Renewable Energy Research Laboratory, University of Massachusetts at Amherst

Wind Power

Interpreting your Wind Resource Data

Wind Power on the Community Scale

Community Wind Power Fact Sheet # 6

RERL—MTC Community Wind Fact Sheet Series

In collaboration with the Massachusetts Technology Collaborative's Renewable Energy Trust Fund, the Renewable Energy Research Lab (RERL) brings you this series of fact sheets about Wind Power on the community scale:

1. Technology
2. Performance
3. Impacts & Issues
4. Siting
5. Resource Assessment
6. Wind Data
7. Permitting

Overview

This document will help you understand the statistics commonly used to describe wind when it is studied for the purpose of evaluating wind power facilities.

Wind Statistics

1. *Long-term mean wind speed*: Often given as the annual mean (average) wind speed, this number represents the quality of the wind resource.

Long-Term Mean Wind Speed m/s	Long-Term Mean Wind Speed mph	Relative Quality of Wind Resource for Commercial Turbines*
0 – 6	0 – 13.5	0 - 73%
6 – 7	13.5 – 15.8	73 - 100%
7 – 8	15.8 – 18	100 - 125%
> 8	> 18	125 % & above

** Based on typical annual energy production at 6, 7 and 8 m/s annual averages, as a percentage of production at 7 m/s. Note that quality will vary with other factors that affect project economics.*

The power in the wind is related to the cube of the wind speed, so a small improvement in resource quality results in a large increase in electrical power.

2. *Prevailing wind direction*: The direction from which the wind blows most often is the prevailing wind direction. Knowing the directional behavior of the wind is useful when considering where to install wind turbines. If the prevailing winds come from the west, for example, you would not want to install a turbine somewhere with an obstacle to the west.

3. *Average turbulence intensity*: Turbulence intensity is a measure of the "gustiness" of the wind and is calculated as the standard deviation (over a short interval, e.g. 10 minutes) of the wind speed divided by the mean wind speed. Lower turbulence results in less required maintenance and better performance from a wind turbine. Average turbulence intensities are used to compare different sites. In New England, turbulence intensities range from 0.1 to 0.5. Offshore values may be even lower. Further discussion is found in the Graphs section below.

Wind speeds are usually measured in units of meters per second (m/s).

1 m/s = 2.25 mph

4. *Wind shear*: Usually, wind speeds increase with height above the ground. This change in wind speed with height is called wind shear. Wind shear can be characterized by the exponent, α, in the so-called "power law" equation:

$$U = U_r \left(\frac{z}{z_r} \right)^{\alpha}$$

where U is the wind speed at the height (z) of interest (say, hub height), and U_r is the speed actually measured at another height z_r. The larger the shear, the more the wind speed increases at higher elevations.

5. *Data quality*: When collecting data, it is important to know the quality of the data. Poor quality data are not trustworthy. Two numbers often reported are:

- *Gross data recovery percentage*: The percentage of data expected which were actually recorded in the logger.

- *Net data recovery percentage*: The percentage of data expected which passed a quality control process. Differences between the gross and net percentages are usually due to sensor icing or malfunction.

Inside this Edition:

Wind Data

Renewable Energy Research Laboratory

University of Massachusetts at Amherst

160 Governors Drive
Amherst, MA 01003
Phone: 413-545-4359
E-mail: rerl@ecs.umass.edu
www.ceere.org/rerl/

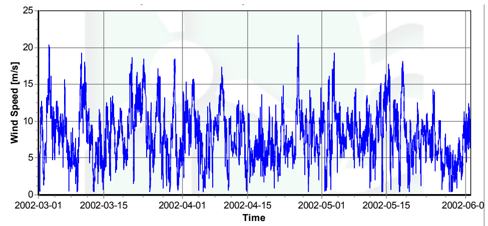
MASSACHUSETTS TECHNOLOGY COLLABORATIVE
RENEWABLE ENERGY TRUST

Mass. Technology Collaborative
Mass. Renewable Energy Trust
75 North Drive
Westborough, MA 01581
phone: 508-870-0312
www.mtpc.org/RenewableEnergy/

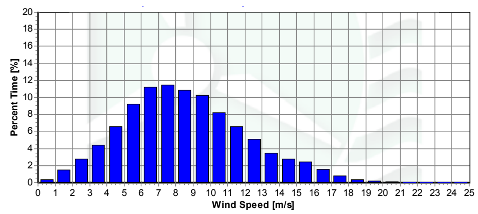
Community-owned wind turbine, in Hull, MA.

