## Lesson Plan Information

**Name:** Design a Wind Turbine

**Grade:** 4-12

**Topic:** Students will learn how wind turbines turn wind into electrical energy. Students will use materials to construct a miniature wind turbine and measure the electrical current they produce.

**Time:** 30-45 mins.

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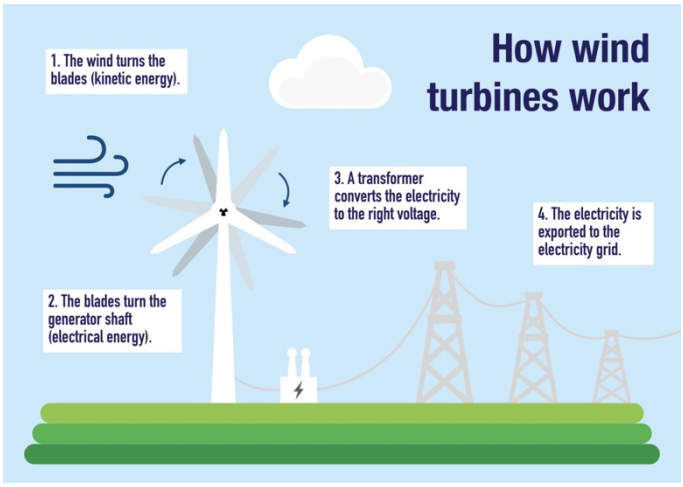
## Introduction:

Have you ever felt a really strong wind? Have you ever felt blown around by the wind? Wind can do work for us by moving things around. For example, when the wind moves the blades of a wind turbine, the turbine produces useful energy in the form of electricity. Engineers design wind turbines that turn kinetic energy of the wind into mechanical or electrical power.

Let's talk about what happens to get electricity from the wind. First, to change the wind energy into electricity, rotor blades spin the hub or center of the turbine. Inside the turbine is an electric generator, which is a rotating machine that supplies an electrical output with voltage and current. The rotating action of the hub turns a magnet inside a coil of wire in the generator, producing electricity. A turbine is basically a motor connected backwards. Rather than connecting a battery to the motor to make something move, a wind turbine is connected to the motor, and its movement generates electricity.

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So, when does a wind turbine work best? The power produced by a wind turbine depends on elevation, wind speed, and air temperature. Wind turbines are best located in areas in which the wind speeds are 16-20 miles per hour with the windmill at 55 yards high. The greater the wind speed the more power generated.

Why is it important to use wind generated electricity? Producing electricity from wind produces minimal air and water pollution. Wind power is a renewable source of energy, meaning it will never run out. Generating wind electricity is an environmentally friendly process that does not emit any greenhouse gases.

Since 2017, DFW airport has purchased 100% of its electricity from renewable sources, specifically Texas wind farms. Texas has over 19,000 wind turbines and produces the most wind power of any U.S. state, accounting for more than a quarter of the entire country's wind power generation. In fact, if Texas were a country, it would rank fifth in the world for wind power generation. Last year (2024), 24% of the Texas' electricity came from wind power.

## Key Terms:

**Electrical Energy –** electrical energy exists when charged particles attract or repel each other. Television sets, computers and refrigerators use electrical energy.

**Energy –** the ability to do work.

**Generator –** a device that transforms mechanical energy into electrical energy.

**Green House Gases–** greenhouse gases are gases in the Earth's atmosphere that trap heat. They let sunlight pass through the atmosphere, but they prevent the heat that the sunlight brings from leaving the atmosphere.

**Hub –** the center part of a wheel, fan or propeller.

**Kinetic Energy –** the energy of motion. For example, a spinning top, a falling object and a rolling ball all have kinetic energy. The motion, if resisted by a force, does work. Wind and water both have kinetic energy.

**Mechanical Energy –** mechanical energy is energy that can be used to do work. It is the sum of an object's kinetic and potential energy.

**Potential Energy –** when potential energy is the energy stored by an object as the result of its position. A roller coaster at the top of a hill has potential energy.

**Renewable Energy –** energy that is made from sources that can be regenerated. Sources include solar, wind, geothermal, biomass, ocean and hydro (water).

**Rotor –** the rotating part of an electrical or mechanical device.

**Turbine –** a machine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a series of buckets, paddles, or blades on a rotor to rotate.

