TITLE: Ocean Energy and Education

KEYWORDS: alternative energy • waves • ocean currents • electricity

Waves are a potential energy source for the future.

ABSTRACT: As the population of this planet continues to increase, and the availability of nonrenewable sources like fossil fuels remains limited, there is a need to identify and develop new sources for our electrical energy needs. One potential source of renewable energy that has the potential to be harnessed in North Carolina is converting energy from the natural motion of water through ocean currents and ocean waves into electricity.

UNC Coastal Studies Institute (UNC CSI) currently leads an effort to check the feasibility of this type of energy for North Carolina. The UNC CSI Ocean Energy program is focused on identifying the resource that is available offshore, engineering new technology for energy storage and transfer, and understanding the impacts energy creation could have on surrounding environments. This program will introduce the subject of ocean energy, outline the types of technology used to harness energy from the ocean. Students will explore the basics of electricity through an activity where they build a basic generator.

OBJECTIVE: Inspire students to think about energy challenges we face, and the role of alternative energies could play for future power production.

TIME: 1.5- 2hr **GRADE LEVEL**: 7-12

STANDARDS: 7.P.2, 8.P.2, 8.E.1, PSc.3.1, PSc.3.2, PSc.3.3, EEn.2.8, Phy.2.1, Phy.2.2, Phy.3.2

SUPPLIES:
Presentation:

- Powerpoint
- Internet for videos
- Projector

Shake-a-generators

- 35mm film canister
- Insulated copper wire (30 guage magnet wire)
- Magnets (neodymium magnets work best)
- Sandpaper
- Scissors
- Tape
- Voltmeter

BACKGROUND: Cape Hatteras juts out into the Atlantic Ocean in a place where currents converge creating a very dynamic and powerful environment. It has been the goal of UNC Coastal Studies Institute to lead a program in partnership with schools of engineering at UNC Charlotte, NC State, East Carolina University and NC A&T to investigate the power potential available off the coast of NC. The mission of the North Carolina Renewable Ocean energy Research Program is "Conceptualize, research, design, construct, operate and market new technologies to harness the energy of the ocean." UNC CSI is focused on four research initiatives: assessing the power available in the Gulf Stream, improving the efficiency, maintenance and power outputs of renewable devices, assessing the environmental impacts and regulatory concerns, and assessing marine hydrokinetic device testing in the field.

Assessing the power available in the Gulf Stream includes oceanographers using Acoustic Dopler Current Profilers (ADCPs) to research the movement of water in the currents. They are attempting to define the western edge of the Gulf Stream, and are searching for the ideal location for placing an energy-capturing device. The Gulf Stream is a warm water current flows at an average speed of 5 mph, just 15 miles off the coast of Cape Hatteras and has more power in water movement then all the rivers in the world

combined. There is immense potential as an alternative energy source if we can identify the most consistent and economical location.

Researchers have also been working on creating gears that use magnets to run and don't actually touch each other. These magnetic gears would reduce on maintenance issues and last longer before wearing out. Many of the ocean current alternative energy devices may be deployed at deep depths, and servicing and maintaining them is a significant challenge. These gears will also convert the low rotational speed of renewable energy sources to a high rotational speed needed for power generation. There is also on-going research on ways to store electrical current until it is needed. Researchers are working on a compressed-air gas storage device that would take advantage of the pressure gradient to store energy as compressed gas under water and would be released from depth and run through a gas expander with generator to produce energy when needed.

Placing any type of equipment on the seafloor requires significant permitting. UNC CSI has undertaken creating guidelines to deploying ocean energy equipment in North Carolina. UNC CSI is also interested in potential environmental impacts from using the ocean as an energy source. Research has identified species that may be impacted by harnessing energy from the ocean. Identifying human users of these areas is also important for success moving forward.

There are a number of different devices currently in use to capture ocean currents and ocean waves in other geographic locations. The point-absorber device floats on the surface of the water with an anchoring system to the bottom. As surface waves push the point absorber up, it uses Faraday's Law to create an electrical current. Another device called the Surge WEC, and pictured below, is placed on the bottom in near shore environments. When waves pass overtop of the device they cause the paddle to move back and forth, which can be used to pump hydraulic fluid or spin a generator. Those devices are outlined in the powerpoint uploaded with this lesson plan, and overview of the UNC CSI program is provided in the video link. Many devices use Faraday's Law to create electrical current from the movement of high-powered magnets through coils of copper wire.

Wave Energy Conversion device off of Jennette's Pier.

PROCEDURES:

Engage

Introduction to ocean energy : We live in a society that continues to rely on fossil fuels for majority of our energy needs. Alternative energies are a valuable resource for us to utilize to reduce our reliance on fossil fuels.

Who has been in the ocean before? Who has been knocked over by a wave? Would you say that the ocean is powerful? There are scientists working to convert that energy available in the ocean to electrical energy.

Exploration

The powerpoint provided outlines the benefits of alternative energies, the UNC CSI program and examples of ocean energy devices currently being tested. The UNC CSI video https://vimeo.com/41117210, explains the North Carolina Ocean Energy Project lead by UNC CSI.

Elaboration

Build a Basic Shake Generator – this displays the concept of Faradays Law and is used in the technology of ocean energy devices.

1. Coil 500 – 1000 turns of wire around a film canister
2. Be sure to leave 6 inches of wire free on both ends (before wind and after)
3. Scrape insulation off wire ends to make a clean connection
4. Connect to very small LED light or voltmeter
5. Place a powerful magnet inside canister and close canister.
6. Shake magnet back and forth – this should create a voltage

For more detailed instructions visit : http://www.creative-science.org.uk/gensimple1.html

Evaluation

In the classroom a basic evaluation of how well each generator works would provide insight into how well they follow directions and understand the principals used to create an electrical current. Student evaluation at UNC CSI will be done by monitoring the amount of voltage created by each of the ocean energy devices. In order to engineer a working ocean energy device, students will have to understand the dynamics of waves, Faraday's Principle and some engineering principles.

Extensions

UNC CSI offers a variety of K-12 programming at the campus on Roanoke Island. The Harnessing Ocean Energy program offered at UNC CSI provides students the opportunity learn electricity concepts through hands-on experiences, make observations about devices and waves in a 10-meter wave tank, and engineer their own ocean energy device to compete against their classmates to create the most amount of electricity.

The discussion questions below can be used to start a discussion in the class. If there seems to be students with opposing viewpoints then a debate could be set up.

Students observe waves in UNC CSI 10 meter wave tank.

Background Reading for Teachers:
http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/8093/report/F

http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydrokinetic-energy-works.html#.VMuzZCcn1BI

http://www.epa.gov/region1/eco/energy/re_ocean.html

DISCUSSION:

1. Explain how the movement of water can be turned into electricity?

2. Some water current turbines look a lot like wind turbines. Why do current turbines spin at slow water speeds but wind turbines need a minimum of a few miles per hour of wind to spin?

3. What is Faraday's Principle?

4. What are some challenges with using alternative energies?

5. What is UNC CSI doing to overcome these challenges?

6. Do you think the Gulf Stream is a good source of energy? Why/why not?