Cotton Wind Farm
Information Sheet
Operational Noise & Vibration

Hoare Lea Acoustics

Hoare Lea Acoustics is an independent consultancy with over 15 years experience in wind farm acoustics, offering services to developers, government bodies and opposition groups. Our role in the Cotton Wind Farm is to evaluate the scheme according to stringent government policy relating to noise from wind farms.

Do wind turbines produce any sound?

Yes wind turbines do produce some sound. Modern wind turbine designs, as would be used at the Cotton Wind Farm, emit sound levels which vary according to the wind speed. When the wind is very light the turbines may not be operating or operating at a low output power and therefore produce less sound. As wind speeds increase the sound emitted by the turbines progressively increases. Once the turbines are generating at or near to their maximum power output they tend not to increase their sound output any further. In most rural environments, the increase in wind speed will also cause the general sound of the background environment to increase for example, sources such as rustling leaves and air movement around buildings to increase.

How is the noise from Cotton Wind Farm being assessed?

Government policy on wind farm noise refers to guidance[1] that seeks to limit the noise from wind turbines to acceptable levels outside of nearby dwellings but, importantly, does not seek to make turbine noise inaudible. The guidance was released in 1996 and has been proven to provide a robust level of protection for the vast majority of residents leaving near to wind farm developments. The methodology set out in the guidance has been subject to extensive examination by government funded research and public inquiries for wind farm developments across the UK. The methodology remains the endorsed planning guidance in England, Scotland and Wales. In very general terms, a modern wind farm that is designed to comply with this guidance will typically be limited to noise levels between 35 and 45 dB[2] at the nearest surrounding properties. These noise limits are very low when compared to those afforded to other types of development which are considered to offer national benefits. For example, mining operations in England may produce up to 55 dB where lower levels are impractical to achieve, and even higher levels of 70 dB are allowed for periods of up to 8 weeks of a year. In the case of new road schemes, government guidance permits levels of over 65 dB before making provisions to insulate the homes of affected residents. Another point of comparison is a UK government funded noise survey[3] (unrelated to wind farm noise) reported in 2002 found that 90% of the population of England and Wales lived in dwellings exposed to average day time noise levels of more than 50 dB. These comparisons demonstrate the stringent nature of the limits used to restrict wind farm developments to acceptable levels.

The assessment method for wind farms compares the predicted level of noise from the turbines with the existing background noise in the area at those locations closest to the wind turbines. Four background noise monitoring locations have been chosen in consultation with South Cambridgeshire and Huntingdonshire District Councils to be representative of the lower background noise environment at residential dwellings near to the proposed site of the wind farm. The measurements are analysed by removing weekday day time periods when the noise may be higher, and any periods where rainfall is known to have occurred. Then for each 10 minute measurement sample, the quietest 10% of the period is recorded. Noise predictions are made assuming properties are downwind of the turbines and therefore represent worst case conditions. Predicted noise levels from the turbines are then compared to noise limits derived from the background noise survey data according to national guidelines. The results of the assessment are to be provided in the information accompanying the planning application for Cotton Wind Farm. The wind farm will have planning conditions which will apply for the lifetime of the site to ensure the noise emitted remains within acceptable levels.

What do wind turbines sound like?

Describing how something sounds tends to be highly subjective and will naturally vary from person to person. The equipment within the hub of the turbines (the generator, gearbox and associated control equipment) are well engineered in the modern turbines that would be used at Cotton Wind Farm, so that the mechanical noise sometimes heard from older machines is no longer a significant feature of the total noise heard. In particular, a condition of the planning permission, as well as npower renewables' own operational procedures would include strict requirements that limit the extent of mechanical noise features. The main source of audible sound from a modern wind turbine is the movement of the blades through the air, which has a character that is more difficult to distinguish from the natural sound of the wind. An important aspect is that the character of the sound near to a turbine is very different to the character at greater distances. When heard close to a wind turbine the sound can have a rhythmic characteristic often described as a swish or whoosh. When heard further away from the turbines the character of the sound tends to contain less rhythmic swish but this will be much more variable and is likely to come and go with time.

Will we hear the wind turbines at our house?

