

## Solar Energy South Africa

# Power generation formula of wind turbine



## Overview

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What is the Formula for Wind Power Energy?

The formula for wind power energy is  $P = \frac{1}{2} \rho A v^3$ , where P is power,  $\rho$  is air density, A is blade area, and v is wind speed. How do you calculate the power of a wind turbine?

The power in the wind is given by the following equation:  $\text{Power (W)} = \frac{1}{2} \times \rho \times A \times v^3$ . Thus, the power available to a wind turbine is based on the density of the air (usually about 1.2 kg/m<sup>3</sup>), the swept area of the turbine blades (picture a big circle being made by the spinning blades), and the velocity of the wind.

How do you calculate wind energy?

The formula (equation) to calculate wind energy is : where: The unit of measurement of wind energy is joule [J]. The air flow area, also called swept area, is the area through the air (wind) is flowing. The swept area of the turbine can be calculated from the length of the turbine blades using the equation for the area of a circle: where:.

How to calculate the output power of a wind turbine?

Multiplying these two values produces an estimate of the output power of the wind turbine. Below you can find the whole procedure: 1. Sweep area of the turbine. Before finding the wind power, you need to determine the swept area of the turbine according to the following equations: For HAWT:  $A = \pi \times L^2$  For VAWT:  $A = \pi \times L^2$

How much power can a wind turbine generate?

A large offshore wind turbine with 80-meter blades: Swept area =  $\pi \times 80^2 = 20,106 \text{ m}^2$ \* Rated wind speed = 15 m/s Assuming  $C_p = 0.45$ ,  $N_g = 0.98$ ,  $N_b = 0.97$   $P = 0.5 \times 1.225 \times 20,106 \times 15^3 \times 0.45 \times 0.98 \times 0.97 \approx 12 \text{ MW}$  The power generation capacity of a single wind turbine varies dramatically based on its size and design.

How many kWh would a wind turbine produce at 6 m/s?

The total output at 6 m/s would be: 24.7 kW (the output at 6 m/s from the power curve table) x 4 hrs = 98.8 kWh. Based on the power curve table above, the total output for this day would be: One last consideration to make for wind turbines (or any energy source) is something called capacity factor.

How do you calculate swept area of a wind turbine?

Suppose we have a wind turbine with a blade radius of 5 meters, operating in an area with an average wind speed of 7 m/s. Assuming standard air density (1.225 kg/m<sup>3</sup>), a power coefficient of 0.4, and generator and gearbox efficiencies of 0.95 each: Calculate swept area:  $A = \pi r^2 = 3.14 \cdot 5^2 \approx 78.5 \text{ m}^2$

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### [Wind Turbine Calculator](#)

The equation used to calculate wind turbine power is:  $Power (W) = 0.5 \times \rho \times \pi r^2 \times C_p \times CF \times v^3$ . where  $\rho$  is wind density in  $kg/m^3$ ,  $\pi r^2$  is the swept area of the turbine,  $C_p$  is the power coefficient,  $CF$  is the capacity factor ...

### Physics of Wind Turbines , Energy Fundamentals

The installed capacity or rated power of a wind turbine corresponds to an electrical power output of a speed between 12 and 16 m/s, with optimal wind conditions. For safety reasons, the plant does not produce greater power at ...



### How to calculate wind energy and wind turbine energy

The wind energy calculator allows you to calculate the wind energy and wind turbine energy using the equations defined above. You need to enter the wind (air) speed, wind turbine blade length, wind turbine efficiency, wind turbine ...

### Wind Turbine Calculator - Calculating Wind Turbine Power ...

Wind Turbine Calculation Formula. The

fundamental equation for calculating wind turbine power output is:  $P = 0.5 \rho A v^3 C_p N_g N_b$ .  
Where: P = Power output (watts);  $\rho$  (rho) = Air density ...

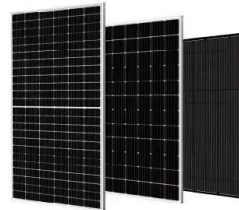


## Physics of Wind Turbines , Energy Fundamentals

which drives the wind turbine for the small period of time. Then the wind power is given as. The wind power increases with the cube of the wind speed. In other words: doubling the wind speed gives eight times the wind power. Therefore, ...

## Wind turbine , Renewable Energy, Efficiency & Design ...

Estimating power generation. the maximum amount of power that a wind turbine can generate cannot exceed 59 percent of the wind's kinetic energy. A rough estimate of annual electric production in kilowatt ...



## Wind Turbine Calculator - Calculating Wind Turbine Power Output

Wind Turbine Calculation Formula. The fundamental equation for calculating wind turbine power output is:  $P = 0.5 \rho A v^3 C_p N_g N_b$ .  
Where: P = Power output (watts)  $\rho$  (rho) = Air density ...

## [Wind turbine power coefficient](#)

The total wind power flowing into the turbine is defined by the fairly simple wind power formula, shown to the right. The power into the turbine blades is a function of the wind speed to the 3rd power ( $V$  times  $V$  times  $V$ ), air density, and swept

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