BUILDING A WINDMILL GENERATOR

Overview:

In this supplementary lesson, students build a working windmill generator that demonstrates the use of wind as an alternative energy source.

Objectives:

The student will:

- build and test a windmill generator; and
- speculate on conditions necessary for successful use of wind power as an alternative energy source

Targeted Alaska Grade Level Expectations:

Science

[7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[7] SB2.1 The student demonstrates understanding of how energy can be transformed, transferred, and conserved by explaining that energy (i.e., heat, light, chemical, electrical, mechanical) can change form.

[8] SB2.1 The student demonstrates and understanding of how energy can be transformed, transferred, and conserved by identifying the initial source and resulting change in forms of energy in common phenomena (e.g., sun to tree to wood to stove to cabin heat).

Vocabulary:

LED unit – light emitting diode

interlock – to fit into each other, as parts of machinery, so that parts work together

armature – the pivoted part of an electric device, as a buzzer or relay that is activated by a magnetic field

housing – a fully enclosed case and support for a mechanism

rotor – a rotating part of a machine

Whole Picture:

In the old days, Athabascan people would sing songs to the wind spirit to bring about favorable conditions for hunting and traveling. Even today, understanding the complexity of wind patterns is an important skill for subsistence hunters. One old way of forecasting wind was to observe the stars. When the stars twinkle intensely it meant strong winds were coming. The people would say, "Wind makes the stars sway."

Wind energy is an alternative energy source used in many parts of the world. The largest wind farm in the world is located in Texas at the Horse Hollow Wind Energy Center. Scientists and engineers are working on ways to capture wind power at sea and above Earth. Wind generators are a clean, renewable way of producing energy, but they only work when the wind is blowing. In this activity, students will be able to see how a wind turbine generator works. After building and testing their wind turbine generators, students will be able to develop an informed prediction about the likelihood of adding wind power to their community's energy sources.

Materials:

- Green Science™ "Windmill Generator" Kit (one for each team)
- Small hex head screwdriver (one for each team)
- Empty plastic two-liter bottle (one for each team)
- Box fans (at least one-preferably one for each team)
- STUDENT WORKSHEET: "Wind Power"

(Note: Green Science Windmill Generator Kits can be purchased online.)

BUILDING A WINDMILL GENERATOR

Activity Preparation:

1. Several days before the activity begins collect enough empty two-liter plastic bottles so that each team has one. Fill each bottle half full with sand/dirt or fill each half full with water and freeze. Water in its liquid state is not recommended, as the LED will not work if it gets wet.

2. At least one day before the activity, build a generator from one of the Green Science Windmill Generator kits to use as a demonstration model for students. Set up a box fan and determine if it has sufficient power to turn the rotor blades fast enough to light the LED unit.

Activity Procedure:

1. On the day of the activity, group students into teams of two. Explain each team will build a wind-powered generator. The purpose of the construction is to demonstrate how wind energy is transformed to electric energy. Explain that after each team completes a generator the product will be field tested to see if it works.

2. Distribute the Green Science Windmill Generator Kits. Instruct students to take out the instructions in each kit and look them over. Each team should check that their kit is complete.

3. Distribute the hex head screwdrivers. Tell students to follow the instructions contained in the kit to build their wind-powered generators. Assist as necessary.

4. Set up one or more box fans as students work on windmill generators.

5. When each team completes the windmill generator give each a plastic bottle filled with sand/dirt or ice. Have the students attach the generator to the bottle as described in the instructions.

6. As each team completes their windmill generator with the bottle/base attached, give each student a copy of STUDENT WORKSHEET: "Wind Power," and ask each student on the team to complete the two hypotheses on the worksheet.

7. Have each team field test the windmill generator using one of the box fans. Ask them to record their observations on the worksheet.

8. Once observations are completed, ask students to return to their seats and complete the rest of the student worksheet.

9. After all students have field tested their windmill generators and completed their student worksheets discuss observations and conclusions of the teams. Discuss responses to prompts regarding land and climate features necessary for successful implementation of wind power as an alternative energy source. Collect student worksheets.

