Where Will We Build the Wind Farm?

Activity developed by Duane Keown

— LuRay Parker

Overview

All of us who live in Wyoming know that Wyoming has plenty of wind. Many wind farms for electricity generation are on the drawing boards for Wyoming. This activity leads students to experiment and discover where they may build a make-believe wind farm. They construct anemometers to measure wind speed and compare measurements of average wind speeds to decide on the site for the farm. The whole issue of alternative methods of energy production is considered.

Objectives

Students will:

- be able to list the positive and negative aspects of electricity production by coal powered and wind powered generating plants.
- be able to state several criteria used in selecting sites for "wind farms", and identify which of these can be found in Wyoming.
- demonstrate an awareness for the need to develop alternative energy forms that do not deplete the finite supply of fossil fuels.

Goals and Concepts

A 17, 27, 29; **B** 1; **C** 13; **E** 3, 15, 17

Grade Levels 4-6
Time Needed 2 hours
Subjects to Integrate Science, Math, Art, Social Studies
Topics measuring wind speed, environmental considerations in energy production, per capita energy use, personal and national conservation in energy use
Skills measuring, motor, communication, scientific experimentation, prediction, interpretation of data, kinesthetic concept development

Materials

Cardboard disks about 10 inches in diameter (disks from the buckets of Kentucky Fried Chicken are excellent)
Paper cups
Stapler
Glass tubing about 1/8 inch in diameter or the tops from ball point pens

Propane torch to close tubing
File to scar glass and break tubing
Wire and wire cutters
Bright colored marker
Molding clay
Watch with second hand

Background

There is the joke that if you ask seasoned truckers what it is like to drive across Wyoming, they will tell you they are always going uphill or facing a wind. The geographic conditions cause the state to be very windy. Wind, wherever it blows, is usually viewed as something negative. Maybe before long this will change. Wind represents energy. In Wyoming and other states wind is being harnessed for generating electrical energy. Altamont Pass Windplant, near Berkley, California is the largest wind farm in the world. It contains 3,500 wind mills and produces 350,000,000 watts (350 megawatts) of electricity. The largest coal fired power plant in Wyoming is the Jim Bridger plant near Rock Springs. It produces 2000 megawatts of electrical energy. Wind farms are on the drawing boards for Wyoming and they will make a significant contribution to the electrical energy needs of the West. How would it be to file "wind claims" on the land like mineral claims are filed?

The Foote Creek Rim wind project is Wyoming's first commercial facility to generate electricity from wind. Located near Arlington, it began commercial operation on Earth Day, April 22, 1999.

One cause of the strong and constant winds in parts of Wyoming is the height of the Rocky Mountains. The Rocky Mountains in southern Wyoming do not rise nearly as high as in northern Wyoming and Colorado. In fact, the continental divide near Rawlins is only 6,000 feet in some areas. This configuration of the Rockies funnels the wind through the low spots. Near Medicine Bow, Wyoming, there is a location called Windy Gap. At that particular site there are the most constant relatively high-speed winds in the U.S. Such a site makes an ideal location for a wind farm since a major drawback to wind energy as a source for electricity production is that the wind does not blow constantly at any site. But our electrical energy needs are constant, 24 hours a day, 365 days of the year.

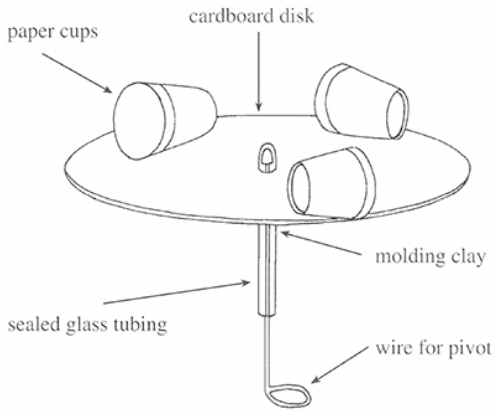
In locating sites for a possible wind farm, many factors must be considered: the constancy of the wind, the velocity (speed) of the wind, distance to carrier lines, and accessibility to the wind turbines throughout the year. These are some factors that figure into the price of producing electricity using wind energy. But there are other considerations.

