Evaluation of wind flow with a nacelle-mounted, continuous wave wind lidar

Nacelle-mounted lidar is becoming widely recognized as a tool with potential for assessing power curves, understanding wind flow characteristics, and controlling turbines. As rotor diameters continue to increase, and the deployment of turbines in complex terrain becomes more widespread, knowledge of the characteristics of the incident wind field beyond the mean speed and direction at hub height become essential, for example, in the calculation of rotor-equivalent power curves. A scanned, continuous wave lidar can provide a wealth of such information.

This paper evaluates data collected from a ZephIR DM lidar mounted on the nacelle of a 550 kW turbine at the Risø campus of the Technical University of Denmark (DTU). Lidar measurements of wind speed and turbulence were compared against those made by anemometers on a high-quality traditional mast. Analysis showed excellent correlation between mast and ZephIR, increasing the confidence in the ZephIR for measuring wind parameters in this configuration. SCADA data from the turbine was combined with measured wind speeds and directions to derive power curves from the mast data (hub-height) and from ZephIR data (hub-height and rotor-equivalent). The rotor-equivalent power curves were derived in accordance with the procedure detailed in the February 2013 draft of the IEC Guidelines and accounted for the effects of varying air density, shear, veer and turbulence. Once again, the ZephIR and the mast were shown to give very similar results.

It is believed that this is the first time that a commercially available nacelle-mounted lidar has been used to evaluate such rotor-equivalent power curves.

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