COUNCILLORS' BRIEFING NOTE
LARGE SCALE WIND TURBINES
& WIND FARMS

May 2009

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1.1 BACKGROUND & PURPOSE

The Council is receiving an increasing number of scoping studies, proposals and planning applications relating to large-scale wind turbines and wind farms within the district and neighbouring areas and it is expected that this will continue. There is growing interest towards large-scale wind power leading to both positive feelings towards it and concerns in relation to the proximity of these to domestic dwellings and environmentally sensitive areas. The purpose of this briefing paper is to ensure councillors are well informed of the facts and considerations with respect to large-scale wind turbines so that they can make informed decisions about it when required.

This briefing paper is intended to be neutral and unbiased and information contained within it has been sourced from national wind generation experts and websites, along with expert opinions from planning and environmental health officers from the Council. It is not possible to generalise about wind, as each planning application will be unique in relation to the proposed number of turbines and its location.

1.2 OPERATIONAL & STRUCTURAL INFORMATION

How does a wind turbine work?
A simple way to consider how a wind turbine works, is to imagine the complete opposite of how a fan works - a fan uses electricity to make wind, but turbines use the wind to make electricity. Almost all wind turbines that produce electricity have rotor blades, which rotate around a horizontal hub. The hub is connected to a generator (either directly or through a gearbox), which is located inside the nacelle, which is the large part at the top of the tower where electrical components are located.

Most large wind turbines have two or three blades, which face into the wind and when the wind blows, it turns the blades round, spinning the shaft, which connects to a generator that produces electrical energy (electricity) from mechanical energy. The blades rotate at up to around 22 revolutions per minute.

The majority of modern wind turbines have three blades, as this design has been found to have a greater aesthetic appeal, but the disadvantage is that each blade will add to the overall cost and weight and can be more difficult to install. Two bladed machines are cheaper and lighter, with higher running speeds and they are easier to install, but two bladed machines can be noisier and can appear 'jerky' when they turn.

What are wind turbines made of?
The towers are mostly tubular and made of steel. The blades are made of glass-fibre reinforced polyester or wood-epoxy. The towers and blades are generally painted a matt light grey because this is the colour which is most inconspicuous under most lighting conditions and it also reduces reflected light.

How big are wind turbines?
Large modern wind turbines have rotor diameters ranging up to 100 metres and towers range from 25 to 100 metres in height.

How much space do wind turbines require?
A typical wind farm of 20 turbines might extend over an area of 1 square kilometre, but only 1% of the land area would be used to house the turbines, electrical infrastructure and access roads; the remainder can be used for other purposes, such as farming or as natural habitat.
To obtain 10% of our electricity from the wind would require constructing around 12,000 MW of wind energy capacity. Depending on the size of the turbines, they would extend over 80,000 to 120,000 hectares (0.3% to 0.5% of the UK land area). Less than 1% of this (800 to 1,200 hectares) would be used for foundations and access roads, the other 99% could still b used for productive farming. As a comparison, between 288,000 to 360,000 hectares (1.2-1.5% of the UK land area) is covered by roads and some 18.5 million hectares (77%) are used for agriculture.

1.3 ENERGY GENERATION

How strong does the wind have to blow for the wind turbines to work?
Wind turbines start operating at wind speeds of 4 to 5 metres per second (around 10 miles an hour) and reach maximum power output at around 15 metres/second (around 33 miles per hour). At very high wind speeds, i.e. gale force winds, (25 metres/second, 50+ miles/hour) wind turbines shut down.

What happens when the wind stops blowing?
No problems arise when the wind stops blowing and it is highly unlikely to have stopped blowing all over the country at the same time. The UK Energy Research Centre (UKERC) reported on the costs and impacts of intermittent renewable energy on the UK's electricity network, reviewing over 200 studies on the subject and confirms that variable generation from sources such as wind and other renewable technologies need not compromise electricity system reliability in Britain over the next 20 years.

How much of the time do wind turbines produce electricity?
A modern wind turbine produces electricity 70-85% of the time, but it generates different outputs dependent on wind speed. Over the course of a year, it will generate about 30% of the theoretical maximum output - this is known as its load factor. The load factor of conventional power stations is on average 50% and a modern wind turbine will generate enough energy to meet the electricity demands of more than 1,000 homes over a year.

