fundamental series 10

The Continuing Professional Development Programme, produced in association with energy INSTITUTE

Current thinking on...

Small-Scale Wind Power

This *EiBI* CPD module is sponsored by: EDF ENERGY

Nicholas Newman, editor, Oxford Prospect Magazine

Since 2005, some 17,000 small wind systems have been installed in the UK According to the British Wind Energy Association, a mixture of factors has contributed to this upsurge including reductions in the cost of renewable generating technology, rising energy costs and up until now, generous government subsidies. The current government, like its predecessor, favours renewables out of concern for the environment, energy security and rising costs of energy, as power generated from domestically energy sources makes Britain's economy and consumers less susceptible to international price fluctuations.

The BWEA defines wind turbines on the basis of capacity i.e. small turbines have a generating capacity of up to 50kW; medium sized ones can produce between 50kW and 500kW, while large units have a 500kW plus potential output. The Oxford English Dictionary defines renewables as a source of energy, which is not depleted by use, such as water, wind, or solar power.

Prime site for turbines

Britain is a prime site for wind turbines; its territories both on and off-shore contain around 40 per cent of the EU's natural wind resources. However, only 5 per cent of the UK's electricity comes from renewables while Germany and Denmark produce, proportionally, more of their power from renewables. As of January 2012, Britain's total installed wind capacity was put at 5,954MW by Eurostat, making the UK the eighth largest global producer of wind power. Moreover, it is forecast that by 2020, Britain could have a wind generating capacity of at least



28,000 MW. RenewableUK, a wind industry lobby group puts small wind power system's energy contribution at 42.97MW for the beginning of 2012 and forecasts that by 2020, small wind units should be delivering as much as 1,300MW.

However, there is a divergence between capacity and actual output. RenewableUK estimates that over the course of a year, a turbine (any size) will only generate about 30 per cent of its theoretical maximum output, while the John Muir Trust (JMT), one of Scotland's leading conservation bodies, claims actual output from the sites it investigated stands at only 22 per cent of capacity.

The government is encouraging the promotion of wind farms as part of its ambition to cut carbon emissions by 60 per cent by 2050 as well as to satisfy binding EU targets that 15 per cent of the nation's energy mix should come from renewable sources by 2020. However, the EU-wide target for 2020 is a 20 per cent cut in CO2 emissions and a target of 20 per cent of energy to derive from renewables. A typical household's domestic small wind system could have a capacity ranging between 2kW and 6kW, while a small business might use a 50 KW unit. 1kW is sufficient to power an electric heater rated at 1kW for one hour.

Two basic designs

Wind turbines have two basic designs distinguished by axis orientation. One is the vertical axis and the other is the horizontal axis design. The choice of axis orientation will depend on cost, location and specific wind conditions of the location. The chief advantage of the vertical axis design is that both the gearbox and generator are at ground level, making servicing and repair easier and less costly and these can function at slower wind speeds than the horizontal axis design.

Turbines come in two basic forms: a stand-alone turbine which is ideal for remote locations distant from the grid such as islands, canal boats and caravans as well as farms where a single turbine can be used to provide power for electric fences, pumps and security systems. Increasingly, such units are also being employed as back-up for diesel generators on remote farms to reduce the cost of generating electricity and to charge batteries. For example, a 100W turbine unit is commonly used to charge 12V or 24V batteries.

Then there is the grid-connected turbine, which is increasing in popularity among both domestic

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and business consumers seeking to reduce power costs and to take advantage of earnings generated by selling surplus power to the grid. However, owners of small wind turbines will need to install a special inverter and controller to convert DC power to AC electricity, a requisite piece of equipment to import and export power to the grid.

There are two types of domestically sized wind turbine. The first is an independent, stand-alone, pole-mounted turbine. The second type is attached to a building. Pole-mounted wind turbines are free standing and are erected in a suitably exposed position, often with a generating capacity of around 5kW to 6kW. Those sited on buildings tend to be smaller than mast-mounted systems and can be installed on the roof of a home where there is a suitable wind resource. Often these are around 1kW to 2kW in generating size.

