OPG Grade 1
Teacher Guide

LIVING POWERFULLY

ONTARIO POWER GENERATION

Living POWERfully: A Teacher's Guide to Electrical Energy

is brought to you by

ONTARIO POWER GENERATION

OPG Education Program

Ontario Power Generation (OPG) is a company that generates electrical energy for the province of Ontario. Each year, OPG's 65 hydroelectric stations, 3 nuclear stations, 5 thermal stations, 2 co-owned gas-fired stations and 2 wind power turbines produce about two-thirds of Ontario's electricity needs.

OPG's focus is on the efficient production and sale of electrical energy, while working safely and operating our facilities in an open and environmentally responsible manner.

For more information and an electronic version of this document, visit our website at:

www.opg.com/learningzone

Acknowledgements

OPG would like to thank Grade 1 teachers who contributed their time and expertise to the development of this resource.

Developed by Let's Talk Science

Lesson Summary

Lesson 1:	**What is energy?**	In this lesson students will develop an understanding that energy is needed to make things happen and examine some of the many sources of energy, focusing on electrical energy, batteries, wind and "people power".	**2 X 30 minutes**
Lesson 2:	**How do we know something uses electrical energy?**	In this lesson students will look for evidence of electrical energy use in the classroom by locating and counting plugs, switches and electrical outlets.	**1 X 30 minutes**
Lesson 3:	**How does electrical energy work?**	Students will learn how electrical energy powers simple devices such as a light bulb. They will also see how basic switches start and stop the flow of power.	**1 X 30 minutes**
Lesson 4:	**Where does electrical energy come from?**	Students will create a mock electrical energy grid in the classroom to learn how electrical energy that is made in electrical generating stations comes into our homes, schools and community to make things work.	**2 X 30 minutes**
Lesson 5:	**When do we use the most electrical energy?**	Students will categorize electrical appliances according to daily and seasonal use and discuss the need for different power generation capacity in different seasons and at different times of the day.	**1 X 30 minutes**
Lesson 6:	**What would a day without electrical energy be like?**	In this culminating activity students will demonstrate an understanding of the effect of an electrical power loss on their own daily activities and their community and gain a better understanding of how electrical energy is involved in everything we do.	**2 X 30 minutes**

Electrical Energy as a Context

From a very young age we know that to make many things work we need to switch them on, plug them in—or insert a battery. We see first hand that electrical energy is transformed into light energy, sound energy, heat energy or mechanical energy in our use of lights, radios, heaters, washing machines etc. Familiarity with electrical energy will help students understand *"that energy is what makes the things they do or see happen"* and describe how their own family uses electrical energy. They should also be able to relate to the concept of a lack of electrical energy easier than a lack of other forms of energy such as heat or light energy.

With these understandings you can then move from the familiar, electrical energy, to the less familiar sources of energy such as the sun and wind and their relationship with life on Earth. To help in developing these understandings, Ontario Power Generation has developed this Teacher Resource "Living POWERfully". The Living POWERfully Teacher Guide, and the accompanying Student Guide, is intended for your **Grade 1** students. This resource supports the ***Science and Technology, Energy in Our Lives*** strand of ***The Ontario Curriculum, 2007***, with a focus on electrical energy, a major source of energy in today's world.

Fundamental Concepts and Big Ideas
(Science and Technology, The Ontario Curriculum, 2007)

Fundamental Concept:	Energy comes in many forms. It is required to make things happen.
Big Ideas:	Everything that happens is a result of using some form of energy.
	Humans need to be responsible for the way in which we use energy.

POWERful Learning at Home and School

Living POWERfully involves the teacher, students and parents in developing an understanding of the role that energy plays in our lives. The Student Guide contains worksheets for use in the classroom along with a corresponding activity for use at home with parents and older siblings. Ideally, the Student Guide is intended to be sent home, following the classroom activity, for completion of the home activity and then returned to the class. Alternatively, you may wish to send the Guide home with the students only when all classroom activities have been completed.

You can use the following note in your parent newsletter to describe the project:
"This month our class will be working on a Science and Technology unit focusing on energy in our lives. In particular, we will focus on electrical energy and the role that it plays in our homes, schools and community. Throughout the unit I will be sending home a booklet produced by Ontario Power Generation with activities for the students to complete at home. Please return the booklet for continued use in the classroom."

What is electricity?

Electricity is a commodity to be bought and sold. It is a service by which we receive electrical energy in our homes and communities, but electricity itself is not energy. Electricity is a **secondary source of energy**, specifically electrical energy, which is just one of many different forms of energy. It is a secondary source because it is manufactured from primary sources such as fossil fuels, falling water or nuclear reaction. Although the primary sources of energy used to manufacture electricity may be renewable or non-renewable, electricity itself is neither. In an effort to be scientifically correct, throughout this document we use the more correct term of **electrical energy** rather than electricity to refer to the form of energy that runs our modern lives.

Ontario Curriculum Alignment

		Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Science and Technology: Understanding Matter and Energy: Energy in our lives							
1.	**assess uses of energy at home, at school, and in the community, and suggest ways to use less energy**	x	x		x	x	x
1.1	describe their own and their family's uses of energy; identify ways in which these uses are efficient or wasteful, taking different points of view into consideration; suggest ways to reduce personal energy consumption; and explain why it is important for people to make these choices	x	x		x	x	x
1.2	describe how the everyday lives of different people and other living things would be affected if electrical energy were no longer available						x
2.	**investigate how different types of energy are used in daily life**	x	x	x	x	x	x
2.1	follow established safety procedures during science and technology investigations			x			
2.3	design and construct a device that uses energy to perform a task			x			
2.4	investigate and compare seasonal differences in the ways we use energy and the types of energy we use					x	x
2.7	use appropriate science and technology vocabulary, including **explore**, **investigate**, **design**, **energy**, and **survival**, in oral and written communication	x	x	x	x	x	
2.8	use a variety of forms to communicate with different audiences and for a variety of purposes	x			x	x	x
3.	**demonstrate an understanding that energy is something that is needed to make things happen, and that the sun is the principal source of energy for the earth**	x	x		x	x	x
3.1	demonstrate an understanding that energy is what makes the things they do or see happen	x					
3.3.	identify food as a source of energy for themselves and other living things	x					
3.4	identify everyday uses of various sources of energy	x	x		x		x
3.5	demonstrate an understanding that humans get the energy resources they need from the world around them and that the supply of many of these resources is limited so care needs to be taken in how we use them.	x			x		
Mathematics: Data Management and Probability							
Collect and organize categorical primary data and display the data using concrete graphs and pictographs, without regard to the order of labels on the horizontal axis							
–	demonstrate an ability to organize objects into categories by sorting and classifying objects using one attribute and by describing informal sorting experiences	x	x			x	

Ontario Curriculum Alignment

	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
– collect and organize primary data that is categorical, and display the data using one-to-one correspondence, prepared templates of concrete graphs and pictographs, and a variety of recording methods	x	x			x	
Read and describe primary data presented in concrete graphs and pictographs						
– read primary data presented in concrete graphs and pictographs, and describe the data using comparative language	x	x			x	
– pose and answer questions about collected data	x	x			x	
Language Arts						
Oral Communication						
1. listen in order to understand and respond appropriately in a variety of situations for a variety of purposes					x	
2. use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes					x	
Reading						
1. read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning		x		x		
2. recognize a variety of text forms, text features, and stylistic elements and demonstrate understanding of how they help communicate meaning					x	
Writing						
1. generate, gather, and organize ideas and information to write for an intended purpose and audience					x	x
Social Studies						
Canada and World Connections: Overall Expectations						
– recognize that communities consist of various physical features and community facilities that meet human needs				x		
Arts						
Drama and Dance						
– solve problems in everyday situations through role playing and movement in drama and dance				x		
Visual Arts						
– produce two- and three-dimensional works of art that communicate ideas (thoughts, feelings, experiences) for specific purposes				x		

Lesson 1 What is energy?

