

Lesson #3

Where's the Power?

Subject Areas

Science, Social Studies, Language Arts

Student Skills

cooperation, investigation, peer teaching, communication, critical thinking, reflecting

Developing Vocabulary

fossil fuels, tidal power, solar power, nuclear power, wind power, hydro power, geothermal, biomass, bioenergy, ethanol, biodiesel, photosynthesis, micro-hydro, displacement, greenhouse gas, carbon dioxide, fission, atom, gravity, tidal barrage, industrialized, water cycle, competitive, earth's crust, continental plates, volcano, geyser, generator, turbines, watt, megawatt, gigawatt, terawatt

RELATED BACKGROUNDERS



**Renewable
Energy**



**Non-Renewable
Energy**

Students become "experts" on the pros and cons of one of nine renewable and non-renewable energy sources. In small groups, they share what they learn with their classmates. They each write a short persuasive letter about the energy source of their choice. This lesson may be best suited to students in Grades 6 and 7.

Learning Objectives

- ◆ understand the pros and cons of a variety of energy sources
- ◆ work collaboratively in small groups to share their energy learning
- ◆ demonstrate their learning by writing a persuasive letter in support of a particular energy source

Materials You Need

- ◆ The Energy Source Cards, provided at the end of this lesson plan. You need one Energy Source Card per student. Select enough from the set of 36 to ensure that there are at least three or four students in each energy source group: there are four cards for each of the nine energy sources. If you choose to have only three cards (i.e., students) per energy source, excluding the same card number will make it easier to group students later.
- ◆ The jigsaw handout, also provided at the end of this lesson plan. You need a copy for each student.
- ◆ Cardboard backing that you can paste the Energy Source Cards onto for durability. You may want to laminate them as well.
- ◆ A basket or container to hold the Energy Source Cards.
- ◆ Two EnerAction backgrounders: *Renewable Energy Sources* and *Non-Renewable Energy Sources*.

Time Estimate

Lead In

Main Activity

Wrap Up

20 minutes

60 minutes

40 minutes

2
HOURS

Note: You will need about one hour to prepare the Energy Source Cards.

What You Do

Lead In

20 minutes

Lead In

1. Create a list of student ideas about how our use of energy affects the planet. Focus their attention on different energy sources and impacts. Ask questions to find out what students already know about energy use:
 - ◆ Where do we get our energy?
 - ◆ What are some of the sources called?
 - ◆ How do the sources differ?
 - ◆ How does energy production impact the environment?

If your students are not ready to create such a list, work together as a class to review the material in two EnerAction backgrounders: *Renewable Energy Sources* and *Non-Renewable Energy Sources*.

2. Tell students that they will have a chance to learn more about energy sources by focusing in on one and then sharing their findings in groups.
3. Place the Energy Source Cards you selected into a basket or container. Ask students to select a card and keep others from seeing it. Alternatively, you can pre-select cards for certain students to ensure that each group has a blending of skills.
4. Give students time to read their cards to themselves.
5. Have students form themselves into groups by energy source. To do so, students can mime their energy source (i.e., use only gestures and sounds but no words or written clues) until everyone has gathered into groups.
6. Ask groups to find a space to work in while you distribute a jigsaw handout to each student.

Main Activity

60 minutes

Main Activity

PART 1 — Energy Source Groups

7. Ask groups to read their cards together. Inform students that the statements on their cards may fit into one or more columns on the jigsaw handout. Tell them to decide which column(s) provides the best fit for each statement, and encourage them to discuss the reasons for each choice they make. Explain that good group skills and collective decision making are important to successfully completing this task.
8. When all statements have been read, each student in the same group will have written the same information for the group's energy source onto their own jigsaw handout.

