Institution: University of Southampton

Unit of Assessment: 15 General Engineering

Title of case study: 15-31 Micro-Wind Turbines: Field Trial And Policy Impacts

1. Summary of the impact

The University of Southampton's research into micro-wind turbines – small-scale devices for generating electricity at the point of use – has been instrumental in the shift away from turbines mounted on buildings in urban areas to more productive pole-mounted devices in the countryside. It has informed public understanding of the potential and limitations of micro-wind power, and helped inject a new realism into the process of micro-wind power generation, forcing manufacturers to retreat from claims that could not be met. The research has been used to help set government subsidy levels for micro-wind power, and as a basis for modelling projections of future energy.

2. Underpinning research

Micro-generation of electricity provides an opportunity for households to become 'mini power stations' by means of turbines fixed to the house or mounted in the garden that harness the power of wind, or photovoltaic cells that convert sunlight to electricity. A current team from the University of Southampton's Faculty of Engineering and the Environment, Dr Patrick James (Senior Lecturer in Energy and Buildings), Dr AbuBakr Bahaj (Professor of Sustainable Energy) and Dr Luke Myers (Lecturer in Thermofluids) carried out a study in 2004-06 funded by the Economic and Social Research Council (ESRC, RES-338-25-003, £205K) [3.1] which looked at three micro-generation technologies: photovoltaics, micro-CHP (combined heat and power) and micro-wind to try to determine whether they were suitable for large-scale uptake. The study included analysis of wind speeds across a number of UK sites, and the development of tools to predict the power output of wind turbines located on or near buildings. In the resulting report, Myers predicted micro-wind turbine yields significantly lower than those claimed at the time by the industry trade body [3.1, 5.3].

In 2007 the Energy Saving Trust (EST) appointed the University of Southampton with funding of £68,000 to undertake the data analysis component of a study to look at both building-mounted wind turbines and more powerful pole-mounted turbines [3.5]. Southampton selected the sites to be monitored from an existing pool of 600 grant-funded micro-wind turbine sites in the UK. The researchers looked at the impact of location on wind turbine performance, and determined the threshold wind speeds below which it was not viable to install wind turbines. No other study has provided such a comprehensive analysis of micro wind turbine performance in the built environment. James led the data analysis and reported to the trial steering committee, which included key policymakers and major industrial partners such as the Scottish Government, the Department for Environment, Food and Rural Affairs (DEFRA), the home improvement retailer, B&Q, as well as several of the UK's main energy suppliers, including EDF Energy, Npower, NIE Energy, and others.

The research demonstrated conclusively that micro-wind turbines mounted on buildings perform very poorly, some actually consuming more power than they generate. Even at the best sites, exposed rural areas, annual yields were still far lower than the estimates produced by industry modelling tools. No building-mounted turbine in the trial had a financial payback time within the expected life of the device.

By relating wind speed observations at the test sites with national windspeed maps, James assessed the market potential for micro-wind using both building and pole-mounted turbines. When DEFRA farm statistics were overlaid with the wind speed data to estimate the potential number of turbines across the UK, it was clear there was significant potential for exposed, agricultural farms as sites for pole-mounted turbines. At the request of the Department of Energy and Climate

Change (DECC) the research was extended to provide projections for future levels of micro-wind power generation. The entire research team, including Dr Arif Anwar, who oversaw the statistical integrity of the work, remains in place at the University of Southampton.

3. References to the research (the best 3 illustrating quality of work are starred)

3.1 Unlocking the power house: policy and system change for domestic micro-generation in the UK. Watson J., Sauter R., Bahaj A.S., James P.A.B., Myers L.E. and Wing R., ISBN 1-903721-02-4 (2006) http://eprints.soton.ac.uk/53362/

3.2* Bahaj A.S., Myers L.E. & James P.A.B., Urban energy generation: Influence of micro-wind turbine output on electricity consumption in buildings, *Energy and Buildings*, Vol. 39, Issue 2, pp 154-165, 2007.
doi: 10.1016/j.enbuild.2006.06.001

3.3* James P.A.B., Sissons M.F., Bradford J., Myers L.E., Bahaj A.S., Anwar A. & Green S., Implications of the UK field trial assessment of building mounted horizontal axis microwind turbines, *Energy Policy*, Vol. 38, Issue 10, pp 6130-6144, 2010
doi: 10.1016/j.enpol.2010.05.070

3.4* Sissons M.F., James P.A.B., Bradford J., Myers L.E., Bahaj A.S., Anwar A. & Green S., Pole-mounted horizontal axis micro-wind turbines: UK field trial findings and market size assessment, *Energy Policy*, Vol. 39, Issue 6, pp 3822-3831, 2011.
doi: 10.1016/j.enpol.2011.04.012

3.5 Energy Saving Trust, micro-wind data analysis contract, £68K, 2007-2009
James P.A.B., Bahaj A.S., Myers L.E. & Anwar A.
Location, location, location: Domestic small-scale wind field trial report, Energy Saving Trust, July 2009 http://eprints.soton.ac.uk/353113/

3.6 HM Government, 2050 Pathways Analysis, July 2010, pp212-215
Available from:
http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/2050/216-2050-pathways-analysis-report.pdf
Analysis provided direct to DECC at their request.

