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Wind farm simulation and validation of analytical and CFD based Wake Models

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Abstract

Wind turbines in wind farms regularly operate in the wake of other wind turbines and experience lower wind speeds, higher turbulences and a reduced yield.

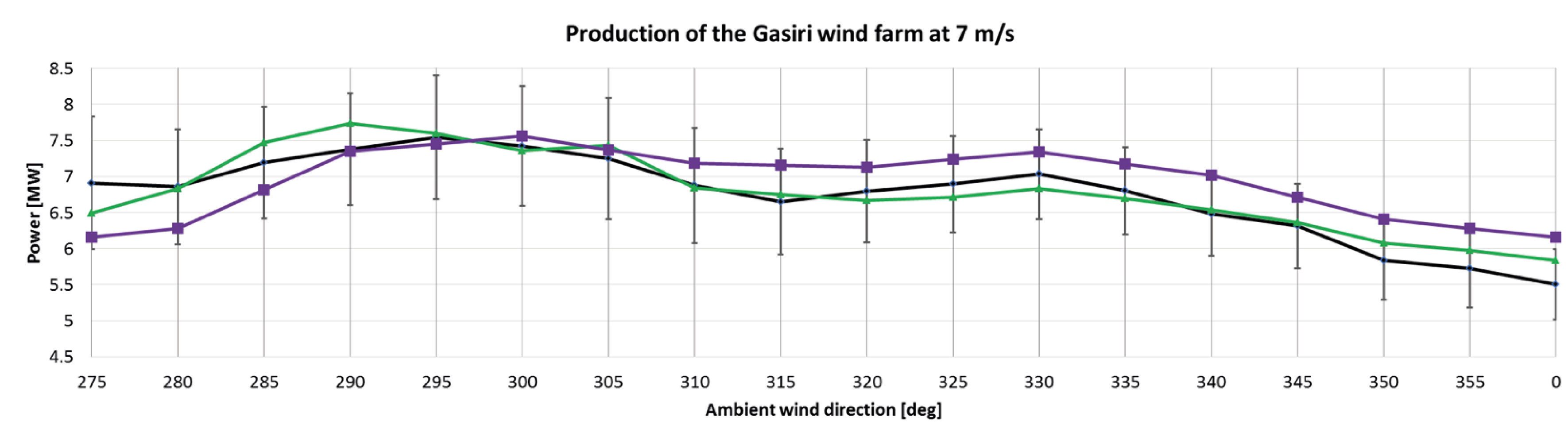
To assess the wake effects models of different fidelity can be used. These models range from simple ones like Jensen to complex CFD models

