the burning of biomass creates pollution).


CHAPTER 2

Section 2.4 Consuming and Conserving Electrical Energy

Key Terms
electric meter
power
energy consumption
energy efficiency
energy conservation

Figure 2.9 Refrigerators and dishwashers are among the top household appliances in terms of consuming electricity. How can you conserve electricity within your home?

Do you know how much electricity you use every day? Your home's **electric meter** monitors the amount of electricity used by you and the other members of your family at home. The electric company uses information from a building's meter to calculate the cost of electricity. You can also get an idea of how much electricity your home uses by calculating the electricity consumed by the appliances you use regularly. Every appliance bears a label indicating how much **power** that appliance uses. Power is the rate at which electrical energy is transformed into a useable form such as heat, light, or motion. You will discover how to find this information in the next activity.

Figure 2.10 This is an electric meter. A technician can read the dials to find out how much electricity has been used since the last reading. Do you know where to find your home or building's electric meter?

Chapter 2 Power to You • MHR 49

SECTION 2.4 CONSUMING AND CONSERVING ELECTRICAL ENERGY

What Students Do in Section 2.4

- discover how appliance energy-consumption labels can be used to determine the energy consumption of household devices
- learn about energy efficiency and conservation
- develop strategies for home and community energy conservation

BACKGROUND INFORMATION

- Power is a measure of the amount of energy consumed in a given time period. It is measured in watts (1 joule per second). Your power bill is measured in kilowatt-hours (kWh).

TEACHING STRATEGIES

- **Begin the Lesson**—Differentiate between electrical energy and electrical power (see Background Information above). These two terms are often used to mean the same thing but are actually measures of different properties.
- **During Reading**—Use Figure 2.10 to make students aware of how the power company and they themselves can monitor their energy consumption.
- **After Reading**—*ICT Option:* Use Internet resources to show how an electric meter is read. Similarly, for more information on EnerGuide, encourage students to visit the EnerGuide web site. Links can be found at www.mcgrawhill.ca/links/ns+science6.

Common Misconceptions

- Often when people discuss electrical energy it is referred to as "power." Electric devices use electrical energy at different rates. The rate of consumption and output is a device's power. The amount of energy consumed may be equal if a high-power device is used for a short period of time or a low-power device is used for a long period of time. The electric company bills based upon the total energy consumed.

Figure 2.9

Students explore the topic of energy conservation in At Home Activity 2-E, question 4. Use this opportunity to get students thinking about possible suggestions related to not keeping the door of the fridge open or not making frequent trips in and out of the fridge or freezer.

Figure 2.10

A building's electric meter is generally placed on the outside of the building, close to the driveway or street. It is at or below eye level so that the meter reader can easily read it each billing period.

AT HOME ACTIVITY 2-E WATTS UP?

Purpose

- Students will use energy-rating labels to determine the energy consumption of a number of household appliances.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Ask students to examine a number of electric devices at home and bring in a list of the wattage value of at least three of them.
1 day before	– Photocopy BLM 2.7 Watts Up? or have students copy the data table from the student textbook into their notebooks.

Suggested Time

- 30 min of class time to discuss how to read and compare labels
- 30 min of home time to read labels and do calculations

Safety Precautions

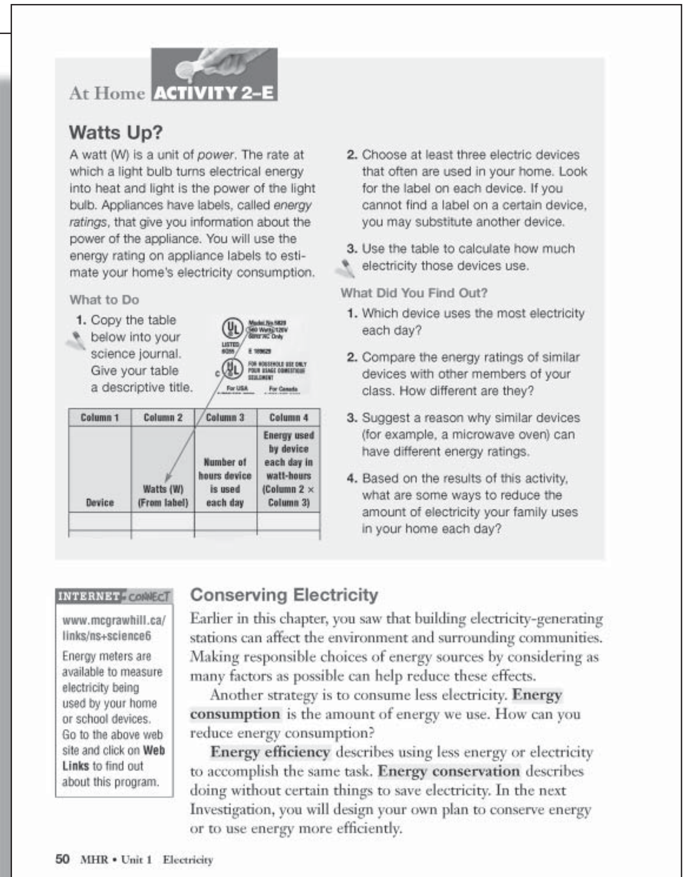
- Advise students to ask a parent or guardian for both permission and assistance, especially if searching for labels on dryers, refrigerators, and stoves. Parents may also assist in estimating the number of hours each device is used.
- Advise students that they should unplug devices before they start examining them.

HINTS & HELPS

- Ensure that the class compares a variety of devices in order to have a good discussion of overall energy consumption at home. Encourage them to check out more than three devices if possible.

Implementing the Activity

- This activity involves problem-solving skills. You may want to emphasize the steps of asking questions, gathering evidence, and designing and proposing solutions.
- Review the calculations thoroughly with the class and be sure they are using the proper units for each measurement.



At Home **ACTIVITY 2–E**

Watts Up?

A watt (W) is a unit of *power*. The rate at which a light bulb turns electrical energy into heat and light is the power of the light bulb. Appliances have labels, called *energy ratings*, that give you information about the power of the appliance. You will use the energy rating on appliance labels to estimate your home's electricity consumption.

