Verifying the accuracy of Virtual Met Mast™ for small and medium wind industry using Aeolus Power (Wind-Energy) Ltd

VIRTUAL MET MAST™

Virtual Met Mast™ (VMM) is a service offered by the Met Office to help developers assess the long-term wind resource at any specified site and turbine hub height. Accurate wind data is required to calculate the long term power yield and the resulting revenues over the lifetime of the asset.

Given the prohibitive costs associated with erecting physical meteorological masts carrying high quality calibrated anemometers to measure wind speeds over extended periods of up to one year, the Virtual Met Mast™ has become the bankable standard in the small and medium wind industry. It also has the advantage that the statistics delivered are for a full 25 years’ climatology, and can be produced within a few days.

Using Virtual Met Mast™ is a reliable and scientifically robust method of generating a long-term wind climatology.
ACCURATE WIND ASSESSMENTS VITAL TO POWER YIELD CALCULATION

Given the sensitivity of the power yield calculation to the underlying wind speed data, it is important that this wind data is as accurate as possible to avoid significant over or under predictions of power yield, which in turn results in unrealistic return on investment scenarios.

Producing accurate wind assessments for the small and medium wind industry where typical hub heights range between 20 and 40 metres above the ground is particularly challenging as wind speeds at these heights are influenced by the surrounding terrain.

USING SCADA DATA TO VERIFY ACCURACY

To further verify the accuracy of Virtual Met Mast™, we approached turbine distributor Aeolus Power (Wind-Energy) Limited to request wind speed SCADA data captured by their nacelle-mounted anemometers.

Aeolus Power was the first approved UK distributor and installer of Endurance Wind Power turbines in the UK and has now installed over 80 Endurance EWP E-3120 turbines across the UK. Importantly, Aeolus was able to support the Met Office as a result of its unique TOPAZ (Turbine Output Performance Analyzer) system which is fitted to each individual turbine.

TOPAZ was commissioned, designed and developed to meet customer demand for performance information about their turbine. It collects and transmits accurate, real-time, location-specific data over the mobile phone network, detailing the performance of individual wind turbines. The information can be accessed 24 hours a day by the turbine owner on their own password protected page of the Aeolus Power website.

Aeolus Power’s SCADA data is independent of any other data the Met Office has used to assess performance of Virtual Met Mast™. We then worked in collaboration with Endurance Wind Power to interpret the data.

COMPARING VMM WITH SCADA DATA

The Met Office was supplied with 41 sites from the total number of available Endurance turbines. Sites were selected to ensure that at least three months’ SCADA data was available and that there was a representative geographic spread across the UK, with varying terrain complexity and at hub heights between 25 and 32 metres. Virtual Met Mast™ was run at each turbine location and hub height, generating hourly time series data which was used to compare with the equivalent period of SCADA data taken from TOPAZ. A resulting bias figure (VMM – observations) was calculated for each hour, and the mean of these calculated for each site.

It was found that, with no adjustments to the SCADA data, VMM returned a significantly higher average wind speed across all sites of +0.74 m/s.

As with all wind turbines’ nacelle anemometers, the wind speed readings were greatly affected by the extraction of kinetic energy from the air by the turbine on which the anemometer is mounted. Studies have indicated a large variability in the Uplift Correction Factor that should be applied to return the readings to the ‘free-stream’ value (that which would be recorded if the turbine had not been present, and which the VMM is designed to model) due to site or turbine specific effects. Depending on the turbine, an Uplift Correction Factor typically between 7.5% and 12.5% is required to correct SCADA data values to represent free-flow wind. It should be noted that in the case of Endurance turbines the rotor is downstream of the tower, such that the anemometer is upstream and so not affected by the less significant component of rotor wakes resulting from aerodynamic ‘viscous effects’.

The more significant explanation of the difference between the nacelle anemometer and free-stream wind speeds is the stagnation of the flow due to the extraction of energy. This ‘axial induction factor’ changes little just upstream and downstream of the rotor and it could be argued the positioning of the nacelle anemometer has little effect on the required Uplift Correction, compared to the large stochastic variability.

CONCLUSIONS

Results have been plotted for comparison of the VMM with anemometer data using Uplift Correction Factors of 7.5%, 10% and 12.5%.

Virtual Met Mast™ can be used with confidence by developers of small and medium wind projects to support their investment case.
It can be seen that with the expected Uplift Correction Factor of 7.5% the positive bias is just over +0.3m/s. At 10% the overall bias is around +0.2 m/s, while an Uplift Correction Factor of 12.5% results in a mean bias across all 41 sites of just +0.05 m/s. It should also be noted that in the case of high complexity sites there is small negative bias of -0.17 m/s.

This set of independent verification data demonstrates that Virtual Met Mast™ exhibits a small positive bias against the corrected SCADA wind data. This is consistent with the results of a previous case study carried out using calibrated anemometer data across 44 sites which compared VMM with the publicly available NOABL database. We have extracted NOABL data for each of the 41 sites in this case study and the results of both cases are presented side by side below.

These verification studies show that using Virtual Met Mast™ is a reliable and scientifically robust method of generating a long-term wind climatology. It can be used with confidence by developers of small and medium wind projects to support their investment case.

*Endurance observations that VMM and NOABL are compared to have been uplifted by 10% to better represent ‘free flow’ observed wind speed.