What You Do

Main Activity (continued)

PART 2 — Jigsaw Groups

9. Jigsaw the groups to create three or four new ones with one student “expert” represented for each of the different energy sources. To do so, you can group students by the number on their cards, assigning a different number to each corner of the classroom. You may need to double-up some experts.
10. In their new groups, have each student read the two statements on their handout that they consider to be the most important for their energy source. Other members of the group record the statements on their handouts. At the end of the exchange, each student will have some information about each energy source.

Wrap Up

40 minutes

Wrap Up

11. Ask questions to debrief the activity as a class:
 - ◆ What did you learn about energy sources?
 - ◆ What information on the cards seemed most important to you?
 - ◆ What was the most challenging part of this activity?
 - ◆ Which energy sources do you feel most strongly about and why?
 - ◆ Were there ideas about a specific energy source that convince you it is especially good for Canadians? What ideas suggest the opposite? Why?
 - ◆ If we stop using fossil fuels, what changes would we need to make to the way we get around and transport things?
 - ◆ How will it affect natural and built environments if countries use more renewable than non-renewable energy sources?
 - ◆ If sustain means “to keep going or operating,” what do we need to sustain while we meet our energy needs?
 - ◆ How did people in other times and places use energy for transportation, food and heat? What about your great grandparents, for example?
 - ◆ How can this knowledge help us deal with the growing energy needs we see today?
 - ◆ How might we balance the amount of energy we use?
12. Ask students to select one energy source and write a persuasive letter to someone at home or to someone else in their community, province or country. Explain that the goal of the letter is to convince the reader why the energy source is particularly appealing and how it helps Canadians safely meet their energy needs. Encourage students to use examples from the jigsaw activity and the class discussion to explain their ideas.

Adaptations & Extensions

- **Stage a debate.** After students classify the energy sources as renewable or non-renewable, they can debate these two categories using the information from the Energy Source Cards as key points. To strengthen their arguments, students could also do further research into energy sources (e.g., they could investigate how hydro-electric power can be both a renewable and a non-renewable energy resource).
- **Build a number line.** Using student input, build a number line that shows watts, kilowatts, megawatts, gigawatts and terawatts with numbers and units. Define watt as the amount of energy needed by a Christmas light bulb for one second. Define kilowatt hours, the unit used by electrical supply companies, as a measure of how much energy is delivered to our homes, schools and businesses.
- **Assign student presentations.** Have students create a multi-media presentation about a chosen energy source and share it with the class. Give students time to find out interesting facts about their energy source beyond what they learned from the Energy Source Cards. You could use the EnerAction backgrounders (especially Backgrounder #3, Energy Sources: Both Renewable and Non-Renewable) or have them do an internet search.
- **Use the Wrap Up to begin again.** Use the questions provided during the Wrap Up as starting points for writing exercises, research projects or group discussions.
- **Contrast then & now.** Have students create web addresses that reflect the differences between modern day energy use and that of the past (e.g., www.uselittleandbeefficient.com vs. www.usealotandgloat.com). They can also create a webpage or poster to illustrate these ideas.
- **Add an eLearning component.** Students can visit the EnerAction website at <http://eneraction.greenlearning.ca> to identify energy use choices by exploring the Carbon Calculator. Encourage students to consider what features of the different energy sources would appeal most to Electra and Sparky. How would the Carbon Critters likely feel about energy source choices?
- **Go on a fieldtrip.** Take students to one or more regional energy generating plant. Ask students to prepare questions before the visit. After the visit, have them report on their experience and express their views on local energy production by writing an opinion article.

Assessment Rubric

These criteria can be expanded or adapted to emphasize different aspects of the lesson. You can use the rubric to help students to self-assess their participation and experience, and then pose follow-up questions to the class encouraging them to reflect further on their challenges and insights.

