



Small Scale Wind Generation: A Guide for Farmers

INTRODUCTION TO RENEWABLE ENERGY

Renewable energy is the term used to describe any naturally occurring, theoretically inexhaustible source of energy such as biomass, solar, wind, tidal, wave, and hydroelectric power that is not derived from fossil or nuclear fuel. Useful energy may in the form of heat, as with solar water heating or indirectly as electricity as with wind.

Fossil fuels are in contrast, finite sources of energy. Their combustion releases CO₂ which contributes to climate change. As the reserves of fossil fuels dwindle and demand increases, prices are tending to increase and security of supply is becoming an issue. Therefore the comparative viability of renewable energy is steadily improving.

The key challenge in using renewables is to derive usable energy, in a practical and economic way.

This guide covers the issue of small scale wind generation and how it can be applied.

WIND ENERGY

Wind energy is one of the most cost effective forms of renewable energy. Britain has the greatest wind resource in Europe; about 500 large turbines with a total capacity of 175MW are in place, mostly in our windier regions in the southwest of England and in Wales. It is believed that we could eventually derive up to 20% of our electricity from wind power, if suitable sites can be found.

Single or small groups of turbines can also be used for a wide range of small scale applications from powering electric fence units or small water pumps to producing enough electricity to run a reasonably sized dairy farm. Wind power is usually converted to electricity but for some applications it can be used as mechanical power.

Wind generation technology is proven and there are many commercial units available to suit a wide range of situations.

One problem with wind power is that wind speeds are variable and unpredictable so generator outputs can vary from zero to full power over short periods of time. As such it is sometimes best to consider small scale wind generation for use in conjunction with solar photovoltaic panels or a diesel generating set and battery back-up to produce a constantly available stand alone power source. The sophistication of the system depends on the application and the need for continuity of supply.

Generating power using a wind turbine has a high initial capital cost and relatively low running costs but financial viability is very dependant on wind speed. Sites that experience only light winds may not be able to capture enough power to make the turbine economic.

Typical farm uses for wind turbine generated energy are:

- Lighting
- Heating
- Water pumping
- Electric fence units
- Other domestic uses

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Some small scale wind generator applications are as follows:

Application	Detail
Lighting	domestic; farm; security
Heating	into buffer storage heaters to allow continuity
Water pumping	for domestic or stock water tanks (these need to be sized for a minimum 3 days supply)
Electric fence units	trickle charging for battery powered systems
Other domestic uses	water heating; household appliances

TECHNOLOGY

A wind turbine usually comprises:

- A propeller i.e. a bladed rotor that will turn when wind passes over it.
- The shaft on which the rotor is mounted.
- Gears or a gearbox to match the speed of rotation required by the generator.
- An electrical generator driven from the gearbox.
- The nacelle i.e. the housing at the top of the tower that contains some of the above.
- A vane or equivalent to turn the propeller into the wind.
- A feathering or furling device to disconnect the turbine if winds are too high.
- A tower or column upon which the propeller or nacelle is mounted.
- Electrical control equipment to ensure the output is in the form required.

SIZES

Wind turbines can be simply classified into two types:

1. Large grid connected machines rated at between 200kW and 1MW.
2. Smaller turbines for remote power generation (about 50W to about 25kW).

Typical small scale wind generator sizes

Rotor Diameter (m)	Mast height (m)	Generating output at 10m/sec wind speed	Operating voltage
0.9	6	50-72W	12 / 24
1.14	Not specified	300W	12 / 24
1.8	6.5	340W	12 / 24
2.55	5.5 or 6.5	600W	12 / 24 / 48
3.5	6.5	2.5kW	24 / 48 / 120
5.5	9	6.0	48 / 120 / 240
10.2	15	20kW	415 – 3 phase

When considering the size of generator required it should be noted that favourable generator

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wind speeds can only be assured for relatively short periods. Therefore average output is between 25% and 30% of full potential. So the average output of a 6kW machine is generally less than 2kW.

A good site will have average wind speeds in excess of 5m/s. The following table gives an indication of wind speed comparisons.

