# SMALL WIND POWER

## Introduction to Urban Small Scale Wind in the UK

**The UK has set a target to source 10% of its electricity from renewables by 2010 and 15% by 2015 with an aspiration to reach 20% by 2020. The Government believes that micro-generation (i.e. under 50kW for electricity), which includes small-scale wind, can make an important contribution to this target[1]. Katerina Syngellakis, IT Power, Steve Carroll, Loughborough University and Peter Robinson, Reading University report.**

In addition to contributing to the national target for renewable energy, there are a number of other benefits that small-scale urban wind can offer, such as:

- $CO_2$ emissions reductions;
- electricity generation at point of use thus eliminating transmission losses;
- strengthening of the grid reducing the need for upgrades; and
- visibility in the highly populated urban environment leading to raised awareness of sustainability and renewable technologies.

Some local authorities, such as Merton and Croydon, have already established Development Plans that require a percentage of energy for all major developments[2] to be sourced from onsite renewables. Guidance laid out in the national Planning Policy Statement PPS22 and the support for renewables by the Greater London Authority is encouraging other local authorities to follow suit[3]. Small wind generators can be used to meet these local targets opening up a new market for these technologies in towns and cities across the UK. Educational and environmental reasons are currently the main drivers for installations[4]. Around the country there are already approximately 100 small-scale wind installations in urban areas and with the potential market slowly starting to open up, there is interest being shown in designing, manufacturing and installing small wind turbines for the urban environment.

| Turbine type | Company | Years manufacturing, in 2005 |
|---|---|---|
| Micro HAWTs (<1.25m diameter) not aimed at the urban market | Marlec | over 25 |
| | LVM | over 25 |
| | Ampair | over 25 |
| Small HAWTs (>1.25m and <2m) not aimed at the urban market | Marlec | over 25 |
| Micro HAWTs (<1.25m) that are aimed at the urban market | Eclectic Energy | This year |
| Small HAWTs (>1.25 and <2m) that are aimed at the urban market | Windsave | This year |
| | Renewable Devices | This year |
| Larger HAWTs (>2m diameter) aimed at both urban and rural markets | Iskra | 1 |
| | Proven | 14 |
| | Gazelle | 7 |

*Table 1: Summary of manufacturers*

## Manufacturers

Currently in the UK there are nine companies manufacturing 17 small wind turbines (all horizontal axis wind turbines or HAWTs). There are also eleven organisations designing and developing 11 prototype small wind turbines. Of these 4 are HAWTs, while 7 are vertical axis wind turbines (VAWTs). Although any of these 28 small wind turbines could be placed in urban surroundings, 18 of the turbines are specifically aimed at the urban environment as manufacturers are recognising the potential of this new market and designing new products that are adapted to perform well in the wind regimes of densely built up areas.

The larger HAWTs (with a rotor diameter greater than 2m) made by Proven Energy, Iskra Wind Turbines and Gazelle Wind Turbines are established products suitable for the built environment - and which should generate substantial amounts of electricity. These products are almost always ground-based, although Proven has recently ventured into building-mounting their turbines with installations in the UK and Japan. Other established products that could be used in the urban environment are micro HAWTs (with a rotor diameter less than 1.25m), which, although generating much smaller amounts of electricity, can be used for educational purposes and awareness raising. Recently, three turbines have been launched onto the market which are specifically intended for the urban environment and can be building-mounted on domestic properties

(and other buildings). These are micro and small HAWTs (in the range of 400 W to 1.5 kW) made by Eclectic Energy, Windsave, and Renewable Devices Swift Turbines.

There are no VAWTs currently on the market in the UK, but many VAWT prototypes are currently being tested and should be available in 2006/2007. These are generally designed to be building mounted and suitable for the urban environment. Table 1 summarises the different companies, the kinds of turbines they manufacture and for how long they have been manufacturing them. Tables 2 and 3 summarise the turbines currently being manufactured or designed specifically for the urban environment. Table 3 is not exhaustive as new ideas are being developed constantly and sometimes limited information is available on new developments due to commercial sensitivity. The tables also show whether each turbine is suitable for building mounting or not.

Up until now all turbines installed in the UK have been HAWTs but if the prototype VAWTs make the progression to fully available market products in the near future there could be a shift towards these kinds of turbines as they may be more suitable for the urban environment & building mounting, and are often regarded as more aesthetically pleasing. However, more practical experience is needed with VAWTs (and HAWTs) in the urban environment to verify their electricity production levels. Some electricity suppliers are showing interest in offering small wind as part of their service package. Scottish & Southern Energy (SSE) have signed a contract with Renewable Devices (Swift Turbines), while British Gas and Powergen are interested in the Windsave and Eclectic Energy D400 turbines respectively. Electricity suppliers may be seeing this as an opportunity to 'lock' customers in to long-term contracts by offering a package with a small wind turbine and special green electricity tariff. As a result, they may offer the turbines at cost price or less. More information on UK and European urban wind turbine manufacturers and technologies is available from the website of the WINEUR project (Wind Energy Integration in the Urban Environment) www.urbanwind.org