What to Do

1. Copy the table below into your science journal. Give your table a descriptive title.

Column 1	Column 2	Column 3	Column 4
Device	Watts (W) (From label)	Number of hours device is used each day	Energy used by device each day in watt-hours (Column 2 × Column 3)

2. Choose at least three electric devices that often are used in your home. Look for the label on each device. If you cannot find a label on a certain device, you may substitute another device.
3. Use the table to calculate how much electricity those devices use.

What Did You Find Out?

1. Which device uses the most electricity each day?
2. Compare the energy ratings of similar devices with other members of your class. How different are they?
3. Suggest a reason why similar devices (for example, a microwave oven) can have different energy ratings.
4. Based on the results of this activity, what are some ways to reduce the amount of electricity your family uses in your home each day?

INTERNET CONNECT

www.mcgrawhill.ca/links/ns+science6

Energy meters are available to measure electricity being used by your home or school devices. Go to the above web site and click on **Web Links** to find out about this program.

Conserving Electricity

Earlier in this chapter, you saw that building electricity-generating stations can affect the environment and surrounding communities. Making responsible choices of energy sources by considering as many factors as possible can help reduce these effects.

Another strategy is to consume less electricity. **Energy consumption** is the amount of energy we use. How can you reduce energy consumption?

Energy efficiency describes using less energy or electricity to accomplish the same task. **Energy conservation** describes doing without certain things to save electricity. In the next Investigation, you will design your own plan to conserve energy or to use energy more efficiently.

50 MHR • Unit 1 Electricity

Adaptations

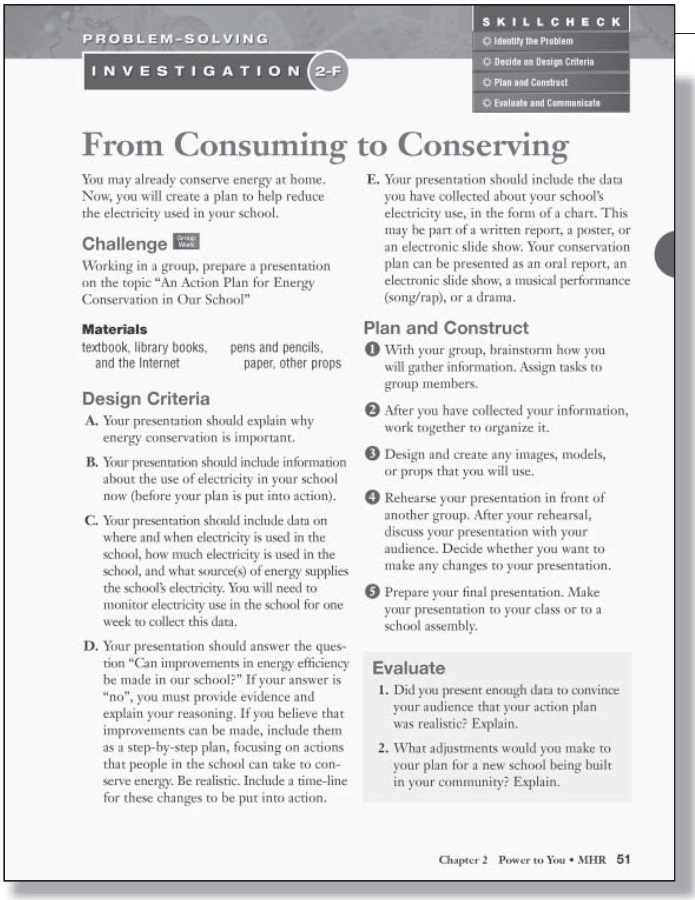
- Some students may have difficulties finding energy-consumption labels. Have a few copies of sample labels for these students to use. A comparison between old and newer electric devices could be used to demonstrate improved energy efficiency.
- Allow students to use calculators to complete the activity.
- You may wish to distribute BLM 2.7 Watts Up? to assist students in organizing their data.
- Students with a strong interest in this area should be encouraged to examine the consumption rates of different devices that perform the same function, such as light bulbs. Energy meters are available for home use in this activity. They can be borrowed from the school, school board, or local library.

Activity Wrap-Up

- Discuss the students' findings and the devices that surprised them in terms of the amount of energy consumption associated with daily use.

Assessment Option

- Use Learning Skills Rubric 5, Research Project to assess student work in this activity.



PROBLEM-SOLVING INVESTIGATION 2-F

SKILLCHECK
- Identify the Problem
- Decide on Design Criteria
- Plan and Construct
- Evaluate and Communicate

From Consuming to Conserving

You may already conserve energy at home. Now, you will create a plan to help reduce the electricity used in your school.

Challenge

Group Work

Working in a group, prepare a presentation on the topic "An Action Plan for Energy Conservation in Our School"

Materials

textbook, library books, and the Internet
pens and pencils, paper, other props

Design Criteria

A. Your presentation should explain why energy conservation is important.

B. Your presentation should include information about the use of electricity in your school now (before your plan is put into action).

C. Your presentation should include data on where and when electricity is used in the school, how much electricity is used in the school, and what source(s) of energy supplies the school's electricity. You will need to monitor electricity use in the school for one week to collect this data.

D. Your presentation should answer the question "Can improvements in energy efficiency be made in our school?" If your answer is "no", you must provide evidence and explain your reasoning. If you believe that improvements can be made, include them as a step-by-step plan, focusing on actions that people in the school can take to conserve energy. Be realistic. Include a time-line for these changes to be put into action.

E. Your presentation should include the data you have collected about your school's electricity use, in the form of a chart. This may be part of a written report, a poster, or an electronic slide show. Your conservation plan can be presented as an oral report, an electronic slide show, a musical performance (song/rap), or a drama.

Plan and Construct

1. With your group, brainstorm how you will gather information. Assign tasks to group members.
2. After you have collected your information, work together to organize it.
3. Design and create any images, models, or props that you will use.
4. Rehearse your presentation in front of another group. After your rehearsal, discuss your presentation with your audience. Decide whether you want to make any changes to your presentation.
5. Prepare your final presentation. Make your presentation to your class or to a school assembly.