Do we really need wind power? Why can't we just be more energy efficient instead?
Although we are becoming more efficient in the way we use energy, our demands on energy are increasing dramatically – in our homes and in our businesses, energy efficiency is important. So, it's important to investigate alternative and renewable sources of energy to meet these growing demands.

How long does it take for a turbine to 'pay back' the energy used to manufacture it?
Wind turbines typically take between 3 to 10 months to produce the electricity consumed during their life cycle, from production and installation through to maintenance, and final decommissioning, which compares favourably with coal or nuclear power stations, which take about six months. (D *Milborrow*: *Dispelling the Myths of Energy Payback Time*,. *Windstats Vol 11*, *no 2*, *Spring 1998*). The comparison of energy used in manufacture with the energy produced by a power station is known as the 'energy balance'. It can be expressed in terms of energy 'pay back' time, i.e. as the time needed to generate the equivalent amount of energy used in manufacturing the wind turbine or power station.

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A wind turbine typically lasts around 20-25 years and during this time, some parts may need replacing. The very first of the mass-produced turbines celebrated their 20th birthday in May 2000; the Vestas 30kW machine has operated steadily throughout its lifetime, with none of the major components needing to be replaced.

Is wind energy expensive compared to other forms of energy generation?
The average cost of generating electricity from onshore wind is now around 3-4p per kilowatt hour, competitive with new coal (2.5-4.5p. Costs for carbon capture and storage need to be included in new coal and these are uncertain as it has not been undertaken on a commercial scale and cheaper than new nuclear (4-7p). As gas prices increase and wind power costs fall, both of which are very likely, wind becomes even more competitive.

Trying to compare the cost of generating a kilowatt-hour of gas, coal, oil, nuclear or wind energy is extremely difficult, due to differing methods of calculation. Also, the 'external costs' i.e. the costs arising from pollution, or increased carbon emissions need to also be considered. Coal, oil and gas have supplied most of our electricity for many years and have released billions of tonnes of carbon into the air, but this environmental damage is not shown on our bills. All forms of new carbon-free electricity generation (including nuclear power or carbon sequestration and storage) will be more expensive than new gas-fired plant, unless the high cost of carbon emissions is included in the calculations. It has been estimated that, if carbon costs are included, then the net additional cost to the consumer of having 20% wind power by 2020 could be as low as zero. There is also a benefit from the additional fuel security offered by wind power – the majority of UK's gas will come from Russia over the coming years and heavy reliance on one source of fuel for our electricity system is not sensible.

Will there be cheaper or even more expensive electricity because of wind power?
No. UK energy trading rules mean that it is not possible to reduce energy prices to the people around a wind energy project. However, power from wind in the UK is traded on the wholesale market and has a small, although growing influence on the price the consumer pays.

Does wind energy need back-up to work?
All forms of power generation require back up and no energy technology can be relied upon totally. The UK's transmission system already operates with enough back up to manage the instantaneous loss of a large power station. Variations in the output from wind farms are barely noticeable over and above the normal fluctuation in supply and demand, seen when the nation's workforce goes home, or if lightning brings down a high-voltage transmission line. Therefore, at present there is no need for additional back-up because of wind energy.
Even for wind power to provide 10% of our nation's electricity needs, only a small amount of additional conventional back-up would be required, in the region of 300-500 megawatts (MW). This would add only 0.2 pence per kilowatt-hour to the generation cost of wind energy and would not in any way threaten the security of our grid. In fact, this is unlikely to become a significant issue until wind generates over 20% of total electricity supply.

Will installing wind farms shut down power stations?
Power plants in the UK are being shut down through European legislation on emissions or old age, so replacement power sources need to be found from a range of existing technological solutions.

Why doesn't the UK also invest in other renewable energy technologies and energy efficiency instead of wind power?
Wind energy's role in combating climate change is not a matter of either/or. The UK will need a mix of new and existing renewable energy technologies and energy efficiency measures, and as quickly as possible. Significant amounts of investment have been allocated for wave and tidal energy development, and these technologies, along with solar and biomass energy will have an important role in the UK's future energy mix.

