The Power of Water

This activity center is part of the **Water Science** theme.

What's the purpose of this activity?

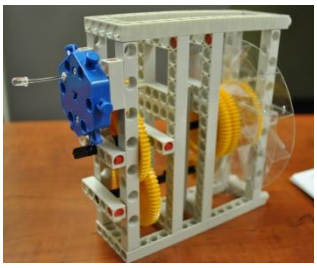
Students will learn about how the force of water is used to generate clean, reliable and renewable energy.

Key messages:

- The energy of moving water has been used by humans for thousands of years to create power. In the early years waterpower was used for flour mills and irrigation systems.
- Waterpower generation was Ontario's first choice of electricity. Up until the late 1950's almost all of Ontario's electricity came from waterpower.
- Waterpower uses the hydrological cycle to make energy – it is renewable (i.e. continuous)
- Waterpower is the most reliable form of renewable power generation, as water is continuously flowing, providing clean, reliable power generation at all times.
- The average waterpower facility converts kinetic energy to electric energy at a rate between 75%-95%

Materials

- 4-5 water wheel models
  - Make sure LED (light-emitting diode) is attached
  - This will light up when electricity is generated



- 4-5 white Rubbermaid tub
- 4-5 pitchers (to pour water over models)
- 4-5 buckets (to hold excess water)
- 4-5 Laminated Model instructions/steps
- OPG Hydropower Plant banner
- Water Cycle poster

Set up:

- Make sure the Hydropower Plant banner is tied up so all participants have a clear view
- Place each water wheel model inside a white Rubbermaid tub
- Spread out each model & tub slightly allowing for small groups of 2-3 students to work at each
- Place a pouring jug and bucket of water beside each model
- Tape down a laminated instruction sheet beside each model
- Test all models to make sure lights come on:
  - If the lights don't turn on, then take a closer look at the gears. All gears need to mesh.
  - Check that the light bulb is inserted correctly.
  - If still no light, replace bulb.

What will I be doing?

Explain to the students that this station is about electricity!

- Ask the students, "How do we/you use electricity?" … think about what you do in a day
  - Let them answer

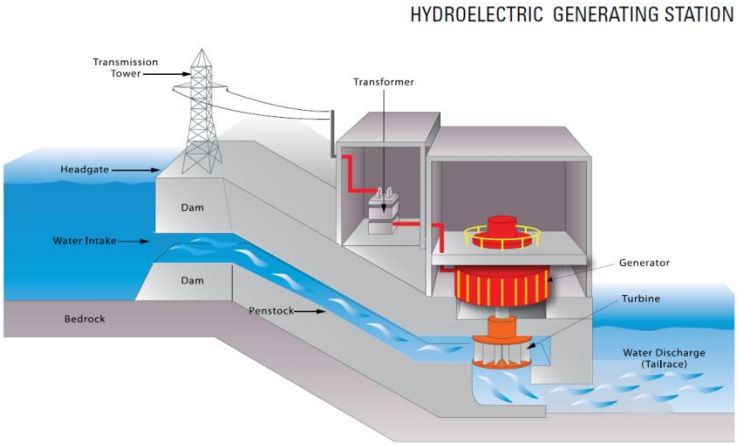
Explain:

Electricity is the flow of electrical power or charge.

- It is a secondary **energy** source.

- Which means that we get electricity from the conversion of other energy sources.
- These other energy sources are called primary sources.
- Do you know what some of these primary sources are?
    - Non-renewable (Fossil Fuels):
        - Coal
        - Natural gas
        - Oil
    - Renewable:
        - Water
        - Sun
        - Wind
    - Nuclear power

At this station, you are going to explore ***The Power of Water***!



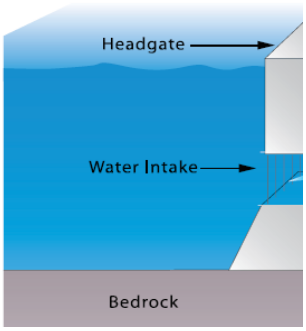
Waterpower …(use the banner as you explain)

- is created by the force of water rushing through a large tube called the penstock which turns turbines.
- These turbines power generators which creates electricity.

