

# Wind Farm

## Introduction

A wind farm is a collection of turbines (windmills) built in an area to provide electricity. Wind power, like solar power, is a renewable energy resource and an alternative to nonrenewable fossil fuels (oil, natural gas, coal). Engineers find new sources of energy.

This activity is based on a real wind farm in the Netherlands. At a site on the coast, engineers installed 9 turbines, each taller than the Statue of Liberty or Big Ben (just over 300 feet or 94 meters in height). Two weather vanes on each turbine constantly monitor wind direction and modify turbine direction to face the wind. Each rotor blade is 40 meters long and made of flexible fiberglass reinforced plastic, and is permanently elastic. The turbines generate enough electricity to power about 20,000 homes and will prevent 20,000 tons of carbon dioxide, or greenhouse gas, emissions from fossil fuels.

## Age Level

Activities are appropriate for any age group, depending on the depth of the technical explanations and further explorations. The audience here is late elementary through middle school, or primary school.

## Object Of Activity

Learn about considerations for constructing a successful wind farm, such as local conditions and turbine placement, and then design an efficient and environmentally-friendly facility.

## Discussion

Prior to installation, months of research are necessary to find a suitable location with strong and consistent winds, no obstructions such as hills or tall buildings that will slow the wind, and access to a power grid.

When an ideal location is found, engineers must also consider placement of the turbines in relation to wind direction, local concerns about noise and obstructed line of sight, and potential impact on wildlife migration patterns or habitat.

Students may want details on how the wind is converted to electricity. To convert wind to electricity, the rotor blades of a wind turbine (a modern windmill) turn a shaft that is attached to a gear transmission box. This transmission box increases the turning speed of the shaft that connects to a generator that creates electricity. Winds must be blowing at least 12-14 miles per hour, or 19-23 km, to generate electricity.

## Activity 1: Design and construct model turbines (pinwheels)

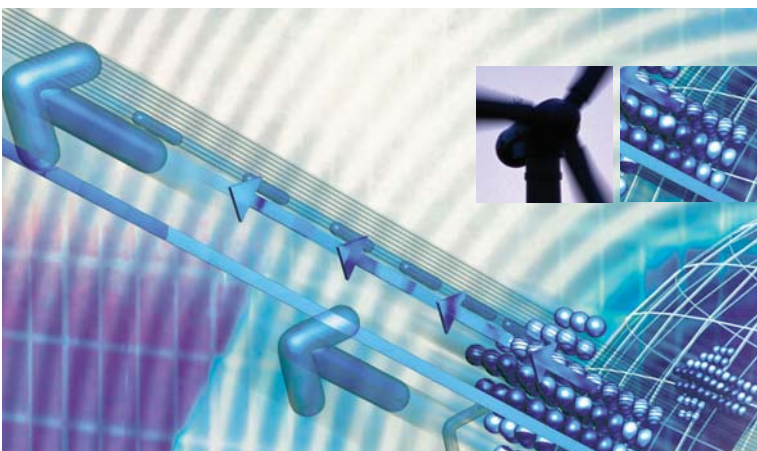
### MATERIALS

#### *per person*

- Lightweight paper (at least 2 sheets per person).
- Ruler
- Pencil
- Scissors
- Straight pin or push pin  
(NOTE: DO NOT hand out the pins with the rest of the materials.)
- Unsharpened pencil with eraser.
- Small bead(s)

#### *per group*

- Play dough or modeling clay
- Small electric fan and extension cord
- Yardstick or meter stick
- Marking pen
- Masking tape
- Standard classroom textbooks
- Long roll of paper on which to draw a coastline





## Design and Construction

CHECK WITH THE CLASSROOM TEACHER BEFORE STARTING CONSTRUCTION. S/he may want an adult to handle the pins.

Have several pinwheels already made. Give students several minutes to try to figure out how to design their own. Give hints depending on age (for example: "Start with a square."). Then lead them through the construction process:

- Begin with a 4 1/2 inch or 11 cm square
- Fold into 2 triangles
- Measure, mark and cut 2/3 of the way along each fold
- Bring every other point into the center and stick a pin through all four points. The head of the pin forms the hub of the pinwheel. Turn the pinwheel over -- make sure the pin pokes through in the exact center.
- Roll the pin around in little circles to enlarge the hole a little. This guarantees your pinwheel will spin freely. Hint: to decrease friction, separate your pinwheel from the eraser with a bead or two.
- Stick the pin into the eraser end of the pencil.

Have the students blow on their pinwheels. Ask them to start blowing directly at the hub, and then gradually change the orientation of the wheel. Summarize their findings; for younger students, accept all observations but look for comments that indicate the pinwheel has to change position to capture the most wind.

## Activity 2: Design the wind farm

For this next activity, divide the class into 2 or more teams and position them on opposite sides of the classroom, or a hallway, etc. Give each team a roll of paper and marking pen, and masking tape to fix the paper in place. Have them draw a coastline on the paper. Then, using the clay as bases for the pinwheels, give each team 5 minutes to build a wind farm along the coastline. Have one team member use the measuring stick to measure 3 feet or 1 meter out from their middle pinwheel. Place the fan at this point and, using the lowest setting, see how many of the pinwheels turn. Record the totals and repeat for each team. Give teams a chance to re-design their farms and re-test, recording the totals.

## Activity 3: Interaction with local environment

Give each team a textbook to represent a coastal town. Have them place the town within the wind farm and 6 inches or 15 cm from the coastline. Deduct one point from the team's total for every turbine that is between the town and the coast, and deduct another for every turbine that had to be moved.

*This activity provided by BP p.l.c. For more educational resources, go to <http://www.bpes.com>.*

## Further Explorations

Go to [www.eweek.org/site/DiscoverE/activities/index.shtml](http://www.eweek.org/site/DiscoverE/activities/index.shtml) for further explorations on this activity, such as determining ratios, redesigning the pinwheels, or making an anemometer to estimate wind speed.

