Novel Approach to Wind Direction Measurements
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Abstract
It is well known that some wind farms suffer from the so-called “underperformance syndrome”, to some extent related to “inaccurately measured” wind direction [1].

In line with these issues, the recently updated IEC61400-12-1 (2017) now requires complete assessment of wind direction measurement uncertainties [2], given the impact that incorrect wind direction measurements have.

Low accurate wind direction measurements may result in:
1. Wrong wind field modelling and AEP calculation.
2. Unforeseen wake effect losses.
3. Higher than expected turbine loads leading to lower turbine service-life.

The alignment of the wind sensor body to a known direction has traditionally presented a challenge to even the most experienced individual. Auditors typically apply a wind vane installation uncertainty of ±5°, mainly attributable to the use of magnetic methods and the physical impossibility of verifying the sensor final orientation on the boom [3].

The presented method accurately measures the sensor body orientation by using the Sun’s azimuth, thereby eliminating any error associated with poor sensor orientation that was either introduced during installation or came about throughout the measurement campaign.

Objectives

Drastically reduce traditional wind vane offset errors to get the most accurate wind direction measurements available in the industry.

Method

Due to the problems associated with the determination of True North using magnetic methods [4], a solar method has been implemented using an optoelectronic device equipped with high-resolution photosensing elements that can be coupled to any wind vane or ultrasonic anemometer.

The device receives the Sun’s direct radiation and then obtains its orientation with respect to True North by comparing the theoretical Sun’s azimuth \( \Psi \) calculated by its embedded processing unit with the relative-measured azimuth \( \theta \) read by its built-in photosensing means.

\[
\text{offset} = \theta = \Psi - A_m
\]

The device does not physically orient the wind vane but rather provides a correction value to be applied in the post processing of the dataset.

Results

An independent commercial wind developer has carried out a real-world test by installing the system onto one of their met mast to check the orientation offset of two existing wind vanes with respect to True North.

The wind vane met mast configuration consists of two wind vanes located at 117 and 90 meters height respectively. A third wind vane equipped with the presented device is installed in between them, at 114m.

The test reveals an offset error of 15° and 17.5° for the existing wind vanes, as it is shown on the frequency wind rose on the right.

Conclusions

Measuring the Sun’s azimuth relative to the body of a wind direction transmitter as presented in this poster is a reliable and automatic method to drastically reduce the main uncertainty in wind direction measurements today: the wind vane mounting bias.

The results of applying the proposed method lead us to think that wind vane offsets are much greater than currently estimated by the industry.

References


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