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

### Specific Expectations

- **E1.1** assess social, economic, and environmental costs and benefits of using a renewable and a non-renewable source of electrical energy, taking the issue of sustainability into account

### Skills

- identify and locate relevant sources
- analyze information for reliability and bias
- draw and justify conclusions
- communicate using a variety of formats

### Materials

- Please see the teaching notes for each activity for a list of the materials required. Please see page TR-48 for a summary of the materials required in this topic.

## Overview

In this topic, students will examine how three different sources of energy (hydroelectric, thermoelectric, and nuclear) are used to generate electricity. They will compare renewable and non-renewable energy sources according to their impact on the environment, society, and technology. By conducting Investigation 4A, Leapin' 'Lectricity, students will gain an understanding of Canada's EcoLogo program, and research a specific power company that produces "green" electricity.

## Common Misconceptions

- **Students may believe that renewable sources of energy have no environmental impact.** This is not the case. Renewable sources of energy have a much smaller impact than other sources, but energy from wind can be dangerous to birds, energy from biomass adds carbon dioxide to the atmosphere, and all sources of energy require the production and transportation of components to function. Have students complete Activity 4.2, Assess the Sources, on page 249 to help them realize that both renewable and non-renewable sources have impact on the environment.

## Background Knowledge

In Ontario, the Independent Electricity System Operator (IESO) manages the generation, transmission, and distribution of electricity. See **www.scienceontario.ca** for a link to their Website, which provides hourly updates on Ontario's demand of electrical energy and the amount of generation by fuel type.

Whether an energy source is renewable or non-renewable, the process of generating electricity involves converting kinetic energy into electrical energy by turning a turbine that is connected by a shaft to a generator. Renewable energy sources, which can be replaced within a human lifetime, include water, wind, solar, biomass, tides, and geothermal (heat from below Earth's surface). Non-renewable energy sources, which cannot be replaced, include fossil fuels (coal, oil, natural gas) and uranium.

This table shows some advantages and disadvantages of using different energy sources to generate electrical energy, according to their impact on the environment, society, and technology (see Activity 4.2 on page 249 of the student textbook).

| Energy Source | Advantages | Disadvantages |
|---|---|---|
| fossil fuel | • Society: Coal is inexpensive. | • Environment: It produces carbon dioxide, a greenhouse gas, and other gases that contribute to acid rain.<br>• Technology: The process is only 30% efficient. That is, about 70% of the energy produced is lost as heat before it reaches the consumer. |
| nuclear (uranium) | • Environment: There are no greenhouse gas emissions.<br>• Society: A small amount of nuclear fuel will produce a great amount of energy. | • Environment: When cooling water is discharged into the lake, the temperature of water rises.<br>• Technology: Power plants are very expensive and radioactive waste must be properly stored. |
| water | • Environment: There are no combustion emissions.<br>• Technology: Operating costs are low and it is about 90% efficient. | • Society and Environment: Large areas of land are flooded to create dams and reservoirs.<br>• Environment: When submerged vegetation decays, it produces methane and releases mercury. |
| wind | • Society: There are no fuel costs and supplies are abundant in some areas. | • Environment: Rotating blades are a danger to birds.<br>• Society: Wind turbines can spoil the view and the rotating blades are noisy; may cause ill health to those who live nearby.<br>• Technology: It is unreliable, since wind speed can change at any time. |
| Sun | • Environment: There are few negative effects.<br>• Society: Solar panels on roof can help save on electricity costs. | • Technology: Electricity cannot be produced when the Sun is not shining, and solar cells are only about 33% percent efficient. |
| biomass | • Environment: Using plant matter before it decomposes prevents the release of methane gas.<br>• Society: Biomass usage reduces dependency on fossil fuel. | • Technology: Burning plant matter adds carbon dioxide to the atmosphere.<br>• Society: A large supply of biomass fuels is not readily available. |
| tides | • Society: It is very economical; no fossil fuels are needed. | • Environment: Some smaller animals may be displaced.<br>• Technology: Energy can only be produced near the coast, and electricity can be generated only for about 10 h each day, as the tide moves in and out of the water basin. |
| geothermal | • Environment and Society: Geothermal plants use less land space than other electricity plants; operating costs are low. | • Society: Geothermal energy can be accessed only in areas where the steam or hot water sources are relatively close to Earth's surface.<br>• Technology: Sometimes water pumped from below the Earth's surface contains pollutants that need to be removed before it is used in a power plant. |