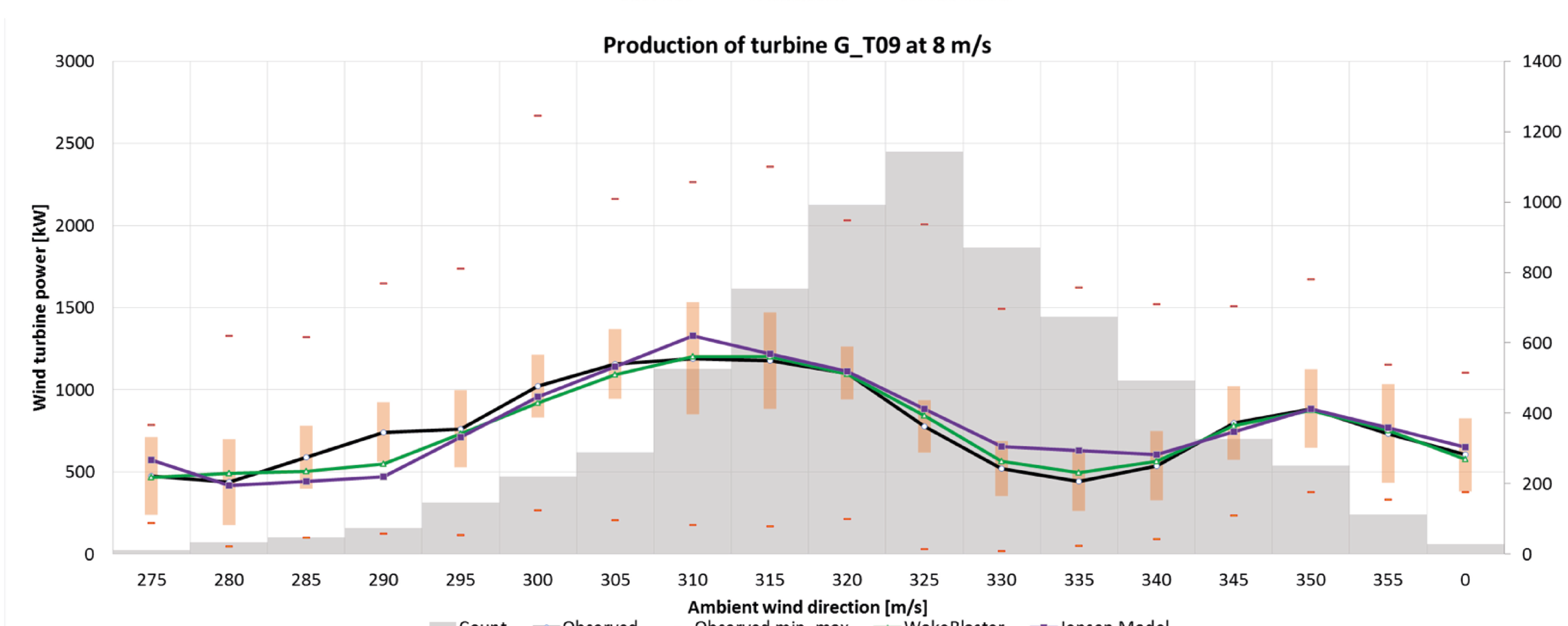
The new wake model WakeBlaster is a compromise between the requirements of accuracy and performance. It is implementing a solver for the 3D RANS (Reynolds-Averaged Navier Stokes) equations and is using an advanced actuator disk model as turbine representation.

This poster compares the results of the Jensen model and WakeBlaster with the power generation for two onshore wind farms. Through this comparison the uncertainties of the models can be determined which leads to a better AEP prediction of future wind farms and an improved understanding of wake effects.

Objectives

This poster demonstrate methods to validate wake models with operational data from full scale wind farms. The delegates can learn the relative merits of validation with bin-averaged flow cases.





Methods

Siemens Gamesa Renewable Energy (SGRE) have processed several years of SCADA production data from two wind farms, one in Ireland and one in South Korea. Both wind farms are onshore wind farms with significant wake effects present. The wind farms were selected to allow separating the wake effects from wind flow modifications caused by orography and roughness changes.

The level of detail and accuracy of WakeBlaster was validated by comparing the model results with full scale wind farm performance data of two wind farms.