Wind energy may have important advantages over production using fossil fuels or nuclear sources. It will not cause air pollution. It will not deplete the finite supply of fossil fuels. Earth should not run out of wind as we someday may run out of fossil fuels as a practical source for energy. Using wind energy will not disturb the land like mining projects.

But wind energy has limitations and drawbacks, too. To make a significant contribution to the total energy needs of the population, thousands of wind turbines are necessary. Great numbers of windmills use a lot of land. Some may see the wind turbines as visual pollution. Birds of prey and bats are sometimes killed by the wind props of the turbines.

Procedure

Students work in teams of three or four.
First the teams makes an anemometer.
Note the diagram below.



Prior to the activity, the teacher prepares the glass tubing which is made into a glass bearing. Scar the glass tubing into lengths about two inches long. Make a scratch on the tubing with the file and snap it. It will break cleanly. Then turn one end of the soft glass tubing in the blue part of the propane torch flame. Keep the end of the soft glass tubing turning in the flame until it melts and closes the hole in the tube. Let the tube cool. You have a glass bearing for the anemometer. An alternative bearing for the anemometer is the top of ballpoint pen. Cut a length of wire and put a loop on the end

of it for a handle. Poke a hole in the middle of the disk and insert the glass tube or the ballpoint pen top in the very middle of the disk. Press molding clay around the tube on both sides of the disk to hold the bearing securely in place.
Students can attach the four cups to the disk using a stapler. The bottom of one cup is marked with a bright spot using a marker. This will enable the students to count the revolutions of the disk.

Decide on a section of the school yard, or perhaps a park near the school, where the wind farm will be located. About an acre will be necessary. Each team is given a limited number of sites to test for wind speed. At each site the team determines the revolutions of the cups per minute caused by the wind. Of course they must determine the exact location of the tested sites. To do this they must use coordinates or mark the site with a marker (paper under a rock). The team should draw a map of the examined area.

Back in the classroom, the students compare their maps and wind speeds with other teams. Finally the teams compare results and decide where 200 wind mills will be placed. The wind farm planned for the site by Arlington, Wyoming, between Laramie and Rawlins, will produce 70,500,000 watts (70.5 megawatts) of electricity.

Discussion Questions

1. Look at a wind farm near your town. Find out from the company how much electricity the average home uses. How many watts will each wind turbine produce? How many homes would the turbine supply? How many homes would the entire wind farm supply?

2. How does the capacity of this wind farm compare with a large fossil fuel powered plant like Jim Bridger near Rock Springs?

3. What are environmental hazards of wind farms? What are environmental hazards of coal plants? What are the environmental hazards of nuclear plants?

4. Call a representative of Rocky Mountain Power, which is the primary producer of electricity for Wyoming, to talk with your students. Customers can choose to buy electricity produced by the wind. Have your students prepare questions for the representative. Where are the windiest sites in Wyoming? Will antelope and other wildlife remain in the sites? Where will the electricity produced go?

5. Where does personal and industrial conservation figure into the future production of electricity? Are we as individuals, a state, or a nation using too much electricity? How does our per capita use of electricity compare with other nations?

Extending the Activity

1. Find out about other considerations in using the wind. How many Wyoming people would be employed?

2. Could individuals with strong winds crossing their property build their own wind turbines and plug the electricity they produce into the Western grid of power?

3. What other renewable sources of energy are being considered? (geothermal, biomass, hydroelectric) Have students research other alternative energy forms. Will they work in Wyoming? Why or why not?

4. Draw a Wyoming landscape as you may imagine it with wind generators producing electricity. There is a variety of kinds of turbines: propeller windmills, helix rotors, Savonius rotors

5. Find out where Wyoming's wind produced electricity goes.

6. Have students write a letter to a Congressional representative about the need for sustainable energy.

Assessment

1. Have your students make three lists in three columns. Beneath each kind of power source have them list the positives and the negatives in the production of electricity by the two methods.

Wind Farms		Coal Plants		Nuclear Plants	
+	-	+	-	+	–

2. Students can list what criteria should be important in selecting a site for a wind farm.

Additional Resources

Good Website
www.
energyatlas.org/PDFs/LowRes/atlas_state_WY.pdf
This site has an excellent map of Wyoming showing the best wind areas.

eia.doe.gov/kids/classactivities/wind_elemrev.pdf
This is an excellent collection of activities and readings from the U.S. Department of Energy. They are grouped by grades: K-3, 4-7, and Intermediate, 6-9.

