Harvest the Wind

Objective

Students will read about wind power in Oklahoma, use weather maps to track the wind and construct windmills.

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.

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.

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.

People have been harvesting the power of the wind for centuries. Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships.

The first use of wind power by humans was likely the use of sails for powering sailboats. Windmills were probably first used in Iran as long ago as 600 A.D. 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.

Wind is a renewable energy source because we will never run out of it. Today we use wind energy to produce electricity with an updated version of the windmill—a wind turbine. While windmills in the past were mostly used to convert the wind's kinetic energy into mechanical power to grind grain or pump water, modern wind turbines are used primarily to generate electricity. The wind turns the turbine, which turns a generator producing electrical energy that can be

Oklahoma Academic Standards

GRADE 3
Physical Science: 2-2,4.
Earth Science: 2-1

GRADE 4
Physical Science: 3-1,2,3,4.
Earth Science: 3-1

GRADE 5
Earth Science: 2-1

Materials

pencils or single hole punch

rubber bands

scissors

small paper cups

string

straws

Kinetic and Potential Energy

Wind power is kinetic energy, the energy of motion. A spinning wheel (like a car wheel) or a projectile (like a thrown ball) are examples of kinetic energy. Potential Energy is energy that is waiting to be used. It stored chemically, electrically or mechanically.

The energy in your muscles is a form of chemical potential energy. (Think of a sprinter in the starting blocks). Potential energy can also be mechanical, as in a simple windmill as described here.

A roller coaster is an interaction between kinetic and potential energy. When the cart is at the top of a loop ready to fall, it has no kinetic energy but lots of potential energy (distance it can fall). At the bottom of the loop when the cart is going very fast it has lost all the potential energy and converted it to kinetic energy (speed). As the cart uses its momentum to go up the next "hill" it trades the kinetic energy back for potential energy. If it were not for things like air resistance and friction in the wheels, this process might go on forever.

Online Resource

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

stored in a battery or transmitted on wires. The energy produced by large wind turbines must be used immediately, since storing it in batteries is not economically practical.

Like old-fashioned windmills, today's wind turbines use blades to collect the wind's kinetic energy. The wind flows over the blades, causing lift, like the effect on airplane wings. This causes the blades to turn.

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. Wind farm owners must carefully plan where to place their wind turbines. They have to consider how much the wind blows in an area, how close they are to electrical transmission lines and local zoning codes.

Wind farms also need lots of land. Just 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 around the machines. Many farmers in Oklahoma, especially in the western part of the state, have installed wind turbines on their farms to take advantage of a different kind of harvest.

Science

1. Read and discuss background and vocabulary
2. 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 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.
3. Students will make windmills, using the pattern provided with this lesson and the following instructions.
   —Use pencils or a single hole punch to punch a hole through the center circle and then punch a hole in each corner circle.
   —Cut out the pattern, cutting only on the solid lines and making sure not to cut the center hole.
   —Insert a straw through the center hole.
   —Fold each corner along the dotted line and insert the straw through each corner hole.
   —Wrap a rubber band around the straw on each side of the windmill to keep the windmill in place in the center of the straw.
   —Punch two holes on either side of a small paper cup. Thread one end of the string through both holes and tie it to the middle of the string. Tie the other end of the string to one end of the straw.

—Hold the straw with both hands with the windmill in the center. Blow on the windmill. As the windmill turns, the straw rotates, winding the string and lifting the cup. For best results, the windmill and straw should move together.

4. Students will use the Scientific Method Format included with this lesson to design and conduct experiments using the windmills they created in Activity 1.
   —Students will report the results of their experiments to the class.
5. Students will brainstorm about other inventions that depend on the wind (hot air balloons, airplanes, hang gliders).
   —Provide an assortment of materials for students to work in groups and design their own wind-powered inventions.

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? Windmil*l, Cherry Lake, 2011.

Vocabulary

absorb—to transform (radiant energy) into a different form usually with a resulting rise in temperature

atmosphere—the whole mass of air surrounding the earth

axis—a straight line about which a body or geometric object rotates or may be conceived to rotate

electricity—a form of energy that is found in nature but that can be artificially produced by rubbing together two unlike things (as glass and silk), by the action of chemicals, or by means of a generator

energy—a source of usable power

equator—an imaginary circle around the earth everywhere equally distant from the North Pole and the South Pole

expand—to increase in size

groundwater—water within the earth that supplies wells and springs

horizontal—parallel to the horizon

kinetic energy—energy associated with motion

mechanical—made or operated by a machine, which is a combination of parts that transmit forces, motion, and energy to do some desired work

motion—an act or process of changing place or position

power—force or energy that is or can be applied to work

pump—a device that raises, transfers, delivers, or compresses fluids especially by suction or pressure or both

radiation—the process of giving off radiant energy in the form of waves or particles

renewable—capable of being replaced by natural ecological cycles or sound management procedures

shaft—a commonly cylindrical bar used to support rotating pieces or to transmit power or motion by rotation

technology—the application of science, especially to industrial or commercial objectives transmission