Government policy on wind farm developments requires the noise[4] at surrounding properties to be restricted to relatively low levels. However, even at these low levels, the sound of a wind farm may be audible on occasion at some of the closer residential properties. This will be highly dependent on a number of factors, such as the distance you live from the turbines, and the amount of noise from other sources, such as road traffic and natural wind generated background sounds etc. Even at locations where wind farm sound can be heard occasionally, it is important to note that this would only occur for a limited period of time under certain wind speeds and directions. The greatest chance of hearing a wind farm is when the wind is blowing directly from the turbines towards the house. In contrast, when the wind is blowing from the house towards the turbines, the sound level is greatly reduced and it is much less likely that the wind farm could be heard. To provide a context to the occasions where audible noise might be perceived, the proposed Cotton Wind Farm is currently being designed to remain within a noise level range of 35 to approximately 40 dB (and in practice, less than 40 dB for the majority of the time) at the nearest properties for the most frequent wind conditions that would occur. For comparison, the following table provides examples of typical noise level ranges associated with different environments and activities. When comparing the expected noise of the wind farm with other types of sources, it is important to note that the decibel values do not arithmetically add because it is a logarithmic scale (for example, 40 dB from one source, plus 40 dB from another source is equal to 43 dB not 80 dB).

Noise Level Range dB	Example / Description
0	Threshold of hearing
10 - 20	Recording Studio Inside a quiet bedroom in a rural area remote from major roads
20 - 30	Outside in a very quiet rural area in very still conditions remote from major roads Inside a bedroom at night in a quiet suburban area.
30 - 40	Outside in a quiet rural area in relatively calm conditions. Inside a quiet library area or private office
40 - 50	Outside during the day in a quiet suburban area Outside in a quiet rural area during moderately windy conditions
50 - 60	Outside during the day in a suburban area up to 1000m from of a major arterial road. Inside an open plan office environment. Quiet conversational voice levels
60 - 70	Raised conversation voice levels Inside a relatively busy restaurant environment Inside the cabin of a typical medium to large size passenger jet aircraft
70 - 80	Average level within 20 to 30m of a busy dual carriage way
80 - 90	Inside a performance venue with low level amplified music
90 - 110	Inside a performance venue with live music. Inside a noisy industrial environment where hearing protection is required

Why is noise sometimes claimed to be a problem associated with wind farm developments?

There are 166 wind farms (1951 wind turbines)[5] operational in the UK today and the majority of these wind farms operate without reported noise disturbances. In a very limited number of cases, wind farm noise has given rise to disturbance of neighbouring residents. In the early days of wind farm development, much of the attention relating to noise was caused by features which are no longer present in modern wind turbine designs. For example, technological improvements in gearbox insulation, blade design and speed regulation have all led to dramatically reduced noise emissions and improved sound characteristics. These improvements are now common features for the types of turbines being considered for the proposed Cotton Wind Farm. Reaction to noise will always vary from person to person, no matter how quiet or infrequent. However, the improvements of modern turbine design combined with the low levels that are required by UK guidelines reinforce that the majority of individuals are unlikely to experience noise disturbance.

Whilst there have been legitimate cases where noise has represented a disturbance to residents, wind farm developments have also attracted media commentary which in some cases has grossly exaggerated or misrepresented noise considerations. The technical nature of the language used to describe noise assessments often lends itself to misinterpretation and false claims, both on the part of advocates and opponents of wind farm developments. Some of the most frequently cited documents that suggest noise problems from wind farms refer to valid research carried out by respected professionals in the field of acoustics, but all too often presents the information in a selected way to convey a conclusion that is inconsistent with the findings of the original research. Examples of this type of misrepresentation have been demonstrated in cases where the authors of original research have been compelled to issue public statements of clarification in response to repeated misuse and referencing of their work (examples of which are provided in the following sections).

Are wind turbines noisier at night?

It has been suggested in studies elsewhere in Europe[6] that turbine noise can be greater than predicted at night and that conventional assessment methods used for turbines do not take account of this effect. This effect was linked to larger than expected differences between wind speed measurements taken at 10 metres above ground level and the wind speed experienced at higher positions where the turbine rotors are located. This phenomenon has been factored into the assessment for Cotton Wind Farm by using wind speed measurements taken at multiple increased heights (10, 30 and 50 metres) that enable a much closer representation of the wind that the turbine rotors will actually experience in practice. In so doing, this potential source of under prediction is removed from the assessment.

Do wind turbines emit infrasound, low-frequency sound and vibration?

In common with many other sources of noise, wind turbines emit low levels of infrasound, low-frequency sound and ground vibrations. However, what is often overlooked is that these types of sound and vibration are a feature of the every day environment in which we live. For example infrasound and low-frequency sound is produced by regularly encountered natural and man-made sources, such as the infrasound produced by the wind or distant traffic. The important point in relation to wind turbines is that the levels of these types of emissions are extremely low and therefore, in most cases, cannot be reliably measured amidst normal background levels.

