Topic 4.7

How can we conserve electrical energy at home?

Key Concepts

- Conserving energy at home requires an understanding of how energy is measured.
- People can conserve energy by making informed choices.

Key Skills

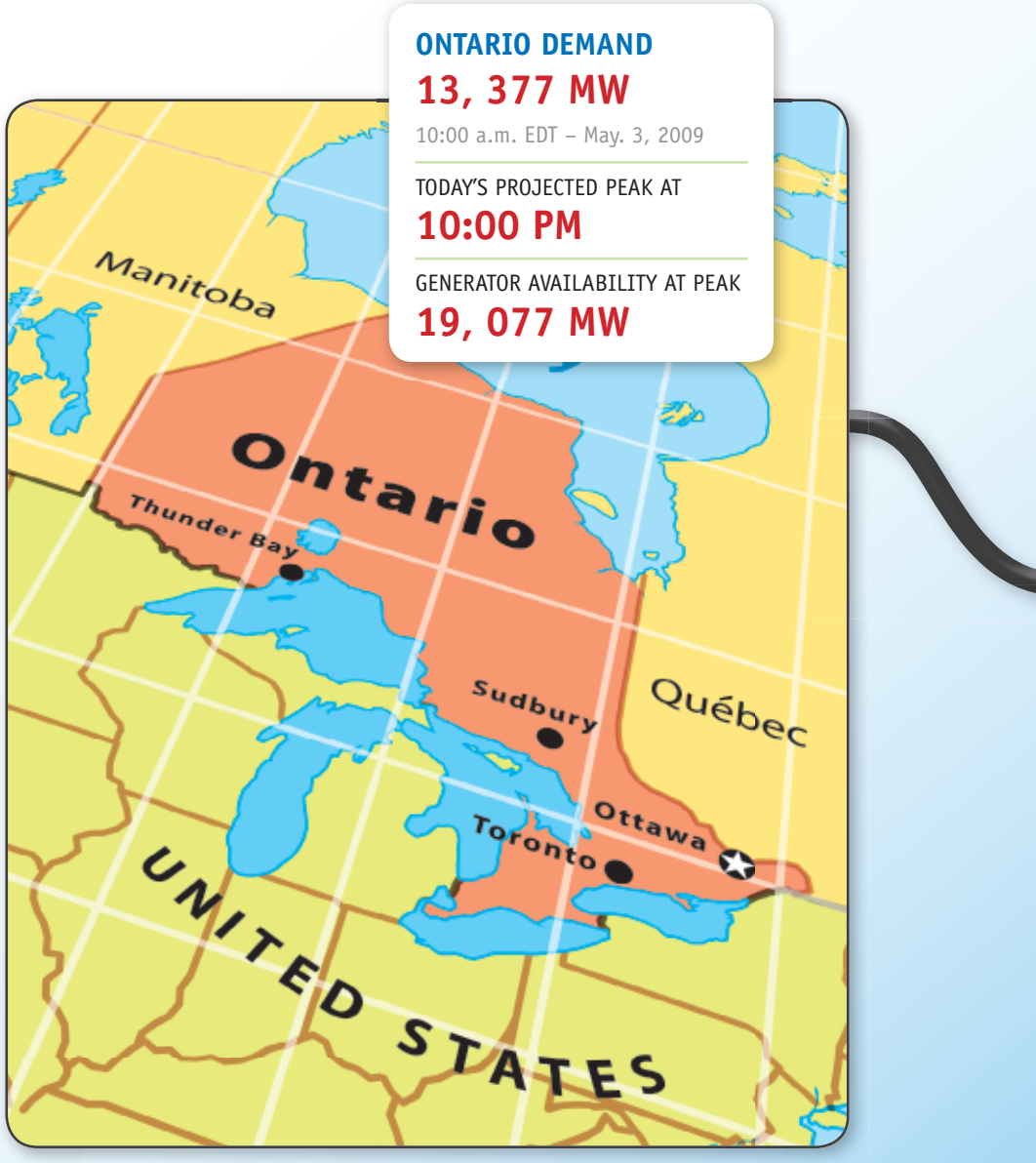
Inquiry

Literacy

Key Terms

EnerGuide label
ENERGY STAR® label

At any given moment, on any given day, you are linked to each of the 12.7 million or so people with whom you share the province of Ontario. This linkage exists because you and your fellow Ontarians draw on the same overall "pool" of the province's supply of electrical energy. It is up to all of us—as individuals and as a provincial community—to use our share of electrical energy wisely and sustainably.



Starting Point Activity

1. Why should we be concerned about using electrical energy in a sustainable manner? If you need to review the meaning of "sustainable," turn to page 65.
2. What are some examples of sustainable uses of electrical energy?
3. What are some examples of unsustainable use? How could these examples be made more sustainable?

Conserving energy at home requires an understanding of how energy is measured.

If you look at an energy bill, you will see that the electrical energy you use at home is measured in units called kilowatt hours (kWh). You probably recognize the "watt" part of that term. Most home appliances are labelled with the number of watts they use. For example, the old types of light bulbs came in varieties such as one hundred watts (100 W) and sixty watts (60 W). An iron might be rated at 1000 W.

A kilowatt has the prefix *kilo-*, which means "one thousand." So a kilowatt is one thousand watts, or 1000 W. If you use an appliance that is rated at 1000 W for 1 hour, you will have used 1 kWh of energy. **Figure 4.37** shows some examples to help you get an idea of the amount of energy in 1 kilowatt hour (1 kWh).

▶ **Figure 4.37** Examples of tasks that involve 1 kWh of energy

A You have used 1 kWh of energy if you have used a 100 W light bulb for 10 h.

B You have used 1 kWh of energy if you have used a 1000 W iron for 1 h.

C You have used approximately 1 kWh of energy if you have jogged for 1 h.

D You have used 1 kWh of energy if you have taken a hot shower for about 3 min.

