CONSERVATION STATION

WEEK OF RESOURCEFULNESS CLASSROOM ACTIVITY

TOPIC

Improving Water Efficiency

KEY LEARNING OBJECTIVES

Students will be able to:

- **Discover** how turbines can be used to convert the kinetic energy of flowing water into electricity that can be used by people
- **Design** a simple water turbine that will maximize efficiency and produce the most energy.

OVERVIEW:

In this activity, students will view a demonstration of a water turbine in action that is made with an empty soda bottle, dowel rod, and simple straight plastic fins. The water turbine will spin, producing kinetic energy as water is poured over the external fins. Students will count the number of rotations that the turbine makes as the water is poured over it.

When the demonstration is complete, students will be asked to think about how they could design a water wheel that can spin faster to create more energy using materials provided, such as small cups, plastic spoons, long pieces of plastic, different shapes/sizes of plastic bottles, etc. Students will get into groups and be given 10 minutes to create a 2-D design or drawing of a more efficient water turbine, that shows how the original would be improved upon with the materials provided in the classroom.

Each group will briefly pitch their design improvements to the class and explain how their modification would increase the efficiency of the water turbine. The class will vote on the best design, or if time allows winning designs can be created and tested to end the activity.

CONNECTION TO THE ENERGY-WATER NEXUS

- The movement of water can be used to produce energy, called hydroelectric power or hydropower
- Hydropower is considered to be a renewable source of energy

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NATIONAL STANDARDS

Science

Next Generation Science Standards

MS-PS3-4 Energy

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

BACKGROUND INFO

Have you ever wondered why we build huge dams? It may seem like the purpose must be to stop water from moving, but in actuality it is to use the power of water that is moving! The use of water to help power the tasks for people is called hydropower.

Hydropower produced by a dam harnesses the kinetic energy of water flowing down through a turbine. As the water turns the turbine, the generator attached to it creates electricity. This electricity can then be fed into the power grid and send to homes and businesses to help power all the things we require energy for in our daily lives.

But the best part about using water for energy is that water isn't used up! Because water will continue through the water cycle, returning to the atmosphere and then falling back to earth's surface, we can consider hydropower to be a renewable source of energy that can be used again and again.

KEY VOCABULARY

Hydropower

Kinetic energy

Water cycle

Turbine

MATERIALS

- Empty plastic 2L or 20oz. soda or water bottle
- Scissors
- Thin wooden dowel rod (must be longer than the length of the plastic bottle)
- Duct tape

- String
- Small art knife or box cutter
- Plastic pieces for the turbine fins (cut from another soda bottle or stiff plastic sheet) **Number and shape/size of fins for the demonstration turbine can be determined by the instructor*
- Drill
- Permanent marker
- Hot glue
- Hot glue gun
- Timer or stopwatch
- Source of water—faucet or hose

TEACHER PREPARATION

Teacher will need to make the demonstration water turbine before the lesson:

1. Drill holes through the cap and bottom of the plastic bottle—wooden dowel rod must be able to fit through these holes and allow the bottle to spin easily.
2. Use the small art knife/box cutter and scissors to make straight cuts through the body of the plastic bottle that will allow the plastic fins to fit snugly in them, so that they will not fall out when water passes over them.
3. Hot glue can be used to secure the fins to the body of the bottle.
4. Use the permanent marker to clearly mark one of the fins. This mark will make it easier to count the number of rotations that the turbine makes.
5. Thread the dowel rod through the holes on the ends of the bottle, so that it will act as an axle for the bottle to spin around.
6. Test out the turbine to ensure that it will spin when water passes over the external fins.

*Teachers may want to make more than one demonstration water turbine; this will allow student groups to experiment with the turbines themselves as create their designs for more efficient turbines.

PROCEDURE

1. Begin by displaying a picture of a hydroelectric dam (such as the Hoover Dam in Nevada, see image right) in the front of the classroom and asking students if they know why we build dams such as these. Allow students to share their initial ideas with the class.

Image 1: Hoover Dam

2. Direct students to the **Resourcefulness: An Introduction to the Water-Energy Nexus app** on their devices at http://stem.guide/water-for-energy/ and read the sections "Hydroelectric Energy" and "Energy From Falling Water." When students finish reading, ask them to share why dams are considered to be a very efficient source of energy.
3. Next, play the following short video clip https://www.youtube.com/watch?v=PvJHjnELVSM that explains how a dam works. After viewing the video, ask students to identify the importance, or role, of a turbine in the production of energy from the dam.
4. Explain to students that their task is going to be to design a simple water turbine that will maximize efficiency. This means it will spin at the fastest rate, which will in turn produce the most energy if the turbine was attached to a generator.
5. Using the pre-built bottle water turbine, demonstrate to students how the turbine will spin as water moves over the fins. (This could be done in a sink with a faucet, or outside using a hose, if available.)
6. Have students form small groups. Ask them to think about the design of the bottle water turbine. How could they change or alter the design of the turbine to maximize the spinning as water passes over the fins? Could they change the shape of the fins? Add more fins? Make them out of a different material?
7. Give student groups 10–15 minutes to discuss their ideas and create a simple sketch explaining how they would alter the design of the water bottle turbine to maximize its efficiency. If students have access to devices (laptops or tablets) the teacher may choose to allow them to do research using the internet to help them in their design improvements.
8. When the design and sketch time is complete, ask each group to choose a spokesperson to share their group's design improvements and sketch with the class.
9. To summarize, the teacher may ask students to vote on which design they feel would be the most efficient, students may share who they voted for and why they voted for that particular design.

EXTENSION

An extension of this lesson could require that student groups use the ideas in their design sketches and simple materials to build their improved design of the water turbine. Groups could then test the improved bottle water turbines in a head-to-head competition and count the number of rotations in a given time period to determine which design allowed the bottle to make the greatest number of rotations, which would allow them to produce the most energy.

SOURCES

https://www.energy.gov/articles/ensuring-resiliency-our-future-water-and-energy-systems

https://www.energy.gov/policy/initiatives/energy-water-nexus

http://www.iwa-network.org/hydroelectric-power-and-the-water-energy-nexus/

https://www.energy.gov/eere/water/how-hydropower-works

Resourcefulness App: stem.guide