IWEA
Irish Wind Energy Association

Wind Microgeneration

Step by Step Guide

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Cover photo courtesy of C&F Green Energy

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Introduction

In Ireland we are extremely fortunate to have one of the world's best natural wind resources which can be seen through the development of commercial wind projects and some autoproduction and microgeneration developments, however when compared to neighbouring markets such as the UK, the significant potential for microgeneration in Ireland still remains relatively untapped. This is an important aspect of generation for combating climate change, as the electricity generated locally can go towards reducing the overall electricity demand and meeting our national targets, as well as giving the user control over how and when they use their electricity. It provides the opportunity for users to demonstrate our determination to reduce carbon dioxide emissions, individually, collectively and nationally, and can help raise local awareness and understanding of clean renewable energy.

Microgeneration is the production of energy on a small scale for the domestic home, farm, business or other use. Typical Microgeneration technologies include Wind Turbines, Solar Photovoltaic, Hydro Power and Combined Heat & Power (CHP) with equipment ratings below 11kW.

Microgeneration is defined by ESB Networks as a source of electrical energy, designed to operate in parallel with ESB Networks Low Voltage (LV) System and rated up to and including:

- **25 amperes at low voltage [230 volt] when the connection is single phase (~ 6 kW)**
- **16 amperes at low voltage [230/400 volt] when the connection is three phase (~11kW)**[1]

Home owners have availed of exporting electricity from their premises to the national grid since 2007. The vast majority of domestic and agricultural customers are connected at single phase.

Current Installed Capacity for Micro generation in Ireland

Micro Generators	kW Installed Capacity	No. of Installations	Average Installation (kW)
Micro Wind	3984.86	763	5.22
Micro Photovoltaic	1203.788	375	3.21
Micro CHP	72.91	15	0.53
LPG Gas	1.2	1	1.2
Micro Hydro	61.85	13	4.76
Total	5324.608	1167	4.56

Source: Information from ESB Networks as of September 2014

This guide aims to outline the different aspects of microgeneration that should be taken into consideration when deciding if wind microgeneration is the right choice for you.

[1] http://www.esb.ie/esbnetworks/en/generator-connections/micro_gen_connections.jsp

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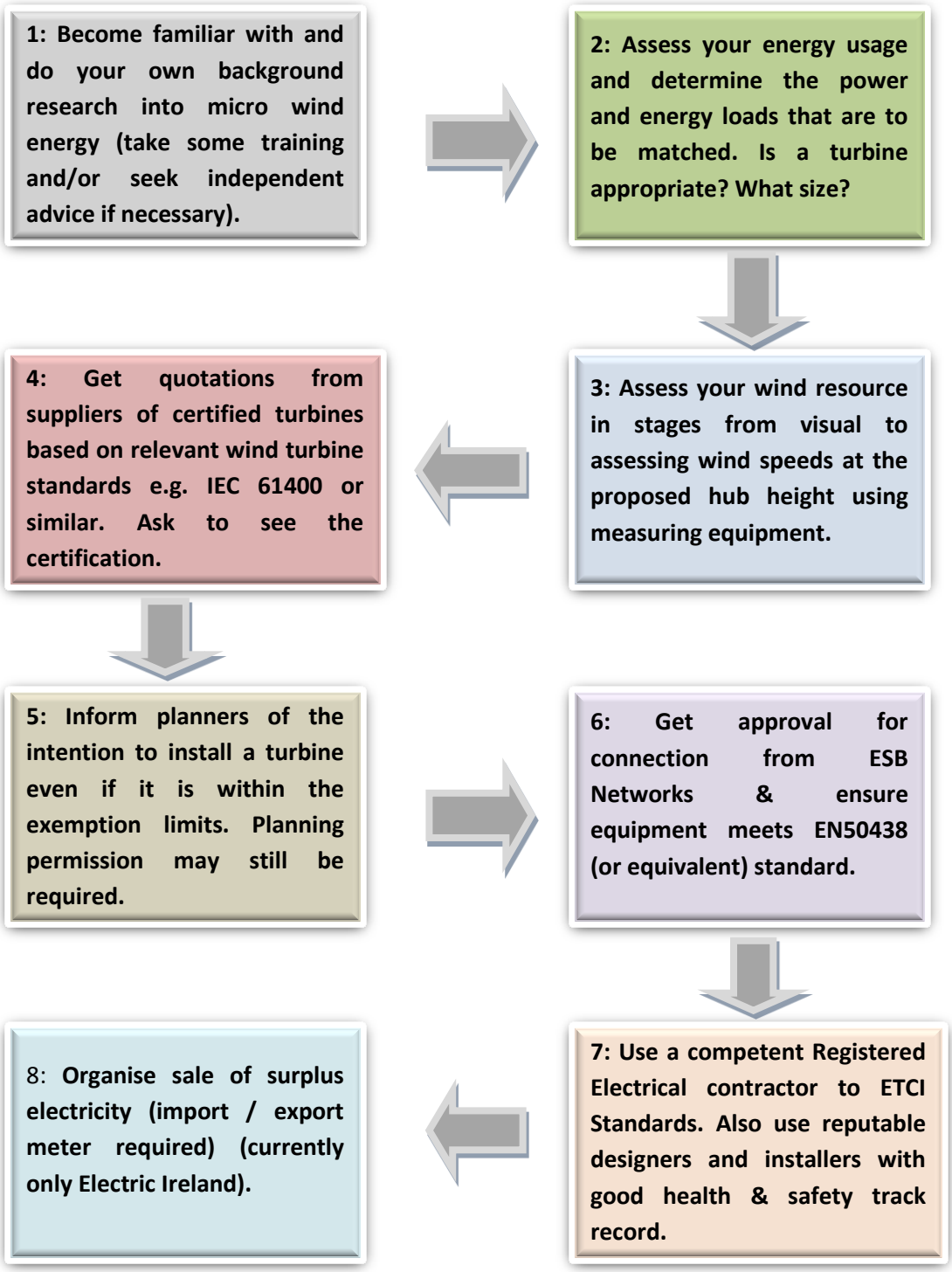


