CLASP. Climate Change Local Area Support Programme

Planners' reference guide no. 6: Small wind



Introduction

Small wind refers to turbines in the range 2 – 100kW, although the majority of installations in the UK so far have been 2-15 kW range. Turbines of this size are generally pole-mounted but these can be positioned on rooftops.

There are two types of turbine – horizontal axis (twin or triple bladed) and vertical axis (often helical). Vertical axis ones are seen more in urban environments because they are less susceptible to changes in wind direction and turbulence, but they are also less efficient.

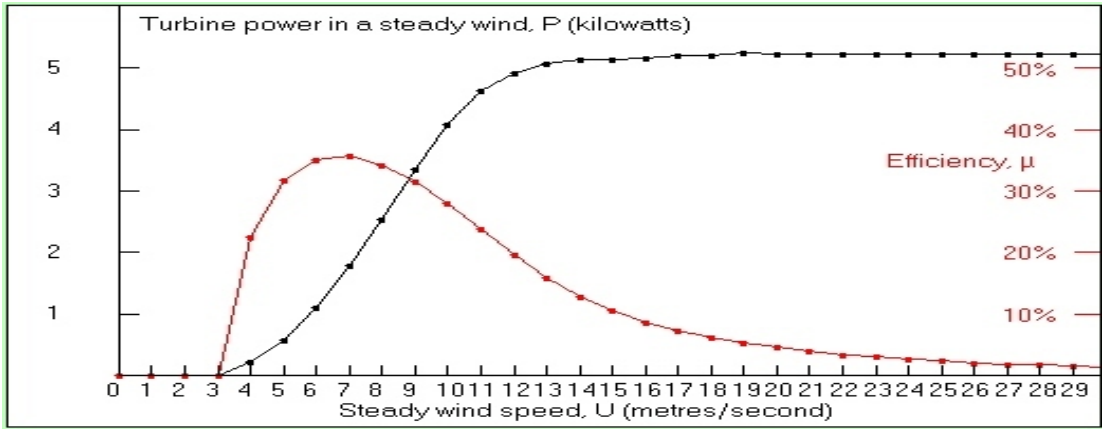
Turbine rating & output

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. 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%.

Turbines are rated for their output at a specified wind speed. A typical output and efficiency curve is shown below.



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. Quoted load factors for small wind are usually in the range 17-20% but can be 25 – 30% for a well-sited turbine. The table below shows the range of actual outputs of well-sited small turbines.

Rating kW	**2.5**	**5**	**6**	**11**	**25**	**50**
Min Output (kWh/yr)	3,285	6,570	7,884	14,454	32,850	65,700
Max Output (kWh/yr)	6,570	13,140	15,768	28,908	65,700	131,400

Wind speed

Small turbines are generally uneconomic at wind speeds below 5 m/sec, although some are designed for low wind speeds.

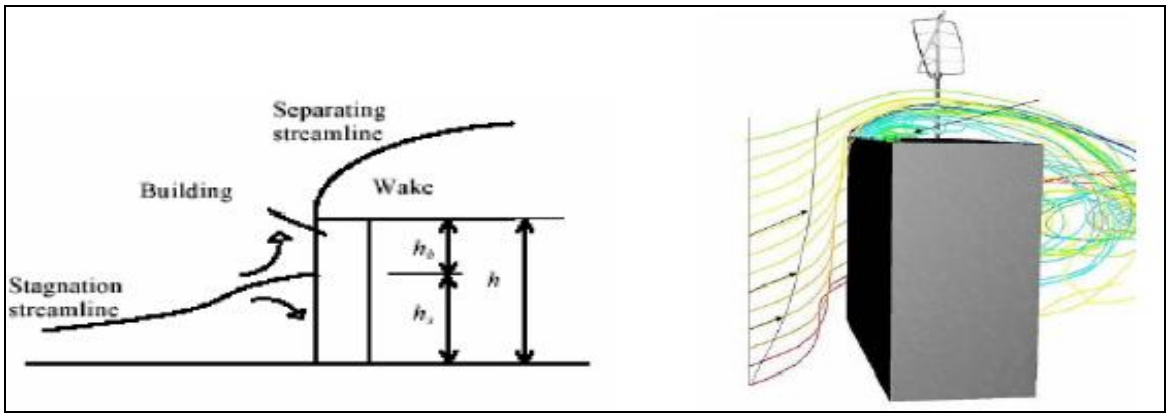
The average wind speed for each 1km grid-square is given on the NOABL database, at mast heights of 10m, 25m and 45m above ground level. However this data is averaged for the area and should not be wholly relied upon for a specific location. A recent Energy Saving Trust study of small wind turbines found that this database over-estimates wind speed, and the Carbon Trust Wind Yield Estimation Tool was more accurate.