Answers:

Answers will vary. Data and Wind Direction sections should indicate that consistent and strong wind create the most efficient circumstances for energy generation. The direction section should show that 45-degree angle direction provides optimal results. In the Analysis section students should conclude that a source of wind that is strong and consistent is needed for efficient use of wind power as an alternative energy source.

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WIND POWER

Testable Question:

What geographic and/or climate features are necessary for efficient use of wind as an alternative energy source?

Background Information:

Wind power is an alternative energy source used in many places in the world. Scientists are looking at new ways to harness the energy of the wind. However, not all communities or areas are good candidates for the use of wind power. The activity in this lesson involves testing a miniature generator to discover the circumstances under which it operates most efficiently, then predicting land and/or climate features that would be necessary to use wind efficiently as an alternative energy source.

Hypothesis:

A hypothesis is an "educated guess" about the outcome of an experiment. A hypothesis is the scientist's "educated guess" about WHY something he/she observes is happening. A hypothesis is often stated as an "if-then" statement. Sometimes a hypothesis is supported; sometimes it is not. Either outcome gives a scientist important information. Before you begin the field tests of your windmill generator make a hypothesis about the relationship of the intensity of the wind and the power generated by the windmill generator. Make another hypothesis about the relationship of the wind direction and the power generated by the windmill generator. Here is a sample hypothesis: *If wind speed increases, then the brightness of the LED light will stay the same.*

Wind Intensity Hypothesis:
Make a hypothesis about the relationship of the wind's *intensity* and the power created by the windmill generator.

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Wind Direction Hypothesis:
Make a hypothesis about the relationship of the wind's *direction* and the power created by the windmill generator.

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Investigation:

Materials:

- Two - liter bottle half filled with ice
- Green Science™ Windmill Generator Kit
- Hex head screwdriver
- Box fan

Procedure:

1. Follow the instructions in the Green Science Windmill Generator Kit to build the generator. Use the hex head screwdriver provided to put the windmill generator together.

2. Attach the completed windmill generator to the top of two-liter bottle half filled with ice by the screw cap at the bottom. The LED light is now inside the bottle.

3. Take the completed windmill generator to the nearest box fan. Set the windmill generator on the tape mark in front of the fan.

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Data:

Wind Intensity: Set the bottle containing the windmill generator directly in front of the fan. Note what happens at each fan setting.

Low Setting: Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit

Medium Setting: Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit (brighter or less bright as compared to previous test?)

High Setting: Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit (brighter or less bright as compared to previous test?)

Wind Direction:

Set the bottle containing the windmill generator directly in front of the fan. Turn the setting to "High."

Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit

Turn the windmill generator at a 45-degree angle to the fan. Turn the setting to "High."

Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit (brighter or less bright as compared to previous test?)

Turn the windmill generator at a 90-degree angle to the fan. Turn the setting to "High."

Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit (brighter or less bright as compared to previous test?)

Turn the windmill generator at a 180-degree angle to the fan. Turn the setting to "High."

Did the rotor blades turn? Yes____ No____

Did the LED light? Yes____ No____
Note brightness of LED unit (brighter or less bright as compared to previous test?)

Data Analysis:

1. What happened to the brightness of the LED unit as wind speed increased?

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2. What happened to the brightness of the LED unit as the angle of the windmill to the box fan increased?

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Conclusions:

3. Does the intensity of the wind make a difference in the performance of the windmill generator?

   Yes_____ No_______

Based on your observations explain how you reached your conclusion. Use complete sentences.

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4. Does the direction of the wind make a difference in the performance of the windmill generator?

   Yes_____ No_______

Based on your observations explain how you reached your conclusion. Use complete sentences.

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Further Questions:

5. Based on your observations of the small wind powered generator, what land and climate features need to be present in order for wind to be considered as a source of alternative energy for a whole community? List at least two.

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Write the name of your community on the following line. ____

Does your community have the land and climate features necessary to consider wind as a source of alternative energy?

   Yes_______ No_________

6. In the space below, explain your answer. Use complete sentences.

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