Why don't we put all the wind turbines out to sea?
We will need a mix of both onshore and offshore wind energy to meet the UK's challenging targets on climate change. At present, onshore wind is more economical than the development of offshore wind. Also, offshore wind farms take longer to develop, as the sea is a more hostile environment and these will not be enough on their own for the UK to meet its renewable energy targets and commitments to tackling climate change.

Climate change and wind power
Wind power is a clean, renewable source of energy, which produces no greenhouse gas emissions or waste products. The UK currently emits 560 million tonnes of carbon every year and the Government target is to cut this by 60% by 2050 [Carbon Budgets announced 23/04/2009]. Power stations are the largest contributor to carbon emissions, producing 170 million tonnes of carbon each year. Just one modern wind turbine will save over 4,000 tonnes of carbon emissions annually. In terms of global carbon emissions, the contribution of the UK is small at around 2%, however, every nation must play its part in reducing emissions in order to avoid dangerous climate change.

Lifecycle perspective and carbon emissions
Although wind turbines generate sustainable energy, and no carbon is emitted during the production of electricity, from a life cycle perspective of a wind turbine i.e. through manufacture, installation, operation and decommissioning, carbon will be emitted during the various processes. It has been calculated that, for every 1 kWh of electricity generated by an onshore wind turbine (using a Vesta V90 3.0MW machine), there is an impact of 5.25 grams of carbon. BWEA recommends a static figure of 430g CO_2/kWh which is based on the current UK energy mix. It is also possible to calculate savings based on emissions from gas-fired and coal-fired forms of energy generation.
See Table 5C at http://stats.berr.gov.uk/energystats/dukes08_c5.pdf

1.4 WIND TURBINES, WIND & LOCATION

Is Northamptonshire a windy area?
The UK is in the enviable position of having some of the best wind resource in the whole of Europe. Wind speeds in Northamptonshire are comparable with those in Germany, Spain and Denmark, where wind has been successfully contributing to the electricity generation mix for many years. The indicative map linked to below demonstrates this, albeit in a broadbrush fashion taking little account of local variations in terrain for example, see http://www.windpower.org/en/tour/wres/euromap.htm

1.5 NOISE, HEALTH AND SAFETY

Wind Turbines and Noise
The evolution of wind farm technology over the past decade has rendered mechanical noise from turbines almost undetectable with the main sound being the aerodynamic swoosh of the blades passing the tower. There are strict guidelines on wind turbines and noise emissions known as ETSU-R-97 and any wind farm development must meet these noise requirements and designed, well-sited turbines can be quiet enough to cause no disturbance to people living just a few hundred metres away. There is always low frequency noise present in any ambient (surrounding) quiet background and it can be produced by a variety of man-made sources, including machinery and transport and natural sources such as the sea, wind and thunder.

Do wind turbines produce low frequency noise?
Low frequency noise is not clearly defined but is generally taken to mean noise below a frequency of about 100 to 150 Hz. Noise at frequencies below about 20 Hz (the normal threshold of sound heard by people) is sometimes referred to as infrasound and this type of noise presents even greater difficulties in its measurement and assessment. At these particularly low frequencies complainants often have difficulty in describing the source of their complaint, sometimes referring to “feeling the noise” or to “pressure sensations”

A study of the effects of low frequency noise can be found on the Department for Business Enterprise and Regulatory Reform. The study conducted by Hayes McKenzie in 2004 was undertaken following reports in the press of complaints of low frequency noise from wind farms. Of the 126 wind-farms in the UK, just five have received complaints regarding low frequency noise making such complaints the exception rather that the rule. The reports finds that infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of the wind farm neighbour. For further information, see: http://www.berr.gov.uk/energy/sources/renewables/explained/wind/onshore-offshore/page31267.html

In response to recent unscientific accusations that wind turbines emit infrasound and cause associated health problems, Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Defra Report on Low Frequency Noise and its Effects, says: "*I can state quite categorically that there is no significant infrasound from current designs of wind turbines. To say that there is an infrasound problem is one of the hares which objectors to wind farms like to run. There will not be any effects from infrasound from the turbines*."

