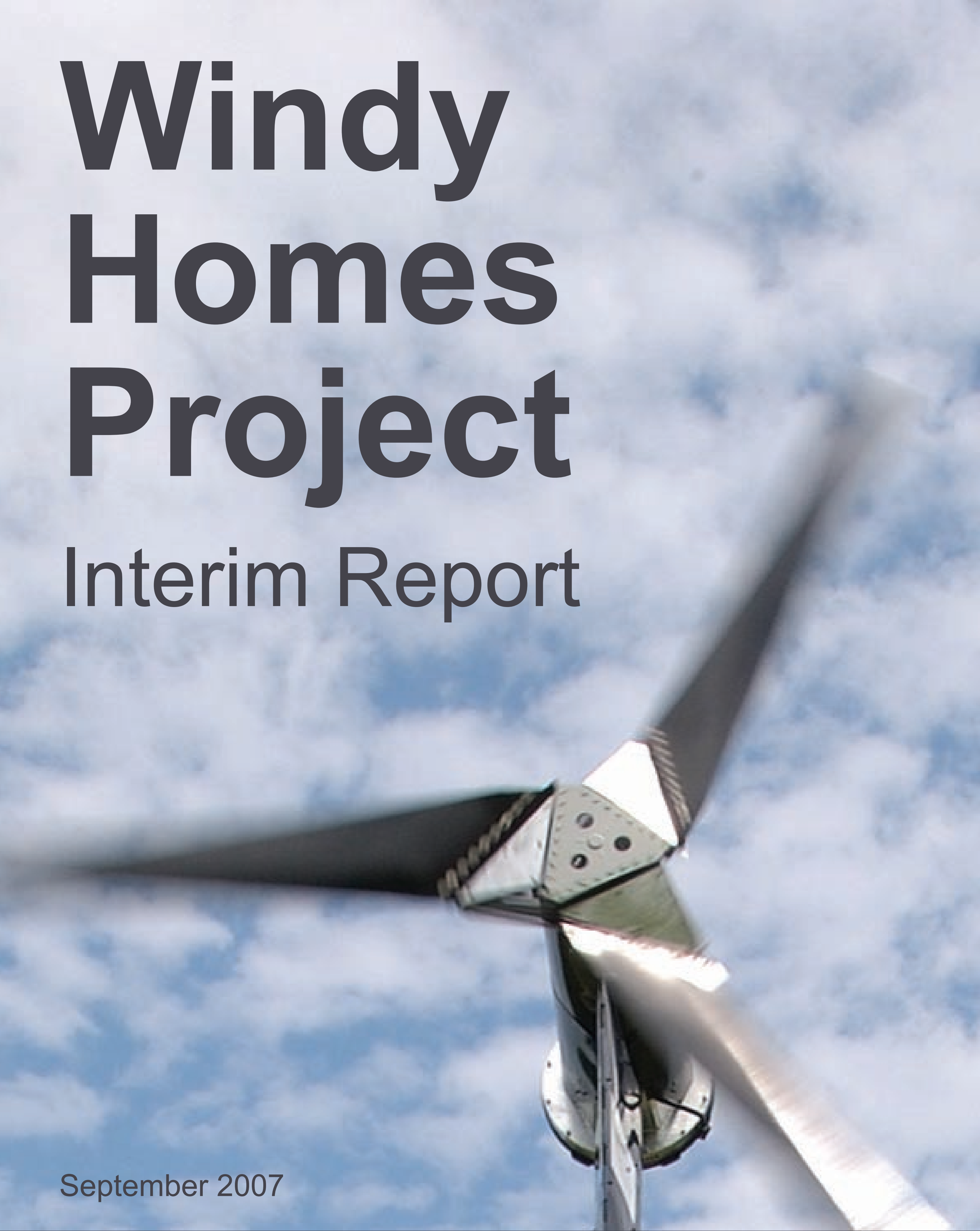
Windy Homes Project

Interim Report



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The 'Windyhomes' Project Interim Report

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Executive Summary

In the search for technologies that will increase options to generate electricity, the idea of ‘microgeneration’ – or the generation of electricity on the site for which it is intended – has gained momentum. One result of this is the appearance of the residential building-mounted wind turbine to the market.

There have however been doubts expressed by a number of professionals about various aspects of these units, not least of which is whether the urban residential wind environment will be appropriate and sufficient to generate enough electricity to justify their purchase and installation. Also at issue are potential environmental impacts, such as noise, visual intrusion, and the effect on birds or bats, and whether they will have an adverse affect on the building fabric.

In an attempt to address and hopefully answer some of these doubts, a group of 5 local authorities in Hampshire embarked on the Windyhomes Project to trial one model of residential wind turbine, the Windsave 1kW. Over approximately 18 months, the project group attempted to co-ordinate the installation of a large number of these turbines on the homes of local residents, with the intention of monitoring why householders were interested in the technology, what were the barriers created by planning restrictions and the installation process but also the resulting performance and levels of electricity generation. In addition, in order to gauge why there appeared to be such great public interest in residential wind turbines (and the Windsave in particular), a questionnaire was sent to approximately 100 people who had originally expressed interest in the taking part in the project.

The following are the interim results as at September 2007. Due to various difficulties in arranging for both initial surveys of the properties, and for installation once the surveys were complete, the project group managed to get only one turbine installed on a home in Eastleigh by this date. Therefore, in order to provide comparisons, 3 other sites where a Windsave turbine had already been installed were identified in other local areas, and information regarding their installation, performance and generation are also included. The low number of sites reduces the validity of the project results regarding potential electricity generation, but can nevertheless provide indicators of what might be found when the trials organised the Energy Savings Trust - including 100 sites - are complete in 2008. This report nevertheless gives valuable insights into the real life experiences of householders wanting to install a micro-windturbine on their home.

1. Introduction

1.1 The place of residential wind turbines in the energy mix

The need to find alternatives in the provision of electricity to our homes has been a key driver for the development of new technology and of new or under-utilized fuel sources. One of the ideas under investigation is that of generating heat and/or electricity within the home itself. The term 'microgeneration', when applied to the generation of electricity, can include solar photovoltaics, mini-'combined heat and power' systems ("CHP") using biomass or natural gas, ground source heat pumps and small wind turbines.

Microgeneration has several advantages over the traditional national grid based system. Perhaps most importantly, it avoids the inevitable power losses that arise when the electricity is generated centrally and thus has to travel great distances before being delivered to the home. This has the added benefit of granting a certain security of supply due to its independence from a central source. There could be potential difficulties that may result from the addition of perhaps thousands of independent sources of electricity being fed back to the grid from the home, but these are not thought to become an issue within the foreseeable future by the grid district network operators (DNOs) (Wineur 2006).

A further benefit of a residentially mounted wind turbine is that of increased public awareness of both renewable energy and energy efficiency. The wind turbine could be particularly effective in that it is can be quite visible in the neighbourhood. Research by the Sustainable Consumption Roundtable[1] has found that, even where the electricity generated by microgeneration has not contributed a substantial proportion of energy, nevertheless it did have a considerable impact on the 'energy intelligence' of the householder (SCR 2005).

This interim report is based on a study that examined the feasibility and current state of the technology of small - specifically building-mounted - residential wind turbines (BMWT). The study, named, appropriately, the "Windyhomes Project", aimed to coordinate the installation and monitoring of the Windsave 1kW-rated turbine onto a number of homes within the study area – composed of 5 local authority boroughs within Hampshire. See Appendix 1 for a complete list of participants.

1.2 Predicted problems with the technology in this context

The Government's Department of Trade and Industry (DTI) commissioned a report on the potential for microgeneration (DTI 2006), which was undertaken by the Energy Savings Trust. This report determined that, although there was a possibility that microgeneration could deliver about 25% of residential energy by 2050, there was little willingness in consumers to take financial risks with these new technologies. The report summarised the main obstacles to the growth of microgeneration as high capital cost, the low purchase price of electricity generated in the home and exported to the grid, and planning

[1] A joint initiative between the Sustainable Development Commission and the National Consumer Council

permission. Therefore the Government has responded by putting into place the provision of capital grants through the Low Carbon Buildings Programme[2] (a successor to the ClearSkies scheme), and the intention to both impose the obligation for utility companies to pay a better price for exported residential electricity, and to remove the requirement for planning permission for these technologies, through the Climate Change and Sustainable Energy Act 2006.

However, there are other obstacles that may prove more difficult to overcome specifically with respect to microgeneration delivered by wind power. While the basic wind turbine technology is simple and well understood, the use of it in this way – attached to the building it serves, within a built up area, and tied into the home's grid-fed electricity system ('ring main')- is not. It was tried in America a few years ago and one wind professional has reported severe problems in both noise and low generation (Gipe 1999). However with a renewed drive to find energy alternatives, and because wind is Britain's greatest renewable energy resource, it has gained a new momentum in this country, and indeed in other parts of Europe.

Electricity Generation

There have been a number of commentators and professionals who have raised doubts about the feasibility of the use of the technology is this way (Martin 2005, Elliott 2006, Gipe 2006, Shore 2006, and Bahaj 2007). Most of these doubts have centred on the whether a wind turbine that is attached to a building, particularly within a built up area, will be able to generate sufficient electricity to justify its cost. This is because the characteristics of the wind within a typical residential neighbourhood are not thought to be well matched to the needs of the technology. Those characteristics, although not sufficiently understood at the point (Syngellakis et al 2006, Mertens 2003, Dutton et al 2005) include a low average windspeed, but with a high level of turbulence – or a tendency towards erratic gusting and changes in direction – which results from the proliferation of surrounding buildings and other obstacles.

Power in the wind is given by the formula:-

$$\textbf{Power (W)} = \tfrac{1}{2}\rho A V^3$$

Where

- ρ represents the air's density – which is affected by both pressure and temperature, this is generally 1.225 in kg/m^3 at sea level,
- A is the area of the blade surface, in m^2
- V is the velocity of the wind in m/s.

It is clear from this that because the power is proportional to the *cube* of the windspeed, any changes in windspeed will have a dramatic effect on the power, and therefore electrical current output of the turbine.

[2] www.lowcarbonbuildings.co.uk

The wind turbine works best when it is subject to a smooth, consistent and strong wind speed. This is particularly true of the horizontal-axis (that is where the central hub of the blades directly face the wind) which will react to turbulence by constant turning or 'yawing' to face the direction of the wind. This quality will be especially unhelpful where the generated current must be 'inverted' from DC to AC to be fed into the grid-fed mains. This process requires that the turbine receives a constant wind above the minimum windspeeed (or the 'cut in' windspeed) for a certain amount of time (which will vary), to give the voltage time to climb to the correct level for feeding in to the ring main. A situation of high turbulence may tend to frustrate this process and so, although there may be a great deal of wind and windpower around the home, very little of it will be able to end up feeding into the home's electricity ring-main. Alternatively, buildings can also create windspeed acceleration, if their placement serves to funnel the wind. Therefore the response of turbines within the residential environment is complex, and will not be fully understood without site trials.

Environmental Impacts

The environmental impacts will include noise and vibration and visual intrusion, both inside and outside the home upon which it is placed. There have also been fears that the turbines may be harmful to local wildlife, such as birds and bats.

Noise can arise from the spinning of the blades – both from the gearing and due to the blades cutting through the air – and from vibration arising from the turbine's attachment to the building fabric. It is this last aspect that was seen to cause difficulties in the American experience (Gipe 1999), although manufacturers of the newer models have given assurances that this issue has been resolved.

Again, the only way to gain a realistic picture of actual environmental impact will be to see how they behave in real settings.

Other Issues

Finally, there may be a whole range of issues – not uncommon when a new technology arrives on the market - that could arise when attempting to arrange for installation, including supply of the units, sufficient personnel with training and expertise, and the suitability of a BMWT to each dwelling's particular situation, with reference to the property construction and surroundings.

1.3 Summary

The development of the residential building-mounted wind turbine (BMWT) has offered an alternative method of delivering electricity to the home from renewable sources. However, there are those that predict problems around sufficient levels of generation, and environmental impacts such as noise and vibration, visual intrusion. and impacts on wildlife. Further concern has been expressed about the consumer's willingness to pay the capital cost of the units, and of whether the necessity of obtaining planning permission was serving to block the technology's growth in the domestic market.

To investigate these issues a group of local authorities have combined in partnership to support and coordinate the installation of a number of the Windsave 1kW rated BMWTs, and to monitor the experience of those involved in the process and the behaviour and actual generation of the turbines where the installation process was successful. That project, "Windyhomes" intended to monitor successful installations for an entire year and so will be complete in March 2008, as the first (and as it turned out only) installation went up in March 2007. This report is based on experience so far, and on the results of a questionnaire that was sent out to all those that had expressed a wish to participate. The final results will be available in 2008.

2. The Windyhomes Project

The Windyhomes Project was initiated in November 2005 and intended to continue monitoring output until data on electricity generation had been collected for a full year after installation of the turbines. The project partners consisted the representatives from the following local authorities: Eastleigh, Havant, Gosport and Basingstoke & Deane Borough Councils, and East Hampshire County Council. The local authority project members were responsible for gathering names of those in their area willing to participate in the project, and to support the process of installation, including liaising with respective planning departments. The Environment Centre in Southampton offered facilitation and an administrative centre[3].

The intention was to carry out field trials of one specific model of BMWT (the Windsave 1kW) in order to test the general efficacy of the technology, and with the hope that the project could be used to raise the profile and encourage greater uptake of residential wind turbines, as well as of microgeneration generally.

The Windsave 1kW roof-mounted turbine was chosen for the field trials due to the fact that it was by far the most affordable, being about 2/3 the price of the least expensive of the other equivalent sized BMWTs on the market, and this allowed for a greater number of participants. This turned out to be an appropriate choice as, during the project, the Windsave became available through the popular DIY chain, B&Q.

The type of area within which the project participants lived ranged from semi-rural to suburban to urban. The windspeed in the area was found to average about 5 m/s[4], according to the DTI windspeed database[5]. This compares reasonably well with the British average. According to Sara Batley from the Wind Energy Training Centre of de Montfort University, the UK has an average windspeed of about 6 m/s around the coast, rising to about 10 m/s in the mountainous and island regions of Scotland.[6]

Each local authority worked relatively independently in finding participants in their own area. A publicity drive was carried out to seek those that were interested in taking part. The NOABL (DTI) windspeed database was used to prioritise applications where there was a limit on the number of participants. Some Councils offered additional funding to a small number of participants, and used the database as an aid to shortlist these, but otherwise did not restrict those that wished to take part in the monitoring project without receiving additional funding. Also as part of the shortlisting process, householders were asked to confirm that they would qualify for the Low Carbon Buildings Programme grant, in other words that their house had already incorporated those energy conservation measures required under the scheme.

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[3] See Appendix 1 for a full list of participants.
[4] Meters per second
[5] http://www.bwea.com/noabl/index.html
[6] http://www.iesd.dmu.ac.uk/wind_energy/sustainable_dev/wcwind.html *accessed April 2007*

Although each Council representative to the Windyhomes Project helped to facilitate the acquisition of the turbines by being the main point of contact with the installers and manufacturers, the commercial relationship remained between the householder and the supplier. The householders were responsible for applying for both the Low Carbon Buildings Programme grant and for obtaining planning permission, although with regard to the latter, the Council representative did offer some additional advice and liaison with the planning officers involved.