**Voltmeter –** an instrument that measures electromotor force in units called volts.

**Wind Turbine –** a machine that converts the moving energy of wind into mechanical and/or electrical energy.

## Materials:

Kit will include:

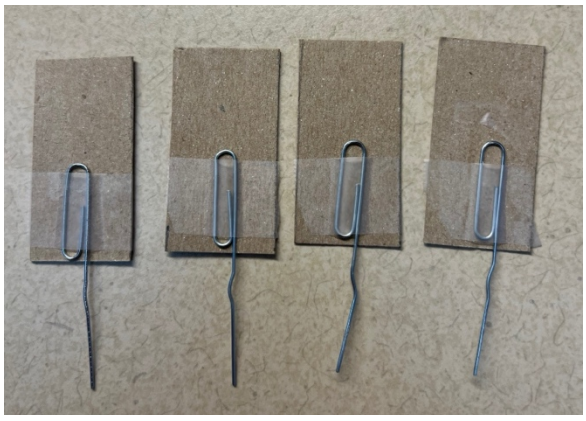
- Small DC toy motor
- 2 pieces of thin electrical wire with alligator clips
- Rubber band
- Wooden ruler
- Cork
- 4 paperclips
- Cardboard sheets
- DC Voltmeter (one for the entire class to share)
- Wind Turbine Worksheet

Not included in the kit:

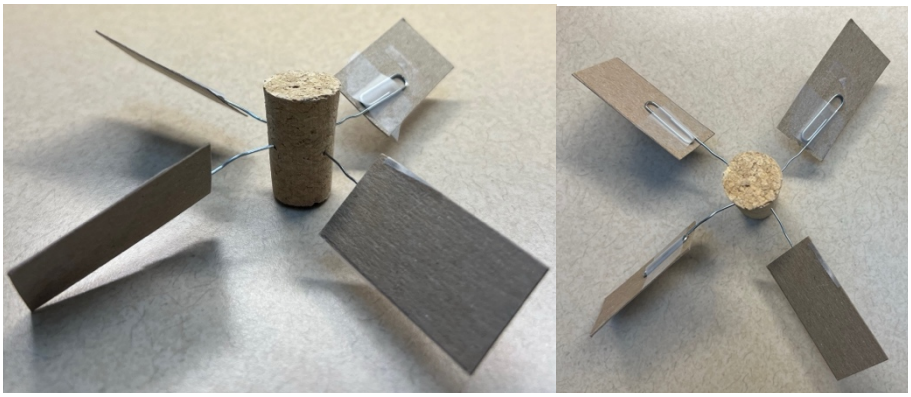
- Scotch tape
- Scissors
- Small electric fan or hair dryer (high velocity)

## Procedure:

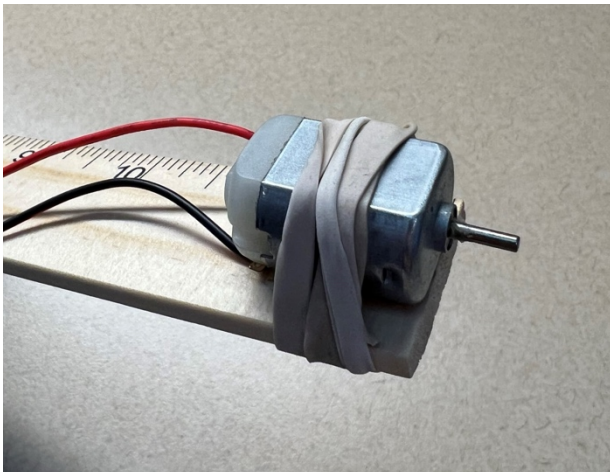
1. Setup a test station with the voltmeter and a wind source (high velocity fan or hair dryer) where students can take turns measuring the output of their wind turbine generators.
2. Provide each student with materials to create their own wind turbine.
3. Straighten out the lower part of each of the four paperclips.
4. Cut out four 1 x 2 inch pieces of cardboard. Use tape to firmly attach a piece of cardboard to each paperclip.



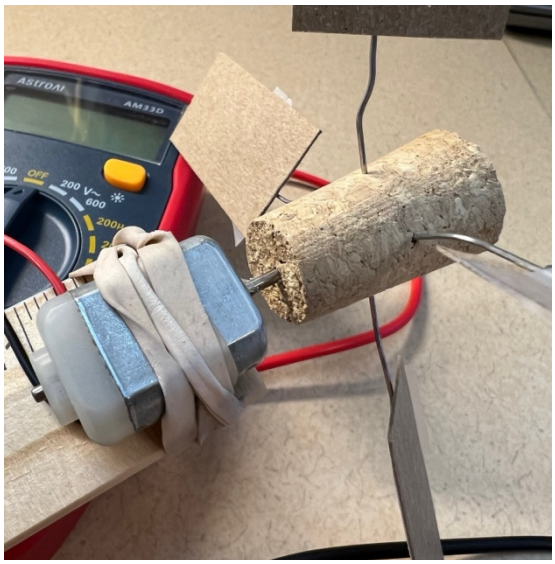
5. Stick the straightened part of each paperclip into the curved sides of a cork to create four turbine blades. Be sure to space the blades equally around the cork.