## Literacy Strategies

**Before Reading**

- Preview the key terms by having students identify the root word in both: new. Then work with them to identify the prefixes and suffixes that change the meaning in each Key Term. Look at Literacy Skills Toolkit 4 Word Study, on page 388 of the student textbook, with students.
- ELL Provide English language learners with synonyms for root (starting word), prefix (before), and suffix (after). English language learners may not have the same understanding of root words that English speaking students do. An organizer like the one below will aid in analyzing new words. Columns in which students can print the word in first language (where appropriate) and include a sketch are beneficial. English language learners may not have the complex language required to define the word. Instead, encourage them to include an example of what the word means. This could be a simple sketch or a word.

| Word | Root | Prefix or Suffix | My language | Sketch/ Example |
|---|---|---|---|---|
| renewable | new | re able | | |

- ELL Before reading the text, use drawings, concept maps, and video clips to develop a context for what will be read. Introduce key vocabulary in an interactive, visual way.

**During Reading**

- As students read the section about the three main sources of energy used to generate electrical energy in Ontario, they should ask themselves, "What are the similarities and differences among the three processes?" and "What are the advantages and disadvantages of each type of power generation?" Students can use a T-chart to organize their notes. Model how to identify relevant information by referring to Figure 4.2 captions.
- ELL Pairing an English language learner with an English speaking peer, who can read the passage aloud, will allow the English language learner to follow the text visually with little pressure. This will also provide a greater opportunity for comprehension. Alternatively, you can read the text aloud to students.
- ELL Since understanding this passage will help them with the Learning Check questions and Activity 4.2, Assess the Sources, English language learners may need more support with reading. You can provide this support by setting a limited amount of text to read and a purpose for reading it. For example, the purpose could be to assess what words are new to the English language learner and then teach that vocabulary. Have English language learners read to a certain point in the text, using sticky notes to indicate words and phrases they do not understand. After discussing and resolving the words, they continue to read.
- Have students work with a classmate to interpret diagrams. Ond student reads the captions while the other points out relevant features of the diagram.

**After Reading**

- Have students write two facts that they found the most interesting in the topic. Ask them to write a paragraph to explain why these ideas caught their interest. Also have them ask questions they could answer with further research. Instead of writing a paragraph, English language learners can list three questions for each fact they would like to learn more about.

**Assessment FOR Learning**

| Tool | Evidence of Student Understanding | Supporting Learners |
|---|---|---|
| Learning Check questions, page 247 | Students list similarities and differences in generating electricity from moving water, burning fossil fuels, and nuclear reactions. | • Have students use a Venn diagram to compare two methods at a time.<br>• Have students complete **BLM 4-5 Comparing Methods of Generating Electricity**. |
| Activity 4.2, page 249 | Students list advantages and disadvantages of renewable and nonrenewable energy sources. | • The groupwork inherent in this activity should support students who require assistance. Establish homogenous groupings.<br>• Make the group responsible for ensuring that each student is prepared to explain the group's process and results. |
| Investigation 4A, page 250 | Students interpret and analyze information on a Website to draw conclusions about renewable energy sources. | • Ensure students understand what is meant by the term "green", and the nature of ecological endorsements. |

## Topic 4.1 (Student textbook pages 244–251)

### Using the Topic Opener (Student textbook pages 244–245)

- Start the topic with the Starting Point Activity to help students realize the magnitude of the role that electricity plays in our lives. Look at the two photos in the opener spread. Some students take it for granted that when they flip the switch to turn on an electrical device at home, electricity will "magically" flow to it and it will always work. But where does the electricity in their homes come from? Ask students to share their thoughts on this topic. Maybe someone they know works for the utility company.

Consider asking your community's utility company to send a representative to speak to the class about how it operates. Companies are often willing to do this, and if you describe the type of class you are teaching, the company may send a speaker who can identify with the students and their academic abilities. Doing this supports society initiatives and makes students aware of careers they can explore.