Knowledge & Understanding	1	2	3	4
Identify a variety of forms of energy	Demonstrates limited understanding by identifying one form of energy	Demonstrates some understanding by identifying two or three forms of energy	Demonstrates considerable understanding by identifying at least four forms of energy	Demonstrates a thorough understanding by identifying more than four forms of energy
Identify the topic, purpose and audience for a variety of writing forms	Ineffective identification of topic, purpose and audience	Limited effectiveness of identification of topic, purpose and audience	Effective identification of topic, purpose and audience	Highly effective and comprehensive identification of topic, purpose and audience
Thinking	1	2	3	4
Identify their point of view and other possible points of view, and determine, when appropriate, if their own view is balanced and supported by evidence	Unable to clarify their point of view and others, and unable to present a balanced view, supported by evidence	Simple presentation of their point of view and others; can determine if their own view is balanced and supported by minimal evidence	Detailed presentation of their point of view and others; can effectively determine if their own view is balanced and supported by some evidence	Comprehensive presentation of their point of view and others; can very effectively determine if their own view is balanced and supported by a significant amount of evidence
Communicate orally and through a variety of text (e.g., graphic, print, media) with different audiences for a variety of purposes	Limited effectiveness; communicates in a simple and fairly understandable form	Some effectiveness; communicates with one variety of text	Considerable effectiveness; communicates with a variety of text to a specific audience	High degree of effectiveness; communicates with a wide variety of texts with a variety of audiences
Application	1	2	3	4
Compare the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources	Cannot effectively compare the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources	Can compare the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources to a limited extent	Can compare the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources effectively	Can compare the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources to a high degree

What is it?**OIL & GAS 1**

- ◆ Oil, which is also called *crude oil*, was formed millions of years ago from fossilized animals.
- ◆ Crude oil is usually a black-brown mixture of different sized hydrocarbons as well as sulphur, oxygen and nitrogen.
- ◆ Oil is a non-renewable resource. Natural gas supplies are expected to last 67 to 72 more years, and oil only about 40 to 45 more years.

**What is it used for?****OIL & GAS 2**

- ◆ Oil and gas are used for heat and electric power as well as for fuel for transportation.
- ◆ Many products that we buy and use are made from crude oil — for example, gasoline (octane), diesel, jet fuel, and all plastics.
- ◆ When crude oil is found mixed with sand, as it is in the Athabasca oil sands in Alberta, it is called *crude bitumen* or *oil sands*.

**How is it used in Canada?****OIL & GAS 3**

- ◆ Most of the natural gas and oil in Canada is shipped from place to place in pipelines.
- ◆ On average, every Canadian uses about three tonnes of oil each year. Like the people of the United States, Saudi Arabia, the Netherlands and Iceland, Canadians use more oil per person than other people in the world.
- ◆ More than half of Canada's total energy use comes from oil and gas: 33% oil and 25% gas.

**How does it impact the environment?****OIL & GAS 4**

- ◆ Oil creates more harmful carbon dioxide (CO₂) than natural gas, but it creates less than coal.
- ◆ Each barrel (~160 litres) of oil that comes from the oil sands of Alberta uses two to five barrels (~320 to 800 litres) of fresh water.
- ◆ In some parts of Canada, the carbon dioxide (CO₂) that is created when oil is produced could be buried underground in deep water bodies instead of released into the air.

**What is it?****COAL 1**

- ◆ Coal was formed millions of years ago from decayed and fossilized plants.
- ◆ Coal is a brownish-black rock made mostly of carbon and sulphur. It burns easily and releases heat energy.
- ◆ Coal is a non-renewable resource that burns easily and releases heat energy.

**What is it used for?****COAL 2**

- ◆ Coal can be used to create heat for industry and to create electric power.
- ◆ When burned in a power plant, about one third of the energy stored in coal is used to generate electricity. The rest is lost as waste heat.
- ◆ Coal is the fossil fuel we have the most of, and the earth's supply of coal is expected to last another 164 to 252 years.

**How is it used in Canada?****COAL 3**

- ◆ Coal played an important role in history because it allowed countries to become industrialized.
- ◆ Canada used 35 million tonnes of coal equivalent in 2006. That adds up to about 1% of world's use of coal that year.
- ◆ Coal is the biggest source of electricity worldwide.

