Programme overview

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TUESDAY, 5 FEBRUARY 2013
11:00 - 12:30 RESOURCE ASSESSMENT PART 1
Learning level: Intermediate

RESOURCE ASSESSMENT

Session description

The two session will deal with different aspecst of resource asssesment. Part 1 will focus modelling with CFD including stability and complex terrain siting challenges not directly involving modelling of complex terrain. This includes, but is not limited it, issues such as forests, cold and hot climates, estimation of long-term climatological values, and turbulence prediction. Abstracts addressing these or other siting challenges are welcomed, with priority given to those that also discuss what the next steps within this field should be.

Lead Session Chair:
Mike Anderson, RES, United Kingdom

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Peter Stuart (TBC), RES

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ID: 76 OC

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APPLICATION OF CFD FOR TURBULENCE RELATED OPERATIONAL RISKS ASSESSMENT OF WIND TURBINES IN COMPLEX TERRAIN

Introduction

Turbulent wind conditions arising from complex terrain pose a significant risk for the industry. It is essential to reproduce the flow conditions accurately for risk prediction. In an existing wind farm, one of the turbines has recorded a particularly high frequency of yaw failures. LES-based CFD was employed and the turbulent flow pattern observed in the results agreed qualitatively well with the high turbulence intensity seen from the SCADA data. These failures are therefore likely to be caused by excessive turbulence. This demonstrates that CFD has the potential to be an effective tool for predicting turbulence risks beforehand.

Approach

In the past seven years of operational record since operation began, the combined total number of yaw gear and yaw motor failures was investigated. SCADA data were analysed in depth. Data frequency count exceeding IEC turbulence class A standard was plotted and comparisons were made between the affected turbine and another turbine nearby. Turbulence intensity vs wind speed graphs were plotted in 10 degree wind direction bin sector to identify the wind direction which registers high turbulence. Finally LES-based CFD was carried out for that particular wind direction to simulate the flow conditions.

Main body of abstract

As the amount of relatively flat area available for wind power reduces, the ability to predict turbulence risks for complex terrain sites is becoming an important issue. Here the cause of the repeated failure of yaw systems for an existing operational turbine was investigated with a combination of SCADA data analysis and LES-based CFD. The total number of yaw gear and yaw motor failures for the affected turbine (T7) reached over thirty for the past seven years, significantly higher than the rest of the turbines at the same site. SCADA data shows that T7 records a significantly high data count of turbulence intensity (TI) exceeding the IEC Class A. TI vs wind speed graphs in 10 degrees wind direction sector bin reveal the highest turbulence intensity falls in the W to NW wind direction sector. Upon close inspection of the terrain, highly complex undulating terrain is present in the WNW direction from T7. The effect of this terrain was investigated by applying LES-based CFD. The computational grid was set at 401(x)×631(y)×61(z), a total of 15,434,891 grid points. The flow direction was set at 290 degrees with inflow wind speed at 7m/s. The CFD results show vortex generation and flow separation occurred in the upstream, which translates into highly fluctuating wind speed at hub level and also large vertical and horizontal wind shear across the rotor face of T7. These highly fluctuating wind conditions explain qualitatively the high TI data and also the frequent yaw system failures.

Conclusion

In this study, it was found that turbine T7, which records the highest number of yaw system failures, also records the highest count of turbulence intensity exceeding the IEC standard. CFD was carried out and the results clearly show T7 is under the influence of turbulence, which qualitatively explains these yaw systems failures. It can be concluded that unsteady LES-based CFD has the potential to be an effective tool for assessing the operational risk associated with turbulent wind conditions, for both existing operational wind farms and new wind farms under planning.

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