Introduction

There are many characteristics that can affect the annual energy production of any turbine. Consumers can carry out an early assessment before considering a more detailed assessment. In the early assessment there are a few questions to consider.

Many residential areas are not suitable for wind turbines as buildings and trees shade the wind and create turbulence which can reduce the efficiency and lifespan of a turbine considerably. Generally speaking, the ideal location is on top of a high tower on a south westerly facing hill with gently sloping sides surrounded by clear countryside which is free from obstructions such as trees, houses or other buildings. Here the wind flows relatively smoothly and steadily enabling it to drive wind turbines with greater efficiency. An early visual assessment could rule out a site or indicate that further analysis is warranted.

Assessing your energy needs

In order to determine if a turbine is suitable and what size you require you need to look at your energy demand. At this point it is necessary to define the difference between 'Energy' and 'Power'. *Energy* is what you pay for in your electricity bill and is measured in units. The technical term for a unit of electricity is one 'kilowatt-hour' kWh. *Power* is the rate of delivery of energy. It is measured in Watts. A load, which uses 1000W of power will use 1kWh of energy in one hour. In two hours it will use 2kWh. On average, Irish households use 5,000 kWh of electricity per year[2].

To carry out an assessment of your energy needs you need to determine both the power requirements of a load and the hours for which it will run. Then you can calculate the energy it will use. Consideration should also be given as to whether you have flexibility to change the time of electricity use, so that you can run the heavier loads at times of higher wind, and therefore higher power output from the turbine. When you compare this against the cost of a turbine, you will be able to get an understanding of whether a turbine will be of benefit and, if so, what size is required. A turbine supplier should be able to assist you in this regard. Independent advice should also be sought.

Ultimately, each householder should always make a decision in their individual case if it is worthwhile to install a micro wind turbine, taking into consideration:

1) **the local climate conditions, e.g. the local wind speeds and directions**
2) **the electricity use requirements**
3) **the micro wind turbines available**
4) **the financial incentives for micro wind generation.**

[2] SEAI Guide to Connecting Micro-generation to the Electricity Network

Preliminary Assessment

What is my Average Wind Speed? The most important criterion for a wind power site is the annual average wind speed, measured in metres per second (m/s) and annual wind speed distribution which shows the proportion of time the wind blows at various wind speeds over the year. To carry out a full and accurate wind speed and distribution assessment you would need to erect an anemometer in the proposed location, ideally for a 12 month period at the proposed turbine hub height. If this option is not in your budget, you are advised to make an independent assessment taking into account the location, the ground conditions and the height of the tower. A review of the **SEAI Wind Atlas**[3] would provide you with an idea of wind speeds in your area although the lowest height available on this is 50m. It is important to note that wind resource may be very different at lower heights and **micro siting a turbine correctly is very important**.

