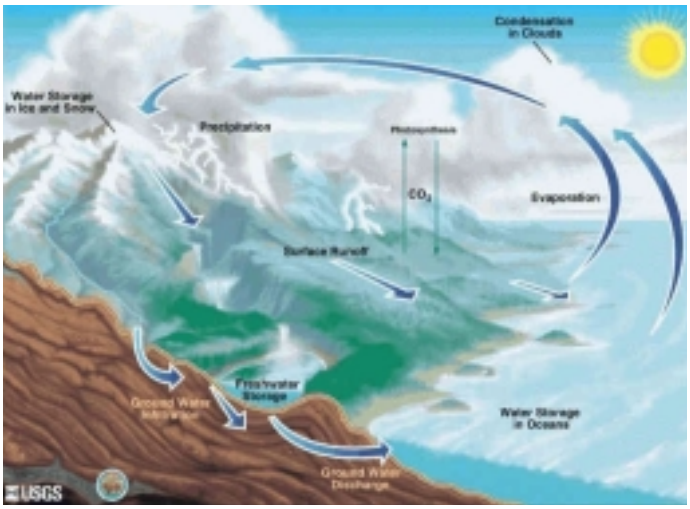
The Power of Moving Water

All around planet Earth, water is on the move. In rivers and creeks, water flows downhill under the force of gravity. It starts off as rain or snow falling on the highlands and mountains. Running water forms tiny rivulets and streams, which gather to form large rivers. Most rivers find their way to the edges of the continents, where they dump massive loads of fresh water and sediments into the oceans. Evaporation from the surface of rivers, lakes, and oceans brings the water back into the atmosphere as invisible water vapour. Under the right conditions, unseen water vapour condenses from the air to form clouds and possibly rain, snow, or hail. Seasonal rain and snowfalls bring fresh water back to the headwaters of streams, completing a very important ecological system called the "hydrologic cycle." By bringing fresh supplies of water to the highlands, the hydrologic cycle ensures that we always have energy available from flowing water.



The hydrologic cycle brings continuous supplies of fresh-water to the uplands that feed river systems.
Photo courtesy of United States Geological Survey

Rivers and streams are among nature's most powerful forces. The force of water moving down a moderately-sized river can exceed several million horsepower. Over time, this force can slice through mountain ranges, and haul billions of tonnes of soil and debris to the oceans. This is the force humans attempt to harness when they build dams to generate electricity.

Moving water is one of nature's mightiest forces.

Rivers are the most familiar form of water in motion, but there are others! Ocean waves, tides, and currents move unimaginable amounts of water around every day. Currents and waves are usually caused by winds blowing over the surface of the ocean, while tides are caused by the moon's gravity pulling gently on the earth. The action of waves, tides, and currents is especially noticeable near coastlines and islands, where they cause significant erosion.

Moving water is an important source of mechanical energy. Water is very dense compared to air, and flowing water carries with it far more energy than a similar volume of moving air. Humans have long appreciated the power of moving water, and have been using it for thousands of years.

Early Water Power

The oldest machines for capturing the energy of moving water were waterwheels. In the days before electricity, it was common to use water wheels to provide the power for mills that ground grain or cut lumber. To start the mill, the miller simply opened a gate to let the water flow over the top of the wheel. The water wheel was connected to a massive millstone or metal saw blade through a system of

gears. Water for the wheel usually came from a small dam and reservoir, called the millpond.

Some of the earliest powered machines were waterwheels.
Photo courtesy of David T. Gilbert

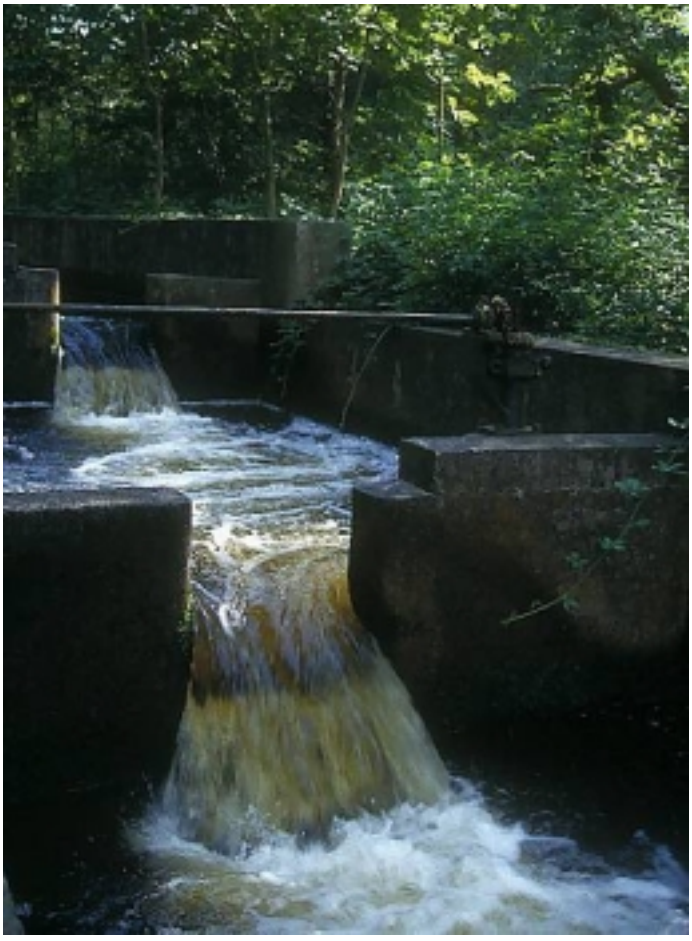
Large-scale Hydro Power

Canada has more fresh water in its lakes and rivers than any other country in the world. Many of Canada's largest rivers have been used to produce electricity. In fact, 61% of Canada's electricity comes from the energy of falling water. Electricity generated this way is called **hydroelectricity**.

