Hydropower Workbook

Grand Valley State University
Regional Math and Science Center

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Hydropower

Shining New Ways of Sustainable Power

Introduction

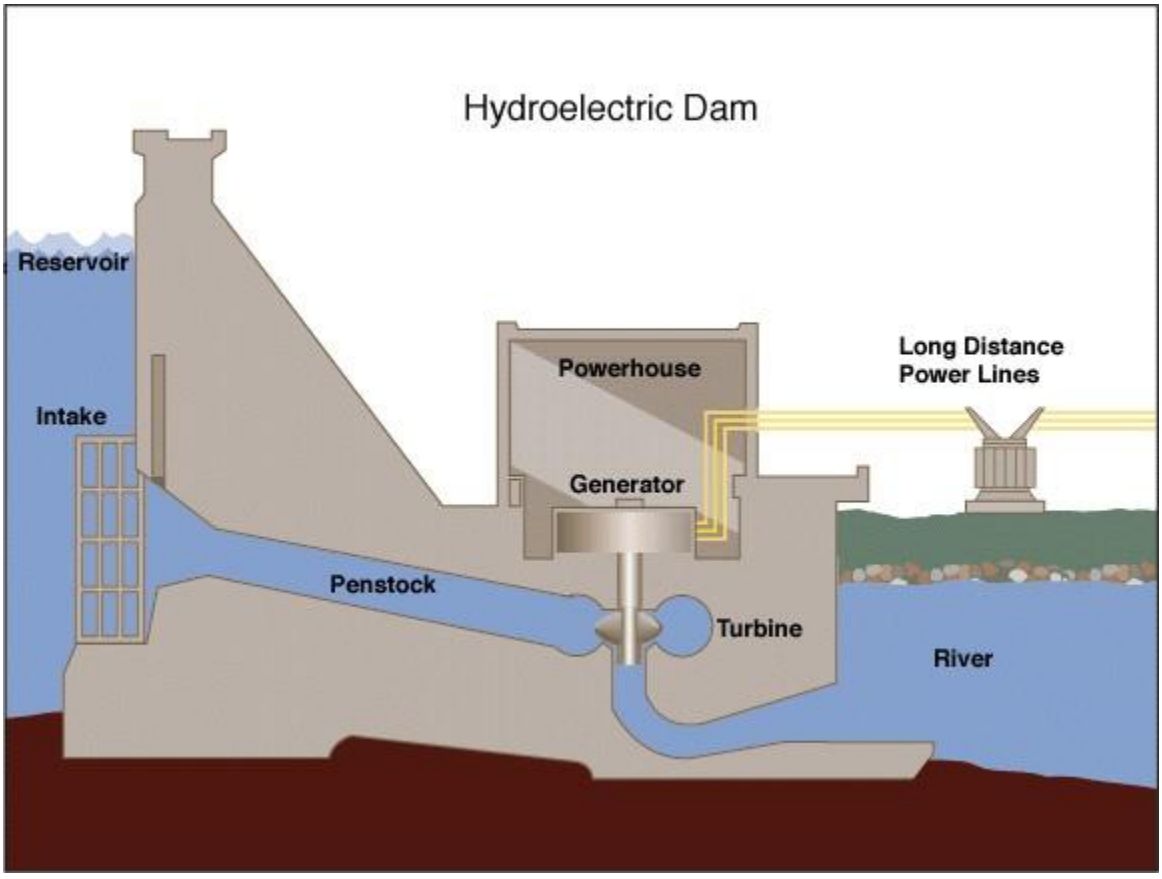
Key terms:

Kinetic energy: the energy of motion.

Mechanical energy: energy that can be used to do work.

Turbine: a machine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a series of buckets, paddles, or blades on a rotor to rotate.

Hydroelectricity: electricity produced by the energy of running water. **Potential energy:** the energy stored by an object as a result of its position.



Hydropower 101 - Check out this video to learn the basics of hydropower and how it impacts the environment!
Hydropower is the renewable energy source that uses flowing water to generate electricity. Hydro plants produce electricity using turbines and generators. The moving water creates mechanical energy that allows motors on the turbine to spin. The turbine is connected to an electromagnetic generator which is able to produce electricity when the turbine spins. Dams and flow of rivers are two main types of hydroelectricity production and they use potential energy from water to generate electricity.

Hydropower has many benefits such as being cost competitive and reliable. It can be used as base-load power, reliable water supply, and can also sometimes help with flood control. But, even though dams have many advantages, they also have some concerns regarding the environment and human safety. Large dams can change wildlife habitat as well as block fish passage, and force people in the riverside communities to move out of their homes. Another concern is that in the case of dam failure there could be some catastrophic consequences to the lives of those who live downstream.

Water Wheel Instructions

Water wheels use the energy of flowing or falling water (or both) to turn the wheel. The axle of the turning wheel can then be used to power other machines. Water wheels have historically been used for many purposes (e.g. milling flour, grinding wood to make paper, and ore crushing) and are a good example of the power of water. With this in mind, you will construct your own water wheel to examine hydropower firsthand. To do this, gather the materials listed below and then construct your water wheel following the instructions.

