Question marks

Katerina Syngellakis has been involved in recent research examining the growing interest in small turbines for the urban environment in the UK

Information regarding urban wind turbine use in the UK has been gathered and analysed as part of the EC-funded WINEUR project (Wind Energy Integration in the Urban Environment). The aims of this project are to put some of the questions surrounding urban wind turbine use into context and provide answers and advice to prospective wind turbine owners and professionals, so that barriers facing the industry can be recognised and solutions developed.

Interest in small turbines for the urban environment in the UK is coming from many sectors, from educational and environmental establishments to commercial developments. Fuelling this interest are the newly introduced sustainable policies of a number of UK local authorities, such as Merton Borough Council's expectation of new developments to generate 10 per cent of its energy demand. At the same time, domestic electricity consumers are showing a strong interest: significant numbers of household level enquiries have been reported by small wind turbine manufacturers such as Swift and Windsave for their 1.5 kW and 1 kW building mounted turbines respectively.

To assess the current state of the UK small wind turbine industry, ques-

Demand for small turbines that can be used in an urban setting is coming from many different sectors

Eclectic Energy, based in Nottinghamshire, designs and manufactures small-scale renewable energy systems for a range of applications. The company entered the marine leisure market four years ago with its innovative DuoGen combined wind and water generation system for cruising yachts and has since developed dedicated wind generators. Rated at 400W and with a rotor diameter of 1.1metres, the D400 is suitable for a variety of low voltage, off-grid applications, including farm buildings, boats and remote telemetry and communication.

More recently the company has launched the StealthGen, a high voltage variant of the D400, suitable for grid-linked installation. Easy to mount on buildings, this turbine should typically produce 600 to 700kWh per year.

Peter Anderson, managing director for Eclectic Energy, says, "Our wind turbines have been designed to operate in close proximity to people, and quiet, non-threatening performance is of paramount importance. We achieve this by having a slow-speed alternator, allowing the rotor blades to run at about one quarter the speed of other small turbines. Yet the StealthGen/D400 is very powerful and efficient for its size."

The StealthGen is supplied in black with translucent blades in order to render the unit unobtrusive in an urban environment.

In addition to domestic applications, microwind turbines are suitable for installation, singly or in multiples, at business premises, and on public and community buildings. The power produced can be connected to the grid, via a G83 inverter. It can also be used as a direct supply for applications such as water heating or pumping. Alternatively, together with a battery storage bank, the turbine can form part of a stand-alone system where no grid power is available.

There are several grid-linked StealthGen installations around the country presently, including three units on houses at Barratt Homes' eco-village in Lancashire, a suburban semi in Nottingham, sponsored by Powergen, and the home of an environmental journalist in South London.

New developments in technology allow small wind turbines to be quiet enough to be building mounted

Renewable Devices' Swift Rooftop Wind Energy System is a silent, building-mountable wind turbine designed to produce more energy in its lifetime than was used to manufacture it.

With a 20 year predicted lifespan and low maintenance requirements, the 1.5kW turbine is capable of generating up to 2000 - 3000kWh of electricity a year and is suitable for operation in the urban environment. Its design can cope with turbulent airflow and the silent mast mounting technology used in its installation eliminates unwanted vibrations.

The turbine safety system complies with International Standard IEC 1400-2, for the safety of wind turbines and if required, it can generate electricity in line with Electricity Association Requirement G59 for power quality. The electronic controller has been designed and tested for EMI suppression and is LVD directive- and EMC directive-compliant.

tionnaires were sent out to turbine owners, manufacturers and installers, and to the relevant departments of Distribution Network Operators. Information from the (now defunct) ClearSkies government grants programme for small-scale renewables was considered and a thorough literature review carried out to find any previous analyses that had been done on the costs and benefits of small wind turbines.

There are currently at least ten UK companies manufacturing and selling more than twelve different small wind turbine models; eleven of these are horizontal axis wind turbines (HAWT), with only one being a vertical axis wind turbine (VAWT). In addition, several organisations are designing and developing small wind turbines specifically for urban applications. Of these prototypes at least three are vertical axis. In total there are more than 15 companies either manufacturing or designing more than 20 different small wind turbines, all of which could theoretically be placed in the urban environment.

More established products that can generate a substantial amount of electricity and that are available for the built environment, are the 'larger' HAWTs made by Proven (6kW and 15kW), Iskra (5kW) and Gazelle (20kW). Traditionally these products are ground-based, but Proven has started building-mounting its turbines. 'Smaller' turbines that have recently emerged onto the market, and that are specifically designed to be building-mounted, are made by Ampair, Eclectic Energy, Renewable Devices, Swift and Windsave. These devices are typically in the range of 0.6 to 1.5kW and are all HAWTs. There are also some 'micro' HAWTs technologies produced by LVM and Marlec that could be considered suitable for installation in an urban environment, although their primary market is the yacht industry.

There is currently only one VAWT manufactured in the UK, a 6 kW machine suitable for building mounting produced by the company XCO2, although others are under development for the built environment (and should be suitable for building-mounting). The prototypes currently being tested should be available in 2007/2008.

The total installation costs per kW installed for the 21 systems for which questionnaires with cost data were received show a significant variation in the cost of small systems, with both the variation and cost reducing as installed capacity increases. The average cost per installed kW for the systems analysed was 4870 /

kW. Following the results from the questionnaires, research focused on identifying the factors that influence the economic viability of small wind installations, particularly in an urban environment.