Other questions to ask in a preliminary assessment

Tower Height: **What height of tower would you need? Will this be covered by current planning exemptions for turbines under 13 metres? (See section 4 under planning requirements)**

Site Location: **Where can the turbine be located? Is it close to the grid? How much will the cable costs be?**

Obstructions: **Are there trees, buildings or other obstructions impeding on your site location? Obstructions lead to wind turbulence which can seriously impede on your wind flow and hence reduce your energy output. Particular attention should be paid to obstructions in the path of the prevailing wind direction.**

Hazards: **Is it safe at this location, e.g. ground conditions, proximity to other equipment, etc.**

Site access: **Is there easy access to the site? Will trucks/cranes etc be able to enter the site to erect a turbine?**

Importance of Wind Speed

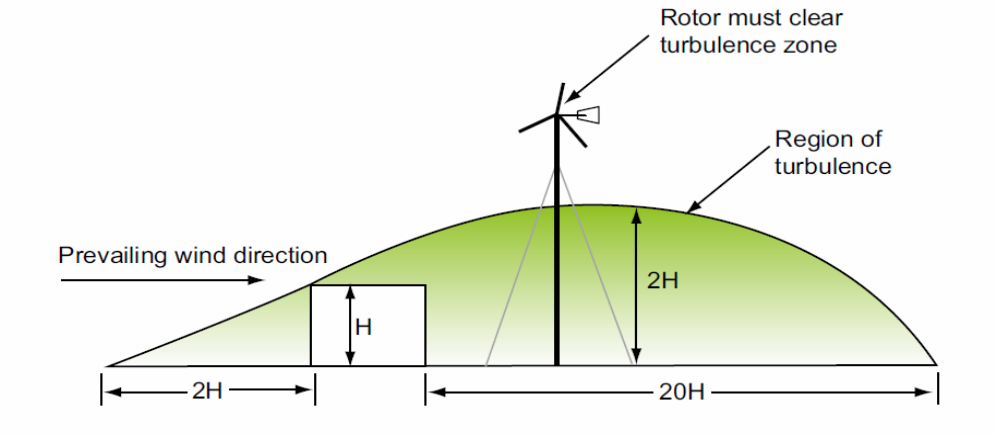
The importance of wind speed should never be undermined by other site characteristics. Meeting the planning exemptions alone is not a good reason to install a turbine as the wind resource at these heights could in many cases be poor. **A taller tower could result in significantly more energy generation but will require planning permission - this may be more economically beneficial in the long term**. A 2011 study on the economic viability of micro turbines showed that the micro wind turbine is currently not economically viable if it is installed in locations with relatively low annual

[3] http://www.seai.ie/Renewables/Wind_Energy/Wind_Maps

average wind speed (<5 m/s), however it appears more promising when is installed in locations with relative high annual average wind speed (>6 m/s)[4].

Turbulence

Turbulence is another important factor, apart from wind speed, to bear in mind. Turbulence is the fluctuation of wind speed and direction due to eddies and other circulation of wind caused by friction with the ground surface and obstacles. Turbulence increases wear and tear on a turbine and its tower structure and reduces the energy output of the turbine. This diagram below[5] outlines the turbulence effect and shows how to avoid turbulence from an isolated obstacle of height H. Again this is indicative and does not substitute for site specific measurements.



Turbine Supplier Systematic Resource Assessment

Turbine suppliers should provide a trained site assessor as part of their service. Although it is extremely difficult to predict the exact average wind speed, a systematic resource assessment and a thorough site assessment can estimate a range within which a given turbine should be expected to perform. You should ensure that when discussing output with the turbine supplier, they are using measured power curves to relevant standards rather than the theoretical output under perfect conditions.

Detailed assessment

IWEA recommends that a more detailed assessment of the wind resource be carried out, however this does have an additional cost associated with it. If you are making a significant investment and wish to determine the wind resource that a turbine would experience, you should put up a wind monitoring mast at turbine height for at least 12 months. This will give more accurate information on the wind resource on your site in terms of both wind speed and direction, distribution and levels of turbulence. It gives you an appreciation for the varying levels of annual energy production that could be expected for different tower heights for a given turbine model with its own specific measured power curve. It also informs neighbours of your intentions.