Meters for Measuring Home Energy Use

Most houses and apartment buildings have meters that are connected to the cable that brings electrical energy into the buildings. Old-style meters like the one in **Figure 4.38** continuously measure the amount of electrical energy that is used in the building. The power-supply company sends a person to read and record the numbers on each meter on a regular basis. At the main office, computers calculate the cost of the energy used that month. For example, if a building used 345 kWh of energy and the company charges 10.9¢ per kWh, the company would charge 345 kWh × 10.9¢/kWh = 3760.5¢ ($37.61) for the energy.

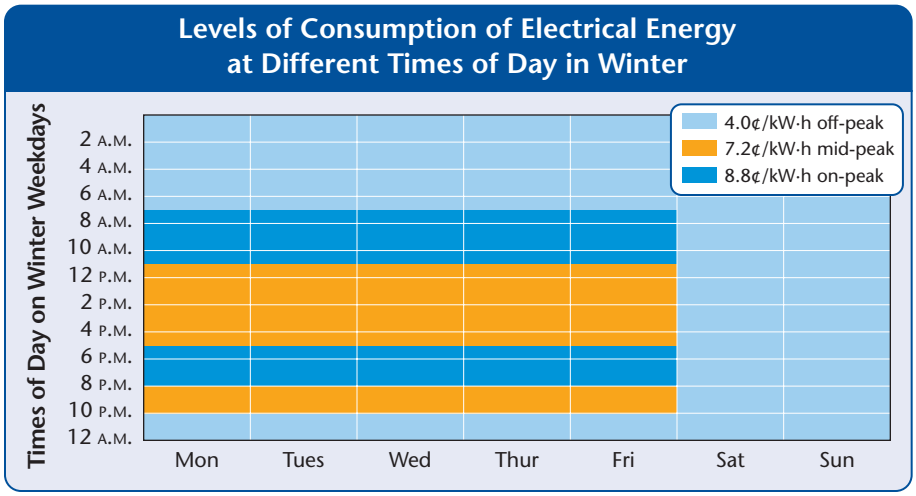
▲ **Figure 4.38** The old-style type of meter records the amount of electrical energy used continuously, 24 hours a day, 365 days a year.

By the year 2010, technicians from power-supply companies will have replaced the old-style meters with new smart meters. A smart meter like the one shown in **Figure 4.39** measures energy use in a way that is different from the old-style meters. Smart meters measure the amount of energy that is used every hour in the home or apartment building. The data are then transmitted automatically to the head office. No one will have to go to every house or business and read each individual meter.

Time-of-Use Prices

Use of the smart meter lets power-supply companies charge different prices for electrical energy that is used at different times of the day. Prices will be highest when the most electrical energy is being used. This is referred to as on-peak use. Prices will be lowest when the least electrical energy is being used. This is referred to as off-peak use. Periods between on-peak use and off-peak use are called mid-peak hours. The graph in **Figure 4.40** compares on-peak, mid-peak, and off-peak periods during winter. The schedule is different for winter energy use and for summer energy use, because people use electrical energy at different times and in different ways. For example, many people use air conditioning in the summer but not in the winter.

▲ **Figure 4.39** The new smart meters measure energy use each hour. The meters encourage "smart" behaviour on the part of Ontarians by giving us the means to think about how and when we use electrical energy.



◀ **Figure 4.40** The key on the upper right of the graph shows possible costs for energy during the different time periods.

LEARNING CHECK

1. Identify the unit used to measure the amount of electrical energy used by most appliances.
2. Define the term "kilowatt" by using an example.
3. Predict how many kilowatt hours you might use at home in a day.

Inquiry Focus

Activity 4.14

BEST TIME TO USE

1. Predict how your use of electrical energy in summer would be different compared with winter. Sketch a graph similar to Figure 4.40 to show your predictions.
2. Explain why it makes sense to have different prices and different time periods during these two seasons.
3. Give three examples of how time-of-use data would help you change the way your family uses energy.

People can conserve energy by making informed choices.

In a typical home, certain appliances tend to use more electrical energy than others. These include the refrigerator, the washing machine, the clothes dryer, and the electric stove. However, some appliances of the same type are more energy-efficient than others. For example, front-loading washing machines use less energy than top-loading washing machines.

The Government of Canada has set up regulations that require companies to put a label on all new electrical appliances to show how much energy the appliances use in a typical year. That label is called the **EnerGuide label**. Figure 4.41 shows a typical EnerGuide label and how to read it.

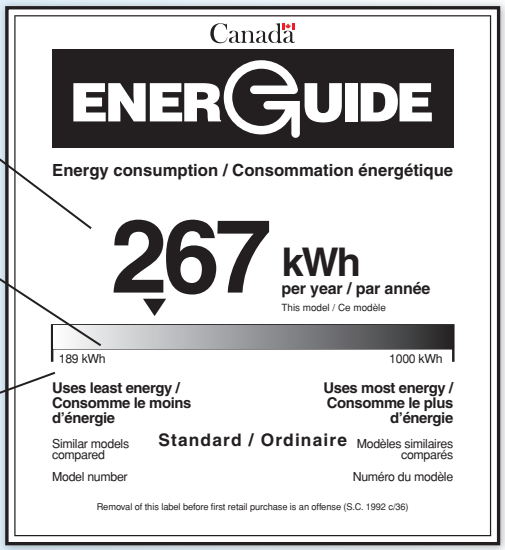
EnerGuide label: a label that gives details about the amount of energy that an appliance uses in one year of normal use

Sometimes, the appliance that uses the least energy is more expensive to buy than some others. It might sound strange, but you would probably save money by buying the more expensive appliance. Over the life of the machine, the amount you save by paying lower energy bills will be greater than the amount you would save by buying a less-expensive appliance.

The large number shows how much energy the appliance uses in one year of normal use.

The shaded bar below the large number shows how the appliance compares with similar ones on the market.

