CONCEPT 3

Electrical energy is generated in different ways from different sources.

Activity

Charge It

You are at school working on a group science project late one afternoon. An unexpected snowstorm hits your region. It knocks out all the electrical energy, and none of the school phones work. It looks like you may be here a while. Luckily the cafeteria is stocked with food, and you have warm clothing. You do have one cellphone, but it needs to be charged. As a group, brainstorm how you could charge the phone to tell your families that you are safe. You can only use materials and objects found in your school. When you are done, share your ideas as a class.

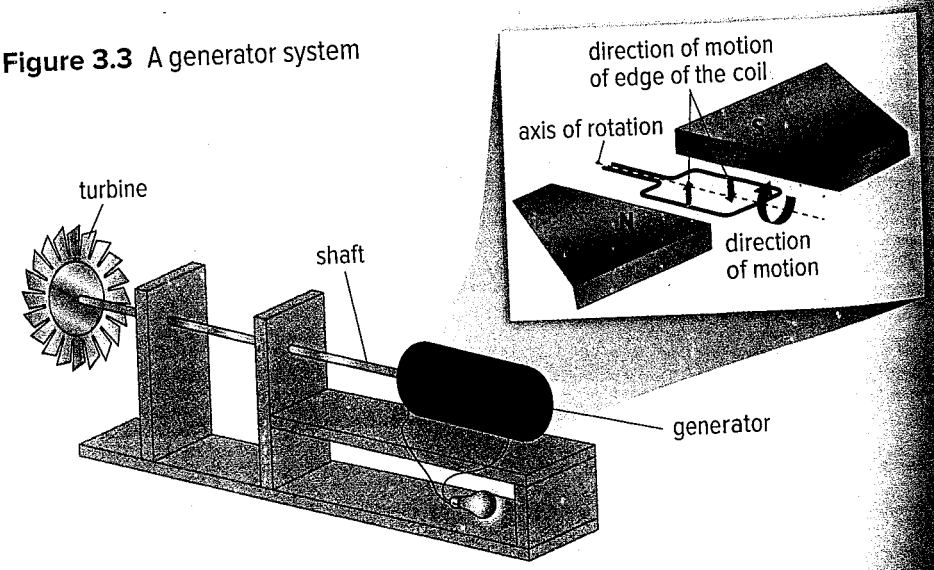
Many different types of energy can be transformed into electrical energy, but how? Several different methods are explored in this Concept.

Kinetic Energy to Electrical Energy

generator system a system that transforms kinetic energy to electrical energy

Most of the electrical energy in Canada is generated by transforming kinetic energy into electrical energy. The source of kinetic energy may be moving water or wind. It may also be moving steam produced by thermal energy generated in nuclear reactions, or by burning fossil fuels. In each case electrical energy is generated using a **generator system**. **Figure 3.3** shows a model of a simple generator system. The system has three parts: a *turbine*, a *shaft*, and a *generator*.

Figure 3.3 A generator system



Turbine: Steam, water, or wind cause the turbine to spin.

Shaft: The shaft connects the turbine to the generator. As the turbine spins, it makes the shaft spin.

Generator: The kinetic energy of the spinning shaft is transformed into electrical energy inside the generator. This happens when energy from the shaft turns a wire loop or coil. A magnet surrounds the rotating wire, as shown in the inset. As the wire turns, electrons flow in the wire. This flow of electrons powers electrical devices.

Generating Electrical Energy in Canada

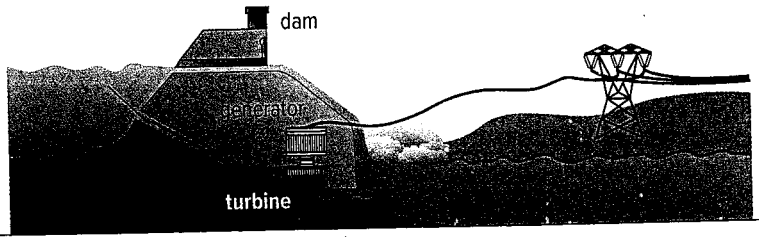
Most of the electrical energy used in Canada comes from river flow, fossil fuels, and nuclear reactions. In B.C., river flow is the main source. B.C. also uses fossil fuels to generate electrical energy, but it has no nuclear reactors. **Figure 3.4** outlines how river flow, fossil fuels, and nuclear reactions generate electrical energy.