- ELL Another way to start conversation is to bring in a number of items students use in their daily lives that require electricity: a hair dryer, a laptop computer, a cell phone, an MP3 player, and so on. Pictures would work in lieu of the real item. Ask what all of these items have in common or how they are the same. This real connection will help English language learners to see that these items all require electricity even when it is not obvious. For instance, a cell phone must be charged to work, so it requires electricity, even when it is not plugged in to a wall socket. Students will appreciate that so many items we use each day require electricity.
- Discuss the topic question: "How do the sources used to generate electrical energy compare?" Refer students to the topic's key terms to guide the discussion. What preconceived ideas are students bringing to this topic?
- If possible, book the computer lab for students to access an online storybook about electrical energy. See **www.scienceontario.ca**.
- Go to the storybook about electrical energy and ask volunteers to take turns reading aloud the story. After completing the topic, students may return to the website to review information and/or play games about electricity generation, renewable energy, and energy efficiency.

### Starting Point Activity (Student textbook page 245)

#### Pedagogical Purpose

Students will assess social, economic, and environmental costs and benefits of using a renewable and a non-renewable source of electrical energy and recognize that the need for power generation and transportation structures is related directly to individual use of electricity.

| Planning | |
|---|---|
| **Time** | 30 min in class |

#### Background Knowledge

The electrical grid found throughout North America is a continuous network of current carrying conductors that allows anyone to obtain electrical energy at the flick of a switch.

#### Skills Focus

- make connections between lifestyle choice involving use of electricity and the need for infrastructures that provide this electricity

### Activity Notes and Troubleshooting

- Read the first question to students while standing at the light switch in the class room. Turn off the light briefly, then ask students what might happen if the electricity remained off for an extended time. Direct students to consider the direct relationship between personal choice and decisions related to use of electricity and the need for generators to produce it and wire and towers to carry it to users.

### Additional Support

- DI Pair students who have strong logical-mathematical skills with those who require support to activate their pattern-recognition abilities.
- Students with visual challenges will find this activity difficult; have a classmate with excellent communication skills describe each picture to them.
- DI Allow bodily-kinesthetic learners to move around the room as they consider tasks that require electricity.
- ELL When considering the costs of using different energy sources, English language learners may think only about economic costs, and not what social and environmental costs are also involved. To help with this, print the following on the board or overhead:
  - social: having to do with people and communities
  - economic: having to do with money
  - environmental: having to do with animals, plants, earth, air, and water

  Draw simple sketches to accompany each term. Have English language learners record these definitions in a glossary of terms.
  - ELL You may need to explain idiomatic expressions such as "flick of the switch" to English language learners.
  - ELL Students new to Canada may not know how power is generated and transmitted in this country. You may wish to pair English language learners with classmates with strong communication skills who can help to explain and guide English language learners through the activities.

## Answers

1. For the switch to control anything, electricity must travel great distances from the power plant to our homes through those giant power lines in the picture.
2. Almost everything around us uses electricity. Computers, televisions, lights, phones, video games, heating and cooling systems, stoves, microwaves, and much more all require electrical energy.
3. From the picture, we can see that to transport the electricity from the power plant to our homes many electrical lines must be created and disrupt the environment around them. Also, the production of electricity produces harmful byproducts such as greenhouse gases and radioactive waste.

## Instructional Strategies for Topic 4.1

### Different sources of energy can be converted into electrical energy

(Student textbook pages 246–247)

- There are social, economical, and environmental impacts associated with building a generating station. Have students brainstorm some of these impacts to elicit interest in the topic. Read aloud the information about the generator and its main parts. If possible, bring in a hand-crank flashlight or a hand-crank radio and ask a student volunteer to show how mechanical energy can be used to produce electrical energy to power the device.

- ELL Direct English language learners to copy and label the diagram of the generator on page 246 into their notes. Define "kinetic" as meaning "movement" or "motion". Be sure students understand there is always an initial or first source of energy. Have them practise orally explaining to a partner how a generator works. The partner can coach them through the steps.
- Have students examine Figure 4.2 to compare the ways in which falling water, fossil fuels, and uranium are used to generate electrical energy. Have students work with a partner to discuss and answer these questions: "What parts of the processes are similar?" "What parts are different?" Suggest students use a graphic organizer of their choice to organize their responses. Provide a template with one or two examples in place to prompt students to complete the organizer. This will help students who struggle by allowing them to focus on the content, rather than on what type of organizer they need.
- ELL English language learners will benefit from modelling how to compare information using a simple T-chart with the headings Similarities and Differences. For example, have them look at Figure 4.2 and talk about the initial (first) source of energy in each of the three method. Ask if this information would go under Similarities or Differences. Continue referring to the diagrams and prompt students by asking questions.

