Alternative Energy Workshop: Day 2

Olin College Engineering Discovery

This curriculum is designed for a three hour workshop with approximately 30 middle school students. These activities should take approximately 2 hours 15 minutes – the remaining time can be used for a guest speaker on a different alternative energy topic

Contents

Introduction Discussion

Objectives

After completing this lesson, students will

- Recall knowledge gained last week about different types of energy
- Have brainstormed many alternatives to fossil fuels
- Have learned about the differences and similarities between a motor and a generator
- Have connected the motor and generator concepts to alternative energy sources

Preparation

Location:

A typical classroom is fine.

Safety:

There are no safety issues with this portion of the lesson.

Student Knowledge

To get the most from this lesson, a student should know a general definition of energy

Instructor Knowledge

An instructor should be able to converse scientifically about these topics:

- Energy

- Power
- Electricity

These resources might be helpful for preparation:

- Wikipedia on LEDs - http://en.wikipedia.org/wiki/LED
- How LEDs Work - http://electronics.howstuffworks.com/led.htm

Materials

No materials are needed for this portion of the lesson

Lesson

Fossil Fuels:

Q. What did you all learn last week about fossil fuels? What are they used for?
Goal: To have kids recall what they learned on the last day
Looking for: Fossil fuels are burned and used for energy

Q. What are the advantages and disadvantages of fossil fuels?
Goal: Try to have kids think more about the disadvantages and why fossil fuels are not the best.
Looking for: Lead into an environmental discussion of fossil fuels and about how they are non-renewable so we might run out…Might want to talk about supply and demand but make sure to focus discussion on environmental impacts

Q. What are some things we can use besides fossil fuels?
Goal: Try to get kids to think of alternatives.
Looking for: renewable alternatives such as wind, water, solar, etc.

Q. Can someone draw a wind turbine on the board?
Looking for a drawing that can be used to point out where the generator is located on the wind turbine.

Q. What does the generator do?
Looking for something about the conversion of the rotation to electrical energy.

Motor Demonstration:

Say: The generator is very similar to this small electric motor here.

Q. What will happen if I connect the battery to the motor?
Goal: Kids should talk about how battery will supply energy and turn the wheel.

Connect motor with battery and have wheel spin.

Q. What do you think will happen if I connect this LED to the battery?
Goal: Kids will figure out that the battery will light the LED.

Connect LED to battery to light it up.

Q. Is there a way we could light the LED with only the motor?
Goal: Kids will make the connection that the motor can work backwards, i.e. If it is spun it will generate electricity.

Q. Do you remember the different forms of energy we discussed last week? What two energy forms are involved in lighting up the LED with the motor?
Goal: They realize turning the wheel converts mechanical energy to electrical energy.

Q. So we can generate energy by just turning this wheel. What is the problem with this setup? Is this an effective way of generating energy?
Goal: Lead kids to thinking about how we cannot just keep spinning a wheel by hand >> very inefficient

Q. So, what can we do instead of using our hands to spin a wheel? Can you think of any alternatives that would make the wheel spin?
Goal: Discussion should lead to kids thinking about wind and water.

Q. Where have you seen wind and water being used to turn wheels?
Goal: Kids should be able to recall windmills and water turbines >> make a connection to turning a wheel (This should be more of a general thing, not specific examples)

Q. What would be the advantages of using wind or water over fossil fuels?
Goal: Lead discussion toward the fact that wind and water are already occurring in nature; they are renewable and will always exist so don't need to worry about depletion. These energy sources are more environmentally friendly (no need to burn fossil fuels so not directly producing carbon dioxide, a greenhouse gas)
Can also mention economic benefits since rising costs of fuels is insignificant in the use of wind and water

Q. Can you think of some of the disadvantages of using wind or water as energy sources?
Goal: Might want to touch on how dams can actually be environmentally damaging? Kids should be able to come up with the fact that we cannot find continuous wind and water everywhere (This can lead into a further discussion of where we can find wind >> probe kids for answers by giving them clues like thinking about where violent winds occur).   There are also some construction costs. Aesthetics perhaps?