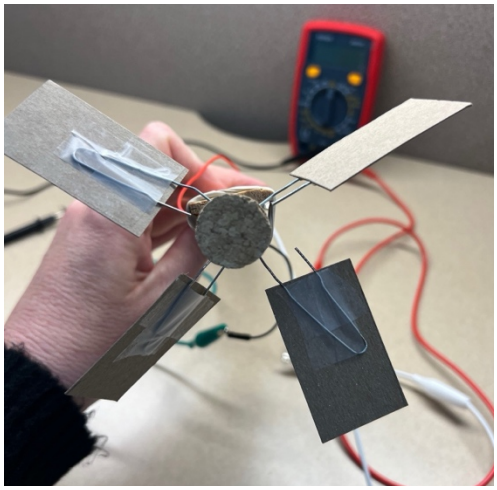
6. Have students use a rubber band to attach the electric motor to the ruler with the motor shaft positioned at the end of the ruler. The ruler serves as a platform for the wind turbine.



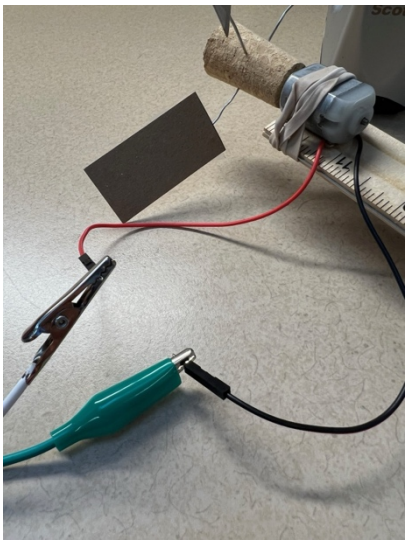
7. Push the cork onto the motor shaft. Make sure the shaft goes into the exact center of the cork.



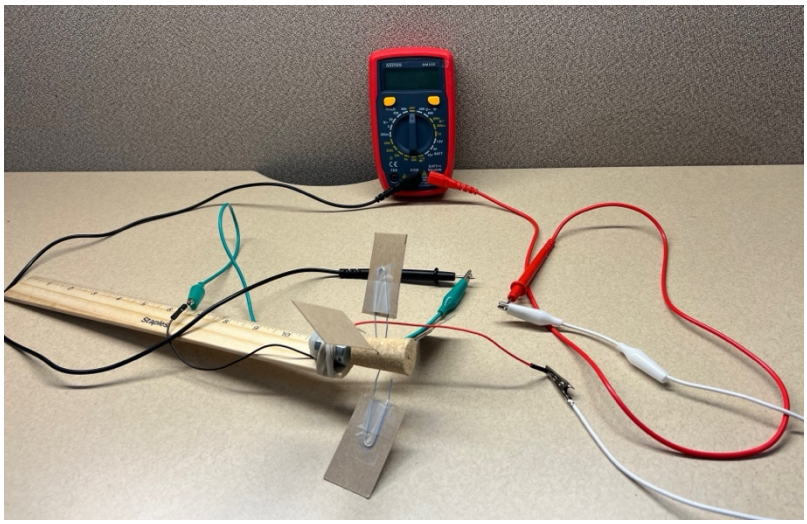

8. Rotate the blades in the cork so that they are at a 45° angle to the flat plane of the edge of the ruler.



9. Attach the alligator clips to the ends of the wires coming off the motor.



10. Have students carry their wind turbine over to the testing station. For one student at a time, use the alligator clips to attach the red wire from the motor to the red wire coming from the voltmeter. Repeat this for the black wires.



11. Turn the dial on the voltmeter to the 200m setting.


12. Have the student hold their wind turbine about 12 inches away from the wind source. Adjust the distance, depending on the strength of the wind source.
13. Turn on the wind source. The blades should start turning. Measure the voltage produced and record it on the worksheet (if the blades do not turn the wind source may not be strong enough).
14. Repeat with the wind turbine at different distances from the wind source. Record on the worksheet.
15. After all the students have had a turn at the test station and have completed their worksheets, conclude with a class discussion. Describe the movement of energy in the generator, starting with the wind and ending at the voltmeter. Review the students results and observations. Did the anyone's turbine design produce more voltage at the same distance, compared to the rest? Did anyone adjust the angle of the blades? What did that do? What happened as you moved the wind turbine closer or farther away from the wind source? How might you alter your turbine design or position to better capture the wind and produce more voltage? What factors might engineers consider when deciding where to put a wind turbine generator or a wind farm?

## Conclusion/Key Take away:

After completing this activity students will:

- Learn about the different types of energy.
- Learn how wind energy is transformed into electrical energy. They will explore how design and position of their wind turbine affect the electrical energy production.
- Improve observation skills.

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