

Windmill Energy Challenge

Instructions: Upon completion of each design challenge, students will select at random one of the following content questions to answer.

1. Describe the strongest base you can have, why?

Open-ended question

2. How do you turn wind energy into mechanical power?

The "energy out" is the energy converted by the turbine blades into mechanical energy.

$$\text{POWER IN THE WIND} = (\text{DENSITY OF AIR}) \times (\text{TURBINE BLADE DIAMETER})^2 \times (\text{VELOCITY OF WIND})^3 \times (\text{A CONSTANT})$$

$$\text{POWER IN THE WIND} = d \times D^2 \times V^3 \times C$$

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3. How do you attach the axel to the frame, while still allowing the blades to freely rotate?

Open-ended question

4. How do you put your initial plan into action?

Open-ended question

5. How do you minimize the friction between the axel and the frame?

Open-ended question

6. What is the definition of efficiency?

Efficiency is the percentage of wind that the windmill is able to capture and convert to electrical or mechanical energy.

7. What is the efficiency of an ideal wind turbine?

The efficiency of an ideal wind turbine is 59.3 percent. That is, 59.3 percent of the wind's energy can be captured.

8. What is the definition of speed tip ratio?

How many times faster than the wind speed, the blade tip is designed to run. The tip of a blade can travel faster than the wind. The tip speed "ratio" is the optimum between stall and runaway.

Typical tip speed ratios are 1 thru 10. Tip Speed Ratio (tsr) = (tip speed of blade) / (wind speed). What are the steps involved in transferring wind into energy?

9. What are some things that affect the efficiency of the turbine?

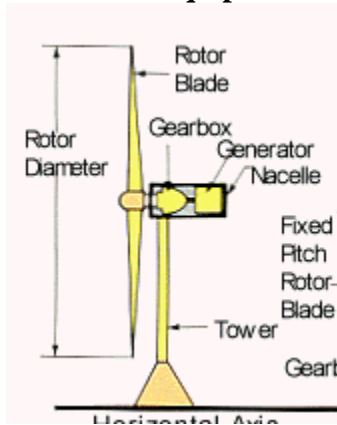
The height of the tower, the number of blades, the shape of the blades

10. What units is electrical power measured in?

Electrical power is usually measured in watt (W), kilowatt (kW), megawatt (MW), etc. Power is energy transfer per unit of time.

11. What are the major components of a wind turbine?

Rotor blade, tower, generator, and electrical equipment



12. What is the difference between a windmill and a wind turbine?

If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electricity, the machine is called a wind turbine.

13. How does the direction of the wind affect the design and efficiency of the wind mill?

To get the highest efficiency out the windmill, it should face directly into the wind.

14. Why is it important to control the speed of the turbine?

To keep the generator, rotor and tower operating within their limits, to optimize efficiency in lighter winds, to allow the windmill to stop in case of maintenance, and to reduce noise

15. Does the size and the amount of blades matter? Why?

Generally, the longer the blade the better. But it is important to keep the weight of the blades to a minimum, as too much weight puts excess load on the turbine and causes you to lose efficiency. Also, the cost of the turbine blade increases as the weight and number of blades increase.