Q. How do these wind mills and water turbines work?
Goal: Go into the mechanisms a little. Make sure to talk about both wind and water.   (For water, can talk about how power comes from potential energy of damned water)

Q. We're going to do a wind turbine activity next. But first, does anyone know of something happening locally relating to windmills?
Goal: Have the group talk about Cape Wind

Q. What do you think are important things to think about when designing fins for wind turbines?
Goal: Have kids think about fin design. Lead into a discussion about how the fins should be shaped and why certain ways might be more effective than others.
Lead topic into the next part of the day, building wind turbines.

Wind Turbines: Fin Design Activity

Objectives

After completing this lesson, students will

- Gain experience with hands-on construction of systems that convert energy
- Understand advantages of different materials in designing these systems
- Appreciate real-life applications of engineering

Preparation

Location :

A typical classroom with group table space works well. Depending on the source of "air power," a separate room or hallway may be required.

Safety:

Propeller pieces may fly off using the fans, so safety glasses are required for this exercise.

Students may use scissors or Exact-O knives for creating their fins. Cutting with Exact-O knives should be supervised and students should wear safety goggles during that time.

Student Knowledge

To get the most from this lesson, a student should know:

- Basic construction techniques and tradeoffs

Instructor Knowledge

An instructor should be able to converse scientifically about these topics:

- How fin shape affects performance of the wind turbine
- How the wind turbine works

Materials:

Item	Description	Quantity	Where?	Price
Alligator clips		20	Allelectronics.com	$6
Multimeters		6	Allelectronics.com	$48
Safety Glasses		30	Olin	$0
Cutting mats		6	Cutting-mats.net	$54
Knives		6	Storage	$0
Rulers		6	Office depot	$18
Lego motor		1	Stockroom	$0

Foam Core		5 sheets	Target	$15
Turbine Setups	Originally from Kid wind.com	6	Storage	$0

Lesson

Introduction:

Leading out of the previous discussion, explain the mechanics of how the activity will work:

- Teams of 3-4 students work best
- Start off by following the directions in the worksheet
  - Each group will cut out 3 different designs
  - Safety for cutting fins
  - Getting fin designs approved by instructors
- Testing stations with fans
- Using same multimeters from last week to measure how fast the turbine is spinning

Activity:

Pass out fin design worksheets(next two pages) and let them work. Have instructors around the room to give guidance and help with testing the designs.

Conclusion:

- What designs worked best?
- Why do you think they were better?
- What was the optimal fin angle?

Name: ______________________________
Date: _______________________________

Fin Design Challenge

Purpose: Wind turbines offer a clean, renewable way to generate electricity. As with any other engineering task, it is important to design a wind turbine to be as efficient as possible in order to maximize the amount of energy generated for the cost it takes to build the turbine. In this activity, you will experiment with various fin configurations and designs to determine which one generates the highest voltage at the given (constant) wind speed.

Procedure:

Fin Tilt

1. Pick three fins of the same material, size, and shape, and attach them at even intervals along the disk connected to the motor. Make sure the flat sides of the fins face you (i.e., the fins should not be tilted). Turn on the fan. What happens?

2. How might you be able to improve the fin configuration?

3. Once you have adjusted the fins, turn on the fan and observe the motion of the turbine. Experiment with the tilt to find the angle at which you generate the highest amount of voltage. By approximately how many degrees is the flat plane of each fin offset from the flat plane of the disk?

4. Draw a side view of the turbine. The side (narrow) edge of the disk should be visible in your drawing, as should one fin pointing out of the page at you. Show the flow of air hitting the fin with an arrow.

Number of Fins

5. Experiment with the number of fins attached to the disk at the same time, using the optimal angle as determined above. How many fins do you need to use to generate the highest possible voltage?

6. Why do you think this is?

Fin Shape

7. Using the optimal number of fins and fin angle found above, design three different sets of fins. Once you have drawn your designs on paper, get one of the instructors to approve them. Next trace the designs onto foam core and cut them out. What design worked best? Why?

Other questions

8. What happens when you use fins of different sizes or weights on the same turbine?

9. How might you be able to further improve the optimal fin configuration you just discovered?

Hydropower Simulation

Objectives

This activity is intended to teach students about hydropower as a form of energy and to get them to consider concerns associated with hydropower generation.