Graphs

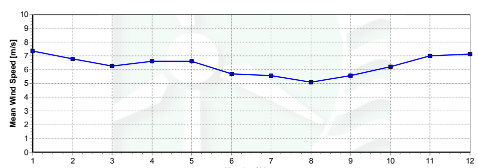
Wind speed time series: This graph shows trends and the variability of the wind.



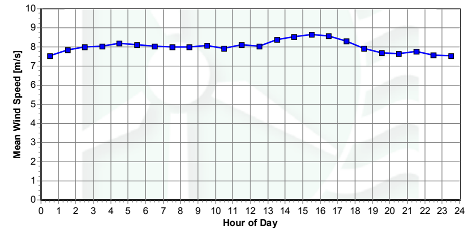
Wind speed distribution: This shows the percentage of time that the wind blew at a given speed. The highest percentage indicates the wind speed most often experienced. This may be different than the mean wind speed.



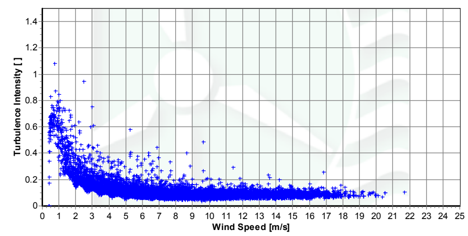
Monthly average wind speeds: This plot of the monthly average wind speeds shows the trends in the wind speed over the year. New England winds are usually faster in the winter and slower in the summer.



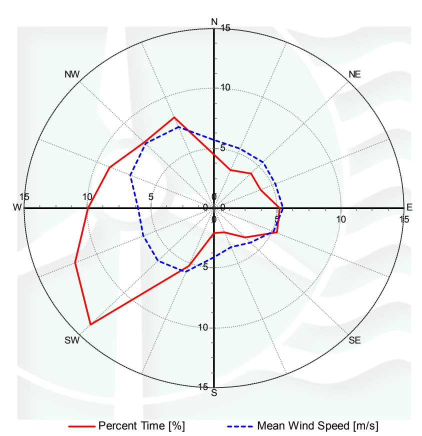
Diurnal average wind speeds: This plot shows the average wind speed for each hour of the day. The typical diurnal pattern at low elevations in New England is low speeds in the morning, winds increasing through the afternoon, then subsiding at night. While this pattern usually exists throughout the year, the specific times of day at which the highs and lows occur will vary from season to season.



Turbulence intensity: This graph shows the gustiness of the wind at different wind speeds. Together with the Wind Speed Distribution, this graph can be used to determine the level of turbulence present under typical operating conditions. A turbine manufacturer will use this graph to predict maintenance scheduling.



Wind rose: A plot, by compass direction, showing the percentage of time that the wind comes from a given direction and the average wind speed in that direction. This plot is used to determine how to orient and space a group of turbines.



For More Information

Another model of wind shear explained by windpower.org:
www.windpower.org/en/tour/wres/shear.htm

New England wind resource map by TrueWind:
truewind.teamcamelot.com/ne/

US Department of Energy wind resource info:
www.eere.energy.gov/RE/wind_resource.html

National Wind Technology Center's wind resource publications list: www.nrel.gov/wind/wind_pubs.html

Wind Energy Explained, Theory, Design and Applications, Manwell, McGowan, Rogers, Wiley, 2002

For the on-line version of this fact sheet with the complete set of links, see www.ceere.org/rerl/about_wind/