Evaluate

1. Did you present enough data to convince your audience that your action plan was realistic? Explain.
2. What adjustments would you make to your plan for a new school being built in your community? Explain.

Chapter 2 Power to You • MHR 51

What Did You Find Out? Answers

1. Devices such as stoves, dryers, and water heaters should be high on the list.
2. Answers will depend on student samples. This would be a good opportunity to discuss the federal government's EnerGuide labels.
3. Different models of a device can use slightly different technologies, have different options (defrost, warming, automatic settings) requiring different electricity consumption, and have different insulation ratings.
4. Accept all reasonable answers. Possible suggestions include turning down your home thermostat, turning down the thermostat on your water heater, turning off lights that are not in use, washing dishes by hand rather than using a dishwasher, taking shorter showers, watching less TV, hanging clothes to dry on a line rather than using the dryer, or washing clothes in cold water. Some students may come up with novel suggestions such as using a bike to run a generator to generate electricity to watch TV.

CONSERVING ELECTRICITY

BACKGROUND INFORMATION

- Canadians consume more energy per person compared to other nations. We use twice as much energy per person as those in Japan and three times as much as Danish people. Our high consumption is partly due to our climate, to the vast distances in our country, and to the large amount of primary industry.

TEACHING STRATEGIES

- **Begin the Lesson**—Discuss the use of various types of light bulbs. Students should be aware of the growth in the use of compact fluorescent light bulbs (CFLs).
- **After Reading**—*ICT Option:* Use web sites to assist student learning. Conserve Nova Scotia is an organization that discusses ways that businesses and individuals can do their part to conserve energy and protect the environment. The web site is a good launch point for discussions. You may also wish to discuss the One Tonne Challenge with students. Links can be found at www.mcgrawhill.ca/links/ns+science6.

INTERNET CONNECT You may wish to obtain electrical consumption meters for students and have them plug them into one of their favourite electric devices for a week. Have them explore the cost of operating the device both in terms of the monetary price and the possible environmental impact of energy consumption. They can also use the energy meter at home to track the energy consumed each day for a week. On the high-consumption days, they should identify what was going on in their homes to create the increase in overall consumption. Students should then suggest ways to reduce consumption on the peak days.

Cross-Curricular Connection

- This section provides an opportunity to make a connection with math. Use previously developed data, via energy meters, comparing energy usage between the CFLs and incandescent bulbs. Project this over the lifetime of the bulbs to get an appreciation of real value.

Teaching notes for Problem-Solving Investigation 2-F From Consuming to Conserving appear on pages TR 2-52 and TR 2-53. ➜

PROBLEM-SOLVING INVESTIGATION 2-F FROM CONSUMING TO CONSERVING

Purpose
- Through research, students will discover ways to conserve electrical energy in and around their homes.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Reserve the library and/or computer lab and collect the necessary resources for students to complete the activity.

MATERIALS
Per group: – textbook, library books, and the Internet – pens and pencils, paper, other props

Suggested Time
- 2 h for research and data collection
- 2 h for presentation organization
- 10 min each for group presentations

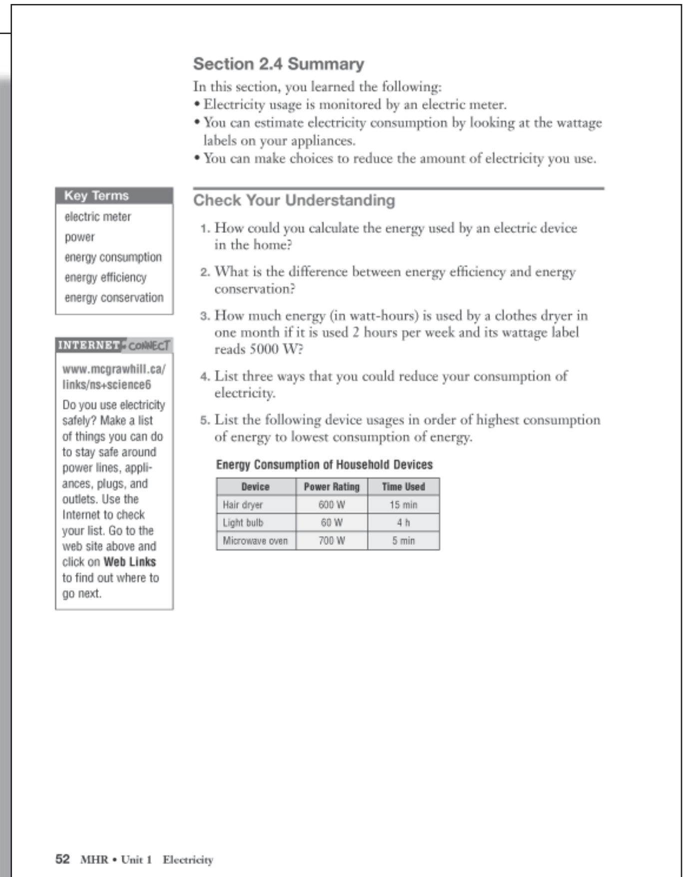
HINTS & HELPS
- *ICT Option:* Encourage students to look to web sites from the Government of Canada and the Government of Nova Scotia as launch points for their investigation. Clean Nova Scotia also has information about various programs available to the general public in order to conserve energy at home and at work. Links can be found at www.mcgrawhill.ca/links/ns+science6.

Implementing the Investigation
- Encourage students to assign individual and group roles before beginning research.
- Clarify any questions about presentation formats before beginning the research. Advise students of the proper use of citations and images collected from the Internet.
- Encourage students to use a variety of presentation methods to display and clarify their discoveries.

Adaptations
- Organize groups so that individuals will have complementary strengths to ensure a successful presentation for all students. Consider not giving a group mark.

Investigation Wrap-Up
- Discuss the answers to the Evaluate questions as a group. Have students pose questions of their classmates based upon the presentations.

Assessment Option
- Use Process Skills Rubric 11, Problem Solving to assess student work in this activity.