There are several types of energy involved (again, use banner as you explain:

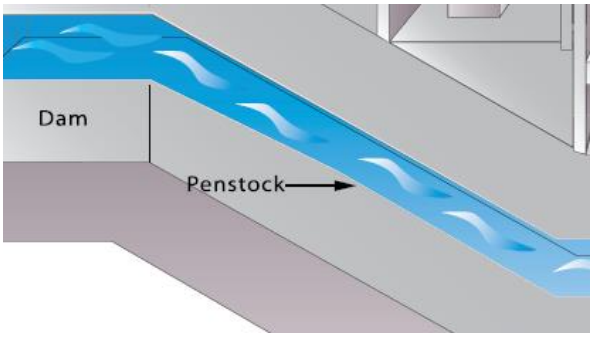
1. The reservoir:

- Is the **Potential Energy** or stored energy.
- It is in the water sitting in the reservoir.



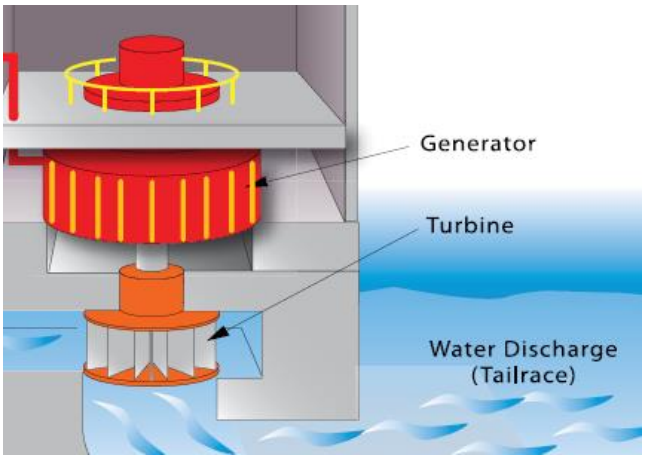
2. The Penstock (or Tube):

- The rushing water flows through the penstock creating **Kinetic Energy** (from the motion)
    - This is like a waterfall!
    - This brings the water into the bottom of the facility or powerhouse.
    - The more water falling from a higher height will generate more force and therefore turn the turbine faster.



3. The Turbine:

- The kinetic energy (from the moving water) is then turned to **Mechanical Energy** as it works to turn the turbines.
- Mechanical energy is energy transferred to an object.



4. The Generator:

- Mechanical energy (from the turbine) powers the generator which then transforms the energy into electricity.
- Electricity the power generated from mechanical energy (voltage/power lines/lights)

5. **Transformer:**
    - Is the apparatus that transfers electrical energy and converts from one voltage to another
6. **Power Lines:**
    - Electricity is then passed along the power lines to supply power to our homes, schools, businesses, etc.

Okay … are you ready to make some sparks? … well, maybe not sparks but your goal is to make some electricity using the power of water!

Introduce the water models:

- These models have water wheels which are the turbines.
- The spinning water wheel (turbine) moves the generator which makes electricity.
    - The generator's axle has to turn very quickly for it to work.
- You will see if electricity is being made by the light!
- These models have a three-stage transmission with each gear having a transmission ratio of 1 to 3.
    - This means that when the water when is turning at a rate of 100 rotations per minute, the generator shaft will be turning at a rate of 900 rotations per minute!
    - So, we need the wheel to spin fast.

Try these 3 different steps:

Step 1:

- Pour water on the wheel so that it turns in one direction.
    - Did the light turn on?
- Now pour the water on the wheel so that it turns in the other direction.
    - Did the light turn on?
- Does it matter which way you make the water wheel turn to make electricity?
    - Yes!