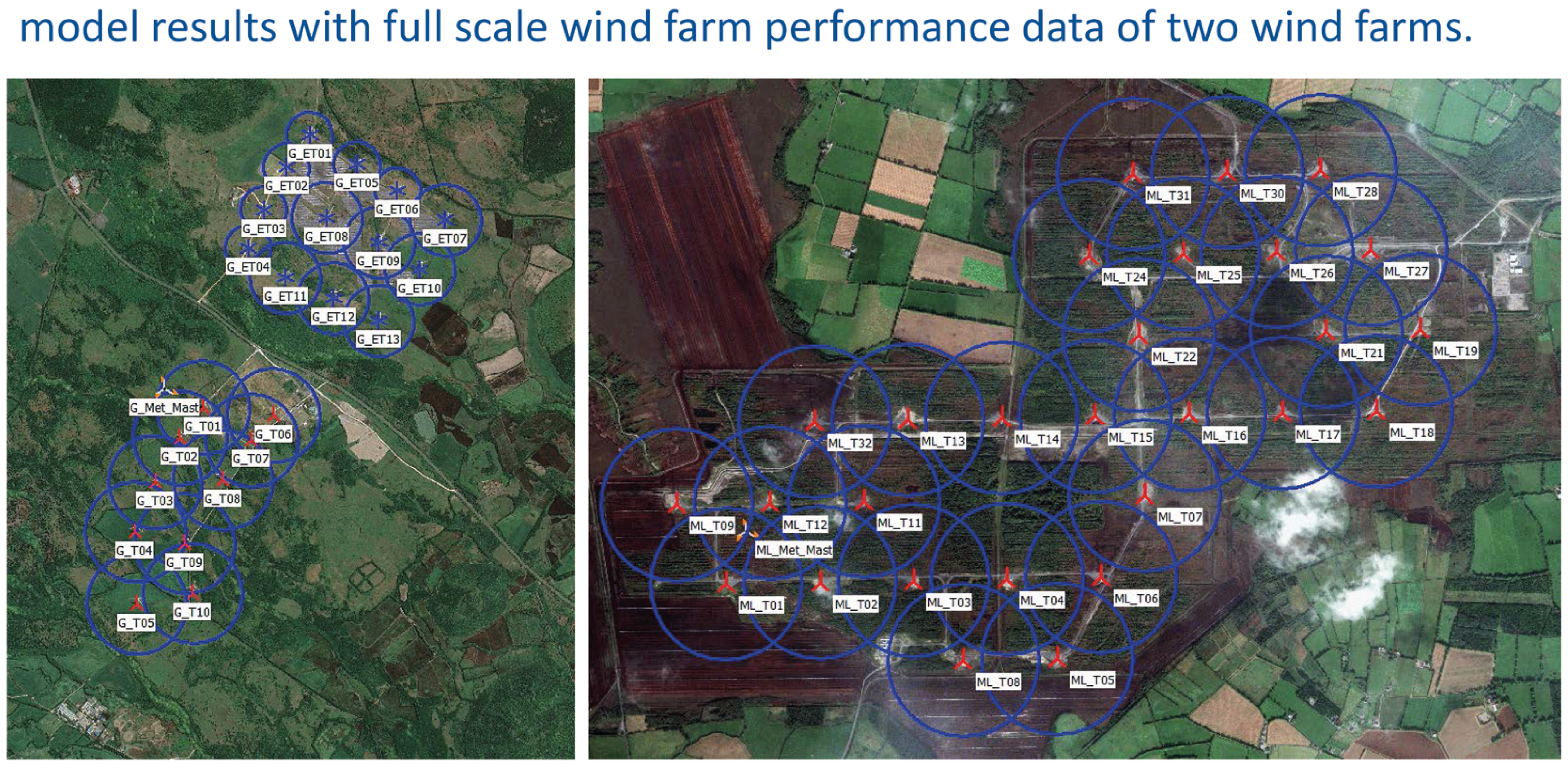
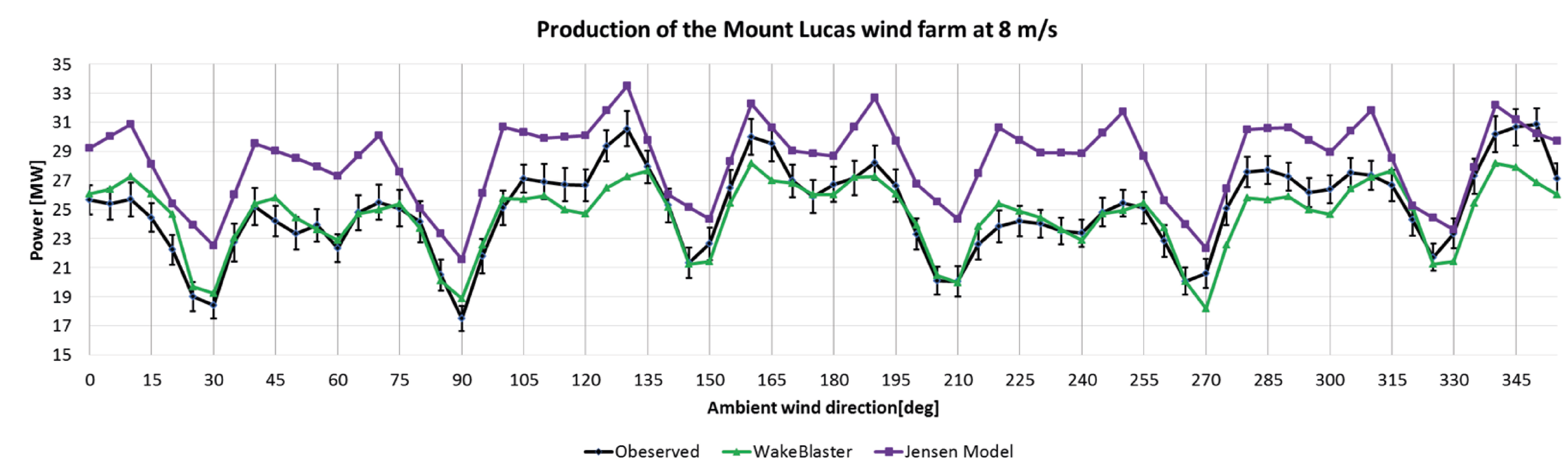
