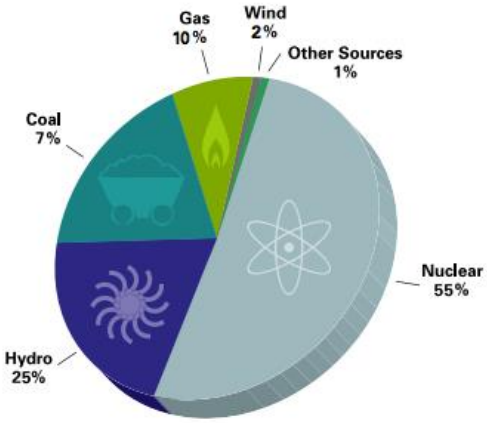
G9 Science: Class 9 Homework

Read the following excerpt and answer the questions below. Adapted from Ontario Power Generation - http://www.opg.com/communities-and-partners/teachers-and-students/documents/grade9student.pdf

HOW IT WORKS: ELECTRICITY GENERATION

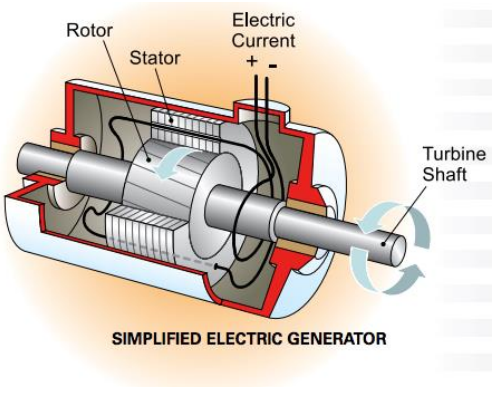


Ontario gets its electricity from a mix of energy sources. About half of our electricity comes from nuclear power. The remainder comes from a mix of hydroelectric, coal, natural gas and wind.

Most of Ontario's electricity generating stations are located in the southern half of the province close to where the demand for power is greatest. The majority of these power stations are owned and operated by Ontario Power Generation (OPG), a government owned company that generates about two-thirds of Ontario's electricity.

Most power plants, whether they are nuclear, hydroelectric, fossil-fuelled or wind, do essentially the same job, transforming kinetic energy, the energy of motion, into a flow of electrons, or electricity. At a power plant, a GENERATOR is used to make electricity. Inside a generator, a magnet called a ROTOR spins inside coils of copper wire called a STATOR. This pulls the electrons away from their atoms, and a flow of electrons is created in the copper wires. Those electrons can then be sent along power lines to wherever electricity is needed.

Giant wheels called TURBINES are used to spin the magnets inside the generator. It takes a lot of energy to spin the turbine and different kinds of power plants get that energy from different sources. In a hydroelectric station, falling water is used to spin the turbine. In nuclear stations and in thermal generating stations powered by fossil fuels, steam is used. A wind turbine uses the force of moving air.



NUCLEAR POWER

Nuclear power plants use URANIUM to generate heat and boil water into steam. Uranium has the largest atoms of the 92 naturally occurring elements on earth, making uranium atoms more likely than other atoms to split.

When subatomic particles called NEUTRONS come in contact with uranium atoms, the atoms split releasing heat energy. This occurs all the time in nature, but at a very slow rate. Nuclear reactors are able to greatly speed up this process by slowing down the neutrons and increasing the likelihood that they will hit and split the uranium atoms. When uranium atoms split they also release more neutrons which can then go on and split additional atoms ensuring a chain reaction of atom splitting. This is called NUCLEAR FISSION.

At the heart of every nuclear reactor are FUEL PELLETS no bigger than the tip of your finger. Despite their small size, these fuel pellets hold the potential to produce tremendous amounts of energy. Ontario's nuclear reactors use fuel pellets that are made from naturally occurring uranium that is mined in Canada. The pellets are inserted into tubes about half-a-metre in length made from a zirconium alloy, a special type of metal that has a high resistance to corrosion. The tubes are welded shut and several are assembled together into what is called a FUEL BUNDLE. One of these half-metre fuel bundles can provide enough electricity to power 100 homes for a year.

Thousands of fuel bundles are inserted into the core of a nuclear reactor where the uranium atoms split giving off vast amounts of heat. The heat is used to boil water to create steam, which then spins a turbine and generator producing electricity.