Aerodynamic modulation
The above report also identified that, complaints that were indicated to be low frequency noise complaints, were actually associated with aerodynamic modulation. This in effect is a low noise associated with the aerodynamic noise from the blades of the turbines causing an effect either individually or in unison. The report identifies that *“Although the internal noise levels associated with this noise source are not high enough to result in the awakening of a resident, once awoken the audibility of this noise can result in difficulties in returning to sleep. It is not uncommon for a wind turbine to be identified by the resident as a cause of the awakening although noise levels and measurements/recordings indicate to the contrary”*

The numbers of complaints of this nature are relatively rare and there is no conclusive evidence as to the causes of the amplitude modulation.

How 'safe' is wind energy?
It is a matter of record that no member of the public has ever been injured during the normal operation of a wind turbine, with over 25 years operating experience and with more than 70,000 machines installed around the world. Wind energy has no associated emissions, harmful pollutants or waste products.

How likely is 'ice-throw' to occur from turbines?
Ice build-up on wind turbines leading to ice-throw is more likely to occur in countries with colder climates than the UK, or in upland areas. However it does infrequently occur in the UK, but because of the wide separation between turbines and homes it is unlikely ever to be a problem. For ice to build up on the blades, particular weather conditions are required which in England, tend to occur for less than one day per year. If icing of the blades does occur, modern turbines are fitted with sensors to pick up vibration, and will automatically shut down if ice is detected. Ice throw is generally more of an issue when a "parked" wind turbine is restarted. The icing of wind turbine blades can be monitored and the restarting of the turbine can be held off until the ice has thawed. Studies in Canada suggested that for safety, turbines should be set back a distance of at least turbine height plus the rotor diameter from residential dwellings, so setbacks of greater than 400m are considered to be ample.

A turbine control system will normally detect icing indirectly. The system will continually monitor the turbine power output and the wind speed seen by the control anemometer mounted on the nacelle. Any icing of the blades will degrade performance significantly, and the control system having detected that the turbine is now operating outside the expected power to wind speed 'envelope', will take precautionary shut-down action in the knowledge that an unspecified fault has arisen. In the unlikely event that the turbine continues to operate and that an ice build-up or throw occurs, the vibration sensors will cause the turbine to shut down immediately.

Research conducted in the Swiss Alps and Canada (both obviously more prone to freezing conditions than the East Midlands) indicates the maximum distance of any recorded ice throw as being 100m. To put the issue into context, the Canadian study, while acknowledging that icing is a risk operators should mitigate (through the means described above), also calculates that a person standing anywhere between 50m and 300m from a turbine would, on average, be hit by fragments of ice once every 137,500,000 years. See
http://www.canwea.ca/images/uploads/File/GH-RiskAssessment-38079or01a(1).pdf

What is shadow flicker and is it harmful to health?
Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow moves and where this passes a narrow window the effect is known as 'shadow flicker'.

Shadow flicker only occurs inside buildings within 130 degrees either side of north, relative to the turbines, where the shadow is seen through a narrow window opening. The phenomenon only occurs at distances within 10 rotor diameters of the turbine. A single window in a single building can be affected for a few minutes at certain times of the day during short periods of the year, depending on wind speed, direction and cloud cover at the time in question.

In the event of these circumstances coinciding it is possible to calculate the times and locations this is likely to occur and the turbine causing the effect can be programmed to shut down automatically for this brief period, thereby removing the potential for disturbance completely, however, the time of day the effect occurs should also be taken into account, as for example a brief shadow flicker occurrence at 6am would have less impact than a similar effect at 6pm.

Planning guidelines in the Republic of Ireland specify criteria for acceptable levels of shadow flicker. They recommend that shadow flicker should not exceed 30 hours per year or 30 minutes per day without mitigation being taken. For more information see,
http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,1633,en.pdf

Do wind turbines frighten livestock?
Wind farming is popular with farmers, because their land can continue to be used for growing crops or grazing livestock. There is no evidence to demonstrate that sheep, cows and horses are disturbed by wind turbines. The first commercial wind farm in the UK was built at Delabole in

Cornwall. The land is also home to a stud farm and riding school. Holmside Hall Equestrian Centre is also located very close to an operational wind farm in County Durham, as the home page of their website indicates. See http://www.holmsidehallequestrian.co.uk/index.html

Will there be an impact on the local wildlife?
Applications for consent for wind farms have to be accompanied by an Environmental Impact Assessment, which details the likely impact upon the environment and wildlife, amongst other things. Discussions are always held with the relevant nature conservation organisations before commissioning any studies, and they are frequently consulted throughout the assessment process and there are also statutory consultees including Natural England when the planning application is submitted. Nationally accepted standards also exist for survey and monitoring for a number of species and species groups, and developers would be expected to comply with these.