Suggested Timing: 2 x 30 minutes
Whole class and individual

Overview

This lesson is structured so that it will take **two class periods** to complete. In part A, students will develop an understanding that energy is needed to make things happen through discussion and artwork. In part B we go further to examine some of the many sources of energy, focusing on electrical energy, batteries, wind and "people power".

Background Information for the Teacher

Energy can take many different forms and it can change from one form to another. Nothing happens, or can happen, without it but no matter what form the energy takes, there is a finite amount of energy in the universe. We cannot create more, but neither can we destroy it.

Ontario Curriculum Alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 1, 1.1, 2, 2.7, 2.8, 3, 3.1, 3.4, 3.5

POWERful Words

Energy, electrical energy

Skill Development (The Scientific Inquiry/Research Skill Continuum)

Initiating & Planning: questioning; Performing & Recording: organizing data on a chart; Analysing and Interpreting: drawing conclusions based on information gathered; Communicating: oral communication, art as communication

Assessment Strategies

- **Knowledge & Understanding:** The energy pictures will illustrate student understanding of the need for energy to make things happen.
- **Knowledge & Understanding:** Students may also create a collage of "high energy" and "low energy" pictures cut from magazines to further demonstrate their understanding of this concept.
- **Knowledge & Understanding:** The completed chart from part B will demonstrate student understanding of the different sources of energy available and the types of things that use each source.

Materials and Resources

- Plain paper,1 per student
- Coloured markers, crayons or pencils
- *Student Guide*, page 2: What are some sources of energy?
- BLM 1 clip art, 1 sheet per student (or similar pictures cut out of magazines), Appendix A

Get Ready

- For part B, photocopy the clip art, BLM 1, (1 per student) or have students draw pictures or provide similar pictures cut from magazines, Appendix A.

Teaching and Learning Sequence

Part A

Minds-on:

1. As a class discuss the need for energy to make things happen.
   Guiding questions:
   - When someone says that you're "full of energy" what does that mean?
   - What does it mean when you say you have no energy?
   - Why do we need energy?
   - Where do we get our energy from?
     Students could also physically demonstrate having high and low energy.

2. Write on the board or chart paper:
   Running Sleeping Colouring Watching TV

3. Discuss which activity requires the most energy and which requires the least and why. Order the activities from lowest to highest energy need.

Action:

4. Explore student understanding of this concept further by asking students to draw two pictures—one that shows very little energy and one that shows lots of energy with a description under each picture.

Consolidation and Connection:

5. Post the pictures and allow time for the class to tour the pictures.

POWERful Facts

Lewis Urry was a Canadian chemical engineer and inventor. He invented both the alkaline battery and the lithium battery while working for the Eveready Battery company.

6. As a class discuss the types of activity that require lots of energy and those that require little energy.

7. Conclude by asking students to describe what energy is or does—energy makes things happen!

Part B

Minds-on:

8. Before the activity, discuss what makes kids "work". Where do they get their energy from? Does everything get energy from food? Where does a car get its energy from? Where do plants get the energy to grow from? Conclude there are many sources of energy.

Action:

9. Working individually, have students complete the activity on page 2 of the *Student Guide* by matching the action item to the source of energy that makes the action happen. Note that some objects may use both electrical energy from plugs and batteries (e.g. laptop computer, CD player). "People Power" can also be referred to as muscle power if students relate to that terminology.

Consolidation and Connection:

10. Working in small groups students can compare these charts with one another and discuss any discrepancies.

11. As a class debrief the activity. Students may then make changes to their charts if necessary

Other Curriculum Links

Following these two activities it may be appropriate to discuss other forms of energy such as that from the sun and from the food we eat (specific expectations 2.6, 3.2. 3.3).

Misconception Alert

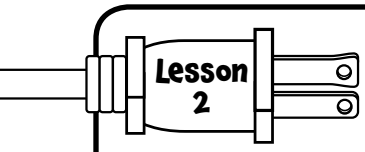
We often use the phrase "I have no energy today" and students may believe that there are times when there is no energy e.g.., when they are sleeping. If this is the case, remind them that even though they are asleep they breathe and move around. They are always doing something and so they always use energy.

Possible responses to *What are some sources of energy?*

Electrical – CD player, laptop computer, light bulb, fridge, toaster, desk top computer, vacuum, fan, stove, hair dryer
Battery – CD player, game player, iPod, calculator, toy robot, flashlight
Wind – balloon, windsurfer, kite, clothesline, windmills, flag, sailboat
People – drum, tricycle, roller blades, wagon, rocking chair, canoe, rocking horse, hammer

POWERful Families

Have students ask their parents about items in their own home that could use both batteries and electrical energy.



How do we know something uses electrical energy?

Suggested Timing: 1 x 30 minutes
Whole class and small group

Overview

Evidence of our use of electrical energy is all around us. In this lesson students will look for evidence of electrical energy use in the classroom by locating and counting plugs, switches and electrical outlets.

Background Information for the Teacher

Things that use electrical energy must connect to the source of this energy. Electrical outlets allow us to connect to a source of electrical energy through wires that come from a power generating station where electrical energy is made. This connection is usually made with a plug. Electrical energy is the availability or potential of a flow of electric charge to do work, which we also call power.

Across Canada and in the United States we see the same type of plugs in our homes and businesses, but when we travel the world we may see that plug shapes, plug holes, plug sizes and sockets are quite different in other countries.

POWERful Facts

The first plug looked like the base of a light bulb. In the early 1900s, appliance plugs were plugged into a light socket to work. To view a picture of a 1909 toaster with a screw-in plug go to the following website: Electricity Around the World: everything about plugs, sockets, voltages, converters, etc. **http://users.telenet.be/worldstandards/electricity.htm#plugs** (retrieved May 21, 2009)

Ontario Curriculum Alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 1, 1.1, 2, 2.7, 3, 3.4

POWERful Words

Plug, cord, switch, outlet, light bulb, socket, power bar, electrical energy, appliance, power generating station, prong

Skill Development (The Scientific Inquiry/Research Skill Continuum)

Initiating & Planning: brainstorming; Performing & Recording: charting the number of plugs, switches and outlets; Analysing and Interpreting: drawing conclusions based on information gathered; Communicating: oral communication

Assessment Strategies

- **Communication:** Cooperative work can be assessed as students work in pairs or small groups to do their investigation in the classroom and/or other rooms in the school.
- **Communication and Mathematics:** The student worksheet can be assessed for accuracy of observation and addition.
- **Knowledge & Understanding and Application:** The reflection portion of the worksheet can be assessed for understanding and connections.

