Wind turbine generator power output

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How to calculate the power generated by a wind turbine?

Most U.S. manufacturers rate their turbines by the amount of power they can safely produce at a particular wind speed, usually chosen between 24 mph or 10.5 m/s and 36 mph or 16 m/s. The following formula illustrates factors that are important to the performance of a wind turbine. Notice that the wind speed, V, has an exponent of 3 applied to it. This means that even a small increase in wind speed results in a large increase in power. Read How high should your small wind turbine be for more information. That is why a taller tower will increase the productivity of any wind turbine by giving it access to higher wind speeds as shown in the Wind Speeds Increase with Height graph. The formula for how to calculate power is:

Where:P = Power output, kilowattsCp = Maximum power coefficient, ranging from 0.25 to 0.45, dimension less (theoretical maximum = 0.59)r = Air density, lb/ft3A = Rotor swept area, ft2 or p D2/4 (D is the rotor diameter in ft, p = 3.1416)V = Wind speed, mphk = 0.000133 A constant to yield power in kilowatts. (Multiplying the above kilowatt answer by 1.340 converts it to horse- power [i.e., 1 kW = 1.340 horsepower]).

The rotor swept area, A, is important because the rotor is the part of the turbine that captures the wind energy. So, the larger the rotor, the more energy it can capture.

The air density, r, changes slightly with air temperature and with elevation. The ratings for wind turbines are based on standard conditions of 59? F (15? C) at sea level. A density correction should be made for higher elevations as shown in the Air Density Change with Elevation graph. A correction for temperature is typically not needed for predicting the long-term performance of a wind turbine.

Although the calculation of wind power illustrates important features about wind turbines, the best measure of wind turbine performance is annual energy output. The difference between power and energy is that power (kilowatts [kW]) is the rate at which electricity is consumed, while energy (kilowatt-hours [kWh]) is the quantity consumed. An estimate of the annual energy output from your wind turbine, kWh/year, is the best way to determine whether a particular wind turbine and tower will produce enough electricity to meet your needs.

A wind turbine manufacturer can help you estimate the energy production you can expect. They will use a calculation based on the particular wind turbine power curve, the average annual wind speed at your site, the height of the tower that you plan to use, and the frequency distribution of the wind-an estimate of the number of hours that the wind will blow at each speed during an average year. They should also adjust this calculation for the elevation of your site. Contact a wind turbine manufacturer or dealer for assistance with this calculation.

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To get a preliminary estimate of the performance of a particular wind turbine, use the formula below.

Where:AEO = Annual energy output, kWh/yearD = Rotor diameter, feetV = Annual average wind speed, mph

The Wind Energy Payback Period Workbook from the National Renewable Energy Labs is a spreadsheet tool that can help you analyze the economics of a small wind electric system and decide whether wind energy will work for you. It asks you to provide information about how you"re going to finance the system, the characteristics of your site, and the properties of the system you"re considering. It then provides you with a simple payback estimation in years. If it takes too long to regain your capital investment--the number of years comes too close or is greater than the life of the system--wind energy will not be practical for you. Read here for more on the physics and economics of wind turbines.

Can someone show me a chart of wind turbine output vs wind speed? Also, a chart of wind speed vs time of the day? I am trying to find the real time output of gratiot county wind farm vs time of day and cannot find it. Only max output is listed.

Andile ~ tricky question. It depends on the family and their behavior. It depends on the house, is it heated with wood or forced air heating which required a blower frequently. If they’re off grid they should live around the weather. Pump water and do energy intensive things while it’s windy and go into conservation mode when it’s not. Batteries are expensive. I often tell people about their ‘battery bill’ ~ just figure the monthly cost of owning them. I prefer small battery banks and good habits. (so does my back)