Wind turbine power performance measurement with the use of spinner anemometry - DTU Orbit (04/11/2019)

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The spinner anemometer was patented by DTU in 2004 and licenced to ROMO Wind in 2011. By 2015 the spinner anemometer was installed on several hundred wind turbines for yaw misalignment measurements. The goal of this PhD project was to investigate the feasibility of use of spinner anemometry for power performance measurements. First development of spinner anemometer was related to calibration of yaw misalignment measurements. Here the first innovation was made in the spinner anemometer mathematical model, introducing a new calibration constant, $k_\alpha = k_1/k_2$. This constant was found to be directly related to measurements of inflow angle (yaw misalignment and flow inclination). The calibration of the constant was based on yawing the stopped turbine several times in and out of the wind comparing the varying inflow angle measurement with the yaw position sensor. The calibration for inflow angle measurements was further improved with an innovation step to calibrate without use of the yaw position sensor, saving cost and time of installing the additional yaw sensor. The so called "wind speed response method" was validated by comparing 27 different calibration tests to the fist methods. This method is now used as default in commercial calibrations. To evaluate the power performance of a wind turbine with the use of spinner anemometry, an experiment was organized in collaboration with Romo Wind and Vattenfall. A met-mast was installed close to two wind turbines equipped with spinner anemometers at a flat wind farm site. A procedure to calibrate the spinner anemometer for wind speed measurements was developed to determine the $k_1$ calibration constant, and the IEC61400-12-2 standard was used to measure the nacelle transfer function (NTF). The power curves of the two wind turbines with use of met-mast and spinner anemometer were then compared. Application of the NTF from one turbine to the other was made with a difference of only 0.38% in AEP. Different methods of analysis of fast sampled measurements such as the Langevin power curve were tested, concluding that the method of bins (IEC61400-12-1) was the most simple and robust method, and could also be applied directly to fast sampled measurements. The probability distribution of wind speed was playing a major role in being able to complete a power curve measurement in short time.

General information
Publication status: Published
Organisations: Meteorology & Remote Sensing, Department of Wind Energy
Contributors: Demurtas, G.
Number of pages: 135
Publication date: 2016

Publication information
Publisher: DTU Wind Energy
Original language: English
(DTU Wind Energy PhD. No. 0063(EN)).
Keywords: DTU Wind Energy PhD-0063, DTU Wind Energy PhD-63
Electronic versions:
Wind_turbine_power_performance.pdf