**5E Template- Science**

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| **Content Area: Science** | **Grade Level(s): 6** | **Topic(s): Wind Energy** |

**Standards (SOL)**

**Science 6.1c -** scale models are used to estimate distance, volume, and quantity

**6.1i -** models and simulations are designed and used to illustrate and explain phenomena and systems

**6.2d -** renewable energy sources

**6.2e –** energy transformations

**Objectives (UKD’s) The students will learn the origin of wind, illustrate land and sea breeze diagrams, and will learn that wind can do work by building a sample windmill to see how many paperclips it can raise. Students will take a wind survey to see their current knowledge about the growth of wind as an alternative energy source.**

**Materials & Resources**

**Sea and Land Breezes** During the day, the sun heats both land and water, but not to the same temperature. It takes more energy to heat water than it does land because they have different properties. When the sun shines, the land heats faster than the water. Land also gives up its heat faster than the water at night when the sun is not shining. Since land absorbs more heat and releases it more quickly than water, the air above land gets warmer than the air above water. The heated air above land rises, creating an area of low pressure. The air above the water is cooler, creating an area of higher pressure. The cooler air over the water moves to the area of low pressure over land. This is called a **sea breeze** because the breeze is coming from the sea. At night, the land gives up its heat and cools more rapidly than water, which means the sea is now warmer than the shore. The air over the water becomes warmer than the air over the land. The warm, rising sea air creates an area of low pressure, and the cooler air above land creates an area of higher pressure. The air moves from higher to lower pressure, from the land to the water. This breeze is called a **land breeze**. Draw diagrams on the board to show land and sea breezes.

Materials for a simple windmill

 4-Blade Windmill template Large foam cup

 1 Large straw 3 Straight pins

 1 Small straw (coffee stirrer) Binder clip

 Tape Ruler

 50 cm String Hole punch

 Paperclips Marker

Fan

Wind survey

**Safety Considerations**

Students will be cautioned about working with straight pins.

**Engage – Time Estimate 10 minutes**

Let’s make the wind blow! Show me how you can make a wind in the classroom. Moving notebooks or paper fans can make wind. We like to feel a breeze when we are warm. It cools us off. Where does wind come from? Let’s see how much you know about wind and wind energy. Pass out the wind survey.

**Explore – Time Estimate 40 minutes**

After the wind survey is taken a diagram of land and sea breezes will be put on the overhead and students will draw the diagram in their notebooks. Then students will work in partners and make a scale model of a windmill to see how many paperclips can be raised to the top.

**Directions for windmill construction**

1. Turn the cup upside down.

 2. Cut the large straw so that you have an 8 cm length, discard the other portion. Tape the large straw horizontally to the bottom of the cup (which is now the top) so that there is an equal amount of straw on both ends. Set this aside.

3. Prepare the windmill blades using the 4-Blade Windmill Template.

4. Measure 0.5 cm from the end of the small straw and make a mark. Insert a pin through the small straw at this mark. This is the front of the straw.

5. Slide the straw through the windmill blades until the blades rest against the pin. Gently slide each blade over the end of the straw. Secure the blades by wrapping a piece of tape around the front end of the straw. Insert a second pin directly behind the blades.

6. Insert the small straw into the large straw on the cup. Place a pin through the small straw directly after the large straw to hold everything in place.

 7. Tape the string to the end of the small straw. Tie the other end of the string to a paperclip. Make sure you have 30cm of string from the straw to the top of the paperclip.

 8. On the very end of the small straw near where the string is attached, fasten a binder clip in place for balance and to keep the string winding around the straw. 9. Investigate: Keep adding paperclips one at a time to determine what is the maximum load that can be lifted all of the way to the top. Record your data.

When the wind blows, it pushes against the blades of the wind turbine, making them spin. They power a generator to produce electricity. Most turbines have the same basic parts: blades, shafts, gears, a generator, and a cable. (Some small turbines do not have gear boxes.) These parts work together to convert the wind’s energy into electricity.

**1.** The wind blows and pushes against the blades on top of the tower, making them spin.

**2.** The turbine blades are connected to a low-speed shaft. When the blades spin, the shaft turns. The shaft is connected to a gear box. The gears in the gear box increase the speed of the spinning motion on a high-speed shaft.

**3.** The high-speed shaft is connected to a generator. As the shaft turns inside the generator, it produces electricity.

