ACTIVATE WIND POWER! (1 Hour)

Addresses ITEEA
Difficulty Level: 3
Grade Range: K-2

OVERVIEW

In this activity, students will create their own windmills and test them in a wind created by a fan.

Topic: wind energy

Real World Science Topics:

- An exploration of the design process
- An exploration of how different fan blades can affect how a windmill functions

Objective

Students will gain an understanding of the engineering design process by designing windmills.

Materials Needed for Student Activity

Materials Needed for Each Team of 2-4 Students

- corrugated cardboard (or thick cardstock)
- 1 pencil with eraser
- 1 straight pin
- drinking straw (pre-cut to a length just shorter than the straight pin)
- tape

Materials Needed Per Class For Testing Wind Turbines

- stopwatch
- pencil
- one toothpick
- foam block (approximately 15 cm x 15 cm x 5 cm)
- electric fan

Materials Needed for Demonstration

- toy pinwheel

Teacher Notes

Use your knowledge of your class to help you decide when to allow students to build parts of the windmill and conduct the simple windmill efficiency tests. In many cases, especially with younger students, it may be more appropriate for them to observe you assembling and testing the windmill. If so, be sure to narrate the design and testing process for your students, asking them questions to engage them throughout the activity. Leveled methodologies for K-1 and 2-3 grade levels are provided where appropriate.

STEPS FOR *ACTIVATE WIND POWER!*

1. warm-up Activity: Open the class by showing your students a pinwheel. Then, show them the picture below of a large **wind turbine**. Discuss the similarities and differences between the two structures, including what they are used for. Ask students how they think these structures were made. Guide the students by asking them how they would design one. Would they build a full-scale version first or would they build a small model to test out the design? Do they think the wind speed affects how fast the blades spin? Tell them that engineers ask questions like this during the **design process**. During this activity, they will design a windmill.

grades K–1 Use the questions above to guide a short discussion with your students, simplifying the questions if needed and providing simple answers to help trigger student thought.

grades 2–3 Ask your students the above questions, and tell them that it's okay if they don't know the answers to some of the questions at this point in the lesson.

This wind turbine is used to supply electricity. It was designed by engineers who used the design process. The wind turbine generates electricity to power things like our lights and appliances.

2. Distribute the *Activate Wind Power!* handout and materials to each group of 2–4 students.

3. Tell the students that the goal of the project is to build a windmill that spins when a fan blows air on it. They will observe how well their windmills and those of the other groups spin.

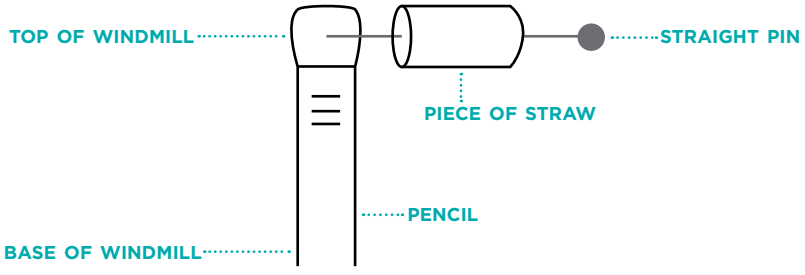
4. Show students several different shapes of fan blades.

grades K–1 Tell students that their group will receive one type of fan blade. Each group will have a fan blade of a different shape. Ask groups to think about how the different shapes might behave in a wind.

grades 2-3 Show students several different shapes (diamond, oval, square, etc.). Tell them that they must decide on a shape to use, and that they will cut out their shapes in Step 6. Ask groups to think about how the different shapes might behave in a wind.

5. Have students view or assemble their windmill.

grades K-1 Give students a pre-assembled windmill setup, as shown in the image below. When each group has their windmill, ask them to point to the different parts as you say them: base of windmill, top of windmill, pin, and straw.



