CLASP. Climate Change Local Area Support Programme

Planners' reference guide no. 7: Medium – large wind

Introduction

Medium - large wind refers to turbines in the range 100 kW – 3MW, and includes wind farms and single turbines, usually on an industrial site.

All large scale turbines at present are horizontal axis, and typically three-bladed. The typical power rating has increased steadily from 300-500kW in the early1990s to 1.5 – 3MW for wind-farm scale turbines, although smaller single turbines are still installed.

Turbine rating & output

The power output of a turbine is a function of swept area of the blades, the conversion efficiency of the turbine and the cube of the wind speed:

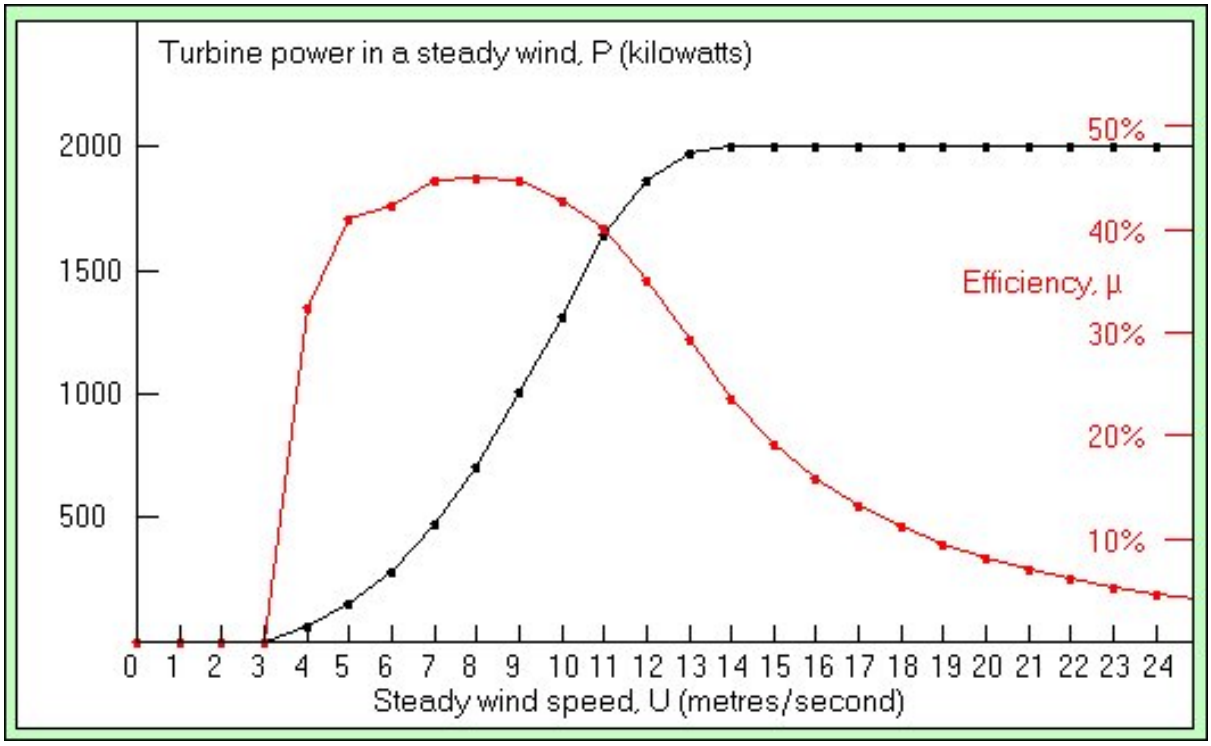
Power = 0.5 x Swept Area x Air Density x Turbine Efficiency x Velocity^3

Because of this, wind speed is the most significant factor determining the most effective location for a turbine and in general the higher the hub, the greater the windspeed. An example of outputs for the same 3MW turbine at different hub heights is given below.

Tip Height	Annual Output (MWh)	Increase above 100m
100m	5136	
125m	6486	26%
132m	9064	76%
150m	9823	91%

There is also a physical limit to the amount of energy that can be extracted from the wind, known as the Betz Limit, which is 59.3%.