The numbers on the bar give a range of efficiency for yearly energy use. The left end is the lowest (most efficient). The right end is the highest (least efficient).



▲ **Figure 4.41** How to interpret an EnerGuide label

▲ **Figure 4.42** Products with this label use 10 to 50 percent less energy compared with a standard product in the same category.

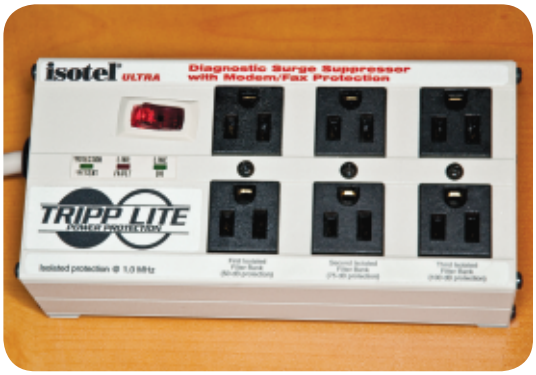
ENERGY STAR®: a label that identifies a product as meeting or exceeding certain standards for energy efficiency

The **ENERGY STAR® label** makes it even easier to identify the most efficient appliances. The Government of Canada has set minimum standards of efficiency for electrical appliances and equipment that will save energy. Appliances or equipment that meet or exceed these standards can have the ENERGY STAR® label that is shown in Figure 4.42.

Fight the Phantom (Load)

Many electrical devices are on even when you think they are switched off. They are in stand-by mode. For example, if you have a remote control to turn on a television, the television must be able to sense the signal, and this requires energy. The electrical energy that is used by a device when it is turned off is called a phantom load. Clock displays, such as those on microwaves and coffee makers, and external power adapters also require phantom loads. If you touch an external adapter, you will observe that it is quite warm. This is evidence of a phantom load.

Studies carried out by Thunder Bay Hydro estimate that phantom loads account for about 900 kWh of energy use each year! **Figure 4.43** shows one way this total can be reduced. Of course, people can also unplug devices when they are not in use. The cost of this inconvenience is a few seconds. On the other hand, the energy savings can be in the tens or even hundreds of dollars.



◀ **Figure 4.43** Many surge protectors have a light that tells you if they are on. They also have a switch. When you turn off the switch, power is cut off to all equipment that is plugged into the surge protector. Turning off a switch is much easier than unplugging several pieces of equipment.

LEARNING CHECK

1. Compare the information on an EnerGuide label with the information on an ENERGY STAR® label.
2. Explain how the information in **Figure 4.43** can help your family save electrical energy and money.

Literacy Focus

Activity 4.15

READING ENERGUIDE LABELS

Your teacher will give you several EnerGuide labels. Answer these questions about each one.

1. What is the estimated consumption of energy per year of the least efficient appliance that is similar to this one?
2. What is the estimated consumption of energy per year of the most efficient appliance that is similar to this one?
3. What is the estimated consumption of energy per year for this appliance?
4. Is the energy consumption of this model closer to the most efficient model or closer to the least efficient model?
5. Would you recommend buying this appliance? Why or why not?

Go to **scienceontario** to find out more

Case Study Investigation: People Power

1979 DAY 24

SPRING SUMMER PERSONAL

Late summer, 1979
Day 24 of Dmitra Constantino's (me!) exercise captivity
Can you believe Dad is still on this energy conservation kick? Okay, here's the skinny—24 days ago (I counted each and every one of them!) he hooked the TV up to a bike! He went on and on about how the bike links to the generator to make electricity. I told him it's bad enough that we don't have a colour TV when every single one of my friends does, but now I have to exercise to watch the Dukes of Hazzard? TV is all about relaxation, not exercise! How can he be so cruel? He says it is quite easy and we all need to do our part during the energy crisis. I asked him if there is an energy crisis, why our family has to be in crisis too? He just frowned. Dad says he lost his sense of humour when he had kids but I suspect he never had one! Next he'll probably hook up my record player so I have to jog in place to listen to my new Jaws soundtrack album. (That movie was so awesome, to the max!) Okay, gotta go bike some more. Catch ya on the flip side!

The Science Behind the Story

While the 1970s energy crisis was initially linked to oil shortages, people around the world were urged to use all forms of energy more efficiently. Everyone jumped on the energy efficiency band wagon: rich and poor, young and old, politicians and citizens alike. People began to think about using alternative energy sources to generate electrical energy. Many people also developed an interest in using our own bodies to generate electricity. Using pedal power to run an electrical device, such as a TV or washing machine, is an example of how people can produce power.

Pause and Reflect

1. How did people try to improve energy efficiency in the 1970s?

Can "people power" help reduce our use of electricity today?

Fast forward to the 21st century. In British Columbia, Professor Max Donelan is working on a device that captures the energy we generate every day—by walking! His device, the Bionic Energy Harvester, is secured around the knee. While it looks a lot like a common knee brace, this device generates energy in an unexpected way. Each time we take a step, our leg muscles slow our knees just before our feet touch the ground. The Bionic Energy Harvester recovers the energy our leg muscles absorb during this braking process. How much energy can be generated this way? A mere minute of walking can power a cell phone for 30 minutes!

The Bionic Energy Harvester, invented by Max Donelan of British Columbia

Pause and Reflect

2. What is the Bionic Energy Harvester?
3. How does it work?

Inquire Further

4. What caused the energy crisis in the 1970s? Do you think we are in one now? Why or why not?
5. Find out more about a pedal powered machine or vehicle that interests you. Learn its history and determine how it works. Present your findings in a poster or other suitable medium.
6. Design your own pedal powered machine. Your pedal power can generate electricity or it can mechanically move a device (i.e. pedaling can mechanically move the agitator in a washing machine). Create a sketch of your device and write a paragraph explaining how it works.

Making a DIFFERENCE

Katie Pietrzakowski was brushing her hair when she came up with the idea for her award-winning science fair project. She observed how different particles were attracted to her brush and wondered if these forces of attraction could be used to clean recycled grey water.