Materials and Resources

- Student Guide, page 3: *How do we know something uses electrical energy?*

Get Ready

- Arrange access to other classrooms or rooms in the school for a few minutes during the period this activity is to take place if you wish to extend this investigation to rooms other than the classroom.

Teaching and Learning Sequence

Minds-on:

1. As a class review the different sources of energy learned about in Lesson 1. Inform students they will focus on things that only use electrical energy in this lesson.

2. Brainstorm the features that indicate something uses electrical energy to work. Appliances that use electrical energy have a cord and plug that goes in an outlet on a wall. Most things that use electrical energy have an off/on switch to start and stop the flow of electrical energy. Electric outlets provide a connection through wires to power generation stations where electrical energy is made. **Be sure to discuss safety issues with respect to plugs and outlets, e.g., ensure students understand not to place objects into an electrical socket or outlet.**

POWERful Facts

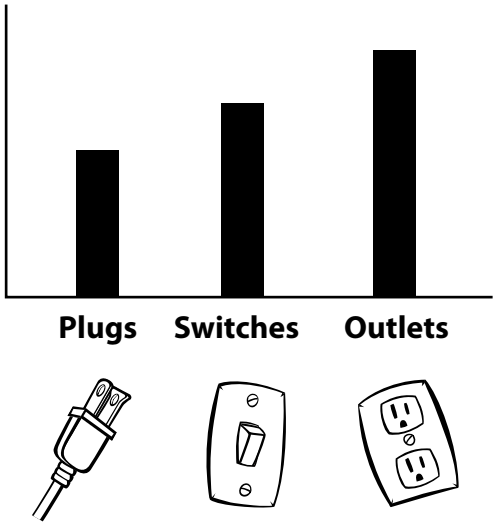
Why are plugs different? Just about every appliance with metal in it produced today has a three-pronged plug. Older appliances may have two-pronged plugs. The left prong of two- or three-pronged plugs is a grounded prong. A third prong also grounds the metal case of the appliance to protect the person using the appliance from electric shock. In the event the metal case became 'hot' or electrified from a loose wire inside, this ground prong connects to a fuse box or breaker box which immediately cuts off the flow of electrical energy to the appliance.

Action:

3. In small groups have students search the classroom to locate and record the number of plugs, switches and electrical outlets. Model the data collection chart on page 3 of the Student Guide on the board or chart paper. Students can make tally marks on their datasheet to record plugs, switches and outlets as they find them. Have students analyze their results by counting (adding) the tally marks and recording the totals on the data sheet. You may wish to extend this investigation to other rooms in the school, such as the gym, library and computer area.

Consolidation and Connection:

4. Compile the information from the inquiry as a large histogram (see example) on chart paper. Each group of students can report their findings to produce the final histogram. Alternatively, the class could also create a floor plan of the school and include their findings on the plan.



5. Have students make conclusions based on the data in the class chart. Students can complete the written reflections section of the Student Guide on page 3, *"What I learned About Plugs, Switches and Outlets".*

Guiding questions

- *What did you find out about plugs, switches and outlets?*
- *Are there more of some things than others? Why might this be?*
- *Was there much variety in the type of plugs, switches or outlets? What were the differences?*
- *How can we be safe around plugs, switches and outlets?*

Centre Activity

Create a learning centre of different types of plugs, switches, outlets, bulbs and sockets for students to observe and handle. Small appliances from different countries, travel appliances or adapters could also be included. Glass light bulbs should only be investigated with teacher supervision. Electrical appliances should not be connected to a live electrical source and only be demonstrated under teacher supervision. **Safety surrounding the use of electrical energy should be discussed with the students** (specific expectation 2.1).

POWERful Families

Students can locate and record the number of plugs, switches and outlets in their home using Student Guide, page 4: *How do I know something uses electrical energy?*

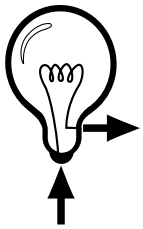
Lesson 3

How does electrical energy work?
Optional

Suggested Timing: 1 x 30 minutes
Whole class and small group

Overview:
This is a hands-on activity that will allow students to design and construct a device that uses energy to perform a task – lighting a light bulb - using simple, easy to find materials (specific expectation 2.3). Students will also examine how basic switches start and stop the flow of power. Materials for this activity may be available from your Grade 6 colleagues. If materials are limited, this activity may be done as a demonstration or see the website Making an Electric Circuit Online: **http://gwydir.demon.co.uk/jo/elect/index.htm**. (retrieved May 22, 2009)

Background Information for the Teacher
Electrical energy travels into buildings through wires into an electrical panel which consists of circuit breakers that are tripped when too much power is passed through them. Wires leading from the electrical panel distribute electrical energy throughout buildings (e.g., into electrical outlets). An electrical circuit can be simply described as a continuous loop that allows a continuous flow of power. Switches, either wired into buildings or in the devices themselves, can stop or start the power flow by breaking or completing the circuit.


Energy flow

For safety, batteries will be used in this investigation as they provide a safe, alternative source of energy. As with all experiments standard safety procedures should be followed. Batteries should not be ingested nor disposed of in the garbage when drained. Batteries are a source of chemical energy which, when connected in a circuit, will initiate a flow of electrical energy.

To make a light bulb work, electrical energy must pass through the light bulb, making connections with both the bottom tip of the bulb and the side of the metal thread. In this way, the electrical energy passes through the bulb as shown in the diagram. A piece of metal within the bulb, known as the filament, resists the flow of electrical energy and heats up causing the bulb to glow.

POWERful Facts

Although it is commonly accepted that Thomas Edison invented the first electric light bulb in 1879, in actuality, many other scientists experimented with producing light before him. Edison's invention was, however, the first device that resulted in a long-lasting light.

Ontario Curriculum Alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 2, 2.1, 2.3, 2.7,

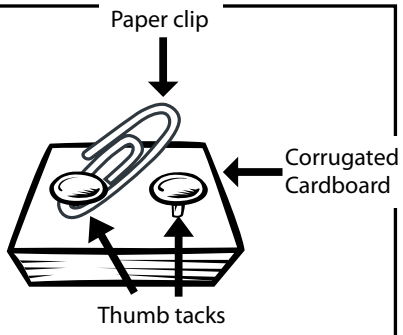
POWERful Words
Battery, circuit, connection, electrical meter, electrical panel, light bulb, power, socket, switch, wire

Skill Development (The Scientific Inquiry/ Experimentation Skill Continuum)
Initiating & Planning: questioning, predicting; Performing & Recording: using materials safely, completing a circuit diagram; Analysing and Interpreting: describing the experiment; Communicating: oral communication

Assessment Strategies
- **Thinking & Investigation:** Observe student participation in creating the circuits. Do the light bulbs light?
- **Communication:** Assess completed circuits using Student Guide, page 5: *How does electrical energy work?*

Materials and Resources

- Plug-in lamp
- Copies of photos – BLM 2, Appendix A
- Flashlight bulb, 1 per group
- Battery (C or D cell), 1 per group
- Insulated copper wire (22 gauge) 30 cm long, 3 per group (can replace with prepared aluminum foil, ~5 x 30 cm/wire – see note below)
- Mini light socket, 1 per group (can replace with clothes pin)
- Corrugated cardboard (~ 5 x 5 cm), 1 per group
- Thumb tacks, metal but not brass, 2 per group
- Student Guide Page 5



Safety note: Aluminum foil can become warm when connected in a circuit. Test before using with students and reduce the amount of aluminum if necessary. If using aluminum foil wires, also use 1 elastic/group to hold the wires on the battery.

