A Practical Approach for Wind Park Performance Warranties

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SUMMARY

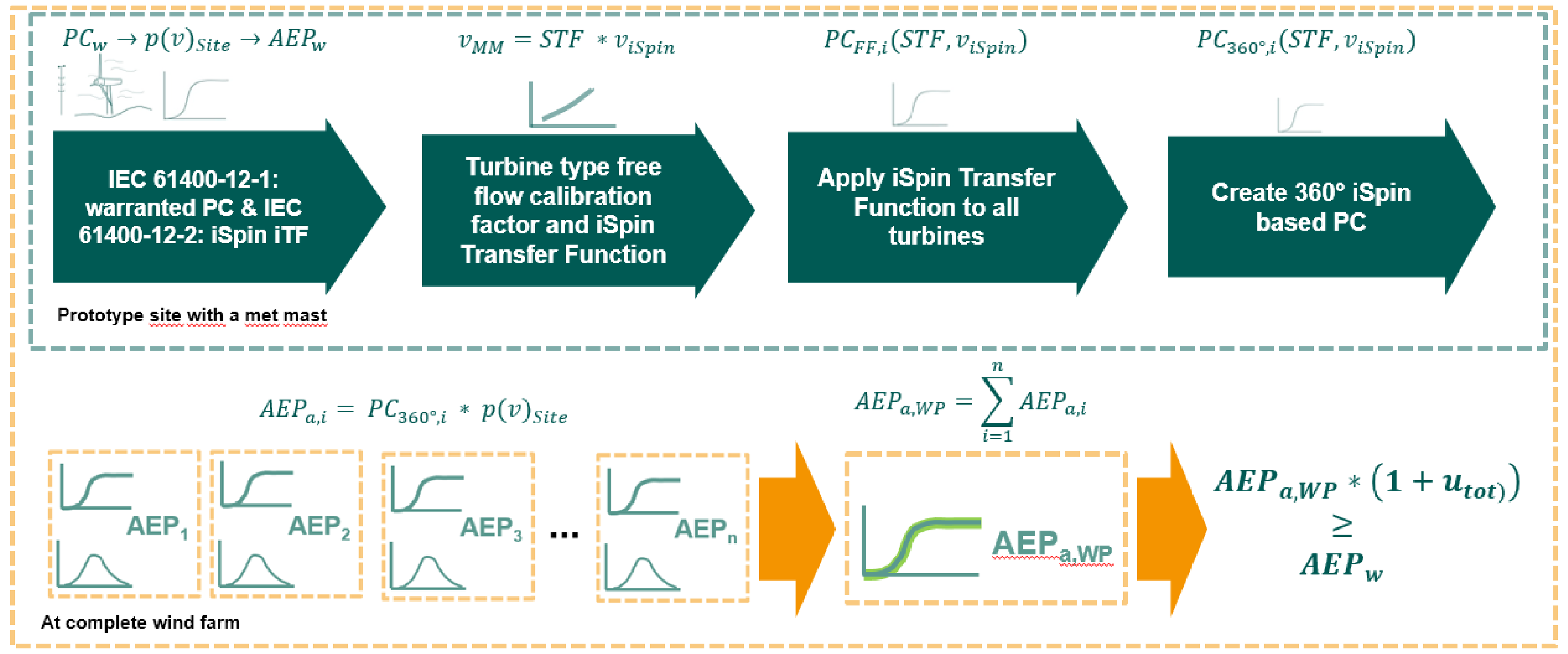
The wind industry suffers from the fact that the performance of wind turbines is difficult to measure and assess. The complexity and variability of the wind resource, which is the input parameter to the energy conversion equation poses such difficulties, that so far it has only be possible to determine the performance of wind turbines by means of power curve evaluations for few, selected wind turbines. This is done in combination with a wind met mast or a ground based lidar according to IEC 61400-12-1 and only in particular terrain complying with the requirements of the standard. The performance of all the other wind turbines in a wind farm have not been considered so far and therefore are in the dark.

The method proposed[1] utilises the iSpin technology in order to provide accurate and precise wind measurements on each of the turbines in a wind farm independently from site or wake (360° measurements) conditions. Therefore allowing the measurement of power curves on all turbines in a wind farm by adapting or even enhancing the methods described in IEC 61400-12-2 to the iSpin capabilities and to measure and monitor the performance on each of the wind turbines in the wind farm at any time during the life time. Make them comparable to each other, as well as to other reference measurements (met masts, lidar, warranted power curves) and over time to detect changes in the performance. For the first time this would enable to manage the performance of all turbines in a wind farm actively, detect underperformance as early as possible, conduct counter measures and re-establish performance.