Hydroelectric facilities often depend on a dam to raise the level of the water in the reservoir. Water from this reservoir is allowed to fall through huge pipes to a building that houses water-driven turbines. Pressure from the falling water spins the turbines at high speed. The turbines are connected to huge generators that make electricity as they turn. This electricity is carried to cities and towns that may be located hundreds or even thousands of kilometres away.

Large-scale hydro usually has a big impact on the ecology of the river upstream from the dam. When the reservoir is filled, areas of forest or farmland are covered by water. Dams block the natural migration of fish and other creatures up and down the river, and

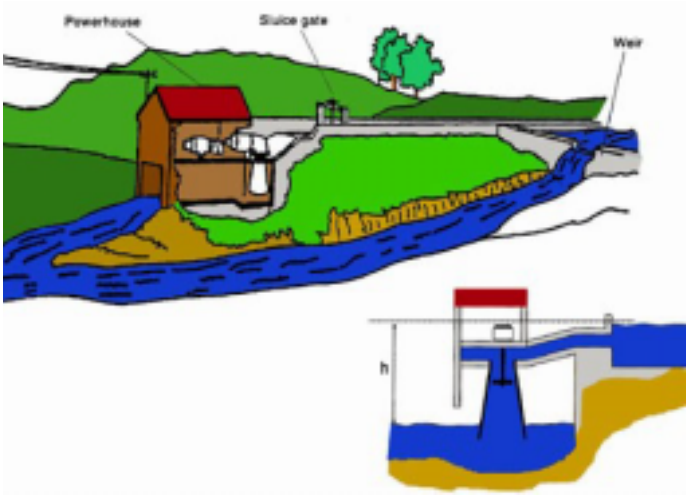
62% of Canada's electricity comes from hydroelectric facilities such as this one in Ontario, Canada.
Photo courtesy of Thunder Alley, Niagara Falls



Fish ladders such as this can help salmon and other migratory fish swim upstream around a dam or other artificial obstructions of the stream.
Photo courtesy of freefoto.com

replace a flowing water ecosystem with an artificial lake. Salmon, which travel up rivers to spawn, are particularly affected by this ecosystem change. To reduce the impact of dams on salmon, some dams are equipped with "fish ladders"-narrow artificial streams up which the salmon can swim to get around the dam.

There can also be environmental problems downstream from the dam. Operations of the dam and generating station often cause the water level in the river to rise and fall drastically on a daily basis. Many organisms including most fish are not well adapted to such frequent and severe changes in water levels. Rivers that experience these changes usually contain far fewer organisms than they would without the dam and reservoir.



A small scale hydro system with a micro-hydro turbine.

Small-scale Water Power

One of the most environmentally friendly ways to make electricity is with a device called a micro-hydro turbine. The turbine itself may be as small as 10 centimetres in diameter, and consists of spoon-shaped cups arranged around the center of a wheel. The wheel is mounted on a shaft that turns smoothly on sealed bearings. Jets of high-pressure water cause the wheel to spin at high speed. The spinning shaft

Small scale hydro installation can bring the benefits of electricity to remote communities without the problems and costs associated with fossil fuel or large dams.

can be used to power a variety of machines, including electrical generators, woodworking tools, pumps, fans, and more.

For communities in remote mountainous regions, small-scale hydro systems have a number of important environmental and social advantages:

- Micro-hydro is simple to install and maintain. The pipes, generators, and other parts are usually cheap and easy to find, and are small enough to be handled without heavy equipment. This is especially helpful in areas where the terrain makes it expensive and difficult to build complex structures.

- Micro-hydro is environmentally friendly. It produces no pollution, and requires only very slight changes to the flow of a small stream. No large dam or reservoir is necessary.

- Because the electricity is produced very close to where it is used, there is no need for an expensive electrical transmission line to carry the electricity to the community from far away.

- Micro-hydro systems are built with simple technology, making it possible for local people with basic training to maintain their own power systems. This reduces the community's dependency on outside sources of energy, and provides valuable local jobs.

Tides and currents are a potential source of clean energy.
Photo courtesy of Marine Current Turbines Ltd.

Lunar Power?
The moon's gravitational pull on the Earth is responsible for rising and falling tides experienced around the world.

Tides and tidal currents are a possible source of vast amounts of electrical energy. Specially designed machines submerged in the water may be able to capture large amounts of energy from the rising and falling tide and from ocean currents. These machines convert the energy of moving water into electrical energy, which is then carried to land via underwater electrical cables.

Tidal power is not without problems, however. The equipment can be damaged by storms and waves, or struck by ships. Tidal electric facilities may also interfere with the natural movement of currents, which can have negative ecological consequences, particularly in shallow bays and estuaries.

Questions
1. Explain how or why electricity derived from moving water can be considered renewable energy.

2. What are some of the environmental problems associated with large-scale hydro dams?

3. What type of location would be best suited for a micro-hydro electrical system?

4. What are the advantages of waterpower over fossil fuel for making electricity?

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