HARVESTING THE POWER OF THE WIND

Last month, we looked at the potential of wind power and noted that wind speed is critical. The power of the wind varies as the cube of its speed. Obstructions such as trees and buildings slow the wind and create turbulence near the ground, so a wind turbine should be mounted as high as possible. A counsel of perfection is that the turbine should be 10 metres higher than any obstruction within 100 metres, but that is not practical in most of over-crowded Britain. At the very least, don’t position a turbine in the lee of obstructions to the prevailing wind – which is from the South West in most of Britain. Masts of 10 to 20 metres are generally recommended, but a lower mast may be acceptable – and in a windy location a wind turbine on a 6 metre mast would still be much more cost effective than a PV system.

Types of wind turbine

Most readers will be familiar with the sight of large, commercial turbines, and these invariably have a horizontal axis.

There are two variants:

- **Upwind turbines**
  - The blades are at the front of the turbine (eg, all the large turbines and most of the micro-turbines).

- **Downwind turbines**
  - The blades are at the rear (eg, the popular Proven micro-turbines).

More power is generally available to an upwind turbine as the blades are situated in an undisturbed air stream. The advantage of a downwind turbine is that in extreme winds the blades can bend to spill the wind without hitting the mast. This makes for a very safe design. Also they can produce a lot of power in very high winds, when many other turbines would slow or stop for safety reasons.

Large, commercial turbines are kept facing the wind by a servo-motor. For micro-turbines, a ‘tail’ suffices. The downside of this simple method is that the turbine might be slow to adjust to sudden changes in wind direction, resulting in a loss of efficiency in turbulent winds.

For small installations, vertical axis turbines are feasible, and many different designs have been tried out. Their big virtue is that their rotation is independent of the wind direction, so they are well suited to the turbulent winds found near buildings. However, in general, a turbine with a vertical axis is less efficient than one with a horizontal axis.

(I have heard about a 2.5 kW vertical axis turbine to be marketed within a few months. This will give useful output at low wind speeds, will be silent, and will be offered as a total system for a remarkably low price. Watch this space.)

At present, there is no standard wind speed for rating the power output of turbines, so comparing their efficiencies is difficult. Last month I mentioned a report about building-mounted wind turbines, and one of its recommendations was that a national test centre should be established. Amongst other things, the centre could produce standard measurements of performance for micro-wind turbines. Will the government fund such a centre? And what about funding a test centre for solar
systems, too? There are misleading claims being made in both the micro-wind and solar industries, and objective evaluations of performance would be most helpful.

A useful table in a book by Hugh Piggott, ‘Choosing Windpower’, gives outputs for many turbines at one wind speed, 10 m/s – based on manufacturers’ claims. Real life outputs are being assessed by the Energy Saving Trust. In the autumn, they will be publishing a report about household turbines based on 100 existing installations.

**Basic grid-connected wind power system**

The blades of a turbine are attached to an alternator, and when the wind blows, the alternator produces alternating current of varying voltage and frequency. A rectifier converts this to direct current of variable voltage. A cable of appropriate thickness carries the current to the house where an inverter converts the DC to mains synchronised AC (230 Volts, 50 Hertz). The inverter must comply with the G83 technical standard for small systems, or the G59 standard for a current greater than 16 amp.

**Costs**

‘Choosing Windpower’ gives some representative costs for a system with a 3m diameter turbine. Including VAT, but excluding delivery:

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind turbine (3m diameter)</td>
<td>£3,500</td>
</tr>
<tr>
<td>Tower (20m high)</td>
<td>£2,000</td>
</tr>
<tr>
<td>Cable (SWA, ie, Steel Wire Armoured)</td>
<td>£50</td>
</tr>
<tr>
<td>Inverter</td>
<td>£1,500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>£7,050</strong></td>
</tr>
<tr>
<td></td>
<td>(£6,000 ex VAT)</td>
</tr>
</tbody>
</table>

Representative costs for a domestic wind turbine

The above costs do not include installation. VAT should be refundable for a selfbuild. Sometimes the tower can cost as much as the turbine.

Where the mean wind speed is about 5 m/s, the table in last month’s article shows that the output of a 3m diameter turbine is likely to be about 2,100 kWh a year. On a windy site with a mean wind speed of 7 m/s the output would be about double – but as an investment the financial return would still be small.

**Factors to be considered**

- **Grid connection.**
  Some micro-turbines were developed for stand-alone battery systems and are unsuitable for connecting to the grid.
  (Connecting a Windsave, as from B&Q, couldn’t be easier – you just plug it into a spurred socket.)

- **Cut-in windspeed.**
  The cut-in windspeed is the lowest wind speed at which the turbine produces...
significant output – typically about 3 m/s. However, don’t attach too much weight to this factor, as the power available from winds of low speed is very small.

- **Gearbox.**
  Many micro-turbines don’t have a gearbox, and so tend to be quieter.

- **Magnets.**
  Permanent magnets are usually used in the alternators of micro-turbines. Neodymium magnets are smaller and lighter than ferrite ones.

- **Weight.**
  A heavy turbine is more difficult to mount high in the air than a light one. On the other hand, heaviness might possibly indicate sturdier build quality.

- **Voltage.**
  If there is a large distance between the turbine and the house, a higher voltage is preferable so that the power losses in the underground cable are minimised. Anyway, most inverters for grid connections require higher voltages (eg, more than 100V).

- **Tower.**
  A tower (or mast) 10 to 20 metres is recommended by the experts, but this height is not always feasible. Some towers are tied in place with three or four guys. Some stand alone but these need strong foundations. There needs to be space in the garden for the tower to lie on the ground.