4. Details of the impact

The EST report containing the data and analysis provided by the University of Southampton was widely covered in the national and regional media in July 2009, including on BBC News, and the University of Southampton researchers gave a number of media interviews [5.1]. The research was frequently cited in reports about the problems besetting manufacturers of micro-wind turbines; one manufacturer, Ampair, was forced to amend the specification of their Ampair600 device as a result of this study. B&Q and Windsave are two examples of major players in the micro-wind market to whom James delivered presentations about the research and its implications in 2008. After the report was formally released, B&Q withdrew from micro-wind generation altogether, refunding customers who had bought its domestic wind turbines [5.2]. Its turbine supplier, Windsave, ceased trading within two months of the release of the EST report, citing their products being dropped by B&Q as part of the reason on their website.

Another major impact of the research has been to halt the practice of siting significant numbers of micro-wind turbines in the built environment and to persuade the industry to be far more circumspect about site selection if it wants to avoid the charge of mis-selling its products. According to the *Small Wind Systems: UK Market Report 2012* published by the British Wind Energy Association (BWEA – see [5.4]) there were only 4 building-mounted turbines installed in 2011, compared to a peak of 1054 in 2007. In contrast, the pole-mounted market (1.5-15 kW) was

975 turbines in 2011, an increase of 57% on the 2007 figure. The total sales value of the UK micro-wind industry in 2011 was £50 million. The new focus is on mounting turbines on poles in rural locations - BWEA, cited Southampton's research in its assessment of the potential for farm-based micro-wind turbines [see 5.5]. The BWEA states that manufacturers forecast industry-wide revenue to rise by up to 176% in 2012, with the predominant share coming from the 1.5–15kW and 15–100kW market segments [5.4].

Another direct result of the research has been a tightening of training standards with the Micro-generation Certification Scheme in respect to micro-wind in particular, and a revision of the Building Research Establishment's Standard Assessment Procedure (SAP), the methodology used to generate Energy Performance Certificates for homes in England and Wales [5.1] Internationally, the data generated by Southampton [5.6] has fed into an International Electrotechnical Commission study on wind classes and turbulence intensity IEC MT2 led by Dr. Jonathon Whale of the Australian Small Wind Turbine Centre [5.1, 5.7]. The DECC used the work as further evidence to accelerate the switch from 'up-front' grants to feed-in tariff (FIT) based subsidies, on the basis that FITs reward generation not installation and spell out to potential customers a turbine's failure to deliver a clear financial return [5.8]. FIT came into effect in April 2010, and the setting of the level of tariff for the feed-in for micro-wind was informed by Southampton's research. The DECC also incorporated the findings into its UK 2050 energy pathway analysis [3.6] which examined possible future scenarios for the part played by micro-wind generation. In addition, the data generated was used to validate an interactive tool on the EST website allowing members of the public to enter their postcodes to discover if their location was suitable for siting a micro-wind generator [5.9]. A more comprehensive assessment tool is offered by the Carbon Trust and this too has been validated using the micro-wind turbine dataset by Southampton University at the Carbon Trust's request [5.10]. Both tools have been designed to help build public confidence and reduce the risk of inappropriately sited systems being installed which damage the industry and waste taxpayers' money if grant support is offered.

5. Sources to corroborate the impact

5.1 EST micro-wind project, impact on wind industry, policymakers in UK
Jaryn Bradford, Senior Technical Manager, Energy Saving Trust

5.2 Influencing B&Q's decision to stop selling micro-wind turbines and offer to refund all existing customers
Ben Earl, formerly Environmental Affairs Manager B&Q, now Water Efficiency Manager, Southern Water

5.3 RenewableUK (formerly BWEA) UK Market Reports 2008
http://www.aeoluspower-windenergy.co.uk/PDF/BWEA%20SWS%20UK%20Market%20Report.pdf
BWEA, Small Wind Systems, UK Market Report 2008

5.4 RenewableUK (formerly BWEA) UK Market Reports 2012
http://www.renewableuk.com/en/publications/reports.cfm/SMMR2012
BWEA, Small and Medium Wind Market Report 2012

5.5 Industry view to study. BWEA response to feed in tariff consultation
Alex Murley, formerly Head of Small Systems at BWEA, now Programme Manager at RWE Npower

5.6 PhD Thesis Impact of data loss on micro-wind assessment
Sissons M.F., Micro-wind power in the UK: Experimental datasets and theoretical models for site-specific yield analysis. May 2011, PhD Thesis, University of Southampton

5.7 IEC MT2 - Wind classes and turbulence intensity
http://www.ecobuild.co.uk/var/uploads/exhibitor/1450/3hohvuu8on.pdf
International Energy Agency (IEA) Small Wind Annual Report 2009

http://www.ieawind.org/task_27/PDF/Task%2027%20publication%202009_Small_Wind_Annual_Report.pdf

5.8 Impact on DECC's policy on micro-renewables and micro-wind, feed in tariffs
Penny Dunbabin, Senior Scientific Officer, Department for Energy and Climate Change (DECC)

5.9 EST micro-wind wind speed prediction tools
http://www.energysavingtrust.org.uk/Generating-energy/Choosing-a-renewable-technology/Wind-turbines/Wind-Speed-Prediction-Tool

5.10 Carbon Trust wind estimate tool – checking and validation against trial data.
Henrietta Stock, formerly Technology Acceleration Manager, Carbon Trust, now Portfolio Strategy Manager, EDF Energy