Considerations relating to infrasound, low-frequency sound and vibration do present a greater concern amongst practitioners in the field of noise assessment, particularly for large scale industrial complexes involving combustion plant. However, the overwhelming consensus, demonstrated by measurements made at numerous wind farms in the UK and around the world, is that wind turbines emit such low levels of these emissions that they do not pose any risk in terms of disturbance or health effects.

These types of emissions have been the subject of considerable misrepresentation in media commentary. Notably, the work of Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Department for Environment Food and Rural Affairs' Report on Low Frequency Noise and its Effects[7] is frequently cited in some documents which continue to claim concerns about infrasound and low-frequency sound from wind turbines. However, Dr Leventhall has made a clear statement[8] to clarify these types of misrepresentations:-

"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. The turbines produce a modulated higher frequency - the swish, swish - which people may not like, but this is not infrasound. There is no low frequency in it. There is negligible infrasound and very little low frequency noise from wind turbines - a few low level tones from the gearbox."

Another example of this type of misrepresentation has centred around work carried out by Keele University on ground vibration. Professor Peter Styles and his team at Keele University undertook a study of the effects of wind turbines on the seismic detection array at Eskdalemuir. The results of this work were widely misinterpreted and resulted in a statement[9] from Professor Styles:-

"We are writing to clarify some misconceptions .... about wind farm noise. While it is technically correct that 'vibrations can be picked up as far away as 10km', to give the impression that they can be felt at this distance is highly misleading. The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect. The Dunlaw study was designed to measure effects of extremely low level vibration on one of the quietest sites (Eskdalemuir) in the world, and one which houses one of the most sensitive seismic installations in the world. Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise - they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health. It is, however, an issue for the Eskdalemuir seismic array, as it can detect this level of vibration. It is designed to detect explosions and earthquakes of a low magnitude from all over the world. The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health."

Is amplitude modulation a problem with wind farm noise?

The former Department of Trade and Industry commissioned an investigation into noise complaints at three wind farms where low frequency noise had been reported. The investigation[10] concluded that infrasound and low frequency sound levels were too low to be the source of disturbance. However, the study noted that the complaints appeared to relate to the change in the sound of the blades as they rotated, which was described as "audible modulation of the aerodynamic noise". In response to this finding, Salford University were commissioned to investigate the extent that amplitude modulation may have lead to increased noise disturbance around existing UK wind farms. The investigation[11] found that the incidence of amplitude modulation related noise effects was very low. Specifically, the report highlighted that out of the 133 wind farms in operation at the time of the study, amplitude modulation was identified as a factor at 4 of the sites, 3 of which had been resolved via the wind farm control systems. The fourth site, located in Deeping St Nicholas, has been the subject of ongoing measurement studies by independent consultants acting on behalf of the developers as well as Environmental Health representatives of the South Holland District Council (SHDC). In a statement released by the operators of the site in question, it has been reported that SHDC's measurements and observations did not support the claimed nuisance at the property, and were insufficient to warrant further investigations of alleged breaches of planning requirements. The reasons behind the reported disturbance in this isolated instance thus remain unknown. However, the available information demonstrates that it is very unlikely that neighbours of wind farm developments would encounter similar experiences.

References

[1] The Working Group on Noise from Wind Turbines. 'The Assessment and Rating of Noise from Wind Farms', ETSU Report ETSU R 97, 1996.

[2] All references to dB in this document relate to A-weighted decibels which reflects the way the human ear responds to sound

[3] The National Noise Incidence Study 2000 (England and Wales) prepared for the Department for Environment Food and Rural Affairs, 2002.

[4] Often the term 'noise' will be used when referring to the sound emitted by turbines, the strict definition of 'noise' is unwanted sound and therefore has a subjective judgement already associated with the term.

[5] British Wind Energy Association, February 2008

[6] G.P. van den Berg, University of Groningen, Netherlands. 'Effects of the wind profile at night on wind turbine sound'.

[7] Defra (2003), A Review of Published Research on Low Frequency Noise and its Effects, Report for DEFRA by Dr Geoff Leventhall Assisted by Dr Peter Pelmear and Dr Stephen Benton.

[8] Dr. Geoff Leventhall - Personal communications 7th Sept 2004

[9] Keele University Rejects Renewable Energy Foundation's Low Frequency Noise Research Claims. http://www.bwea.com/ref/lfn_keele.html.

[10] The Measurement of Low Frequency Noise at Three UK Wind Farm. The Hayes McKenzie Partnership. July 2006.

[11] Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". University of Salford, final report for Department of Environment Food & Rural Affairs contract NANR233, 2007.