### Energy sources have advantages and disadvantages

(Student textbook pages 248–249)

- Ask students to make a chart with two columns: "Renewable Energy Sources" and "Non-renewable Energy Sources." Have confident readers take turns reading aloud the information on page 248. Ask students to make summary notes under each heading. English language learners can use **BLM 4-6 Renewable and Nonrenewable Energy Sources** to help them make notes.
- Before assigning Activity 4.2, Assess the Sources, on page 249, ask students where they have used renewable energy and non-renewable energy. Some examples for using renewable energy may include solar calculators, outdoor clothesline, riding a bicycle, buses that use biofuels, and so on. Some examples for using non-renewable energy may include most cars and production of plastic products. Note: For homes and buildings, Ontario's electricity grid provides electrical energy that is generated from both types of energy sources.

## Activity 4.1 Your Source of Energy (Student textbook page 246)

### Pedagogical Purpose

Students will use an inquiry process to determine the source of electrical energy for their community.

| Planning | |
|---|---|
| Time | 5–10 min in class |

### Skills Focus

- formulate hypotheses to focus research
- identify and locate relevant sources
- select relevant information from various sources

### Background Knowledge

In 2008, Ontario Power Generation generated about 70 percent of the electricity in Ontario or 107.8 terawatt hours (TWh). The 2007 generation mix consisted of 45 percent nuclear, 34 percent hydroelectric and 22 percent fossil-fuelled electricity. For current statistics, visit **www.scienceontario.ca**.

### Activity Notes and Troubleshooting

- Have students discuss this question in groups of four. It is unlikely anyone could pinpoint the exact source of electrical energy supplied to each home in the electrical grid. It is much more likely students will develop an appreciation for the mix of energy sources now in operation in Ontario.
- Have groups brainstorm a list of possible ways to find the answer, then choose one and develop a plan for research.
- For students located near wind energy sources, such as at Wolfe Island, the amount of energy coming from renewable energy sources is considerable and could provide fruitful discussion. This will be the topic of the next activity.

### Additional Support

- ELL Pre-teach vocabulary: hydroelectricity, fossil fuels, nuclear, uranium. Ensure English language learners are recording these in a glossary.
- ELL Place English language learners in groups with strong, supportive first language peers.
- Use multiple entry points to engage student interest with questions to elicit personal experiences. For example, "Where did the energy come from to light these lights, or prepare your breakfast?"

## Activity 4.1 Answers

Answers will depend on where students live. Students should consult the Ontario Power Generation website to research this question. See **www.scienceontario.ca**. From the map of operations at the website, there are generating stations throughout the province, such as coal in Thunder Bay, natural gas in Windsor, nuclear near Toronto, and hydroelectric plants in many locations.

## Learning Check Answers (Student textbook page 247)

1. Most electrical energy in Canada is generated from three sources: uranium, falling water, and fossil fuels such as coal, oil, and natural gas. In each case, the source of energy is converted to electrical energy by means of a generator system.
2. A generator system consists of a turbine, a shaft, and a generator. The initial source of energy causes the turbine to spin, which causes the shaft to rotate. The generator converts the kinetic energy of the spinning shaft into electrical energy.
3.

| Comparing Energy Sources | | |
|---|---|---|
| **Water** | **Fossil fuel** | **Nuclear reactions** |
| uses water | uses fossil fuels | uses uranium |
| converts kinetic energy to electrical energy | converts chemical energy to electrical energy | converts nuclear energy to electrical energy |
| falling water spins giant turbines | steam spins giant turbines | steam spins giant turbines |

4. For example, my life would probably be much like what life was like for people before the generator was invented. There would be more use of trains and horses for transportation. We would not have any devices that used electricity, such as computers, television, MP3 players, radios, electric guitars, and electric lights. There would still be books, writing letters to each other, and acoustic guitars, though.