*A house making use of more than wind power. Photo: Berwickhsire Housing Association*

## Policy and planning

Planning policy statements (PPS) set out the Government's national policies for different aspects of land use planning in England. These policies need to be taken into account by regional planning bodies in preparation of regional spatial strategies and by local planning authorities in preparation of local development documents. PPS22 recognises that urban areas can be used for renewable energy developments; however, it does not include guidelines on small scale generation, except to state that small scale schemes should be encouraged. This lack of guidance has lead to an overall omission of small scale wind references in regional and local planning documents. This omission will hopefully be addressed with the release of the Micro Generation and Low Carbon Building's strategy currently being developed by the DTI, which is to replace the Clear Skies funding initiative for domestic and community renewables in April 2006.

Planning permission should always be applied for when installing a small wind turbine[5] with many local authorities recommending a pre-planning consultation. Constraints experienced by small wind turbine owners when applying for planning permission are mainly centred on the local planning departments and individuals' lack of experience with small wind installations. They often suffer from the same prejudices as their multi-megawatt big brothers. To aid in a successful planning application the visual appearance, noise emissions, power output and contribution to regional and/or local renewable energy targets should be

| Model and Manufacturer | Type of turbine | Building mounting possible | Rated Power, kW |
|---|---|---|---|
| D400 (Eclectic Energy) | HAWT | Yes | 0.4 |
| Windsave | HAWT | Yes | 1 |
| Swift (Renewable Devices) | HAWT | Yes | 1.5 |
| Proven WT600 | HAWT | Yes | 0.6 |
| Proven WT2500 | HAWT | Yes | 2.5 |
| Iskra | HAWT | No | 5 |
| Proven WT6000 | HAWT | Yes | 6 |
| Proven WT15000 | HAWT | Unknown | 15 |
| Gazelle | HAWT | Unknown | 20 |

*Table 2 - Turbines being manufactured for the urban environment*

addressed. Many small wind turbine manufactures offer planning advice and have published information which can be used in planning applications.

Due to small wind only recently being seen as an option for large scale implementation the only major funding scheme was the national Clear Skies programme (which came to an end in March 2006). The UK government has a green certificate based system to enable its RE targets to be met. A Renewable Obligation Certificate (ROC) is issued to accredited generators for every MWh of electricity produced from renewable sources. ROCs can be freely traded and have a current market value of approximately £46/MWh[6]. Small generators of electricity (<50kW) can claim ROCs on a yearly basis, unlike larger generators who claim monthly. This makes it infinitely more possible for smaller systems to achieve a generated target of 1MWh, but the administration, paperwork and technical knowledge required in gaining the status of an accredited generator is often too arduous for domestic, community groups and small organisations to justify completing. Therefore only approximately a quarter of small wind installations are currently claiming their ROCs[7].

For ROCs to be claimed where generators use some of their own electricity (which is the case of most UK Small Scale Embedded Generators or SSEGs) the generator must also have a buy and sell back contract with a supplier, this adds further complications of metering and finding an appropriate contract. Companies exist which will collect ROCs on your behalf, and tariffs such as Good Energy will give you ~ 4.5p/kWh produced and then claim the ROCs on your generation. Due to the complications of claiming ROCs the SSEG industry has not greatly benefited from this incentive. If ROCs were easier to claim for small scale generators their economics would greatly improve and this may give the micro generation market the stimulation it needs.

## Costs and economics

A questionnaire was distributed as part of the WINEUR project, the results of this questionnaire showed that only 4% of small wind turbine installations were financially driven, with most installed for educational or environmental reasons. The average cost of systems was £4200/kW[8], but this varied greatly depending on site factors. The underlying driver for an economic wind installation is of course the site mean wind speed. Smaller installations cannot warrant the financial outlay of onsite wind speed measurement prior to erection, therefore the Noabl database[9] is being used by many to predict the mean speed in urban areas. The Noabl database shows the result of a mass wind flow model across the UK with corrections made for land/sea interfaces. The model has a 1 km resolution and does not take into account roughness changes such as in urban areas and it is likely that predictions of the wind speed in areas of complex terrain are inaccurate. It was seen that by calculating wind speeds in urban areas from the actual power output of two small wind installations at a 9 m hub height that the Noabl database over predicted by approximately 2 m/s[10].

| Model & designer/developer | Type of turbine | Building mounting possible | Rated Power, kW |
|---|---|---|---|
| Rugged Renewables | VAWT | Yes | 0.4 |
| Eurowind | VAWT | Yes | 1.3 to 30 |
| FreeGEN | Unknown | Unknown | Unknown |
| Posh Power | VAWT | Unknown | ~2-2.5 |
| Smaller Swift (Renewable Devices) | HAWT | Yes | Unknown |
| XCO2 | VAWT | Yes | ~6 |
| Wind Dam | VAWT | Yes | 2 (modular design) |