Once the list of householder participants was determined, the group approached Windsave, and asked them to begin the process of assessing the properties for suitability and, where appropriate, arranging for installation of the turbine. This was in November 2005, and preceded Windsave's partnership with both the Mark Group as installers, and B&Q as retailers of the product. The following table lists the total number of people who expressed an interest in taking part in each area, totalling 99.

Local Authority	Number of participants
Basingstoke & Deane Borough Council	31
Eastleigh Borough Council	30
East Hampshire District Council	2
Gosport Borough Council	4
Havant Borough Council	32

For the area we are considering in Hampshire, the average windspeed taken from the NOABL database tended to be about 5 m/s. Therefore (assuming this windspeed is an accurate representation, and that the efficiency does not significantly change with windspeed) we can adjust the expected output as

$$\text{Power} = \tfrac{1}{2}\rho A V^3 = 0.5 \times 1.225 \times 2.4 \times 5^3 = 183\text{W} \times 38\% = 70\text{W average.}$$

The figure of 38% representing the turbine efficiency is implied by the Windsave rating of 1kW at 12.5 m/s.

The power resulting from this windspeed is substantially less than the 1kW rating and it was the intention to determine, within the limits of the project, whether this is a reasonable prediction of the level of electricity generation that can be expected in this type of area. Although this average windspeed would imply this output, uncertainty remains about whether, and by how much, the variation in wind – some higher speeds mixed with some lower to obtain this average – and the effect of acceleration due to turbulence, could affect the actual output over a period of time.

3. Areas of Investigation - Background

The development of the wind turbine for use in the typical residential environment has presented particular challenges and these have formed the basis of the Windyhomes investigations. The background to those issues will be described in this section.

Aside from the obstacles identified and addressed by government action as noted above, ie cost and planning restrictions, there are a range of other aspects to the technology whose impact on the consumer have not been sufficiently investigated in actual on-site trials. These will be described here by referring to published views of professionals in the field, and by examining research that has been undertaken regarding the technology's environmental impact. The list of factors to be addressed are:-

- suitability of the residential environment to electricity generation,
- noise and vibration,
- visual impact,
- electricity connection, and
- ease of installation – which is related to availability of the technology and of expertise to assess the site and carry out the installation.

3.1 Electricity Generation

The main issue, and one that has been highlighted by many, has been the uncertainty of the actual output of these small wind turbines when attached to dwellings. Some feel that there have been over-optimistic claims by a few manufacturers (Martin 2005, Elliott 2006, Gipe 2006, Shore 2006, and Bahaj 2007). Other studies have been more optimistic, providing the turbine is sited appropriately (SEA/RENUE 2005). However, it has been very difficult to verify whether this, and other issues peculiar to the residential wind turbine, are true, because they can only be reliably tested in-situ, and preferably in as many different circumstances and environments as possible – reflecting the diversity of the residential neighbourhood. The Energy Savings Trust have embarked on just such a trial, monitoring out put from 100 sites, covering a variety of turbine models and environments[7]

3.2 Turbulence

It is acknowledged that the flow dynamics of the wind within the built environment for the purposes of power generation has not yet been adequately understood and studied (Syngellakis et al 2006, Mertens 2003, Dutton et al 2005). Mertens notes that, although there have been many studies of wind in the built environment, they were focused either on assessing risk to pedestrians or to the building itself.

[7] www.energysavingstrust.org.uk

With respect to the operation of a wind turbine, the issue has two aspects: (1) the reduction of windspeed and (2) the turbulence arising through obstructions around and from the building. For a BMWT this second aspect would feature to some extent whether the building was in placed within a built up area or not. Dutton et al (2005) have noted that buildings will cause a separation in the flow of the wind-current as it hits the side, causing a wind 'shear' (a velocity gradient) along the wind's flow as it speeds up over the building. However, the acceleration of windspeed through interaction with buildings also has the potential to *increase* power potential, and this will undoubtedly form part of future design development. If however a traditional horizontal-axis[8] turbine is sited just along the roof-line, the wind is likely to attack the turbine at a 30˚ angle, moving upwards. This would serve to reduce its power and, coupled with the inevitable local turbulence, the turbine's output is likely to be severely hindered (Mertens 2003). The most common site considered for the placement of the BMWT is along the roofline, as the highest point.

If the turbine is connected via an inverter to a home's ring man, then another way that turbulence will decrease the generation potential is because the inverter requires a steady current from the turbine to be able to synchronise its frequency to the mains, after transforming it from AC to DC. If the turbine is a horizontal-axis design the turbulence will likely mean an erratic operation, with constant stops and starts because it often needs to turn ("yaw") to face the incoming wind. In this case a lot of wind power will be wasted. This effect has led some to suggest that a vertical axis turbine is the better design for urban environment (Taylor 2005, Mertens 2003).

3.3 Windspeed in built up areas – the NOABL windflow model

Apart from the issue of turbulence, it is suggested that average windspeed in built up areas are generally too low to be of much use for wind electricity. To get a general idea of the wind resource available at any one site, it is possible to access a national windspeed database available on the DTI website, which has used the 'NOABL' wind flow model to determine the 'average' windspeed within a 1 km^2 grid system. BMWT manufacturers, and others, have suggested that this database can be used to estimate a turbine's output. However, a study has shown that the windspeeds available from this database were found to be, on average, about 1.5 m/s lower than that derived from on-site measurement, with less than 20% having a difference of less than 0.5 m/s (Dutton et al 2005).

This is because the model does not take the complexity of the built environment into consideration (Syngellakis et al 2006). It assumes no obstacles (and must do as it would not be possible to account for the variety of possible terrain in a model of this type). A recent Energy Savings Trust study also compared measured wind speeds at 12 locations through Britain, and found "significant discrepancies" between these and the NOABL database, leading to an average difference in windpower content of about 42% (Martin & Watson 2007).

[8] where swept area of the blades faces the wind

3.4 Noise and Vibration

One of the first things that many people seem to worry about with large wind farms is the visual impact, but for the small ones - those that are proposed to be placed within the neighbourhood - it is noise that features as a chief fear, although there are as yet "no noise guidelines for small wind" (Syngellakis &Prentice 2006). Paul Gipe notes both proper noise studies as well as anecdotal evidence that some early domestic turbines had unacceptable levels of noise output (Gipe 2000a), and although most manufacturers claim that this issue is no longer a problem, this is still an area that will need to be assessed in practice. This is particularly true as noise is a very subjective issue – what one person finds an annoyance might seem to another as pleasant, even soothing. According to Emma Dayan of the Buildings Research Establishment, noise is still an issue for residential turbines (Dayan 2006), and Dutton et al (2005) say that the noise of building mounted turbines is one of the "main technical considerations".

Noise arises from a wind turbine and its components in several ways, and all along the system. The gearing as the turbine turns to meet wind coming from a different direction and the turning within the hub can create audible high-frequency sound. There are claims that the current designs minimize friction and so reduce these sounds to acceptable levels. However, the turbine's blades will also create low frequency sound due to the sudden displacement of air at the blades' surface, and this effect, although less audible than the high frequency noise, can have a greater impact as it is able to transmit through the fabric of the building, and may be 'felt' by those both inside and outside the building (Van den Berg 2004).

A further source of low frequency noise with particular respect to BMWTs is that which could be transmitted due to vibration through the structure of the dwelling itself. Dutton et al (2005) puts this issue in the category of high priority for development, and states that this is a challenging problem and suggests it is addressed by careful design of the turbine itself, and attention to how and where it is mounted on the building.

There may also be noise arising from the inverter, which connects the current generated by the turbine into the ring main. This could be a significant source of noise and annoyance, not due to its level, but because the inverter is placed actually in the house.

3.5 Visual Impact

Although visual intrusion has become the main issue of contention for objectors to wind farms, it has not been cited as a one for small BMWT, perhaps partly due to there being so few about. Planning officers will clearly be concerned as one of their chief tasks is to ensure that no unsightly additions are made. Some concern also emerged from a recent opinion poll conducted by the Open University (Herring, Roy & Caird 2007). There is however a more important possible impact related to the visual aspect of BMWTs – and that is the potential for light flicker from the rotating blades. Syngellakis & Prentice (2006) mention this in their study as an issue, but dismissed it due to the small blade diameter. They do note though that it is possible for this flicker to have an exacerbating effect on those suffering from epilepsy, and so this must be considered.

One example of this problem is that found by the Head of Estates, Gilbert Snook, at City College Plymouth, who reported that the erection of two 6kW Proven turbines on a college building roof had resulted in a "strobe effect" through the windows of the neighbouring library, and that this factor led to their being braked on a sunny day (Snook 2007). These turbines are much bigger than the small BMWTs, but it is as yet an uncertain impact.

3.6 Electrical connection within the home

Although little mentioned in the literature, this issue is one that has a great underlying importance as there is a measure of potential risk involved both in the home and to workers on the national grid, especially as the concept of grid-connected microgeneration is still relatively unfamiliar.

When any grid-connected microgenerator is installed into a domestic dwelling you have current running 1) from the actual generator to an inverter 2) from the inverter to the dwelling's own electricity ring main, and, where there is more electricity generated than drawn from within the home, 3) back to the electricity grid. All need to be carefully controlled, and raise various potential issues, including those concerning safety, regulatory and procedural issues.

So there are safety and performance issues regarding the connection of the generator into the home's system. Research carried out in the Windyhomes Project found that there have been questions raised regarding the specific method by which the microgenerator is connected into the home's circuit. It is also uncertain how well inverters will perform in their task to match the microgenerator current to the grid voltage when dealing with the intermittent and variable nature of current produced by a wind turbine in a potentially turbulent and complex wind regime.

As a result of these concerns, a new version of G83/1, the guidance issued by the Network Operators, will be published in January 2008. In the meantime, the Electrical Safety Council (ESC) has produced a Best Practice Guide that does address this question specifically. It states uncategorically that "The microgenerator must not be connected to an installation by means of a plug and socket". Along with the Energy Savings Trust Best Practice guide (EST 2004) it also "strongly" recommends that the generator is connected onto its own dedicated circuit, through the consumer unit, which is felt to be clearer, simpler and so less open to problems, rather than directly into an existing final circuit through the back of a socket. However, the ESC guide recognises that this latter method is more cost effective and so may be desirable where the "financial viability" of the technology may be in question, and sets out strict requirements that must be met if connecting in this way (ESC 2007).

3.7 Summary of Research questions

To summarize, the questions regarding the BMWT performance and impact that will be addressed by this research are:

- Is the residential BMWT, including both turbine and inverter, able to perform reliably and to generate sufficient electricity

- Will the BMWT produce an unacceptable level noise or vibration, and is there any visual intrusion or impact

- Is the residential electricity system, its ring main, compatible with this system.

With regard to potential administrative and planning barriers:

- Is planning permission an obstacle due to refusals or bureaucracy

- Are there a sufficient number of trained installers and/or supply of product.

Finally, by having contact with a large self-selected group of people interested in the BMWT, the study sought to assess consumer attitudes and expectations, as well as how their experience may have affected these.

The next section will describe the actual methodology and tools that were employed to investigate these questins.

4. Methodology

The scope of this study is quite wide ranging, and the issues it intends to examine very diverse, but it was thought likely that the factors would tend to interact and compound each other in ways that had also not yet been identified, and this would form a crucial part of the findings. It was therefore important to examine the entire process: from obtaining the turbine, installing it, and determining the system's performance, as all would play their part in whether the technology would be accepted by the public.

Other factors that had to be taken into account in developing the methodology were 1) the low monitoring budget, which meant that there was a strict restriction on how much monitoring equipment could be installed, and even more importantly 2) the fact that the turbines were to be placed on people's homes, and that the inverters, from which the overall cumulative measure of electricity generation would be read, had to be placed inside the homes. This meant that the research depended on a certain amount of co-operation from those householders.

As it turned out, the Project was only able to include and monitor one turbine installation in the study area. This was one in which the householders had independently bought the unit and was awaiting planning permission. The Windyhomes Project then arranged for an anemometer to be included in the installation.

The monitoring of only one site imposed serious limitations on the validity of the study, and so it was crucial to identify comparison sites to allow a greater perspective. Three others where the same model of BMWT had already been installed were found and included in the interviews, questionnaires (for two sites) and data collection. These other sites were two residential households in Purbeck and Poole, and one installation at the University of Portsmouth, on a building that forms part of the Institute of Marine Sciences, the site of which is on a small spit of land at the edge of Portsmouth island facing the Solent.

4.1 Tools

The methods will be described below, and will include the following research tools. Some of the research questions were addressed by more than one of these tools.

1. Interviews

- Experiences derived from discussions amongst the Windyhomes Project group.
- Face to face interviews with those that had installed a turbine**.**

2. Questionnaires were sent to all those that had expressed an interest in taking part in the project. There was about a 50% return rate for the questionnaires (51), which is reasonably good, but this was expected as most of the participants had volunteered themselves to be part of the study and had an interest in its outcome. See Appendix 2 for a copy of the Questionnaire, Appendix 3 for summary of responses, and Appendix 4 for a list of additional comments.

3. **Collection of data** representing windspeed readings from the anemometer on the primary site, and corresponding electricity generated as read from the Windsave inverter display. This is discussed in greater detail below. Also included were generation levels reported from 3 other sites outside study area to provide comparators.

4.2 Issues in Monitoring Electricity Generation

In order to give an indication of the Windsave's efficiency in situ, and to keep within the budgetary constraints of the project, it was decided to choose one household as a primary site. The site had the anemometer and data-logger installed along with the turbine, and it was intended to relate the generation on this site with an estimate of the windspeed, as an additional cross-check of generation potential.

To get some perspective on the validity and reliability of the method used to determine generation performance, we can compare it to the strategy proposed by the Energy Savings Trust (EST) in their own study.

As a guide to good practice in monitoring on-site roof mounted turbine performance, EST commissioned a document which forms the basis of their own study into the efficacy of this technology (Martin & Watson, 2007). This study intends to give a measure that is as accurate as possible of actual performance efficiencies of various BMWTs on site, and therefore the standards are quite detailed and rigorous. In most areas, the Windyhomes study was not able to adhere to these standards due to a lack of money for proper equipment and of scientific expertise in this area, the small number of installations, and, with respect to this report, a lack of time due to the delay in turbine installations.

However, the document has served to give an indication of how close to an accurate estimate the Windyhomes results can be viewed, and what factors in the test set up will influence this. A paper written by Paul Gipe , "Testing the Power Curves of Small Wind Turbines" (Gipe 2000), and advice contained within the 'Wind Energy Handbook' (Burton et al 2001) also echoed the points made in the EST paper.

There are two main factors to consider in attempting to determine the performance of the turbine at any particular site:- the raw windpower that gets to the turbine, and the resultant electrical power that is fed to the household's ring main.

Power in Wind on Site

There are inherent difficulties in assessing the precise level of windpower that a turbine has used to produce a resultant level of electricity. In order to gauge the windspeed actually hitting the turbine, you would have to put the anemometer at precisely the same point as the hub of the turbine blades, but without the turbine there, as its presence would of course interfere with the wind and so render the measurements meaningless. This is particularly true in circumstances of high turbulence, where the windspeed and direction will be constantly changing.