## Learning Check Answers (Student textbook page 248)

1. A renewable energy source is one that can be replaced or restocked within a human lifetime, or less. Examples include as flowing water, wind, tides, and geothermal energy. A non-renewable energy source is one that cannot be replaced or restocked within a human lifetime, such as fossil fuels and uranium.
2. Uranium is a non-renewable energy source because it was formed in the explosions of stars before Earth was formed billions of years ago. Water is a renewable energy source because the water cycle helps it to be replaced within a short period of time.
3. It is important to assess every energy source in terms of its advantages and disadvantages because each has its pros and cons, whether it is renewable or not. We want to choose the sources with the most advantages and the fewest disadvantages for each use.

## Activity 4.2 Assess the Sources (Student textbook page 249)

### Pedagogical Purpose

Students will develop research skills and their decision-making ability based on evidence collected and shared as a class.

| Planning | |
|---|---|
| **Materials** | Internet access<br>chart paper (one per group)<br>markers (at least one per group) |
| **Time** | 60 min in class |

### Skills Focus

- gather and organize data
- make decisions based on evidence

### Background Knowledge

Electrical energy cannot easily be stored in large quantities. This means that the electricity utilities always need to produce the amount needed at that time. As a result, the utilities need to predict carefully how much energy they need to produce. A certain amount of generation must always be held in reserve to cushion an electrical grid against inevitable disturbances and losses.

Demand for electricity continues to grow as our economy develops. The United States showed a 12 percent increase in demand during each year of the first three decades of the twentieth century, a rate of growth that is now being experienced by emerging economies such as those of India or China. Historically, the growth rate for electricity demand has outstripped that for other forms of energy. Environmental concerns with electricity generation have led to an increased focus on generation from renewable sources, in particular from wind- and hydropower. While debate can be expected to continue over the environmental impact of different means of electricity production, energy from renewable sources seems relatively "green".

### Activity Notes and Troubleshooting

- Organize students into heterogeneous ability groups; the only criteria should be that students will work together.
- Groups will need access to the Internet.
- Ask for assistance from senior students who can act as guides and answer simple questions.

### Additional Support

- ELL Where possible, English language learners will benefit from working with senior students who have the same first language that they do.
- DI Cooperation among students within groups and among groups will be the challenge in this activity. Ensure interpersonal learners are spread among the groups to encourage cooperation and active participation among group members.
- Students with visual challenges will find this activity difficult. Have a classmate with strong communication skills describe each source of electrical energy to them.
- Research should focus on the key characteristics of each energy source and the differences that make each source unique. Remind students to think of the table they will be recording in as they evaluate the usefulness of information they find. Provide a starting example to prompt students.

- ELL You may choose to provide English language learners with additional support by strategically grouping them with students who have demonstrated skills of communication. Alternatively, work with a small group of English language learners to guide them through this task using a template like the one that follows. Discuss the headings and complete the columns for one source of energy for the students, thinking and talking aloud and referring back to information sources to find ideas.

## Activity 4.2 Answers

Each energy source has the potential for being recommended as the best choice. Here is a sample answer.

| Research the Energy Source | Advantages of the Energy Source | Disadvantages of the Energy Source | Decision |
|---|---|---|---|
| fossil fuel | • Society: Coal is inexpensive. | • Environment: It produces carbon dioxide and other gases that contribute to acid rain.<br>• Technology: The process is only 30 percent efficient. That is, about 70 percent of the energy produced is lost as heat before it reaches the consumer. | Bad choice, since it harms the environment. and is inefficient. |
| nuclear (uranium) | • Environment: There are no greenhouse gas emissions.<br>• Society: A small amount of nuclear fuel will produce a great amount of energy. | • Environment: When cooling water is discharged into the lake, the temperature of water rises.<br>• Technology: Power plants are very expensive and radioactive waste must be properly stored. | Good choice, since it does not harm the environment when properly handled. |
| water | • Environment: There are no combustion emissions.<br>• Technology: Operating costs are low and it is about 90% efficient. | • Society and Environment: Large areas of land are flooded to create dams and reservoirs.<br>• Environment: When submerged vegetation decays, it produces methane and releases mercury. | Good choice since it is efficient and renewable, but it can harm the environment. |
| wind | • Society: There are no fuel costs and supplies are abundant in some areas. | • Environment: Rotating blades are a danger to birds.<br>• Society: Wind turbines can spoil the view and the rotating blades are noisy.<br>• Technology: It is unreliable, since wind speed can change at any time. | Good choice for secondary energy source. |
| Sun | • Environment: There are no negative effects. | • Technology: Electricity cannot be produced when the Sun is not shining, and solar cells are only about 33 percent efficient. | Good choice for secondary energy source. |
| biomass | • Environment: Using plant matter before it decomposes prevents the release of methane gas. | • Technology: Burning plant matter adds carbon dioxide to the atmosphere.<br>• Society: A large supply of biomass fuels is not readily available. | Good choice for secondary energy source. |
| tides | • Society: It is very economical; no fossil fuels are needed. | • Environment: Some smaller animals may be displaced.<br>• Technology: Energy can only be produced near the coast, and electricity can be generated only for about 10 h each day, as the tide moves in and out of the water basin. | Good choice for secondary energy source. |
| geothermal | • Environment and Society: Geothermal plants use less land space than other electricity plants; operating costs are low. | • Society: Geothermal energy can be accessed only in areas where the steam or hot water sources are relatively close to Earth's surface.<br>• Technology: Sometimes water pumped from below the Earth's surface contains pollutants that need to be removed before it is used in a power plant. | Good choice for secondary energy source. |