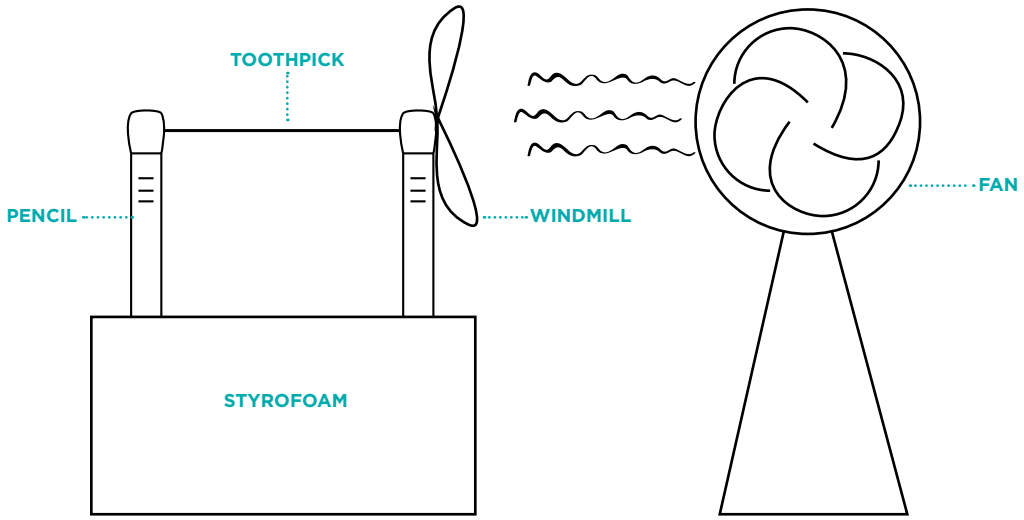
grades 2-3 Give students all of the parts they need to assemble their windmill. The sections of straw should be pre-cut to be just shorter than the straight pin. Demonstrate for students how to build the windmill assembly by placing the straw over the pin, then poking the pin into the eraser. Instruct students to use caution when working with the sharp pin. Circulate as they work to offer assistance.

6. Instruct students to attach simple blades to the short section of straw.

grades K-1 Give each group pre-cut blades. Each group should receive a differently shaped blade, as discussed in Step 4. Students should describe and draw their fan blade on the student handout. Demonstrate how to tape the blades to the straw, and circulate as groups work to help them tape their own blades. Help students make predictions about what will happen when the wind hits the windmill. Then, tell groups to make a sketch of their windmill on the handout.

grades 2-3 Tell students to cut out fan blades from pieces of cardboard and tape them to the straw. They should attach at least three fan blades, all of the same shape (as discussed in Step 4). You may want to suggest that they cut small tabs on the blades; these tabs can then be more easily taped onto the section of straw. Students should describe and draw their fan blade on the student handout. Tell students to write a short prediction about what will happen to the windmill when it receives air from the fan. Then, tell groups to make a sketch of their windmill on the handout.

7. Set up the testing mechanism in front of a fan. Assemble the clicking mechanism by sticking a toothpick into the eraser end of a pencil. After you have done that, push the pencil into the foam block. This assembly will work for all of the different windmill designs. The windmill to be tested should also be pushed into the foam so that it does not wobble when the fan is turned on. When testing the windmills, make sure that the blades are barely able to touch the toothpick. Otherwise, it may substantially slow down an otherwise good design. The diagram below shows how the setup should look. When the fan is turned on, the blades of the windmill should turn. As each blade hits the toothpick, it should make a faint clicking sound.



STEPS FOR *ACTIVATE WIND POWER!*

8. Work with each group to help them test their windmill. You, the teacher, should conduct all of these tests while the students observe.

grades K-1 Set up one windmill at a time and turn the fan on low. Instruct the students on each group to count the number of times the toothpick clicks (one click per revolution of the windmill blades). Tell students that they may sometimes get different numbers than other members of their group, so they should all count carefully. Count out loud with students as you test each windmill. Do one 10-second test per windmill. Write the results on the board. Repeat the test for each windmill, instructing all students to observe how other windmills behave in the wind.

grades 2-3 Set up one windmill at a time and turn the fan on low. Instruct the students in each group to count the number of times the toothpick clicks (one click per revolution of the windmill blades). Tell students that they may sometimes get different numbers than other members of their group, so they should all count carefully. Count out loud with students as you test each windmill. Do three 10-second tests per windmill, and compute the average result (do this step for your students, explaining that an average is what typically happens even if individual tests vary slightly). Write the results on the board. Repeat the test for each windmill, instructing all students to observe how other windmills behave in the wind.

