UTAH GOVERNOR'S OFFICE OF
**ENERGY DEVELOPMENT**

# The Power of Wind

**Grade/Subject*:* 4th Grade**

**Strand/Standard 4.2.4 Design a device** that converts energy from one form to another. *Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution.* Emphasize identifying the initial and final forms of energy. Examples could include solar ovens that convert light energy to heat energy or a simple alarm system that converts motion energy into sound energy. (PS3.B, PS3.D, ETS1.A, ETS1.B, ETS1.C)

**Lesson Performance Expectations:**

- Identify wind power as a source of energy
- Engineer a windmill to create enough power to light an LED light bulb
- Using the engineering process students will determine construction of the blades, the housing unit and wind power enough volts to light one LED light bulb
- Students will understand why we can't rely solely on this resource for energy

**Materials:** Materials listed are enough for one group of 3-4 students.

- 20 - 30 small wooden craft sticks
- Small hobby motor, 6 - 12 volts -- Can be purchased in most model stores or on Amazon
- Low temperature glue gun and glue sticks
- Different types of paper (examples: construction, copy, cardstock, color copy paper, newspaper or recipe cards)
- Hair Dryer, fan or windy day
- Drill (for teacher use) and drill bit that matches the same size as motor shaft
- Alligator clips with copper wire
- 2- 3 Voltmeters for testing area.-- Can be purchased at most hardware stores or on Amazon
- Optional: LED light bulbs Amazon

**Time:** 3-4 days 45 - 60 mins

Day 1 Introduction and research
Day 2 Building the prototype
Day 3 Testing prototype and Redesign
Day 4 Test redesign and record the data

**Teacher Background Information:**

- Wind Energy Video: https://www.youtube.com/watch?v=2UqVwvnXzNM

- Wind is air moving between regions of different pressure. Temperature differences between regions, which are the result of variations in the solar energy received at the surface of the Earth, cause the pressure differences that drive winds. The rotation of the Earth also affects the direction of winds.

- Wind is a powerful force that can be used to produce energy. It is a renewable energy source, which means we can use it over and over again without ever using it up. Another benefit of using wind as an energy source is that

wind is an emissions free energy source. While wind is a great energy resource, we have to find a way to capture its power. Engineers designed machines called wind turbines that look a little like windmills in order to do just that. You may have seen wind farms or groups of wind turbines in certain parts of Utah. They most often resemble tall, white pinwheels on a large "stick".

- A typical wind turbine contains numerous components, many of which are made from steel, cast iron, and concrete. Some parts of the wind turbine require materials mined here in Utah, like copper, iron, and zinc, so an increase in the number of wind turbines manufactured also generates increased need for mining.

- How does a wind turbine work? The turbine blades are connected to a gear box, which makes it spin faster and is connected to the generator. As the wind blows, the blades of the turbines spin, which turns a generator that creates electricity for our use. A turbine also has a brake in case the wind starts blowing too fast.

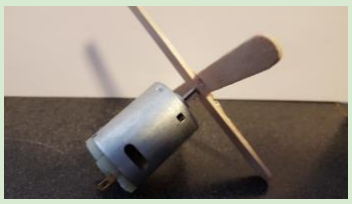
- Wind turbines may also slow or stop, producing little or no electricity, when the wind is blowing too slowly o not at all.

- Utah Geological Survey identified wind development zones covering approximately 1838 square miles of land in Utah, or about 2% of the state's surface area. These zones have the potential of producing up to 9145 MW of wind generating capacity. Currently there are two wind farms in Utah: Spanish Fork Wind Park in Utah County and Utah's largest wind energy project, Milford Wind, in Millard and Beaver Counties.

**Student Background Knowledge:**
Students need to know how to read a voltmeter. Video on How to read a voltmeter: The Best Multimeter Tutorial (1:00 min)

**Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.**

Teacher Preparation:


To help the students create the windmill portion, glue two craft sticks together in the middle. Once the glue has set, drill a hole in the middle so it will fit tightly around the drive shaft on the mini motor. You may want to have a drill during the building of the project in case students need to make some changes. It is also suggested to make extra cross pieces. You will also need to divide the students into groups of 3-4 students.