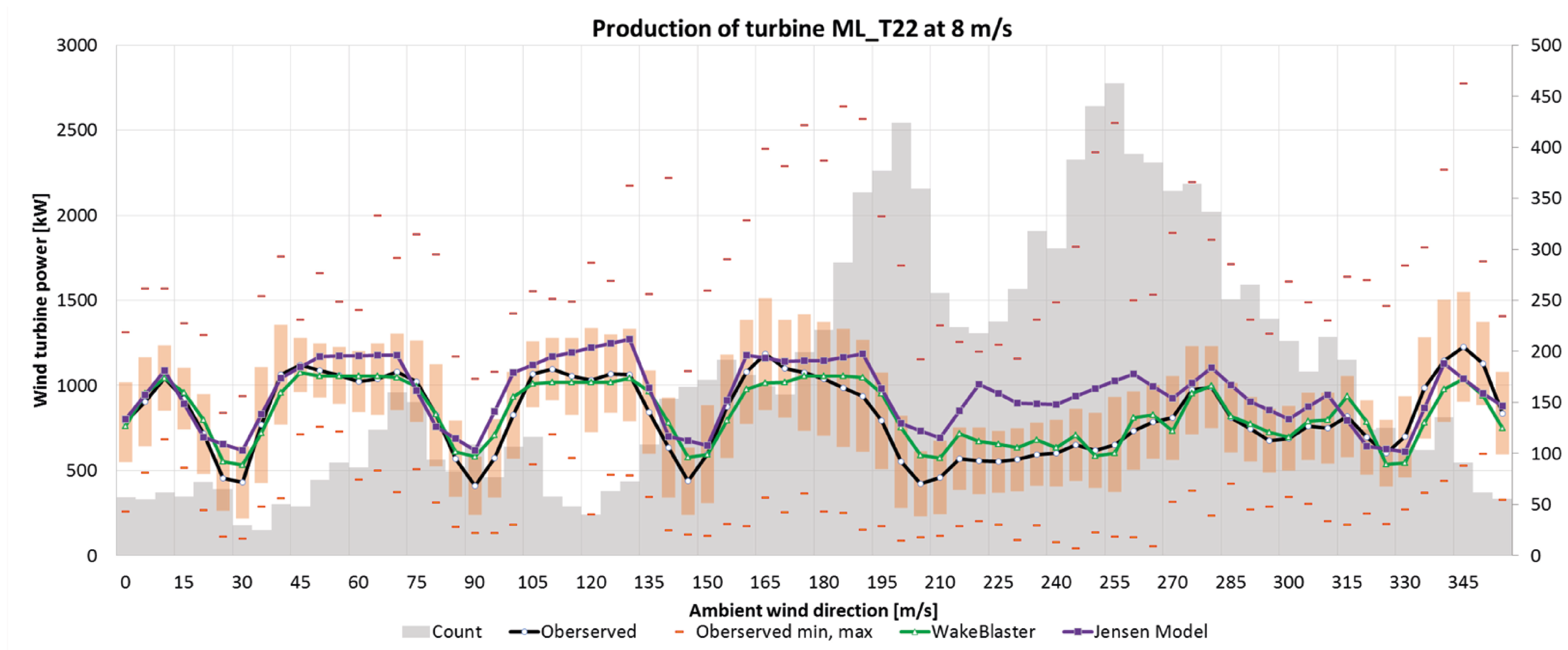