An output and efficiency curve for a 2MW turbine is shown below. The efficiency decreases once the peak operating power is reached as there is more energy available in the wind than the turbine can harvest.



Source: Wind Power Programme

The ratio of Actual Output to the theoretical maximum Rated Output is known as the Load Factor i.e. **Actual Output = Load Factor x Turbine Rating x 8760 hours/year.**

The average Load Factor increases with the size of the turbine and location. Load factors for large wind turbines should be in the range 25 - 40%.

Annual operating hours are generally 80 – 85% of the total available.

Typical annual output ranges for large turbines are shown below.

Turbine Rating	750 kW	1 MW	2 MW	3 MW
Min Output MWh/yr	1,600	2,200	4,400	6,600
Max Output MWh/yr	2,300	3,200	6,500	10,500

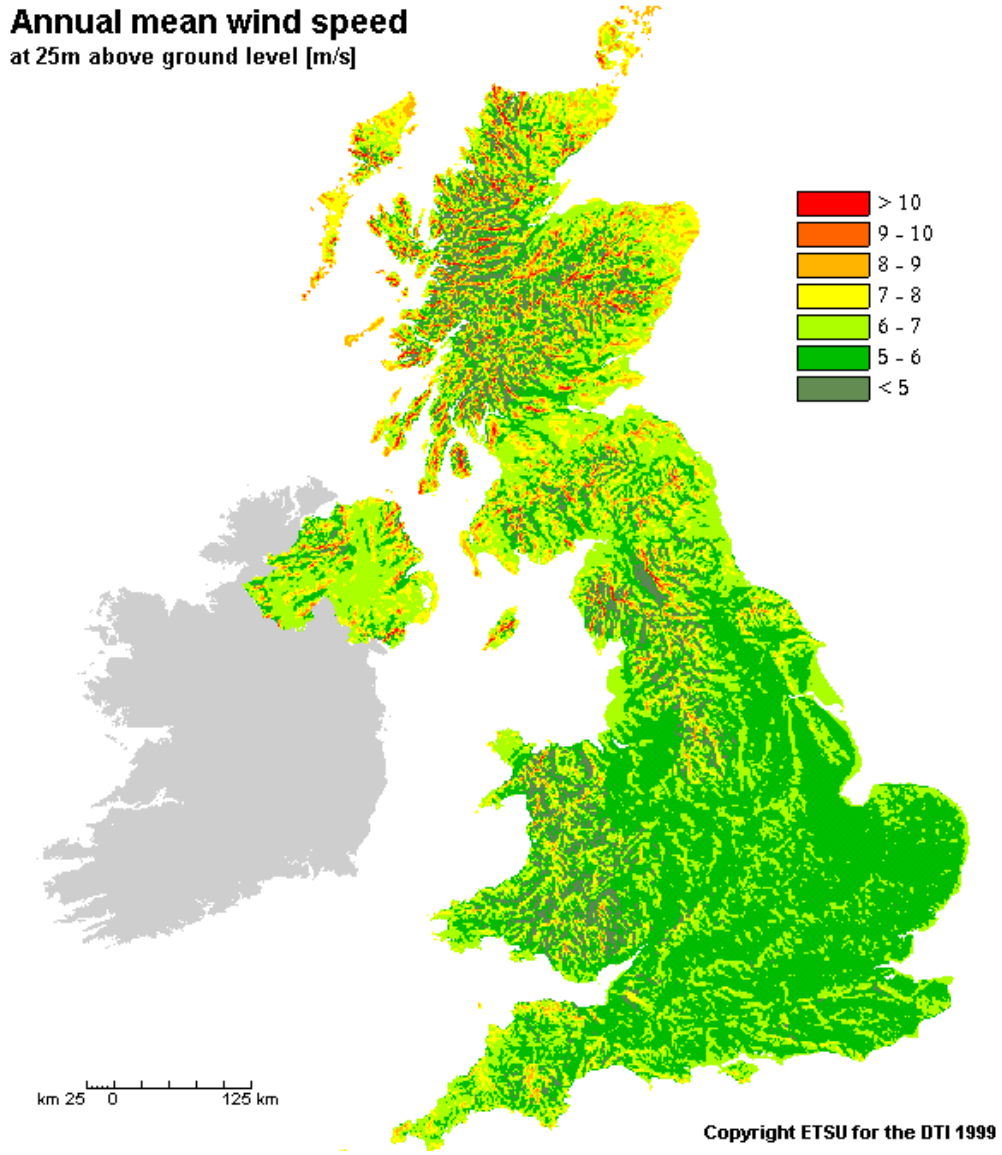
Wind speed

Large turbines are generally not suitable for sites with a wind speed below 7 m/sec.