Section 2.4 Summary

In this section, you learned the following:
- Electricity usage is monitored by an electric meter.
- You can estimate electricity consumption by looking at the wattage labels on your appliances.
- You can make choices to reduce the amount of electricity you use.

Key Terms
electric meter
power
energy consumption
energy efficiency
energy conservation

INTERNET CONNECT
www.mcgrawhill.ca/links/ns+science6
Do you use electricity safely? Make a list of things you can do to stay safe around power lines, appliances, plugs, and outlets. Use the Internet to check your list. Go to the web site above and click on **Web Links** to find out where to go next.

Check Your Understanding

1. How could you calculate the energy used by an electric device in the home?
2. What is the difference between energy efficiency and energy conservation?
3. How much energy (in watt-hours) is used by a clothes dryer in one month if it is used 2 hours per week and its wattage label reads 5000 W?
4. List three ways that you could reduce your consumption of electricity.
5. List the following device usages in order of highest consumption of energy to lowest consumption of energy.

Energy Consumption of Household Devices

Device	Power Rating	Time Used
Hair dryer	600 W	15 min
Light bulb	60 W	4 h
Microwave oven	700 W	5 min

52 MHR • Unit 1 Electricity

Evaluate Answers
1. Student answers will depend on their presentation and those of their classmates. Seek student input on how to answer this question ahead of time.
2. Student solutions might include generating electricity through solar panels or a wind turbine, using passive solar heating via southward-facing windows, making sure the school has proper insulation, growing trees to provide shade to decrease summer temperatures and reduce the need for air conditioning, and other factors that will reduce energy consumption.

SECTION 2.4 SUMMARY

Read the section summary together and discuss questions that students still have related to electricity conservation. Ask students to create five fill-in-the-blank questions that address the key concepts introduced in Section 2.4.

✓ ASSESSMENT OPTIONS FOR SECTION 2.4
- Assign some or all of the Check Your Understanding questions on page 52 as a quiz to review the section.
- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook as a guide to evaluation.
- Assess student questions.

Prepare Your Own Chapter Summary

Summarize this chapter by doing one of the following:
- Create a graphic organizer such as a concept map.
- Produce a poster.
- Write a summary to include the key chapter ideas.

Here are a few ideas to use as a guide:
- Describe how electrical energy is transformed into other energy forms.
- Provide examples to show the importance of electromagnetism.
- Use diagrams to explain how turbines are used to generate electricity from three different sources. Point out similarities and differences.
- Make a chart listing the different ways that electricity is produced in Nova Scotia. In columns, try to identify possible advantages and disadvantages of each method.
- Explain the difference between renewable and non-renewable sources of electricity and identify how electricity should be generated in the future.
- Prepare step-by-step instructions on how to determine the energy usage of a home, school, or business. Include sample calculations.
- Draw a concept map to describe ways you can conserve electricity at home and at school.

Chapter 2 Power to You • MHR 53

Check Your Understanding Answers

1. You can calculate the energy used by an electric device in your home by multiplying the power rating of the device by the amount of time it is used. This gives an energy amount expressed in watt-hours.
2. Energy efficiency refers to using less energy to complete a task (i.e., a more energy-efficient device uses less energy to complete the same task as a less efficient device). Energy conservation refers to doing certain things to save energy, such as cutting back on the use of non-essential devices or finding alternate methods to complete some tasks, thereby using less energy.
3. The dryer would use 40 000 watt-hours of energy each month (estimating 4 weeks in a month).
4. Some ways to reduce consumption of electricity might include upgrading the insulation in homes; using devices such as television, radio, and video games less; adding solar cells or small wind turbines to the electrical system in our homes; changing the lights in homes to compact fluorescent bulbs; buying energy efficient appliances; turning down thermostats; turning off lights that are not in use; washing dishes by hand rather than using a dishwasher; taking shorter showers; hanging clothes to dry on a line rather than using the dryer; or washing clothes in cold water.
5. Highest consumption: light bulb; second-highest consumption: hair dryer; lowest consumption: microwave.

INTERNET CONNECT Student lists may include not touching downed power lines or frayed power cords (and telling an adult if they encounter one), childproofing outlets so younger siblings do not put their fingers in them, sharing information about electrical safety (e.g., do not place a fork in a toaster when it is plugged in), using appliances that are grounded, unplugging appliances during a storm, or not using electric appliances near water.

Prepare Your Own Chapter Summary

Student summaries should incorporate the following main ideas:
- Electricity flows in a circuit and produces a response in loads connected to the circuit. As charges pass through a load, electrical energy is converted into other forms of energy.
- An electric current produces a magnetic field. An electromagnet is a temporary magnet created by an electric current.
- An electric generator uses energy to spin a turbine. The turbine moves a magnet across a wire conductor, producing an electric current in the wire.
- Most of Canada's electricity comes from three energy sources: hydroelectric power generation, burning fossil fuels, and nuclear reactions.
- Sources of energy can be renewable, meaning they can be renewed or replaced, or non-renewable, meaning they cannot be renewed or replaced within a human lifetime. Many renewable energy sources will work only in certain regions (due to availability of resources) or under certain conditions (e.g., windy areas).
- As demand for electricity in Canada continues to grow, using renewable energy resources to generate electricity will become more important.
- An electric meter monitors electricity usage. You can estimate electricity consumption by looking at the wattage labels on your appliances.
- We can all make choices to consume less energy. We can do this by using more efficient appliances or by conserving energy by doing without certain things.

CONVERSATION WITH AN ELDER DR. ELSIE CHARLES BASQUE

BACKGROUND INFORMATION

- The Spirit of St. Louis mentioned in this feature was the aircraft flown by Charles Lindbergh in the world's first non-stop, solo, trans-Atlantic flight in 1927. The flight took 33 hours. The plane was the most streamlined model available at the time but had an increased weight due to the extra-large fuel tanks required for the long-distance flight. Students may be interested to learn that because the fuel tanks were located at the front of the plane, there was no front windshield. The pilot could only look out the side windows. A periscope was installed in one of these windows to give the pilot a view ahead.

