Wind Measurements

wilmers
Environment · Measurement · Systems

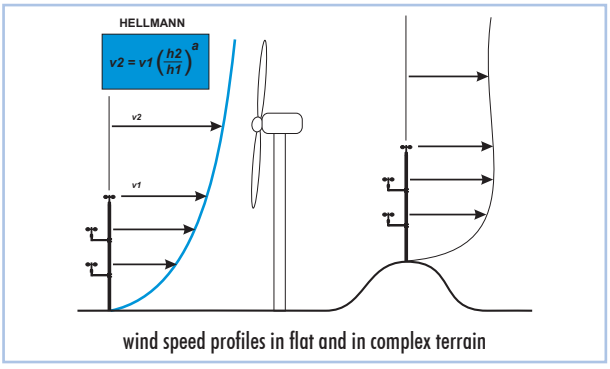
Wind Energy

During the promotion of wind energy projects it is required to obtain detailed information about the wind resource at the planned wind turbine site to guarantee a correct prognosis of the energy yield. Wind measurements provide the most accurate information. Wind speed, wind direction, and optionally other relevant data for wind turbine site assessment are recorded for at least one year in order to consider seasonal fluctuations.

This document shall assist the planner at the design of a measurement system suitable to achieve bankable wind data.

Wind Profiles

Local wind climates are influenced by the orography and the roughness of the terrain. Usually, wind speed increases with the height above ground. The HELLMANN formula decribes the vertical wind profile for flat terrain. It is used to extrapolate measured wind speed from mast height to hub height of a wind turbine. Hills lead to distortion of ideal wind profiles. In order to achieve reliable information it is recommended to measure at least in 3 or 4 levels and to measure the closest possible to hub height.



wind speed profiles in flat and in complex terrain

Selection of Sensors

The electrical power output of a wind turbine can be described by the following formula:

$$Pel = \rho/2 * v^3 * cp * S$$

Pel	=	electrical power output of the wind turbine
ρ	=	air density, depends on temperature and barometric pressure
v	=	wind speed
cp	=	power coefficient, f(v)
S	=	swept rotor area

Wind Speed

Power output varies with the cubic of the wind speed. An uncertainty of 3% in wind speed measurements leads to an uncertainty of 10% for the energy yield. This shows that wind speed measurements must be as accurate as possible. International standards ([1], [2]) define the design and behaviour for an anemometer that is suitable for wind site assessment. It must have conical cups, a long shaft and a small body. The following figures show some examples for well-designed and poorly-designed anemometers.

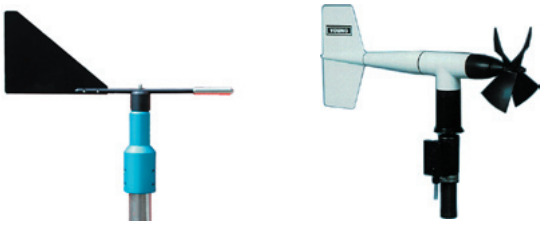

‚well-designed' anemometers


‚poorly-designed' anemometers

The financing banks of a wind energy project usually require calibrated, IEC classified anemometers. The two anemometers in the upper picture are IEC class 1. Anemometers should be calibrated in a MEASNET [5] certified wind tunnel before use.

Wind Direction

Information about the wind direction is used to optimize the configuration of several wind turbines in a wind farm. Wind direction is measured by a wind vane or by a combined sensor for wind speed and wind direction.


wind direction sensor and combined wind sensor

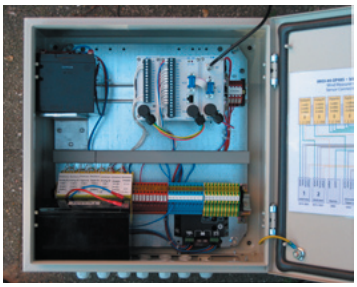
Temperature, Humidity, Barometric Pressure

The air density depends on air temperature and barometric pressure. Temperature and humidity of the air provide information about potential icing of sensors and wind turbines. A radiation shield protects temperature sensors and thermo hygro sensors against rain and solar radiation. Barometric pressure sensors are usually integrated in the data logger shelter box.

thermo hygro sensor with radiation shield

Data Logger and Data Transmission

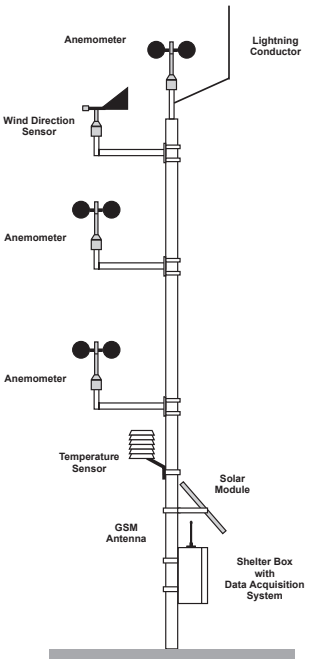
The 'heart' of a wind measurement system is the data logger. It records the signals from all sensors and stores measured data as time series. A GSM modem enables remote transmission of measured data. The measurement system is supplied by a solar module with backup battery. A steel shelter box houses data logger, surge protection, modem and power supply.



shelter box with data logger, GSM modem and solar power supply

Measurement Mast

Sensors are placed at different heights on the measurement mast. The complexity of the terrain and the hub heights of the planned wind turbines determine the mast height. A complex terrain requires higher measurement levels in order to obtain reliable data. Measurements in hub height provide the most accurate results. However, a minimum mast height of 40m is recommended.



wind measurement station

Detailed recommendations for the design of mast and mounting booms are provided by the IEC guidelines [2].

Norms and Further Information

1) Hunter, Raymond S. (Ed). Expert Group Study on Recommended Practices for Wind Turbine Testing and Evaluation. Vol 11: Wind Speed Measurement and Use of Cup Anemometry. 1st Edition. IEA 1999

2) IEC 61400-12-1: Power Performance Measurements of Electricity Producing Wind Turbines. 1st edition Dec. 2005 (www.iec.ch)

3) Klug, H., Busche, P., Kluin, R., Mellinghoff, H., Varlik, M.: Calibration and Classification of Cup Anemometers. DEWI Magazin No. 22, Feb. 2003

4) Krebs, H., Steinbach, E., Wilmers, W.: How to Perform Complete Wind Measurements. EWEC 2006 (www.wilmers.com)

5) MEASNET: Cup Anemometer Calibration Procedure. Version 1. 1997 (www.measnet.org)

6) MEASNET: Power Performance Measurement Procedure. Version 3. 2000 (www.measnet.org)

Your Distributor

wilmers
Environment · Measurement · Systems

Wilmers Messtechnik GmbH
Hirschgraben 24 • D-22089 Hamburg • Germany
Tel.: +49(0)40-75 66 08 98 • Fax: +49(0)40-75 66 08 99
info@wilmers.com • www.wilmers.com