Noise from wind turbines

The Facts

Prepared with assistance from the Hayes McKenzie Partnership, Consultants in Acoustics, Southampton and Machynlleth.

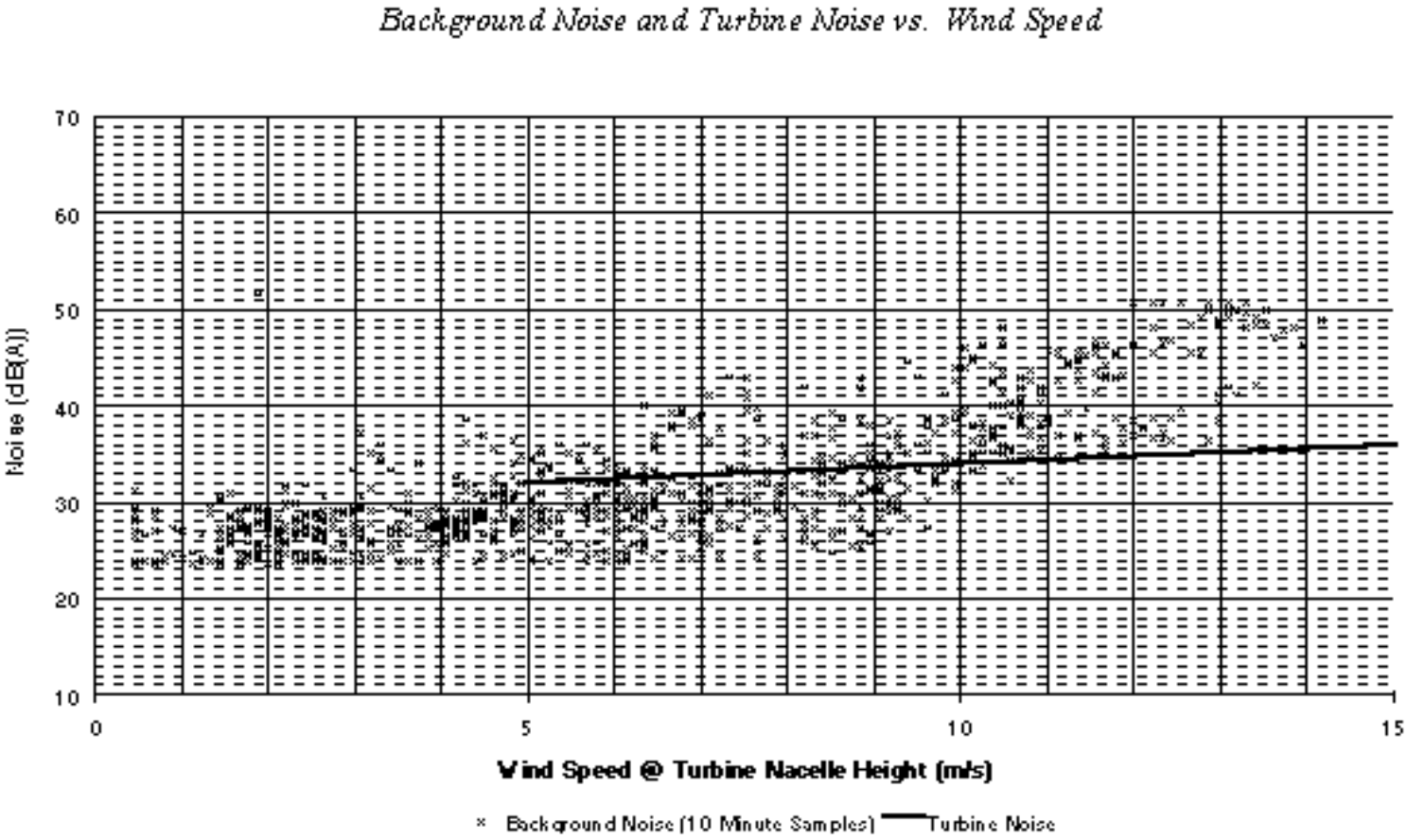
Virtually everything with moving parts will make some sound, and wind turbines are no exception. Well designed wind turbines are generally quiet in operation, and compared to the noise of road traffic, trains, aircraft and construction activities, to name but a few, the noise from wind turbines is very low. Outside the nearest houses, which are at least 300 metres away, and more often further, the sound of a wind turbine generating electricity is likely to be about the same level as noise from a flowing stream about 50-100 metres away or the noise of leaves rustling in a gentle breeze. This is similar to the sound level inside a typical living room with a gas fire switched on, or the reading room of a library or in an unoccupied, quiet, air-conditioned office.

Source/Activity	Indicative noise level aB (A)
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	35-45
Car at 40mph at 100m	55
Busy general office	60
Truck at 30mph at 100m	65
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

Information taken from The Scottish Office, Environment Department, Planning Advice Note, PAN 45, Annes A: Wind Power, A.27. Renewable Energy Technologies, August 1994

As the table shows, the sound of a working wind farm is actually less than normal road traffic or an office. Even when wind speed increases, it is difficult to detect any increase in turbine sound above the increase in normal background sound, such as the noise the wind itself makes and the rustling of trees.

The best test is always to experience the noise from a turbine for yourself. You will find that it is perfectly possible to stand underneath a turbine and have a normal conversation, without raising your voice.



What makes the noise?

