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Making the grade

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Over recent years, site assessment techniques have constantly been upgraded, reflecting the increased understanding of the physics of the lower atmosphere and the rapid development of computer power and IT technology. All this enables a much more comprehensive understanding of the flow of wind across an area of land. The principles of site assessment are decided by Measnet, IEA, IEC and national building codes but the methods used may differ depending on the group of analysts.

Measure

Wind analysis experts usually begin an analysis by using meteorological masts to measure wind speeds, wind directions, fluctuations in wind flow, turbulence and other vital characteristics. Flow modelling techniques are then applied to the measurements to derive the parameters describing the potential wind field across a site. For this to be successful, an in-depth understanding of atmospheric physics is just as important as a detailed knowledge of the applicability and limits of wind flow models.

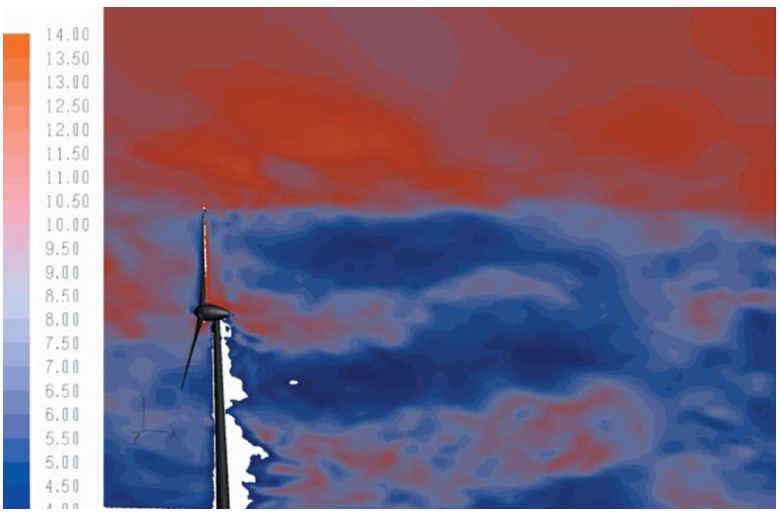
Combining the estimated wind flow and wind turbine production characteristics, such as by a power and thrust curve, a wind farm energy yield may be estimated. Particular attention is given to park internal wakes and other potential losses driven by the wind farm's surrounding environment, terrain and roughness. One of the major limiting factors in the application of flow models is the terrain complexity, as flows over terrain exceeding 15 degrees can easily be misinterpreted by the modelling software.

Having determined the energy yield, the uncertainties in measurements, analysis and modelling are assessed using a stochastic approach. This enables the estimate to be converted and increased to a higher confidence level. Typically of interest are estimates of 75, 90 or 95 percent exceedance level.

Critical

Although many wind site analyses don't consider wind turbine type until after planning applications are approved, it is critical to the feasibility of a potential wind farm site to determine turbine suitability as early as possible. Suitability describes the 'fit' of a candidate wind turbine type to the wind regime at the site and relates to the dynamic wind loads a turbine structure is designed to withstand. Turbines can be categorised into IEC Type Classes IV to I which define a collection of 'design points', or thresholds of structural integrity, that the manufacturer must guarantee. These include the maxima of average wind speed, extreme wind speed and turbulence level, flow inclination, wind speed shear, and air density.

Essentially it is the strength of the structure that determines its capabilities; for example, higher wind speeds demand greater tower wall thickness, and stronger blades, gearbox and foundation. In theory, that should mean that comparing the



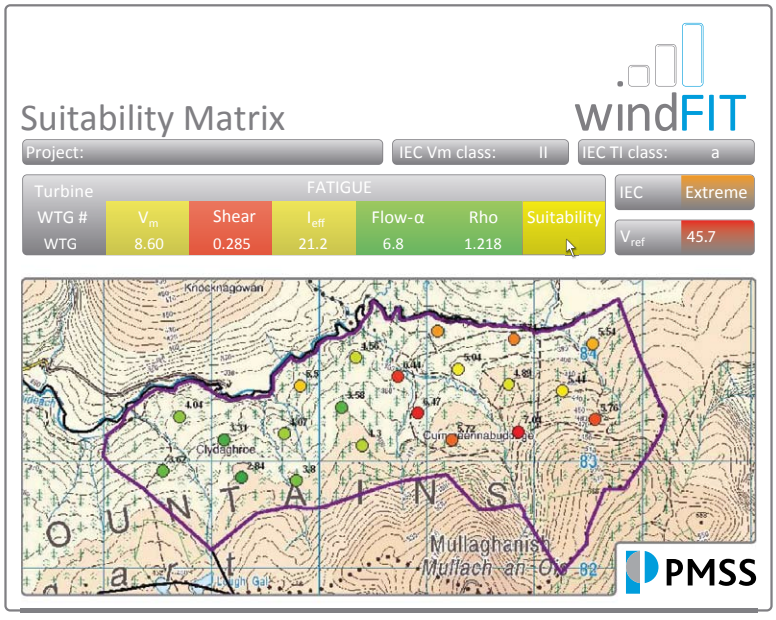
Right: Source: 3D-simulation of the turbulent wake behind a wind turbine, Weßow, Sitzki, & Hahm, Journal of Physics: Conference Series 75 (2007) 012033 [The Science of Making Torque from Wind], doi:10.1088/1742-6596/75/1/012033

wind characteristics of the site to the IEC building code thresholds should identify wind turbines of suitable strength.

Designed

However, in practice the two cannot be directly compared. For example, an IEC TC II wind turbine is designed to withstand 8.5m/s^{-1} average wind speed, 42.5m/s^{-1} extreme wind speed, 8° flow inclination and 18 percent turbulence at 15m/s^{-1}. However, if one or two of these parameters are exceeded, the turbine will not necessarily be unsuitable as parameters and design points are not independent. For instance, low air density would partially compensate for higher wind speed with an IEC TC II turbine being easily capable of withstanding wind speeds exceeding 9m/s^{-1} (IEC TC I) and hence operating at a higher capacity factor (CF).

A full simulation of the 'operational behaviour' of wind turbines under defined scenarios is undertaken by a number of wind turbine manufacturers for borderline sites prior to a sale. The new PMSS service package, windFIT, has been in development for six months following a year's trial of its predecessor product, and claims to significantly improve on procedures used by other wind analysts. The package aims to provide preliminary turbine suitability assessment alongside the energy yield estimation and wind analysis service already available. By coupling wind flow models and CFD (computational fluid dynamics) codes, windFIT's 'Suitability Matrix' is able to calculate the likelihood of the turbines operating outside their design limits, even in normally problematic terrains. The matrix works by 'weighting' the individual load contributors to model the balance of the superimposed parameters against the compensating effects of other parameters. So, a low value of one dynamic load allows another dynamic load to exceed its limit by a calculated amount. The windFIT package displays the assessment results in a traffic-light ranking (red, amber and green) to clearly show the suitability of a site. Engineering staff with substantial experience in the wind energy sector also carry out a plausibility check of the results to determine any necessary site specific adjustments to the weighting.



Flexibility

By using the windFIT package before planning permission has been secured, PMSS hope to ensure greater certainty in wind turbine selection, optimised site design and increased energy yield. This should reduce the risk of selecting the wrong turbine which could be unsuitable at a later stage, at which point it is too late to change due to planning restrictions.

Currently windFIT is primarily for onshore applications, due to the more complex flow over land. However, typical offshore problems referred to as either large-array or deep-array effects are being considered and an offshore version of windFIT is expected to deal with these specific conditions in the future.

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