Project Learning Tree - Curriculum: PLT's Energy & Society Program. In addition to hands-on activities, Energy & Society integrates music and dance. www.plt.org/curriculum/energy.cfm - 25k
Project Learning Tree, American Forest Foundation 1111 19th Street, NW Washington, DC 20036

For a field trip to the Happy Jack Wind Farm west of Cheyenne contact Sharon Fain at Cheyenne Power and Light Company, (307) 638-3361 sharon.fain@cheyennepowerandlight.com

Wyoming Science Standards

CONTENT STANDARD

1. CONCEPTS AND PROCESSES
In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

BENCHMARK Grade 8
EARTH, SPACE, AND PHYSICAL SCIENCE
12. Forms and Uses of Energy: Students investigate energy as a property of substances in a variety of forms with a range of uses.

CONTENT STANDARD

2. SCIENCE AS INQUIRY
Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK Grade 8
2. Students use inquiry to conduct scientific investigations.
• Clearly and accurately communicate the result of the investigation.
3. Students clearly and accurately communicate the result of their own work, as well as information obtained from other sources.

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BENCHMARK Grade 4
EARTH, SPACE, AND PHYSICAL SYSTEMS
9. Physical Phenomena: Students investigate physical phenomena commonly encountered in daily life, including light, heat, electricity, sound, and magnetism.

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scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK Grade 4
1. Students research answers to science questions and present findings through appropriate means.
2. Students use the inquiry process to conduct simple scientific investigations.
A. Collect and organize data
B. Use data to construct simple graphs, charts, diagrams, and/or models
C. Draw conclusions and accurately communicate results, making connections to daily life
D. Pose or identify questions and make predictions
E. Conduct investigations to answer questions and check predictions
3. Students identify and use appropriate scientific equipment.

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS
Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK Grade 4
2. Students recognize how scientific information is used to make decisions.
A. Identify and describe local science issues, such as environmental hazards or resource management.

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Wyoming Math Standards

CONTENT STANDARD

4. ALGEBRA Students use algebraic methods to investigate, model, and interpret patterns and functions involving numbers, shapes, data, and graphs in a problem-solving situation.

BENCHMARK Grade 6
1. Students recognize, describe, extend, create, and generalize patterns, such as numeric sequences, by using manipulatives, numbers, graphic representations, including charts and graphs.
2. Students apply their knowledge of patterns to describe a constant rate of change when solving problems.

CONTENT STANDARD

5. DATA ANALYSIS AND PROBABILITY Students use data analysis and probability to analyze given situations and the results of experiments.

BENCHMARK Grade 6
2. Students, given a scenario, recognize and communicate the likelihood of events using concepts from probability (i.e., impossible, equally likely, certain) appropriate to grade level.

CONTENT STANDARD

1. NUMBER OPERATIONS AND CONCEPTS Students use numbers, number sense, and number relationships in a problem-solving situation.

BENCHMARK Grade 5
3. Students demonstrate an understanding of whole number operations by: explaining the relationships between the operations of addition, subtraction, multiplication, and division; and multiplying by two-digit whole numbers and dividing by single-digit whole numbers.
4. Students explain their choice of estimation or problem-solving strategies and justify results when performing number operations in proble- solving situations.

CONTENT STANDARD

3. MEASUREMENT Students use a variety of tools and techniques of measurement in a problem-solving situation.

BENCHMARK Grade 5
6. Students use time, in problem-solving situations to:
- **compare relationships among seconds, minutes, hours, and days, and**
- **use elapsed time to the nearest minute.**

Social Studies Standards

CONTENT STANDARD

3. PRODUCTION, DISTRIBUTION, AND CONSUMPTION
Students demonstrate an understanding of economic principles and concepts and describe the influence of economic factors on societies.

BENCHMARK Grade 4
1. Students describe the importance of major resources, industries, and economic development of the local community and Wyoming.

2. Students describe different ways that people earn a living in the local community and in Wyoming.