In the Windyhomes study, the anemometer was placed about a meter down from the bottom of the blade tips of the turbine, and about a 0.3m to the side. The anemometer behaviour was recorded using a “Wind Prospector” data logger, which was placed next to the Windsave inverter. The windspeeds collected are therefore not precisely those that hit the turbine blade area, but the information was nevertheless useful as an indication of the level of turbulence, and the “ballpark” level of windspeed at the same time as the turbine generation readings.

Meter Issues

The EST specification notes the various issues that need to be addressed to ensure accurate metering of the electricity generated. This includes a consideration of the parasitic power taken from the grid to keep the meter itself running, which can be ~5W. The Windsave display requires a constant 6W. The ideal is to include a self-powered meter that detects current actually fed to the ring main as useful electricity, relative to windspeed at that moment. Additionally, due to the wide range of power generation possible (the cube relationship to windspeed), there are often resolution issues with the meter.

By contrast, the Windyhomes project will in effect need to rely on the Windsave’s own inverter meter and display, with all the uncertainties with regard to accuracy that that implies.

It would be very desirable to have an independent, and as the EST report suggests, self-powered meter to record actual current being fed to the home’s ring main and unfortunately that was not possible in this study.

4.3 Windyhomes Project method for Assessing Turbine Performance

It can be seen that the accurate measurement of the performance of a wind turbine for a given windspeed and environment is extremely complex and, if it is to be done to any degree of accuracy, requires sophisticated and expensive equipment, a time period of at least 12 months, and to be done, ideally, over several sites to determine the impact of a variety of factors. The Windyhomes project is not capable of meeting these requirements and so at best it can give only a very broad indication of what the householder might expect if they were to install one in an environment such as those included in the study.

The method adopted was to enlist the cooperation of the householders at the primary site to take daily readings of both the anemometer readings of windspeed over several points of speed and of the generation displayed on the Windsave inverter. The fact that the meters on both anemometer and inverter recorded cumulative readings allowed these readings to be confirmed by periodic visits.

All the data and information were then analysed to get an idea of the level of performance of the BMWT, at least when sited in a ‘typical’ setting such as the one described. The analysis took the form of calculating the actual power in the wind each day, using the formula shown on page 2 to come up with the total power in the wind at the roof level of the house, using windspeed readings from the anemometer. The same formula was then re-calculated for each day, but including only those windspeeds above the “cut in” speed of 3 m/s – as any below this level would not be high enough to be useful to the turbine. The results of these calculations were compared to that shown on the Windsave inverter to give an independent assessment of how much the wind might have been able to deliver to the house in the form of electricity, and how much was actually delivered.

Data from the site in Poole was recorded, by the householders, from the Windsave inverter display and posted to the researcher, and is reproduced here for comparison (Appendix 5), and finally, the turbines at Purbeck and Portsmouth University reported their cumulative kWh readings and the time period they related to, which allowed for an average daily generation to be deduced.

5. Results

The following section presents the results that were collected as at September 2007. Windspeed and electricity generation readings continue to be recorded at the primary site in the borough of Eastleigh, as the intention was to monitor the performance for an entire year. However, the questionnaires and interviews have been carried out, and because the project was only, in the end, able to arrange for the installation of the one turbine, it will only be the householders in this site that will be interviewed at the completion of the project, in March 2008.

5.1 General Findings with regard to installation

The Windyhomes Project began in November 2005 with approximately 100 potential participants. These participants were not all committed to installing a turbine, and there were undoubtedly several whose interest in taking part was enhanced by their local authorities offering additional financial and other support for the process. As at June 2007 – 18 months later - one turbine had been installed as part of the study (this site had actually been found through their planning applications to install the turbine). The questionnaire results, described below, give some reasons for this small number.

One key reason for the delay is due to the fact that only one company had been selected to carry out surveys and installations for the Windsave unit and this arrangement came into being just prior to the high level marketing of the product. This company needed to recruit staff, and to arrange for the training they required in order to understand the issues that had to be addressed in the survey, and in the particular process required to install the turbine.

The Project team found that there were extremely severe delays in arranging for the initial ‘survey’ of the property to be carried out, and this resulted in some people withdrawing altogether. There were several instances in which the installation company stated that a second survey was necessary to clarify the position, some time after the first had already been completed. It appeared that the process suffered from a severe underestimation of the complexity and variation of dwelling and environment that would face those that had been trained to carry out the surveys and they were thus unable to deal with situations that did not fit the standard model. The Warwick Wind Trials project also reported the same experience, and in that case, Windsave finally withdrew from the study (Encraft 2007).

Windyhomes Project members did attend many of the surveys, both those carried out by a representative of the manufacturer, Windsave, and by the installation company, the Mark Group. The surveys were typically about 30 minutes, and intended simply to establish in a superficial manner whether the property was suitable. This was in fact often enough, as a quick look proved that there were one or more tall obstructions in the path of the prevailing wind (for Britain this is generally from the Southwest). It also emerged that some homes – for example all those in the Eastleigh town centre area – had been built using lime-based mortar. This type of construction is not sufficiently robust to withstand the load and vibration and so it was immediately apparent that they were not suitable. This restriction on building fabric is noted on the Windsave website.

The issue of surveys carried on for several months, both in terms of appointment delays and with respect to the competence and completeness of the survey. One result was that the installation company, acknowledging that the staff carrying out the surveys were not trained to a sufficient standard, arranged for a second set of surveys to be carried out. This engendered even more delays.

5.2 Inverter Behaviour

The Windyhomes project site, along with the 3 comparison sites, all encountered many problems with the inverter, and all were either upgraded or fully replaced at least once.

Then in March 2007 a letter went out from Windsave informing all those who had turbines on order that they were suspending further installations until all those that had already been installed, and all inverters in stock, were to be “upgraded”.

5.3 Findings from Questionnaires

The questionnaires were designed to obtain a sample of the public attitude to BMWTs, their motivation for their interest in purchasing one, their willingness to pay and expectations with regard to performance, and where applicable, their experience in trying to, or succeeding in, installing one.

An overwhelming majority of those who had originally expressed an interest in installing a BMWT as part of the Windyhomes project had either not yet reached the stage of applying for planning or for the LCBP grant, or had dropped out altogether when the questionnaires were sent out

Of 102 questionnaires sent, 51 were returned. In most cases, many of the questions were not answered – generally those covering the planning or LCBP application – and so the results cover the households themselves and their attitudes to microgeneration and/or BMWT, their experience with having a ‘survey’ carried out by the installer or manufacturer, their reasons for not proceeding if this was the case, and their comments about how the process may be improved.

Note that when percentages of total responses are noted, that should be considered to be “of those that responded to the question” ie they should not be seen as percentages of total participants, or of the total questionnaires returned.

The questionnaire itself can be seen as Appendix 2, a summary of responses at Appendix 3, and additional comments at Appendix 4.

Household Characteristics

Although half of the respondents indicated that they were in full time employment, fully 37% said that their primary income source was a pension. This is seen again for those that proceeded to full installation and whose interviews are described later: all 3 of the households were couples on a pension. This agrees with a survey report from the Open University Design Innovation Group ("*Grey greens' go solar?"*) which found that take up of microgeneration is most common among "older middle-class couples", and that it is often retired couples that succeed because they have the time to devote to the process (Herring, Roy & Caird 2007).

Attitudes

Priorities in Reasons for Interest

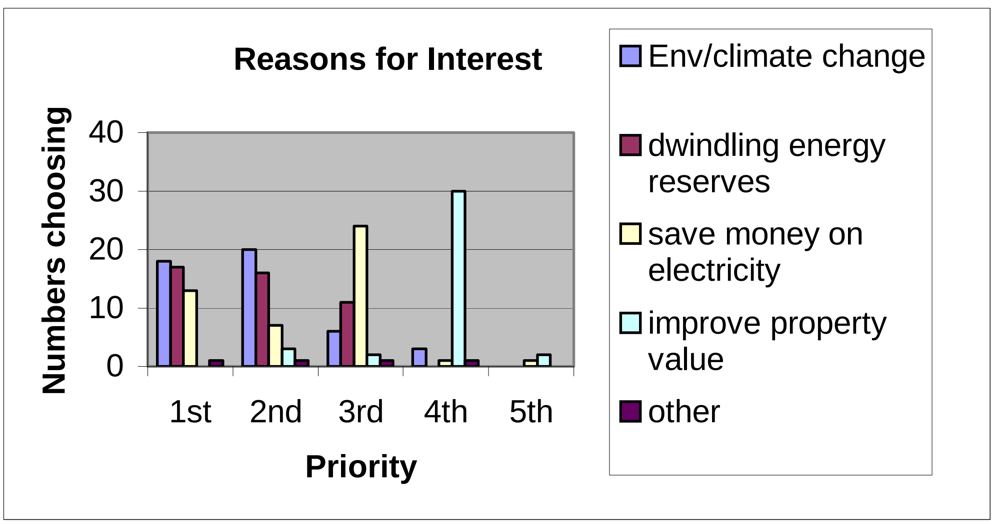
Table 1 below sets out the reasons that people wished to installed microgeneration as a weighted sum, based on their choice of priorities (Qu. 1.2a).

Env/climate change	194
dwindling energy reserves	182
save money on electricity	168
improve property value	80
other	14

Table 1. Reasons for Purchase

The sum was calculated by allocating 5 'points' each time a respondent chose a factor as a first priority, 4 for each second priority response, and so on and the totals summed for each reason.

Graph 1 on page 19 shows that climate change was most often put as a first priority, with a close second an awareness of dwindling energy reserves. The weighted average allows all choices to be taken into consideration and, although it is clear that people will invest for an environmental good, the high score for "save money on electricity" and the number of people who put this as a first priority, shows also that manufacturers cannot rely on people buying a product that is "green" without also being cost effective.



Graph 1

Reasons for Wishing to Install a Residential Wind Turbine

Existing Renewable Energy Installations

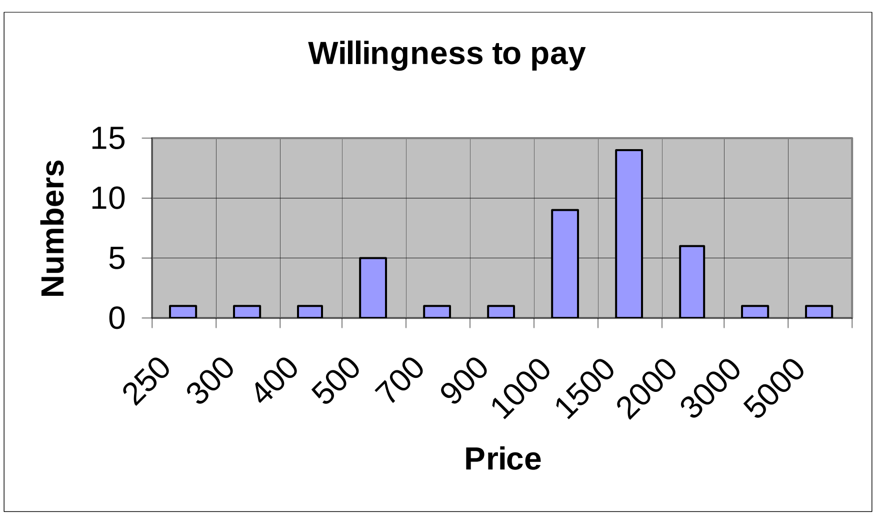
Ten respondents (20% of total returned questionnaires) said they had solar water heating already installed. While this is not surprising due to the relatively high acceptance of this technology, it highlights even more clearly the problems still experienced by those that wish to go on to wind. This suggests that at least some of these people are those that, if they express an interest in this technology, are likely to be serious about installing it, and able to navigate the process.

Willingness to Pay and Payback

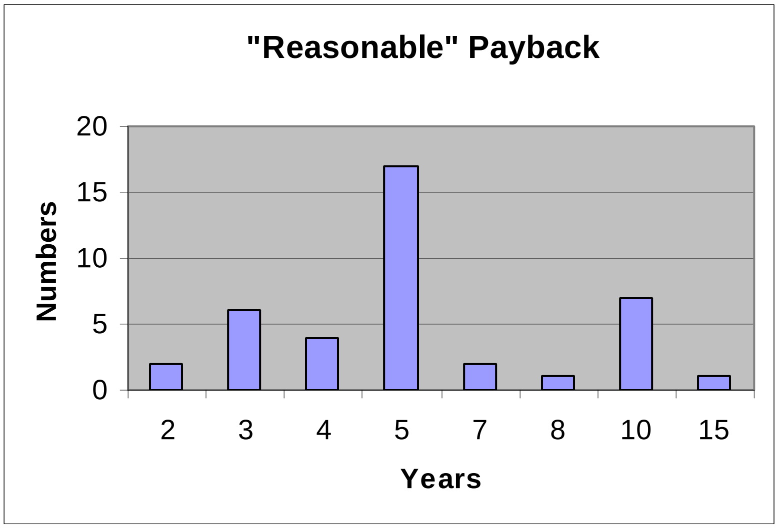
Returning to the economics, answers to the next 3 questions give a more detailed picture of people's attitudes to the cost and payback, at least with regard to the BMWT.

Although about 69% said that they would consider purchasing a BMWT if there were no grants, 80% said that they were only willing to pay £1500 or less, half of these only going to £1000 (see Graph 2). This is an interesting result because the BMWT is already by far the cheapest available residential renewable technology – particularly the Windsave that is marketed at about £1500. Compare this to the much greater take up of solar water heating, which markets at closer to £4000. What *would* have been an interesting question is "why, if so, are you willing to pay less for a wind turbine than for solar hot water system". This could be due to expectation – having seen the turbine available at this price, they are then pegged at this value in the public mind. It could also be due to the unproven nature of the technology.

Regarding payback, 81% said that it was essential that the turbine paid for itself within a "reasonable" time scale. When asked what a reasonable timescale was, 70% thought this should be 5 years or less, the rest felt it should be within 10 and only one person going so far as allowing for 15 years (Graph 3).



Graph 2. Willingness to Pay



Graph 3. What is a "Reasonable" Payback Period?

Although it is likely that the figure of 5 years is partly a rounded central point, it does give an indication of the expectation that those participating in this study had regarding the financial benefits of the BMWT. Payback within 5 years would require that the turbine saves about £300 per year (or if a grant was deducted, £200 per year). This would mean that after the initial 5 years, households would in effect be 'taking home' this £200 to £300. Is this a reasonable expectation? The average household electricity consumption in the UK is about 4000 kWh. At about 9p per kWh, this equates to about a £360 annual electricity bill. Therefore, it appears that there is an optimistic impression (however unexamined by those that hold it) that the turbine could, or *should* generate about a half of the annual electricity, or perhaps about 2000 kWh. It must be said that although the manufacturers have been criticized about over-stating the output, they do not claim to be able to generate half of the household annual electricity.

Council Support

Two-thirds of those that responded to this question said that the involvement of the local authority was "crucial" to their feeling confidence in the technology and process. The specific reason for this was not requested in the questionnaire but perhaps should have been.

