Wind Power

For centuries, humans have harnessed wind power as a form of energy by various means, from wind sails to windmills. Today, windmills have evolved into wind farms, consisting of hundreds of wind turbines that generate enough electricity to power thousands of homes.

In this activity, students will discuss the differences between the Bear Creek Wind Park and Bergey Windpower turbines. Students will learn the basic parts of a wind turbine and then build their own model wind turbine out of recyclable materials. Students will test their model wind turbines using three different-sized blades to determine which size harnesses the most wind.

Grade Level: 6th – 8th grade
Subject Matter: Physical Science
National Standards:NS.5-8.1, NS.58.2

Wind Turbines: Size Matters, http://www.sciencefriday.com/videos/watch/10294

How would you describe the size of a wind turbine? There's no right answer. Turbines come in different varieties tuned for different uses. Compare the 256-foot-tall Gamesa G87 turbines, found at Bear Creek Wind Park in Penn., with the mini turbines developed by Bergey Windpower in Norman, Okla. The scale of both may surprise you.

Activity Materials:
Milk cartons, one quart size – one for each group of students
Sand – each group of students will need one cup
Measuring cups – one per group of students
Roll of masking tape
Rulers – one for each group of students
Pens – one for each group of students
Plastic straws – one for each group of students
Small round pushpins – each group of students will need two.
Ball of string or yarn
Paperclips – each group of students will need one
Scissors – one pair for each group of students
Quarters – each group of students will need one or two
Brass fasteners – each group of students will need several.
Measuring cup
Electric fan
Yardstick
Stopwatch
Turbine blade circles: Prepare the turbine blade circles before the lesson by using a compass to make three circles on cardstock paper with the following diameters: 10cm, 15cm, 20cm. Cut out enough circles so that each group of students will have one circle of each size.

Vocabulary
Blade: the part of the turbine or windmill that spins when it catches the wind.
Windmill: a building or device that harnesses wind power.

Turbine: a machine that uses rotating blades to generate energy.
Simple machine: a basic device that reduces the amount of force required to do work.

What To Do
1. Begin the lesson by having the students watch the Science Friday video, "Wind Turbines: Size Matters." Review with students how the turbines at Bear Creek Wind Park and Bergey Windpower Company work. What are some of the similarities and differences between the two? Which turbine produced the most power? Does the size or shape of the blade matter?

2. Inform students that they will be working in groups to build wind turbine models, and testing the effects of using different sized blades on each model. Review with students the basic parts of a wind turbine: base, axle and blades. How do these parts relate to a simple machine?

Activity One: Wind Turbine Base
Note: In order to conserve materials students will be making one turbine base per group.

1. Organize students into groups so that each group will be building one wind turbine base. Hand out to each group: one milk carton, one cup of sand, masking tape, a pen, a ruler, a straw, a paperclip, two pushpins and a roll of string.

2. Have students measure out one cup of sand, and pour it into the milk carton and then tape the spout closed with masking tape. Why do they think it is important to add sand to the base of their wind turbine?

3. On the center of one side of the milk carton, have students use a ruler to measure three centimeters down from the top edge. Have them mark this spot with a pen, then turn the carton to the opposite side of the carton and repeat. Why do they think these spots are being marked?

4. With a pen, have students carefully poke a hole through these two marks. What part of the wind turbine should these holes be for? What material do they have that can serve as the axle? Have students insert a straw through the holes, to ensure that the holes are large enough for the straw to fit through both holes. The straw should be able to turn easily, and should have an equal length exposed through the hole on each side of the carton.

5. Have students push one small round pushpin through both protruding parts of the straw close to the carton, so that the straw will not slip out during the experiment. Remind students to be careful and not to poke themselves with the pins as they continue building their turbines.

6. Have students measure and cut a piece of 15cm-long string. They should tie one end of the string to a paper clip and tape the other end of the string to one end of a straw. Tell students that the string will be used to measure how quickly the blades turn. What do they think will go on the other end of the straw? Inform students that the milk carton will serve as the wind turbine base to test three different-sized blades.