*Table 3: Prototypes being designed for the urban environment*

As installers advise that small wind turbines are erected far from habitation to reduce the risk of noise nuisance and increase the distance from obstacles which can extract energy from the wind, the cost of cabling can become significant. In some cases cable laying can account for up to half of the installation cost, especially where concrete needs to be excavated at up to £90 per metre. Manufacturers of small wind turbines above about 2.5kW often recommend an annual service. This may cost £200+ and will therefore cancel out much of the revenue gained in electricity savings from such a turbine. Yearly maintenance mainly involves inspection and some re-greasing, the costly aspect of the service is paying for an installer to travel and lower the turbine to working level. Due to the comparatively less demanding wind regime of an urban area, there may be scope for reducing the maintenance intervals or even better, conducting the service yourself. In the absence of

*Two turbine configuration on a house. Photo: Berwickshire Housing Association*

suitable feed-in tariffs a good price can still be received for generated electricity providing the turbine is sized appropriately so that the need to purchase electricity from the supplier is offset, and ROCs are claimed.

Many of the issues facing the economics of today's small scale turbines will not be so significant in the building mounted sector. Building mounted turbines should be closer to the distribution board, mounted higher above ground level, and the Swift and Windsave systems also claim to be maintenance free. However, new issues which will affect the economics of the installation may start to emerge, such as structural surveys and building strengthening costs. The Swift system is currently available at £7000 plus installation costs. This figure has reduced from £8k earlier in 2005. SSE predicts the costs will reduce to £2000 within 24 months, and at that point the domestic market will be targeted. British Gas plans to supply and install the Windsave system at a cost of £1,500[11], it will pilot the scheme later this year in Scotland and the South West, and if successful, it will be rolled out across the country. Both systems must be installed by approved installers.

## Grid connection aspects

Grid connection of small wind power systems fall into two categories, those which supply up to 16 amps per phase and must comply with engineering recommendation G83/1 and those which supply over 16 amps per phase and must comply with recommendation G59/1. The relatively new G83/1 regulation has enabled many generators to connect to the distribution network through its simplified approach. It also gives the Distribution Network Operator (DNO) discretion to "use this engineering recommendation if it is considered more appropriate than G59/1". Many DNOs do indeed allow turbines such as the 6kW Proven which potentially supply in excess of 16A/ph to connect under the G83/1 regulation. The recommendation recognises that single connections will have negligible impact on the network and the installer need only supply the DNO with necessary installation information within 30 days of the commissioning of the SSEG, without the need for prior approval or consultation. For multiple installations in a close geographical area i.e. as part of a housing development, the DNO will need consulting beforehand as the effect on the network may need a more detailed assessment

Under the G59/1 regulation micro generators with an output of over 16A/ph must comply with the technical standards of generators up to 5MW in size. This type of connection is significantly more expensive and burdensome than a G83/1 connection as it requires additional work such as network analysis, potential network alterations, additional protection equipment and technical data submission, which can significantly hinder small scale installations. Creeping voltage rise on networks caused by an increasing number of individual G83/1 connections is the main concern of most DNOs. However, there would have to be an enormous increase in micro generation installations for these conditions to occur, so there is probably no real danger of this ever arising just from the small scale wind industry.

The introduction of G83/1 has largely removed the barriers for single small wind installations to connect to the grid. A simplified connection standard for SSEGs supplying more than 16 Amps per phase would help to make slightly larger installations more straightforward and reduce costs. At the moment, urban grid-connected small scale wind systems do not pose any major problems to DNOs as numbers are too small to have an effect on their networks. In the future, as micro-generation, not just small wind, expands there may need to be changes to the networks but this next step is still many years away.

## References


1. Energy White Paper 2003
2. Definition of a major development. With dwellings: >10 or total area > 0.5 hectares. Other uses: floor space >1,000m2, or site > 1 hectare.
3. The EU Energy Performance of Buildings Directive, when it comes into force, may also have some impact, but it remains to be seen how much.
4. WINEUR project, IT Power, 2005
5. PPS22 Companion text states a wind turbine development of 50MW or less installed capacity will need planning permission granted by the local planning authority
6. Average ROC auction prices from, http://www.nfpa.co.uk/ , click "ROC auction prices"
7. Statistic from WINEUR Questionnaire, IT Power, 2005
8. IBID
9. Available from the BWEA website, www.bwea.com
10. 'Installations of Small Wind Turbines in an Urban Environment' - CREST MSc Paper 2005, S Carroll, CREST Lboro University
11. http://www.windsave.com/news.htm


*A Proven 6kW turbine at a BP service station. Photo: Proven Energy*