Wind Energy

econews.com.au

What is Wind?

- Wind is air in motion, creating energy.
  - During the day, air above land mass warms more quickly than over water masses. The warm air is pushed upward by the cooler air, creating wind. The opposite happens at night.

Wind Energy

Wind is Kinetic Energy

- In order to be Kinetic Energy, there must have mass (m) and motion (velocity (v)).
- Air has mass because it is composed of molecules, such as carbon dioxide, nitrogen, oxygen, etc.
- Wind has motion and therefore has Kinetic Energy. This energy can be captured by sails of a boat, wind turbines and windmills for pumping water.

How is Electricity Produced by a Wind Turbine?

- Wind turbines use an electric motor.
  - There are conducting copper windings that spin between North and South magnetic poles in the electrical motor.
  - As wind turns the turbine blades, the shaft that holds the copper windings rotate, generating an electrical current.

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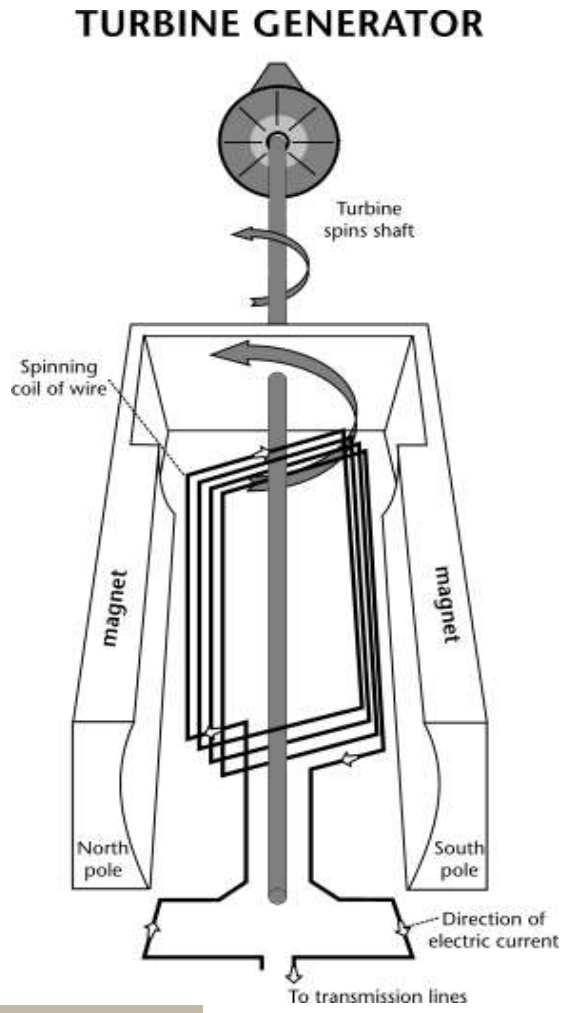
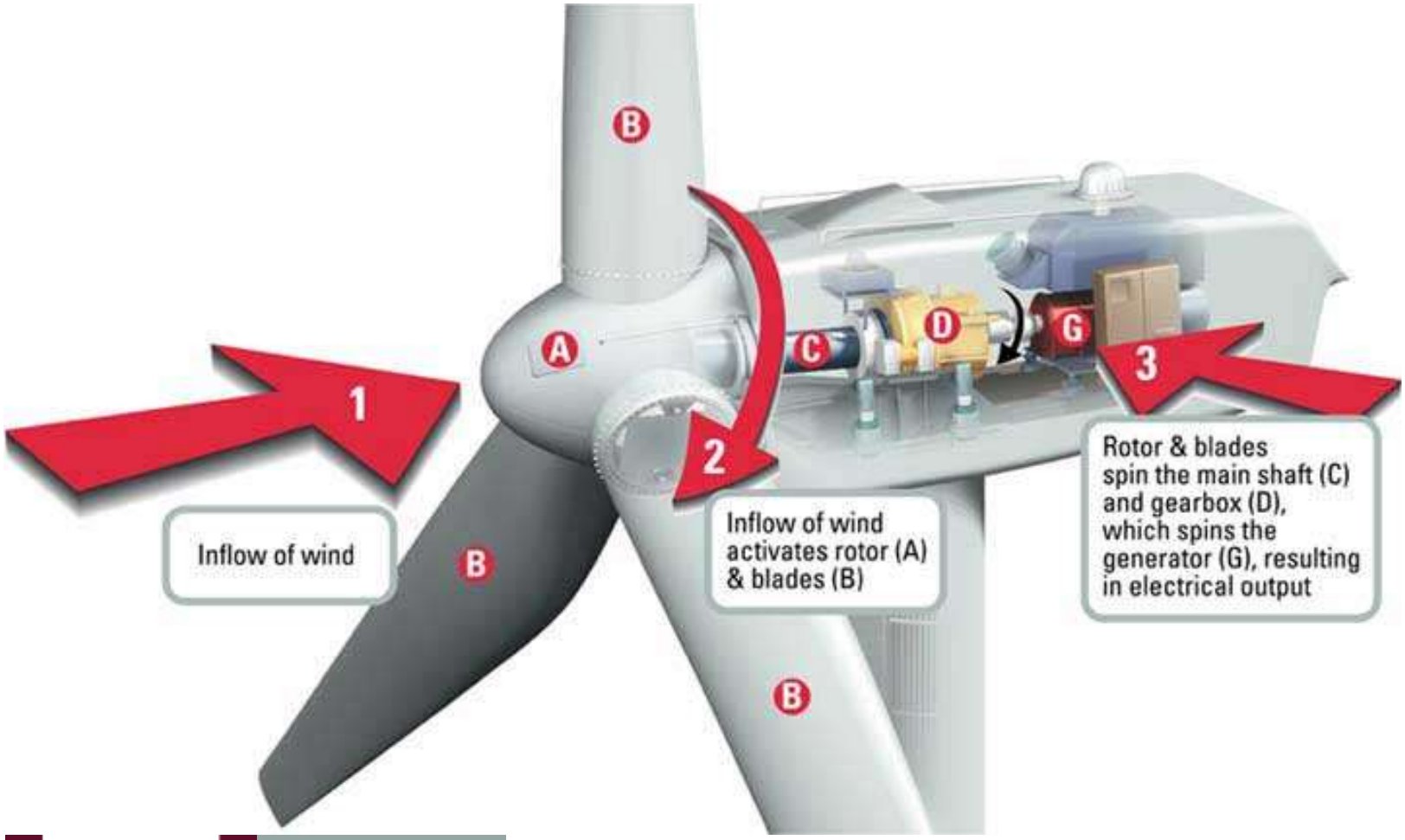
How is Electricity Produced by a Wind Turbine?

