Energy Transformation and Hydroelectric Power

Sixth Grade
Activity: 8
Time: 1-2 Class Periods

General Description

Students will explore the difference between kinetic and potential energy. Students will also discover how a hydroelectric dam works to change potential energy into electrical energy. They will identify the locations of hydroelectric dams in Arizona.

Objectives

Students will explore potential and kinetic energy.
Students will explain and provide examples of how potential energy is use to make things move.
Students will compare how energy can be transformed: mechanical to electrical.
Students will identify the locations of hydroelectric dams in Arizona.

Arizona State Standards

SC06 S5C3 PO1 Identify various ways in which electrical energy is generated using renewable and non-renewable resources (e.g., wind, dams, fossil fuels, nuclear reactions)
SC06 S5C3 PO2 Identify several ways in which energy may be stored
SC06 S5C3 PO3 Compare the following ways in which energy may be transformed:

- mechanical to electrical
- electrical to thermal

W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic

Teacher Information

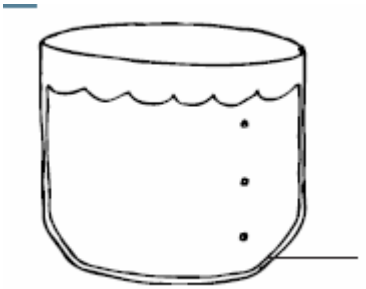
Potential energy is energy that is stored in an object or substance. Typically this stored energy is as a result of gravity. When an object is moved in the opposite direction of gravity or the force acting on the object potential energy is built up. For example, when a ball is lifted off the floor, energy from the muscles in the hand that lifted it plus the force of gravity energy is transferred to the ball. The ball has the "potential" to fall and transform its potential energy into kinetic energy (the energy of motion). The farther something is lifted off the ground (in the opposite direction of gravitational force), the more potential energy it will have. This principle is used in dams to generate electricity. The potential energy of the water behind the dam is used when the water is released and changed into kinetic energy as it falls. Water pressure plays a significant role in determining where and how to release the water. The release of water is most effective near the bottom of the dam because of the greater amount of water pressure/ gravitation force from above.

Materials

Activity Cards 6-8a,6-8b, 6-8c, 6-8d, 6-8e, 6-8f, 6-8g
Plastic two-liter soda bottle with the top cut off
Small picture hanging nails
Rubber bands
Meter sticks
Ramp-made out of scrap wood
Small toy cars (i.e. Matchbox)

Set up Directions

Punch three holes in a vertical line with small nails: one near the top, one near the middle, and one near the bottom. See picture to the right. Leave the nails in the bottle and fill with water. (If the bottle leaks too much either tape the holes or use volunteers to cover the holes with their fingers.)



Procedures/Exploration

1. Discuss potential of kinetic energy with the students. Give the students a rubber band (be sure to have safety rules in place) and have the students barely stretch the rubber band, ask them how far they think it will go, and then let go.
2. Have them measure how far it traveled.
3. Ask them what they have to do to make the rubber band go the furthest. Have them investigate if their idea is correct. They should use the meter stick to measure how far the rubber band went.
4. Provide time for the students to share their ideas/discoveries.
5. Give the students a toy car and a wooden ramp.
6. Have them explore how they will use the ramp to make the car go the furthest.
7. Teacher Note: the higher the ramp the further the car should travel.
8. Ask them to explain how height/opposite force caused the car/rubber band to move. Have the students explain the difference between potential and kinetic energy.
9. Hand out the Hydroelectric Information sheet (Activity Card 6-8a). Read the information and discuss the vocabulary words.
10. Show the students the two-liter bottle of water with the push pins. Ask the students to predict what will happen if all three nails are removed at the same time. Ask if they think there will be a difference in the amount of flow or the force of the flow from each hole. Remove nails. (Students should see that the bottom hole produces a stronger, longer stream of water due to the increased water pressure.)
11. Have students record their predictions, observations and hypotheses as to why this occurred on the Hydroelectric Data sheet (Activity Card 6-8b).
12. Discuss the implications this has for the construction of dams. See Turning on the Switch Teacher Information Sheet (Activity Card 6-8c) (The lower the water is released from the dam, the more forceful the water is - due to the pressure of the water.)