Students should be introduced to:

- Gravitational Potential energy
- The purpose of a reservoir
- The risks associated with hydropower
- The economic side of power generation
- The fact that power usage and rainfall both vary over the course of a year

Preparation

Location :

This activity is best done in a room with tile floors, as there is a possibility that water will be spilled. Plenty of towels should be kept around for any possible spillage.

Safety:

There are no safety concerns with this activity.

Materials

Item	Description	Qty	Where?	Est. Cost
2 L Bottle		18?	Olin	$0
5’ - 10’ of Tubing - $4		5	Lowes	$20
½ ‘’ T - $2.30		5	Lowes	$11.50
Balloons			Storage	$0
Duct Tape			Storage	$0
Dice		1 per team	Olin	$0

Pre-Setup (shown on next page)

Power needs bottle mark lines as follows:

- 1” water “start”
- 200 more mL “Fall”
- 350 more mL “Winter
- 200 more mL “Spring”
- 200 more mL “Summer

Spillage/power sales bottle lines:
-1” water “start”
- ebery 50 mL for 1000 mL

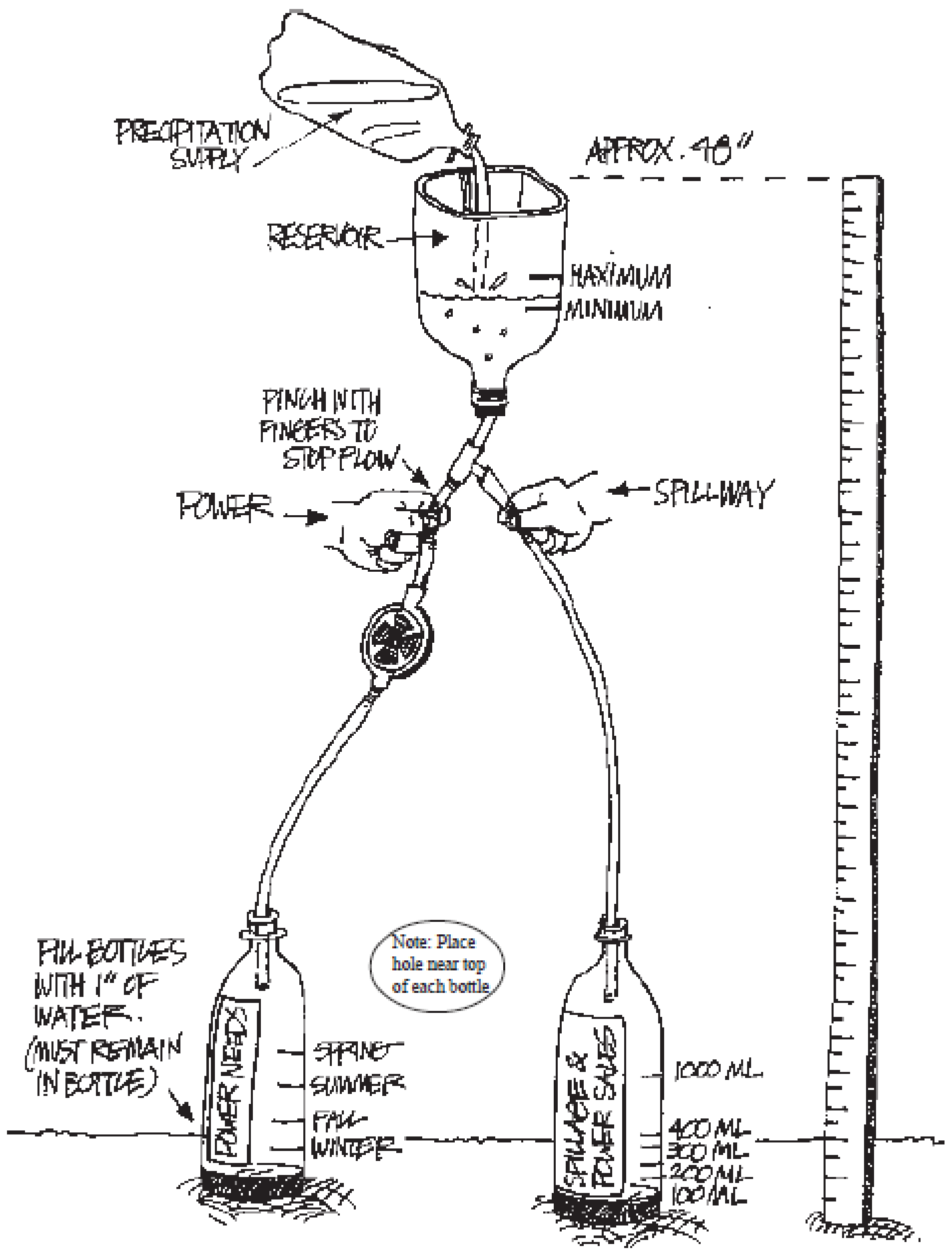
Tubing: cut to length that will allow resevoir to be3- 4 ft above the ground, install T – joint, attach to resevoir bottle