The average wind speed for each 1km grid-square is given on the NOABL database, at mast heights of 10m, 25m and 45m above ground level. However this data is averaged for the area and should not be wholly relied upon for a specific location, and wind speed monitoring will usually be carried out for up to a year before installation.

NOABL wind speed database: www.bwea.com/noabl/index.html

Wind speed quality and consistency are key factors. Laminar flows are ideal; on an exposed hillside with a smooth air flow in straight line and little side gusting, the speed and turbine output can be very predictable.



Cut in speeds range from 2 – 4 m/sec (4 – 9 mph).

Peak operating output is usually designed for 12 – 14 m/sec (24 – 31 mph).

Cut out speeds range from 25 - 35 m/sec (55 – 78 mph)

Dimensions

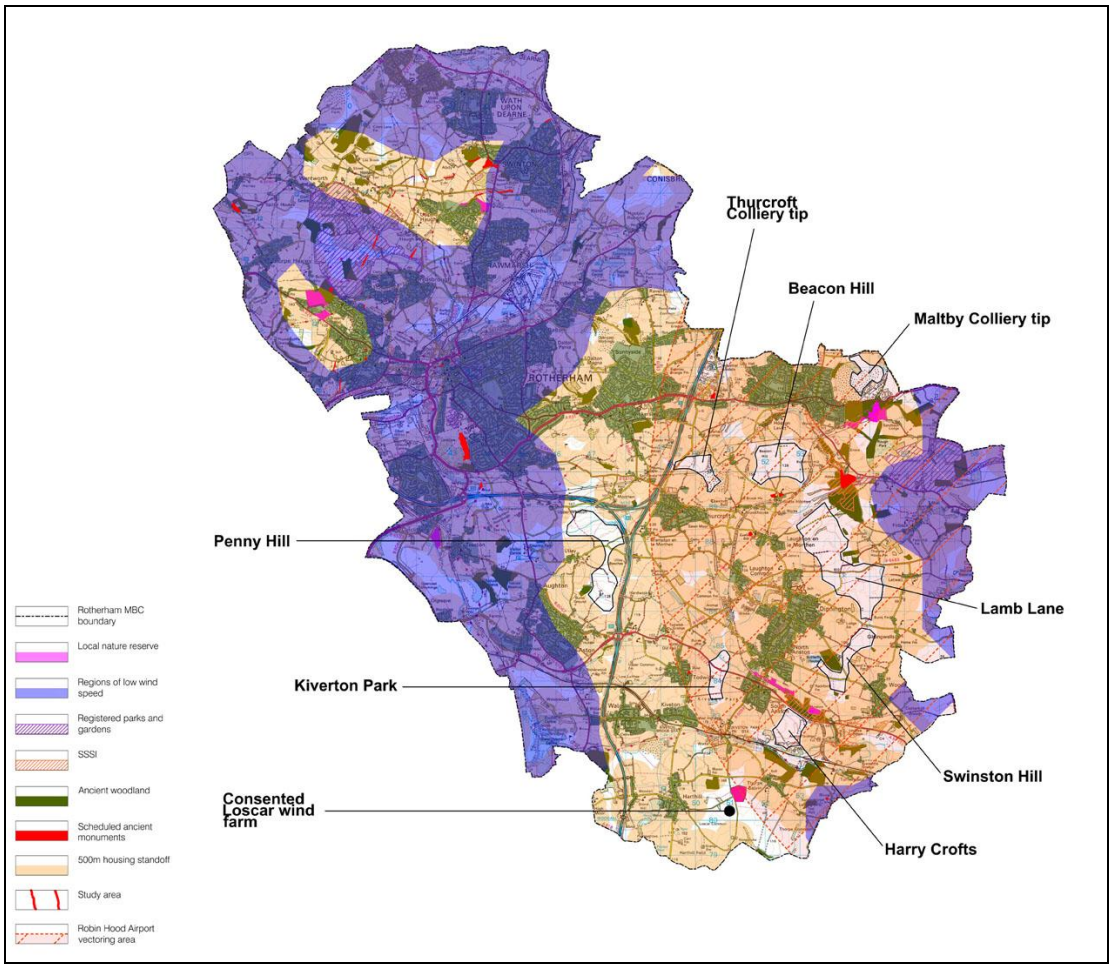
Typical dimensions of large turbines are given below.

