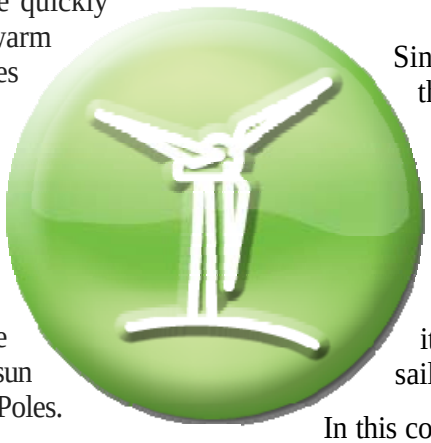
INTRODUCTION TO WIND

Information from NEED Project 2008 (Energy Infobook), Next Era Energy Resources, Danish Wind Industry Association

WHAT IS WIND?

Wind is simply air in motion. It is caused by the uneven heating of the earth's surface by radiant energy from the sun. Since the earth's surface is made of very different types of land and water, it absorbs the sun's energy at different rates. Water usually does not heat or cool as quickly as land because of its physical properties.

An ideal situation for the formation of local wind is an area where land and water meet. During the day, the air above the land heats up more quickly than the air above water. The warm air over the land expands, becomes less dense and rises.



The heavier, denser, cool air over the water flows in to take its place, creating wind. In the same way, the atmospheric winds that circle the earth are created because the land near the equator is heated more by the sun than land near the North and South Poles.

Today, people use wind energy to make electricity. Wind is called a **renewable** energy source because the wind will blow as long as the sun shines.

WIND DIRECTION

A weather vane, or wind vane, is used to show the direction of the wind. A wind vane points toward the source of the wind. ***Wind direction is reported as the direction from which the wind blows,*** not the direction toward which the wind moves. A north wind blows from the north toward the south.

WIND SPEED

It is important in many cases to know how fast the wind is blowing. Wind speed can be measured using an instrument called a **wind gauge** or **anemometer.**

One type of anemometer is a device with three arms that spin on top of a shaft. Each arm has a cup on its end. The cups catch the wind and spin the shaft. The harder the wind blows, the faster the shaft spins. A device inside counts the number of spins per minute and converts that figure into mph—miles per hour. A display on the anemometer shows the speed of the wind.

HISTORY OF WIND MACHINES

Since ancient times, people have harnessed the wind's energy. Over 5,000 years ago, the ancient Egyptians used the wind to sail ships on the Nile River. Later, people built windmills to grind wheat and other grains. The early windmills looked like paddle wheels. Centuries later, the people in Holland improved the windmill. They gave it propeller-type blades, still made with sails. Holland is famous for its windmills.

In this country, the colonists used windmills to grind wheat and corn, to pump water, and to cut wood at sawmills. Today, people occasionally use windmills to grind grain and pump water, but they also use new wind machines to make electricity.

TODAY'S WIND TURBINES

Like old-fashioned windmills, today's wind turbines use blades to capture the wind's kinetic energy. Wind turbines work because they slow down the speed of the wind. When the wind blows, it pushes against the blades of the wind turbine, making them spin. They power a generator to produce electricity.

Most wind turbines have the same basic parts: blades, shafts, gears, a generator, and a cable. (Some *turbines do not have gearboxes.)* These parts work together to convert the wind's energy into electricity.

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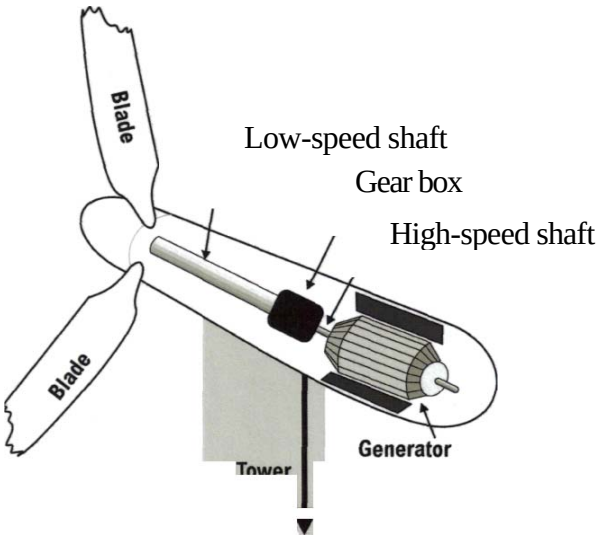

1. The wind blows and pushes against the blades on top of the tower, making them spin.
2. The turbine blades are connected to a low-speed shaft. When the blades spin, the shaft turns. The shaft is connected to a gearbox. The gears in the gearbox increase the speed of the spinning motion on a high-speed 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 that 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.

WIND POWER PLANTS

Wind power plants, or **wind farms,** are clusters of wind turbines used to produce electricity. A wind farm usually has dozens of wind turbines scattered over a large area.

Choosing the location of a wind farm is known as **siting a wind farm.** The wind speed and direction must be studied to determine where to put the turbines. As a rule, wind speed increases with height, as well as over open areas with no windbreaks.

Turbines are usually built in rows facing into the prevailing wind. Placing turbines too far apart wastes space. If turbines are too close together, they block each other's wind.

The site must have strong, steady winds. Scientists measure the winds in an area for several years before choosing a site. The best sites for wind farms are on hilltops, on the open plains, through mountain passes, and near the coasts of oceans or large lakes.

The wind blows stronger and steadier over water than over land. There are no obstacles on the water to block the wind. There is a lot of wind energy available offshore.

Offshore wind farms are built in the shallow waters off the coast of major lakes and oceans. Offshore turbines produce more electricity than turbines on land, but they cost more to build and operate.

Underwater construction is difficult and expensive. The cables that carry the electricity must be buried deep under the water.

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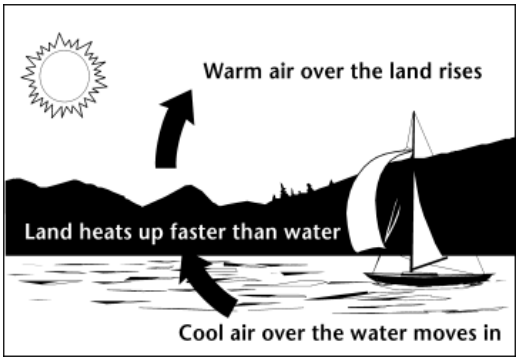
- Growth expectations for the wind industry are greater than growth expectations for the Chinese economy
- Energy in the wind more or less follows the human 24 hour power consumption cycle
- One 2 MW wind turbine on a good location can cover the electricity consumption for 2000 households per year
- Sound from the wind turbine has the same sound level as ordinary speech
- Offshore wind foundations increase the local variety of marine animals
- Wind turbines and wind mills have been a natural part of the northern European landscape for more than 800 years
- Wind turbines reduces CO2 emissions
- Today the largest wind turbines in the world have blades longer than a football field



- Wind energy is generated in 30 different states. Those with the most wind production are Texas, California, Minnesota, Iowa and Washington
- A typical horizontal wind turbine stands as tall as a 20-story building and has three blades that span 200 feet across
- U.S. wind farm installations totaled more than 16,800 megawatts in 2007 – enough power to serve approximately 4.5 million average American households