- **Earthing.**
  The tower needs to be earthed by copper strips and rods in the ground. (A new house will almost certainly have PME – Protective Multiple Earth – and a mast/tower away from the house should not be connected to the house earth.)

- **Cable from the turbine.**
  A turbine swivels to follow the direction of the wind, and so the cable from the turbine tends to twist. One way to avoid this is by the use of a slip ring connector near the top of the cable. Another method is simply to allow the cable to twist, leaving it free between the turbine and the ground. It is remarkable that, at any particular spot, over a long period, the overall sum of all the veering and backing of the wind is nil. (‘Veering’ is when the wind direction changes sunwise, eg, SW to W, and ‘backing’ is the opposite, eg, SW to S.) However, over a few weeks there may be some net movement one way or the other, and the householder should occasionally check the amount of twist in the cable – and, if necessary, at ground level unplug and untwist the cable.

**Maintenance**

One of the virtues of PV systems is that they don’t need maintenance – it’s a case of fit and forget. In contrast, turbines are machines with moving parts that are sometimes subject to extreme stresses. So most turbines need some periodic
maintenance, usually annually, though tri-annually for some. As the turbine is high in the air, maintenance is not so easy. It may involve putting up scaffolding, getting in a cherry picker, or lowering the mast to the ground.

There’s a limited life expectancy for a turbine, too, eg, twenty years. Turbulence puts a wind turbine under stress, so a turbine which is sited where there is a lot of turbulence can be expected to have a shorter life.

**Safety**

Various methods are used to prevent the blades rotating excessively fast in storms:

- **Furling**
  Normally the tail and the generator are in line, but it can be arranged so that in strong winds the angle between them is changed (‘furling’). Since the tail remains in line with the wind, the turbine will ‘yaw’ away from the wind.

- **Feathering**
  The pitch (angle) of the blades is changed so they catch less wind.

- **Stalling**
  The turbine is braked.

If a commercial turbine were to break up in a storm, sheep might be in danger. For a turbine in your own back garden, a lot more would be at risk. You need a turbine and mast/tower that will be robust enough to withstand the most severe storms. As it says in ‘Choosing Windpower’,

‘Parts can and do fall off small wind turbines’.

There is also a need to prevent the turbine going excessively fast should there be no electrical load, eg, if the system closes down because of a power failure in the grid. ‘Dumping’ the unwanted electrical energy by heating air is one method.

**DIY wind power**

Since the Seventies, eco enthusiasts have played a large part in the development of micro-wind power, and many of the enthusiasts have had a DIY approach. This keeps the costs down and makes the technology more financially viable. Another book by Hugh Piggott, ‘Windpower Workshop’, is intended for DIYers. (See Further Info.) The author even explains how to carve blades out of wood – a good material as wood is less likely than metals to break as a result of fatigue.

A halfway house could be to import a turbine kit from the USA – less than £1,000 for a 10’ (3m) turbine (plus £300 for shipping). (See Further Info.)

**Conclusions**

Large wind turbines, like PV’s, are a fairly mature technology. Not so micro-turbines, for which there are, at present, more questions than answers. It’s a small industry, and micro-turbines are produced by micro-companies. (In contrast, the PV industry is dominated by global giants like Sharp, Sanyo, and BP.)
In five years time, say, it will be much clearer how much of a role there is to be for micro-wind power in individual selfbuilds. (There must be a bright future for medium sized turbines serving new housing estates.)

Over the last three decades, successive governments have been half-hearted about supporting the development of new technologies to utilise Britain’s wealth of renewable resources. It’s time for the government to go beyond the rhetoric and to invest in new technologies which can reap the harvest. Micro-wind is one technology where it is not too late for the UK to be a world leader.

FURTHER INFO:

Choosing Windpower
By Hugh Piggott. Published by CAT (£8).
A practical introduction to the subject, with details of many turbines.

Windpower Workshop
by Hugh Piggott. Published by CAT (£12).
Mainly for the DIYer, but useful technical background for anyone serious about windpower.

Homepower
American magazine dealing with domestic wind power, solar, hydro, biofuels, etc.
Annual subscription: online $25, printed $35.

Assessment of household wind turbines
Report by the Energy Saving Trust which is to be published in the autumn.
The assessment will be based on results measured over a year for 100 household wind turbines, and will include:
- Amount of electricity generated.
- Factors affecting output, including wind speed, turbulence, etc.
- Comparison of actual wind speeds with published wind data.
- Relationship between design output of a turbine and the local wind conditions.
- Amount of electricity exported.
- Financial performance.

Scoraig Wind
This is the website of Hugh Piggott, the author of the books above. He installs wind turbines and runs DIY courses. Lots of links.

Renewable Energy UK
Informative website about renewable energy from wind, sun, etc.
www.reuk.co.uk.

The Back Shed
An Australian website with a DIY approach.

Danish Wind Industry Association
Lots of technical info, but more relevant to large turbines.

www.windpower.org.

Turbines:

Ampair

Proven
A popular, innovative and safe design.
www.provenenergy.co.uk.

Swift
The distinctive ring around the blades cuts down noise.

Windsave
Plug in and save (on a small scale). Maintenance free. Can be supplied and fitted by B&Q (£1,900).

Otherpower
American turbine kits, 10' (3m) diameter – less than £1,000 (plus £300 shipping).

Inverters:

SMA
German manufacturers of Windy Boy inverters (and Sunny Boy inverters for PV).
www.sma.de (Select English language version.)

Suppliers and installers:

Wind & Sun
Handheld anemometer for measuring windspeed.
And much else.
www.windandsun.co.uk.

Most turbine manufacturers publish lists of suppliers and installers.

Words: 2142.