Wind Turbines
Electrical and Mechanical Engineering

Objective

- Introduce students to the concept of alternative energy.
- Explain the math and scientific principles behind engineering wind turbines.

Standards and Objectives

- 8th Grade Standard 4, Objectives 1 and 3
- Earth Systems Standard 6, Objective 2
- Physics Standard 4, Objectives 2 and 3

Learning Outcomes

Students will learn:

- Fundamental engineering design and how it applies to wind energy
- About how surface area and shape effects wind turbine efficiency

Essential Questions

- How do engineers improve our sources of energy?
- How can we harness energy from the wind?

Time Required (Itemized)

- Design introduction – 20 minutes
- Student construction time
    - *Option 1*: 150 minutes
    - *Option 2*: 30 minutes
- Assemble wind farm (*Option 2*) – 30 minutes (you can do this while students are working on their blades)

Assessments

- Ask students to write a one-page essay about wind power. Encourage students to discuss the pros and cons of wind design. Students can find this information online, or you can give this information as part of your introduction.

Materials

Option 1

- Balsa wood sticks (at least 10 for each turbine)
- Balsa wood planks or cardstock
- Generator (one per turbine)
- Wind blades hub (one per turbine)
- 3 – 4 inch dowels (3 – 6 per turbine)
- Duct tape

- Wood glue
- Multimeter
- Standing fan

Option 2

- Wind Farm Kit (available to check-out from College of Engineering)
- Generator (one per turbine)
- Wind blades hub (one per turbine)
- 3 – 4 inch dowels
- Duct tape
- Multimeter
- Several standing fans

Lesson Description

Wind is created from the sun. When the sun heats up the ground, the hot air eventually rises and lowers the air pressure. Denser air moves into the areas of lower pressure and creates wind. Think about summer canyon winds. The valley floor is heated from the sun. Cooler evening temperatures allow the hot air to rise from the valley floor, and cooler, denser mountain air sweeps into the valley from the canyons.

Air has mass, so once it starts moving, it contains kinetic energy. The sun's energy is eventually converted into wind's kinetic energy through the process previously described. Wind's kinetic energy moves wind turbine blades and is then transformed into usable mechanical or electrical energy with the help of the turbine located inside the wind blades hub. Wind energy is created through conservation of energy!

Designing a wind turbine takes a lot of ingenuity. The designer must determine the best balance between the wind turbine's energy production, size, cost, footprint, and amount of materials used. Engineers create blades that have enough surface area to catch the wind. However, blades cannot be too large or else large wind gusts could damage the basic structure. Some blades are designed on angle to be able to utilize wind's kinetic energy, but also prevent structural damage. During forceful winds, some turbines are actually designed to rotate the entire head of the turbine to be parallel with the direction of the wind. This prevents structural damage. There are a lot of design elements each engineer must consider when designing wind turbines.

Questions to ask students:

- Would you want a large footprint (the area on the ground that is covered by the turbine base)? Why or why not?
- How many blades do you think you would need to harness a significant amount of the wind's kinetic energy?
- Do you want your turbine to be tall or short?
- Do you think your blades should be long or short? Think about this…How can you make sure your blades do not hit your base structure?
- How will attach your blades, hub, and generator to your base structure?

Lesson Procedure:

Option 1 – This option is for students to build their entire wind turbine from the ground up. They will create the base structure that will support the wind turbine. They will also design the blades. Additionally, they will need to figure out how to make the entire system work: how will they connect their blades to their base structure and how will they ensure the blades do not hit their base structure?

- Give students background information on wind turbines. You can go into as much detail as you see is appropriate. Mention some pros and cons of wind turbines, and discuss our need for alternative energy development.
- Divide students into teams
- Explain to students the basic design concept and goal
- Draw a picture on the board to help students understand they need some type of structure that will support the blades, hub, and generator
- Give students their supplies, and have them start working.
- To test the wind turbines, individually call groups up to a testing station.
- The testing station will consist of at least one standing fan, a table to set the wind turbine on, and a multimeter.
- Use the fan to create wind kinetic energy.
- Measure the energy output using the multimeter
- Keep track of each group's energy production on the board
- Use the energy production information to discuss why certain designs worked better, and/or how each group could improve their design.

Option 2 – Use the College of Engineering's wind farm. This is available to check out. The wind farm will have the base structure already created, so students will only be required to develop the blades. In this option, the class will attempt to make a high energy output as a whole unit instead of individually.

- Give students background information on wind turbines.
- Divide students into teams (there are only 10 base structures in the College of Engineering Wind Farm)
- Explain to students the design goal: to make blades that will produce the most energy
- Give students supplies, and have them start working
- Set-up the wind farm in a large space
- As teams finish their blade designs, call the team up and attach their blades to the wind farm.
- Test class wind farm energy output (follow Wind Farm directions included with the College of Engineering Wind Farm Kit)

Notes from the College of Engineering:

- A National Geographic article is included in this lesson plan. This is a good resource for students to learn some of the pros and cons of wind energy.