TEACHING STRATEGIES

- **Begin the Lesson**—Ask students when they thought all of Nova Scotia had access to electricity. Then read the interview aloud with the class to initiate class discussion.
- **During Reading**—During the section where Dr. Elsie Charles Basque reminisces about her first experiences with electric devices, have students identify some technologies using electricity that have been developed since their grandparents were born (video games), their parents were born (DVD players), and they were born (touch phones).
- **After Reading**—Ask students to identify some additional questions they would add to the interview that relate to the content of the unit.

Common Misconceptions

- Many students cannot imagine a world without electrical energy. They find it hard to imagine a time when some of Nova Scotia did not have power. They may erroneously believe that the entire province had electricity since as early as the 1800s. Most students will be surprised to discover that it was not until the 1950s that the entire province had access to electricity.

UNIT 1

Conversation with an Elder

Dr. Elsie Charles Basque

Dr. Elsie Charles Basque was the first Mi'kmaq to earn a Nova Scotia Teacher's Certificate and the first Mi'kmaq to teach in a non-native school. She has lived in many different villages and towns in Nova Scotia, including Hectanooga and Meteghan near Yarmouth, Truro in the central part of the province, and Mabou Ridge in Cape Breton. As well, she lived many years near Boston, in the United States. Now she is back in the Yarmouth area, in Saulnierville.

The Nova Scotia Teachers' College awarded Elsie Charles Basque an honorary doctorate to recognize her work for Mi'kmaq people.

Q. **What was your first experience of anything electrical?**

A. When I was eight years old, a friend of my family bought a battery-operated radio and brought it to the store in Hectanooga. It was a large piece of furniture that stood on the floor. Several people could listen to it at once through several sets of earphones. When a large group wanted to listen, the twist of a button made the sound come through the speaker on the wall. It was magical!

The first broadcast I ever listened to was at Christmastime. I heard Santa Claus reading letters he had received from children all over the world. I was so excited! I remember hearing sleigh bells during that show. They sounded far away at first and then came closer.

Q. **What else did you hear?**

A. Other times when my family visited the store, we listened to the World Boxing Championship fights between Jack Dempsey and Max Schmeling. And of course we heard the serials of the time, such as "The Green Hornet" and "The Lone Ranger." Gathering around the radio was our family entertainment.

Q. You must have used a lot of batteries! When did Hectanooga get electricity from the Nova Scotia power grid?

A. Not until the 1950s. By that time I was in my 30s or 40s and had moved away.

54 MHR • Unit 1 Electricity

EXPLORING FURTHER

Purpose

- Students will conduct interviews to discover when certain electric devices first came into common usage and learn about the changes these devices made in people's lives. They will create an oral or written report to share what they learned with the class.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Review the purpose of the activity and have students identify people they might interview and questions to ask each individual.

Suggested Time

- Students will complete most of the work outside of the classroom. The time spent doing research and preparation will depend on the student.
- 10 min per student for presentations.

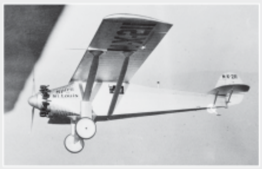
HINTS & HELPS

- You may wish to identify some items such as MP3 players, DVD players, digital cameras, or other devices for students to ask about.

Q. When did you first see TV?

A. My family bought our first TV set while we were living near Boston. I remember we had "rabbit ears" sitting on the TV to get better reception. My husband got the TV so he could watch the boxing championships. Nova Scotia had TV then, too. The first broadcast was in 1954.

What other early memories do you have of new technology?



In May 1927, when I was 11 years old, I remember my father telling me that I was going to hear a motor in the sky that night. I was quite frightened at that, but I went outside with Papa to listen for the roar. I held his hand tightly. Later on that night I did hear a motor in the sky. The noise turned out to be the engine of *The Spirit of St. Louis*, Charles Lindbergh's plane that was flying from New York to Paris. That was the first time anyone had tried a solo flight across the Atlantic Ocean. I also remember Papa saying that sometime in the future planes would carry lots of people at once, unlike the small, single-seat plane that I had heard flying overhead. Papa also predicted that in the future man would fly to the Moon.

EXPLORING Further

We all count on using electrical appliances to do many things, such as keep our food fresh, light our homes, cook our food, dry our hair, keep buildings cool in summer, or provide entertainment. We also have many battery-powered electrical devices for work and for fun, such as watches, MP3 players, cell phones, Blackberries, and video games. Can you imagine what life was like before all these inventions?

Interview an older person in your family about their experiences with electrical devices. A person who is over 70 or 80 years old may even remember what life was like before electricity. Someone over 40 will remember the days before CDs. Even someone over 30 will be able to tell you about life before a few devices that you are familiar with.

Select one or two items to discuss in the interview. Ask questions like these, and more that you write out:

- Tell me about the first time you saw (or heard or owned) a ________.
- What did you think of it?
- Before you had the ________, what did you do (use) instead?
- Did the ________ make your life better? Why or why not?

Make notes during the interview. Then, write up the interview and present it as a news item for a local paper, or do an "on the spot" oral news report for your class.

Unit 1 Conversation with an Elder • MHR 55

Implementing the Activity

- Have each student identify some specific electric devices that they think would be new to their interview subjects before conducting the interviews.
- Discuss multiple formats for the report presentation. Students may wish to write newspaper articles, record video news segments, or create podcasts.
- If students are working in groups, assign individual roles to each of the group members in order to facilitate the participation of all members.

Adaptations

- Students with small families or limited access to transportation may need to be paired up with interview subjects within the school.
- If students are working in groups, organize them so that a number of complementary strengths are present in each group.
- Some students may require a presentation and question template in order to initiate the activity.

Activity Wrap-Up

- Have everyone, including you, the teacher, describe a new technology that has developed in their lifetime.

Assessment Options

- Use Learning Skills Checklist 3, Oral Presentation to assess student work in this activity or work with students to develop an appropriate rubric using Process Skills Rubric 18, Rubric Template.

