

Harvest the Wind

Objective

Students will use weather maps to track the wind and construct wind-powered items.

Background

When the winds of change blow, some people build walls and others build windmills.

—Chinese Proverb

Wind is air in motion, caused by the uneven heating of the earth's surface by the sun. Since the earth's surface is made up of land, desert, water and forest areas, the surface absorbs the sun's radiation differently in different locations.

During the day, air above the land heats more quickly than air above water. The hot air over the land expands and rises, and the heavier, cooler air over the body of water rushes in to take its place, creating local winds. At night, the winds are reversed because air cools more rapidly over land than over water. Similarly, the large atmospheric winds that circle the earth are created because land near the equator is heated more by the sun than land near the north and South Poles.

Wind power is the conversion of wind energy into a useful form of energy. The first use of wind power by humans was probably the use of sails for powering sailboats. Windmills were probably first used in Iran as long ago as 600 AD. Ancient windmills had small sails that caught the wind to turn an axis that produced mechanical power to grind grain. By the 1100s Europeans were using windmills for grinding grain and pumping water from lowlands.

The American windmill was developed for farmers during the 1800s and 1900s. The wheels of these windmills were made from curved blades of wood or steel. They were mounted at the end of a horizontal shaft. This shaft was connected to a pump by a vertical rod sunk deep into the ground. The windmill blades moved to face the wind, which blew on them and produced enough mechanical power to pump water up from the ground. The groundwater ran through a horizontal water pipe after it came up from the ground. The farmer placed a large tank at the end of that pipe and kept it filled with water for the farm animals to drink. Some farm families also had windmills near their homes to provide water for household use.

Today we use wind energy to produce electricity with an updated version of the windmill—a wind turbine. Wind turbines are mounted on towers. At 100 feet (30 meters) or more aboveground, they can take advantage of the faster and less turbulent wind. Usually, three blades are mounted on a shaft to form a rotor. The wind flows over blades, causing lift, like the effect on airplane wings. The blades are connected to a drive shaft that turns an electric generator to produce electricity. The energy produced by large wind turbines must be used

Oklahoma Academic Standards

GRADE 3

Physical Science: 2-1

Earth Science: 2-1

Economics: 3. Geography:
1B; 2C

GRADE 4

Physical Science: 3-2,3,4.

Earth Science: 3-1

GRADE 5

Earth Science: 2-1

immediately, since storing it in batteries is not economically practical at this time.

Wind turbines can be used as stand-alone applications, or they can be connected to a utility power grid or even combined with a photovoltaic (solar cell) system. Stand-alone wind turbines are typically used for water pumping or communications. However, homeowners, farmers, and ranchers in windy areas can also use wind turbines as a way to cut their electric bills.

Wind power plants, or wind farms, are clusters of wind turbines used to produce electricity. A large wind farm usually has hundreds of wind machines in all shapes and sizes. One large wind machine needs about two acres of land, so a wind power plant can take up hundreds of acres. Wind farms work well on farm land because farmers can grow crops and graze cattle around the machines.

A standard two-megawatt (MW) wind turbine in the US generates enough electricity to power more than 550 average American homes, nearly twice the productivity of wind turbines in China and Germany. Today there are over 52,000 wind turbines in 41 states, producing enough electricity for 25 million average American homes.

Many farmers in Oklahoma have installed wind turbines on their farms to take advantage of a different kind of harvest. The western half of Oklahoma is in America's wind corridor, which stretches from Canada into North Dakota and Montana, south into west Texas, where the vast majority of the country's best on-shore wind resources are located. In 2015 Oklahoma ranked third in the nation in net electricity generation from wind. The total number of direct and indirect jobs in the state from wind power development is estimated to be between 1,000 and 2,000. In 2016 wind generation capacity in Oklahoma was more than 6,600 megawatts, supplying about a quarter of the state's generated electricity. Nationwide, an average 10 new wind turbines are built every day.

Procedures

1. Discuss wind as a natural resource that is abundant in Oklahoma. Is there a limit to this resource? What are the limitations?
 - Students will use Oklahoma Mesonet or some other online source to track wind speeds around the state for a month and find the highest and lowest average wind speeds.
 - Students will research where wind farms are located in Oklahoma and compare those locations with what they have learned about average wind speeds around the state.
 - Students will use appropriate graphs to report the information.
 - Students will brainstorm reasons the wind blows more in some parts of the state than others and use online or library resources to research the answer.
 - Students will share what they have learned with the class.
2. Students will brainstorm about other inventions that depend on the wind (hot air balloons, airplanes, hang gliders, etc.).
 - Provide an assortment of materials for students to work in groups and design their own wind-powered inventions.
 - Students will present and demonstrate their inventions in groups.

Extra Reading

Benduhn, *Wind Power (Energy for Today)*, Gareth Stevens, 2008.

Byars, Betsy, and Doron Ben-Ami, *Tornado*, HarperCollins, 2004.

Friedman, Mark, *What Does It Do? Windmill*, Cherry Lake, 2011.

Online Resource

Oklahoma Mesonet Wind Speeds: http://www.mesonet.org/index.php/weather/map/wind_speed_gusts_with_arrows/wind