Low Carbon Buildings Programme

Again, so few people had gotten to this stage, there is little feedback from the questionnaires about it. Those that did apply for it seemed to have no problems, despite the press coverage of money running out, but they were those that had applied in the early stages, up to about October 2006. However, one thing the Windyhomes study wished to determine was, in the face of a lack of testing and certification, what did people assume was implied by the accreditation for the grant? Comments in reply to the question "What did you assume that the LCBP accreditation would guarantee?" can be seen at Appendix 4. Three said simply "Nothing" or "Nothing much!", but 8 of the 16 had assumed that the accreditation would assure the consumer that the turbine operation had been tested and output shown to be as promised, to be "efficient", or at least for its environment benefits to outweigh its costs. The accreditation was given to those manufacturers who had passed the Clear Skies criteria of meeting the British Standards and safety regulations. It does not confer any comment on its output or performance.

Surveys

In the case of the Windyhomes Project, the Council representatives tended to arrange for the surveys from the manufacturer or the installation company, so this was not done as would normally occur if people buy them independently. It was reported above that there were a great deal of problems and delays in arranging for surveys and a general opinion of those members of the Project that attended the surveys was that they were insufficiently rigorous, and in some cases incorrect information was given out.

However, in the questionnaire, 43% said that the surveyor was either "very competent" or "competent", 34% said "neither" and 23% chose either "incompetent" or "very incompetent". Nevertheless, it might be said that even 23% being considered incompetent is not a good thing when there is a significant household investment, and issues to do with building fabric and electricity systems involved. Comments about the survey are at Appendix 4. A couple of comments were positive, but several express an impression that the surveyor who turned up had insufficient knowledge and that generally the whole operation could have been done much more efficiently. Five of the 16 comments mentioned that more than one survey had to be undertaken. See below under Comments for Improvement for suggestions.

Planning Permission

Very few people in the study got to the planning permission stage and only 8 in the questionnaires. Six of these felt that they were given clear advice, despite the Planning Departments themselves expressing uncertainty as to how to approach the applications, and 5 said that the planners were supportive, (the other said "neither supportive nor unsupportive").

Of this small number, three-quarters (6 out of 8) said that the most difficult aspect of applying for planning was producing the scale drawing of the house with turbine, and one person who did not in the end apply for planning and eventually dropped out said that producing this drawing was one of the obstacles that stopped her proceeding (the other being lack of confidence in output).

Reasons for *Not* Proceeding

Reasons given for not proceeding with the installation are given in Table 2 below. Note that some sites gave more than one reason.

Reasons for not proceeding		
Wary that not value for money - not effective	17	39%
Too many trees or other obstacles	12	27%
Unsuitable building type	6	14%
Lack of confidence in installer/mfg	3	7%
Planning obstacle	2	5%
Maintenance	1	2%
No suitable place externally	1	2%
Deface property	1	2%
Internal placement difficulties	1	2%
TOTAL	44	

Table 2. Reasons for Not Proceeding with the Installation

Comments expanding on the reasons for not proceeding are given at Appendix 4.

It emerged between the comments and the answer to the tick list of reasons that the reasons for not proceeding arose mainly due to either their own research suggesting to them that they would not get the output they expected in the average residential environment, or that a surveyor told them this when the site was investigated. Note that there were many participants that had not yet gotten around to even having their survey, and who did not return the questionnaire, and so this delay is also likely to have contributed a major reason as to why many will not eventually proceed.

Comments for Suggested Improvements

Comments for suggested improvements in the process of installing a BMWT can be found at Appendix 4. They mostly centre on the muddled nature of the whole procedure, which was found to be too complex and time-consuming, engendered too many delays, and that there was insufficient guidance and cohesiveness between the various aspects of the process of installation. Many of those that live in situations that are clearly not suitable, felt that it was an unnecessary waste of their time to go through the process of arranging for the survey, and of taking the time to investigate other aspects prior to this survey, because this unsuitability could have been easily determined, with a little guidance, from one glance. The large number that had mentioned the difficulty in producing scale plans for the Planning Department also suggests that this is one important obstacle that would need to be addressed.

5.4 Interviews of those that installed the turbine

The following section describes feedback derived from face to face interviews with 3 households that had succeeded in installing the Windsave turbine, and with the Director of Estates at Portsmouth University, where a project to assess the Windsave BMWT was carried out.. Only one of the four were a part of the Windyhouse Project.

All three households had completed the questionnaires, so their responses to these aspects have already been covered in the findings. The interviews focused on the process of installation itself, how the turbines performed once installed, and the experiences of the householder regarding the presence of the BMWT as part of their dwelling.

Interview 1 : Household A – Hedge End, Eastleigh, Hampshire

Household A (HA) is that of the Primary Site.

H.A. lives in the Hedge End area of Eastleigh on a street in a suburban area composed generally of two storey houses and bungalows. The street has a mild slope, at about 20˚ along the street, with H.A.'s detached two-storey house placed about half-way up. There are more rural areas in relatively close proximity. Apart from the presence of other houses, there were no significant obstacles, such as large trees, blocks of flats, etc. The site would therefore be considered a very good one, relative to an average residential neighbourhood. On the DTI NOABL windspeed database, the postcode for this property was shown as having an average windspeed of 4.9.

H.A. bought the turbine through B&Q in late October 2006, applied for planning permission and this was granted in January 2007. The survey from the installer was carried out in November 2006 and it was determined that the site was suitable and the placement on the building identified. The turbine would be installed at the gable end on the back of the house, facing S/SW – the direction of the prevailing wind – and the inverter would be placed near the consumer unit to the left of the front door, on the far side of the house.

Installation was fixed for 23 February 2007. The Windyhomes researcher attended, and the householders – a couple – were also both present. The householder also assisted in erecting the pole for the anemometer, which was sited approximately 1 m below the hub of the turbine (approximately 60 cm below the turbine blade end) and displaced laterally respective to the hub about 25 cm. The anemometer was therefore about 25 cm above the roofline.

Installation went well with one hitch; that was when it was realized that the installer, not a fully qualified electrician, was not able to complete the connection as a small additional circuit – or fused spur – was required. It was therefore necessary to call in an electrician. However, this resulted in an additional cost of only £25 as the work took only a few minutes.

The installers had to return to complete the installation the following day to allow the bonding cement fixing the brackets to the outer wall to completely dry. However, the next day when carrying out the standard stress test on the brackets, it was found that the bricks were beginning to be slightly displaced, and therefore the test failed and the installers informed the householder that they could not proceed. The householder decided that he would carry out remedial works on the side of the house, such that the wall would be sufficiently robust to carry the loads of the turbine, and he, himself, a shipwright, carried out the works. After a few weeks delay to ensure that the mortar was completely dry, the installation was completed on 12 March 2007.

The Windyhomes researcher re-visited the property on the 14th March. At this point the turbine had produced approximately 2kWh. The householders were disappointed with this output as they reported that it had been quite windy, and they had expected this to be much higher. Other issues that had arisen in these first two days were that

- the inverter had frequently displayed an error, and shut down (it did however re-start each time). This happened twice in the two hours the researcher was in attendance. The researcher contacted the installers the following day, as the Manual did not have information about what the error code referred to (Err03). The error apparently meant that incoming voltage from the mains was higher than that allowed by the inverter.

- the inverter's internal fan was also turning itself on very frequently – again this happened twice while the researcher was in attendance. The householders found the noise of the fan very annoying, even with the door closed. They said it sounded like "a Hoover".

- the Manual gave instructions that the turbine should be braked if the householders were to be away for any length of time. The householders found this unsatisfactory as one of the reasons they had invested in the turbine was because they tended to live abroad a few months of the year, and had planned to sell the excess electricity generated while they were away back to their supplier.

- a further noise arose from the low frequency vibration of the turbine down the pole and into the building fabric. This was described by the householders as a "foghorn".

- there was little or no noise from the turbine in operation outside of the dwelling.

The installers were contacted and told about these issues and they acknowledged that it appeared that the inverter was faulty and an appointment was made to upgrade its software. This was carried out on 20th March. After this time, the householder said that they believed that the generation was improved. The researcher gave the householders copies of forms upon which to record the windspeed data at the same time each day, along with the record of current cumulative generation.

The issues regarding the inverter going into error, and its fan frequently coming on were resolved with the upgraded inverter. However, the low frequency sound through the building fabric has not and the householders found this very disturbing, with one member of the household actually wearing earplugs at night. They also reported by letter that their neighbour "says she can hear a noise at night that sounds like low flying planes when

"Windy" is going round". The couple arranged for a telephone interview to be carried out between the researcher and their neighbour and she confirmed that she could hear this noise, as described, particularly at night if her windows are open.

She also mentioned that she was experiencing the intrusion of a flickering light reflecting from the turbine into her kitchen if it is active on a sunny day, and that she has actually left the room because she suffers from migraines and this exacerbates it. She has not mentioned this directly to her neighbours because she doesn't want to "bamboozle" them with too many complaints.

They report that the sound level is proportional to the wind strength. The couple have again contacted Windsave, who have arranged for the installers to attend again. A second letter from the householders reports that they "will be coming along on the 29th of this month [June 2007] to fit a new inverter, turbine and vibration suppressor. I have been told the new equipment is more efficient and makes better use of lower wind speed. We will see!".

A final contact was made on 30th June, after the entire system had been replaced on 29th June, including the turbine itself and inverter. It was too early to tell if the performance would improve, and the uncomfortable low frequency noise was still evidence. Windsave also promised that a rubber gasket would be placed around the turbine pole, and it was hoped that this would help to absorb some of this noise.

The householders were contacted once the gasket had been in place and this did resolve the issue satisfactorily.

Interview 2 – Household B – Poole, Dorset

Household B live in a slightly denser residential neighbourhood than the Primary site, but the semi-detached two-storey house is very well placed for a BMWT as the neighbourhood covers the side of a steep hill (~40˚ incline) at right angles to the street. Therefore any buildings facing the house are below its level. There are also other houses to the rear of H.B., and on a higher level. In addition to this, the front of the house looks out to Poole Harbour in the distance. They wanted to install a wind turbine because one member of the household had simply always loved windmills.

The turbine is attached to the side of the building, near to the roofline, and faces out to the south, towards the harbour. The side upon which the turbine is attached faces a second semi-detached house, which is at a slightly lower level.

They bought the BMWT at B&Q at about the time as H.A., and had no problem with the survey or arranging for installation. Unfortunately they did not know about the Low Carbon Buildings Programme – they had asked a local Councillor if there were any grants and had been told there were none. Applying for planning was not a problem, but the permission included a restriction that they had to brake the turbine between the hours of 11pm and 7am. This would be the case unless the householder applied for a Variation, giving evidence that the turbine's maximum noise levels were below planning guidance.

The turbine was installed on 16 March 2007. When the household were first contacted, they mentioned that there had been some "teething problems". Their experience was similar to that of H.A. above, with the inverter going into error often, the fan frequently coming on.

Windsave were informed 3 days after installation, and in the first instance they arranged for the inverter to be replaced on the 21 March, and gave them an independent power source that would, they said, reset the inverter if it did go into error. It was not clear to H.B. exactly what part the power pack played in the inverter's operation. However, there were further problems. The householder reported that following this visit, the inverter blew the house's fuses twice. On a second visit from the installers on 2 April 2007, the inverter was again replaced.

They said that they, too, could hear the low frequency noise arising from the vibration through the pole and building fabric. They described this noise as if a neighbour were running a lathe a few houses down. They were a little concerned that their neighbour might be bothered by it, particularly as they are in a semi-detached house and this noise may transmit. However, they were reluctant to ask her.

They have provided generation data, recorded from the inverter display and this is reproduced in a table below, without analysis. A letter written on 31 May 2007 states "We are pleased with its performance except for the 'humming', which increases to 'rumbling' when the winds are strong. I think our nights would need earplugs too if we didn't have it turned off."

Readings recorded by Householders – including notes on wind speed, are in Appendix 5. See section 5.5 for a visual representation of the data.

The unit was replaced – upgraded – on 4 July 2007. Further daily readings were sent to the researcher, and although generally mild breezes, did include some days that were very windy, and even "gales" and the units performance on these days may give an indication of the turbine's potential performance. However, again, over 57 days of recording, it was found to generate approximately 0.54 kWh per day. Note again, however, that this is daytime operation only as the turbine must be braked between 11pm and 7am each night.

The most recent letter sent to the researcher noted that the dampening gasket that had been installed had reduced the vibration and noise to an acceptable level. However, they did note that "On the 25th found a decapitated pigeon on the path …. today we have another! Our turbine is resembling the French revolution guillotine!" Whether this would be widespread impact on local birdlife can not be determined from this small study.

Interview 3 – Purbeck Site

The final household (Household C, HC) lives in Purbeck, Dorset, in a 200 year-old cottage, in a semi-rural environment. There are houses to either side, but has open fields behind. The area is approximately 10 miles from the sea. The turbine is attached near to the roof on the back of the house, and faces SW. As a retired engineer, the householder wanted to install the turbine just to “see what it would do”. He had low expectation of significant generation output. Both members of the household have been interested in environmental issues for many years, and have an interest in being moderately self sufficient.

He bought the turbine at the major B&Q on 1 November 2006. He did not apply for planning permission because he said that he was advised that they were not sure that he would need it but suggested he apply to find out. He said he investigated himself and found that, because the back addition of the house is lower than the original front, if he erected the turbine on the back of the house, this would not need planning. Although the turbine cannot be seen from the road, unfortunately a neighbour did complain apparently because they were not consulted.

They did want to sell excess electricity generated by the turbine back to the grid, but because they are on a Superdeal tariff with Scottish & Southern, which requires two import meters this was not possible. He applied and received the Low Carbon Buildings Programme grant.

The survey was carried out within a few weeks, and installed on18 December 2007. He relayed precisely the same experience as that reported by the other two households, except, as with Household A, the inverter did not blow his fuses. They also experienced the low frequency humming sound, although it did not bother them. One has partial hearing.

They reported the problems with the inverter to Windsave and the Mark Group attended on 16 February. On this visit they shut down the inverter and braked the turbine. They also replaced the bolts on the turbine brackets. They said that the inverter would need to be replaced and would let them know when they had the new ones in stock. Finally, on 22 June 2007, the inverter was replaced, and the householder reported, as at 30 June. Generation will be discussed in Section 5.5.