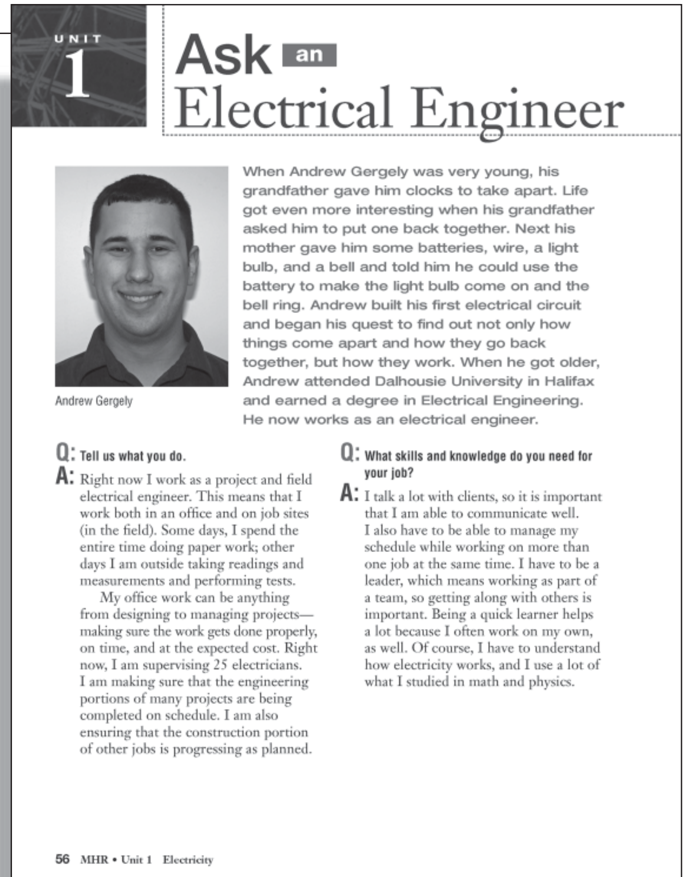
ASK AN ELECTRICAL ENGINEER ANDREW GERGELY

BACKGROUND INFORMATION

- Electrical engineers are largely responsible for the planning and coordination of wiring for buildings, homes, and streets. They often do not actually perform the manual task of installing electrical systems, but they organize electricians to carry out installations and repairs.
- Electrical engineers require from 4 to 7 years of training in order to gain their certification. They have specific assessments they must pass in order to be certified as electrical engineers.

TEACHING STRATEGIES

- **During Reading**—Have students pair off and allow one to read the role of the reporter and one to read the role of the engineer. Encourage them to ad-lib their answers based on their comprehension of the reading. Depending on their knowledge level, they may wish to make a list of other people who work with electrical engineers.
- **After Reading**—*ICT Option:* Create a list of more questions that students would like to ask an electrical engineer. Identify an individual who would be able to answer the questions for the class. The Association of Professional Engineers of Nova Scotia is a place to start exploring. A link can be found at www.mcgrawhill.ca/links/ns+science6.



UNIT 1

Ask an Electrical Engineer

When Andrew Gergely was very young, his grandfather gave him clocks to take apart. Life got even more interesting when his grandfather asked him to put one back together. Next his mother gave him some batteries, wire, a light bulb, and a bell and told him he could use the battery to make the light bulb come on and the bell ring. Andrew built his first electrical circuit and began his quest to find out not only how things come apart and how they go back together, but how they work. When he got older, Andrew attended Dalhousie University in Halifax and earned a degree in Electrical Engineering. He now works as an electrical engineer.

Andrew Gergely

Q: Tell us what you do.

A: Right now I work as a project and field electrical engineer. This means that I work both in an office and on job sites (in the field). Some days, I spend the entire time doing paper work; other days I am outside taking readings and measurements and performing tests.

My office work can be anything from designing to managing projects—making sure the work gets done properly, on time, and at the expected cost. Right now, I am supervising 25 electricians. I am making sure that the engineering portions of many projects are being completed on schedule. I am also ensuring that the construction portion of other jobs is progressing as planned.

Q: What skills and knowledge do you need for your job?

A: I talk a lot with clients, so it is important that I am able to communicate well. I also have to be able to manage my schedule while working on more than one job at the same time. I have to be a leader, which means working as part of a team, so getting along with others is important. Being a quick learner helps a lot because I often work on my own, as well. Of course, I have to understand how electricity works, and I use a lot of what I studied in math and physics.

56 MHR • Unit 1 Electricity

EXPLORING FURTHER

Purpose

- Students will identify and describe the different sub-specialities of electrical engineering.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Identify some sources of information that will allow the students to complete the exploration. Print off copies for each group in the class.

Suggested Time

- 30 min

HINTS & HELPS

- *ICT Option:* The Association of Professional Engineers of Nova Scotia and Engineers Canada have information regarding electrical engineering. This can be printed off or shown on a projector to the class. Links can be found at www.mcgrawhill.ca/links/ns+science6.

Q: **After you finished university, did you continue learning?**

A: Yes, I learned a lot on the job. Each employer provides specific training so staff can perform the job to their standards and learn new skills and technology. Part of being a good leader and working as a team is being willing to learn from anyone and any situation. Over time, I have learned from electricians and other engineers, as well as from co-workers such as accountants and administrative assistants.

When a part of a project is unfamiliar to me, I usually ask for help from someone who has experience. Co-workers are always a great source of information. Usually, one of them will have done a similar project and can answer some of my questions if I get stuck. Now I also learn by applying my own experience. By taking on new projects, I am forced to find new solutions.

Q: **So learning doesn't end when you finish school?**

A: No, this is a job that is always changing. I learn something new every day. I am a member of the IEEE (Institute of Electrical and Electronics Engineers). This organization provides workshops and conferences to help members keep up with new technologies and ideas. It is a great opportunity to meet and talk with other engineers.

Q: **Do you enjoy working as part of a team?**

A: Working in a team has many benefits. Each person is different and thinks differently. This is really good for bringing new ideas to the table.

Q: **Is safety a big issue in your work?**

A: Safety is the number one concern. Most of the work I do is on industrial sites, so I have to be aware of any possible dangers. Every day, I assess potential hazards and find ways to either eliminate them or control them. We often deal with live electrical circuits. There is always a risk involved. My company has a procedure that we all follow to prevent any shocks.

