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Information paper – 26
Wind speed data

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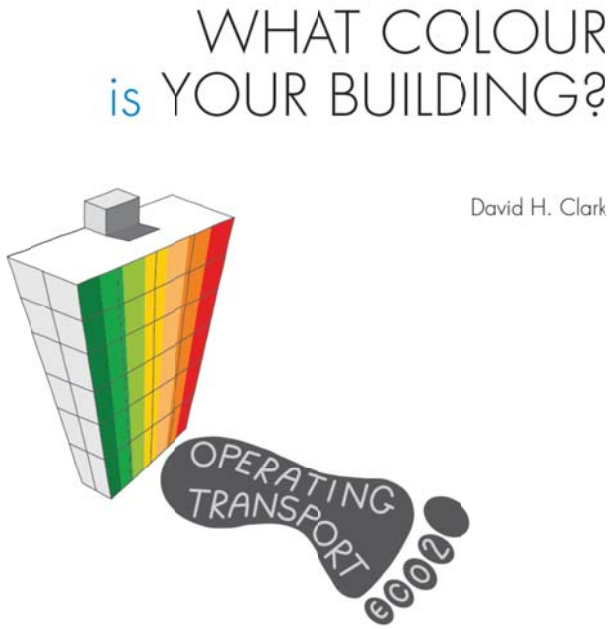
A paper referenced in the book:



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This information paper is one of a series of papers written during the preparation of the book **What Colour is Your Building?** (www.whatcolourisyourbuilding.com). The papers do not form part of the book and have not been peer reviewed. They provide further technical detail, analysis and information to support statements made in the book. All of the papers can be downloaded from www.wholecarbonfootprint.com.

Wind speed data

This information paper provides some more detail on wind speed data used in assessing outputs from wind turbines in urban environments.

1. SOURCES AND IMPORTANCE OF WIND SPEED DATA

Getting reliable wind speed data is crucial to determining the feasibility of wind turbines in a particular location. A number of countries have produced wind resource maps or databases which give an indication of likely wind speeds at different heights above ground (typically 10 m, 25 m, 50 m or 80 m) – refer to the box on page 4 for examples.

Figure 1 shows annual mean wind speeds for the UK at 25 m above ground level. It is based on the UK Government's Numerical Objective Analysis Boundary Layer (NOABL) database, sometimes known as the DTI Wind Speed Database, and is no longer maintained.[1] Using this, without adjustment, to estimate wind turbine outputs in urban areas has led to unrealistic predictions in the past.

The Energy Saving's Trust report *Location, location, location: Domestic small-scale wind field trial report* dated July 2009 states that:

'The Government's Numerical Objective Analysis Boundary Layer (NOABL) database, has until recently been the primary tool used by manufacturers, installers, planning authorities and consultants to determine a site's potential wind speed. This model, which provides annual average wind speeds for a 1 km UK grid square, has been shown to overestimate the potential wind speed at many sites in this field trial especially those in urban and suburban locations. This is because the database does not consider the impact of local obstructions, including trees and buildings, in its methodology.'

For example, the Ashenden House wind trial (refer to Appendix I and *Information Paper 27 – Wind turbine performance* for more details) measured the annual wind speed on top of a 10 storey building (approximately 40 to 50 m above ground level) in London as 3.65 m/s. The wind speed data from the NOABL database for this site (grid ref: TQ3278) is shown in Table 1.

Height above ground level	NOABL wind speed	Difference to measured data
10m	4.8 m/s	+ 31%
25m	5.6 m/s	+ 53%
45m	6.1 m/s	+ 67%

Table 1 Wind speed data from NOABL database for Ashenden House compared to measured wind speed

This doesn't mean the wind turbine produces 67% less than would be estimated assuming 6.1 m/s average wind speed. It is far less than this because the power in wind varies by the cube of the wind speed. Very crudely the power in wind at 3.6 m/s is 20% of that in wind at 6.1 m/s.