All power needs of home

It has been claimed that the latest generation of roof attached wind turbine will meet all the power needs of a typical UK semi. However, siting a wind turbine on top of any building can prove problematic with turbulence caused by the building itself reducing the turbines operating efficiency.

The cost of producing wind power is often said to be 'free'. It, like the proverbial free lunch, is neither free nor costless! Potential investors and users of wind turbines need to be aware of the installation and maintenance costs. For instance a 1kW roof-mounted micro turbine can cost around £2,000 to purchase and another £100 to £200 per annum to maintain. A 2.5kW pole-mounted system costs around £15,000 to purchase and install. Furthermore, the inverter may need replacing during its likely 20-year lifespan, which can range in cost for larger systems at around £1,000 to £2,000 at today's prices. However, despite these costs there are some benefits for high electricity consumers. Producing your own power can cut your power bills significantly, in addition, domestic and larger wind turbine systems can qualify for Feed in Tariffs (FiT). The FiT



is a government subsidy paid to renewable electricity generators with a capacity below 5MW. It offers a payment per kWh produced each year. This payment varies depending on the technology and size of generation. It replaces the Renewables Obligation Certificate scheme for eligible generators under 50kW. Generators between 50kW and 5MW will have the option of choosing either the FiT or the existing ROC arrangement. The Energy Saving Trust suggests that a well-located 6kW wind turbine can produce up to 10,000kWh per year, which can earn its owner up to £3,200 in combined savings and income.

Finding the right location can be a problem, even in windy Britain. If you want a small wind turbine but your site doesn't receive an average annual wind speed of at least 5 m/s then it would be wise to think again. You may think you live somewhere windy, but first check out the UK wind speed database available at http://www.decc.gov.uk/ for a general indication of local wind conditions. In addition, before investing any money - purchase an anemometer - a device for measuring wind speed used by most weather stations to check out actual wind conditions at your proposed site for at least three months, so that you can work out the average wind speed conditions on your chosen site.

The next is issue is the height of the turbine. As a rule of thumb, the higher above ground, the stronger the wind, the greater the energy produced and hence the attraction of tall buildings and tall masts. This effect is quite marked: for as the speed of the wind doubles, the quantity of 'potential' power contained in the wind cubes. In other words, when the wind speed doubles, the power generated rises eight-fold (this also means if the wind speed halves, the power declines by a factor of eight). Therefore the best site for a turbine is on top of hills such as the Cotswolds or Chilterns.

Unfortunately for investors, purchasers and users, siting a wind turbine close to buildings and trees is not recommended owing to the intrinsic turbulence generated by such structures which interferes with power generation. Some experts are now favouring vertical axis turbines (the ones that look like egg whisks) for these locations rather than the more traditional horizontal axis turbine. This view might be correct, but it is still unlikely to turn a non-viable site into a viable location. As a rule of thumb, it is best to site a turbine at a distance at least ten times the height of the nearest obstacle, such as a house or cliff. In addition, a higher mast can also assist in overcoming this problem but keep in mind that a turbine hub should be positioned at a height of at least twice as high as the nearest obstruction.

The larger the better

Deciding on the size of your turbine is a major consideration: ideally the larger the better. This is because the power of a unit increases with the square of the rotor diameter. Keep in mind that the longer the turbine blades, the greater the diameter of the rotor and therefore the more wind that can be "captured."

Getting connected to the grid is not as simple as turning a switch! You have to gain technical approval from your local utility. Connecting your wind turbine to the grid can be a costly exercise. Your local power company will insist that all the

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electrical protection equipment and metering technology for monitoring the importing and exporting of power meets the highest technical and health and safety standards. In some locations, the size of wind turbine will be restricted by your local utility due to concerns over protection of the local power distribution network.