Interview 4 – PortsmouthUniversity site

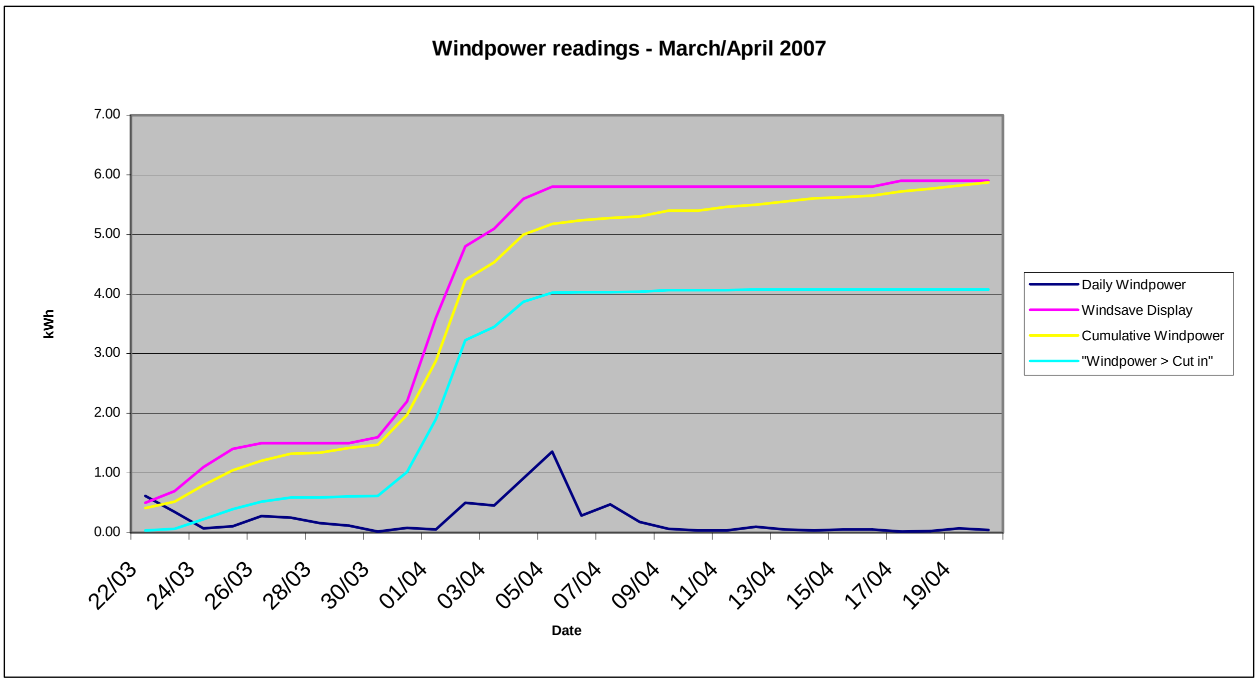
Andrew Cardy, the Director of Estates at Portsmouth University, was interviewed by the Windyhomes researcher, on 23 June 2007.

An MSc student, attending his final year at Portsmouth University, undertook a trial of the Windsave model. The turbine was installed at the beginning of March 2007 on a building that formed part of the Institute of Marine Sciences, the site of which is on a small spit of land at the edge of Portsmouth island. The student, Andre Gipperich, found the equipment dogged by problems, with the inverter cutting out and not re-setting itself as it was meant to. Windsave provided him with a power pack with which to reset the unit, but it was found that this procedure was not successful. Further, the student and staff technicians noted that the tail fin was flipping past the rubber stops, resulting in an uncontrolled spin. Finally, the total system was replaced on 6 June 2007, including turbine and inverter. The student had to return to Germany 3 days later, but the technicians have reported no further problems, and upon visiting the site on 23 June, the inverter display showed a cumulative generation of 19.3 kWh – or about 0.8 kWh per day. In a further communication by email on 12 September, Mr Cardy, reported that the inverter display showed that 110 kWh had been generated from 6 June 2007. This would equate to 110 kWh over 97 days or about 1.1 kWh per day. This is of course over the summer months, but at a site that is directly on the edge of the Solent.

5.5 Generation Data

As described in the section on Methodology, in order to determine how the turbine was performing within the context of the windspeed, Household A took daily readings from the Wind Prospector anemometer data logger, which records these as cumulative hours at each windspeed, along with a record of the cumulative power generated as read from the Windsave inverter. The readings were taken from the day that the inverter was upgraded, 20 March, until 20 April, when the couple flew abroad and did not return until 11 June. When they returned they reported the cumulative readings up to the 14th June. They continued the pattern of daily recordings, and regularly sent the datasheets to the Windyhomes researcher. The data sheets, and the spreadsheets upon which the data is recorded, are available upon request.

The readings were analysed on a spreadsheet in the following way. The windspeed readings (representing hours at each windspeed level) from the Data Prospector were entered for each day. The Windsave inverter readings were also entered for each day. The windspeed-hours data was then fed into the windpower formula, (see page X), using an assumed 38% efficiency. This efficiency is quite high but is assumed from the Windsave rated power. The power results were then summed over all windspeeds hitting the anemometer each day, giving a daily figure of available windpower. A second daily windpower calculation was made, but this time disregarding the windspeeds that were below the Windsave “cut in” windspeed, 3 m/s, which does not have sufficient power to create an effective current. The following graphs give a visual representation of these results

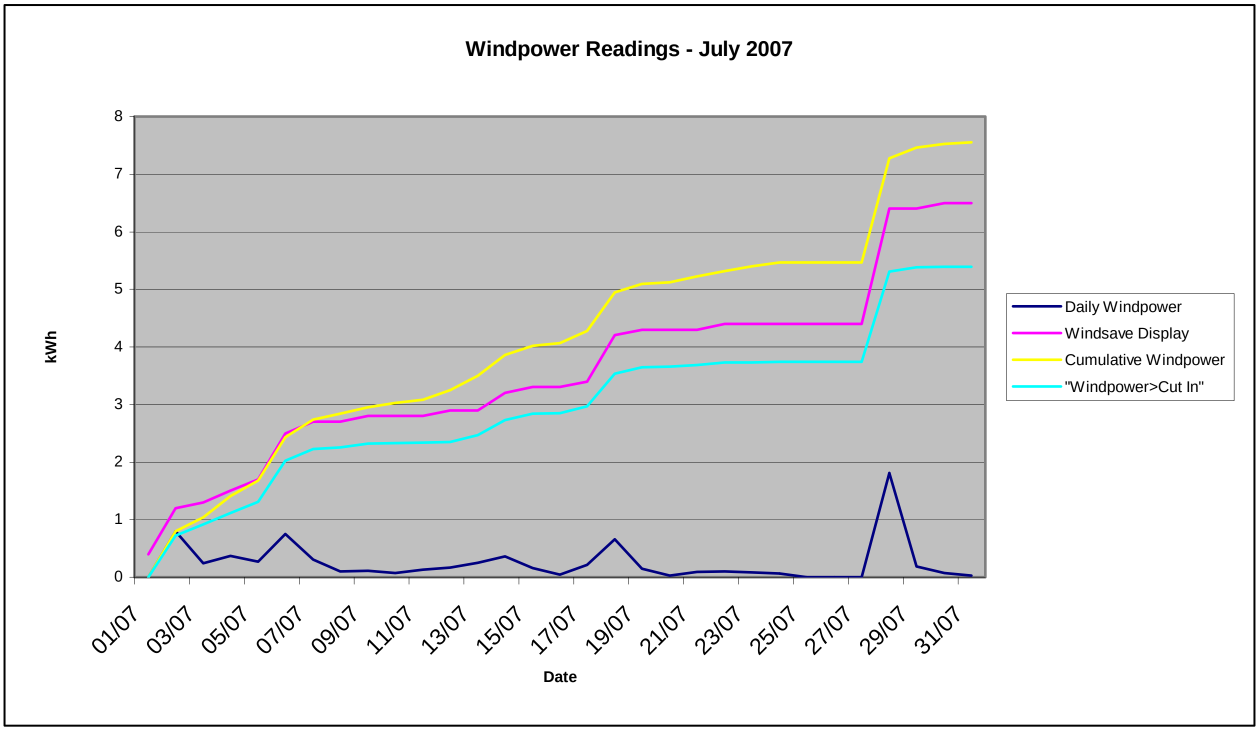


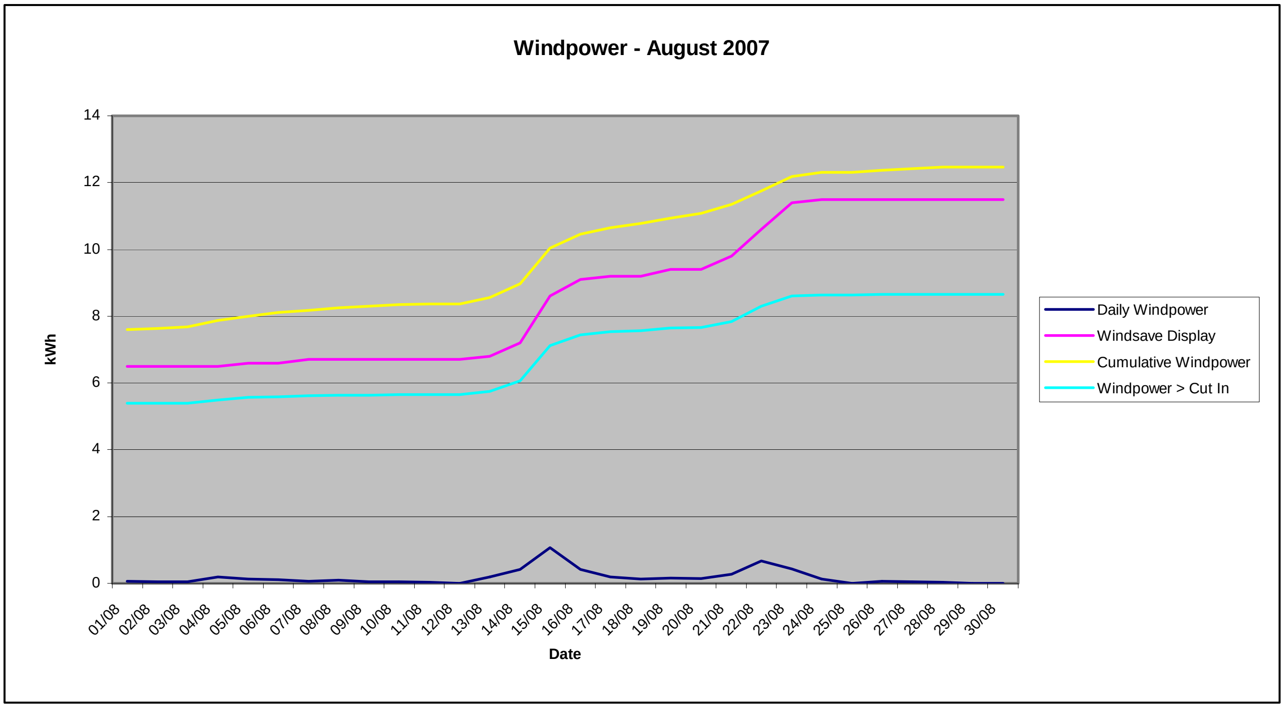
Graph 4 (previous page) – Primary site generation readings – March and April 2007

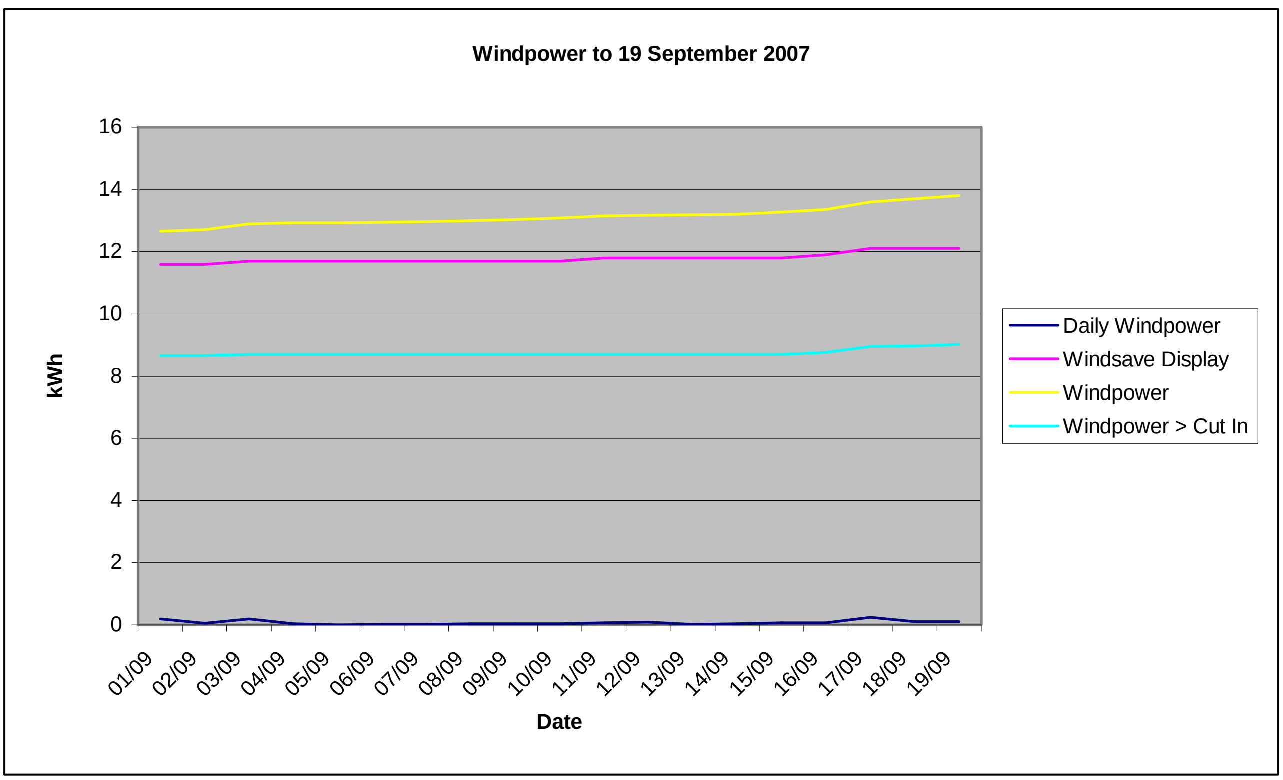
The couple were out of the country between 20 April and 14 June and reported a cumulative generation levels from the Windsave inverter of 17.7 kWh upon their return. This represents the total generated between 21 March and 14 June or 17.7/85 days, giving an average for the spring 2007 of 0.2 kWh per day.

Windsave installed an updated inverter model at the end of June, and the couple resumed their daily readings. The graphs below represent the data from July, August and September.

Graphs 5, 6 and 7 – Primary Site Generation July to September 2007




Windpower - August 2007
kWh
14
12
10
8
6
4
2
0
01/08
02/08
03/08
04/08
05/08
06/08
07/08
08/08
09/08
10/08
11/08
12/08
13/08
14/08
15/08
16/08
17/08
18/08
19/08
20/08
21/08
22/08
23/08
24/08
25/08
26/08
27/08
28/08
29/08
30/08
Date
Daily Windpower
Windsave Display
Cumulative Windpower
Windpower > Cut In


Windpower to 19 September 2007
kWh
16
14
12
10
8
6
4
2
0
01/09
02/09
03/09
04/09
05/09
06/09
07/09
08/09
09/09
10/09
11/09
12/09
13/09
14/09
15/09
16/09
17/09
18/09
19/09
Date
Daily Windpower
Windsave Display
Windpower
Windpower > Cut In

Again, looking at the total generation over the summer months, the Windsave inverter recorded a total cumulative generation of 12.1 kWh from 1 July to 19 September 2007 or 80 days. This equates to approximately 0.15 kWh per day.