[4] Li, Z., Boyle, F., Reynolds, A. Domestic Application of Micro Wind Turbines in Ireland: Investigation of Their Economic Viability. Renewable Energy, 2011

[5] Victorian Consumer Guide to Small Wind Turbine Generation 2010

Planning

Planning Requirements

Small wind turbines are exempted developments in domestic, industrial, agricultural and commercial application if they comply with certain terms & conditions. Below you will find a summary of exemptions set out in **SI 83 of 2007**[6] and **SI 235 of 2008**[7].

Requirements small scale wind (Domestic Dwellings)

No planning permission required if:

- Total hub height not greater that 10m
- Total structure height not greater than 13m
- Maximum rotor diameter 6m (rotor must be greater than 3m from ground at lowest point)
- Distance from nearest neighbour greater than the height of total structure + 1metre i.e. (tower height + radius of rotor) + 1 metre
- Turbine not roof mounted
- Sound level less than 43dB(A) or 5dB(A) above back ground at nearest neighbour
- No advertising logos or reflective surfaces

Requirements small scale wind (Commercial)

No planning permission required if:

- Total structure height not greater that 20m(tower + rotor radius)
- Maximum rotor diameter 8m (rotor must be greater than 3m from ground at lowest point)
- A distance more than 50m from road
- A distance more 100m from nearest dwelling
- A distance more than 2 rotor diameters from overhead lines.
- Distance from nearest boundary greater than the height of total structure + 1metre i.e. (tower height + radius of rotor) + 1 metre
- Sound level less than 43dB (A) or 5dB(A) above back ground at nearest neighbor
- No advertising logos or reflective surfaces

You must consult with your local planners who can inform you if there are location specific conditions applicable to installations in your area which may mean the exemptions do not apply. **IWEA always recommends that a letter of exemption be obtained from the local planning authority.** IWEA strongly recommends also that you discuss your plans with your neighbours at an early stage.

[6] SI 83 of 2007 PLANNING AND DEVELOPMENT REGULATIONS 2007
[7] SI 235 of 2008 PLANNING AND DEVELOPMENT REGULATIONS 2008

Turbine Selection and Costs

One of the first questions asked by any consumer looking to invest in microgeneration is what the average cost of a small scale turbine is? Turbine systems costs vary depending on a number of factors. For a given suitable site the choice of turbine and supplier are the key factors which lead to a successful installation and a positive experience. Grid connected turbine systems generally range from approximately €20,000 to €30,000 for a 6kW unit and from €10,000 to €20,000 for a 3kW unit. A 1kW grid connected unit can cost from €3,000 to €7,000. The cost per kW is usually inversely proportional to the size of the unit i.e. as the unit size increases the price per kW decreases. Suppliers will be able to provide you with indicative costs for the installation or cost of equipment alone prior to giving you an exact quote for your requirements and location.

In the USA, the installed cost of a single wind turbine ranges from 3,000 to 6,000 USD per kW[8]. Renewable UK's study, conducted in 2012 is most relevant when looking at turbine costs which are shown in the table below (Euro prices are a conversion from sterling and given as an approximate guide only).

Capital cost ranges of small wind turbine in the UK

Turbine Rating	Price Range (STG)	(Price Range (€))
2.5 – 6.0kW	£16,000-£24,000	(€18,755-€28,133)
11kW-50kW	£54,000-£210,000	(€63,300-€246,164)

Source: RenewableUK: Small & Medium Wind UK Market Report -April 2012[9]

Standards

Consumers need certainty regarding safety, performance and durability of the turbine they wish to purchase. Countries such as UK, Denmark, USA and Japan have developed their own closely related national standards that are linked to wind turbine certification schemes and financial incentives in those countries. These standards are very closely related as they are based on, and in some cases exceed the International Electro technical Committee (IEC) 61400 international standards for small wind turbines. A list of standards relevant to small wind turbines is shown Appendix 2. While there is currently no certification requirement in Ireland, IWEA recommends that equipment which is approved by the Microgeneration Certification Scheme[10] in the UK or with similar accreditation are used, as this provides a certain level of quality assurance for the product. The Sustainable Energy Authority of Ireland[11] (SEAI) intends to publish a list of wind turbine products that have met relevant standards of certification schemes abroad e.g. in countries mentioned above. It is also recommended that you contact a qualified installer to install your turbine.