Activity Two: Wind Turbine Blades
1. Hand out the turbine blade circles, and inform the students that they are going to be testing three different blade sizes (10cm, 15cm, 20cm). Ask the students to predict which size they think will wind up the string with the paperclip the fastest, and why. Students should record the predictions in their science notebooks.

2. Have students trace a quarter at the center of each of the cardstock circles. This smaller circle will be the area of the windmill blade that will be attached to the straw.

3. Have students use a ruler to draw two lines so that each circle is divided into four equal quarters. Cut along the four drawn lines, making sure not to cut into the inner circle.

4. Have students fold each quarter of the circle in half so that half of each quarter stands up, resembling a pinwheel. Ask students what they think would happen if the circles were left flat.

5. Push a brass fastener though the center of each of the inner circles.

Activity Three: Testing Turbines
Prep: Prepare the testing area by setting a fan on a table and taping a yardstick on the table, so that the distance between the fan and the windmill can be measured. Prior to the class, mark on the yardstick where turbines should be placed for testing. The appropriate distance for the blades to turn will vary depending on the strength of the fan being used.
1. Have students draw the following data collection table in their science notebooks:

	10cm	15 cm	20cm
Trial 1			
Trial 2			
Trial 3			
Trial 4			
Average			

2. Inform students that they will use their wind turbine base to test each of the turbine blades. Students should follow these steps to test each of the turbine blades:
• Tape the brass fastener from the end of one of the turbine blade circles onto the empty end of the straw;
• Place their completed turbine at the marked distance from the fan with the string and paperclip hanging over the edge of the table;
• Turn the fan on and with a stopwatch record in seconds how long it takes for the string to wind around the straw and the paperclip to reach the top.
3. Have students record their findings on the data collection table, and take the average of the three trials for the three different windmill blade sizes.
4. Compare and contrast the results with the entire class. Which of the three turbine blades raised the paperclip the fastest? Did the results match the students' predictions?

What's Happening?
When designing wind turbines, engineers must take various factors into consideration. These factors include the turbine's location, height of the tower, shape, length and number of blades, and the amount of electrical energy that needs to be generated.

The model wind turbine in this activity more closely represents a windmill. This model is a simple machine, specifically a wheel and axle. The wind blows on the blades (the paper wheel), which turns the axle (the straw). As the straw turns, the piece of string starts to wind around the straw and the paperclip rises. The most efficient blade size will vary, depending on how the blades are constructed or folded, the type of fan used and the location of the model wind turbine on the table. Usually, the turbine with the largest blades can harness the most wind energy and will move the paper clip the fastest.

Topics for Science Class Discussion
• How can we re-design the wind turbines so that they lift the paper clip faster?
• What are other ways people can use renewable resources to generate energy?
• What are the benefits and disadvantages of using wind power?
• What are the effects of wind turbines on birds and bats? Are there any solutions?

Extended Activities and Links
Extend the activity by experimenting with different variables, such as the length and width of blades, constructing blades from different materials or changing the number of blades used. Have students record and present results to the class.

Have students make a Wind Power Map by researching and mapping any of the following:
• Best geographical areas around the world suitable for building wind turbines (high winds, flat land, etc.);
• Worst geographical areas for building wind turbines due to lack of wind;
• Countries around the world that are the biggest producers of wind energy;
• Wind farms in the United States.

Learn more about the turbines in this clip by watching two additional Science Friday videos about wind turbines:
Wind Power:
http://www.sciencefriday.com/program/archives/201004093
Cape Wind Project Moves Forward:
http://www.sciencefriday.com/program/archives/201004302
Explore more about wind power:
http://www.eia.doe.gov/kids/energy.cfm?page=wind_home-basics-k.cfm
View an interactive animation on the advantages of wind power and how it works:
http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10501