**How does it impact the environment?****COAL 4**

- ◆ Burning coal creates large amounts of greenhouse gas. It also puts mercury and sulphur into the air and creates a solid waste that is called *slag*.
- ◆ Some people want to try to make coal power cleaner by capturing the carbon dioxide (CO₂) created by coal power plants and burying it underground.
- ◆ To mine coal, you usually have to remove huge amounts of soil from the ground. That can harm natural areas and destroy local habitats.



What is it?**SOLAR 1**

- ◆ The sun is the source of all energy on Earth. It drives the water cycle and wind, and provides all animals and humans with their food supply.
- ◆ The sun's heat and light are a renewable energy source. They send about 2000 times more energy to the earth every day than humans use.
- ◆ After you build a solar system to collect the sun's energy, this energy source costs almost nothing.

**What is it used for?****SOLAR 2**

- ◆ Because the sun isn't always shining, solar power needs to be stored as heat or electricity, or used along with other energy sources.
- ◆ Solar energy can be collected as heat using glass-covered flat metal plates, or as electricity using solar cells that are made from silicon or other semiconductor materials.
- ◆ The set up costs for collecting solar power have kept it from becoming really popular around the world, but it is becoming much more affordable.

**How is it used in Canada?****SOLAR 3**

- ◆ Canada is one of the sunniest countries in the world — even during the winter.
- ◆ Despite all of our sunshine, Canada uses very little solar energy for heat and power. Germany, Spain and China use much more.
- ◆ Canada's first big solar electricity plant is a 40MW plant that will be built near Sarnia, Ontario.

**How does it impact the environment?****SOLAR 4**

- ◆ Solar collectors can be put on roofs, over parking lots or on unused land. They don't have to get in the way.
- ◆ When solar collectors are made, very small amounts of harmful materials must be used. These toxic materials are not released into the environment, and the final product is completely safe.
- ◆ Solar cells can make 9 to 17 times more energy than is needed to produce them.

**What is it?****GEOHERMAL 1**

- ◆ Geothermal energy is the heat stored in the earth's crust from the movement of continental plates and the earth's molten core. It is a renewable energy source.
- ◆ The temperature of the earth rises about 3°C for every 100 meters deeper you go, but it is hotter near volcanos.
- ◆ The earth's crust heats and releases hot water and/or steam when underground water bodies come in contact with volcanic materials — like Old Faithful, for example.

**What is it used for?****GEOHERMAL 2**

- ◆ Geothermal energy can be used for heat and electric power.
- ◆ Geothermal plants can run 24 hours per day and 7 days a week.
- ◆ Unlike other kinds of energy plants, geothermal plants do not have to take the extra step of producing steam to power turbine generators. With geothermal, the steam is already there.

**How is it used in Canada? GEOHERMAL 3**

- ◆ Geothermal energy is used in the Philippines, Italy, Indonesia, Mexico, New Zealand, Iceland, Japan and China.
- ◆ The government of British Columbia is now studying places in that province that would be good for developing geothermal power.
- ◆ If Meager Mountain, the volcanic complex in British Columbia, had a geothermal energy plant, it could produce as much as 100–250 MW of electricity.

**How does it impact the environment?****GEOHERMAL 4**

- ◆ The hot water pumped to the surface sometimes has pollutants in it, such as sulphur, which must be removed before the water can be used in a power plant.
- ◆ The total greenhouse gas emissions from geothermal energy plants are only 5% of the emissions of fossil fuel power plants.
- ◆ Some of the best sources for geothermal energy are in remote wilderness areas, which would have to be disrupted by roads pipes.