Get Ready

- Strip the insulation off each end of the copper wires OR Prepare "wires" by folding pieces of aluminum foil (~ 5 x 30 cm) into narrow strips
- Prepare homemade switches by placing two thumb tacks, one with a paper clip attached, into a thick piece of cardboard (or small wooden block) , as shown.

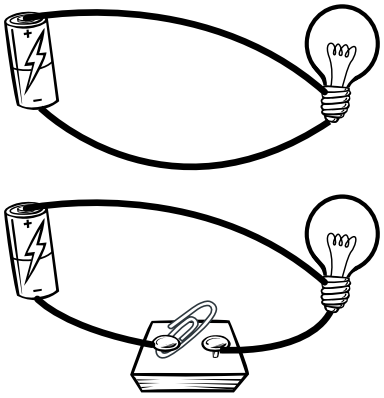
Teaching and Learning Sequence

Minds-on:

1. As a review of Lesson 2, show the unplugged lamp to the class and discuss what is needed to make it work. Talk about the source of power, the outlet and the switch. Plug the light into the outlet and observe whether the light goes on. If it does not, determine what else needs to be done (e.g., turn on the switch). Show the photos of how electrical energy comes into buildings and how it gets from the electrical panel to the outlets (see BLM 2 in this guide, Appendix A). Show the wall cut-away photo and talk about how electrical energy flows through wires to outlets, etc.

Action:

2. **Light Bulb:** Give each group of students 2 wires, a battery, a light bulb and a socket, if available. Tell them to use the materials to make the light bulb light up. If students are not using a light bulb socket then one wire needs to be wrapped around the metal collar of the bulb while the other is touched to the base of the bulb. The clothes pin makes an excellent bulb holder and will secure the wire around the bulb while providing a "handle" for students to place the tip of the bulb on the other wire.



Consolidation and Connection:

3. **Switches:** Give each group one more piece of "wire" and a light switch, and have them add it to their circuits. Can they use the switch to make the light bulb go on and off? Discuss how this works.

Centre Activity

Create a centre with a variety of wires, switches, light bulbs, sockets and batteries. Ask students to find out what happens to the light bulb when more batteries are used. What happens when more light bulbs are added to the circuit? Provide a variety of materials (conductors and insulators) and have students explore which materials allow electrical energy to pass through them and which do not.

POWERful Families

Students can play **POWER Bingo!** at home using Student Guide, page 8: *What items in my home use switches?* In this game they will search for familiar items with switches to see if they can complete a row on the card.

Lesson 4

Where does electrical energy come from?

Suggested Timing: 2 x 30 minutes
Whole class and individual

Overview

This lesson is structured so that it will take **two class periods** to complete. In part A, students will learn how electrical energy from power generating stations comes into our homes, schools and community to make things work by creating a mock electrical energy grid in the classroom. In part B, students will illustrate their understanding of these concepts though mixed media artwork.

Background Information for the Teacher

Electrical energy is made at power generating stations by transforming energy from natural resources into electrical energy. The four basic ways to generate electrical energy are from falling water (**hydroelectric**), nuclear power, fossil fuels and green energy from the sun (**solar energy**) and wind. In most cases the source provides a method for turning turbines in a magnetic field which results in the production of electrical energy.

From the generating station, electrical energy travels through heavy **wires** and passes through a **transformer** that "steps up" the voltage so that it can travel over great distances more efficiently. From there, electrical energy travels through **transmission lines** which carry it to a **substation**, typically found in every neighbourhood. From there, electrical energy is once again passed through a transformer—"green boxes" or on **hydro poles** —to "step down" the voltage further so that it is suitable for use in our homes, schools and businesses.

POWERful Facts

Electrical energy was first made in Ontario at Niagara Falls in 1892.

Ontario Curriculum Alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 1, 1.1, 2, 2.7. 2.8, 3, 3.4, 3.5

POWERful Words

Power generation station, electrical grid, appliances, transmission stations, substations, wires, hydro poles, electrical panel, electrical meter

Skill Development (The Scientific Inquiry/Experimentation Skill Continuum)

Initiating & Planning: questioning, following directions; Performing & Recording: drawing the electrical grid; Communicating: role playing, art as communication

Assessment Strategies

- **Knowledge & Understanding:** Observe student participation in creating the electrical grid and in role-playing.
- **Knowledge & Understanding and Communication:** The mixed media picture created by students can be used to assess their understanding of the components of an electrical grid and how electrical energy travels from the generating station to homes and businesses.
- **Art:** The mixed media picture can also be assessed as artwork.

POWERful Facts

In Ontario almost one third of our electrical energy production is hydroelectric. OPG operates 65 hydroelectric stations and 240 dams on 26 river systems. Many of these facilities are remotely controlled. As demand for electrical energy rises and falls throughout each day, operators stationed many kilometres away open and close dams, and start and stop generating units as needed.

Materials and Resources

Making the Electrical Grid:

- BLM 3, Electrical Grid Components, copied and cut apart, Appendix A
- Pictures of various types of power generating stations
- String, yarn or cording and masking tape

Mixed Media Picture:

- Plain art paper, construction paper, old magazines
- Scissors
- String or yarn
- Glue or tape
- Coloured pencils or markers

Get Ready

- Determine the closest type of power generation facility in your geographic area by going to **http://www.opg.com/power/OPGmap0309.pdf** (retrieved May 22, 2009). This map can be shown in your classroom if you have web-based technology (optional).
- Copy and cut apart the student selection cards from the Electrical grid components BLM 3, Appendix A. Copy the second page, as required to accommodate the number of students in your class.
- You may wish to view or download pictures of generating stations from the Ontario Power Generation website to show your students.

Teaching and Learning Sequence

Part A

Minds-on:

1. As a class discuss the purpose of factories. Introduce the concept that the electrical energy that comes into our homes and schools is made, like other products, in specialized factories called power generating stations. You may wish to show your students pictures of different types of generation stations.

2. Review the concepts from Lesson 3 that electrical energy travels through wires from a source to make things work.

Action:

3. Inform the students that they will be creating a model electrical grid in the classroom to show how electrical energy gets from the power generating station to their homes, schools and other buildings in the community.

4. In the model, students' desks will represent different buildings e.g. homes, school, stores, hospital etc. The teacher's desk will represent the power generating station and string or yarn will represent the wires that electrical energy travels along. If you are in a community close to a power generating station, place a picture of the type of generating station in your community at the teacher's desk.

5. Using the Electrical grid components, BLM 3, assign each student a different part of the electrical grid to take to their desk. The electrical grid should contain two substations as well as homes and services or businesses that are found in communities.

   Connect the wires (string) to the grid components (desks) with masking tape. The substations should be connected to the generating station and the homes, businesses, school etc. should be connected to the substations. For electrical energy to reach each point on the grid there must be no gaps in the wires.

