The Thrill of a Windmill

Activity Rundown:

Let's think of some renewable energy sources. We have Solar, Hydropower and of course Wind power! This project will give you the opportunity to harness that wind power using windmills. Blow away your family and friends with your very own rendition of a wind turbine!

You will need:

- Sticks (approximately 25cm in length) for each group's main structure
- Popsicle Sticks
- String
- Pencil and Paper (for designing and construction)
- Cardboard
- Duct and Masking Tape
- Small scale wind tunnel
- Tin foil
- String
- Bendable Wire
- Scissors
- Tooth picks
- Rubber bands
- Paper Clips

Let's do it!

A) Before we begin building our windmill let's think about renewable energy sources:

What kind of problems do you think can arise with renewable energy sources? (Write down your answer reading below)

Answer: While renewable energy is thought of as much better for the environment, they are not a perfect energy source. An example of this is wind turbines. Some problems with wind energy include large upfront costs, problems with either lack of wind or too much wind for the turbines as well as animals being negatively affected by the wind turbines.

Minds in Motion

1) Now let's begin the project!
2) The goal of this wind turbine is to be able to stand by itself (with the aid of two pieces of tape), withstand high wind speeds.
3) first you must design your wind turbine on paper (including a material list)
4) Once your design(s) are completed, you may collect all the materials needed to build your initial wind turbine design
5) Have members of your household join you in building a wind turbine of their own! Allocate about 15 minutes to build it.
6) Once the wind turbines have been constructed, they can now be tested. The windmills will be placed in the testing area.
7) You will also need two pieces of tape to be placed wherever necessary to secure your windmills. Once the windmill is in place, You or a member of your household will turn on the wind source (blow dryer) to its highest setting about 1 meter from where the windmill is placed.
8) You will be given an opportunity to improve on your wind turbine design after you see the results of your windmill against the treacherous winds!
9) Take a look at the materials you used, improvements that could be made, and develop your idea further!

Minds in Motion

Background:

What is Wind Energy?

Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetation. Humans use this wind flow, or motion energy, for many purposes: sailing, flying a kite, and even generating electricity. The term "wind energy" describes the process by which the wind is used to generate mechanical energy or electricity. Wind turbines convert the kinetic energy in the wind into mechanical energy. Mechanical energy can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical energy into electricity.

How Do Wind Turbines Work?

A wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. Wind turbines, like windmills, are usually mounted on a tower to capture the most energy. Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind. A blade acts much like an airplane wing. When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade.

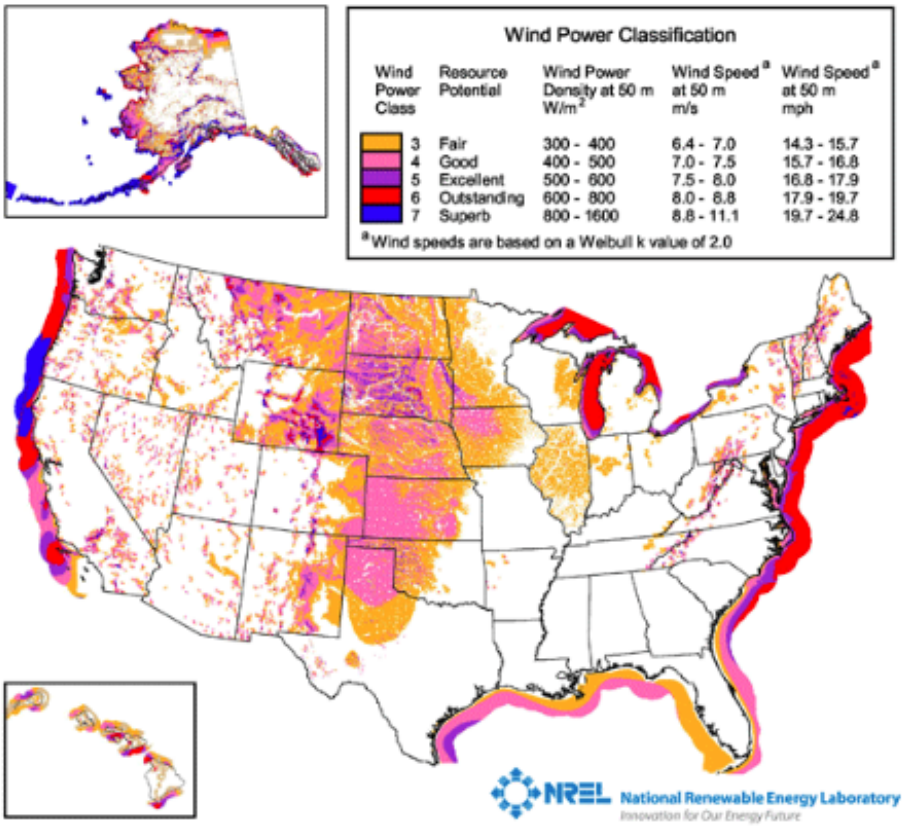
The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity. Wind turbines can be used to produce electricity for a single home or building, or they can be connected to an electricity grid (see illustration to the right) for more widespread electricity distribution.

Site Testing for Wind Energy

Not all locations are suitable for wind energy development. They need to be evaluated to determine if the cost associated with installing a wind turbine will likely be balanced by the value of energy generated over time.