EXPLORING Further

Within the Electrical Engineering discipline, there are specialties in Power Systems, Communications, and Control Systems. Within each one of those specialties, you can choose a narrower focus. For example, in Power Systems, specialties include Electricity Generation, Electricity Distribution, and Electrical Transmission.

Find out and describe the Electrical Engineering sub-specialties in Communications and Control Systems. Prepare a brief report. Then choose one of the sub-specialties in any of the fields related to Electrical Engineering and find out where these graduates might work and what work they might do. If possible, include a brief interview in your report.

Unit 1 Ask an Electrical Engineer • MHR 57

Implementing the Activity

- Remind students to think about what each of the sub-specialties have in common and what makes each of them different.

Adaptations

- Students with literacy difficulties should be grouped with strong readers.
- You may wish to prepare a chart for students to fill in that isolates the key information required.
- Allow students to choose the method of presentation when sharing their discoveries.

Activity Wrap-Up

- Ask students to describe their opinion of electrical engineering and identify where an electrical engineer may be at work in the local community.

Assessment Option

- Use Learning Skills Checklist 5, Research Project to assess student work in this activity.

UNIT 1 PROJECT BUILDING COMMUNITIES

Purpose

- Students will research and discuss the issues related to the selection of a power source for a small town.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2-3 weeks before	– Finalize student groups and have each group formalize their project plan. (Ensure that all three energy sources are represented.)

MATERIALS		
– drawing paper	– pens and pencils	– Bristol board

Suggested Time

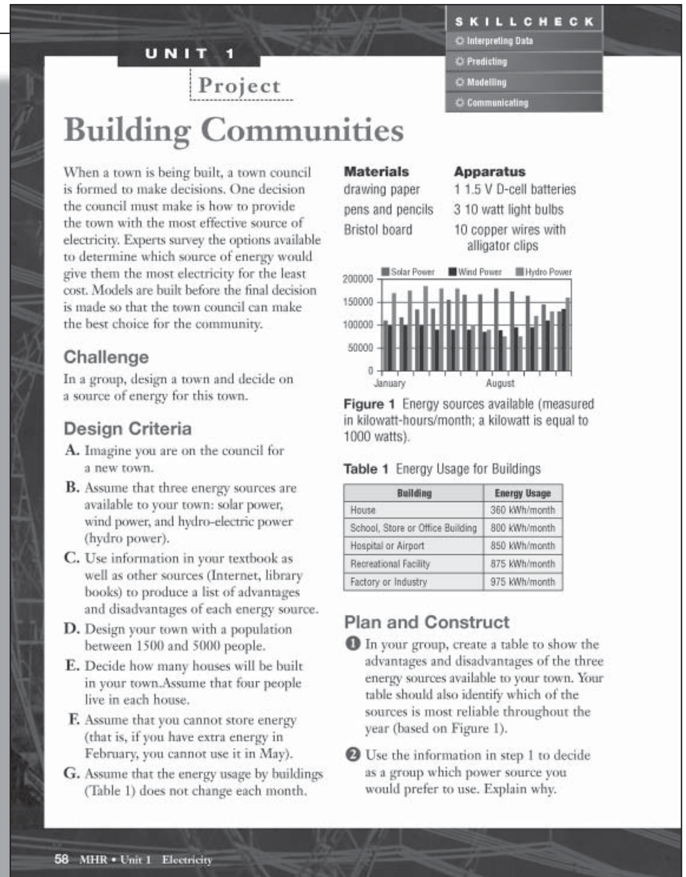
- Several hours for research and preparation
- 1.5 hours for discussion and presentation

HINTS & HELPS

- You may wish to investigate communities in which either solar, wind, or hydroelectric power is the main source of energy. Study the geographical, environmental, and economic conditions of these regions and share your findings in a pre-project class discussion. You may also wish to investigate the growth of wind energy as a power source across Nova Scotia.

Implementing the Project

- Prepare students for the activity in advance. Use periodic reminders and short class sessions to build excitement around the project. Review the design criteria for the project several times.
- Allow students to make mistakes with estimates, so that they can demonstrate their subsequent solutions to any problems that arise. Advise them that they are starting with an idea or model that can be revised.
- Encourage students to examine carefully each available source of energy or suggest alternatives that are not mentioned in the outline.



UNIT 1 Project

SKILLCHECK
- Interpreting Data
- Predicting
- Modelling
- Communicating

Building Communities

When a town is being built, a town council is formed to make decisions. One decision the council must make is how to provide the town with the most effective source of electricity. Experts survey the options available to determine which source of energy would give them the most electricity for the least cost. Models are built before the final decision is made so that the town council can make the best choice for the community.

Challenge

In a group, design a town and decide on a source of energy for this town.

Design Criteria

A. Imagine you are on the council for a new town.
B. Assume that three energy sources are available to your town: solar power, wind power, and hydro-electric power (hydro power).
C. Use information in your textbook as well as other sources (Internet, library books) to produce a list of advantages and disadvantages of each energy source.
D. Design your town with a population between 1500 and 5000 people.
E. Decide how many houses will be built in your town.Assume that four people live in each house.
F. Assume that you cannot store energy (that is, if you have extra energy in February, you cannot use it in May).
G. Assume that the energy usage by buildings (Table 1) does not change each month.

Materials
drawing paper
pens and pencils
Bristol board

Apparatus
1 1.5 V D-cell batteries
3 10 watt light bulbs
10 copper wires with alligator clips

Figure 1 Energy sources available (measured in kilowatt-hours/month; a kilowatt is equal to 1000 watts).