vertical—going straight up or down from a level surface

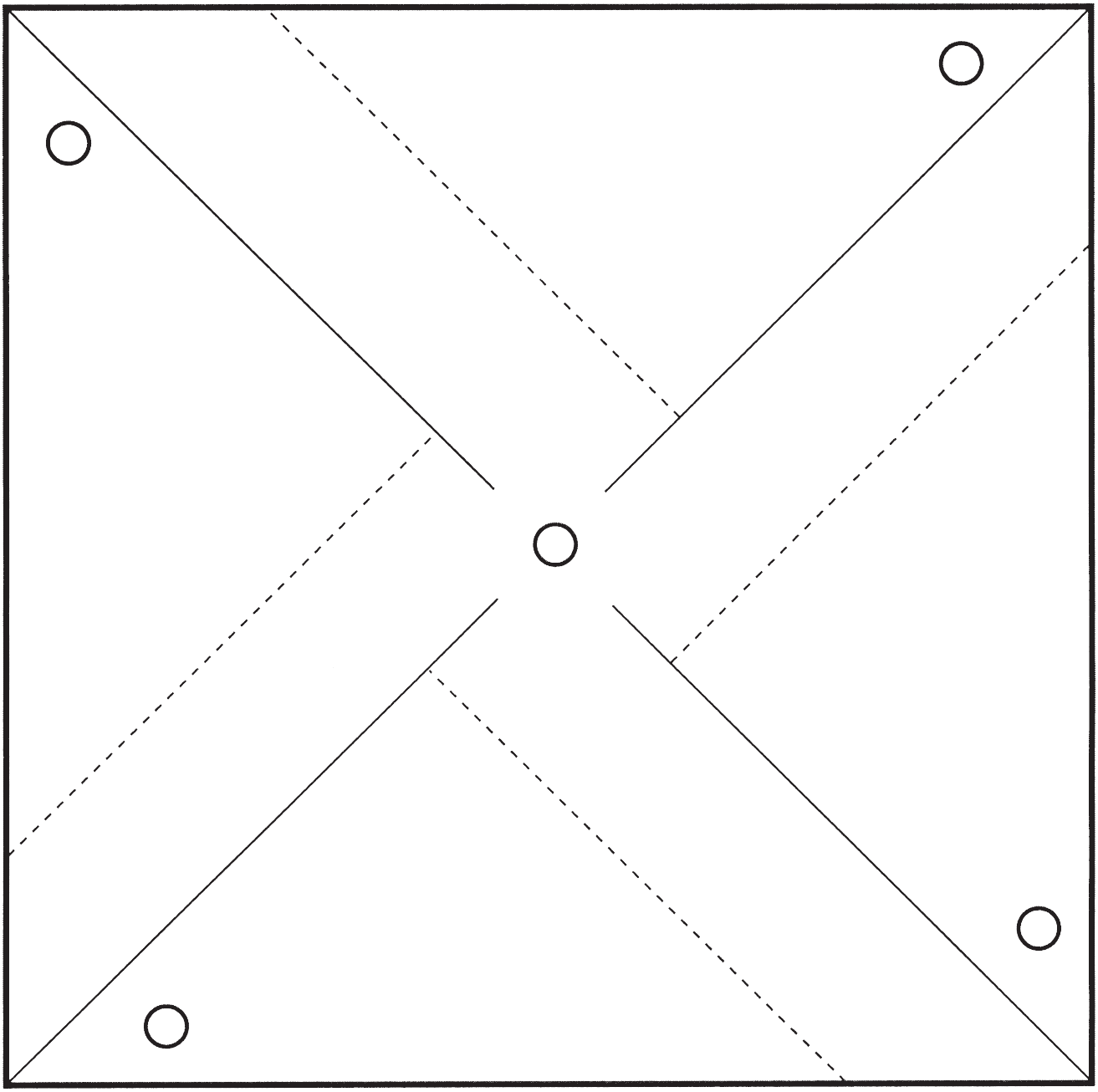
wind—a movement of air

wind turbine—a machine in which the kinetic energy of wind is converted to mechanical power by the impulse or reaction of the wind with a series of blades arrayed about the circumference of a wheel or cylinder

windmill—a mill or other machine that runs off the energy generated by a wheel of adjustable blades or slats rotated by the wind

Windmill Pattern

Cut on the solid lines, being careful not to cut the center circle. Poke holes in the circles with a sharp pencil or hole punch.



Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name_____

Scientific Method Format

Title of Experiment or Study:

I. Stating the Problem:

What do you want to learn or find out?

II. Forming the hypothesis:

What is known about the subject or problem, and what is a prediction for what will happen?

III. Experimenting: (Set up procedures)

This should include: materials used; dates of the experimental study; variables, both dependent and independent, (constant and experimental); how and what was done to set up the experiment; fair testing procedures.

IV. Observations:

Includes the records, graphs, data collected during the study.

V. Interpreting the Data:

Does the data support/defend the hypothesis?

VI. Drawing Conclusions:

Justify the data collected with concluding statements about what has been learned. Discuss any problems or concerns. Use other studies to support the conclusion. Give alternative ideas for testing the hypothesis.

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