Grey water is household waste water from sinks, showers, washing machines, and dishwashers. It can be collected and re-used for lawn irrigation. Re-using grey water helps to conserve water safely and appropriately. Using a system she designed, Katie found that introducing an electric field to grey water could reduce the particulates suspended in the water.

Katie took her project, "Shock the Grey," to the 2006 Canada Wide Science Fair in Saguenay, Québec. She won a bronze medal and a scholarship to the University of Western Ontario. Katie is now a high school student in Sault Ste. Marie and hopes to become a teacher.

What other uses for grey water can you think of?

Fluorescent tubes are popular alternatives to conventional light bulbs. The tubes, however, contain mercury, which is toxic. Many tubes are not recycled and end up in landfills. Hamilton student Patrick Bowman was in Grade 7 when he studied the issue for his science fair project. He learned that up to 1 350 000 mg of mercury from fluorescent tubes enter his city's landfill each year.

To determine the effects these tubes might have on the environment, Patrick made two model landfills using compost. He put broken tubes into one landfill and left the other uncontaminated. He added rainwater to the landfills to model leachate, a liquid produced when precipitation and landfill waste mix. Patrick found that the uncontaminated landfill and leachate supported plant growth and micro-organism life better than the contaminated landfill and leachate. His project "Shedding the Lights from Landfill Sites" won several awards at the 2006 Canada Wide Science Fair.

How could you help raise your community's awareness of the hazards linked with throwing away fluorescent tubes?

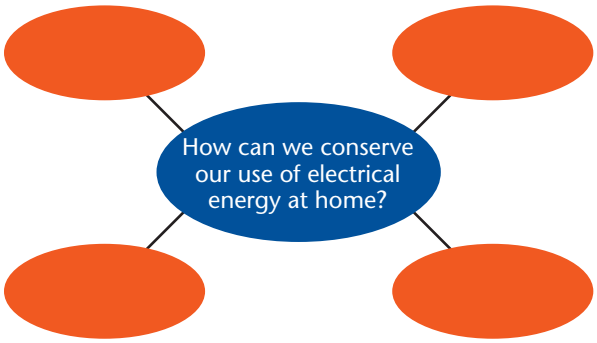
Topic 4.7 Review

Key Concept Summary

- Conserving energy at home requires an understanding of how energy is measured.
- People can conserve energy by making informed choices.

Review the Key Concepts

1. K/U Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. K/U Refer to **Figure 4.41**.

a) Summarize, in your own words, the information provided on an EnerGuide label.

b) Explain how you could use EnerGuide ratings when shopping for a new appliance.

3. K/U Use a main idea web to identify six things that you can do to conserve electrical energy in your home.

4. T/I While shopping with your family to buy a new refrigerator, you find two models that have the desired features. Model A consumes 400 kWh per year, and Model B consumes 460 kWh per year. Model A costs $20.00 more than Model B. Assume the price of electricity is $0.08/kWh. In your notebook, calculate the annual cost to run each refrigerator. Show your work. Which model will cost less in the long term, given that the average life span of a refrigerator is 17 years?

5. T/I Assume that the phantom load for an average television set is 100 kWh per year and that the cost of electrical energy is $0.08 per kWh. In 2003, there were an estimated 21 million (21 000 000) television sets in Canada. Calculate how much electrical energy was wasted in 2003 by the phantom loads of television sets alone, and how much this energy cost Canadians. Show your work.

6. C Write a blog explaining why replacing old appliances with modern ones could save you money and reduce your impact on the environment.

7. A During Earth Hour on Saturday, March 28, 2009, between 8:00 P.M. and 9:00 P.M., people all over the world were encouraged to use less electricity. More than 900 megawatts (MW) of electrical energy were saved in Ontario.

a) How might the organizers of future Earth Hours encourage more people to turn out their lights for one hour on the day selected for Earth Hour?

b) How might the organizers of future Earth Hours inspire people to make long-lasting lifestyle changes that will reduce their use of electrical energy?

SCIENCE AT WORK

CANADIANS IN SCIENCE

▲ Tiffany Hando is a student at Confederation College in Thunder Bay. She is enrolled in a two-year program to earn an instrumentation engineering technician diploma.

Tiffany Hando enjoys detailed work that requires a lot of precision. After completing a high school co-op placement in the electrical department of a mill, Tiffany knew she wanted to work with electricity. She decided to study electrical instrumentation. "I like to work with my hands and use computers," says Tiffany. "I knew I would enjoy instrumentation because it is a little bit of everything I am interested in." She is earning an instrumentation engineering technician diploma. Electrical instrumentation technicians install, maintain, and fix different electronic instruments used to measure and control the function of equipment.

What advice do you have for high school students interested in a career in electrical instrumentation?

Tiffany says there are a lot of opportunities available to students interested in the field, but they should be prepared to work hard. After she earns her instrumentation engineering technician diploma, Tiffany plans to attend college for a third year to earn a diploma in electrical engineering technology. Students can also complete a fourth year at university to obtain an engineering degree.

What challenges do people in your field face?

People in the field must keep up to date on regulations and advances in technology. "It is a constant learning process," she says.