- A generator is a device that converts mechanical energy into electrical energy.
- In 1831, Michael Faraday discovered that when a magnet is moved inside a coil of wire, electrical current flows in the wire.
- This discovery, known as Faraday's Law, proves that there is a relationship between electricity and magnetism.

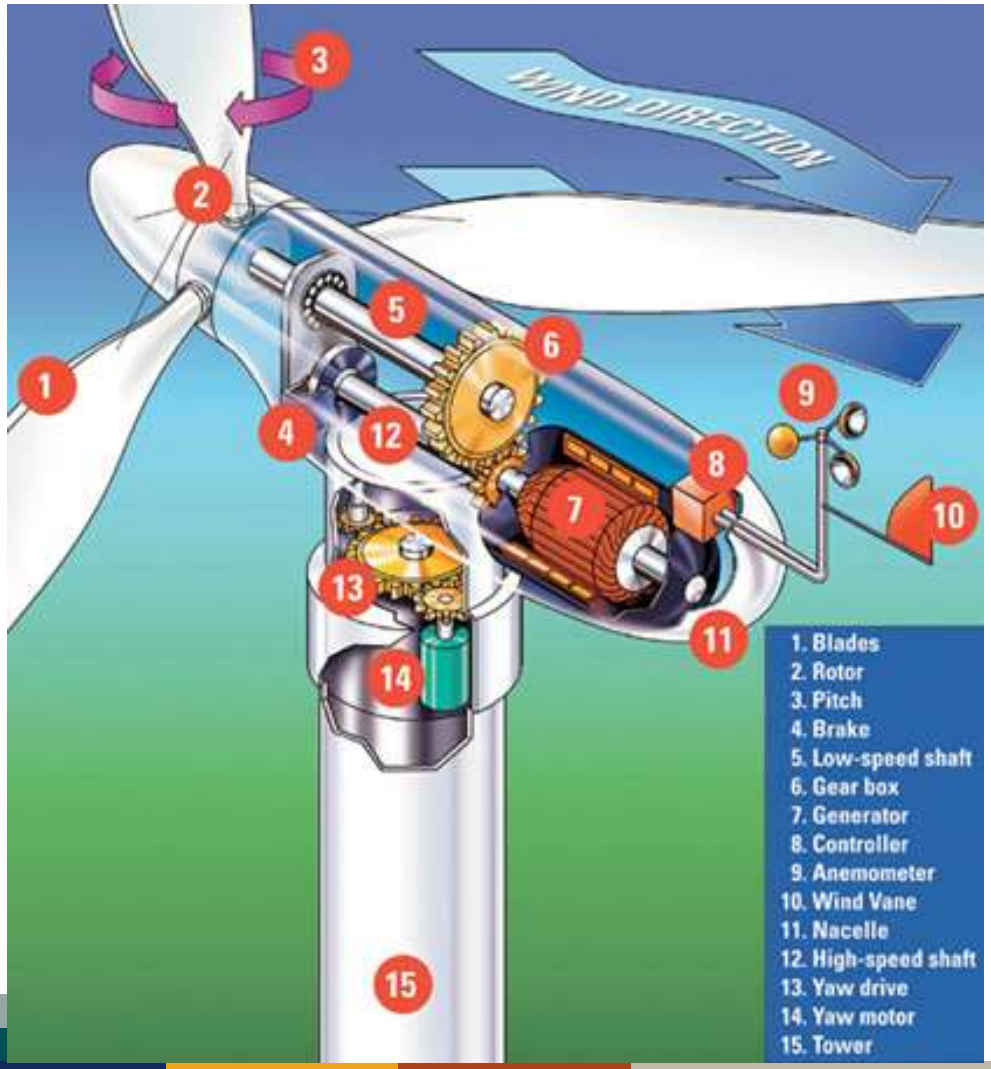


How Does a Wind Turbine Work?



agonist.org

Wind Turbine Parts



www.wwindea.orm

A Watt?

- A “watt” is a term for power and a “watt-hour” is a term for energy.
  - A 100 watt power light bulb will use 100 watt-hours energy if turned on for one hour.
  - A kilowatt is 1,000 watts. Kilowatt hours (kWh) are used to measure energy in homes.
  - A megawatt is one million watts.

Different Sized Wind Turbines

- For electricity in a home a wind turbine size ranges from 1 to 10 kilowatts.
- On a large wind farm, the massive turbines are at least 1.5 megawatts.
- Ocean turbines are even bigger! Around 5-6 megawatts.

Energy Production and Consumption

- In one year, an average household in the U.S. uses roughly 11,000 kilowatt-hours (kWh) of electricity.

- Because of variable wind speed, one megawatt produced by a wind turbine will provide electricity for about 200-300 households annually.

Energy Production and Consumption

Let's use the low estimate of one megawatt for 200 households. In New Mexico, wind power produces a total of 720 megawatts.

How many households, in New Mexico, could receive all of their electricity from wind power?

Electrical Output

- Motors/Generators
  - There are direct current (DC) motors used as generators.
  - Spinning the shaft of a small DC motor will generate a small amount of electricity.
- Measuring and Understanding Electrical Output
  - Voltage
    - The speed at which the shaft is spinning.
  - Current
    - When you measure the amperage of your motor you are basically measuring how much torque force your blades are making.