**4.** The electricity is sent through a cable down the turbine tower to a transmission line. The amount of electricity a turbine produces depends on its size and the speed of the wind. Wind turbines come in many different sizes. A small turbine may power one home. Large wind turbines can produce enough electricity to power up to 1,000 homes. Large turbines are sometimes grouped together to provide power to the **electricity grid**. The grid is the network of power lines connected together across the entire country.

While students are completing windmills and testing the paperclip load that it will bear, statistics about wind and wind energy will be given and discussed. At the end of class the wind survey will be given again.

**Explain -- Time Estimate 10 minutes**

Wind resources can be found across the country. Science and technology are providing more tools to accurately predict when and where the wind will blow. This information is allowing people to use wind on small and large scales. Wind is an increasingly important part of the United States’ energy portfolio.

Wind power plants, or **wind farms**, are clusters of wind turbines grouped together to produce large amounts of electricity. These wind farms are usually not owned by public utilities like most coal and nuclear power plants are. Private companies own most wind farms and sell the electricity to utility companies.

Windmills have been around for hundreds of years. The earliest European windmills, built in the 1200s, were called **postmills**. They were built of wood and designed to grind grain between millstones. The entire postmill could be rotated when the direction of the wind changed. This is how windmills got their name. It was the miller’s job to rotate the postmill. Windmills were used for other work too. Miners used windmills to blow fresh air into deep mine shafts. Windmills provided power to run sawmills and paper mills.

As Europeans came to America in the mid-1600s, they brought with them their windmill designs. Windmills were a common sight in the colonies. American colonists used windmills to grind corn and wheat as well as to cut wood at sawmills. By the 1800s, settlers began to explore the West. Much of the land was too dry for farming. A new style of windmill was invented that pumped water.

In late 1887, Charles Brush built the country’s first wind turbine on his farm in Ohio. The turbine was 60 feet tall and weighed 80,000 tons. With 144 blades, the rotor had a diameter of 17 meters. The shaft inside the tower turned pulleys and belts that ran the dynamo generator he had also built. Brush’s turbine generated 12 kW— kilowatts—of electricity, enough to light 350 incandescent lamps, two arc lights, and three electric motors.

**Extend -- Time Estimate 20-30 minutes**

Students can learn about the wind resources in our area. A tower todetermine if a windmill can successfully be installed in Luray (just over the mountain from our school) is being installed in the fall on 2011. Students can watch a short Powerpoint presentation on wind energy. Powerpoint is posted with this lesson. Students can also try the experiment again with a plastic cup or a larger styrafoam cup or thicker string.

**Evaluate -- Time Estimate 5 minutes**

If students pick up paperclips with their model windmill, then the objectives will have been met. If their score on the wind survey goes up from pre- to post-test, then the objectives will have been met.

**Plans for Diversity**  *Student(s): Category/Characteristics: Accommodations:*

Special needs students will be paired with an able student in order to build the model windmill successfully. The special needs students will listen as the wind survey is taken and discussed.

**Connections**

Renewable and nonrenewable energy sources are a major part of the sixth grade science curriculum. Wind energy has potential in our state. Offshore windmills off the coast of Virginia are a real possibility. Students may want to get involved in the debate on whether this is a good idea or not.

***Wind survey***

**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. **The energy of moving molecules, electrons, and substances is called \_\_\_\_\_\_\_**

a. potential b. mechanical c. kinetic d. electrical

 **2. Renewable energy sources provide what percentage of total U.S. energy consumption?**

a. 1% b. 5-10% c. 10-20% d. 20-30%

**3. The energy in wind comes from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. ocean currents b. solar radiation c. jet stream d. climate change

**4. The direction of a wind blowing from Chicago toward Washington, DC is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. northwest wind b. southeast wind c. northeast wind d. south wind

**5. Wind is measured by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. Doppler Scale b. Beaufort Scale c. Richter Scale d. Coriolis Scale

**6. An instrument that measures wind speed is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. anemometer b. wind vane c. multimeter d. aerometer

**7. A device that uses electromagnetism to produce electricity is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. motor b. generator c. electrometer d. turbine

**8. A wind turbine converts \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. potential energy to electrical energy

 b. kinetic energy to potential energy

c. chemical energy to kinetic energy

d. kinetic energy to electrical energy

**9. A good place to site a wind turbine could be a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

a. mountain top b. sea coast c. narrow valley d. all of the above

**10. Wind energy produces how much of total electricity generation in the U.S. today?**

a. 1-2% b. 5-6% c. 10-11% d. 25-26%