The challenge
Finding the best wind sites for small and medium wind projects is an increasing challenge in the UK as many sites have been developed already or have been ruled out for a variety of reasons including planning and environmental issues. Furthermore, as the Feed in Tariff for small and medium projects continues to reduce over time and development and operational costs continue to escalate, the profitability and payback periods for these smaller projects are becoming increasingly sensitive to the accurate projections of the long term average wind speeds.

Finding accurate wind speed data for the purposes of searching large regions of the UK for suitable sites is a particular challenge as most wind maps do not properly represent winds at typical smaller turbine hub heights of between 10m and 45m. At these heights wind speeds are more highly influenced by the complexity and roughness of the underlying terrain than at higher hub heights associated with much larger turbines. Therefore it is important to use reliable wind data for these lower heights above the ground, to ensure that site search activities for small and medium wind projects are focussed in the most attractive regions of the country.
The Solution

Over the last few years the Met Office has developed a set of long term average wind speeds, based on observation wind data collected from over 230 met stations located the length and breadth of the UK. The first edition of this database used wind data from 1971 to 2000. This second edition of the UK wind database, updated in 2013, uses data from 1981 to 2010.

Wind speeds have been generated at heights ranging between 10m and 45m above ground level and at a resolution of 1 square kilometre. Two separate database products are available:-

- a small wind database product that includes wind speeds at 10m, 15m and 20m above the ground; and
- a medium wind database product that includes wind speeds at 25m, 35m and 45m above the ground

Additional layers can be requested to represent specific turbine hub heights. The wind speed databases can be made available in a variety of data formats and are designed to be used in conjunction with a standard Geographical Information System (GIS) such as ArcGIS.

The small wind database has been verified at a 10m height by omitting 10% of stations from the analysis, and comparing their observed values with the calculated values at those locations.

The medium wind database has been verified against independent calibrated observation data from 57 sites across the UK at hub heights of between 20m and 45m. The long term average wind speeds from the database were extrapolated to site hub height and compared with site average wind speeds over the observation period. The average bias (difference between Met Office database and observed wind speed) across all the sites was computed as 0.4 m/s.

The Met Office wind speeds were compared with NOABL wind speeds, where NOABL mean wind speeds were extrapolated to site hub heights using standard wind profile laws and also compared with site observation data. The following graph shows that the average NOABL bias across all sites with heights between 20m and 45m is 1.0 m/s, compared to the Met Office medium wind speed database bias of 0.4 m/s.

In making this comparison, note that the NOABL long term mean wind speed estimates were generated from observations data from the 10 year period 1975 to 1984. This is a different period from the site observation data which is of varying lengths between the years 2001 to 2013, and also the period for which the Met Office wind speed estimates were generated, from 1981 to 2010. This difference in comparison periods explains some, but not all, of the bias highlighted in Graph 1 above.

For completeness, the NOABL data at 10m, 25m and 45m is also supplied in the Met Office wind databases so that comparisons can be made between the two sets of data in each grid square.

Figure 3 represents an extract of the Met Office wind database highlighting the anomalies (difference between Met Office and NOABL wind speeds), in each square kilometre for a region of the UK. Figure 2 shows that NOABL tends to have higher wind speed averages at lower altitudes and lower wind speed averages at higher altitudes, by more than 1 m/s in many cases.

The data from these met stations was initially used to generate over 2,500 monthly and annual average wind speeds over the 30 year period.

A method was then defined to interpolate these average wind speeds to create a wind grid across the UK including Northern Ireland. The method takes into account:-

- The large scale variations in the wind climatology of the UK
- The altitude of the stations
- The local terrain features
- The percentage of sea within 10 km to represent the coastal factor

The result is a 1sq km grid across the UK containing over 240,000 grid squares. Each grid square contains a 30 year annual average wind speed and 12 monthly average wind speeds which represent the wind speeds at the centre point of each square at 10m above the ground. The additional levels have been extrapolated using a logarithmic profile based on a standard roughness length.

Verification

Verification has been performed on the 2 separate wind speed databases.

The NOABL wind speed database is still used regularly by the small and medium wind industry to provide estimates of annual mean wind speeds throughout the UK. In contrast to the method and data used to generate the Met Office wind speed database, NOABL was generated originally by a different scientific method, using just 10 years of wind data from the mid 1970’s to mid 1980’s taken from only 56 wind stations across the UK, and hence a much lower resolution set of wind data.

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Summary

In summary, the Met Office UK small and medium wind databases should be used in preference to NOABL as a more reliable source of local area long term average wind speeds for site search purposes, for both the small and medium wind market sectors.

It is recommended that, wherever possible, site specific wind data be used as the basis for producing a bankable finance plan for individual projects as wind speeds can vary considerably within any square kilometre depending on the exact nature of the terrain. The Met Office Virtual Met Mast(TM) can be used for this purpose.

References