**Day 1:** Introduction and Research
Introduce the Problem to the students on page 1. Allow students to discuss (3-5 mins) their knowledge of windmills, where they have seen them, and how they work. After the discussion, let the students come up with some questions they may need to know before they create a windmill. Have them write down their questions and draw a model of their knowledge of what a windmill will look on the outside and how does it function on the inside. As a class, look at the questions the groups came up with, but do not give answers to the questions.

Research: The student worksheet has links to videos on turbines and energy production. Students will need to

take notes and look at the previous model they drew. Have students work quietly on their own notes and designs.

Bring the students together in their groups. Ask: How would you change your model to make it more effective and efficient? Using the others in your group what design will you use to create a windmill that will generate energy?

The student groups will use their research to create a model that will meet the criteria and constraints. Make sure they know that time to build their prototype is limited. Students will also need to have a look at what supplies are available to use. (You can make some changes to some of the building supplies.) Groups must make a list of supplies that they will be using. They will also need to have a detailed model with notes of length of blades, height of the windmill etc.

**Day two:** Building your Prototype
Students build their original prototype

**Day three:** Testing, Analyzing and Redesign
Teacher prep: Set up an area where the students can test their prototype by setting up a hair dryer or fan. Place the voltmeters nearby so students can test their prototype.
Video on How to read a voltmeter: The Best Multimeter Tutorial (4:35 minutes)

Students groups can test their prototype, writing down the amount of energy they have created using wind. They will record the amount of volts on the voltmeter as well as any additional observations (example: blades not long enough, blades hitting the base, etc.)

Once the group has tested their prototype, the students need to answer the analysis questions. Students will then get an opportunity to redesign and adjust their prototype. Explain that they don't need to start over but can use this as a chance to look at the problems and use different ideas to come up with a solution. Allow time for the students to make the changes to their prototype.

**Day four:** Testing Redesign and analyzing data
Have students test their redesigns and analyze the data. Once the groups have discussed their data have students complete the Interpretation and conclusion portion of the worksheet.

**Assessment of Student Learning.** Students will complete the Interpretation or Conclusion page. The following questions are asked:

1) Did your prototype meet the Criteria? Why or why not?
2) Did your group succeed in creating wind power? How did the redesign changes help your project?
3) What more changes in the design could you make in the prototype?
4) What did you learn in the process of designing and testing your project?

**Standardized Test Preparation:**

## The Power of Wind

1. What are the advantages of wind power? Choose all that apply.
    a. Wind energy is free.*

b. Wind energy produces fewer emissions.*
c. Wind energy does not require expensive machinery.
d. Wind is always blowing to create a steady source of energy.

2. What are the criteria for a city that wishes to design a system to capture wind energy in a city today? Choose all that apply.
    a. The energy produced must supplement the energy sources currently used.*
    b. The energy must be transformed into usable electricity.*
    c. The energy must allow for enough extra to sell to the electric company.
    d. The energy must replace all other sources of electricity for the household.

3. What are the constraints for the city as it designs a system to capture wind energy. Choose all that apply.
    a. Cost of the wind mills.*
    b. Amount of electricity the wind mills can produce.*
    c. Number of days of adequate wind.*
    d. The size of the area available for windmills.*

4. Why is wind energy attractive to people living in Utah? Choose all that apply.
    a. The energy source is free.*
    b. Wind energy produces little or no emissions.*
    c. Current energy sources produce emissions.*
    d. Wind energy costs less than other sources.

**Extension of lesson and Career Connections:**
Have students look up different careers in wind power. The following is some website to find research.
https://www.energy.gov/eere/wind/wind-career-map Shows different career opportunities
https://www.energy.gov/eere/wind/wind-career-map-text-version Give the students a chance to look at the definition of the careers.