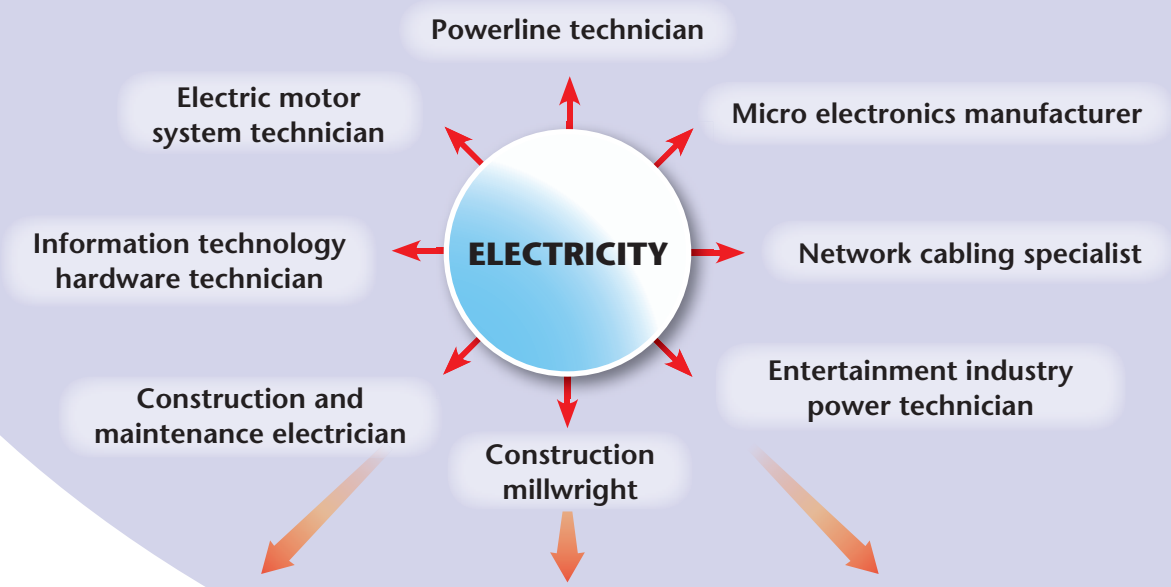
What is most rewarding about working in your field?

Tiffany finds it rewarding when she can relate what she is working on to what she learned in school. She also enjoys working with people who have been in the field for a long time. "It is really great when the worker trusts you enough and believes you have enough knowledge to work on equipment or a process by yourself. That feels great. It is definitely rewarding!"

◀ Electrical instrumentation technicians can work in many types of areas. For example, they can work at plants, mills, and electrical generating stations. They can also work for biomedical equipment manufacturers or telecommunications businesses.

Electricity at Work

The study of electricity contributes to these careers, as well as many more!



▲ Construction and maintenance electricians set up, test, maintain, and fix electrical equipment, fixtures, wiring, and other systems in homes, offices, and industrial buildings. They make sure electrical systems are safe in renovations or new construction projects.

▲ Construction millwrights install and fix machines during the construction of new plants and other facilities. They may be involved in the maintenance of machines and equipment.

▲ Entertainment industry power technicians plan, build, set up, maintain, and take apart power distribution systems. They work in film, television, live theatre, trade shows, and musical events.

Over To You

1. In which types of industries do electronic instrumentation technicians work?
2. Research a career involving electricity that interests you. If you wish, you may choose a career from the list above. What are the essential skills needed for this career? What would you need to do to pursue this career? e-LINK

Go to **scienceontario** to find out more

Unit 4 Summary

Topic 4.1: How do the sources used to generate electrical energy compare?

Key Concepts

- Different sources of energy can be converted into electrical energy.
- Renewable and non-renewable energy sources have advantages and disadvantages.

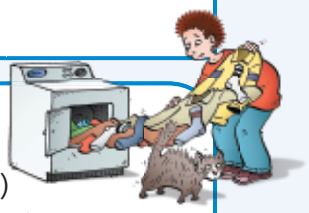
Key Terms

renewable energy source (page 248)

non-renewable energy source (page 248)

Big Ideas

- Electricity is a form of energy produced from a variety of non-renewable and renewable sources.
- The production and consumption of electrical energy has social, economic, and environmental implications.



Topic 4.2: What are charges and how do they behave?

Key Concepts

- Negative charges are electrons, and positive charges are protons.
- Opposite charges attract each other, and like charges repel each other.
- Negative charges can move through some materials but not others.

Key Terms

negative charges (page 254)

positive charges (page 254)

electrically neutral (page 254)

conductor (page 258)

conductivity (page 258)

insulator (page 258)

Big Ideas

- Static and current electricity have distinct properties that determine how they are used.

Topic 4.3: How can objects become charged and discharged?

Key Concepts

- Objects can become charged by contact and by induction.
- Charged objects can be discharged by sparking and by grounding.

Key Terms

charging by contact (page 266)

electroscope (page 266)

charging by induction (page 267)

discharged (page 268)

grounding (page 269)

Big Ideas

- Static and current electricity have distinct properties that determine how they are used.

Topic 4.4: How can people control and use the movement of charges?

Key Concepts

- A constant source of electrical energy can drive a steady current (flow of charges).
- An electric current carries energy from the source to an electrical device (a load) that converts it to a useful form.
- A source, load, and connecting wires can form a simple circuit.
- Potential difference and resistance affect current.
- Meters can measure potential difference and current.

Key Terms

source (page 276)

potential difference (page 276)

current (page 278)

amperes (page 278)

load (278)

resistance (page 279)

ohm (page 279)

electrical circuit (page 280)

voltmeter (page 282)

ammeter (page 282)

Big Ideas

- Static and current electricity have distinct properties that determine how they are used.

Topic 4.5: What are series and parallel circuits and how are they different?

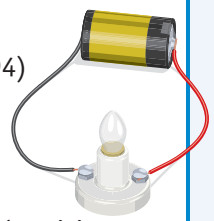
Key Concepts

- The current in a series circuit is the same at every point in the circuit.
- The current in each branch in a parallel circuit is less than the current through the source.
- The sum of the potential differences across each load in a series circuit equals the potential difference across the source.
- The potential difference across each branch in a parallel circuit is the same as the potential difference across the source.

Key Terms

series circuit (page 294)

parallel circuit (page 295)



Big Ideas

- Static and current electricity have distinct properties that determine how they are used.

Topic 4.6: What features make an electrical circuit practical and safe?

Key Concepts

- Practical wiring for a building has many different parallel circuits.
- Circuit breakers and fuses prevent fires by opening a circuit with too much current.
- Higher-voltage circuits, larger cords and cables, and grounding help make home circuits safe.