[8] World Wind Energy Association Small Wind World Report 2012
[9] http://www.renewableuk.com/en/publications/index.cfm/SMMR2012
[10] Microgeneration Certification Scheme
[11] SEAI Registered Products Website

Warranty

Different manufacturers will offer different warranties. It is important to discuss this with the supplier at an early stage. It is also important to liaise with your turbine supplier regarding after sales service provision, and to ensure that you receive the required manuals and certificates. Appendix 1 outlines some of the handover/warranty documentation that should be requested when purchasing a turbine.

Maintenance

It is important to remember that turbines do require maintenance and this cost should be taken into consideration in an early assessment. As a rule of thumb, maintenance could cost about 2%-3% of the initial capital cost annually. It is also important to ensure that spare parts for your chosen turbine are readily available in case they are required during the lifetime of the turbine.

VAT Refund

The existing VAT Refund Order[12], which provides for the refund of vat paid by farmers on the construction of farm buildings, fencing, drainage and reclamation of farm land has been amended and signed into law on the 15th of June 2012 and provides that such farmers may claim a VAT refund on wind turbine systems (including construction and installation) purchased from January 1st 2012.

Insurance

Wind turbine suppliers should be insured for the work they carry out on your premises and for the quality of the installation. Home and business owners should contact their insurer to discuss the implications of installing a turbine and measurement mast. It is advisable to have insurance on the wind system itself and also for any other issues that may arise due to the wind system, e.g. in health and safety.

[12] S.I. No. 201 of 2012 - VALUE-ADDED TAX (REFUND OF TAX) (FLAT-RATE FARMERS) ORDER 2012

Installation

An installation involves civil, mechanical and electrical works. There are potential risks during the installation which should be managed by a trained and qualified installer.

When installing a turbine it is essential that the foundation design and construction is suitable for the chosen turbine. You should engage closely with the turbine supplier and installers to ensure the foundations are fit-for-purpose.

The final sign-off of a grid connected turbine must be completed to **ETCI** (Electro-Technical Council of Ireland) standards. The electrician that the installation company provides should be a member of a certified trade body such as **RECI** (Registered Electrical Contractors of Ireland) and **ECSSA** (Electrical Contractors Safety & Standards Association). Ask your prospective supplier for evidence of training or experience within the company.

Connecting to the grid for microgeneration is a straightforward process known as "Inform and Fit" and can be managed by your installer. A one page NC6[13] form from ESB Networks (ESBN) must be filled out by the applicant. There is no fee to make a domestic grid connection.

ESB Networks NC6 Form

Return Applications Forms to: ESB Networks, P.O. Box 29, Garrycastle, Athlone, Co Westmeath.

Note ESB Networks require other information with the notification including a type test cert, payment for import/export meter, and a valid ETCI Electrical Completion Certificate. Once ESBN receives all documentation, ESBN will install the import/export meter. At this stage the wind turbine will be installed.

EN50438 Type Test Certification

All installed micro-generators must comply with EN50438 Standard[14] or equivalent. A copy of the Type Test Certification results sheet shall be supplied to ESB Networks. A copy of this Test Cert shall be supplied by the micro-generator suppliers to each customer. From Jan 30, 2009, all installations must be wired by a Registered Electrical Contractor by law and a completion certificate issued. Failure to do this will result in the refusal of an export meter. The micro-generator must conform to the information in the following ESB document:

Conditions Governing the Connection and Operation of Micro-generation[15]

Larger Turbines

If you wish to connect a turbine larger than those covered under the microgeneration application process (i.e. 25A at low voltage [230V], when the DSO network connection is single-phase or 16A at low voltage [230/400V], when the DSO network connection is three-phase) a more detailed connection process is required. You will need to make an application to ESB Networks using application form NC5A[16].

[13] ESB Networks NC6 Form
[14] EN50438 (2013). Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks. British Standards Institute.
[15] Conditions Governing the Connection and Operation of Micro-Generation
[16] NC5A

Payment for output is a matter for negotiation between the off-taking supplier, i.e. the supplier to whom you would be selling the exported electricity, and the owner of the microgenerator. To receive payment for any wind exported to the network you will need to contact your Electrical Supplier to see if they offer an export tariff. You will require an import/export meter if you want to get paid for exported electricity.