Currently, because of a lack of centralised energy leadership, the planning regulations that apply to wind turbine development vary from region to region. For instance, you will need planning permission from your local planning authority to install a wind turbine in Wales or Northern Ireland, while elsewhere in the country Permitted Development Rights may apply. However, it is advisable to run over your plans with your local planning authority before you go ahead because the planning rules are complex.

As for England, the Town and Country Planning, England 2011 Act states that wind turbines mounted on domestic buildings fall into a category of Permitted Development provided they meet certain criteria including that the house be detached and that the top of the turbine blade is no more than three metres above the top of the house, or 15m above the ground, and moreover that the turbine is sited at least 5m from the edge of the property.

In the case of pole-mounted turbines, the criteria require that the top of the turbine is no more than 11.1m above ground and that the turbine must not be sited at least 1.1 times the height of the turbine away from the edge of the householder's property. So getting approval to install such a turbine in a very small urban area is unlikely.

In addition, for both types of turbine, installation will be permitted only if there is no other wind turbine and no air source heat pump on the site. Also that the bottom of the blade is at least five metres above ground and the turbine's swept area is no more than 3.8m2. Finally, additional restrictions apply to siting if the turbine is in a conservation area, World Heritage Site or similar. For more details see http://www.legislation.gov.uk/uksi/2011/2056/made

Rules in Scotland

In Scotland, the rules governing turbines are set out in the Town and Country Planning (General Permitted Development) (Domestic Micro-generation) (Scotland) Amendment Order 2010 and are slightly different to England. A building-mounted wind turbine requires planning permission, but other domestic-scale machines are considered permitted development "unless it would result in the presence within the curtilage (usually the property boundaries) of a dwelling of more than one free-standing wind turbine". In addition, a wind turbine that is situated less than 100m from the curtilage of another dwelling requires permission. Furthermore, before beginning the development the developer must apply to the planning authority for authorisation in "respect of the design and extent of the proposed wind turbine; and a determination as to whether the prior approval of the authority will be required in respect of the siting and external appearance of the proposed wind turbine". For more information see Town and Country Planning (General Permitted Development) (Domestic Micro-generation) (Scotland) Amendment Order 2010 at http://www.legislation.gov.uk/

There are a number of grant schemes which offer funding to small scale renewables, mainly for the domestic and community sector as detailed below.

The Low Carbon Buildings Programme is managed by the Energy Saving Trust, which offers grants for domestic, community and larger micro-generation installations in England, Wales and Northern Ireland. Under the LCBP there are two streams of funding available.

Stream 1 offers grants for householders and small to medium enterprises to install micro-generation on small buildings, as well as for non-profit community organisations such as registered charities, community groups, local authorities and schools to install micro-generation on community buildings.

The level of grants offered for wind energy under Stream 1 is a maximum of £1,000 per kW installed, up to a maximum of £2,500 subject to an overall 30 per cent limit of the installed cost (exclusive of VAT) for individual householders and small businesses.

Stream 2 offers grants for large projects from non-profit community organisations plus businesses, building developers, energy services companies, and the public sector to install microgeneration on large-scale building projects.

For more information on the LCBP and how to apply for a grant, visit www.lowcarbonbuildings.org or call the free phone helpline on 0800 915 7722.

Grants are available for those living in Scotland through the Scottish Community and Household Renewables Initiative. http://www.communityenergyscotland.org.uk/finance.