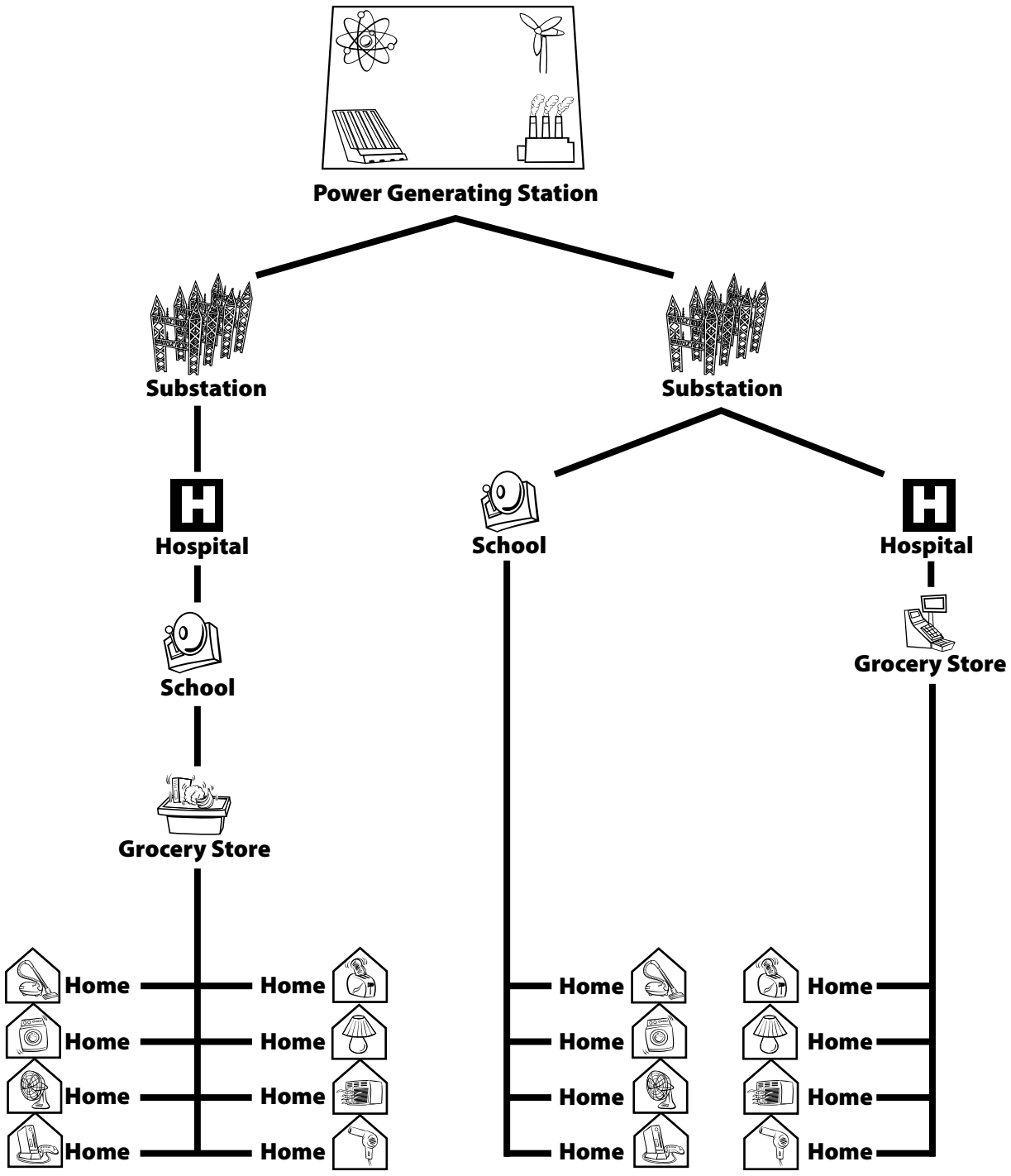
6. Role Play – Once the grid is connected, have the students role play different appliances that are drawing electrical energy from the generating station. Point out to the class that as more electrical appliances are turned on, more electrical power needs to be made at the generating station. The teacher or a student volunteer may wish to do an action that shows that the generating station is working harder to make more electrical energy.

Part B

Consolidation and Connection:

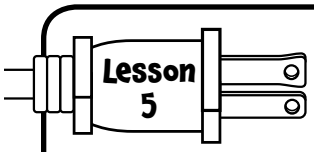
Students will complete the activity by making a mixed media picture of the grid, using any materials available, and showing all the components necessary for electrical energy to travel from the power generating station to their home.

Potential Grid Model



POWERful Families

Students can play the POWER it UP! game using Student Guide, page 6.



When do we use the most electrical energy?

Suggested Timing: 1x 30 minutes
Whole class and individual

Overview

Students will understand the need for different power generation capacity in different seasons and at different times of the day by categorizing electrical appliances according to daily and seasonal use.

Background Information for Teacher

In Canada much of our heating is provided by natural gas rather than electrical energy and so our heaviest demand for electrical energy tends to be during the summer months when air conditioners are operational.

All electrical appliances have a label stating how much electrical energy the item uses. Sometimes this is stated in WATTS and sometimes you are just given the number of AMPS the appliance uses. Power usage is measured in watts so if the wattage is not given you need to multiply the number of amps by the household voltage (110 volts) to arrive at the number of watts used to operate the appliance. Typically, the greater the number of watts the more the item will cost to run. Remember though, that some items may use a large number of watts but for a short period of time (e.g. a microwave) so to determine the actual cost to run an appliance you need both the power used and the time used.

Ontario Curriculum alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 1, 1.1, 2, 2.4, 2.7, 2.8

POWERful Facts

Canada was one of the first countries to adopt labeling appliances according to their energy use and the EnerGuide Program was introduced in 1978. The EnerGuide label provides the annual estimated energy consumption for that appliance allowing us to make comparisons in energy use when we are shopping for new appliances.

In 1992 the ENERGY STAR symbol was introduced to indicate the energy efficiency of computers and monitors but nowadays it is frequently seen in conjunction with the EnerGuide label to identify appliance models that are very energy efficient.

Powerful Words

Power generating station, electrical energy, names of electrical appliances

Skill Development
(The Scientific Inquiry/Research Skill Continuum)

Initiating & Planning: questioning; Performing & Recording: charting appliances used in each season; Analysing and Interpreting: classifying appliances as to seasonal use; Communicating: discussing electrical energy use

Assessment Strategies

- **Thinking & Investigation:** The student worksheet can be used to assess the student's ability to classify electrical items according to seasonal usage.

Materials and Resources

- Student Guide, page 9: *What time of the year do we use the most electrical energy?* 1 per student
- Chart paper (optional)
- BLM 1, 1 sheet per student (or similar pictures cut out of magazines), Appendix A

Get Ready

- Photocopy the clip art, BLM 1 clip art relevant to this activity only (i.e. you do not need items powered by batteries, wind or "people"), 1 page per student or provide similar pictures cut from magazines, or have students draw pictures

Teaching and Learning Sequence

Minds-on:

1. As a class review the types of things at home and school that use electrical energy. Discuss whether there are items that are used at certain times of the year and not at others. Are there items that are used throughout the year but more at certain times than others e.g. lighting inside the home is used more in fall and winter than in summer. People tend to cook less with the stove in summer than winter.

Action:

2. Model the graphic organizer on page 9 of the Student Guide on the board or chart paper and categorize electrical items provided by students according to seasonal usage. Pictures of items cut from magazines or just the names of items can be used for the classification.