Figure 1: Layouts of the wind farms Gasiri (left , circle radius = 2.5 D (rotor diameter)) and Mount Lucas (right, circle radius = 4.4 D). Source Google Earth

Results

For both validation cases WakeBlaster delivers better results than the Jensen model especially for multiple wake cases. The Jensen model results are acceptable for the complete wind farm but for single turbines the deviations of WakeBlaster are a lot smaller.

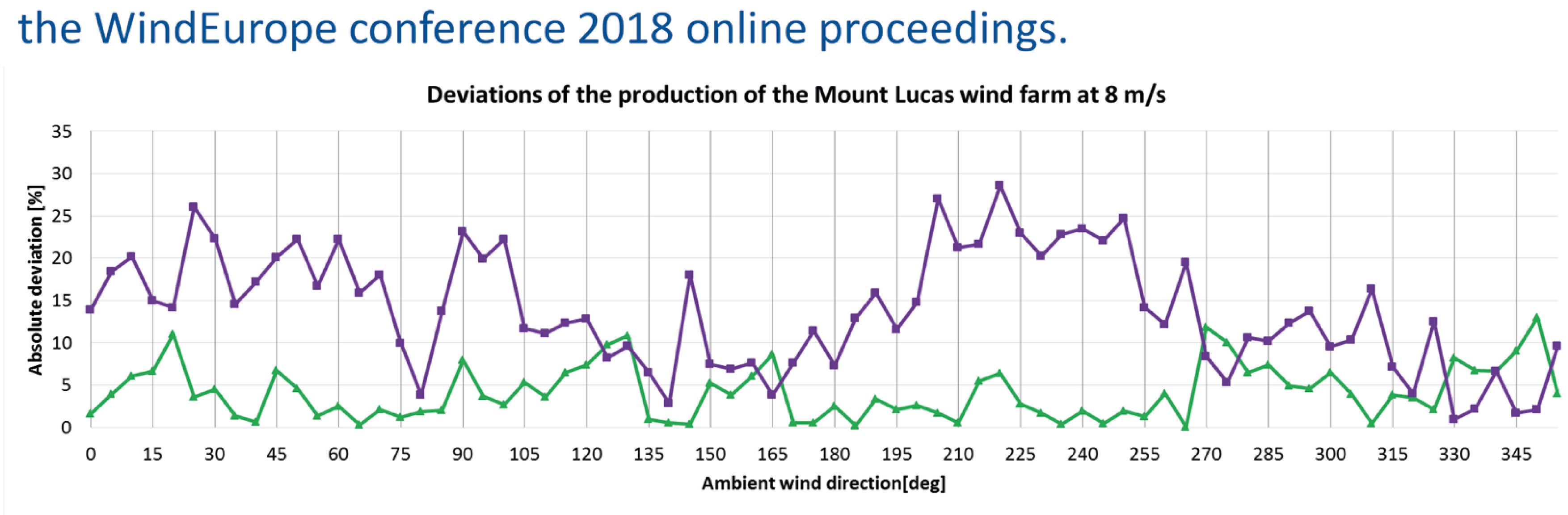


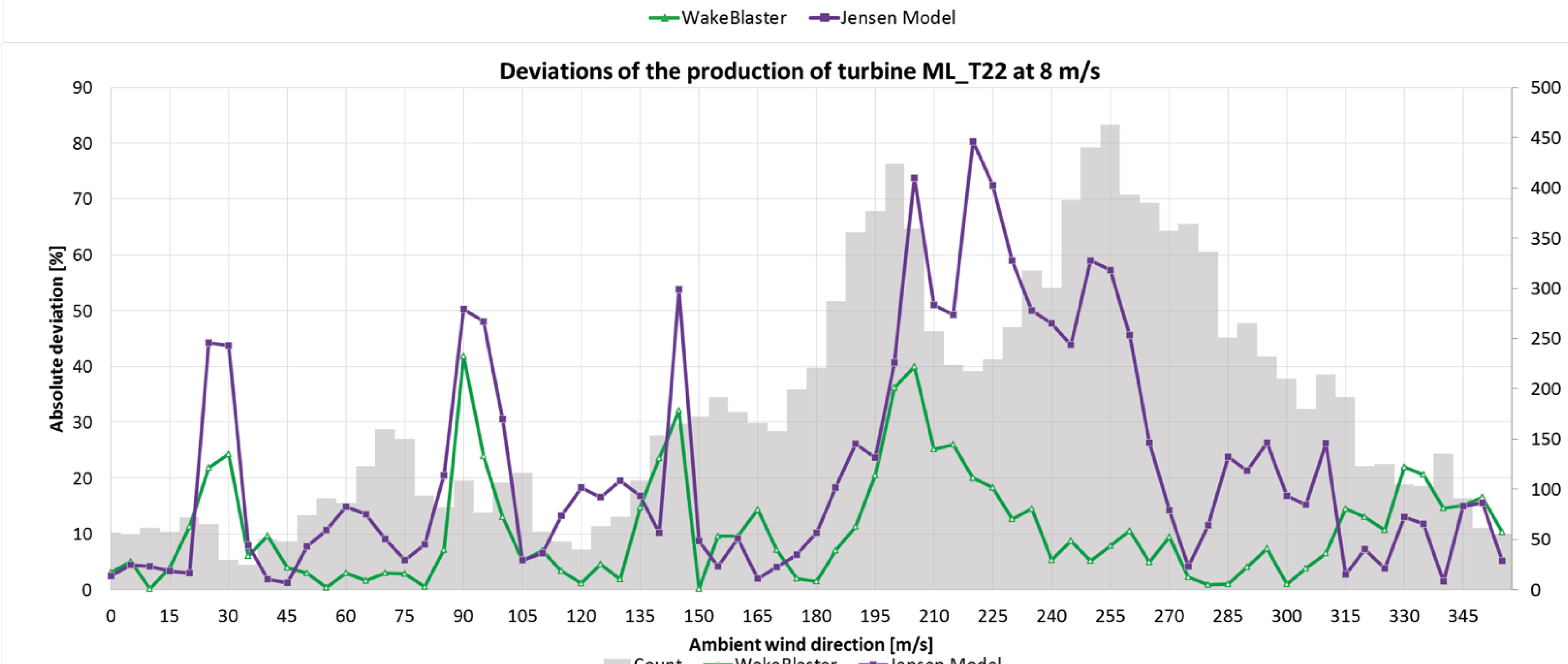


Conclusions

Computational advances have made it possible to use 3 D RANS models like WakeBlaster in the industry. These more accurate models reduce the uncertainties in performance prediction.

More detailed information about this research can be found in the full paper in the WindEurope conference 2018 online proceedings.





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