In conclusion:  We should try to use energy sources such as wind, tides, and Sun because they are relatively "green" and inexpensive. Unfortunately, they are are not always available, so could only be used as secondary sources. Ontario needs an energy source that can provide energy at all times. All of the three main sources that are always available (water, nuclear, fossil fuels) have flaws, but water and nuclear energy seem to be the best sources to use.

## Investigation 4A Leapin' 'Lectricity

(Student textbook page 250)

### Pedagogical Purpose

In this investigation, students expand on their knowledge of the inquiry process and apply their understanding of power generation to consider how the power is produced. Students must make the distinction between conventional power generation and green energy generation. This investigation further prepares students for the unit inquiry project.

| Planning | |
|---|---|
| **Materials** | Internet access |
| **Time** | 60 min in class |

#### Skills Focus

- work cooperatively
- record data in an appropriate format
- connect research to the real world

#### Background Knowledge

The Home Page for Bullfrog Power provides this rationale for using Bullfrog Power for home electricity:

> *Buying renewable electricity for your home or business is an easy, powerful, and affordable way to reduce your environmental impact, cause new renewable generation to be built locally, and create a cleaner world for today and tomorrow.*

In essence, consumers who buy electricity from Bullfrog Power will create a demand for green energy sources. Consumers support Bullfrog Power by buying their electricity. But, consumers could just as easily buy electricity from local public utilities companies for less money. Currently, Bullfrog Power charges an additional 3¢ per kWh for a subscriber. This extra expense is described as the cost for greening your electricity supply. Additionally, Bullfrog Power states:

> *...conventional electricity generation harms the environment. Fossil-fuel powered facilities are a leading industrial source of carbon dioxide, a primary greenhouse gas linked to climate change. Electricity production is also a major source of pollutants including nitric oxide, sulphur dioxide, mercury and particulates that contribute to poor air quality and smog conditions. Larger hydro projects can also harm the environment, including local habitats.*

Bullfrog's green electricity comes exclusively from wind and low-impact hydro facilities that meet or exceed Environment Canada's EcoLogoM standard for renewable electricity.

In contrast, Ontario Power Generation makes this statement about current energy generation in this province.

> *As one of the largest producers of electricity in North America, Ontario Power Generation operates 65 hydroelectric, 5 fossil and 3 nuclear stations producing more than 21,000 megawatts of electricity.*
> *In fact, OPG owns one of the most diversified, low cost and low emission portfolios in North America. Our commitment is to continually improve the efficiency of our generating stations so that Ontario has the power it needs, when it needs it.*
> *In 2008, OPG generated about 70% of the electricity in Ontario or 107.8 terawatt hours (TWh). Our 2007 generation mix consisted of 45% nuclear, 34% hydroelectric and 22% fossil-fuelled electricity.*

## Activity Notes and Troubleshooting

- If necessary, book access to the Internet well in advance of today's investigation.
- Have students work in pairs or groups of four, with a variety of learning styles in each group. Assign each student a role so everyone feels accountable, for example, recording, keeping the group on track, searching online, and helping to interpret the questions supports differentiated instruction.
- If you have a digital projector, use it to show students what the Bullfrog Power website looks like and remind them that each page has the same general look and feel, so it is easy to know when students have left this website.
- If you can, get senior students to act as teaching assistants.