Consolidation and Connection:

3. Following the class activity, students can complete their own organizer on page 9 of the Student Guide.

4. As a class, discuss whether all electrical items need the same amount of electrical energy to work. Using information on their charts discuss what time of year might we need the most electrical energy. Do we need the same, more or less electrical energy at different times of the year? Discuss whether the "electrical energy factory" (power generating station) would make the same amount of electrical energy all year or whether they would make more or less according to demand.

Other Curriculum Links

Having explored the seasonal use of electrical energy you may wish to discuss what steps can be taken to reduce our energy use either seasonally or daily. For example, how could we keep cool without an air conditioner? Is it necessary to have lights on all day? (Specific expectation 1.1).

POWERful Families

Students can analyze and record the daily usage of electrical energy in their own home using Student Guide, page 10: *What time of the day do I use the most electrical energy?*

In class, ask students to report orally on the time of day when their family uses the most electrical items. This activity can be expanded further by creating a histogram of the class responses. Which time of day do people usually use the greatest number of electrical items? What time of day the least number?

Lesson 6 What would a day without electrical energy be like?

Suggested Timing: 2 x 30 minutes
Whole class and individual

Overview

In this culminating activity students will demonstrate an understanding of the effect of an electrical power loss on their own daily activities and their community and gain a better understanding of how electrical energy is involved in everything we do.

Background Information for the Teacher

Every year in Ontario there are severe storms in summer or winter that knock out our supply of electrical energy. Fortunately most storms cause only minor power interruptions and inconveniences to people and their everyday activities. Some storms have caused severe damage.

There can be many causes of power failures. Causes may include faults at power generating stations, damaged power lines, substations or other parts of the distribution system, a short circuit or the overloading of electrical energy mains.

There are three categories of power outages:

Dropout – a momentary (milliseconds to seconds) loss of power often caused by a temporary fault on a power line. Once the fault is corrected power is quickly restored.

Brownout – a drop in voltage in an electrical power supply that typically causes the lights to dim.

Blackout – the total loss of power to an area. These severe outages can last from a few hours to a few weeks.

Ontario Curriculum Alignment – see curriculum chart on Page 4 of this Teacher Guide.
S&T Expectations: 1, 1.1, 1.2, 2, 2.4, 2.8, 3, 3.4

POWERful Facts

In January 1998 one of the largest ice storms in Ontario's history caused a long term disruption to power service as thick ice downed several thousand kilometres of power lines and telephone cables in Eastern Ontario and Western Quebec.

POWERful Words

Electrical energy, power outage, dropout, brownout, blackout

Skill Development (The Scientific Inquiry/ Research Skill Continuum)

Initiating & Planning: planning a day without electrical energy; Performing & Recording: writing/drawing actions and feelings about a day without electrical energy; Analysing and Interpreting: reflecting on a day without electrical energy; Communicating: oral communication, written communication, art as communication

Assessment Strategies

- **Application:** This student writing task or performance can be used as a final assessment.

Materials and Resources

- Chart paper for brainstorming (optional)
- Student Guide, p. 11: *The POWER is On!* 1 per student (optional)
- Materials may vary depending on your choice of student activity

Teaching and Learning Sequence

Minds-on:

1. Brainstorm students' experiences when electrical power has been lost due to a snow or thunderstorm. Are they excited or a little scared? Will it affect the school day? What if it lasts all day—what will they do in the evening? How will they get supper? To help students understand what electrical energy means to them, they can first complete the optional reflection sheet on page 11 of the Student Guide.

Action:

2. Following the brainstorming session, present the following scenario to students.
   You have just arrived at school and a (winter or summer) storm begins. The wind is blowing very fast and suddenly the electrical power goes out. It is a major storm and it will be tomorrow before the electrical transmission lines are repaired and electrical energy reaches the community again.

3. Working in small groups students will make notes on chart paper outlining what it will mean to them and the community to be without electrical energy for the day.

   Discuss the following guiding questions for students to respond to:

   - *Why did the power go out?*
   - *What stops the electrical power reaching your home or community?*
   - *How did you feel when the power went out?*
   - *How did you do your school work?*
   - *What could you use in the school library?*
   - *What couldn't you use?*
   - *What happened at home during supper time?*
   - *What did you do in the evening?*
   - *What do you think happens at the hospital when there is no electrical energy?*
   - *What happens at the grocery store when there is no electrical energy?*
   - *What happens to the traffic when there is no electrical energy to operate the traffic lights?*

Consolidation and Connection:

4. Using their notes, and **one** of the methods detailed below, students will create a comprehensive description of a day without electrical energy in their home and community. The description should address all the guiding questions previously provided.

   A. Create a picture book showing how you would spend a day without electricity
   B. Write and illustrate a personal journal.
   C. Write a story book with illustrations—this can be individual or each small group could contribute a chapter on an assigned topic (e.g. time of day or activity).
   D. Create a comic strip—this can be an individual activity or a class project with each student contributing one section of the comic strip that relates to a specific time of day or activity.
   E. Create a play—Small groups of students can each create a play of a day without electrical power or each group could create one scene that contributes to a class play. The play may then be performed for parents and other classes.
   F. Create Public Service Announcements—small groups can create public service announcements based on:
      - How to have fun when the power is out
      - Staying safe when the power is out
      - How to prepare for a sudden loss of power

POWERful Families

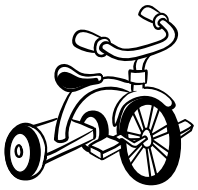
Have students ask their parents about a time when they were without power for a length of time.