Power = volts x amps

How to Use Wind Electricity

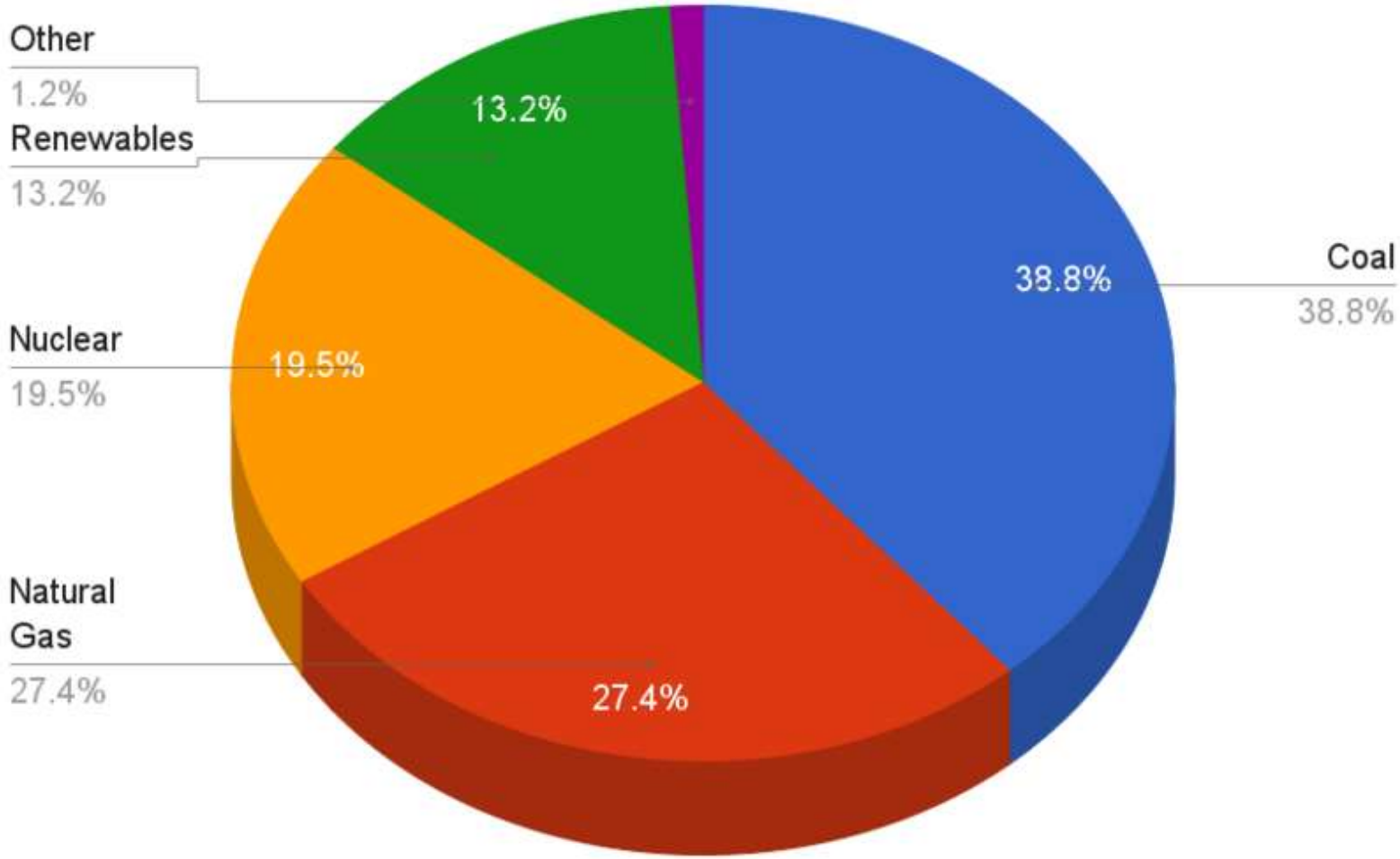
- Direct source
  - This is when the turbine is attached directly to the house or water pump. Batteries can be used to store the energy when the wind is not blowing.

