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Wind Energy FAQ

Basic Principles of Wind Resource Evaluation

Wind resource evaluation is a critical element in projecting turbine performance at a given site. The energy available in a wind stream is proportional to the cube of its speed, which means that doubling the wind speed increases the available energy by a factor of eight. Furthermore, the wind resource itself is seldom a steady, consistent flow. It varies with the time of day, season, height above ground, and type of terrain. Proper siting in windy locations, away from large obstructions, enhances a wind turbine's performance.

In general, annual average wind speeds of 5 meters per second (11 miles per hour) are required for grid-connected applications. Annual average wind speeds of 3 to 4 m/s (7-9 mph) may be adequate for non-connected electrical and mechanical applications such as battery charging and water pumping. Wind resources exceeding this speed are available in many parts of the world.

Wind Power Density is a useful way to evaluate the wind resource available at a potential site. The wind power density, measured in watts per square meter, indicates how much energy is available at the site for conversion by a wind turbine. **Classes of wind power density** for two standard wind measurement heights are listed in the table below. Wind speed generally increases with height above ground.

Classes of Wind Power Density at 10 m and 50 m[a]

	10 m (33 ft)		50 m (164 ft)	
Wind Power Class	Wind Power Density (W/m^2)	Speed[b] m/s (mph)	Wind Power Density (W/m^2)	Speed[b] m/s (mph)
1	<100	<4.4 (9.8)	<200	<5.6 (12.5)
2	100 - 150	4.4 (9.8)/5.1 (11.5)	200 - 300	5.6 (12.5)/6.4 (14.3)
3	150 - 200	5.1 (11.5)/5.6 (12.5)	300 - 400	6.4 (14.3)/7.0 (15.7)
4	200 - 250	5.6 (12.5)/6.0 (13.4)	400 - 500	7.0 (15.7)/7.5 (16.8)
5	250 - 300	6.0 (13.4)/6.4 (14.3)	500 - 600	7.5 (16.8)/8.0 (17.9)
6	300 - 400	6.4 (14.3)/7.0 (15.7)	600 - 800	8.0 (17.9)/8.8 (19.7)
7	>400	>7.0 (15.7)	>800	>8.8 (19.7)

(a) Vertical extrapolation of wind speed based on the 1/7 power law

(b) Mean wind speed is based on the Rayleigh speed distribution of equivalent wind power density. Wind speed is for standard sea-level conditions. To maintain the same power density, speed increases 3%/1000 m (5%/5000 ft) of elevation.
(from the Battelle Wind Energy Resource Atlas)

In general, sites with a Wind Power Class rating of 4 or higher are now preferred for large scale wind plants. Research conducted by industry and the U.S. government is expanding the applications of grid- connected wind technology to areas with more moderate wind speeds.

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