

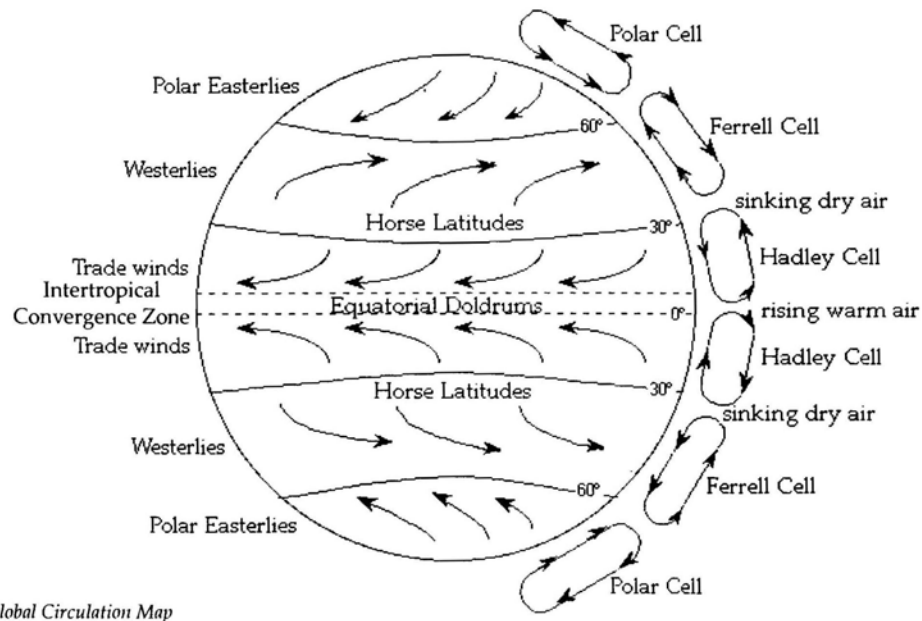


# WHAT IS WIND ENERGY

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## WIND ENERGY

<b>Time Frame:</b>	<b>Standards:</b>
1 ½ hours	8-9.ES.4.2.1 Explain the internal and external energy sources of the earth (654.02a)
<b>Objectives:</b>	
The student will be able to understand and simulate wind formation.	
<b>Background Information:</b>	
<p>What Causes Wind?</p> <p>Air is set in motion by the Pressure Gradient Force (PGF). This is a flow from high to low pressure. The second law of thermodynamics states that higher energy states move toward lower energy states. Nature is always trying to balance. The result of trying to balance and equalize pressure results in wind. What causes the pressure changes in the atmosphere? The primary reason is the warming of air by the sun.</p> <p>The pressure exerted by a gas changes as it becomes more or less dense. Because a cold air mass is denser and has a lower volume than warm air, pressure decreases more rapidly with height in cold air than in warm air. When cold dense air is placed next to warm less dense air, wind is formed as nature tries to balance the pressure differences at each level in the atmosphere between the two air masses. This can occur on all scales of motion. On a large scale, temperature gradients create the polar jet stream and sea breeze circulation; on the small scale, they create lake breezes.</p> <p>The pressure gradient force acts on a horizontal plane. Add the earth's rotation, and you get global wind patterns as hot air rises at the equator and then sinks again in huge convection currents. Conditions on the ground, such as surface topography and the type of terrain, can alter wind speeds and direction considerably from the global circulation pictured below.</p>	



### How Does Wind Energy Work?

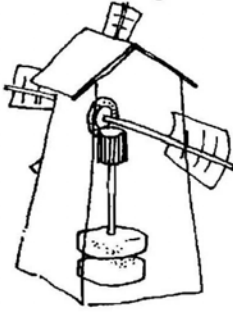
Wind is free, but to harness it we need a wind turbine, sometimes called a wind generator. By using wind turbines, we are able to harness the power of the wind and convert it into electricity. Our search for renewable sources of energy has led us to consider and develop wind power as a source of energy.

There are two types of wind turbine that are regularly used to create energy on a large scale, and both work on the same basic principles. As the wind travels into and through the blades, they rotate and turn a shaft. In turn, this shaft connects to a generator (like a dynamo used to power a bicycle light) that will create the electricity. A two-blade turbine faces away from the wind and a three-blade turbine faces into the wind. Typically, a large number of turbines are combined to create wind farms, capable of powering large numbers of buildings, but there are smaller single turbines available that you can place in your garden and use to power certain aspects of your house.