- Net metering
  - There is no battery. The electrical utility is engaged when the wind is not blowing. When the wind turbine is in use, the utility kilowatt-hour meter rolls backwards. When the wind is not blowing and the utility is used, the meter rolls forward.

How to Use Wind Electricity

- Utility Grid
  - Wind farms produce so much power that it is stored in an electrical grid.
  - The electrical service may be for the surrounding community or may be sold to a utility company many states away.

U.S. 2014 Electricity Generation By Type



By Daniel.Cardenas – https://commons.wikimedia.org/w/index.php?curid=42275660

Why Should We Care About Wind Energy?

- Energy from natural gas, crude oil, Uranium and coal are finite.
- Energy created by the wind is renewable.
- With enhancements in technology, wind power may become more economical.

www.plainswindeis.anl.gov

Wind Farms

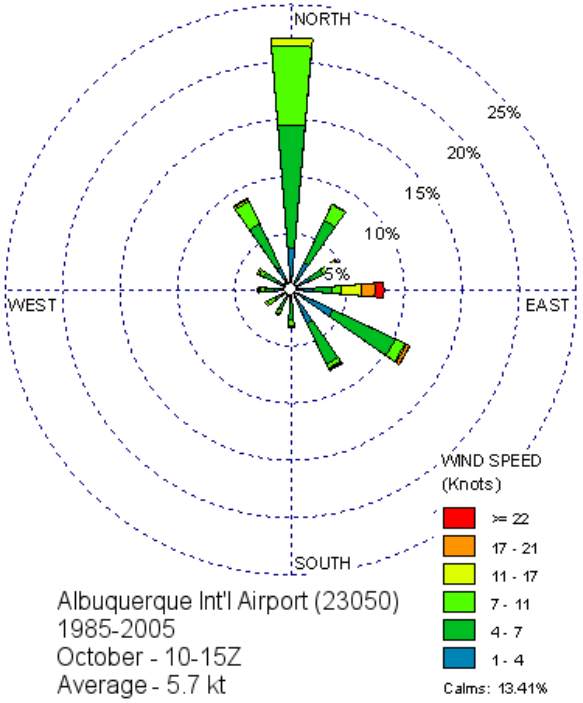
bettergreen.files.wordpress.com

- Wind farms are in areas with abundant wind.
- Wind turbines are grouped together to maximize the energy potential.

Wind Rose

Which direction is the wind blowing?

9:00 – 11:00 a.m.



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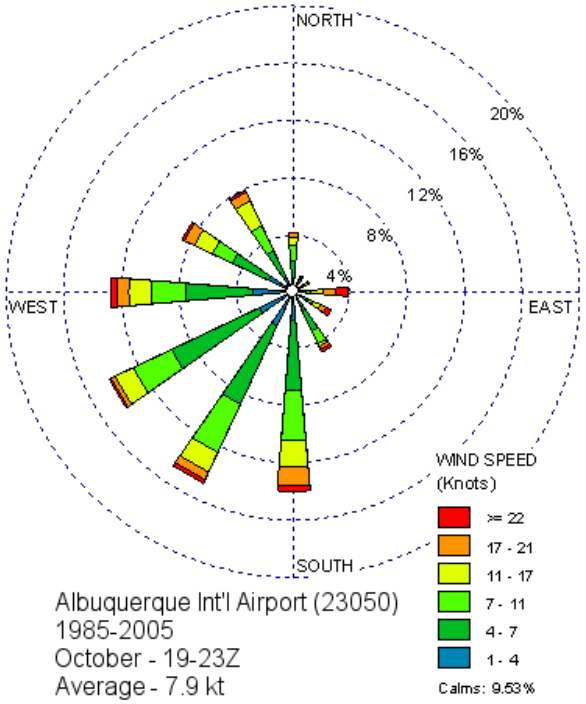

Wind Rose

It is important to know which direction the wind is blowing.

Wind turbines should be placed to access the most prevalent winds for maximum production.