Turbine Rating	750 kW	1 MW	2 MW	3 MW
Blade Diameter	50-60m	50-80m	80-100m	90-120m
Hub Height	50-60m	50-80m	80-140m	80-150m
Tip Height	To 90m	To 120m	To 190m	To 210m

Site identification

Constraint Mapping is a site finding tool used by developers, which identifies areas of least constraint for wind energy by layering the majority of constraints onto a map (landscape designations, ecology designations such as SSSIs, residential standoff, aviation radar and finally areas of low wind speed). The areas falling through are technically and environmentally least constrained. Grid connection availability, actual wind resource, archaeology on site, cultural heritage, or impact on roads will be assessed only for individual sites that pass the constraint mapping.

The map below shows constraints mapped onto an area around Rotherham, with the white areas giving the areas of potential search.



Installation and maintenance

Any large wind turbine is a major construction project, involving foundations, grid connection substation, access tracks etc, although a single turbine can be installed in day.

A wind farm site area is large due to the separation needed between turbines - generally at least 3.5 times the blade diameter, but the access tracks and foundation footprint is only 2-3% of the total area. Foundations are designed to withstand the forces transmitted through the mast and environmental factors over the lifetime of the turbine. Their size is related to the size of the turbines and site geology. Crane pads may also be needed. Planning applications usually have a micro-siting allowance, which allows the turbine location to move by around 25 – 50m to allow for necessary changes due to wind speed, rock, topography, archaeology etc.

Onsite grid connection is usually underground although power take off from the site may be via wooden poles or underground. The substation compound is generally designed to blend in with the landscape.

Wind turbines are designed for a 20-year lifetime. They need regular monitoring and maintenance.

Costs

Large turbine installations cost around £0.75 – 1.5 million per MW capacity (June 2011).

Feed in tariff (FIT) and renewable obligations certificates (ROCs)

Large turbine installations up to 1.5MW (total site) can register for either ROCs or FITs. Schemes over 50kW need to apply for accreditation through Ofgem's Renewable and CHP Register.

The FIT rate to March 2012 for a 500kW – 1.5MW turbine is 9.9p/kWh.

ROCs have a variable market value. The auction rate was 4–5 p/kWh in 2010-11.

Planning considerations

Planning permission will be required for a wind turbine of any size, and a full Environmental Impact Assessment is likely to be needed for all large turbines. The main planning considerations are:

- Visual impact on the local landscape
- Impact on any protected habitats or species that might be present in the locality e.g. birds, bats or newts.
- Impact of the construction on hydrology and flood risk
- Impact of the turbine upon neighbouring residents (noise nuisance, creating 'shadow flicker' or visual prominence).

As the turbine has moving parts, health and safety is another key consideration; if there are any transport routes close to where the turbine would be sited (a road or public right of way), a clearance distance may need to be adhered to on safety grounds (typically the turbine tip height plus 10%).

In certain locations wind turbines can affect communication and aviation infrastructure which may also need to be addressed e.g. wind turbines along a flight path can cause false readings on radar equipment; however this tends to be more applicable to larger turbines. There may also be other site specific issues to be addressed depending on the size and specific location of the proposed turbine.

Further information

BWEA database of operational and planned large wind projects - www.bwea.com/ukwed/index.asp

Planning for Renewable Energy: A Companion Guide to PPS22 - http://www.communities.gov.uk/publications/planningandbuilding/planningrenewable

This reference guide forms part of the CLASP technical support and training programme for North West local planning authorities, delivered by Envirolink, Quantum Strategy & Technology and AECOM (2011).