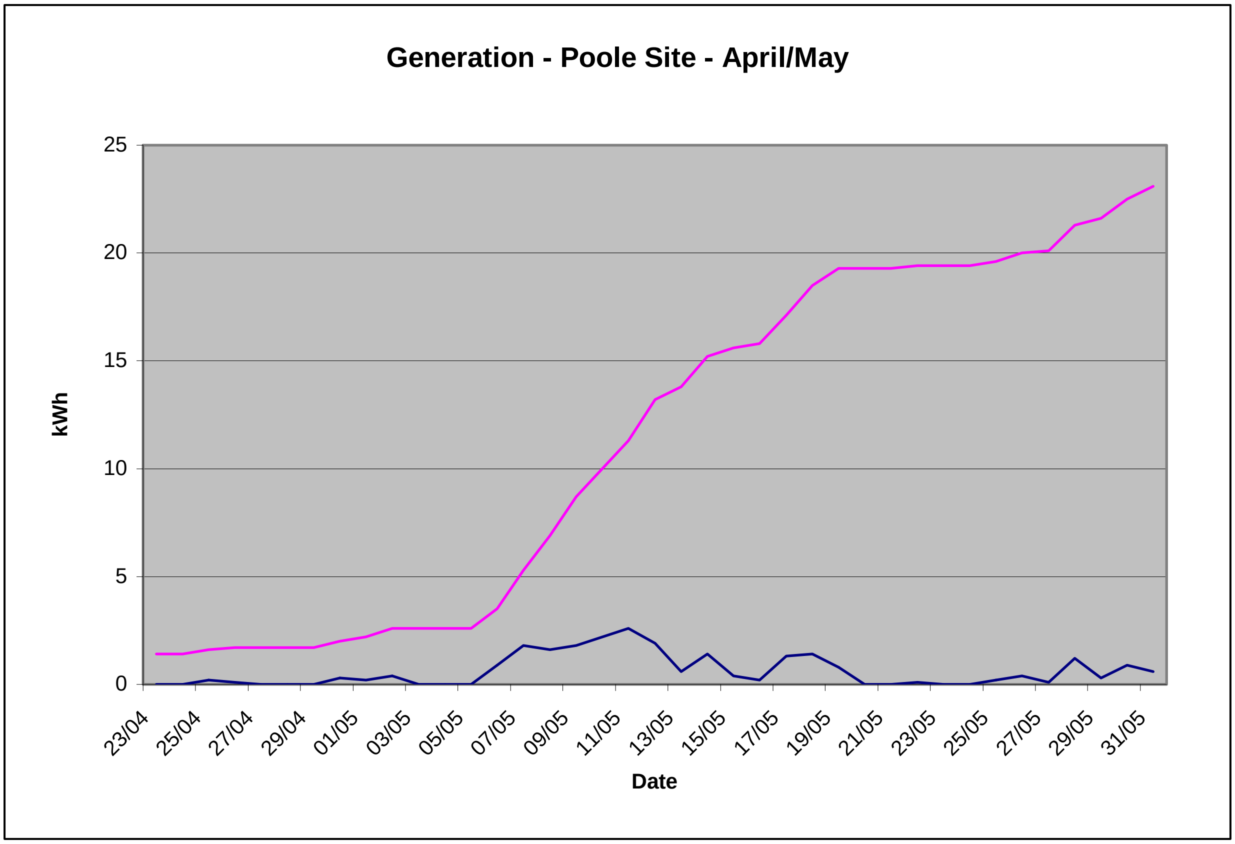
There was a reasonable agreement between the readings from the Windsave inverter and the generation results as calculated using the total windspeeds from the anemometer data logger. However, when we removed the windspeeds below the Windsave cut in – although the majority of the wind was within these speeds – we found that the actual cumulative windpower was closer to 8 kWh rather than 12. It is presumed that this discrepancy is due to the fact that the anemometer was placed lower than the blade face of the Windsave turbine, and so would be subject to significantly less windpower. Additionally, the anemometer would be closer to the roof edge, which is likely to have subjected it to greater turbulenc; there would also be additional turbulence created by the presence of the spinning blades themselves. What this does demonstrate is that the poor generation performance of the turbine is due to a lack of good quality wind, rather than a fault in the turbine's ability to convert that windpower to electricity.

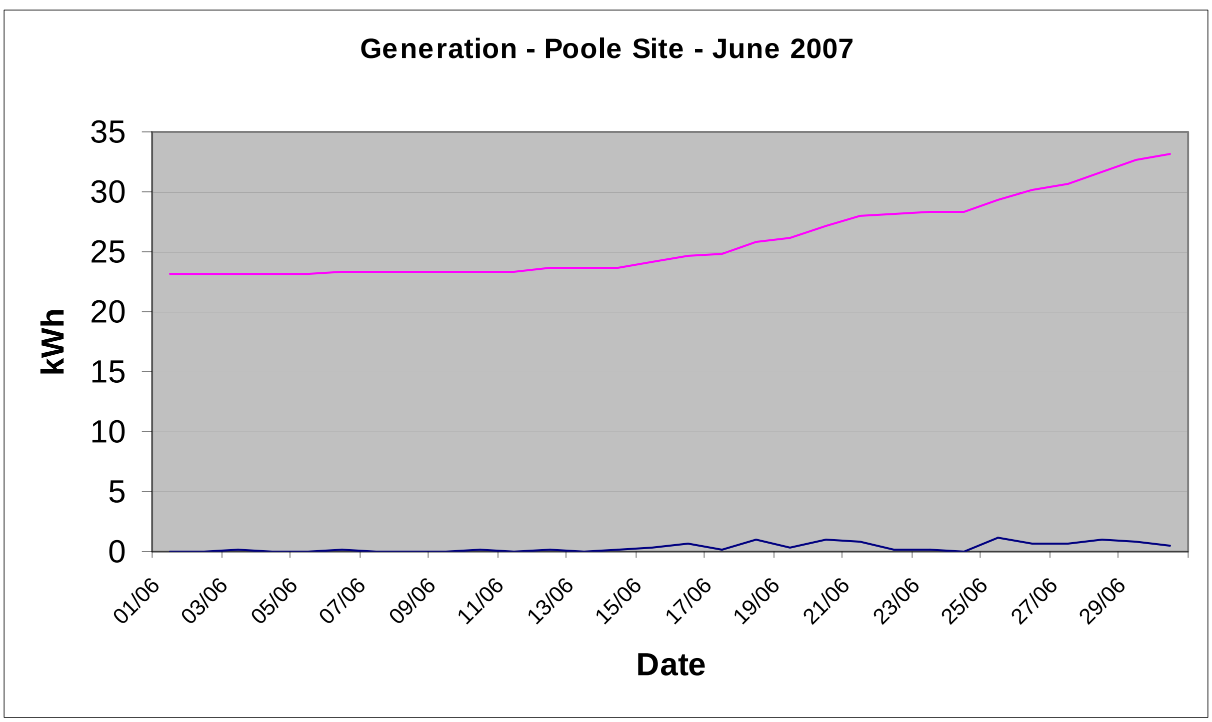
Comparator Site Data

In order to investigate further how representative the results from the Eastleigh primary site were to what might generally be expected, the data from 3 other sites were identified and this is presented below. Four sites, particularly when the data is taken over the spring and summer months, would still clearly be considered as insufficient to get a full idea of the real potential of turbines. The performance would certainly improve over winter months. Nevertheless, the four sites chosen could all be considered reasonably good for residential environments.

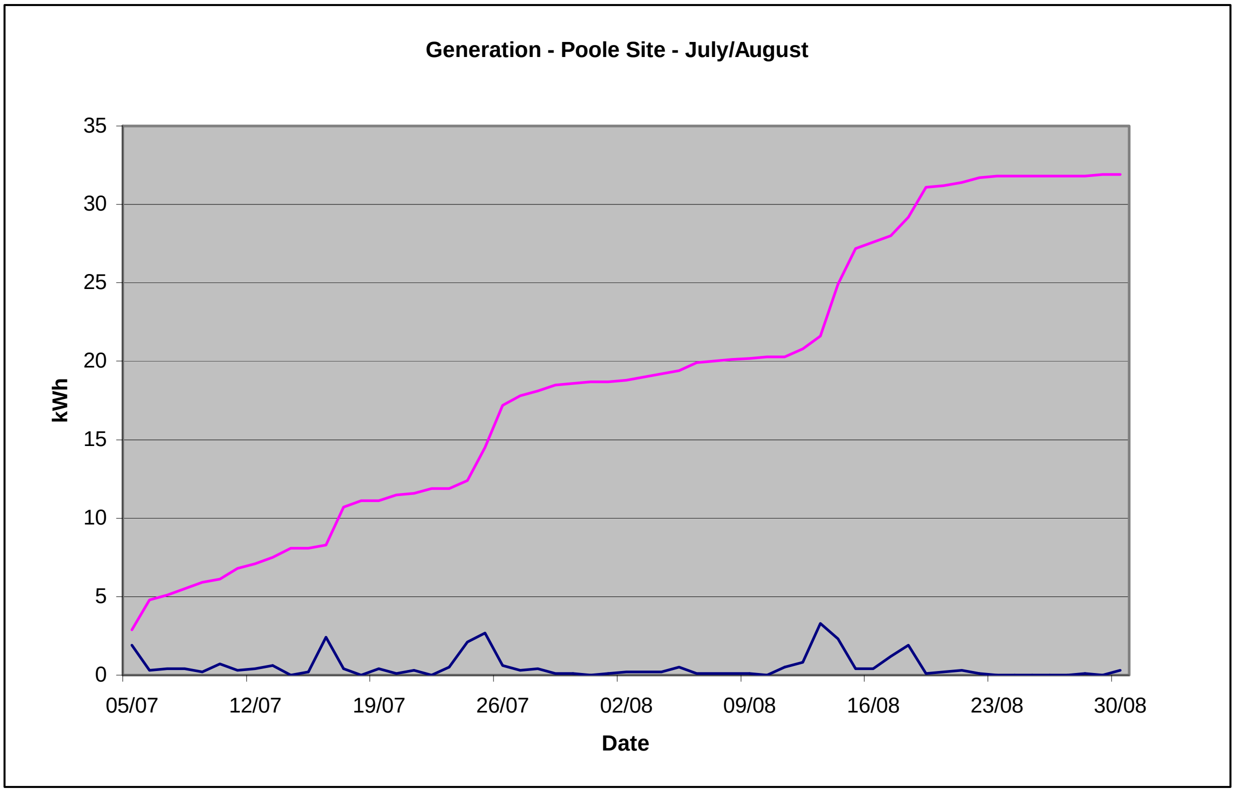
The Poole site is in a typical residential neighbourhood, but the area is in an elevated position, and the occupants of the building can clearly look out at Poole harbour, although this is several miles to the south. It may be considered that the further rise of the hill behind the house may offer a greater wind obstacle than a building placed on a more level standing.

The following graphs represent Windsave inverter readings taken by the householder and regularly posted to the Windyhomes researcher, along with a note of the wind quality that day. See Appendix 5 for a listing of both.





Graphs 8 and 9 – Poole site data – April to June 2007



Graph 10. Poole site data – July and August 2007

Between 23 April and 30 June, the Poole site recorded a total cumulative generation of 31.7 kWh, or just under 0.5 kWh per day. This is with the turbine being turned off between 11pm and 7am each night (planning restrictions), and near the end of June, it was turned off for a few nights at 10pm as the inverter seemed "under stress" – with the fan coming on frequently.

The manufacturer, Windsave, in its running campaign of replacing original units with those that had been upgraded to be able to handle higher windspeeds more efficiently, replaced the Poole site inverter on 4th July. Graph 10 above represents the generation during July and August. The average generation during these high summer months of July and August, with the turbine braked between 11pm and 7am, was 32.2 divided by 57 days or 0.56 kWh per day. Again, although this might be considered a good site for a turbine, the time of year for generation is clearly not optimum, and the restriction of daytime operation further decreases its potential. Nevertheless, it can give an indication of how it responds to high winds (see Appendix 5 for subjective notes on wind quality).

The site in Purbeck, again, could be considered to be a reasonably good one for a small wind turbine, as it is in a semi rural area, and the turbine faces open fields to the back of the house – although there are various stands of trees at some distance away. Purbeck is also near the coast and will benefit from sea breezes. Daily readings for the site in Purbeck were not collected, but the occupants provided cumulative readings. As noted above in the interviews, the turbine was installed on 18 December, and after the householder complained about its poor performance, the installers visited and 'braked' the unit on 16 February 2007. The total generation during this time was 26.7 kWh, or about 0.45 kWh per day. The unit was replaced on the 23 June 2007 with the upgraded inverter, and the cumulative generation from that date to 23 September was 22.7 kWh, or more like 0.25 kWh per day. This site will be included in the Energy Savings Trust 100 site trials, so these results may be checked using more sophisticated equipment in time.

Finally, the site at the Portsmouth University Marine Sciences building reported cumulative generation readings from when the unit was totally replaced (including blades) on 6 June, to 12 September. Andrew Cardy, the Estates Director, reported that the inverter display showed that 110 kWh had been generated from 6 June 2007. This would equate to 110 kWh over 97 days or about 1.1 kWh per day.

6. Summary and Conclusions

The Windyhomes Project, a partnership of five local authorities, and supported by the Environment Centre in Southampton, set out to undertake site trials of one model of small building-mounted residential wind turbine (BMWT), the Windsave, as well as to investigate what the public will experience in the process of installing, or attempting to install a unit on their home. As has been mentioned at several points within this report, the results of the trials can only be taken as indicative, due to various limitations, in equipment, expertise, circumstances, the low number of sites, and, as at the date of this interim report, the short time period within which that the units were monitored.

The Project set out to investigate:-

- the process of installation and availability of the technology
- public perception of residential wind turbines, planning permission, the Low Carbon Buildings Programme, and reasons why, or why not, people were willing or able to go ahead with the installation
- environmental impacts, such as noise and visual intrusion
- generation levels in relatively 'good' sites within a residential environment.

In order to determine these aspects, a range of tools were used including questionnaires, interviews, and the manual monitoring of both windspeeds – using an anemometer and Wind Prospector data logger – and generation – by reading this from the Windsave inverter display.

In summary, the Project found that

1. The process of arranging for a survey and installation was dogged by delays and problems, due to a lack of properly trained surveyors and installers, apparent administrative and communication problems, and the necessity of upgrading the entire stock of units during the time period of the trials. There was also a high percentage, about 30% of those responding to the questionnaire, who found that the building or its immediate environment was unsuitable for a wind turbine.
2. The public felt that the process was overly complex, with insufficient support available. Although there was generally a willingness to pay for the technology for the wider societal good (climate change, fossil fuel depletion) there seemed to be a widespread expectation that the units should have a payback time of about 5 years. This is highly optimistic, and would require generation levels that saved about £200 per year, or more, depending on capital cost and fuel prices.
3. There was an initial issue with noise due to vibration transmitted through the building. This was also heard by the neighbour of one site, and was described

variously as a "foghorn", a "low-flying plane", or a "lathe". However, the attachment of a rubber gasket reduced this to what was considered acceptable levels. One neighbour also reported that there was a slight light flicker on sunny windy days, and which led her to leave the room. This may still need further investigation. One site reported that they had found two pigeons, one decapitated, just outside their house.

4. The generation levels were very poor, ranging from 0.15 kWh per day to just over 1 – this last was on a site directly facing the Solent (albeit during the spring/summer months). At about 9p per kWh, this suggests that the units would pay back their cost in very approximately 25 years. Factors that may have contributed to this low generation level were that most of the readings (though not all) were taken over spring and summer months, one site was required by planning to brake the unit between 11pm and 7am, and readings for the one site that were taken over winter were prior to the upgraded inverter being installed. The generation levels were also in reasonable agreement with the level of wind hitting the roof of the primary site, indicating that the issue is with availability of wind, rather than poor efficiency of the technology.

The Government support was based on the assumptions that the widespread take up of residential wind turbines would be best supported by offering capital grants, removing or lessening the constraints of planning permission, and increasing the price paid by utility companies for exported electricity. However, the above demonstrates that the obstacles are more fundamental than this.