One of the first steps to developing a wind energy project is to assess the area's wind resources and estimate the available energy. To help the wind industry identify the areas best suited for development, the U.S. Wind Energy Program works with the National Renewable Energy Laboratory (NREL) and other organizations to measure, characterize, and map wind resources 50 meters (m) to 100 m above ground.

At the local level, towns and contractors will work with homeowners to determine the cost and likely financial benefits of wind turbine installation. Often the first step is to temporarily install an anemometer to test the wind at a farm or home over several months or even a year.



Blades Options

Blades come in many shapes and sizes, and there is continuing research into which design is best. It turns out that the optimal design really depends on the application, or where and how the blade will be used. Designers look at the "tip speed ratio" that determines efficiency. This is the ratio between the speed of the wind and the speed the blade tip. High efficiency 3-blade-turbines have tip speed/wind speed ratios of between 6 and 7.

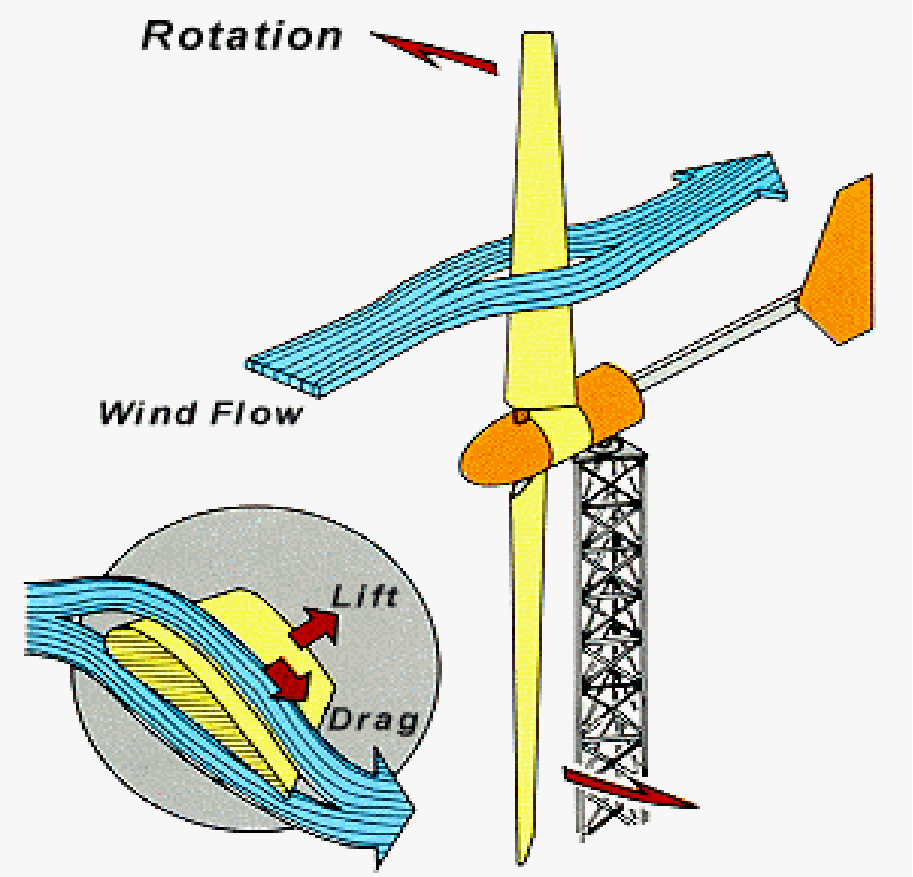
Most wind turbines use either two or three blades. Research indicates that as more blades are added there is a increase in aerodynamic efficiency, but this efficiency decreases dramatically with each added blade. For example, increasing the number of blades from one to two can yield a six percent increase in aerodynamic efficiency, but increasing the blade count from two to three yields only an extra three percent in efficiency. And, of course,

there are cost implications too. Each additional blade in a design will increase the cost of the end product, so engineers have to factor in both the increased efficiency and the increased cost of manufacturing to determine a design that will be the best for an application. Aesthetics is also a consideration. A small, two or three blade design might be best for a residential area, where a homeowner just wants to pull from the wind enough energy to power their own home, and would prefer a quieter option. A giant 12 blade design would not look very nice atop their home and would perhaps generate more energy than they need, and likely more noise too!

Aerodynamics

Most wind turbines are referred to as a horizontal-axis wind turbine (HAWT). The turbine needs to be able to convert the horizontal force of wind into a rotational force that can be used. More specificity a wind turbine transforms the kinetic energy in the wind to mechanical energy in a shaft and finally into electrical energy in a generator. The wind was historically used to move ships, to grind grains and to pump water in and out of irrigation systems.

Today wind turbines are generally used to produce electricity. The main disadvantages of wind power is that electrical generation needs to take place close to turbine (generally incorporated), there needs to be a consistent stream of wind, and it takes up significant space. Other issues currently being studied are low frequency noise and the potential health effects and the influence of wind farms on bird migration patterns.



Principles of Wind Turbine Aerodynamic Lift

Resources:

- http://tryengineering.org/lesson-plans/working-wind-energy

Reach out!

We would love to hear from you about all the amazing STEM projects you are doing at home! Show us your finished products on any of the following social media platforms by tagging us or by using the following hashtags. We hope these projects have brought some excitement to your day during these difficult times.

Let us know how we did! Please click here to fill out a short survey on how well we did and what you would like to see more of in the future. Thank you!

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