Appendix A: Resource Black Line Masters

BLM 1 – Lesson 1 & Lesson 5 activity pictures

Drum

Tricycle



Roller blades

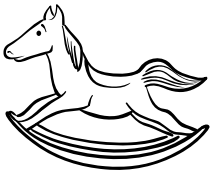
Wagon

Rocking chair

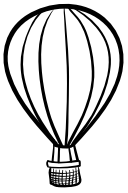
Canoe

Hammer

Rocking horse

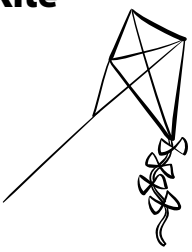


Hot air balloon



Wind surfer

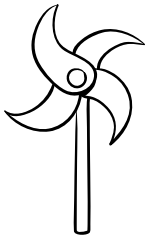
Kite



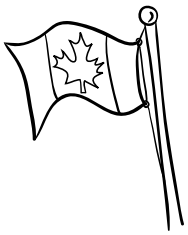
Clothesline

Sailboat

Pin wheel

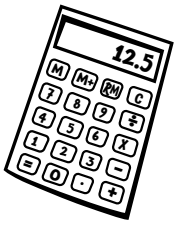


Flag

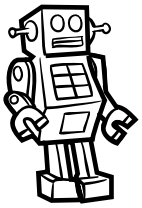


MP3 player

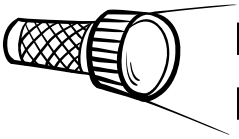
Calculator



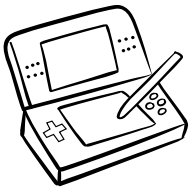
Battery operated toy



Flashlight

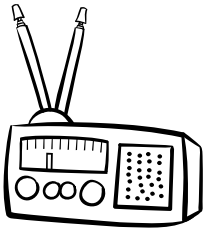


Hand held video game

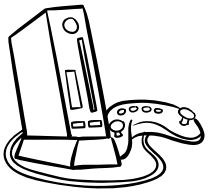


Laptop computer

Radio

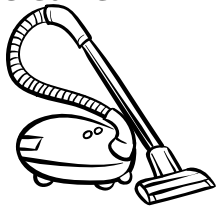


Computer video game



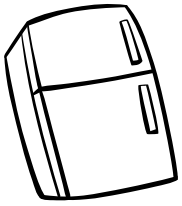
Ceiling light

Vacuum cleaner



Electric fan

Fridge



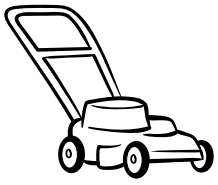
Stove

Hair dryer

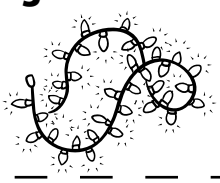
Toaster

Air conditioner

Electric lawn mower

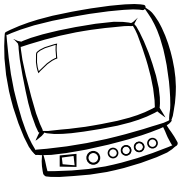


Outdoor holiday lights

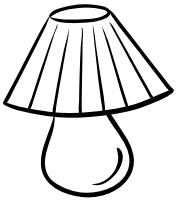


Leaf blower

Television



Lamp



BLM 2 – Lesson 3 – Photographs of a hydro meter, electrical panel and electrical wires in a ceiling

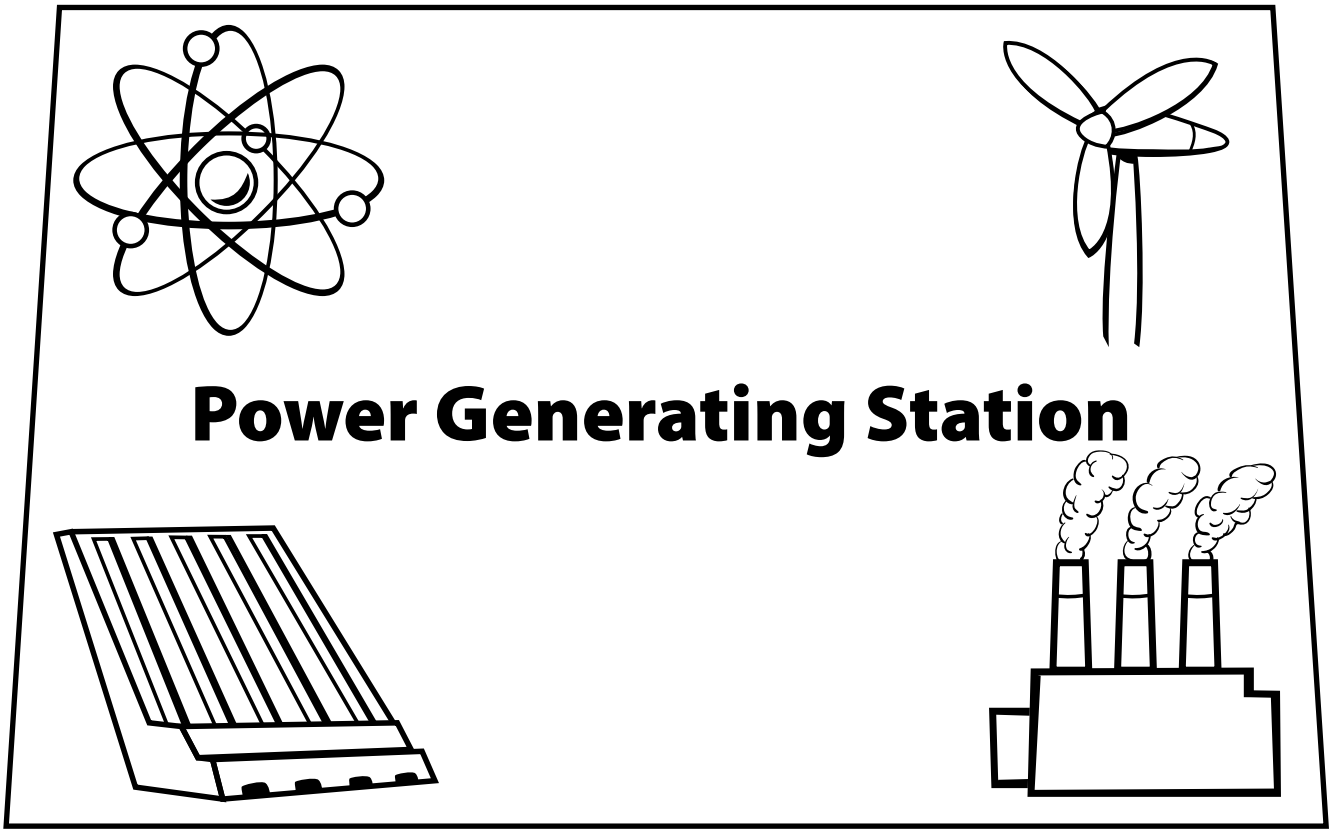
Examples:

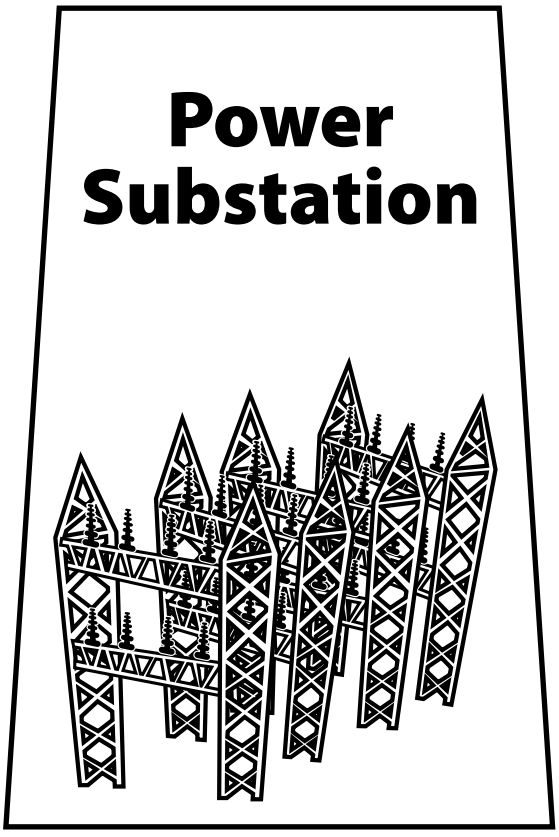
Hydro meter

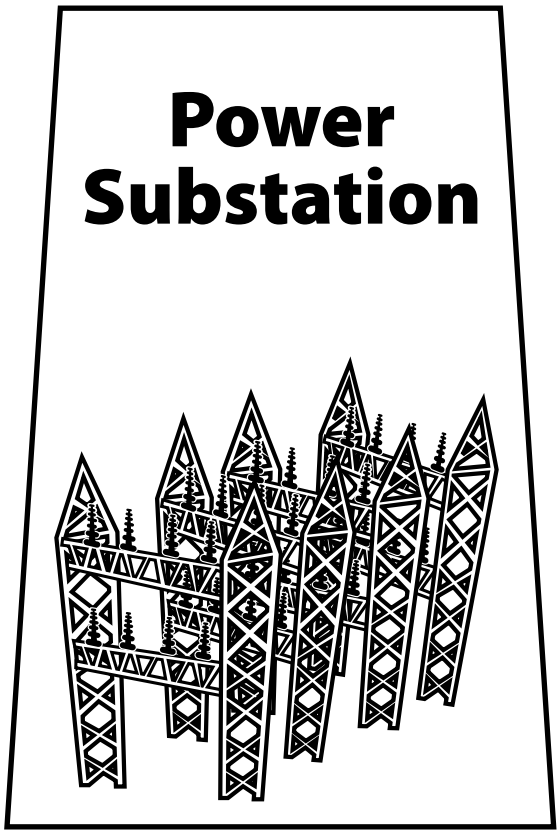
Electrical wires in ceiling

Electrical panel

BLM 3 – Electrical grid components (2 pages) – Copy this page once and cut apart

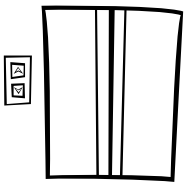






BLM 3 Continued – Copy this page as required to accommodate the number of students in your class and cut apart.

Community Hospital

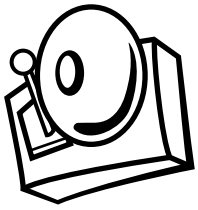


Elevator

Community Grocery Store

Cash register

Community School

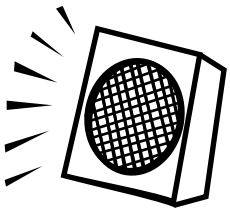


Recess bell

Community Grocery Store

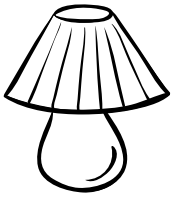
Conveyor belt

Community School



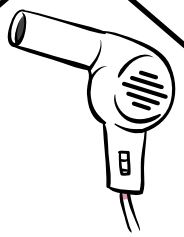
Announcement system

House + Toaster

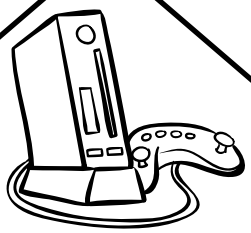


House + Lamp

House + Air conditioner



House + Hair dryer



House + Video game

House + Fan

House + Washing machine

House + Vacuum cleaner

Appendix B: Energy Fact Sheet

Forms of Energy	Examples
Electrical energy	Occurs naturally as lightning. Electrical energy is essential for the operation of appliances and equipment.
Mechanical	Seen in the physical movement of machinery, vehicles, and the body.
Chemical	Food for the body. Gasoline in cars, fuel for aircraft. Burning of fossil fuels to produce heat and/or electricity. Fuel cell, currently used in spacecraft but also a possible future source of power for motor vehicles with water as a by-product.
Gravitational	The energy contained in a dammed lake. A diver poised on a diving board.
Thermal	Heat from the sun in passive solar heating systems. Heat from hot springs used to warm greenhouses for plant growing. Heat from the ground translated into electricity via a heat pump.
Magnetic	Used in scrap yards for moving cars from one place to another. Magnetism and electro-magnetism is used in many control systems. Magnetic Resonance Imaging (MRI) is a valuable diagnostic tool.
Strain	This form of energy is apparent in coiled springs or stretched rubber bands.
Light	We see as a result of light energy from the sun. LASER's are powerful forms of light energy.
Sound	Apparent in music, SONAR and ultrasound diagnostic techniques.
Nuclear	Used in the generation of electricity and in medicine for diagnosis and treatment.

Renewable Sources of Energy

- Sun (solar, passive and solar cell)
- Wind
- Falling water
- Biomass (e.g. waste wood)
- Methane (degradation of garbage)
- Geothermal (heat from the earth)

Non-renewable Sources of Energy

- Uranium
- Natural gas (also propane)
- Oil (gasoline, petroleum products)
- Coal

Examples of potential energy

- A body of water such as a lake.
- Chemicals in fossil fuels or food before they are burnt or eaten.
- An object placed at the top of a hill, a diver poised just before the dive.

Examples of kinetic energy

- Water in a river or waterfall (falling water).
- Physical movement of people or vehicles or machinery.
- The diver during the dive, an object rolling down a hill.
- Heat, light and sound (these are all due to the movement of molecules).

Appendix C: Supplementary Resources and References

We offer you these suggested links to use as resources or as web-accessed components for your students. These are suggestions only and OPG is not responsible for the content of these websites or maintaining the links. Check with your school board to see if there are other books/videos available.

Websites

Ontario Power Generation – Learning Zone: **www.opg.com/learningzone/** (retrieved May 22, 2009)
Includes additional background information and pictures that may be used to supplement this Teacher Guide. Click on the left tab **FOR GRADES 5-8**. Here you will find:
About Electricity – basic information about electricity and famous scientists
Generating Power – pictures of the different types of power generation to show your students
Safety Smarts – activity booklet warning children of the dangers around dams, hydroelectric stations and surrounding waterways.

Basic Electricity: **http://www.1728.com/project2.htm** (retrieved May 15, 2009)

Edison Screw – Wikipedia: **http://en.wikipedia.org/wiki/Edison_screw** (retrieved May 22, 2009)

Electricity Around the World: **http://users.telenet.be/worldstandards/electricity.htm#plugs** (retrieved May 21, 2009)

Energy Kid's Page: Electricity – A Secondary Energy Source:
http://www.eia.doe.gov/kids/energyfacts/sources/electricity.html (retrieved May 22, 2009)

How Stuff Works: **http://www.howstuffworks.com/battery.htm** (retrieved May 15, 2009)
The following topics may be of interest: How Batteries Work, How Circuit Breakers Work, How Circuits Work, How Light Bulbs Work, How Power Grids Work

Making an Electric Circuit Online: **http://gwydir.demon.co.uk/jo/elect/index.htm** (retrieved May 22, 2009)

Watered Down Electricity with Louie the Lightning Bug:
http://www.southerncompany.com/learningpower/h204kids.aspx (retrieved July 21, 2009)

Books

Macaulay, D. (1998) *The New Way Things Work*. Boston: Houghton Mifflin. ISBN 0395938473

Dorling Kindersley. (2005) *Eyewitness: Electricity.* Toronto: Dorling Kindersley Ltd. ISBN 0756613884

Ardley, Neil. (1991) *The Science Book of Electricity*. Toronto: Doubleday. ISBN 0-385-25323-0

Stewart, Wayne, Willson, Judy, Lake, Jo-Anne et al. (2008) *PCSP: Ontario Science and Technology, Grade 1*, Scholastic Canada. ISBN-13 9780779188024

Dominie Factivity Big Books. (2001). *Switch On!* Dominie Press. ISBN-10 0768505569

Videos for use on SMART Boards

A Day Full of Energy Interactive Boardgame
http://www.bp.com/genericResource.do?categoryId=8042&contentId=7037031#preview (retrieved May 22, 2009)

http://library.thinkquest.org/C004471/tep/en/general/media.html# (retrieved May 22, 2009)
This site contains many short animations created by students on the generation of electricity from water and coal as well as how nuclear and solar energy work.