Almost all wind turbines producing electricity for the national grid consist of a tower, which is between 25 and 50 metres high; a nacelle (housing) containing the gearbox and generator, which is mounted on top of the tower, and 3 blades which rotate around a horizontal hub protruding from the nacelle. This type of turbine is referred to as a horizontal axis machine.

There are two potential sources of noise: the turbine blades passing through the air as the hub rotates, and the gearbox and generator in the nacelle. Noise from the blades is minimised by careful attention to the design and manufacture of the blades. The noise from the gearbox and generator is contained within the nacelle by sound insulation and isolation materials.

Standing next to the turbine, it is usually possible to hear a swishing sound as the blades rotate; and the whirr of the gearbox and generator may also be audible. However, as distance from the turbine increases, these effects are reduced.

How is noise measured?

Noise is measured in decibels (dB). The decibel is a measure of the *sound pressure level,* ie. the magnitude of the pressure variations in the air. An increase of 10 dB sounds roughly like a doubling of loudness. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.

The noise a wind turbine creates is normally expressed in terms of its sound *power* level. Although this is measured in dB(A), it is not a measurement of the noise level which we hear but of the noise power emitted by the machine. The sound *power* level from a single wind turbine is usually between 90 and 100 dB(A). This creates a sound *pressure* level of 50-60 dB(A) at a distance of 40 metres from the turbine, ie. about the same level as conversational speech. At a house 500 metres away, the equivalent sound *pressure* level would be 25-35 dB(A) when the wind is blowing from the turbine towards the house. Ten such wind turbines, all at a distance of 500 metres would create a noise level of 35-45 dB(A) under the same conditions. With the wind blowing in the opposite direction the noise level would be about 10 dB lower.

Wind projects

When planning a wind turbine project, careful consideration is given to any noise which might be heard outside nearby houses. Inside, the level is likely to be much lower, even with windows open. The potential noise impact is usually assessed by predicting the noise which will be produced when the wind is blowing from the turbines towards the houses. This is then compared to the background noise which already exists in the area, without the wind farm operating.

There is an increase in turbine noise level as wind speed increases. However, as seen above, the noise from wind in nearby trees and hedgerows, around buildings and over local topography also increases with wind speed but at a faster rate. Wind turbines do not operate below the wind speed referred to as the cut-in speed (usually around 5 metres per second) and wind data from typical sites suggests that wind speeds are usually below this for about 30% of the time.

Preliminary recommendations from the Wind Turbine Noise Working Group[*1], established by the DTI, are that turbine noise level should be kept to within 5 dB(A) of the average existing evening or night-time background noise level. This is in line with standard practice for assessment of most sources of noise except for transportation and some mineral extraction and construction sites when higher levels are usually permitted. A fixed low level of between 35 and 40 dB(A) may be specified when background noise is very low, ie. less than 30 dB(A).

Different Types of Turbine

Wind turbines may be designed in different ways and many of the differences have come about from a desire to minimise noise emissions:

Upwind & Downwind Machines

The majority of horizontal axis turbines are designed in such a way that the blades are always *upwind* of the tower. This has the effect of minimising any airflow changes as the blades pass the tower. Some turbine designs, particularly some of those installed in the USA, have the turbine blades *downwind* of the tower. With this type of design, a strong pulse can sometimes be heard with each passing of a blade behind the tower. However, most turbines currently operating in the UK are of the upwind design.

Twin Speed and Variable Speed Machines

Most horizontal axis turbines rotate at a constant speed, usually between 25 and 50 rpm, irrespective of wind speed. However, twin speed machines operate at a reduced speed when the wind is light. This produces less noise and means that when the noise of wind in the trees is low, the noise of the turbine is also significantly lower by up to 10 dB(A). Variable speed machines change speed continuously in response to changes in wind speed and, although noise output may be higher at higher wind speeds, it is lower at low wind speeds where the low background levels occur.

Direct Drive Machines

These are the latest design concept in turbine technology. Simply put, these machines have no gearbox or drive train, and consequently no high speed mechanical (or electrical) components. Direct drive turbines are therefore much quieter than gearbox machines as they do not produce mechanical or tonal noise. An example of this type of turbine is the 1.5MW 'Ecotricity' turbine installed at Swaffham in Norfolk in September 1999.

In conclusion, the noise produced by typical wind farms is so low that they would not be noticeable in most residential areas in the UK. However, the areas suitable for such developments tend to be in quiet but exposed areas of countryside. A significant amount of effort is put into minimising any noise impact but it should be emphasised that typical noise levels are so low for a carefully considered site that they would normally be drowned out by a nearby stream or by a moderate breeze in nearby trees and hedgerows .

As said by the House of Lords in their Report on Electricity from Renewables[*2]:

"thanks to improvements in technology ...., noise is no longer the issue it was."

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[*1] The Working Group on Wind Turbine Noise, The Assessment and Rating of Noise from Wind Farms, September 1996. ETSU-R-97. Available from:
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The working group was formed from independent experts on wind turbine noise. The main objectives of the group were to define a framework which can be used to measure and rate the noise from wind turbines and to provide indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours and encourage best practice in turbine design and wind farm siting and layout.

[*2] House of Lords Select Committee on the European Communities, 12th Report, Session 1998-99, Electricity from Renewables HL Paper 78, available from:
The Stationary Office, Publications Centre, PO Box 276, London SW8 5DT
General enquiries Lo-call 0345 123 474, Telephone orders Lo-call 0345 585 463, Fax orders 0171 873 8200
The report costs £10.40 and the evidence is £20.30

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