The Windyhomes Project cannot comment on the availability or ease of installation of other small models, which may be better than that found in the Windsave. The Warwick Wind Trials have been looking at the smaller turbine, the Ampair[9].

However, the results in this study – both those referring to generation and to the actual power in the wind experienced at the roof level of the primary site, which are in reasonably close agreement with each other and with 3 other sites, appear to indicate that in this kind of environment, and/or with a placement in this position, there is simply insufficient windpower available to justify the cost, and the trouble, of getting one installed, at least if it is of this traditional type of turbine design.

Assuming that other potential problems, such as light flicker and inverter efficiencies, can be resolved or improved, the recommendations from the trials would be that further research into the dynamics of the wind in a complex built up residential area needs to be carried out. Armed with a greater understanding of this, the emergence of either new designs, or improved siting, may be found to be more effective at exploiting this resource in a much wider array of environments and situations. If the Government wishes to support the uptake of residential wind, it might find that funding, or facilitating, this research proves to be the most effective way to proceed. Otherwise, the use of current

[9] See www.warwickwindtrials.org.uk

traditional horizontal-axis design turbines may only be viable in severely restricted circumstances.

Another suggestion to make best use of what windpower is available in these circumstances is to use a DC current, delivered to DC appliances or a storage medium, as it was discovered that a great deal of the wind energy was wasted because any AC electricity generated that did not match the grid voltage was wasted.

The Windyhomes Project intends to complete its montoring of the turbine in Eastleigh in March 2008; this will then include winter winds in the average annual generation. However, a much larger study, the Energy Savings Trust trials[10], will investigate a variety of BMWT models in a range of circumstances, covering 100 sites and a full year of monitoring. The results of these trials should be able to give some more definitive answers and further guidance on the best way forward to further development of residential wind power.

[10] jointly funded by EST's partners, including B&Q, British Gas, EDF Energy, E.On UK, Northern Ireland Electricity, RWE, Scottish & Southern Energy and Scottish Power

APPENDIX 1

MEMBERS OF WINDYHOMES PROJECT GROUP

Helen Caan	**East Hampshire District Council**
Rosemary Chase	**Havant Borough Council**
Beverley Draig **Jane Altounyan**	**Eastleigh Borough Council** **Researcher, Eastleigh Borough Council**
Kevin Ennis	**Basingstoke & Deane Borough Council**
Carol White & **Lisa Talbot**	**Gosport Borough Council**
Laura Wood & **Tom Galpin**	**The Environment Centre, Southampton**

APPENDIX 2

The 'Windyhomes' Questionnaire
April 2007

This questionnaire should take no more than 30 minutes.
Please return in the enclosed stamped self-addressed envelope by Friday 18 May 2007.
The results of the questionnaire will be included in the Project Report.

Data Protection note
Any personal details of participants in the Windyhomes and/or Respondents to this Questionnaire are to be kept strictly confidential and will not be put into the public domain without express written consent. Only the answers to the questionnaire, and the area/post codes are relevant to this study. However, the questionnaires will be retained as verification for University of East London, or the relevant Local Authority, that the statistics derived are valid.

Name: ____ **Post Code: ____________**

1. General Questions – All participants

1.1 Personal Circumstances

Please tick *one* box in each section that fits your situation:-

a. Household composition

Family with one or more children	☐
Single Parent with one or more children	☐
Couple	☐
Single	☐
Other/Mixed	☐

b. Economic group   Please indicate *primary* source of income

Living on a Pension	☐
One or both adults in full-time employment	☐
One of both adults in part-time employment	☐
Other ___________	☐

c. Building type

Two (or more) storey house	☐
Bungalow	☐
Semi-detached	☐
Terrace	☐

d. Please describe the building fabric of your home, eg brick with cement mortar, etc

____

1.2 Relationship to Microgeneration/Energy efficiency

a). Please indicate in order of priority by putting a '1' in the box of greatest importance, a '2' in that of 2nd most importance, and so on, for the reason that you wished to install a roof mounted wind generator.

A. Environmental/climate change ☐
B. An awareness of dwindling energy reserves ☐
C. To save money on electricity ☐
D. To add to value/desirability of property and/or to take advantage of a local council tax reduction scheme to reward energy conservation measures. ☐
E. Other (please state) _________________________________ ☐
____

b). If you have any other renewable energy source in your dwelling, please indicate this with a tick:-

A. Solar water heating ☐
B. Solar photovoltaic for electricity ☐
C. Ground or air source heat pumps ☐
D. Biomass (wood pellet boiler) ☐
E. Biomass (traditional wood burning stove) ☐
F. Other (please state) _______________________ ☐
G. None ☐

c.) Did you find it difficult to find information about installing renewable energy and/or energy efficiency in your home?

☐ **Y**
☐ **N**

d.) Do you think that you are more aware of your own use of energy in the home as a result of participating in the process of installing or attempting to install a wind turbine?

☐ Y
☐ N

c). Would you have considered installing a roof mounted wind generator if there were no Government grants

☐ Y
☐ N

d). If you can please indicate the most you feel you would be willing to pay or contribute for a roof mounted wind turbine — £ _______

e). Whether or not you put 'payback' as a important aspect to your wishing to install a wind turbine, is it essential that the turbine will pay for itself within a 'reasonable' timescale? — ☐ Y ☐ N

f). If you ticked "Y" above, please give an estimate of the number of years you would expect the turbine, or another micro-generation product, to pay for itself. — Years____

g.) Did you intend or wish to sell the excess electricity back to your electricity supplier? — ☐ Y ☐ N

h.) Was the Council's involvement crucial to your feeling confidence in the technology and process? — ☐ Y ☐ N

i.) Did you carry out any research on your own to determine the potential output of the turbine, and/or any other potential issues that may arise? — ☐ Y ☐ N

j.) If you asked your neighbours of their concerns about your installing a roof mounted wind turbine, were they '1' = unconcerned, '2' = neither nor unconcerned, '3' = concerned, '4' very concerned, or '5' = you did not speak directly to them. — ☐

1.3 The Low Carbon Buildings Programme Grant Programme (LCBP)

a.) Did you need to carry out any additional energy efficiency measures to your dwelling to become eligible for the grant? — ☐ Y ☐ N

b). If you applied for a LCBP grant for the wind turbine, please indicate the number of times that you attempted to do so prior to your either being successful, or abandoning the effort altogether. — ☐

c.) Were you allocated a grant? — ☐ Y ☐ N

d.) Please indicate the ease or difficulty that you found this process by putting a '1' for very easy, '2' for easy, '3' for neither easy nor difficult, '4' for difficult, and '5' for very difficult. — ☐

e.) Would you say that the Low Carbon Buildings Programme Grant programme meant that you proceeded sooner than you otherwise would have to install a turbine, due to the financial — ☐ Sooner ☐ Later help, or later because you were waiting to get a grant? ☐ Neither

f. If you sought help from the LCBP, did you use the website?
g. Did you find the LCBP staff helpful if you sought help by telephone?

h.) Please indicate what you assumed that the accreditation of the wind turbine and manufacturer by the Low Carbon Buildings Programme would guarantee.

____

____

____

____

1.4 Questions regarding the preliminary survey to be carried out or that has been carried out by the installation company.

a.) Please indicate with the appropriate number in the box, how easy or difficult it was to arrange for the survey to be carried out, by putting a '1' for very easy, '2' for easy, '3' for neither easy nor difficult, '4' for difficult, and '5' for very difficult. ☐

b.) Please indicate with the appropriate number in the box, how competent or incompetent you felt the staff member carrying out the survey appeared to you to be by putting a '1' for very competent, '2' for competent, '3' for neither competent nor incompetent, '4' for incompetent, and '5' for very incompetent. ☐

c.) Please indicate what aspects of the turbine installation and operation you assumed that the survey by the installation company would cover.

____

____

____

d.) Was the staff member carrying out the survey able to answer all your questions?

e.) If no, do you recall what questions they were unable to answer.

f.) Any other comments about the survey

____

____

____

2. Have you applied or attempted to apply for Planning Permission for the turbine? ☐ **Y** ☐ **N**

2.1 If Yes: Questions for those who applied – or attempted to - apply for Planning Permission:-

a.) Were you given a clear advice on the required procedure and supporting documentation to apply for planning permission ☐ Y ☐ N

b.) Did you have to provide additional clarification, information or documentation after submitting the application? ☐ Y ☐ N

c.) Did the Local authority waive (or pay for you) the planning fee? ☐ Y ☐ N

d.) Please indicate by putting a '1' in the box if you were given the impression that the Planning staff were supportive of the installation, '2' if unsupportive or resistant, and '3' if neither. ☐

e.) Please indicate how long it took the planning department to rule on your application, in weeks ________weeks

f.) Were you granted planning permission? ☐ Y ☐ N

g.) Please indicate below if there were there any restrictions on the permission – if none, please write none.

____

____

h.) Please indicate below the most difficult aspect of applying for / obtaining planning permission.

____

i.) Please indicate below what could have made the process of obtaining planning permission easier, if any.

____

____

3. Do you intend to proceed with the installation? ☐ Y ☐ N

3.1 If, no: A Question for those who are not proceeding with the installation.

Please indicate below as clearly as possible the reason or reasons if more than one, that you are not proceeding with the installation.

____

____

____

____

4. General final questions for all Respondents.

a.) Please indicate, in order of difficulty, the aspect of the entire process that you found the biggest obstacle, '1' representing the most difficult, '2' the second most difficult, and so on.

A. Doubt or lack of information. ☐

B. The cost. ☐

C. Arranging for or waiting for the survey. ☐

D. Applying for Planning Permission ☐

E. Applying for the Low Carbon Building Programmes Grant ☐

F. Arranging for installation ☐

G. Other (please state) ________________________________ ☐

b. Any other comments or recommendations to improve matters.

____

____

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

APPENDIX 3 - Questionnaire Results						
	1	2	3	4	5	
	Y	N	maybe			
1.1a	**Household Composition**					
A	19		38%			Family w children
B	1		2%			single parent
C	25		50%			couple
D	2		4%			single
E	3		6%			other/mixed
1.1b	**Economic group**					
A	19		38%			Pension
B	25		50%			full time employment
C	2		4%			part time
D	4		8%			other
1.1c	**Building type**					
A	26					2+ detached
B	5					bungalow
C	11					semi-detached
D	7					terrace
1.2a	**Reasons for interest**					
	First	**Second**	**Third**	**Fourth**	**Fifth**	
A	18	20	6	3	0	Env/climate change
B	17	16	11	0	0	dwindling energy reserves
C	13	7	24	1	1	save money on electricity
D	0	3	2	30	2	improve property value
E	1	1	1	1	0	other (interest)
						(interest in wind/results)

	1	**2**	**3**	**4**	**5**	
	Y	N	**maybe**			
1.2b	**Other renewable source?**					
A	10					solar water
B	1					PV
C	1					Heat pump
D						biomass- wood pellet
E	11					biomass - wood burner
F						other
G	20					none
1.2c	**Difficult to find info**					
	16	30				
N/A	2					
1.2d	**More aware?**					
	29	18				
N/a	1					
1.2e	**Considered it with no grants?**					
	33	15				48
	69%	31%				
1.2f	**How much would you be willing to pay**					
250	300	400	500	700	900	1000 –1500 –2000 –3000 – 5000-
1	1	1	5	1	1	9 – 14 – 6 – 1 - 1
1.2g	**Essential to payback in reasonable timescale?**					
	39	9				48
	81%	19%				
1.2h	**Payback years = reasonable**					
1-5	29		88%			"half of expected life"
6-10	10		30%			
10-20	1		3%			
>20						

	1	2	3	4	5	
	Y	**N**	**maybe**			
1.2i	**Wish to sell back?**					
	32	17				
1.2j	**Council's involvement crucial?**					
	27	18				
	60%	40%				
1.2k	**Carry out own research?**					
	34	14				
1.2l	**Were neighbours concerned?**					
	7	4	2	3	26	
1.3a	**LCBP - need to carry out addl e/e to be eligible?**					
	5	8				
Didn't apply	29					
1.3b	**Times needed to apply**					
	6	1		1		
1.3c	**Given a grant?**					
	5	6				
N/A	2					
1.3d	**Ease of applying**					
	1	4	2	2	2	
N/A	2					
1.3e	**Did grant make you buy sooner/later/neither**					
	A	B	C			
	4	2	5			
	sooner	later	neither			

	1	2	3	4	5	
	Y	N	maybe			
1.3g	**Helpline helpful?**					
	2		1			
1.4a	**How easy to arrange for survey**					
	13	7	5	6	5	36
	41%	22%	16%	19%	16%	
1.4b	**Competent / incompetent surveyor**					
	3	12	12	3	5	35
	9%	34%	34%	9%	14%	
1.4d	**Could surveyor answer all questions?**					
	22	11				33
2	**Applied for PP?**					
	8	27				
2.1a	**Clear advice given by Planning Dept?**					
	6	2				
2.1b	**Had to provide addl clarification, info, doc**					
	5	3				
2.1c	**Did LA waive planning fee**					
	4	4				
2.1d	**Did you feel Planners were Supportive?**					
	5	1	2			

APPENDIX 4

1.3h	What did you assume LCBP approval meant?
	"That they were a professional & reliable company"
	"That the government is making a bonfide subsidy for the purpose of creating energy from sustainable sources"
	"Nothing much"
	"Reliability - conformity with stated output"
	"Simply that the full power output of the turbine offered was 1kW, ie a relatively small proportion of my peak demand but a significant energy contribution taken over 24 hours"
	"It would work and be viable"
	"The turbine to be of good quality and to have good energy efficiency"
	"Nothing!"
	"That the product and company had been inspected and possibly tested by the LCBP. And that the company were reliable and trustworthy"
	"Efficiency"
	"a supply of cheap electric always"
	"That it would be efficient ie the environmental cost of production of the turbine would be outweighted by its environmental benefits"
	"Nothing"
	"Guarantee that a high standard of workmanship would be underwritten by accreditation. That any installed turbine would be built to accredited standards"
	"The product would actually work! And could be available"
	"That it would perform to specification"

1.4 f	other comments about survey
	"It took several chases before it was done and the surveyor told B&D rep it had already been done before it was"
	"Any site would 'do'"
	"No consideration was given to the stability of the wall selected for turbine erection"
	"An honest opinion granted for free"
	"At the moment, it is highly frustrating that no progress seems to be made .. Getting a survey about the viability of a turbine seems to be grounded - stuck"
	"Two surveys done - first survey no confidence in staff. I was told my house was unsuitable - too close to neighbours house, which was also too high. This was second survey - first survey did not mention any problems"
	"I felt that my time with the surveyor was wasted and I am sure I knew more about the install and product than he did!"
	"It needed a better qualified engineer from the start who would have decided on first visit our wall wasn’t strong enough."
	"Two dates were arranged for a survey and despite confirmation emails nobody turned up - even took day off work to meet the surveyor"

"It took three attempts to arrange the survey" - "First time they turned up after I had told them it wasn't convenient the day they had suggested!"
"I know it was pioneering but the staff really didn't seem to know what they were talking about"
"Answered questions, but gave the impression of being new to the job and not all answers were convincing"
"Second visit was more useful. Second surveyor pointed out problems with trees surrounding property and probable limited generation possibilities"
"Company approached changed and then missed appointment and have not been in contact since"
"First survey got it all wrong - location, fixing and direction"
"Received second survey to clarify ease of access. Able as a result to suggest modification to placement of inverter"