METHOD STATEMENT

The method[1] stipulates that each of the wind turbines in the wind farm is equipped with the iSpin spinner anemometer technology and therefore allows to measure and monitor the following wind components: wind speed, wind direction, yaw misalignment, inflow angle and turbulence intensity, air pressure and air temperature accurately and precise. Based on this, two methods are proposed to determine the performance of all wind turbines in the wind farm:

1. Comparison of the actual annual wind park energy production with a reference to an IEC 61400-12-1 compliant wind measurement in the wind farm



Based on an IEC 61400-12-1 compliant power curve measurement in the wind farm the Spinner Transfer Function (STF) as well as an IEC 61400-12-2 compliant power curve will be determined and compared. As the iSpin technology has demonstrated that it is capable to determine the free wind speeds accurately for complex terrain or even in wake of other turbines [4,5], the STF will be transferred to the other wind turbines in the wind farm independently from usual limitation factors like uncompliant terrain or no free wind sectors available. After having the measured 360° power curves available from each of the turbines in the wind farm[3] an actual annual energy production (AEP_a) will be calculated based on a normalised wind distribution for all the turbines (contractually agreed Raleigh wind distribution or the one from the wind site assessment report). That wind farm AEP_a then will be compared with the warranted annual energy production (AEP_w) based on the warranted power curves provided by the wind turbine manufacturers (OEM) and the same wind distribution as used in the calculation of the AEP_a. The uncertainties to be considered for this method have been evaluated and documented in the DTU uncertainty report[2].

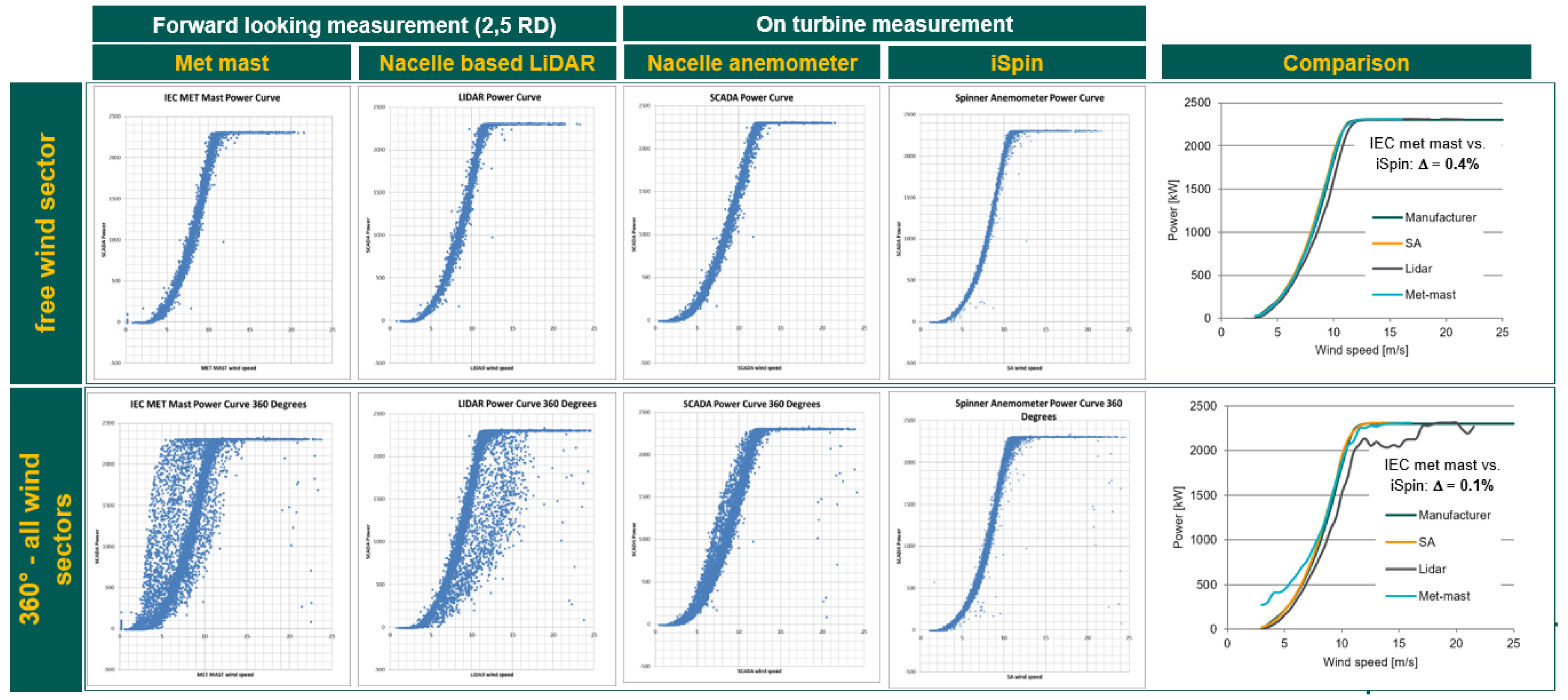
2. Comparison of the actual annual wind park energy production with reference to an external iSpin reference power curve