On the Turning on the Switch sheet (Activity Card 6-8d), have the students color the steps in producing electricity from falling water.

13. Hand out the map of Arizona Dam Sites (Activity Card 6-8e and 6-8g) and have students label the correct names using the chart. Activity Card 6-8f has the answers.
14. Discuss the importance of hydroelectric power with the students. Have them brainstorm a list of pros and cons for electricity generated by hydroelectric power plants.

Hydroelectric Information

Sixth Grade
Activity: 8
Activity Card: 6-8a

Making electricity from falling water is called hydroelectric generation. The Salt River Project has dams at six reservoirs: four have generating facilities. In these hydroelectric units, water is released from the reservoir through a tube called a penstock. At the bottom of the dam, in the powerhouse, this water is forced past a series of bladed wheel-like structures attached to a shaft. These are called turbines.

The pressure of the water rushing past the blades turns the shaft very rapidly, which turns the rotor on the other end of the shaft inside the generator. The generator is made up of a shaft with a huge coil of wire that spins within a magnetic field. This generates electricity. The generator changes mechanical energy into electrical energy, making electricity. Before the electricity is sent to homes, the transformer changes the electricity to the appropriate voltage for it to travel long distances. Before it can be use by homes, schools and other buildings different transformers change the voltage again to 120/240 Volts.

Hydroelectric generation is one of the most inexpensive methods of making electricity because it does not consume natural resources. It is also environmentally clean because no waste is produced. However, there are virtually no new sites in the Southwest that are economically or environmentally feasible for new hydroelectric generating sites. SRP and other Western utilities must rely on more expensive fuels for most power generation.

Glossary

Potential energy- stored energy in an object or substance such as water behind a dam or a car at the top of a roller coaster.

Kinetic energy- energy of an object or substance that is moving.

Turbine- a bladed, wheel-like machine which is made up of a spinning shaft of wire rotating within a magnetic field.

Generator- a device that converts mechanical energy into electrical energy.

Transformer- a device used to change the voltage of an electric current.

Hydroelectric Data

Sixth Grade
Activity: 8
Activity Card: 6-8b

Water Flow Demonstration

1. Observe a two-liter bottle with three vertical holes punched in it. The holes should be covered or plugged with small nails. Predict what will happen when the bottle is filled with water and the holes are uncovered at the same time.

2. Observe the water that flows out of the holes. What happened?

3. What do you think caused this to happen?

4. What implications does this have for the construction of a dam?

Turning on the Switch Teacher Information

Sixth Grade
Activity: 8
Activity Card: 6-8c

1. Explain to the students that other power plants may have other primary energy sources.
2. Distribute Activity Card 6-8d. Have the students point to the building. Questions:
   What is this building called? (power plant, hydroelectric plant)
   What is the purpose of this plant? (produces electricity)
   Where is the electricity sent? (to cities, towns, businesses and homes)
   How is the electricity sent to these places? (through wires)
3. Answers:
   - Color the area from the filter to the turbine blue
   - Color the area that extends from the turbine out of the plant in the form of waste red.
   - Color the turbine orange.
   - Color the generator brown.
   - Color the transformer black.