Figure 3.4 Comparing how river flow, fossil fuels, and nuclear reactions generate electrical energy

Hydroelectric Energy from River Flow

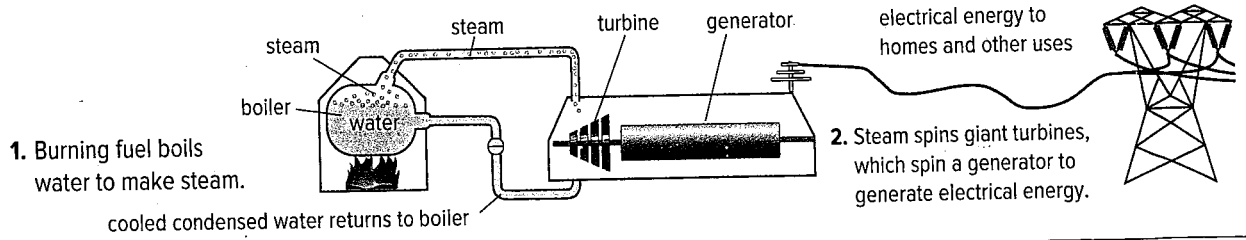
Electrical energy from river flow is called *hydroelectric energy*. Two systems generate hydroelectric energy. At the dam station below, water stored behind the dam has potential energy. As it flows downhill, it gains kinetic energy, which turns a turbine connected to a generator. At a run-of-river station, water flowing freely in a river turns a turbine.

Water flowing through a dam spins giant turbines, which spin a generator to produce electrical energy.



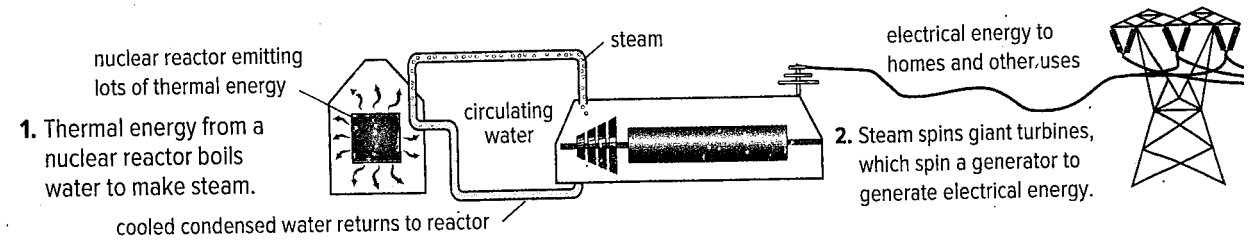
Electrical Energy from Fossil Fuels

In the generating station shown here, thermal energy from burning coal is used to boil water into steam. Pressure associated with the moving steam turns the blades of turbines connected to generators.



Electrical Energy from Nuclear Reactions

Inside a nuclear reactor, uranium or plutonium atoms undergo fission reactions. Splitting one atom sets off a chain reaction that causes more atoms to split. The nuclear reactor contains and controls these reactions and the energy they release. Most of this energy is thermal energy, which is used to boil water into steam. Pressure associated with the moving steam turns turbines connected to generators.



Generating Electrical Energy from Other Energy Sources

Transformation of kinetic energy from wind and solar energy to electrical energy is on the rise in B.C. and Canada as a whole. These processes are described in **Figures 3.5** and **3.6**. Geothermal sources, waves, and tides are small players now, but they hold promise for the future. These sources are described in **Figure 3.7** and **Figure 3.8**.