Resevoir Bottle: Cut off bottom, stand bottle on its cap, mark a “minimum” line 4 inches from the table, fill with water to the line, fill with 400 more mL, mark a max line

Print out money.

Each team also needs a precipitation bottle and a measuring cup (a clear cup marked in increments of 50 mL, and a die.

Hydropower Simulation Set-up



Lesson

Introduction:

- Transition – dams use turbines – how do dams work?
  - Draw a dam
  - Potential and kinetic energy
  - Show Demo of water turbine from design studios
  - Location
  - Environmental impact
- Variables – if you are operating a dam, what concerns do you have?
  - Rain
  - Meeting power needs
  - Flood
  - Spillover - environment
  - Economic
- Introduce model, explain what each bottle represents in a real dam
- Let them practice
- Explain game and handout game rules

Simulation Procedure:

1. Money Distribution.
2. Name your Power Company.
3. Fill the reservoir to half of the way between the minimum and maximum lines
4. Roll the die to see how much rain you get. (The first game is fall) Record it on the records sheet.
   Fall: 100 ml x number shown on die
   Winter: 100 ml x number shown on die
   Spring: 200 ml x number shown on die
   Summer: 0 ml x number shown on die
5. Roll the die to see how much spillage you need: (For fall) Record it on the records sheet.
   Fall: 25 ml x # on die
   Winter: 25 ml x # on die
   Spring: 50 ml x # on die
   Summer: 25 ml x # on die
6. Obtain your water from one of the Olin students
7. Now we're ready to play the game!
   There are four roles to fill:

   Pourer: If you are the pourer, you will need to pour the water into the *reservoir* within the time limit. Make sure you don't pour above the maximum line or let the water drain below the minimum!

Power Regulator: If you are the power regulator, you need to make sure that the town gets enough power, while still leaving enough water in the reservoir. In the first round you're aiming for the fall line.

Spillage/Power Sales Person: You are in charge of the flow into the spillage and water sales container. You must at least meet the spillage requirement for your season. You can sell any extra water you put in this bottle but be careful; you don't want to run out of water in the reservoir.

Timer: The pourer is only allowed to pour for 1 minute. Your job is to make sure the pourer knows how much time he has left.

8. The first season we're playing is Fall. Try to fill to the fall line in the power needs bottle and to meet spillage requirements.
9. Penalties and Purchasing:

Penalties:

Penalty	Fine
Pour past time limit	$40
Not enough spillage	$40
Reservoir water level above the maximum line or below the minimum	$40
Not meeting power needs	$15

Buying:

If your team did not meet the required power needs level, you need to buy enough water from another team in order to reach the level.

Price: $10 for 50 ml

If you think you'll need more water for the next season, you can buy it from another team. Price: $10 for 50 mL, sold in 50 mL units.

10. Record your results on the record sheet.
11. Everyone's power needs water is brought to the fall line.
12. Return to step three, but use the winter numbers.
13. Repeat for spring, then summer.
14. The game is over. How did your team fair?

Conclusion:

- Compare team strategies to find out what worked best
- Ask teams what they would have done differently to improve performance
- Connect back to actual power plant operation – what would the challenges associated with running a real plant be?
- As time permits, cover material learned earlier in the day and from the previous workshop days – how does everything tie together?