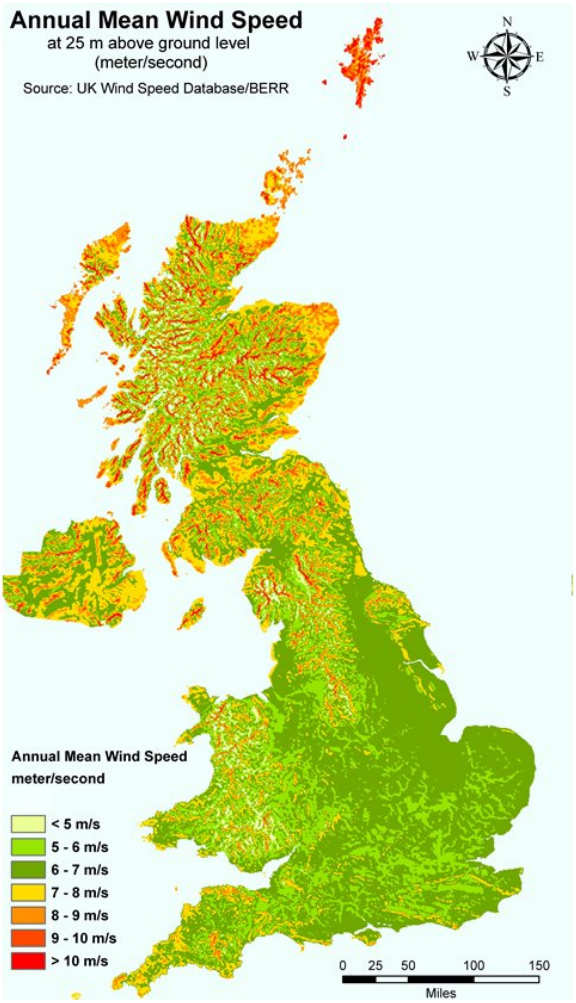

Fig 1 **Annual mean wind speeds in UK at 25m above ground level from NOABL database (source: DECC)**

The Met Office has published a map showing where the older NOABL data set in Figure 1 is over or under estimating wind speed in various regions across the UK, compared with the Met Office NCIC (National Climate Information Centre) data.[2]

SOURCES OF WIND SPEED DATA

Wind speed maps and databases are available for many countries. Examples include:

- Global: www.ceoe.udel.edu/windpower/ResourceMap/index-world.html
- Europe: www.windatlas.dk/europe/index.htm
- UK: www.carbontrust.co.uk/wind-estimator, www.decc.gov.uk/en/windspeed/default.aspx, www.actionrenewables.org/resources/windmap/, www.energysavingtrust.org.uk/Generate-your-own-energy/Can-I-generate-electricity-from-the-wind-at-my-home.
- US: www.nrel.gov/gis/wind.html
- Australia: www.climatechange.gov.au/en/what-you-need-to-know/renewable-energy/atlas.aspx

When considering wind speeds in other countries, it is necessary to adjust the wind speeds from standard databases and wind maps to take into account the effect of buildings and trees on reducing the wind speed.

2. ESTIMATING WIND SPEEDS NEAR BUILDINGS

So how can wind speeds be better estimated? In March 2009, the Carbon Trust launched a new online tool, the Carbon Trust Wind Yield Estimator,[3] to estimate the wind speeds and turbine outputs based on postcode, surrounding landscape and height of the turbine above the surrounding canopy (trees or average building heights – refer to Figure 7.15 in Chapter 7 of the book). The tool was created using 30 years of data from the Met Office's 220 weather stations rather than the NAOBL database.

For further information on the background to the tool, including practical guidance on how wind speeds vary in urban environments and how to site turbines, refer to *Small-scale wind energy - policy insights and practical guidance* published by the Carbon Trust in August 2008.

The tool was used to estimate the output of a 12 kW wind turbine on Building X (refer Chapter 7) in the City of London with the wind turbine power curve shown in Figure 2 (this shows the electrical output at different wind speeds).