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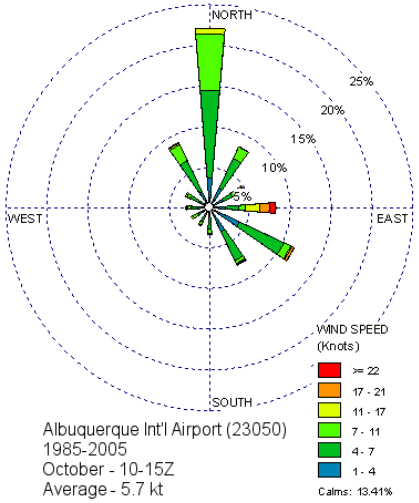

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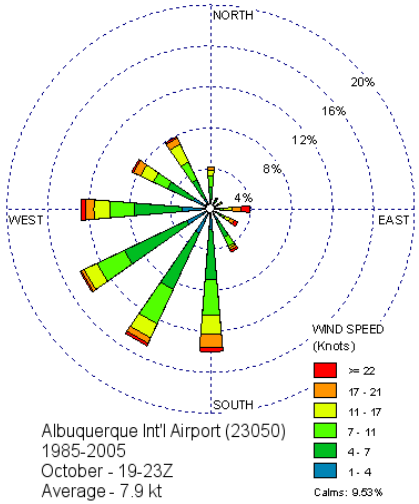
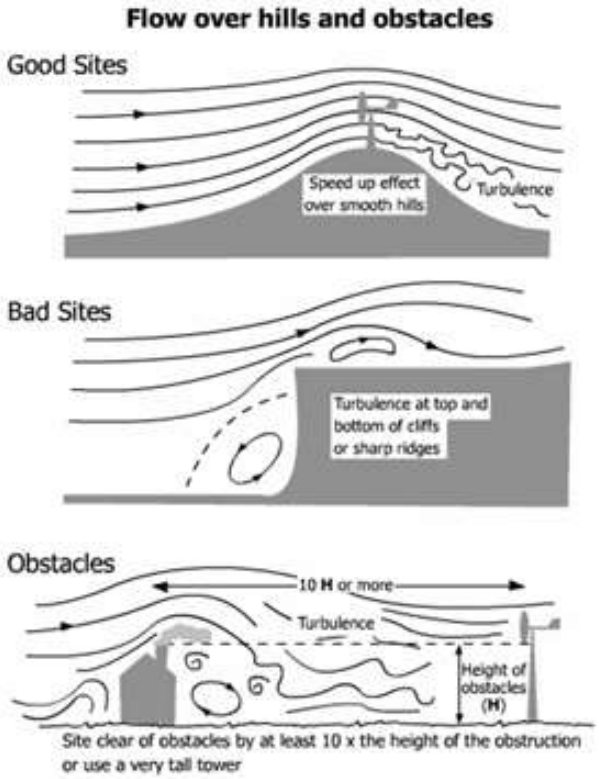


Considerations for a Wind Farm



Turbulence and Obstruction

Turbulence decreases the generation of power. Trees, buildings and topography create wind turbulence.

The area of turbulence downwind of an obstacle is twice the height of that obstacle.

Sheltering

Placing a turbine on the leeward side of hilly terrain or sheltering the turbine from dominant winds will impact the energy output.

Factors for Power Output

- The amount of power your wind turbine produces is dependent on a number of variables, including:
  - Wind Speed
  - Generator Type
  - Blades
  - Turbine Shape & Design

4-H Curriculum

- Students will design, create, build and test a wind powered device.
- Problem solving design of device.
- Adjustments and retests to wind devices are important to the design process.

4-H Curriculum

- Learn about the transfer of energy and using machines to make work easier.
- Explore properties of electromagnetism while using wind power.

4-H Curriculum

- Students use analytical skills to address issues surrounding wind power.
- Develop skills in teamwork, learning from others, planning and organizing.

4-H Curriculum

- Learn about wind and how it is used to produce energy.
- All energy comes from the sun and can be transformed in many ways.
- Geography affects wind power capacity.
- Consider necessary factors for successful wind power projects.

Online content: www.4-H.org/curriculum/wind