Key Terms

circuit breaker (page 308)

fuse (page 309)

Big Ideas

- Static and current electricity have distinct properties that determine how they are used.
- The production and consumption of electrical energy has social, economic, and environmental implications.

Topic 4.7: How can we conserve electrical energy at home?

Key Concepts

- Conserving energy at home requires an understanding of how energy is measured.
- People can conserve energy by making informed choices.

Key Terms

EnerGuide label (page 318)

ENERGY STAR® label (page 318)

Big Ideas

- Electricity is a form of energy produced from a variety of non-renewable and renewable sources.
- The production and consumption of electrical energy has social, economic, and environmental implications.

Unit 4 Project

Inquiry Investigation: Energy Savings

In this project, you will identify the room in your home that uses the most electrical energy. Then you will devise a plan to reduce that usage.

Inquiry Question
How can you reduce the amount of electrical energy used in one room of your home?

Initiate and Plan

1. List the appliances and lighting fixtures that require electricity in three rooms in your home.
2. Summarize the information in a table. Include a column that estimates power consumption of each item.
3. Identify the room that uses the most electricity. Determine whether each appliance is plugged into an outlet or into a power bar.
4. Research the potential impact of dimmer switches and power bars on use of electricity.

Perform and Record

5. Draw a circuit diagram to show the wiring of the room's lighting fixtures and appliances.
6. Revise your circuit diagram to include changes based on your findings on the use of dimmer switches and power bars.

Analyze and Interpret

1. Revise the table you prepared in Step 2 above to reflect the changes you've suggested.
2. Summarize the change in use of electrical energy that you are proposing.

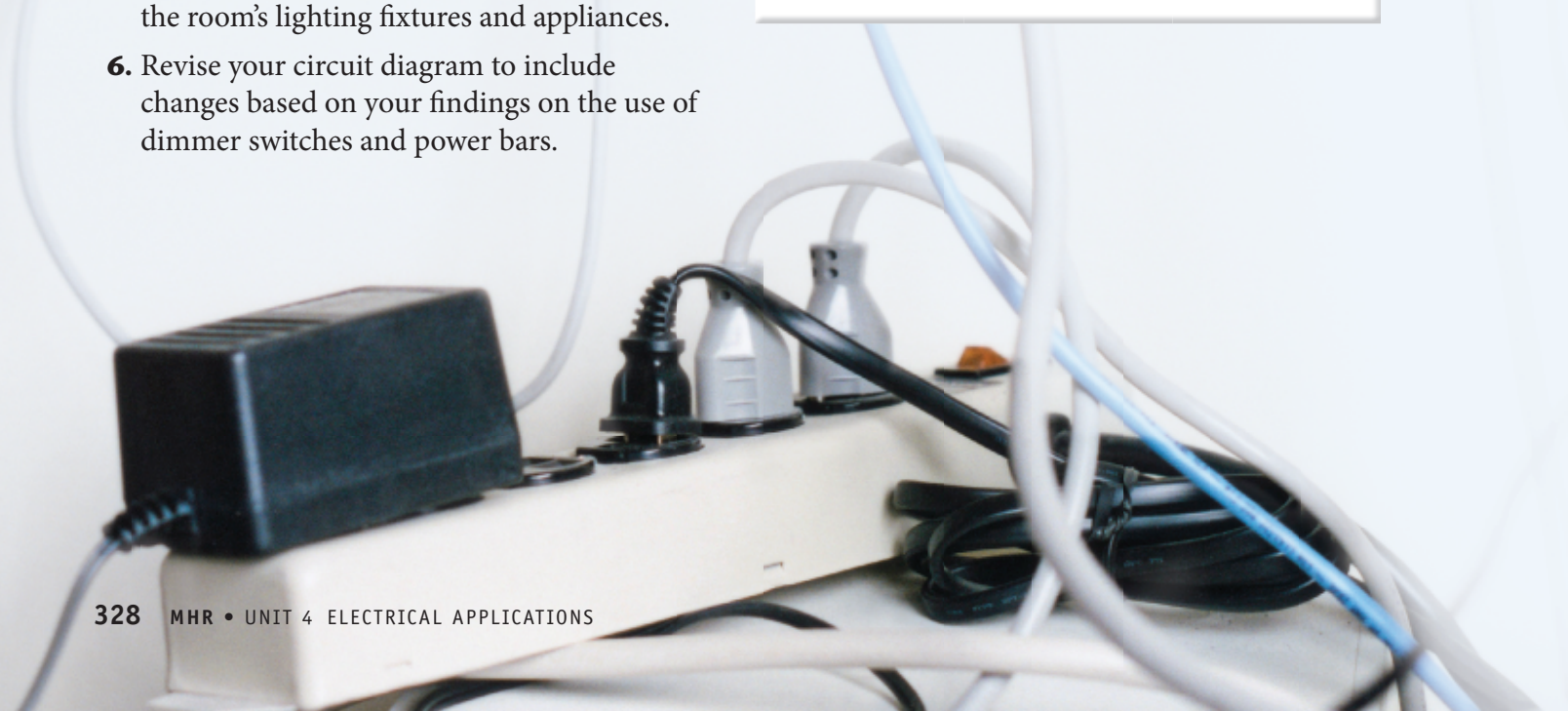
Communicate your Findings

3. Present your original and revised circuit diagrams along with a brief report.
4. Explain how your plan would reduce the amount of energy used in the room.

Assessment Checklist

Review your project. Did you...

- ☑ list all the appliances and lighting fixtures that need electricity in the rooms? K/U
- ☑ accurately identify, with supporting evidence, the room that uses the most electricity? T/I
- ☑ draw two circuit diagrams: one to show the wiring of the room's lighting fixtures and appliances, and a revision to include dimmer switches and power bars? C
- ☑ present your circuit diagrams and a brief written or oral report? C
- ☑ explain what your results suggest about the amount of energy that can be saved using your plan? A



An Issue to Analyze: Choosing Energy Sources in Ontario

You will choose two electrical power companies and do research to decide which company uses "greener" energy sources for the electrical energy that it provides to Ontario home-owners.