Glossary

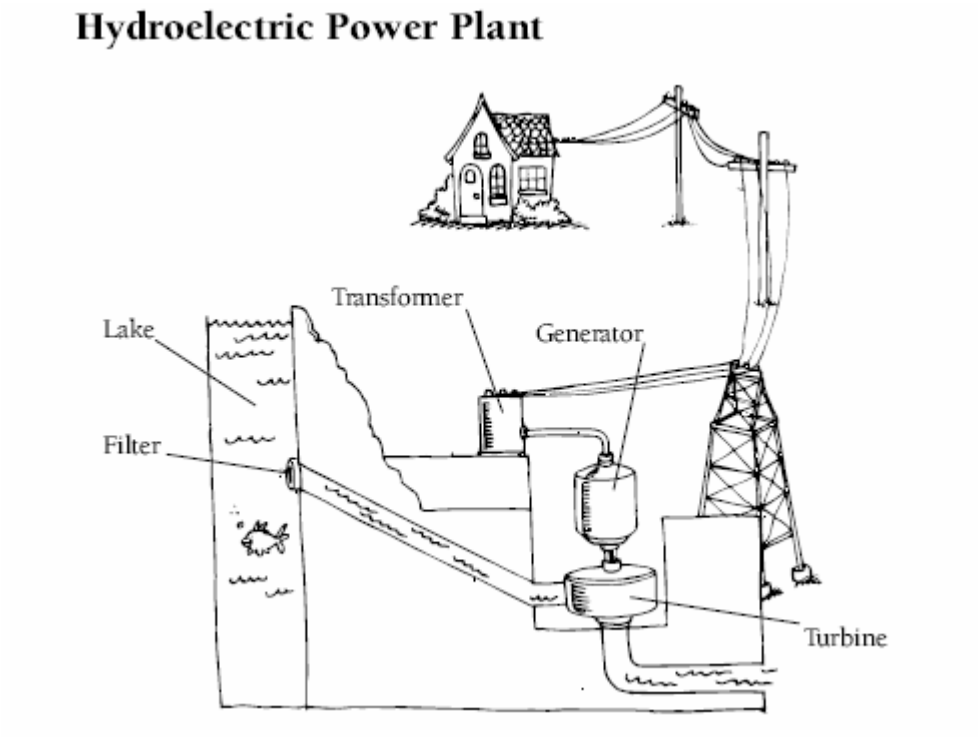
Turbine – a bladed, wheel-like machine which is made up of a spinning shaft of wire rotating within a magnetic field.

Generator – a device that converts mechanical energy into electrical energy.

Transformer – a device used to change the voltage of an electric current.

