megh neel

Wind Kinetic Energy

The formula for Power is as below

Power P = 0.5 * Air Density * Swept Area * Wind Velocity^3

For example to determine the power that can be extracted from a Swept Area of say 2 meter^2 and wind velocity of 14 m/s (50 Kms / hour) is calculated as

Power P = 0.5 * 1.23 * 2 * $(14)^3$

Power P = 3375.12 Watts = 3375.12 Joules / second

Note that not all of 3375.12 watts can be generated as there is one other key parameter which brings down the power generated by a wind turbine.

Betz Law: Betz law states that the maximum power that can be generated by a wind turbine is 59%. Due to the inefficiencies of a turbine even 59% is not achievable; in fact a very good turbine can generate a maximum of only 45%. This factor is called the Power Coefficient C_p of the turbine and this will vary from model to model.

A turbine is usually built to work best for a specific wind speed range during which it gives the maximum efficiency. Outside the wind speed range, the turbine efficiency is usually low. Other factors that negatively influence the efficiency are rotor loss, weight, gears, bearings, blade construction, angle of attack etc.,

In the previous example, assuming a Power Coefficient C_p value of 30%, the total power that can be extracted by a wind turbine is

Turbine Output Power P = 3375.12 * 0.30 = 1012 Watts = 1KW

Applying the above formula in the case of our Vertical Axis Wind Turbine

Wind Swept Area = 6.2 square meters

Wind Speed = 8 meters/second

Power P = 0.5 * 1.23 * 6.2 * 8^3 = 1952.14 Watts

Considering a conservative efficiency of 20%, we will get

Output Power P = 1952.14 Watts * 20% = **390 Watts** megh neel

Important Points

While looking for a Vertical Axis Wind Turbine for your application, it is important to note the following points

i) Choose a Darrieus Vertical Axis Wind Turbine over a Savonius because of the following

   a. A typically well designed Darrieus uses blades that work on the principle of 'lift'. Turbines that are built using these blades offer Tip Speed Ratio greater than 1. (Tip Speed Ratio is the ratio between the tip speed of the wind turbine and speed of the wind.) Whereas the TSR of a Savonius is less than 1.

   b. A Darrieus has an efficiency of 20-35% whereas a Savonius has an efficiency of 10-17%

ii) Power output is proportional to the cube of wind speed. The higher the wind speed, the greater the output.

iii) Do a feasibility analysis before procuring/installing a VAWT.

   a. Determine the wind speed at various seasons

   b. Calculate the power output using a conservative efficiency

   c. Do a cost-benefit analysis

iv) A wind turbine being a mechanical device requires periodic checks and maintenance. Always plan for maintenance.

v) Always cross verify the manufacturer's claims by using the formulas given in this document.