## Additional Support

- ELL Assign a peer helper, or a student in the class if available, to English language learners and other students who need scaffolding. Ask the peer helper to discuss the general information he or she knows about power generation with ELL students. This peer can also help to read and to interpret the data from the website.
- Students who cannot navigate the website can approach you for hints. Provide them with just enough information to get them onto the next step.
- Enrichment—Students could create an advertisement for Bullfrog Power or another EcoLogo company.

## Answers

### What Did You Find Out?

**1. a), b)** A 100% green electricity provider is a company that provides environmentally low-impact renewable electricity such as wind and hydro power plants.

**2. a)** The EcoLogo program is North America's largest, most respected environment certification mark. This program was created in 1988 by the Government of Canada to show customers which products and service meet the standards of environmental leadership.

**b)** Biogas, biomass, water, solar, and wind fuelled power generation programs qualify for the EcoLogo program.

**3.** The Sky Generation Ferndale wind farm is located in Bruce County, Ontario. There are three turbines: one 1.8 MW model and two 1.65 MW models. Sky Generation also has another wind farm in Ravenswood, Ontario, consisting of six 1.65 MW models, two of which are dedicated to supplying electricity for Bullfrog Power customers.

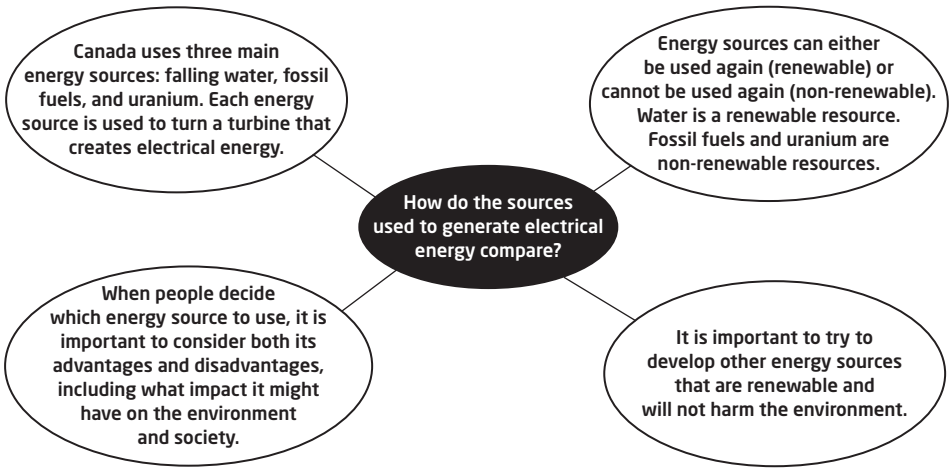
In Alberta, the Alberta Wind Energy Corporation was commissioned to use two 1.8 MW turbines to supply Bullfrog Power customers. Two 1.8 MW turbines can produce more than 10 000 MWh of electricity, enough to power 1400 homes.

## Topic 4.1 Review (Student textbook page 251)

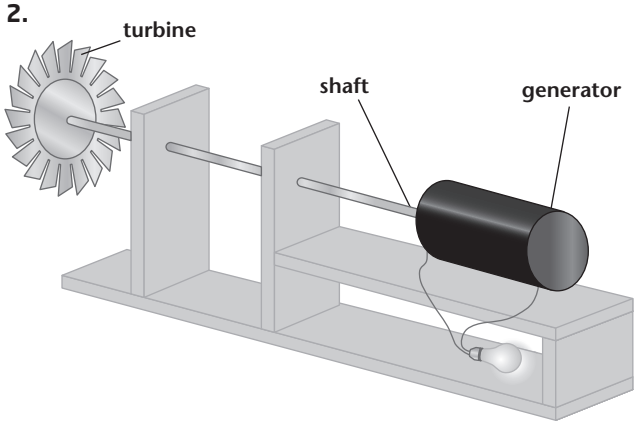
Please see also see **BLM 4-8 Topic 4.1 Review (Alternative Format)**.