Electric Ireland offers an export payment of 9 cents per kWh to **existing** domestic customers; however they **will cease to offer this to new connections** from 31st December 2014. There is currently no other electricity supplier in Ireland offering payment for electricity produced from microgeneration technologies.

Export Meter

An Import / Export Meter (an example of one is pictured to the left) for Domestic Customers will cost €340 including vat for Supply and Installation. For new customers after February 2012, ESB Networks will install a meter after the customer pays cost of installation.

With the expected roll-out of smart metering in the coming years, it is expected that each customer will have a meter that can measure imports and exports. It is recommended that any meter installed at this stage will be fit-for-purpose with the introduction of smart metering.

Appendix 1 - Handover/Warranty Documentation

Following installation of your micro/small wind turbine, the installer should provide you with a set of handover/warranty documents, including, but not limited to, the following;

- A certificate from the installer containing installation details:
  - Client name & address
  - Site address (if different)
  - Installers name & address
  - Date of installation
  - List of any sub-contractors (civil, electrical, etc.)
- List of key components
- Spare Parts/Consumables list
- Mechanical Maintenance Guide including service interval guidelines
- Electrical Maintenance Guide including service interval guidelines
- After sales service provision
- EN50438 Standard (or equivalent) Type Test Certification results sheet
- CE Certificate/Proof of CE Mark (turbine, inverter and controller)
- Final sign-off of the grid connected turbine completed to ETCI standards by competent electrician (RECI & ECSSA Certified)
- WTG Performance projection
- Power Curve
- Noise/Sound Level Guarantee
- Single Line Diagram/Wiring Diagram
- Inverter & Controller Instruction Manuals
- Foundation design drawings/information
- WTG Tower/Lattice Certification

Appendix 2 - Standards

Applicable Technical Standards

All installed micro-generators must comply with EN 50438 with the specific Irish protection Settings. Type testing must be carried out with the Irish Protection settings outlined in EN 50438.

In accordance with EN 50438, each micro-generator shall have interface protection, as specified, which will include the following elements:

- Over Voltage
- Under Voltage
- Over Frequency
- Under Frequency
- Loss of Mains [LOM].

Settings shall be as specified in EN 50438 above. Every new micro-generator interface type and model, shall satisfy the conditions set out in 'Conditions Governing Connection and Operation of micro-generation' March 2009.

The earth electrode system should be installed in accordance with IEEE80 and IEC 1024-1 [1].

International Standards

Certification schemes in the UK and USA require that small scale wind systems are tested by independent testing organisations and these are based on IEC standards which include:

- Product Design Evaluation (IEC 61400-2)
- Safety and Function (IEC 61400-2)
- Duration(IEC 61400-2)
- Acoustic Noise (IEC 61400-11)
- Power Performance (IEC 61400-12)

The **CE mark** should also be in evidence on the major elements of the micro generation system (turbine, inverter and controller). The CE mark is not a symbol of quality but does show that certain standards have been satisfied by the manufacturer.

Appendix 3 - Glossary of Terms

In order to help you understand a small wind turbine system, a list of common terms used in small wind energy is presented below. This might be of help for your early assessment and when discussing terms with a supplier.

Anemometer	A device that measures wind speed. A common type uses cups that use drag force to rotate a shaft.
Average wind speed	The mean wind speed over a specified period of time.
Blades	The aerodynamic surface which generates lift from the movement of the wind.
Brake	Various systems used to stop the rotor from turning.
Cut-in wind speed	The wind speed at which a wind turbine begins to generate electricity.
Cut-out wind speed	The wind speed at which a wind turbine ceases to generate electricity.
Downwind	A 'downwind' turbine is one where the wind meets the tower (or nacelle) before the rotor, i.e. the rotor is downwind with respect to the tower.
kW Kilowatt	A measure of electrical power (equal to 1000 watts).
HAWT	Horizontal axis wind turbine.
Hub height	Vertical distance between the centre of the wind turbine rotor and the ground.
Inverter	A device that converts direct current (DC) to alternating current (AC).
Met Mast	A measurement mast which is a free standing tower or a mast, which carries measuring instruments
Nacelle	The body of a propeller-type wind turbine, containing the gearbox (if the turbine has one), generator, blade hub, and other parts.
O&M	Operation and maintenance.