This method proposes to go a step beyond the actual IEC 61400-12-2 standard by simply referring to another external iSpin power curve measurement, derived on the prototype the wind turbine OEM has measured the warranted power curve with. However, this time the OEM used in addition or as substitution to the met mast the iSpin equipment to determine the warranted power curve. This would yield a considerable reduction of uncertainties according to the DTU uncertainty report[2] and therefore reduce the deductions of the AEP_a compared to the AEP_w . Hence, this would considerably reduce the acceptable underperformance in wind turbine sales contract performance warranties.

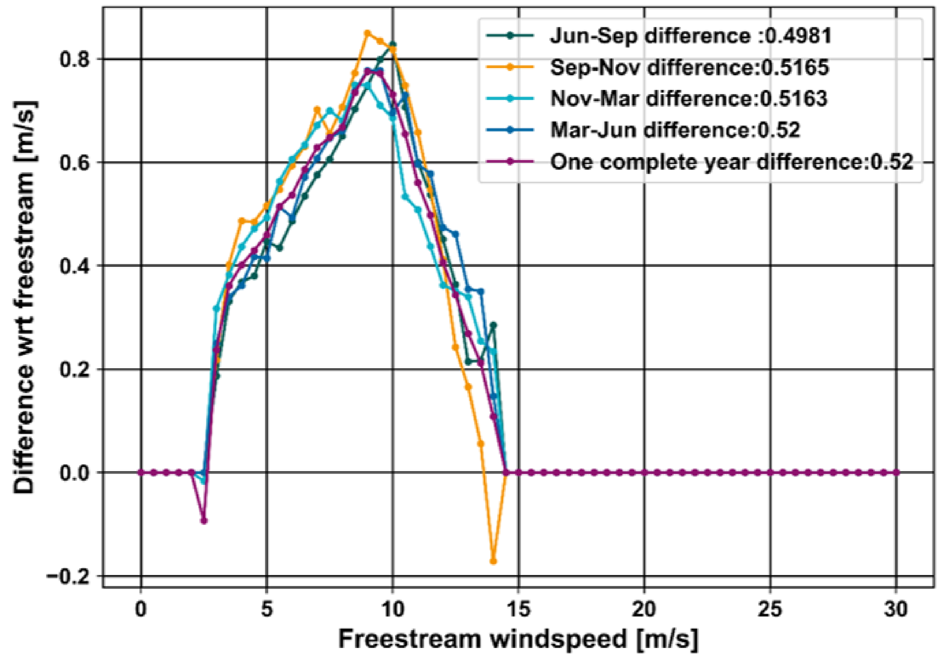
RESULTS

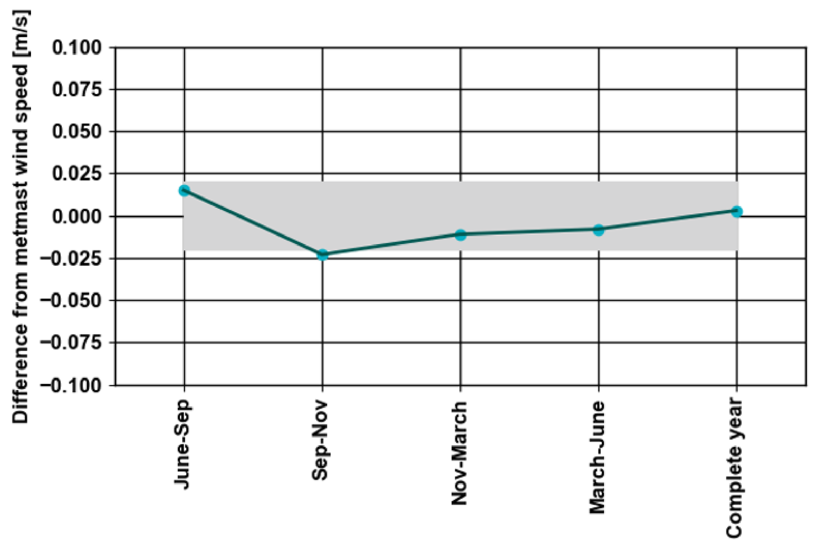
EUDP R&D projects in Nørræker Enge / DK[4] and in the complex terrain (PTP project)[6] have been demonstrated already such capabilities:

- The stability of the STF in wake of other turbines and therefore the capability to measure 360° power curves has been demonstrated



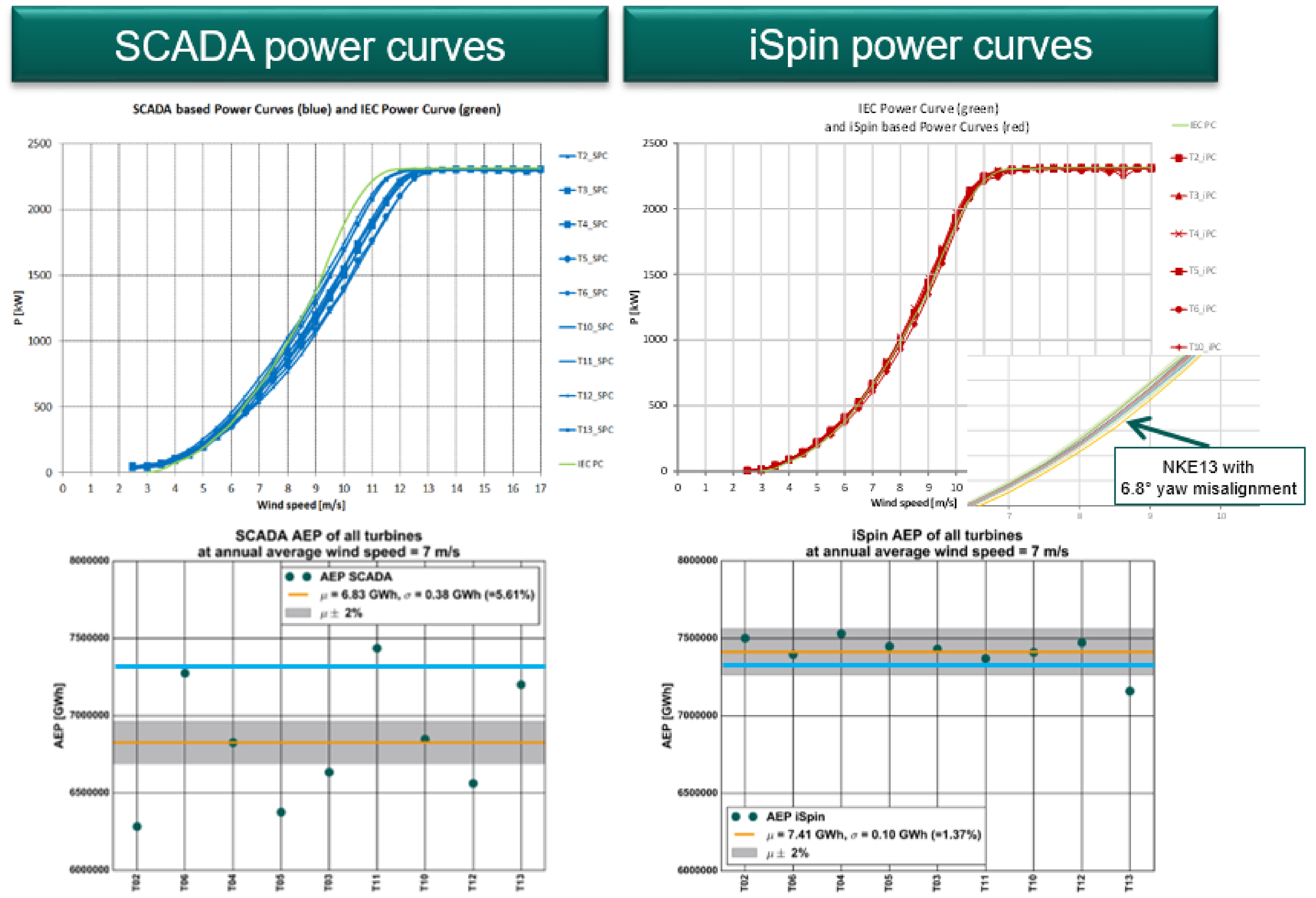
- High seasonal stability of the STF, even in complex terrain (PTP project)[6]:



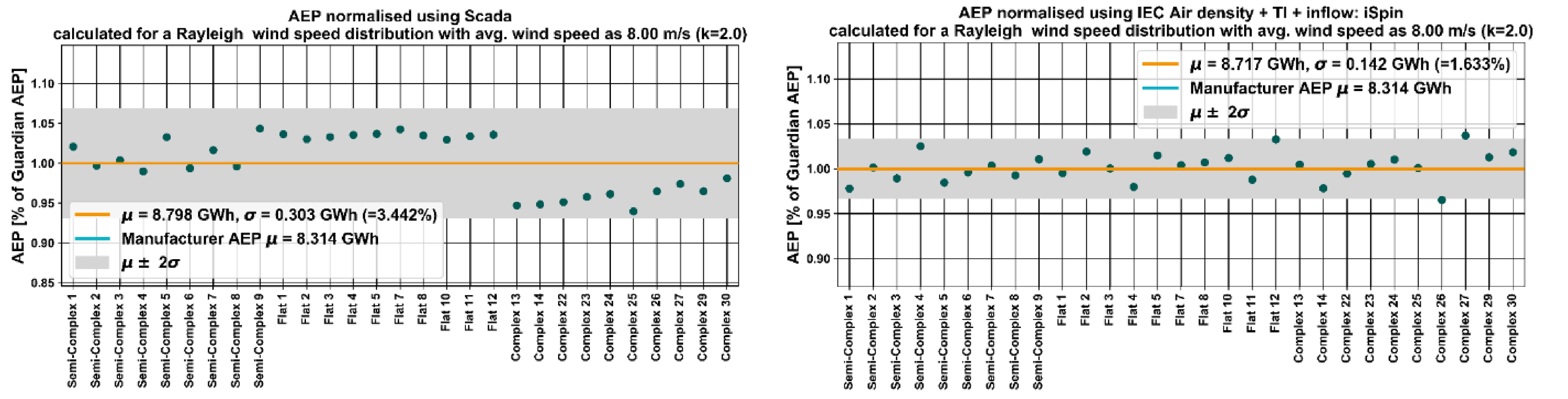


- The comparison between pure SCADA data power curve and iSpin power curve evaluations demonstrated the superior measurement results of the iSpin method in the following ways
  - Uncertainties are by far lower with iSpin
  - SCADA data yield wrong information in terms of which turbine actually underperforms

Case study 1:



Case study 2:



CONCLUSIONS

The method proposed provides wind turbine operators and owners with a tool to assess, measure, monitor and manage the performance of all their wind turbines in a wind farm actively by comparison with reference measurements (warranted power curve, met mast, lidar) with other wind turbines of the same wind turbine type and over long time to determine changes in the performance of a wind turbine. Such a holistic approach for the verification of performance in a wind farm might provide them with reduced investment risk and the ability to actively remain the warranted performance as well as to verify any improvement of performance.

REFERENCES

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[3] Spinner Anemometry – Best Practice; ; T.F. Pedersen, P.G. Arranz, DTU Wind Energy I-0692; 01/2018
[4] Spinner Anemometer Power Curves compared with IEC Measurements, Jørgen Højstrup, Wind Solutions / Højstrup Wind Energy, Henrik Sundergaard Pedersen, Eduardo Gil Martin, Romo Wind A/S, 11/2015
[5] First results from the iSpin Performance Transparency Project (PTP), WindEurope 2018, Harald Hohlen, Sowjanya Subramaniam Iyer, Romo Wind A/S, 9/2018
[6] EUDP Performance Transparency Project homepage: www.ispin-ptp.com

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