Key points to consider when installing a wind turbine

- Make sure you have the right site. For a wind turbine to work you need an exposed windy site not too close to buildings.
- Double and triple check the location, don't rush into things or you could just be erecting an expensive weather vane. This means check the national wind data base and use an anemometer for at least three months.
- Check with your installer that you can connect your system to your property and the grid.
- Tell your neighbours and your local planning authority about your proposals early on. You need to check if you need to apply for planning permission, this is especially the case in a conservation area, Area of Outstand Natural Beauty or National Park. Work with your installer to get your application right.
- Check that your installer and equipment participate in the government's Micro-generation Certificate (MCS) approval. To be eligible for FiTs, grants and future renewable heat incentives, it is a mandatory requirement that your installation is carried using MCS installers and products. MCS applies to turbines and installers in the 0-50 KW range. http://www.microgenerationcertification.org/
- Go ahead if you can find a good location, though the return on investment could take many years.

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Small-Scale Wind Power

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How to obtain CPD accreditation



Energy in Buildings and Industry and the Energy Institute are delighted to have teamed up to bring you this Continuing Professional Development initiative.

This is the first module in the tenth series and focuses on small-scale wind power. It is accompanied by a set of multiple-choice questions. To qualify for a CPD certificate readers must submit at least eight of the ten sets of questions from this series of modules to ***Energy in Buildings and Industry*** for the Energy Institute to mark. Anyone achieving at least eight out of ten correct answers on eight separate articles qualifies for an Energy Institute CPD certificate. This can be obtained, on successful completion of the course and notification by the Energy Institute, for a fee of £15 (for members) or £25 (for non-members).

The articles, written by a qualified member of the Energy Institute, will appeal to those new to energy management and those with more experience of the subject.

The forthcoming modules in the tenth series will focus on: water management, fuel cells, solar thermal, refurbishment, smart meters, LEDs, combined heat and power, training for energy management, and compressed air.

The previous 90 modules from the first nine series are also available free of charge on CD. Send your request to mark.thrower@btinternet.com

MARK THROWER, MANAGING EDITOR

PLEASE COMPLETE YOUR DETAILS BELOW IN BLOCK CAPITALS

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Completed answers should be mailed to:

The Education Department, Energy in Buildings & Industry, P. O. Box 825, GUILDFORD, GU4 8WQ

SERIES 10 MODULE 1: QUESTIONS

Small-Scale Wind Power

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

1. In which EU member state holds 40 per cent of the EU's natural wind resources?
- ☐ France
- ☐ Denmark
- ☐ United Kingdom
- ☐ Spain

2. What is the UK's wind generating capacity expected to be by 2020
- ☐ 28,000MW
- ☐ 26,000MW
- ☐ 5,954MW
- ☐ 12,367MW

3. What is the power range of a typical domestic small wind system?
- ☐ 2 and 6kW
- ☐ 0 to 50kW
- ☐ 0.5 to1.5kW
- ☐ 1.5 to 2kW

4. What was the actual output of the wind turbine sites investigated by the John Muir Trust research?
- ☐ 22 per cent of capacity.
- ☐ 30 per cent of capacity.
- ☐ 40 per cent of capacity.
- ☐ 75 per cent of capacity.

5. How much can a 1KW roof mounted micro turbine cost to purchase?

☐ £1,000 ☐ £1,500 ☐ £2,000 ☐ £2,500

6. What is the minimum average wind speed required to make a site viable?
- ☐ at least 5 m/s
- ☐ at least 10 m/s
- ☐ at least 7 m/s
- ☐ at least 3 m/s

7. What makes a good location for wind turbines
- ☐ Among trees in a forest
- ☐ At the edge of a cliff
- ☐ Near buildings
- ☐ On top of a hill

8. By 2050, by what percentage is the government aiming to reduce carbon emissions?

☐ 60 ☐ 70 ☐ 50 ☐ 45

9. What does FiTS stand for?
- ☐ Flexible Image Transport System
- ☐ Feed in Tariffs
- ☐ Framework for ICT Technical Support
- ☐ File Information Tool Set

10. The Energy Savings Trust suggests that a well-located 6kW wind turbine can produce 10,000kWh per year, which can earn its owner per year up to how much in combined savings and income.

☐ £3,200 ☐ £3,000 ☐ £4,000 ☐ £5,000

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