Green Energy Workshop

LEARNING GOALS: After the completion of this workshop, students will understand:

1. How the different forms of renewable energy used
2. How to construct turbines for small wind generators
3. The basics of Ohm’s law and how each variable contributes to resistance
4. How to use multimeters or LoggerPro to test their turbine design
5. How to alter their design in an attempt to get the highest voltage/amperage reading

CONCEIVE – What do I wish to accomplish through this project?

This stage involves guiding students in defining the goals of the project, then helping them develop conceptual, technical and action plans to meet those goals while considering the technology, knowledge, and skills that apply. This guidance is provided in the form of Essential Questions that use student’s preconceptions, and misperceptions then move them toward a deeper and more realistic understanding of the process and skills needed to complete the project.

ESSENTIAL QUESTIONS:

1. What is energy? What are different types of energy?
2. What is amperage, voltage, and Ohm’s law?
3. How can we create energy? What are limitations to renewable energy?
4. How many wind turbines would it take to power a city?
5. What design criteria will be needed to create a wind turbine that generates the maximum amperage and voltage?

NOTES: Amperage (amps) is the SI unit of electric current; this is the amount of electrons flowing through a circuit. Voltage is the measure of force that these electrons are under. Ohm’s law states that current through a conductor is directly proportionate to the voltage going through the conductor divided by the resistance in units of Ohms, i.e. I=V/R. Also, it would hypothetically take 4,000 five megawatt turbines to power all of New York City (http://engineering.mit.edu/live/news/872-how-many-wind-turbines-would-it-take-to-power-all, accessed 28 Dec 2011).

DESIGN - How will I accomplish the project?

This stage focuses on creating the plans, drawings and algorithms that describe the product, process or system that will be implemented.
1. A brief lecture should introduce students to the concepts involved in renewable energy, such as different types of energy, how power is created, and the general design of a wind energy generator.
2. Students will test the effects of design modifications on the power that their turbine is able to produce. Students can also investigate how the angle of the wind (fan) and the distance effect energy produced. Many different sorts of materials should be available, such as paper of various thicknesses, paper for cutting into different shapes, etc.
3. As a group, discuss what the students discovered about the most effective ways to produce energy.

**NOTES:** Students will construct a wind turbine from CDs, card stock, foamboard, etc. Using LoggerPro 3.8 software, the students will be able to graph the voltage produced by their turbines. Students should be encouraged to alter their turbine designs and observe the effect on power produced.

**IMPLEMENT - From an idea to a product!**

This stage refers to the transformation of the design into a product. It includes hardware, manufacturing, software coding, testing and validation.

**Procedure:** This procedure is flexible to how students want to design and test their turbines; arms can be added or removed and students may select different (or many) turbine materials.

1. Students will be given their turbine material/shapes of choice, four wooden skewers upon which they will attach their turbine blades, and a CD on which the skewers can be glued. This whole contraption will then be fastened on the CD attachment on the motor (see figure 1). A box fan will be used to provide the wind. The fan will be at least 3’ away from the turbines and students can decide at what height to hold it at for the best reading.

**Figure 1:** wind generator setup
Measuring voltage using LoggerPro 3.8 software or a multimeter, students can use the following instructions:

a. Open LoggerPro 3.8 on your computer and check that your device is plugged in from the port on the device to the computer. Also check that the power supply is turned on.
b. Hook in the differential probe to the LoggerPro device.
c. In LoggerPro, go to the “experiment” tab.
d. Go to “Set Up Sensors.”
e. Click Go!Link1
f. Drag Differential Voltage Sensor to “Go” Box
g. Click identify/close window
h. Click ZERO
i. Click the “Collect” arrow to begin data collection.
j. After data collection finishes, click A (autoscale)

NOTES: Building an efficient turbine depends on the number of arms on the turbine and how effectively the arms capture the wind to turn the turbine. Students can also see the effect of different wind speeds if multiple fan settings are available.

OPERATE – Does it work the way I planned?
Students may take their turbines home.

Questions for reflection:

1. What design parameters of the blades did you change to get better results?
2. Did you notice any relationships between voltage and current (amperage)? When 1 changed, how did the other change?
3. What did you find most interesting?
4. What did you find most frustrating?
5. If you had unlimited access to building resources, what would you use to improve your design?
6. Do you think your design would work on a larger scale? Why or why not?

**RESOURCES NEEDED – What equipment and supplies do I need?**

- CDs
- Cardstock, cardboard, paper, and/or any additional turbine supplies
- Pinwheel templates of multiple shapes
  *Have students try cutting holes into paper used for turbines! Does the power increase or decrease?*
- Wooden shishkabob skewers
- Masking tape
- Ring stands
- CD motors
- LoggerPro 3.8 software and setup, including voltage and current probes, cords, and data-acquisition unit
- Laptop(s)
- Powerpoint presentation if desired

**SET-UP**

Have all the materials ready and laid out for students. Provide a variety of materials to support different outcomes. Prepare enough materials for each student or each student team. Ring stands are used to hold the turbine firmly in front of the fan, see figure 1 for illustration.