Turning on the Switch

Sixth Grade
Activity: 8
Activity Card: 6-8d



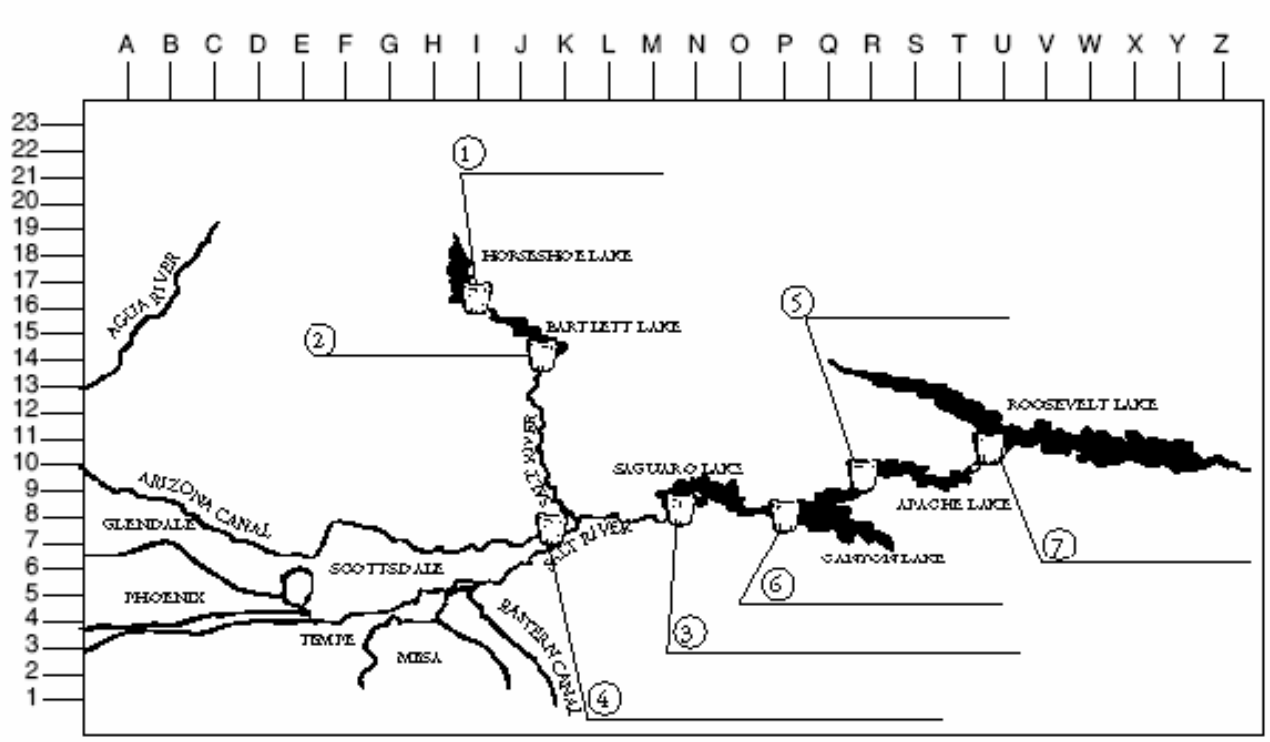
Directions

1. Show how the lake water flows to the turbine by coloring the water blue.
2. Trace the flow of water from the turbine out of the plant by coloring it red.
3. Color the device orange that uses the movement of water to generate mechanical energy.
4. Color the device brown that changes mechanical energy into electrical energy.
5. Color the device black that changes the voltage of the electricity, making it safer for our homes.

Arizona Dam Sites

Sixth Grade
Activity: 8
Activity Card: 6-8e

Directions
Using the descriptions of the dams on Activity Card 6-27, locate and write in the names of the dams on the map below.



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Arizona Dam Sites Teacher Information

Sixth Grade
Activity: 8
Activity Card: 6-8f

Answer Key

1. Horseshoe Dam (I-17)
2. Bartlett Dam (K-14)
3. Stewart Mountain Dam (N-9)
4. Granite Reef Division (K-8)
5. Horse Mesa Dam (R-10)
6. Mormon Flat Dam (P-8)
7. Theodore Roosevelt Dam(U-11)

Arizona Dams Site Information

Sixth Grade
Activity: 8
Activity Card: 6-8g

Verde River Dams

U-11 Theodore Roosevelt Dam - The first dam built to supply a dependable water source to the Valley was the Theodore Roosevelt Dam, completed in 1911. It has a generating capacity of 36,000 kilowatts (kw). Roosevelt Lake, which is formed by Roosevelt Dam, at the conflux of the Salt River and Tonto Creek, has a capacity of 1,381,580 acre-feet of water and a shoreline of 88.35 miles. (An acre-foot of water is enough water to cover an acre one foot deep or 325,850 gallons. The abbreviation is af.) The dam was named for the President of the United States Theodore Roosevelt.

R-10 Horse Mesa Dam - Completed in 1927, Horse Mesa Dam has the generating capacity of 130,800 kw. Apache Lake, which is formed by Horse Mesa, has a capacity of 245,138 af of water. Horse Mesa Dam was named because it was built near a mesa allegedly used for hiding stolen horses.

P-8 Mormon Flat Dam - Completed in 1925, Mormon Flat Dam's generating capacity is 60,200 kw. Canyon Lake, which is formed by Mormon Flat Dam, has a capacity or 57,852 af of water. Mormon Flat Dam was named for a small Mormon community once located at the site.

N-9 Stewart Mountain Dam - This dam was completed in 1930. It has a generating capacity of 12,500 kw. Saguaro Lake, which is formed by Stewart Mountain Dam, has a capacity or 69,765 af of water. The dam was named for nearby Stewart Mountain, landmark of the old Stewart Ranch.

Salt River Dams

K-14 Bartlett Dam - Like Horseshoe Dam, Bartlett Dam has no generating capacity. Bartlett Dam was completed in 1939. Bartlett Lake has a capacity of 178,477 af of water.

I-17 Horseshoe Dam - Has no generating capacity. The dam was completed in 1946. Horseshoe Lake has a capacity of 2,800 af of water.

K-8 Granite Reef Diversion Dam - The purpose of the Granite Reef Diversion Dam is to divert water from the river into the canals north and south of the river for delivery to water users within the Project. No water is stored, and no power is generated at Granite Reef Dam. There are no recreational facilities. Constructed in 1908. The dam is only 29 feet high and is 1,000 feet long.