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

Carbon Trust Wind Yield Estimator:

www.carbontrust.co.uk/emerging-technologies/current-focus-areas/offshore wind/_layouts/ctassets/aspx/windpowerestimator/windpowerestimatorterms.aspx

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. The urban environment with gusting and multi directional wind going round buildings, makes it very difficult to channel air into the turbine, and wind flow modelling will be necessary.



Cut in speeds range from 2.5 – 4.5 m/sec (5 – 10 mph).

Cut out wind speed is the speed at which the turbine puts on a brake to restrict the speed of the turbine, so it doesn't run out of control. Some turbines have no cut-out speed but can adjust the blades to keep them operating. Most also have a maximum design wind speed.

Cut out speeds range from 20 - 35 m/sec (45 – 78 mph)

Maximum design speeds range from 55 - 70 m/sec (123 - 156 mph)

Dimensions

The dimensions of a number of the more popular horizontal axis turbines are given below.

Turbine	Proven 2.5kW	Skystream 3.7kW	Evance 5kW	Proven 6kW	Evoco 10kW	Gaia 11kW	Proven 12kW
Mast Height	6.5,11m	10-21m	10-18m	9-15m	12-15m	18m	15-20m
Blade Diameter	3.5m	3.7m	5.5m	5.5m	9.7m	13m	8.5m
Max Height	12.75m	22.85m	20.75m	17.75m	19.85m	30.5m	24.25m

The dimensions of a number of the more popular vertical axis turbines are given below.

Turbine	Turby 2.5kW	Quietrevolution 5kW	Ropatec 3kW	Ropatec 6kW
Mast Height	5 - 9m	3.4-15m	12.2m	11.8m
Turbine Height	3m	5m	3m	2.5m
Diameter	2m	3.1m	3.3m	4.7m

Installation and maintenance

Pole-mounted turbines require a concrete base and generally a separate anchor point, which then allows the turbine to be dropped for maintenance. Guy-supported turbines require separate anchor points for each guy. Installation of the turbine mast and rotor usually takes one day.

Wind turbines are designed for a 20-year lifetime and come with a warranty of 2-5 years, but the inverter will need replacing after about 10 years. The turbines require annual maintenance by a certified person to ensure the warranty remains valid.

Grid connection

For small systems (< 16 Amps per phase, or roughly 11.4 kW for 3-phase connection) the installer is only required to inform the Distribution Network Operator (DNO) that the connection will happen. For larger systems a grid connection report must be requested from the DNO, who may charge a fee of around £2,000 - 4,000 for this service. If any grid connection strengthening work is required, there will be an additional cost.

As most turbines are located at some distance from the nearest grid connection point, cabling costs can form a significant part of the budget.

Costs

Price ranges for different size turbines, excluding grid connection, are given below (as at June 2011).

Turbine Size	Installed Cost
Small 5 - 6 kW	£25 - 35,000
Medium 10 - 12 kW	£45 - 55,000

Feed in tariff (FIT)

FIT rates to March 2012 are shown below (these are expected to change for 2013 based on the outcome of the FIT Review). For schemes under 50kW to qualify for FITs the system must be installed by a Microgeneration Certification Scheme (MCS) accredited installer. Schemes over 50kW need to apply for accreditation through Ofgem's Renewable and CHP Register.

At June 2011, there were only 9 MCS-accredited turbines but many more are going through the accreditation process.

Technology	System Size	p/kWh	Years
Wind	≤1.5kW	36.2	20
Wind	>1.5 - 15kW	28	20
Wind	>15 - 100kW	25.3	20
Wind	>100 - 500 kW	19.7	20
Wind	>500 kW - 1.5 MW	9.9	20

Planning considerations

Planning permission will be required for a wind turbine of any size. The main planning considerations will be:

- 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 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

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

Energy Saving Trust small wind turbine field trial report - www.energysavingtrust.org.uk/Generate-your-own-energy/Energy-Saving-Trust-field-trial-of-domestic-wind-turbines

Feed In Tariffs - www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/feedin_tariff/feedin_tariff.aspx

Microgeneration Certification Scheme - www.microgenerationcertification.org

Ofgem Renewable & CHP register - https://www.renewablesandchp.ofgem.gov.uk/

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).