Unsurprisingly, the wind speed at an urban site has the greatest influence on its economic viability and is therefore the most important consideration when siting a turbine. Unfortunately the process of obtaining wind speed measurements prior to installation is time-consuming and expensive. Sometimes this can cost as much as a wind turbine installation itself, so measurements are rarely carried out for single turbines even though just a single metre per second difference in the predicted wind speed can make a very big difference to the economics of an installation. Therefore the extra investment required to increase the turbine's hub height and place it in a position to receive a higher average wind speed should always be considered.

It is best practice to distance a wind turbine from habitation - to reduce the risk of noise nuisance - and from tall buildings in general, as these can disrupt airflow. However, underground cabling over a greater distance can also push up costs. For example, cable laying for one school's 2 5 kW turbine through mainly rough ground for a distance of 260 metres accounted for 46 per cent of the total installation cost. Cost increases if the cable has to go under tarmac or concrete, compared to a lawn or a field.

Tall buildings and tower blocks seem to offer an opportunity to capture higher wind speeds and some installations on tower blocks are under way in the UK. Many of the issues facing the economics of today's small-scale turbines will not be so significant in the building mounted sector since the turbines should be closer to the distribution board, will not need underground cabling and will be mounted higher above ground level. However new issues will emerge, such as planning permission, structural survey costs, noise pollution, flicker from the blades, building strengthening costs and possible electromagnetic interference with nearby electrical equipment. There are currently too few building mounted installations in the UK to be able to draw definitive conclusions about costs or success of the installations, but the sector is growing and more data will become available over time.

Results from the questionnaires sent to turbine owners revealed that 30 per cent of current small wind installations are located in villages

30 per cent of small wind installations are located in villages or country parks, with the remainder evenly distributed in more urban areas

The wind turbine installed at Nidderdale High School, near Harrogate, North Yorkshire, was manufactured and installed by Gazelle Wind Turbines with the help of just over £13,000 from Clear Skies, the DTI's renewable energy grant scheme. It was the first of 22 first round community projects supported by Clear Skies to be installed and was constructed to show how wind-generated electricity can be produced 'on site' to meet the needs of similar buildings.

The turbine is expected to have a lifespan of more than 20 years and with an annual mean wind speed of 6.5 metres per second at hub height, is designed to produce over 50,000kWh per year. This is about equal to the electricity used each year by a small primary school.

The three-bladed, 20kW Gazelle is big enough to power the equivalent of five to ten houses. Originally designed by North Energy, the turbine has 5.3 metre-long blades and the current model is suitable for grid-connected sites with a three-phase supply.

As part of its service to clients, the company provides montages of how projects will look upon completion

Construction company Chalcroft is to install a new 15metre-high wind turbine at its head offices. Chalcroft's own staff has the skills and experience needed to complete the necessary groundworks, erect the WT6000 wind turbine and install the generator and inverter, allowing excess electricity to be exported to the National Grid.

The three-bladed 6KW turbine to be used is constructed from wood/epoxy, has a rated RPM of 200, a mechanical brake and a noise measurement at 5metres per second of 45dBA.

Chalcroft's Renewables Division, working in partnership with Scotland-based Proven Energy, offers a complete turn-key service in the installation of small to medium-sized wind turbines.

Based in Kings Lynn, Chalcroft Construction has been establishing a growing reputation within the construction industry for over a quarter of a century and has an annual turnover of more than £40million. As principal contractors, using in-house management, Chalcroft has established considerable experience in a wide range of developments.

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or country parks, with the remainder evenly distributed in commercial, industrial, residential, suburban and inner-city locations. Most are located near open spaces, with only 16 per cent in denser areas near tall buildings. Reasons why organisations installed turbines were 46 per cent for educational purposes, 26 per cent for environmental, 20 per cent to improve the organisations' image and just four per cent deciding to install for financial reasons. Owners were generally happy they were helping the environment, but 37 per cent did not know the annual electricity production from their systems. This was usually due to the installation being very new or monitoring equipment either not installed or not operational.

Those owners aware of the electricity production of their turbines tended to be disappointed with their energy yield. This seems to be because installers estimate the potential energy capture based on the annual mean wind speed for the area found in the Noabl database (the result of a mass wind flow model across the UK with corrections made for land/sea interfaces). The model does not take into account roughness changes such as in urban areas though, and it is likely that predictions of wind speed in areas of complex terrain are inaccurate.

Many owners also commented that their installer's after market service was poor and response to problems slow. Therefore it was often the case that a simple fault would lead to a substantial down time. Despite the issues faced by the small wind sector, 90 per cent of owners say they are happy with their wind turbines and would install again. There is a general customer understanding that the small wind industry is relatively new and there is a learning process that needs completing. However, this understanding cannot be relied upon indefinitely and addressing availability and performance issues should be a priority in the sector in order to retain its customer base.

The UK urban wind industry has much potential and its biggest asset is currently the overwhelming interest from both public and private sector actors and their positive attitude towards the technology. However, it is important at this stage that the industry is realistic about its capabilities. It is evident that wind turbines in urban surroundings receive lower wind speeds and have lower capacity factors, reducing energy production and economic feasibility significantly. However, the systems' reliability can be expected to improve as the technologies mature.

It may be true that small wind turbines are not economic today and cannot be justified as a financial investment, but it is also true that economic factors are not the primary reason for individuals and organisations choosing to install wind turbines. So although improving the economics of installations is necessary and feasible, in the meantime the industry can rely on other incentives such as improving environmental and educational awareness to stimulate the market. □

Site	Hub Height (m)	Calculated Wind Speed (m/s)	Noabl Wind Speed (m/s)
Sports-centre, Scotland	9	2.7	4.3
Primary School, Bucks	9	3.8	6 3
Eco-Centre, Teesside	30	5.2	6.1

The table shows the calculated and predicted wind speeds for 3 sites in the UK. As can be seen the predicted wind speeds from the Noabl database are over-estimated