### Answers

**1.** Answers may vary.




**2.**

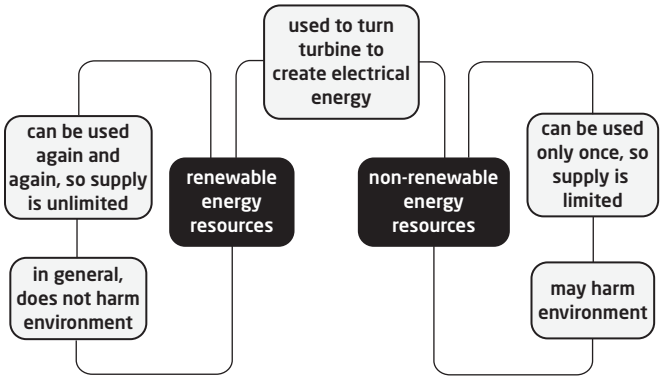



A generator system works as follows: Some energy source is used to turn the turbine. The turbine causes the shaft to rotate, which creates kinetic energy. The generator transforms this kinetic energy into electrical energy.

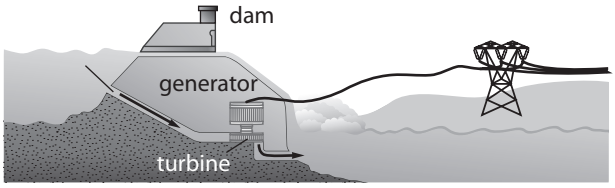
**3. a)** A non-renewable energy source is one that cannot be replaced or restocked within a human lifetime, such as fossil fuels and uranium.

**b)** A renewable energy source is one that can be replaced or restocked within a short period of time, such as flowing water, wind, tides, and geothermal.

**4.** Answers may vary. For example:



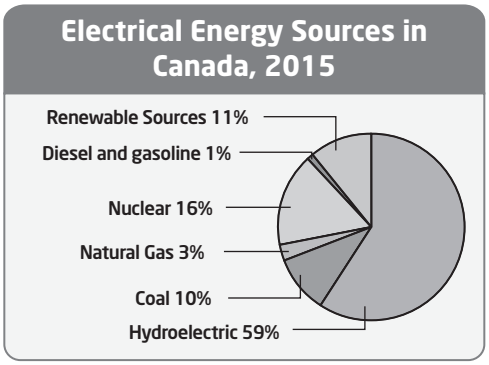

**5.**




Water flows through the dam, which causes a giant turbine to spin. This causes the generator to create electrical energy. The energy is then sent through wires for home use and and other uses.

**6. a)** From the pie graph, the sources of electrical energy production from largest to smallest are: hydroelectric 59%, coal 16%, nuclear 16%, natural gas 5%, diesel and gasoline 2%, and renewable resources 2%.

**b)** For example: I predict the percentages will be as shown in this pie graph.




**c)** I think that as time passes, coal, natural gas, and diesel fuel will be used less often for two reasons. One is that the amount of these sources will decrease and the other is that continued use of these sources is harmful to the environment. I also think that people will find more ways to harness renewable resources so they can be used more. I think hydroelectric and nuclear use will stay about the same.

**7. a)** I think that green power is electrical energy that has been produced without causing harm to the environment.

**b)** I think the energy produced from falling water is green power, although the environment might have been harmed when the dam was built.
I do not think fossil fuels are green power because the environment has to be harmed to dig them out of the ground and when they are burned they cause pollution and smog that is harmful to living things.
I consider that nuclear fuel is green power, because it does not cause pollution. I think some people would not consider it to be green because the waste from nuclear reactions is radioactive and needs to stored very carefully to prevent accidents.

**c)** Answers may vary. For example: I would not be willing to pay a premium to buy electrical energy produced by green power. Electricity costs enough already, and I do not want to pay more than I have to. People have been using non-renewable and "non-green" sources of energy for decades, and the environment has not come to any serious harm yet.
OR
I would definitely be willing to pay a premium for green power. The electricity might cost a little more, but the benefits are worth it. For one thing, the more green energy we use, the cleaner the air will be, and people will have fewer breathing problems. I have do have a budget for the amount I can spend on electric power, but I could use less, and so still pay the same as I do now.