Issue

How should home-owners evaluate and choose a company to supply electrical power?

Initiate and Plan

1. Choose two companies that provide electrical energy in Ontario from different sources of energy.

Perform and Record

2. Make two tables to compare the companies.
3. Use these headings in the first table:
   - Number of Power Plants
   - Total Power Output
   - Source(s) of Energy
   - Reliability
   - Cost per kilowatt hour
   - Number of Customers
4. In the second table, use the headings below to compare the environmental effects of each company's source(s) of energy:
   - Renewable or Non-renewable Energy Source
   - Effects of Energy source on the Environment
   - Planned Changes for Improvement

Analyze and Interpret

1. Use the information in the tables to evaluate the environmental impact of each company. Take into account the size of the company as well as the impact of its energy source(s).
2. Decide which power company is better for the environment.
3. Decide which power company is better for the home-owner.
4. If you were a home-owner, which company would you choose? Explain your choice.

Communicate your Findings

5. Prepare a written or oral report to communicate your recommendation and your reasoning.

Assessment Checklist

Review your project. Did you...

- ☑ choose two companies that provide electrical energy in Ontario from different sources of energy? T/I
- ☑ gather information from a variety of sources to research each company and its impact on the environment? T/I
- ☑ use tables to summarize your information and compare the companies? C
- ☑ clearly state which power company you would recommend, based on your research? A
- ☑ prepare a written or oral report to communicate your findings, with evidence to support your decision? C

Unit 4 Review

Connect to the Big Ideas

1. Electricity is a form of energy produced from a variety of non-renewable and renewable sources. In your notebook, draw a chart or table similar to the one shown below. Complete this chart by filling in the missing information. Please do not write in your textbook!

Energy Source	General Advantages	General Disadvantages	Three Examples of Each Source
Renewable energy sources			
Non-renewable energy sources			

2. The production and consumption of electrical energy has social, economic, and environmental implications. Your local government plans to build a new electrical generating plant near your community. A decision has not yet been made about the type of generating plant that will be built. Assume that your community is able to use any renewable and non-renewable sources for generating electrical energy. Write a letter to the Ontario Minister of Energy and Infrastructure. (Infrastructure refers to basic systems that are needed to support a community, such as water treatment stations and power plants.) Identify which type of electrical generating plant you would like to see built in your community. Support your position by including information on the advantages and disadvantages of this particular energy source and why you think it would be the best choice.

3. Static and current electricity have distinct properties that determine how they are used. Use a t-chart to compare the properties of static electricity with the properties of current electricity.

Knowledge and Understanding K/U

4. Look back at **Figure 4.2**. Use a Venn diagram to compare the similarities and differences among hydroelectric, thermoelectric, and nuclear sources of energy used to produce electrical energy.

5. Explain why fossil fuels and uranium are considered to be non-renewable sources of energy.

6. Explain why wind, water, and the Sun are considered to be renewable sources of energy.

7. Use a t-chart to compare the similarities and differences between positive and negative charges. Include how these charges are related to the different parts of an atom.

8. Use a main idea web to summarize the law of electric charge. Include diagrams in your main idea web.

9. Describe the similarities and differences between a conductor and an insulator. Include examples of each in your comparison.

10. Describe the similarities and differences between charging by contact and charging by induction.

11. Use a labelled drawing to describe how lightning is generated.

12. Look back at **Figure 4.16**. Use this diagram to explain why a hair dryer gets hot when charges flow through it.

13. Draw a circuit diagram showing a circuit that contains a light bulb, two wires, and a source.

14. In your notebook, draw and label two diagrams. In the first diagram, show an electric circuit that includes a source, a switch, and three loads in series. In the second diagram, show an electric circuit that includes a source, a switch, and three loads in parallel.

15. You build a series circuit that consists of a source that is connected to two loads with different resistances. Describe the properties of the current and potential difference in this circuit.

16. You build a parallel circuit that consists of a source that is connected to two loads with different resistances. Describe the properties of the current and potential difference in this circuit.

17. Explain how unplugging your "instant-on" television when you are not watching it will save energy and money.

18. Rice puffs are very light and are electrically neutral. If a negatively charged ebonite rod is placed in a bowl of rice puffs, the puffs cling to the rod. However, a short time later, the puffs fly off in all directions. Explain why this happens.

Thinking and Investigation T/I

19. A friend complains that she sometimes experiences a small shock after using a telephone. She wonders whether the telephone has an electrical fault. You know that your friend often places the telephone handset on one of her shoulders while she talks. The telephone company tests its equipment and reports that neither the telephone nor the electrical circuit powering the telephone has an electrical fault. Predict the likely reason why your friend is receiving the shocks. Outline a simple investigation to test your prediction.

20. Suppose you have a part-time job assembling electronic components at a factory. The electronic components arrive at your metal work table after sliding through a plastic delivery tube. Some of the components you assemble do not work properly, and your manager is concerned. You think you know what could be damaging the electronic components. Write an e-mail message to your manager describing what you think is causing the damage to the components and predicting a way to solve this problem.

21. The data in the table below compare sources used to generate electrical energy in Ontario and Alberta.

a) Make a bar graph based on the data.

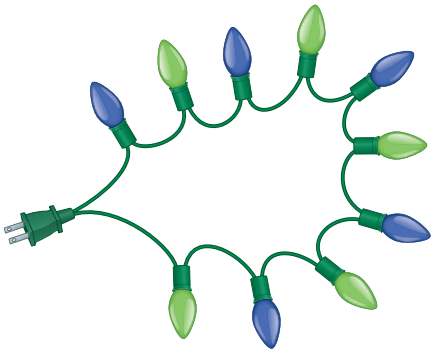
b) Identify the major differences in the sources used by the two provinces.

c) Predict possible reasons why these differences exist.