It is highly unlikely that even with modern turbines you could power an entire house with just one small wind turbine and without a grid-tied system you will still have times of the year when you simply cannot create the power you need because there's no wind. The best way around this is to not solely rely on wind turbines to power a house. One strategy would be to purchase wind turbines and combine them with power from solar panels. If one method isn't providing power, the other probably will. Solar is good for summer days and your turbines will typically produce more power during the winter months.

## WIND ENERGY

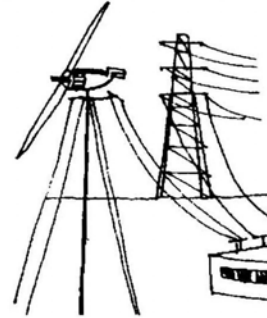
Wind Mill for grinding



Wind Mill for pumping water



Wind Generator for electricity



### Materials:

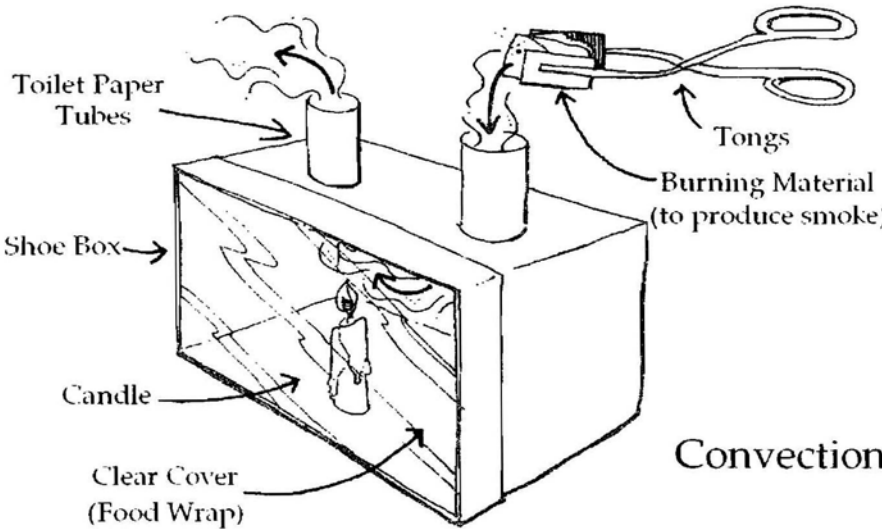
Background Information Sheet, What Causes Wind?  
Student Activity Sheet, What Is Wind Energy?  
Convection box

### Procedure:

1. Brainstorm with students for the uses of wind energy – past and present. List these on the board.
2. Suggest to students that wind is a form of solar energy. Ask them to explain how this is so.
3. Discuss with students the formation of winds on both a global and local scale. A convection box could be used to demonstrate the formation of winds. If a convection box is not available, you can use simple materials to make one (see figure below).
4. Discuss briefly how the wind can be used to produce energy. (Wind machines can be used to pump water, grind grain, and produce electricity. Wind also can be used to power sailing vessels.) You may want to provide students with the Background Information provided.
5. Select questions from the student activity sheet for students to attempt. Discuss their answers and the pros and cons of wind power.

# WHAT IS WIND ENERGY

## WIND ENERGY



**Convection Box**

Toilet Paper Tubes

Shoe Box

Candle

Clear Cover (Food Wrap)

Tongs

Burning Material (to produce smoke)

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**Assessment:**

Have students make a poster that describes the process of forming wind and multiple uses of wind energy.

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**Additional Content:**

Student Activity sheet and answers to student activity sheet

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**References:**

Lesson taken from National Energy Foundation's Energy Action Technology booklet.

## Answers to Questions on the Student Activity Sheet

1. Wind is caused by differential heating of the Earth by the sun.
2. Answers may vary.
3. The rotation of the Earth causes global wind patterns or bands such as the Trade Winds, Polar Easterlies, etc.
4. It is absorbed by the Earth and clouds, reflected by the Earth and clouds, scattered by air, photosynthesis, etc.
5. It would have to be a huge number of turbines.
6. Answers may vary – pump water, grind grain, produce electricity, recreation (fly kites, sail boats, kite surfing).
7. A machine must be built to harness the wind – the machines are not free.

## Student Activity Sheet

### Questions

1. Why is wind energy a form of solar energy?
2. Give three examples, from your experience, that indicate that warm air rises.
3. How does the rotation of the Earth affect the major movement of air (wind) from poles to the equator?
4. Only 2% of solar energy that falls on the Earth becomes wind power. What do you think happens to the other 98%?
5. Although it is theoretically possible to obtain 10 times the world's electricity needs from the wind, this would not be feasible. Why?
6. List five uses of wind energy.
7. Why is it misleading to state that wind energy is free?