Nuclear power stations are able to produce tremendous amounts of electricity from a very small amount of fuel. A single 2.5 centimetre nuclear fuel pellet can produce the same amount of energy as 807 kilograms of coal, 677 litres of oil, or 476 cubic metres of natural gas. As well, because nuclear power plants do not burn any fuels, they produce virtually no smog or greenhouse gas emissions. They do however produce nuclear waste which needs to be handled and stored very carefully.

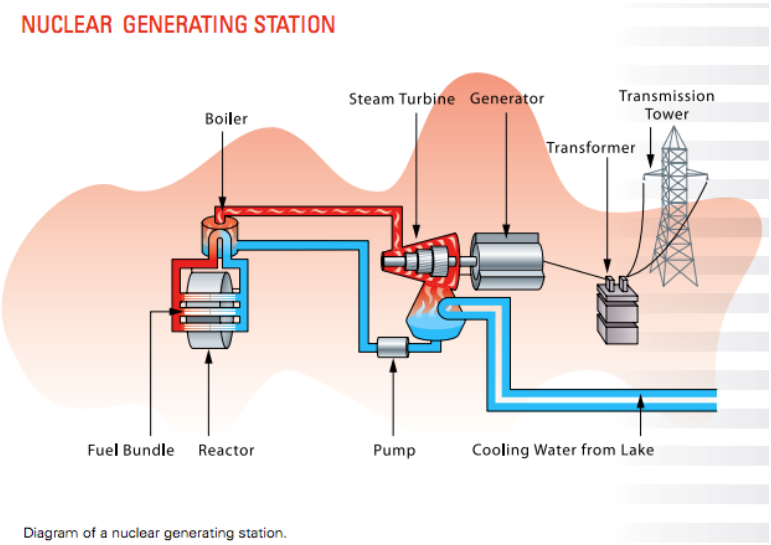


Diagram of a nuclear generating station.

MANAGING NUCLEAR WASTE

When uranium atoms split they form smaller atoms, called FISSION PRODUCTS. These fission products are highly radioactive. As a result, the fuel bundles that hold the uranium need to be isolated from the environment for an extended period of time once they are removed from a reactor.

When they can no longer generate heat efficiently, used fuel bundles are removed from the reactor and placed in WATER-FILLED BAYS to cool down. These water-filled bays are located on the same site as the reactors and are built using reinforced concrete, lined to prevent leaks and designed to withstand earthquakes. The water in the bays helps cool the fuel bundles as well as provide shielding from radiation. The fuel bundles will remain in the bays for approximately 10 years after which time they will have cooled and the radiation they emit will have decreased significantly.

The fuel bundles are then removed from the bay and placed in what are called DRY STORAGE CONTAINERS. These containers are made of concrete and steel and provide shielding from radiation. The containers are welded shut and stored in highly secure warehouses located on the same site as the nuclear generating station.

Canada's long-term plan for managing used nuclear fuel is to have a central, contained isolation facility in a deep rock formation. In the interim, scientists around the world are looking for new and innovative solutions to manage nuclear waste over time.

Nuclear	Natural Gas	Coal-Fired	Hydroelectric	Wind	Solar
30.5	450.0	986.0	25.0	65.5	372.0

Grams of CO_2 produced per kilowatt hour of electricity generated.

QUESTIONS

1. List the positive and negative effects of using nuclear power in Ontario **[4 marks]**

Positive Effects	Negative Effects

2. According to the pie chart on Page 1, what type of energy sources does most of Ontario's electricity come from? **[1 mark]**

3. Briefly describe how kinetic energy is transformed into electricity. **[5 marks]**

4. Why is Uranium used in nuclear power plants? **[2 marks]**

5. Where are neutrons found in the atom and how does it cause nuclear fission? **[3 marks]**

6. Define the following terms: **[3 marks]**

    a) Turbine

    b) Fuel Pellets

    c) Fission Products

7. Once Fuel Bundles no longer generate electricity efficiently, how are they removed and managed? **[3 marks]**

8. How come used Fuel Bundles are stored in concrete and steel? **[1 mark]**

9. What can radiation from a nuclear plant cause and why? **[2 marks]**

10. What precautions should employees at a nuclear power plant take when they work with Fuel Bundles? **[2 marks]**

11. Rank the Ontario's energy sources from the least to the most environmentally friendly using the Table on Page 3. **[6 marks]**

12. Using nuclear power plants for energy production have many advantages however, there have also been many large-scale nuclear accidents related to nuclear energy. Research a nuclear power plant accident and provide a brief explanation of the event, the year, the location, the short-term and long-term health effects. **[5 marks]**