

UNDERSTANDING THE WEIBULL DISTRIBUTION FOR WIND

Characterizing the variations in wind speed throughout the year is essential in developing successful wind energy projects. Wind turbine manufacturers utilize detailed wind information in order to minimize the cost of energy generation by optimizing the design of their turbine. Wind project developers need to understand variations in wind speed to accurately estimate electricity generation, as well as the income it will produce. The variations in annual and monthly wind speed at a particular location can be reliably predicted by fitting the data to a probability density function known as the Weibull Distribution.

The strength of wind varies, therefore an average value for a given location does not alone indicate the amount of energy a wind turbine could produce. The statistical distribution of wind speeds vary from place to place around the globe, depending on local climate, the topography of the landscape, and the surface roughness (low crops, forests, urban area, etc.).

The Weibull Distribution curve is dependent on two parameters, the scale parameter and the shape parameter. The scale parameter (represented by "A") describes the height of the curve while the shape parameter (represented by "K") describes the slope of the curve.

To assess the frequency of wind speeds at a particular location, a probability density function is often fit to the observed data. The Weibull model closely mirrors the actual distribution of hourly wind speeds at a given location. The data below, collected from a MET tower in Ohio, has been used to demonstrate the accuracy of the Weibull Distribution for the area. In the graph below, the blue line is the actual data and the Weibull curve is represented with the orange line.

At a typical site, a Weibull Distribution curve is calculated annually as well as monthly. The table below summarizes the annual and monthly wind speed and Weibull parameters for a specific site in Ohio. This particular site has a mean or an average wind speed of 13 mph.

OHIO MET TOWER DATA SUMMARY			
	Average Wind Speed (mph)	Weibull Parameters	
		A	K
Annual	13.0	14.1	2.4
Jan	14.8	15.9	2.8
Feb	14.4	15.5	3.2
Mar	13.9	15.2	2.3
Apr	13.5	14.2	3.0
May	14.1	15.2	2.7
Jun	13.2	14.4	2.3
Jul	9.9	10.6	2.6
Aug	9.9	10.6	2.4
Sept	9.9	13.0	3.8
Oct	11.3	12.2	2.8
Nov	14.4	15.4	3.2
Dec	14.6	15.3	3.4

STATISTICAL DESCRIPTION OF WIND SPEEDS

The graph below shows a probability density distribution. The mean wind speed is actually the average of the wind speed observations at this site. The distribution of wind speeds is skewed, i.e. it is not symmetrical. Sometimes there will be very high wind speeds, but that is rare. Wind speeds of 13 mph, on the other hand, are the most common ones. If we multiply each tiny wind speed interval by the probability of getting that particular wind speed, and add it all up, we get the mean wind speed.

