Exploring Hydropower

Overview: The students will investigate the hydropower by finding the potential energy for hydropower at a creek flowing into a reservoir.

Keywords: Hydropower, gravitational energy, electrical energy

Age / Grade Range: 10-12

Background:

Hydropower plants usually involve a dam across a river to hold back water in reservoirs. This stored water is released to flow through turbines, spinning generators to produce electricity.

There are different types of dams: a gravity dam (built of concrete), an embankment dam (made of compacted rock or earth), an arch dam (built in a narrow canyon- Glen Canyon Dam), and a buttress dam (a narrow wall supported by buttresses on the downstream side) (The NEED Project, 2012).

There are three main parts of a typical hydropower plant: the reservoir, dam, and power plant (turbines and generators). The reservoir stores the water until it is needed. The dam contains the water; there are openings in the dam to control its flow. The power plant converts the energy of the moving water into electricity (The NEED Project, 2012).

Hydroelectricity is at the core of power in Idaho. According to Idaho Power (2013), which operates 17 hydropower plants throughout the state, hydroelectricity is the company's largest source of electricity. With that being the case, water is an extremely important energy resource for the state of Idaho.

Next Generation Science Standards & Common Core:

Core Idea PS3: Energy
- PS3.A: Definitions of Energy

Core Idea ESS2: Earth's Systems
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate

Core Idea ESS3: Earth and Human Activity
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Core Idea ETS2: Links Among Engineering, Technology, Science, and Society
- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Goals: Students will visit a dam and reservoir used for irrigation, and learn about the basic aspects and functions of a dam. Students will measure the potential

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energy of a creek that flows into a reservoir and calculate the potential hydropower energy that could be used from that creek. Students will also assess the advantages and disadvantages of using hydropower and the effects of climate change on hydropower. If time, students will also take a tour of an actual hydropower site.

- What forms of energy are present in a hydropower system?
- What is the basic structure of a dam?
- How can we measure the potential energy for hydropower of a stream?
- What are the advantages and disadvantages of using hydropower?
- In what ways might climate change affect hydropower in Idaho?

Objectives:

- Students will identify the terms gravitational energy, motion energy, and electrical energy in relation to dams and hydropower.
- Students will explain the parts of a dam give examples of different types of dams.
- Students will calculate the potential energy for hydropower in a stream.
- Students will distinguish the advantages and disadvantages of using hydropower.
- Students will summarize the effects of climate change on hydropower in Idaho.

Materials:

- Types of dams visual
- Structure of dam/energy flow visual
- Flow meter
- LabQuest
- Meter tape & meter stick
- Waders
- Calculator
- Field Notebooks+ Pencils

Set up:

A pre-visit to the dam/reservoir/creek site to survey where it would be best to do activities and measurements might be necessary if the instructor is not familiar with the area. In addition, scheduling a dam tour or scouting out an area to observe may also be necessary to do beforehand.

Classroom Time:

This lesson can be completed in the field in a 1-2 hour time period. Similar lessons to be completed in a classroom can be found under *Additional Resourcs.*

Introduction (Engage):

Ask students to list the different forms of energy (chemical, nuclear, radiant, thermal, sound, etc.). Tell the students that today we are going to be talking

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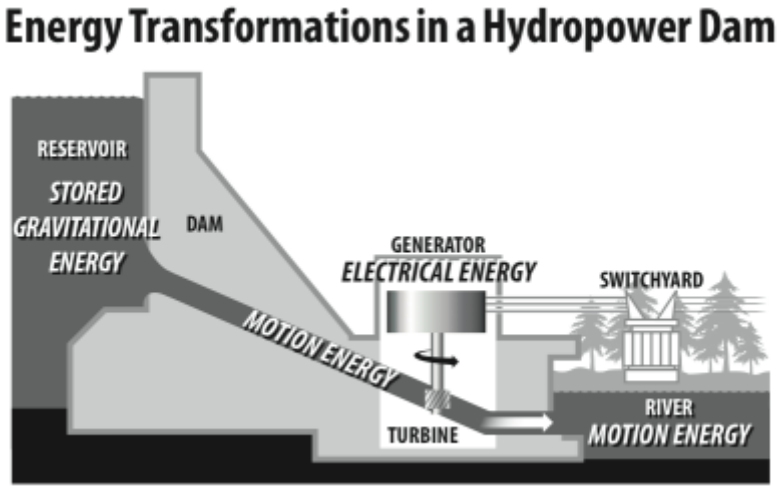
about:
Gravitational Energy: stored energy that an object has because of its height above the earth
Motion Energy: energy that a moving object has
Electrical Energy: energy of charged particles called electrons

- Students will take a short period of time to safely explore the dam area/reservoir , drawing a diagram of the reservoir and dam and labeling on their drawing where there might be different forms of energy. Think, Pair, Share to discuss their findings.