Wind speeds on the Beaufort Scale

Beaufort Scale	Description	Speed (knots)	Speed (m/sec)	Description
0	Calm	0	0	Smoke rises vertically
1	Light air	1 - 3	0.5 - 1.5	Vanes do not turn
2	Light breeze	4 - 6	2.0 - 3.1	Leaves move
3	Gentle breeze	7 - 10	3.6 - 5.1	Twigs move
4	Moderate breeze	11 - 15	5.6 - 7.7	Paper whirled up
5	Fresh breeze	16 - 20	8.2 - 10.3	Leafed branches move
6	Strong breeze	21 - 26	10.8 - 13.4	Wind whistles through wires
7	Moderate gale	27 - 33	13.9 - 17	Small trees move
8 and above	Most turbines will 'feather' or turn out of the wind at high speeds			

SITING

Planning Permission

When considering a permanently sited wind generator contact should be made with your Local Authority at an early stage regarding any necessary planning permission. In certain cases it may be necessary to submit an Environmental Impact Assessment along with the planning application. Also if the planned structure is close to an active airfield, then contact and deliberation with the appropriate authority involved should also be made.

Wind Speed

Wind power varies with the cube speed of wind. The best positions have exposure to the prevailing wind and are away from obstructions such as large trees and buildings. Excessive turbulence caused by nearby topographical features or buildings can cause fatigue damage to the wind turbine and shorten its working life. A smooth hilltop facing into the prevailing wind is an ideal site.

Average annual wind speed data should be acquired when considering the siting of a wind generator or a wind survey carried out over several months (the longer the time the better). Wind speed data is available based on a 1km x 1km square grid covering the whole of the UK. Details of this can be obtained from ETSU and BWEA (see end of document).

Generators can produce power at very low wind speeds but an annual mean wind speed at the wind generator hub of around 6.5m/s is desirable.

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Noise

Wind generators produce noise which in some cases can be irritating and cause complaints from neighbours. Careful consideration should be given to the noise impact a wind generator may have on a particular location.

Decibel (dBA)	Loudness
0	Threshold of hearing
10	Virtual silence
20	Quiet room
30	Watch ticking at 1 metre
40	Quiet street
<i>Small turbine in light winds</i>	
50	Quiet conversation
60	Quiet motor at 1 metre
<i>Small turbine in high winds</i>	
70	Loud conversation
80	Door slamming
90	Busy typing room
100	Near loud motor horn

EXPORTING EXCESS POWER BACK TO THE MAINS

The power from small scale wind generators is often used directly or it can be stored in batteries. These systems are said to operate in 'islanded' mode i.e. there is no interconnection with the mains and therefore no facility to export excess power into the electricity network. Connecting to the mains can be expensive because of the cost of the export metering and electrical protection systems. In the UK, if a 400/415V 3-phase electricity supply exists on the farm then it should be possible to export power (if the economics make sense) subject to agreement with the local electrical distribution company.

Excess power can then be fed back into the mains network. A contract can be entered into with a Public Electricity Supply company to sell power from renewable sources, subject to metering and strict adherence to safety and mains protection arrangements. The value of energy generated can be enhanced by the payment of an enhanced energy rate under a Renewable Obligation Contract (ROC).

Turbine Costs

These illustrative figures do not include batteries, ground work, cables or control gear which is specific to each project.

See table of typical costs overleaf.

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Table of typical Wind Generation costs:

Wind Generator Rating		Typical / Approximate Costs
Output	Voltage (V)	
70W	12 / 24	£200-400
300W	12 / 24	£400-650
340W	12 / 24	£1200
600W	24	£2700
2.5kW	24	£6500
2.5kW	240	£9800
6.0kW	240	£11000
11kW	240 / 415	£26000
20kW	415 - 3 phase	£32750

FURTHER ADVICE

<p>European Wind Energy Association Rue de Trone 26 B-1040 Brussels Belgium Website: www.ewea.org</p>	<p>New and Renewable Energy Enquiries Agency Building 168 AEA Technology – Environment Harwell Didcot Oxfordshire OX11 0JQ Tel: 01235 432450 Fax: 01235 433066</p>
<p>The Centre for Alternative Technology Llwyngwern Quarry Pantperthog Machynlleth Powys SY20 9AZ Tel: 01645 705950 Fax: 01654 702782 Website: http://www.cat.org.uk</p>	<p>Renewable Energy for the Home NEF Renewables The National Energy Foundation Davy Avenue Knowlhill Milton Keynes Buckinghamshire MK5 8NG Tel: 01908 665555 Fax: 01908 665577 Freephone: 0800 138 0889 Website: www.greenenergy.org.uk</p>
<p>Energy Saving Trust 21 Dartmouth Street London SW1H 9AZ Tel: 020 7222 0101 Fax: 020 76542444 Website: www.est.org.uk</p>	<p>British Wind Energy Association 26 Spring Street London W2 1JA Tel: 020 7401 7122 Fax: 020 7402 7125 Website: http://www.bwea.com/</p>

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