Activity

Materials

- 2 styrofoam plates
- Small plastic cups of the same size
- Plenty of tape
- Wooden skewer (long thin piece of wood)
- Pencil
- Water

What to do - YouTube Tutorial

Step 1. CAREFULLY puncture a hole through the middle point of each styrofoam plate using a pencil.

Step 2. Take one cup and one plate and tape the cup to the edge of the plate. The lip of the cup should be in line with the edge of the plate.

- Continue this process around the plate for a total of about 5-6 cups taped only to the first plate. The lips of the cups should be touching the edge of the plate and touching each other.

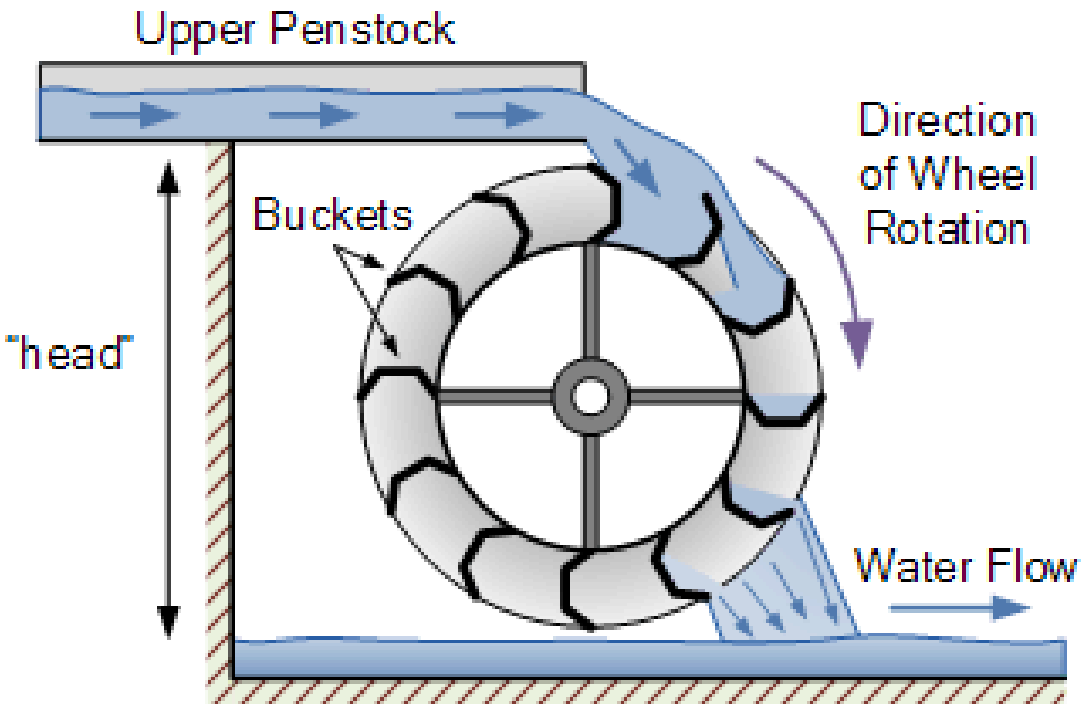
Step 3. Once you have attached all the cups to one of the plates, take the other styrofoam plate and match it with the first plate so that the cups are in the middle, as shown in the picture below. Tape all the cups to the second plate in the same way as you did with the first plate so that they are connected.

Step 4. Once all the cups are attached, poke the skewer through the holes you made in the center of the plates.

Step 5. With hands on both sides of the skewer, hold your water wheel under a sink so that the cups begin to fill with water and the wheel begins to spin!

- Don't pour your water at the very top of the wheel – instead aim for the cups that are slightly down (imagine about 10 o'clock on a clock face). Your wheel should start turning!

You have now created an **Overshot Waterwheel** that functions like the image below.



An overshot wheel includes a vertical wheel with a horizontal axle. A typical overshot wheel has the water channelled to the wheel at the top and slightly beyond the axle. The water collects in the buckets on that side of the wheel, making it heavier than the other "empty" side. The weight turns the wheel, and the water flows out into the tail-water when the wheel rotates enough to invert the buckets. The overshot design is very efficient, it can achieve 90%,and does not require rapid flow.

This specific wheel design is best suited to larger heads than the other types of wheels so they are most often seen in areas with hilly landscapes.

Discussion Questions

Consider the following questions and discuss them with your family and/or friends.

1. What was the purpose of the activity?

2. In your opinion, do pros of hydropower dams outweigh the cons? Why so?

3. What is one thing you learned from this that you didn't know before?

4. In your opinion, how could we further improve dams so that it is not a threat to the wildlife?

5. Do you think there could be a better source of renewable energy other than hydropower?

6. Are there any sources of water in your community that could be (or already are) used to generate hydropower?
    - Consider local water sources, changes in elevation to create power, or potential locations for a hydroelectric plant.

    - To learn more about this, try searching *"Ludington Pumped Storage Power Plant"* for inspiration about ways hydropower is creatively used in West Michigan!

Since you now learned about hydropower and how it works, try explaining it to one of your friends. This will allow you to strengthen your knowledge as well as educate your friend on the importance of hydropower as a source of renewable energy.

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