FACTSHEET 4: Introduction to Small-Scale Wind Power

Introduction

Wind power has been used for thousands of years to mill grain and pump water. Now modern wind power uses the energy in the wind to turn turbines, which convert this energy to electricity. Wind has the potential to produce substantial amounts of green electricity, and small-scale wind power has a genuine role in achieving this.

Wind is a free fuel, it will not run out, and the cost of producing electricity from it can be highly competitive. At the moment wind power is the most advanced and economic of all forms of renewable energy, yet it does come with visual impacts, and alleged noise and health problems, which need consideration. A good small-scale wind scheme will have zero annual fuel costs, low running costs, a long lifetime, high reliability and availability, be completely automated and have a very low environmental impact.

FIGURE 1: SINGLE SMALL TURBINE

As the wind blows it will turn the blades of a wind turbine, rotating a shaft inside the generator, which produces electricity. The amount of power generated depends upon the size of the blades, the wind speed and the wind availability (how often the wind blows). Large turbines and the generator will be mounted upon a rigid steel tower set in concrete foundations. Small-scale turbines are generally mechanically quite simple, reliable, and require little maintenance. They align themselves to the wind using either a tail-vane or a simple downwind alignment, and they also have simple mechanical means of dealing with high wind speeds that could damage the turbine.

1. The site

The U.K. has the best wind resource in Europe, and any exposed windy site has the potential for economical wind power. The power available from the wind is proportional to the size of the swept area of the blades and the cube of the average wind speed. (Doubling the wind speed gives eight times the power). The wind speed is adversely affected by a friction effect close to the ground so the higher a turbine can be sited above ground level the better. The greater the available wind resource in terms of average wind speed and wind availability, the more electricity the site will be able to produce – the economics of a site will be heavily influenced by the Annual Mean Wind Speed (AMWS).

Because the power available increases by the cube of the wind speed, a small difference in AMWS can mean a significant difference in power output. Turbines at a site with an AMWS of 8m/s (metres per second),could produce up to 80% more electricity than the same turbines at a site where the AMWS is 6m/s.

For small turbines, at lower heights, factors such as buildings and trees can affect the wind speeds, and considering these factors and choosing a site with unhindered wind will help to maximise the power output. The most dependable method of assessing the wind potential of a site is to measure it over a twelve month period using an anemometer raised on a mast at the same hub height as the proposed turbine. For smaller turbines the cost of data logging can be disproportionate for the potential energy capture.

For a small-scale installation Meteorological Office data or even local knowledge of a ‘windy’ spot, may be enough to warrant more detailed investigation – look for good elevation, exposure to the elements, and other signs of wind (such as trees growing off in one direction). Small scale turbines will have a cut-in wind speed of 2.5-4m/s, and an optimum wind speed of 10-12m/s. Turbines will have a power rating which denotes their maximum output. However due to varying wind speeds, as a rough guide a good site will produce an average output of 30% of the rated capacity of the turbine.

2. Grid connection

Wind power can be particularly suitable for sites that are not grid connected, and where such connection would be expensive. Here the power is used to charge a bank of batteries to store the electricity. A back up generator might also be necessary, to provide emergency cover for times when the batteries are exhausted.

The power supplied by the batteries will be direct current (DC), so an inverter will often be needed in order to convert the battery power to useful mains 240 volt alternating current (AC). A controller is also

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required in order to ensure that the batteries are not over or under charged, and ideally when the batteries are full to divert electricity to other useful sources such as space or water heaters.

Sites that are connected to the grid can also be viable. Here the power will be fed through an inverter back into the grid, where a two way meter can measure power exported to the grid, and power imported from the grid. If the wind turbine produces more electricity than a site uses, then selling some electricity back into the grid will further help the economics of a site.


FIGURE 2: A SINGLE LARGER TURBINE

3. Environmental issues

Wind power can provide a source of 'clean' renewable energy with minimal adverse environmental effects. Because of their size and need to be located in an exposed position, wind turbines can have a visual impact in the landscape – but this is not an "environmental" impact – simply an impact on the mind of the beholder. Generally nature goes about its business un-effected by wind turbines.
Noise used to be an issue with previous generations of turbines. Direct drive turbines have no gearboxes so completely eliminating that noise source, and the blade tip noise has been dramatically reduced by using a blade profile that rotates more slowly.

Bird fatalities have all but been eliminated by not locating turbines close to bird migration routes.
Planners may suggest placing a turbine in an inconspicuous situation, but a poor site could make an installation uneconomic. Wind availability should always remain the key consideration in siting.

Similarly, the possibility of health problems from low frequency noise and shadow flicker are barely applicable. Small-scale wind turbines can be placed close to, or even on inhabited dwellings without problem.

Sites can be re-instated at the end of a turbine's useful life with little or no discernable impact. Also the energy used in the manufacture of wind turbines is only about 6 months worth of the electricity they produce in their lifetime.

4. Cost

The wind power industry has invested heavily in research and development and the cost of wind power is now cheaper than conventional power.
Typically, for each MW of installed capacity, large-scale turbines cost about £600,000 and will generate about 2,000 MWh of energy per annum. At current electricity prices (£70/MWh) the value of energy produced from each MW would be about £140,000 per year. After maintenance, insurance, business rates and loan repayments are met, and over a 25 year life, large scale wind turbines more than pay the investment.
Generally small-scale turbines don't enjoy quite the same economies of scale because smaller turbines cost more per unit energy output to manufacture. Notwithstanding small scale wind can be economic over the medium to long term. In an off grid location small scale wind can be economic compared to the cost of a grid connection.
The installation cost of domestic scale turbines is likely to be competitive given the number of market players. But pay back times will be site specific dependant upon the local wind speed. A 1-1.5 kW turbine is likely to cost in the region £2k - £5k. A 6-8 kW turbine will be somewhere in the region of £15,000-25,000 A well sited 6kW system will produce a significant amount of power displacing the amount of conventionally produced electricity, and this will result in savings that offset the initial costs and pay back the investment.

If electricity is being sold back to the grid this will also help offset costs, with electricity produced by renewable sources attracting competitive rates due to the governments Renewable Obligation Certificates that guarantee the price of renewably generated electricity.

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