Sources of Electrical Energy in Ontario and Alberta

Source	Ontario (percentage)	Alberta (percentage)
Nuclear	52	—
Hydroelectric	21	7
Coal	18	49
Natural gas	8	38
Wind and other	1	6

22. In the past, strings of decorative lights were connected in circuits like the one below.



a) Predict what would happen in this circuit if one bulb burned out.

b) If one bulb burned out and you had another to replace it, describe how you would find out where the problem in the circuit occurred.

c) Draw a circuit for another string of lights that are connected in a more practical way.

Unit 4 Review

Communication C

23. Use a cartoon, a drawing, or a story to explain how a generator produces electrical energy.

24. Do research to determine how a technological device called an electrostatic precipitator uses static electricity to control pollution. In your notebook, draw and label a diagram of an electrostatic precipitator and write a caption that briefly explains how this device works.

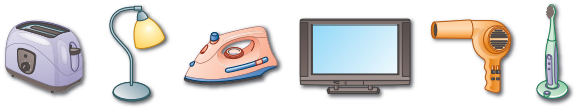
25. Draw a diagram to show the methods that you can use to charge an object.

26. In your notebook, draw a cartoon, create a diagram, or write a blog explaining the dangers associated with plugging too many appliances into a single circuit.

27. At the start of this unit, you read the lyrics for a song called "Electricity." Write the lyrics for your own song with the same title. The song can be about anything related to the concepts and skills you have learned in this unit.

Application A

28. The six objects in the picture below are all electrical loads.



a) List the objects in the order in which you think they would use energy. Start with the object that would use the most energy, and end with the object that would use the least.

b) Look at the top two items in your list. What form of energy do they convert electrical energy into? Do you think this is a coincidence? Explain your answer.

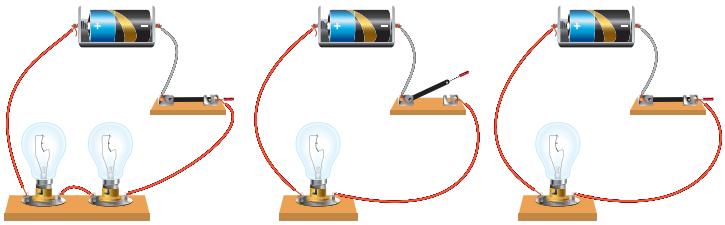
29. Describe the factors that contribute to the environmental costs of burning fossil fuels to generate electrical energy.

30. Most metals are good conductors of electricity. However, the metal wire used in the heating element in a toaster is not a good conductor. Look back at **Figure 4.16**. What properties are needed for a wire in a toaster, compared with copper wire?

31. Suppose you want to connect speakers in a bedroom to the multi-room audio system located in a living room. Look back at **Figure 4.28** and **Figure 4.29**. Identify the type of circuit that would ensure that the speakers receive the strongest possible signal. Explain why this circuit would be the best.

32. An environmental website claims that a large coal-burning plant emits more radioactive materials than a nuclear plant that has the same generating capacity. Do research to investigate this claim. Determine if the claim is accurate or inaccurate and support your position by quoting information from at least two sources.

33. Examine the circuits below.



a) Use symbols to draw circuit diagrams for these circuits.

b) Label each of your circuit diagrams to indicate if the light bulbs should be on or off. Explain how you know.

Literacy Test Prep

Read the selection below, and answer the questions that follow it.

On June 15, 1752, Benjamin Franklin launched a kite into the dark clouds of a developing storm. He correctly assumed that the thunderclouds would have a static charge before there was a lightning strike. His goal was to collect the electricity from these storm clouds. Had lightning actually struck his kite, the precautions that Franklin had put in place would not have been enough to prevent his being electrocuted.

Franklin's apparatus consisted of a kite attached to a long hemp string tied to an iron key. This string was damp from the storm and therefore would conduct the electricity. Franklin held onto the kite by a dry silk string that was attached to the key. Franklin and the silk string were under cover so that they stayed dry. Franklin understood that electricity would not travel easily along the dry silk string. A further safety precaution was a metal wire also attached to the key that led to a Leyden jar. (A Leyden jar is a device that can store charges.)

After flying the kite for a few minutes, Franklin brought his knuckles close to the iron key and a spark jumped from the key to his knuckles. This spark was identical to those produced by friction. Benjamin Franklin had demonstrated that lightning was caused by a build-up of charges in the storm clouds.

Multiple Choice

In your notebook, record the best or most correct answer.

34. Benjamin Franklin believed that

- **a)** thunderclouds would have current electricity before a lightning strike
- **b)** thunderclouds would have static electricity before a lightning strike
- **c)** thunderclouds made electricity when they rubbed together
- **d)** electricity could be harvested from thunderclouds

35. Before flying his kite, Franklin took some safety precautions that included

- **a)** wearing rubber boots and staying under cover
- **b)** attaching a lightning rod and a Leyden jar to his apparatus
- **c)** holding onto the kite by a dry silk string and staying under cover
- **d)** tying a long hemp string with an iron key to the kite

36. A Leyden jar is a device that can

- **a)** store charges
- **b)** store rainwater
- **c)** hold a key
- **d)** produce electricity

37. Franklin attached the Leyden jar to his kite with a(n)

- **a)** long hemp string
- **b)** dry silk string
- **c)** metal wire
- **d)** iron key

38. Franklin flew his kite for

- **a)** a few seconds
- **b)** a few minutes
- **c)** a few hours
- **d)** a few days

39. After flying his kite, Franklin observed

- **a)** a spark jumping from his knuckles to the key
- **b)** a spark jumping from the key to his knuckles
- **c)** a spark jumping from the key to the kite
- **d)** a spark jumping from the kite to the key

Written Answer

40. Summarize this selection. Include the main idea and two relevant points that support it.