Sir Martin Doughty, Chair of Natural England said in 2008: "Climate change is the most significant long term threat facing the natural environment..... The conservation sector must now work with industry and government to find space for renewables and to develop a longer term blueprint for a low carbon economy by 2050..... the conservation sector may in some cases have to accept short term pain for long term gain. Difficult decisions need to be taken if we are going to get serious about tackling climate change."

Impact on Birds
In March 2009 the RSPB published a report calling for more urgency in implementing renewable energy schemes. At the time Ruth Davis, head of Climate Change Policy at the RSPB said: "Left unchecked, climate change threatens many species with extinction. Yet, that sense of urgency is not translating into action on the ground to harness the abundant wind energy around us "We must reduce the many needless delays that beset wind farm developments." For more information, see http://www.ieep.eu/publications/press/positive_planning_for_onshore_wind.pdf

Impact on Bats
With regards to the impact on bat populations, the latest guidance from Natural England states: "We are currently unable to say whether populations of bats are likely to be at risk from turbines in the UK because the evidence base is inadequate. Research, with support from the British Wind Energy Association, is now under way to address this issue." (Natural England Technical Information Note TIN051 11 February 2009). However it is accepted that migration routes for bats are likely to follow major landscape features such as river corridors and woodland corridors. Migration is most likely to be concentrated on the coast and by the time bats move further inland their numbers are likely to be dispersed.

1.6 VISUAL IMPACT & HOUSE PRICES

Visual impact
The debate over the impact made by turbines upon the landscape is highly subjective, and ultimately is a matter of personal opinion. Many of us are reluctant to see any form of change in our immediate environment, of whatever form. It is also important to consider that our landscape has changed over thousands of years due to human intervention and economic activity.

What is the impact of wind farms on house prices?
While there have been a number of opinion studies undertaken within the UK, it is not yet possible to establish the actual impact on house values in the immediate proximity of wind farms. A number of studies have been carried out which appear to show significant variations between locations (in particular between Scotland and southern England) and at different stages during the development process. However, despite improvements in research methodology, the results from existing studies remain inconclusive.

The most recent study, was carried out in Cornwall in 2008 by Sims and Dent from Oxford Brookes University (see link below). They state that:

'Whilst there have been several studies in this area, most have been opinion surveys. As a consequence there is little empirical evidence on the impacts (positive or negative) of living near a windfarm and only five studies which consider the impact on value. One study found a small number of homes could suffer from diminution (Jørgensen (1996). Two studies found

insufficient evidence to either reject or accept the claim that windfarms have an effect on value (Poletti, 2005; Hoen, 2006). One found house values increased (Sterzinger et al. 2003) and the fifth, whilst finding a reduction in house values within one mile of the windfarm, attributed this diminution to a local condition and not the presence of the windfarm (Sims and Dent 2007).'

They go on to say:

'The results found some evidence to suggest that the view of the surrounding environment from a property could influence selling price, although there was no clear relationship between having a view of the windfarm and a reduction in value. Nor was there any evidence to suggest a relationship between distance to the windfarm and house price. Whilst the conclusions drawn relate specifically to this location, they support the findings from other studies (Sims and Dent 2007, Hoen 2006, Poletti, 2005) and therefore may be indicative of the likely impact in other areas within the UK.'

It should be noted that the impact of wind turbines on house prices is not a planning 'material' consideration unlike the other considerations raised in this briefing paper.

1.7 USEFUL RESOURCES

The Department for Business, Enterprise and Regulatory Reform (BERR) website: www.berr.gov.uk/energy/sources/renewables/explained/wind/windspeed-database/page27708.html

The British Wind Energy Association (BWEA) website: www.bwea.com/