

Wind Turbine Worksheet



Problem

What is the problem that you are trying to solve with the design of a wind turbine for a house?

Background Knowledge

What are some things that you already know about wind turbines?

- 1.
- 2.
- 3.

Brainstorming Ideas

Before building your wind turbines, designs must first be thought up. Many different designs exist for wind turbines. Some use blades shaped like a fan's blade with a curvature; some might be flat; some look like egg beaters. The possibilities are almost endless. Use the space below to record your group's brainstorming session (ideas, drawings, etc.) for each of the designs of your turbines. You are designing both a vertical-axis and a horizontal-axis wind turbine. Remember no idea or suggestion is "silly."

Design

Use the space below to detail your group's final designs for your two wind turbines. Be specific. Include drawings and dimensions as appropriate. (Note: remember to design your turbines with the blades on the end **opposite** where the hole is drilled in the block.)

Testing and Analysis

Collect and record the following data at each of three fan speeds. Be sure that for each trial you keep the turbine about 6 inches in front of the fan.

		Speed 1 (low)	Speed 2 (medium)	Speed 3 (high)
Voltage produced with HAWT	Trial 1			
	Trial 2			
	Trial 3			
Voltage produced with VAWT	Trial 1			
	Trial 2			
	Trial 3			

1. Calculate the average voltage produced for each turbine at each speed.

Evaluation/Questions

1. Based on the data your group collected, which wind turbine (vertical or horizontal) seems to be the most efficient (that is, which turbine seems to be better at each speed than the other)?

-
2. Why do you think this type turbine performed better than the other type?
3. The overwhelming majority of wind turbines in use today are horizontal-axis wind turbines. Does this fact seem to agree with your data? Why or why not?
4. One reason why horizontal-axis wind turbines are used more often than vertical-axis wind turbines is because they can be built higher into the air. Why would this allow them to have better performance?

5. Your engineering firm has been designing an energy-efficient house, and has decided to investigate generating power for the house using a wind turbine. Several factors are under consideration when an engineer decides to build a wind turbine. The table below provides details from a recent study into possible wind turbine placement near the house. Use this information and the following questions to help determine which type of turbine to use and the best place to locate the turbine.

Measurements	Location 1	Location 2	Location 3
Average Wind Speed 10 meters above the ground	9.3 m/s	11.1 m/s	10.5 m/s
Average Wind Speed 20 meters above the ground	10.42 m/s	12.43 m/s	11.76 m/s
Average Wind Speed 40 meters above the ground	11.67 m/s	13.92 m/s	13.17 m/s
Average Wind Speed 60 meters above the ground	12.37 m/s	14.77 m/s	13.97 m/s
Number of VAWT that can fit	2	1	1
Height above ground VAWT can reach	40 m	40 m	40 m
Max power rating for each VAWT at 15 m/s	7.5 kW	7.5 kW	7.5 kW
Efficiency of VAWT	91%	91%	91%
Price to install 1 VAWT	\$6,500	\$7,500	\$7,000
Number of HAWT that can fit	3	1	2
Height above ground HAWT can reach	60 m	60 m	60 m
Max power rating for each HAWT at 15 m/s	10 kW	10 kW	10 kW
Efficiency of HAWT	95%	95%	95%
Price to install 1 HAWT	\$7,000	\$8,000	\$7,500

- a. Assume that the maximum power output for each turbine occurs at 15m/s. Calculate the power a VAWT and HAWT turbine would generate at **each site**.

$$P=W/t$$

(Hint: First find the maximum power that each type of turbine could produce at 15 m/s.)

- b. Using the efficiency ratings given, determine the actual power output of one turbine of each kind at each site.

$$P * \eta = P_{actual}$$

c. If we can expect the wind to be blowing about 7.5% of the time at the average speed, how much power can we expect each turbine to produce at each site?

d. How much energy (in kW-hours) would be generated at each site in one year?

$$E = P * t$$

e. If we would like to generate 5900 kWh of energy per year from our wind turbine, which turbine and site would you recommend and why.