Activity (Explore):

- Students will measure the potential energy for hydropower at the creek flowing into the reservoir using the calculation:

  P = D x H x W where,

P= Potential Power of the creek (mkg/sec)

D= Discharge (m3/sec)

Note: Discharge = Width (m) x Depth (m) x Velocity (m/s)

H= Head or width of creek section (m)

W= Specific weight of water (always 1000 kg/m3)

- Students will split up into three groups and work in different areas of the creek.

- First, students will need to find the discharge (the volume of water flowing through at a given time) of the creek. Students will need

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waders to cross the creek while using a meter tape to measure the width (m). In the same general area, students will take depth measurements (m) in three locations with a meter stick and then take the average. Lastly, students will use the flow meter and LabQuest to measure the velocity (m/s) of the creek. Students will use their measurements to calculate discharge using the following formula: *Discharge = Width (m) x Depth (m) x Velocity (m/s)*

- Students now have enough information to calculate potential energy for hydropower for their section of the creek.

  P = Discharge x Head x 1000

- Answer will be in mkg/s. Student must convert this answer to an answer in kilowatts.

- 1 kW = 101.971621298 mkg/s

Explanation

- Once they are done with the calculations students will come together to share their answers and experiences. Students will also compare their findings in kilowatts to the amount of kilowatts needed for a hydropower plant. According to their data, what kind of infrastructure could be supported if this creek was used for hydropower?

- A micro hydropower plant has a capacity of up to 100 kilowatts and a small hydropower plant has a capacity of up to 30 megawatts (The NEED Project, 2012).

- A micro or small hydroelectric power system can generate enough electricity to provide power to a home, farm, ranch, or village. Large hydropower facilities have capacities greater than 30 megawatts and supply many consumers. (The NEED Project, 2012).

- Explain the different types of dams. Ask students if they can name any famous dams or any they have visited.

Elaboration:

Students will break up into three groups again and make predictions on how climate change might affect hydropower systems. Each group will write down three predictions and present them to the rest of the group.

Evaluation:

Stakeholder Debate

- Students will divide into two "stakeholder" groups: the power company and the environmentalists.

- In each group, students will create a platform for why hydropower is or is not important to them and advantages or disadvantages of using

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hydropower in Idaho. Students must think critically in order to defend their given perspective and give legitimate reasons to support their claims. Each group will generate good notes and plan who will say what during the debate.

- Students will come back together and the instructor will ask questions to each group such as: Why do you think hydropower is good or bad for Idaho? What impact does hydropower have on ecosystems? Should we build more dams in Idaho, why or why not? Will climate change negatively or positively affect hydropower use for energy? Explain.
- Emphasis will be put on answering questions with respect and constructive feedback.

After each student has had a chance to speak for their team, each group will write a closing statement concerning the most significant point that was made during their debate. A representative from each group will read the statement and the debate will conclude.

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Additional resources:

Virtual Hydropower Prospector is a GIS tool designed to assist in locating and assessing natural stream water energy resources in the United States.

http://gis-ext.inl.gov/vhp/Default.aspx

Energy for Educators is an online source for lesson plans on renewable energy offered by the Idaho National Laboratory. Lesson plans exist for elementary, intermediate, and high school levels on topics of wind, solar, geothermal, nuclear, hydro, biomass and energy.

http://www.energyforeducators.org/index.shtml

The Nation Energy Education Development (NEED) Project is designed to offer teachers hundreds of resources to educate students on renewable energy sources. The NEED Project offers curricular guides for K-12 teachers. Lessons include both a teacher and a student handbook. Students may find games, puzzles, activities, and science fair projects.

http://www.need.org/

http://www.need.org/needpdf/Exploring%20Hydroelectricity%20Teacher.pdf

Energy Education Resources: Kindergarten Through 12th Grade is published by the National Energy Information Center (NEIC), a service of the Energy Information Administration (EIA), to provide students, educators, and other information users a list of generally available free or low-cost energy-related educational materials.

http://www.eia.doe.gov/bookshelf/eer/kiddietoc.html

Literature Cited:

Idaho Power Company (2013). http://www.idahopower.com/AboutUs/EnergySources/FuelMix/generationResources.cfm

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The NEED Project (2012). Exploring hydroelectricity. http://www.need.org/Curriculum-Guides-by-Grade-Level

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