Step 2:

- With the pitcher close to the model, pour the water onto the water wheel and make it turn as fast as you can.
- Did the light turn on?
    - Slightly
- Did the light turn on easily?
    - No

Step 3:

- With the pitcher higher above the model, pour the water into the water wheel and make it turn as fast as you can.
- Did the light turn on?
    - Yes
- Did the light turn on easier or harder than in Step 2?
    - Easier
- Why?
    - The water fell from a higher distance and fell with greater force.

Step 4:

- Now, make sure there is enough water at the bottom of the tub to partially submerge the bottom of the wheel.
- Was it more difficult to get the light to come on?
    - Yes
- If so, why?
    - The water wheel has more resistance and therefore more water and more force is needed to turn it enough.
    - Therefore the generator is not being engaged enough to make electricity.

Step 5:

- What 2 factors of the water hitting the water wheel contribute to the amount of electricity is made (how the light turns on)?
    - Amount of water (volume)
    - Distance above wheel (how far the water falls)

Let the students work with the models.

Clues for the students if they need help …

- If the lights turn on, everything is working the way it should.
- The water wheel will spin at such a force to transmit electricity depending on the flow and speed (velocity) of water.

Debrief:

1) Discuss the student's findings with the Water Wheel and production of electricity.

2) Start a discussion on "Renewable" … ask students what this means in terms of water.

Hydrological Cycle Description: (use poster)

- The hydrologic cycle begins with the evaporation of water from the surface of the ocean.
- As moist air is lifted, it cools and water vapor condenses to form clouds.
- Moisture is transported around the globe until it returns to the surface as precipitation.
- Once the water reaches the ground Some of the water may evaporate back into the atmosphere or the water may penetrate the surface and become groundwater.
- Groundwater seeps its way to into the oceans, rivers, and streams, or is released back into the atmosphere through transpiration.
- The balance of water that remains on the earth's surface is runoff, which empties into lakes, rivers and streams and is carried back to the oceans, where the cycle begins again.

3) Can you think of any other renewable energy sources?
   - Solar
   - Wind

4) Remember the work needed to generate electricity?
   - Remember that the next time you turn on your computer, television or lights. Water is an extremely powerful tool, but we also need to respect its power
   - Ask the students what are some things they can do to conserve electricity …
     - Turning of lights/electronics when not using, using LED lighting, etc.
     - Try using electricity during low peaks to save energy
       - We pay for energy and will also save money if they conserve.

Additional Background Information:

Electricity in Ontario (source Ontario Power Generation)

About half of our electricity comes from nuclear power. The remainder comes from a mix of hydroelectric, coal, natural gas, solar 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.

Energies:

- Potential Energy - the stored energy an object has because of its position or state. A bicycle on top of a hill, a book held over your head.
- Kinetic Energy - The energy an object has due to its motion. Mechanical Energy
- Mechanical Energy - It is all the energy that an object has because of its motion and its position. It is often defined as the ability to do work. All living things and all machines use mechanical energy to do work.

How you measure a unit of electric power?
Most of us understand electricity in Watts, for example:

- Light bulbs – 25 W, 40W, 60W, 100W
- A Kilowatt = 1,000 Watts (kw).
- The average household uses approximately 1000 kw/hr per month.
- Power generation in waterpower generating facilities is measured in MW.
  - Megawatt = 1 million Watts (MW)
- The average small generating facility creates approximately 3 – 5 MW of power … or enough electricity to power 2400 households.
- Power (watts) = Voltage (volts) x current (amps

Peak Energy Demands
What does this mean?

- Everyone gets home from school/work at the end of the day and turns things on.
- This means a higher need for electricity because more people are using it at the same time
- This is called high peak demand.
- When we sleep or are outside and electronics are turned off, this is low peak times/demand.

Dam Safety

Stay Clear and Stay Safe. Stay away from dams and generating stations. Pay attention to buoys, fences and signs. Explain…

Clean Up Procedures:

Empty all water back into buckets and jugs

Stack white rubbermaid tubs and place into storage bin.

Place models safely back into storage bin

Place laminated instruction sheets back into bin

Leave banner in place, unless this is the last day of the waterfestival, then carefully take down and roll up. Place on storage bin.