Wind speed (m/s)	Output (kW)
2	0.5
3	0.75
4	1
5	1.5
6	2
7	4
8	6
9	8
10 to 25	12

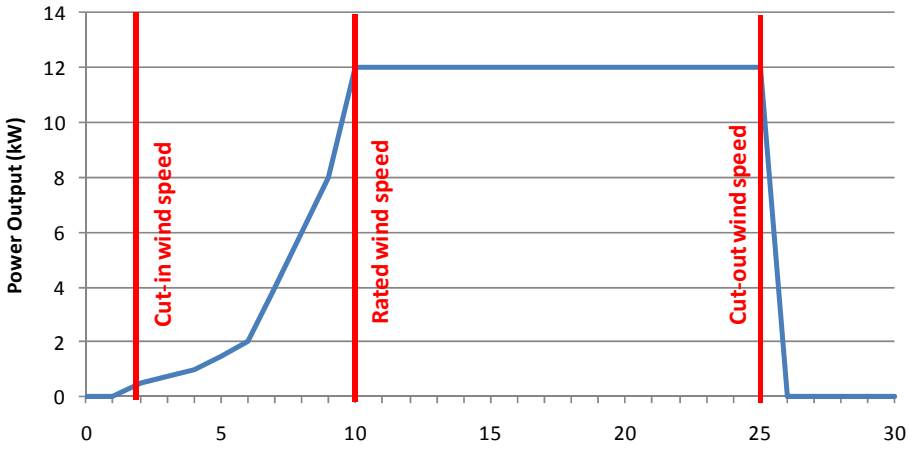

Fig 2 **Typical power curve for 12 kWe wind turbine**

The tool allows different site types to be selected to estimate the canopy height. The calculator also allows users to enter the height of the turbine above the canopy to estimate the average annual wind speed at the turbine. The electrical output, based on the wind turbine power curve, was then estimated.

Table 2 shows wind speeds and corresponding turbine outputs results for the turbine 10 m above the roof of Building X for different surrounding canopy heights. Recognising that power curves can sometimes be optimistic, an adjusted capacity factor has been included – it is the capacity factor calculated by the tool reduced by 25%.

Site character	Canopy height	Turbine on Building X (height above ground level)	Wind speed (m/s)	Predicted electrical output (kWh/year)	Capacity factor	Adjusted capacity factor
City centre – 35 m canopy *	35 m	45 m	3.6	11,100	11%	8%
City centre – 25 m canopy	25 m		4.2	16,000	15%	11%
High height & density	12 m		4.3	17,100	16%	12%
Medium height & density	9 m					
Low height & density	6 m					
Woodland (mature trees)	19.5 m					
Open countryside	0 m					

* user entered canopy height. All other values are the defaults in the tool.

Table 2 **Carbon Trust Wind Yield Estimator outputs for turbine on Building X in London for different site characters**

The height of the turbine at 45 m gives it reasonable access to higher wind speeds. The wind speed is reduced if adjacent buildings are of a similar height to Building X (e.g. a canopy height of 35 m). A wind speed of between 3.6 and 4.2 m/s correlates reasonably well with the findings of the Ashenden House trial which was on a building of a similar height in London (measured wind speeds of 3.6 to 3.8 m/s).

The NOABL database for the same postcode gives a wind speed of 6 m/s at 45 m. This is substantially higher than the likely wind speeds in the urban location and would lead to predicting very unrealistic wind turbine outputs.

Notes

All websites were accessed on 20 June 2013 unless noted otherwise.

1. The NOABL wind speed database can be accessed via www.rensmart.com/Weather/BERR. The wind speed map was from https://restats.decc.gov.uk/cms/annual-mean-wind-speed-map and is crown copyright and reproduced under the open government licence (www.nationalarchives.gov.uk/doc/open-government-licence/)

2. www.metoffice.gov.uk/renewables/wind-map

3. The tool was available on the carbon trust website (www.carbontrust.co.uk/wind-estimator) in 2011 when the calculations in this information paper were first undertaken. However in 2013 it was not available on the website and all reference to it seems to have disappeared.