Table 1 Energy Usage for Buildings

Building	Energy Usage
House	360 kWh/month
School, Store or Office Building	800 kWh/month
Hospital or Airport	850 kWh/month
Recreational Facility	875 kWh/month
Factory or Industry	975 kWh/month

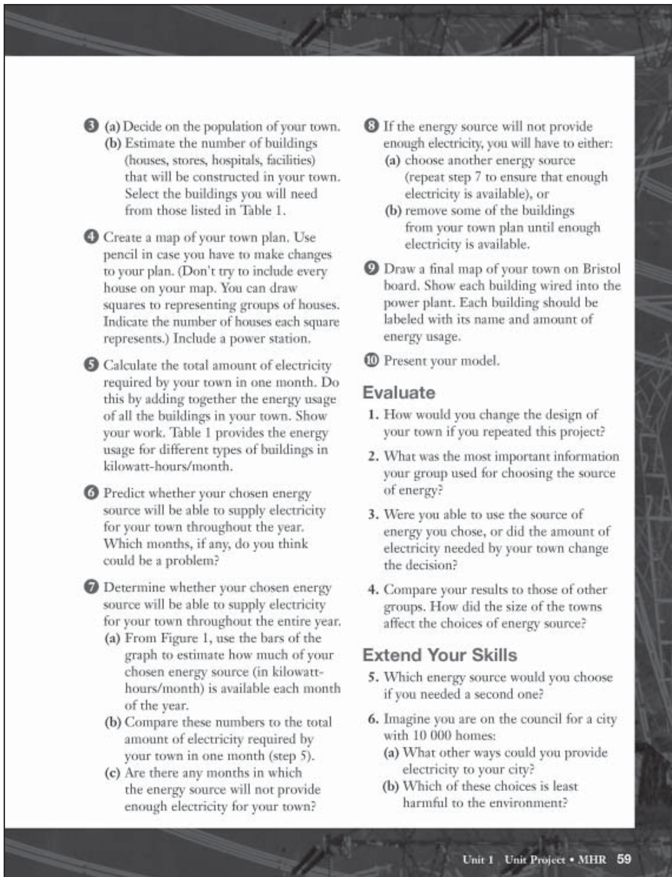
Plan and Construct

1. In your group, create a table to show the advantages and disadvantages of the three energy sources available to your town. Your table should also identify which of the sources is most reliable throughout the year (based on Figure 1).
2. Use the information in step 1 to decide as a group which power source you would prefer to use. Explain why.

58 MHR • Unit 1 Electricity

Adaptations

- Selective grouping may be used to allow for students' individual strengths to be part of the overall project presentation.
- Students may use role-playing to demonstrate the planning committee meeting. Students could also be asked to organize a town-hall debate.
- Students could be assigned the task of contacting the town council or mayor of a town outside Canada to ask about the advantages and disadvantages of the particular source of renewable energy (other than hydroelectric) they use.
- *ICT Option:* Students with strong computer skills may wish to use software to design their model and present their project.



3 (a) Decide on the population of your town.
(b) Estimate the number of buildings (houses, stores, hospitals, facilities) that will be constructed in your town. Select the buildings you will need from those listed in Table 1.

4 Create a map of your town plan. Use pencil in case you have to make changes to your plan. (Don't try to include every house on your map. You can draw squares to representing groups of houses. Indicate the number of houses each square represents.) Include a power station.

5 Calculate the total amount of electricity required by your town in one month. Do this by adding together the energy usage of all the buildings in your town. Show your work. Table 1 provides the energy usage for different types of buildings in kilowatt-hours/month.

6 Predict whether your chosen energy source will be able to supply electricity for your town throughout the year. Which months, if any, do you think could be a problem?

7 Determine whether your chosen energy source will be able to supply electricity for your town throughout the entire year.
(a) From Figure 1, use the bars of the graph to estimate how much of your chosen energy source (in kilowatt-hours/month) is available each month of the year.
(b) Compare these numbers to the total amount of electricity required by your town in one month (step 5).
(c) Are there any months in which the energy source will not provide enough electricity for your town?

8 If the energy source will not provide enough electricity, you will have to either:
(a) choose another energy source (repeat step 7 to ensure that enough electricity is available), or
(b) remove some of the buildings from your town plan until enough electricity is available.

9 Draw a final map of your town on Bristol board. Show each building wired into the power plant. Each building should be labeled with its name and amount of energy usage.

10 Present your model.

Evaluate

1. How would you change the design of your town if you repeated this project?
2. What was the most important information your group used for choosing the source of energy?
3. Were you able to use the source of energy you chose, or did the amount of electricity needed by your town change the decision?
4. Compare your results to those of other groups. How did the size of the towns affect the choices of energy source?

Extend Your Skills

5. Which energy source would you choose if you needed a second one?
6. Imagine you are on the council for a city with 10 000 homes:
   (a) What other ways could you provide electricity to your city?
   (b) Which of these choices is least harmful to the environment?

Unit 1 Unit Project • MHR 59

Project Wrap-Up

- Schedule a day (or days) for project presentations.
- Make a video or a slide presentation of the group projects.
- As a class, consider how you could provide feedback to your town council on the source of power for your community.
- Encourage students to complete an assessment of other groups' projects.

Assessment Options

- Use Learning Skills Checklist 11, Project Self-Assessment or Learning Skills Checklist 12, Project Group Assessment to assess student work in this activity.

Evaluate Answers

1. Students' answers will depend on the source of energy selected and the success of the design. Sample answer: Solar energy would not support the energy needs of our town. If we repeated the project, we would only use solar electricity if the town had less people, as fewer houses, stores, and schools would require energy.
2. Students' answers should include a reference to one of the following topics: location, economics, environmental concerns, public opinion, and safety.
3. Answers will depend on responses to previous questions and research findings. Sample answer: Wind energy would not support the energy needs of our town as the town was too large and the energy needs were too great. As a result, we changed our design to use a combination of wind and hydroelectric energy.
4. Groups that selected large towns will likely choose established technologies such as hydroelectric energy.

Extend Your Skills Answers

5. The use of wind power has grown greatly in Nova Scotia over the past couple of years. As such, it will be a common answer. Students may also suggest tidal energy in the Bay of Fundy. Accept any reasonable answer.
6. (a) Students will mainly choose from hydro-electric, wind, or solar electricity. They may also suggest other sources, such as nuclear, biomass, tidal, or geothermal. They may also choose to burn fossil fuel.
   (b) All other sources of energy are less harmful to the environment than fossil-fuel technologies. Students should be encouraged to explore the pros and cons of their selection.