What is it?**BIOENERGY 1**

- ◆ Humans have been using bioenergy since we learned to use fire thousands of years ago.
- ◆ Plants and trees grow because photosynthesis turns the sun's energy and carbon dioxide (CO₂) into stalks, branches and leaves. These are called *biomass*.
- ◆ Biomass is a renewable resource if it is used for energy at a slower rate than it is grown, and if there is still enough left over for its other important uses — such as food, habitat and lumber.

**What is it used for?****BIOENERGY 2**

- ◆ Biomass can be used to produce heat by burning or making gas. It produces electricity by making steam. It produces transport fuels by making ethanol and biodiesel.
- ◆ Bioenergy is limited by how much farmland and forests are available and by the process of photosynthesis that produces biomass.
- ◆ Collecting and processing biomass resources in large quantities can be a challenge.

**How is it used in Canada?****BIOENERGY 3**

- ◆ Today, 19–90% of the energy in developing countries is bioenergy.
- ◆ In Brazil, one quarter of the cars run on ethanol, which is fuel that is produced from grasses and plant waste. Ethanol creates less pollution than gasoline or diesel fuel.
- ◆ In Canada, ethanol is made from corn and wheat. To be a real alternative to oil, biofuels such as ethanol must not take away from the food supply or affect natural areas.

**How does it impact the environment?****BIOENERGY 4**

- ◆ When used as a renewable energy resource, bioenergy puts the same amount of greenhouse gases into the air as it would if the biomass was to decompose naturally.
- ◆ In Canada, greenhouse gases are released when fossil fuels are used to farm and process crops for ethanol, and then to transport the ethanol.
- ◆ When used, a litre of ethanol produces one third less greenhouse gas than burning oil.

**What is it?****HYDRO 1**

- ◆ To create hydro power, huge amounts of water are stored and then released to make energy available when it is needed. Hydro power is a renewable source of energy.
- ◆ Many of Canada's largest rivers have been dammed to generate electricity, using the energy of falling water to turn giant turbines.
- ◆ Of all the water on Earth, only 3% is fresh water, and 97% is salt water.

**What is it used for?****HYDRO 2**

- ◆ About 19% of world's electricity comes from hydro power, and most of that comes from 45,000 large hydro dams.
- ◆ About 6% of the world's hydro power comes from small rivers and streams that can generate up to 10 MW of electricity.
- ◆ In remote places in Canada, people can use hydroelectric power instead of diesel fuel, as a source of clean electricity.

**How is it used in Canada?****HYDRO 3**

- ◆ More than 50% of Canada's electricity comes from hydro.
- ◆ British Columbia, Manitoba and Quebec generate more than 75% of their power through hydro-electricity.
- ◆ Canada could more than double its hydro power use (from 70,000 MW to 160,000 MW) but that would impact many more rivers, watersheds and valleys.

**How does it impact the environment?****HYDRO 4**

- ◆ When rivers are dammed, land must be flooded, and animals and people can lose their homes.
- ◆ When vegetation is flooded, it can decay and produce the greenhouse gas methane in small amounts — about 18 grams of greenhouse gas per kWh compared to 900 g for coal and 400 g for natural gas.
- ◆ If designed well, hydro power can create a lot of energy with a much smaller impact on the environment than many other energy sources.



What is it?**NUCLEAR 1**

- ◆ Nuclear power is produced from uranium which is found in Canada, Australia, West Africa and Kazakhstan.
- ◆ Uranium ore must be mined and then refined and processed into fuel bundles before it can be used in a power plant.
- ◆ Uranium is a non-renewable energy source.

**What is it used for?****NUCLEAR 2**

- ◆ Water is heated in a nuclear reactor core through the fission of uranium atoms. The steam created is used to produce electricity in a turbine.
- ◆ Because nuclear power plants are not as reliable as other power sources, they often have to be shut down for repairs.
- ◆ Of the 30 countries currently using nuclear energy, France uses it most — creating nearly 80% of its electricity from nuclear power.