2.1	**Planning**
	Didn't apply for planning. Installed after own research decided it was allowed in rules.
	Perhaps more liaison with suppliers would help move it.
	"None [what could have made process easier] - the process is simple"
	"More support. Perhaps knowing we could ask someone to do this for us"
	"Information required is onerous for a full planning application. Never had time available"

3	**Not proceeding**
	"Prefer to go it alone. The person giving the talk at the town hall seemed to know less than we already did"
	"Output of electricity was pathetic - just about a kettle's worth on a good day"
	"Windsave presentation oversold the output from the turbine. My own research indicated much less from my type of site (semi-rural with lots of trees). Also position on my home not easy for maintenance."
	"I will consider more economical and more simple options first" (might still install)
	"Disappointed that my 'older' building was not suitable. Have always bought older bldgs on env grounds. Don't have enough funds to go for solar panels or rainwater harvesting - can't even get biofuel locally. Feeling somewhat frustrated on the 'green front'"
	"Not cost effective - I will be dead before it pays for itself"
	Payback and "limited choice of fixing for turbine"
	"I have asked Windsave or representatives various questions and have not been given answers to several of these. They have failed to contact us with availability of poles, dampers & even the turbine itself. We feel that the whole process has been a disappointment and waste of our time and very let down by Windsave. they do come across as very incompetent"

"The surveyor could not give me any real estimate [of output] - the reason I since discovered is that they are totally unsuitable for urban environment" - "I would have loved to invest in the turbine - good help from Council - but I am sad to say the turbines are not yet developed enough for our type of environment" - "there is a turbine installed in a house near Bishopstoke .. on the 50 or so times I have checked I have never seen it turning!"
"Disillusioned with the contractor - if customer service is this poor in a resale mode, goodness knows what it would be post sales"
"We hope eventually planning permission will not be required. We are also concerned re: publicity that electricity generated is minimal"
"Was informed that would need a controller in the bedroom that had a fan and would create a constant "hum" computer noise at night. Media coverage that generation from domestic wind turbines was low. Obstacles of planning and grant applications. Even with £600 EBC grant did not stack up financially" --- "It seems that the technology is not yet ready for domestic market. Possibly doubtful that wind generation will work on single properties unless very favourable location and constant wind"
"Entry into the scheme this early involves risks"
4 **Ways to improve**
"People arent' used to waiting so long or having such a complex process to get a new appliance - should make the process more seamless"
"Currently it is required to get quotes to obtain a grant, however if prior to this we could get an indication of available grant in order to assess viability before wasting surveyors/companies times"
"I don't think small systems are viable - microgeneration … has become a green fashion item!"
Help on drawing plans for planning
"Overall approach a bit woolly. We should have been given more info re output, max, min, etc"
Try to convince Govt to give 90% grants … until payback can be achieve in max 3 years majority of homeowners will not consider as an energy saving option" also "couldn't get positive feedback that our mains e- supplier would buy or credit us with excess electricity - all very 'iffy'"
"When dealing with installations in urban areas, small details are significant. In the case of wind generation, knowing general averge wind speeds is inadequate. Local conditions only apply. Sales and survey personnel need to be better equipped with these data if real progress is to be made"
"Perhaps Councils could advertise wind turbines or other types of RE. There seems to be a lot of people in this business but could I do it myself or employ someone to do it for me? Who can I rely on to do the job properly?"
"Better advertising and scope from Council"
"I contacted B&Q some weeks ago. None of staff really know about wind turbines. I waited for anhour in the Eastleigh store for someone to come forward.. Despite leaving address & phone no one has contrcted me. No one at B&Q seemed to know about the project"
"It would be much easier to get turbines installed if step by step instructions were to be available. At the moment, everthing seems muddled and confusing"
"Not having to supply detailed drawings"

"Whilst my initial drive has been tempered by inaccurate and incomplete information, I will at a time convenient proceed with the turbine. Apathy from suppliers has tested the resolve to continue with this project. For other less driven it would have been very short brush with Windyhomes"
I would still like to use more 'green' measures to heat & light my home but cost is main barrier"
"Use of OS maps or even Google Earth would enable a quick decision to be made on suitability. Windspeed is the key to making this viable or not"
"It would be great if there was an organization who could guide our household on what themost cost-effective green measures we could install"
"The survey could have been avoided if the initial contact had asked if high trees were in close proximity to the house"
"If some basic criteria had been supplied (eg no trees within N meters, basic house construction requirements, then survey would have been unnecessary as it would have been clear that the site was not suitable"
"I am beginning to wonder if this is worth the effort"
"Poor communication between Windsave and installers"

Appendix 5 – Generation Data from Poole site

Date	kWh as read from Windsave inverter	
23/4	1.4	
24/4	1.4	
25/4	1.4 – 1.6	
26/4	1.6 – 1.7	
27/4	1.7	
28/4	1.7	
29/4	1.7	
30/4	1.7 – 2.0	
1/5	2.0 - 2.2	
2/5	2.2 – 2.6	
3/5	2.6	
4/5	2.6	
5/5	2.6	
6/5	2.6 – 3.5	*strong winds – fan cutting in at intervals*
7/5	3.5 – 5.3	"
8/5	5.3 – 6.9	"
9/5	6.9 – 8.7	"
11/5	9.9 – 11.3	*windy*
12/5	11/3 – 13.2	"
13/5	13.2 – 13.8	*moderate breeze*
14/5	13.8 – 15.2	*windy*
15/5	15.2 – 15.6	*moderate breeze*
16/5	15.6 – 15.8	*light breeze*
17/5	15.8 – 17.1	*windy*
18/5	17.1 – 18.5	"
19/5	18.5 – 19.3	*moderate wind*
20/5	19.3	*slight breeze*
21/5	19.3	"
22/5	19.3 – 19.4	*light breeze*
23/5	19.4	*slight breeze*
24/5	19.4	"
25/5	19.4 – 19.6	*increasing breeze*
26/5	19.6 – 20.0	*moderate breeze*
27/5	20.0 – 20.1	*light breeze*
28/5	20.1 – 21.3	*windy*
29/5	21.3 – 21.6	*moderate breeze*
30/5	21.6 – 22.5	*windy*
31/5	22.5 – 23.1	*windy*

22.4 kWh/23 days = 0.6 kWh/day average <u>daytime generation only</u>

June 2007

1/6	23.1-23.1	*still or slight breeze*
2/6	23.1	"
3/6	23.1-23.2	"
4/6	23.2	"
5/6	23.2	"
6/6	23.2-23.3	"
7/6	23.3	"
8/6	23.3	"
9/6	23.3	"
10/6	23.3-23.4	"
11/6	23.4	"
12/6	23.4-23.6	*slight to moderate breeze*
13/6	23.6	*still or slight breeze*
14/6	23.6-23.7	"
15/6	23.7-24.1	*moderate to brisk breeze*
16/6	24.1-24.7	*brisk breeze*
17/6	24.7-24.8	*slight breeze*
18/6	24.8-25.8	*windy*
19/6	25.8-26.2	"
20/6	26/2-27.2	"
21/6	27/2-28.0	"
22/6	28.0-28.1	*still, light breeze later*
23/6	28.1-28.3	*still, moderate breeze later*
24/6	28.3	*still, slight breeze*
25/6	28.3-29.4	*windy – fan on later (turned turbine off 10pm -*
26/6	29.4-30.1	*sounded under stress)*
27/6	30.1-30.7	*windy*
28/6	30.7-31.7	"
29/6	31.7-32.6	"
30/6	32.6-33.1	"

The Unit was replaced on 4th July.

5/7	1.3-2.9	*windy*
6/7	2.9 – 4.8	*very windy*
7/7	4.8 – 5.1	*moderate breeze*
8/7	5.1 – 5.5	"
9/7	5.5 – 5.9	*light breeze*
10/7	5.9 – 6.1	"
11/7	6.1 – 6.8	*moderate*
12/7	6.8 – 7.1	*light breeze*
13/7	7.1 – 7.5	"

14/7	7.6 – 8.1	*moderate*
15/7	8.1 – 8.1	*light breeze*
16/7	8.1 – 8.3	*“*
17/7	8.3 – 10.7	*very windy – fan came on at intervals*
18/7	10.1 – 11.1	*moderate breeze*
19/7	11.1 – 11.1	*light breeze*
20/7	11.1 – 11.5	*moderate breeze*
21/7	11.5 – 11.6	*slight breeze*
22/7	11.6 – 11.9	*“*
23/7	11.9 – 11.9	*still*
24/7	11.9 – 12.4	*moderate breeze*
25/7	12.4 – 14.5	*very windy – fan on at intervals*
26/7	14.5 – 17.2	*very windy – fan on at intervals*
27/7	17.2 – 17.8	*windy*
28/7	17.8 – 18.1	*moderate breeze*
29/7	18.1 – 18.5	*light breeze*
30/7	18.5 – 18.6	*slight breeze*
31/7	18.6 – 18.7	*“*

August

1/8	18.7 – 18.7	*still then slight breeze*
2/8	“	*“*
3/8	18.7 – 19.0	*slight then breeze*
4/8	19.0 – 19.2	*light breeze*
5/8	19.2 – 19.4	*“*
6/8	19.4 – 19.9	*breezy*
7/8	19.9 – 20.0	*light breeze*
8/8	20.0 – 20.1	*“*
9/8	20.1 – 20.2	*“*
10/8	20.2 – 20.3	*“*
11/8	20.3 - 20.3	*still then slight breeze*
12/8	20.3 – 20.8	*breeze increasing*
13/8	20.8 – 21.6	*windy*
14/8	21.6 – 24.9	*gales! – fan on often (BIG DAY!)*
15/8	24.9 – 27.2	*very windy – fan on often*
16/8	27.2 – 27.6	*breezy*
17/8	27.6 – 28.0	*“*
18/8	28.0 – 29.2	*windy*
19/8	29.2 – 31.1	*very windy*
20/8	31.1 – 31.2	*slight breeze*
21/8	31.2 – 31.4	*“*
22/8	31.4 – 31.7	*“*
23/8	31.7 – 31.8	*“*
24/8	31.8	*still, slight breeze*
25/8	31.8	*“*

26/8	31.8	“
27/8	31.8	“
28/8	31.8	“
29/8	31.8 – 31.9	*slight breeze*
30/8	31.9	“
31/8	31.9 – 32.2	*light breeze*

32.2 kWh over 57 days = 0.54 kWh day <u>daytime generation only</u>

References

AECB (2007) *Network* May 2007

Bahaj A S, Myers L, James P A B (2007) *Urban Energy Generation: Influence of micro-wind turbine output on electricity consumption in buildings* Energy and Buildings Vol 39 Issue 2 154-165.

Bickers-Jones, W. (2006) HECA Officer, Southampton City Council, *pers comm.*.

Boira-Segarra, I.& Luby, S.(2004) *Re Integration – Can the UK Electricity Networks Accommodate the 2010 Renewable Target?* ReFocus July/August 2004

Burton, T, Sharpe, D, Jenkins, N, Bossanyi, E (2001) *Wind Energy Handbook* John Wiley & Sons Ltd

Cardy, A. (2007) Estates Director, University of Portsmouth *pers comm.*

DTI (2005) *Potential for Microgeneration : Study and Analysis* Final Report 14 November 2005 Prepared by the Energy Savings Trust

DTI (2006) *Our Energy Challenge: Microgeneration Strategy: Power from the People* DTI UR 06/993

DCLG (2006) Householder Development Consents Review, Steering Group Report

Dayan, E (2006) *Wind Energy in Buildings* REFOCUS March/April 2006

Dutton A G, Halliday A J, Blanch M J (2005) *The Feasibility of Building-Mounted/Integrated Wind Turbines (BUWTs) : Achieving their potential for carbon reductions Final Report* Energy Research Unit, CCLRC

Electrical Safety Council (2007) *Connecting a Microgeneration System to a Domestic or Similar Electrical Installation (in Parallel with the Mains Supply)* Best Practice Guide

Elliott, D. (2006a) Editorial, *Renew*, Issue 163, Sept/Oct 2006, p. 4

Elliott, D. (2006b) *Micropower Doubts* RENEW, Issue 164 Nov/Dec 2006

Encraft Limited (2007) *The Warwick Urban Wind Trial Project Interim Report* March 2007 www.warwickwindtrials.org.uk

Energy Savings Trust (2004) *Installing small wind-powered electricity generating systems – Guidance for installers and specifiers* – Energy Efficiency Best Practice in Housing.

Energy Savings Trust (2007) *Outline Proposal for Monitoring of Micro-wind Installations on Domestic Dwellings in the UK*

Farhar B.C. (1999) *Willingness to Pay for Electricity from Renewable Resources: a Review of Utility Market Research* NREL July 1999, *quoted in* (DTI 2005) above.

Gipe, P. (1999) *Wind Energy Basics* Chelsea Green Publishing Co.

Gipe, P. (2000a) *Noise from small wind turbines: an unaddressed issue*. *www.wind-works.org/articles/noiseswt.html*. *Accessed October 2006.*

Gipe P. (2000b) *Testing the Power Curves of Small Wind Turbines* www.wind-works.org *accessed October 2006*.

Herring, H., Roy, R. & Caird, S. (2007) *'Grey greens' go solar? Consumer Adoption and use of renewables* RENEW 167 May/June 2007.

Hunt, M. (2007) *Micro wind – a reality check* RENEW 166 March/April 2007

Marsh, G. (2006) *How Much Can the Grid Accommodate?* ReFocus Jan/Feb 06

Martin, N (2005) *Can we harvest useful wind energy from the roofs of our buildings?* Building for a Future Vol. 15 No 3 Winter 2005/06

Martin, N and Watson, M. (2007) *Microwind installations for residential dwellings in the UK: Detailed technical specification for field monitoring* Energy Monitoring Company for the Energy Savings Trust

Mertens, S (2003) *The energy yield of roof mounted wind turbines* Wind Engineering Vol 27 No 6 pp 507-518.

SEA/RENUE (2005) *Urban Wind Feasibility Study* April 2005

Shore, J. (2006) *Warning about roof-top wind turbines* AECB Newsletter November 2006.

Snook, G. (2007) Head of Estates, City College Plymouth, *pers comm.*

Syngellakis, K, Robinson, P., Carroll, S. (2006) *Urban wind turbines: Development of the UK Market* , Wineur Intelligent Energy Europe Programme, funded by the European Commission *www.urban-wind.org*

Syngellakis, K., Prentice, K. (2006) *Wind energy integration in the urban environment: administrative and planning issues – United Kingdom Country Report* Wineur IEEP as above.

Taylor, D. (2005) *Micro and Small Wind turbines* Building for a Future Vol. 15 No 3 Winter 2005/06

Twidell J and Weir, T (1986) *Renewable Energy Resources* E & FN Spon

Van den Berg, G.P. (2004) *Do wind tubines produce significant low frequency sound levels?* 11th International Meeting on Low Frequency Noise and Vibration and its Control, Maastricht, The Netherlands, September 2004.

Wineur (2006) *Urban Wind Turbines, Technology Review. A companion text to the Catalogue of European Urban Wind Turbine Manufacturers*