Connect to Investigation 3-A on page 200

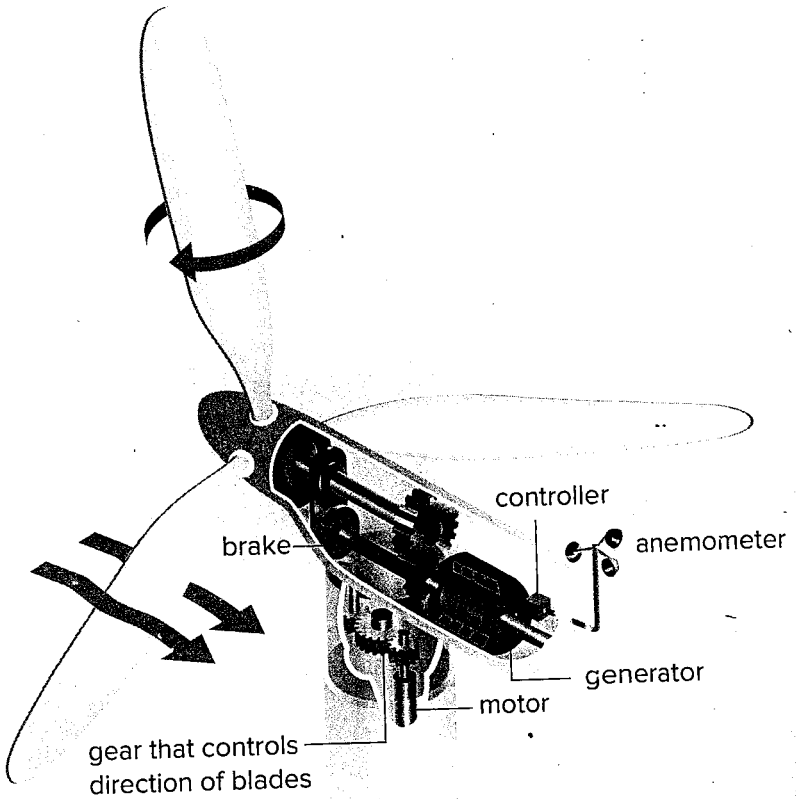


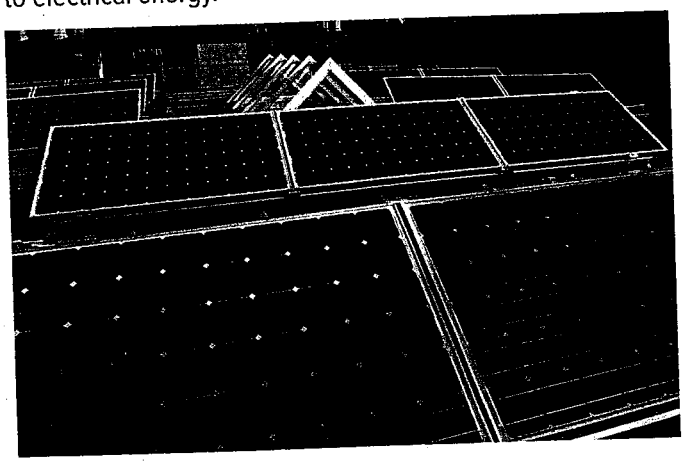
Figure 3.5 A wind turbine and generator transform kinetic energy to electrical energy.

Electrical Energy from Wind

The kinetic energy of wind is transformed into electrical energy as the moving air turns the turbine of a generator system. The most common type of wind turbine in Canada is mounted on a high tower to take advantage of greater wind speeds higher above the ground. This height also reduces turbulence from wind blowing around buildings.

A wind turbine starts to produce electrical energy when wind speed is about 13 km/h. Gears on the shafts increase the speed of the generator. This process increases until wind speed reaches about 55 km/h. For safety, a controller shuts the turbine down when the wind speed reaches 90 km/h. An anemometer is used to measure wind speed.

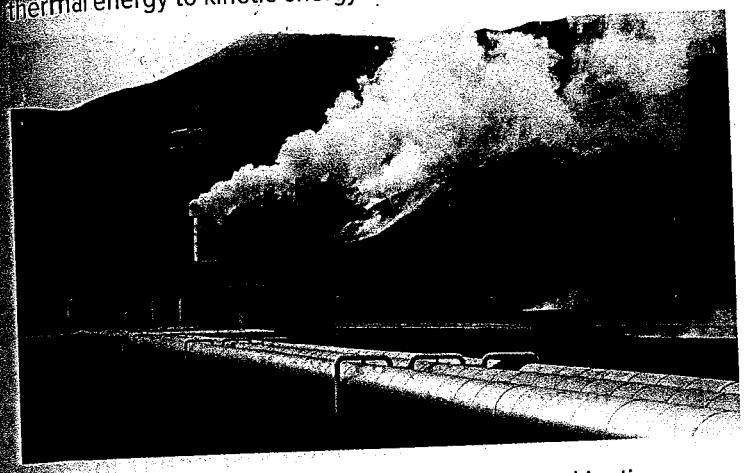
Figure 3.6 A photovoltaic cell transforms solar energy to electrical energy.



Electrical Energy from Sunlight

Some materials produce electrical energy when they are exposed to light. This is called the *photovoltaic effect*. Photovoltaic cells generate electrical energy when visible light strikes their surfaces. The cells are made of thin layers of silicon crystals. When visible light strikes electrons trapped in the cells, the electrons absorb just enough energy to flow freely and generate electrical energy. The Sun emits enormous amounts of solar energy, but converting this energy to electrical energy is a challenge. Currently, photovoltaic cells only transform the energy of visible light to electrical energy. However, scientists are working to create cells that transform other types of electromagnetic radiation into electrical energy.

Figure 3.7 A geothermal generating station transforms thermal energy to kinetic energy to electrical energy.



Electrical Energy from Geothermal Sources

Where Earth's crust is thin and molten rock comes close to the surface, hot steam can be used to turn turbines to generate electrical energy. Some parts of the world have greater access to geothermal sources than others. For instance, the volcanic island nation of Iceland generates 25% of its electrical energy from these sources.

Figure 3.8 A tidal generating station transforms kinetic energy from tides to electrical energy.

Electrical Energy from Waves and Tides

The vertical rise and fall of the waves can compress an air column, which turns a turbine. The B.C. coast is considered one of the best places to generate electrical energy from waves. Tides can spin turbines to produce electrical energy. However, they are only effective where they vary by 5 m or more. At high tide the gates of the tidal generating station shown here close and trap water in a basin. When the tide goes out, the water is directed through pipes to turn a turbine. Such stations only generate electrical energy for about 10 hours a day, as the tide moves in or out.

Activity

What Are the Properties of an Ideal Energy Source?

1. In small groups, make a list of properties of an energy resource that you think makes it the best for all or most possible uses. Note: You are not being asked to name which source you think is best. Your task is to create a list of the most desirable properties that an energy resource should have.
2. Share your group's list with other groups in the class. See if your class can agree on a list of properties that make the ideal energy source.
3. Assess each energy source in this Concept with your final list. In your mind, which source is closest to being an ideal energy source? Explain.

Before you leave this page . . .

1. List the three key parts of a generator system. Briefly describe their functions.
2. Use a flowchart to explain how moving water can generate electrical energy.