9. w rap-up Activity: Review the results with the students. Ask students to look at the results on the board and decide which fan blade design worked the best. Help them brainstorm reasons why some fan designs worked better than others. Help them see that some shapes can capture wind better than other shapes. Ask groups if they would change anything in their design if they repeated the activity.

Activate Wind Power! extension Activity

grade K-1 Show your students images of different types of wind turbines, including ones with curved or spiral blades. Ask them to think about how the different turbines work, asking questions like, “How will this one spin? How is this one made?” Then, allow students to draw a picture of a new wind turbine design. Once complete, students can share their designs with the class and display their pictures around the classroom.

grade 2-3 One major problem with the large-scale use of wind turbines is that the wind doesn’t always blow in the same direction. For an extension activity, students can design a windmill that best captures wind coming from all directions. They should use a procedure similar to that used in the main activity. However, when students test their designs, they should move the fan several times so that the wind comes from four different directions. The best solution usually involves putting a wind vane on the back of the fan and loosening it from the base so that it can spin.

How does wind power work?

In this activity we simplify the production of wind power by taking out the components of a modern windmill that would generate electricity. When the force of moving wind pushes the blades of a real wind turbine, the moving blades cause a rotor to turn. This rotor, in turn, powers an electric generator, which converts mechanical energy into electrical energy.

w here is wind power most prevalent?

Wind turbines are most commonly used in three types of places: on the coastline, on hilltops, and in open plains areas. All three areas are similar in that they have relatively few obstructions blocking the wind. The United States has ample supplies of coastline, mountain tops, and high plains. However, many of the non-coastal areas are far from the people who would need to use the electricity. To use this electricity would require the building of expensive long-distance power lines.

w hich turbine designs are most common?

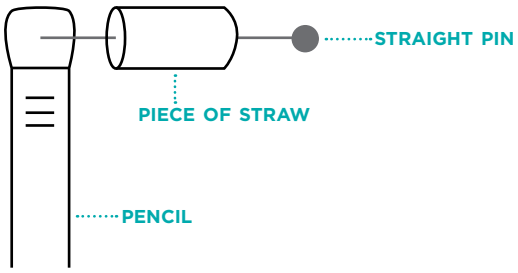
Modern wind turbines generally look very different from the small handheld pinwheels one might get at a parade, or even the older windmills that were made famous in Holland. Those windmills generally have four or more large blades. Modern wind turbines can have as few as one blade, although most have two or three narrow blades.

Key vocabulary

wind turbine: a machine that converts wind energy into electrical energy

design process: a series of steps that engineers use to design products

Follow the directions your teacher gives you to observe the parts of your windmill. Your windmill might be built already, or your teacher might give you instructions to put it together. It should look like the image below.



What is the shape of your fan blade? Describe it and draw a sketch of it.

My fan blade is shaped like an oval. [Sketches will vary.]

What do you think will happen when wind from the fan hits your windmill?

I think my windmill will spin very slowly when the air hits it.

Sketch your completed windmill design below.

[Sketches will vary.]

Name:

Date:

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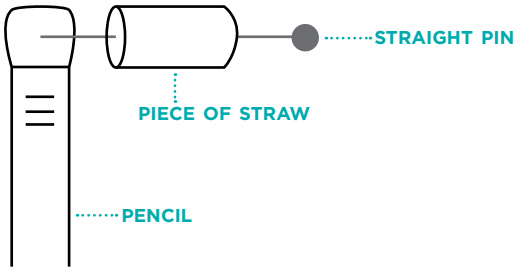

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What do you think will happen when wind from the fan hits your windmill?

Sketch your completed windmill design below.