**How is it used in Canada?****NUCLEAR 3**

- ◆ About 14% of Canada's electricity is generated by nuclear power plants.
- ◆ Canada has ten nuclear power plants in Ontario, Quebec, Manitoba and New Brunswick. The last new one was built in the 1980s.
- ◆ Canadian heavy water CANDU nuclear reactors release the highest rates of Tritium in the world. Tritium is a radioactive material.

**How does it impact the environment?****NUCLEAR 4**

- ◆ Uranium mines are small compared to coal mines, but they produce radioactive waste as well as heavy metals.
- ◆ Nuclear power produces 25 grams of greenhouse gases per kWh of electricity compared with 900 g from coal and 450 g for gas-powered plants.
- ◆ Spent fuel from nuclear reactors can remain active for hundreds of thousands of years. Some of these materials can be used to make nuclear weapons.

**What is it?****WIND 1**

- ◆ Winds are caused from a combination of the sun's heat, the earth's rotation, and local atmospheric pressure differences.
- ◆ Wind power is the world's fastest growing energy source, increasing four times from 2000 to 2006.
- ◆ A wind turbine can generate anywhere from 250 watts to three megawatts (MW) of electricity. That's the difference between 1% of the power needs of one home to enough power for about 1,000 homes.

**What is it used for?****WIND 2**

- ◆ Since winds do not blow all the time, large power storage systems are being built so that wind power can be available anytime.
- ◆ Wind turbines need to be placed where there is consistent wind and wind that is strong enough to power the turbines.
- ◆ The moving parts in wind turbines need maintenance and upkeep.

**How is it used in Canada?****WIND 3**

- ◆ In 2006, wind-power capacity around the world was 74,000 megawatts, about the same as the energy that is generated by 150 coal power plants.
- ◆ Canada now produces 1,588 megawatts of energy from wind turbines. That's enough to power about 480,000 Canadian homes.
- ◆ Wind power meets only 0.5% of Canada's electricity needs, but we can expect to see much more wind power in Canada in the future.

**How does it impact the environment?****WIND 4**

- ◆ Today, wind turbines are quiet, and less likely than a downtown building or a car to be struck by a bird.
- ◆ The land used to set up wind generators can still be safely used for growing crops and by grazing animals.
- ◆ A small amount of greenhouse gas emissions come from manufacturing, installing and using wind turbines — 20 grams per kWh for wind, compared with 900 grams per kWh for coal.



What is it?**TIDAL 1**

- ◆ Tides come from the gravitational forces of the moon and sun and the rotation of the earth. Tidal power is a renewable source of energy.
- ◆ One form of tidal power, called a *tidal barrage*, uses turbines placed in a dam-like structure and creates electricity as water comes and goes.
- ◆ *Tidal fences* generate power using slow turning underwater turbines on the floor of the ocean.

**What is it used for?****TIDAL 2**

- ◆ Because the tides always come in and go out, they produce a very reliable source of power.
- ◆ Tidal power plants last longer than conventional power plants which can help save costs.
- ◆ Tidal fences can gather energy even when the tides move as slow as 3 knots.

**How is it used in Canada?****TIDAL 3**

- ◆ England, France and Canada use tidal energy.
- ◆ The world generates less than 250 MW altogether, but it could create much more — at least 450 Terawatt hours.
- ◆ Asia and North America will likely create the most tidal power in the future.

**How does it impact the environment?****TIDAL 4**

- ◆ Tidal barrage power is harmful to wildlife, birds and fisheries because it changes the amount of time that mudflats (the land exposed when the tide goes out) are exposed.
- ◆ Tidal turbines on the ocean floor (tidal fences) do upset marine life, but they are much less disruptive than tidal barrage.
- ◆ Tidal power creates less greenhouse gas emissions than many other sources.



Pros



OIL & GAS

Cons



OIL & GAS

Other



OIL & GAS

Pros



COAL

Cons



COAL

Other



COAL

Pros



Cons



Other



Pros



Cons



Other



Pros



BIOENERGY

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WIND

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