

Assessment of the acoustic noise issues of wind farm projects in the light of the experience gained in Germany

Pierre Dutilleux, Joachim Gabriel
DEWI GmbH, Ebertstrasse 96, 26382 Wilhelmshaven
p.dutilleux@dewi.de, j.gabriel@dewi.de

1. Introduction

The specifics of the acoustic noise from wind turbine have been discussed in Germany for many years and have led to the formulation of recommendations on how to handle wind farm projects and to assess the potential nuisance according to the Federal Pollution Control Act.

In this paper we will review the main issues, present the point of view of the German community of acousticians and point out to recommendations for other countries interested at developing or adapting their regulation framework for wind farm projects.

In the choice of an acoustic criterion a most important factor is the stability of the decision which it will trigger.

2. Several issues to consider

The assessment of the impact of a wind farm on the acoustic environment involves the consideration not only of the wind turbine as a sound source but also of other phenomena such as the residual noise level, the propagation path, the perceptive issues which are relevant for the neighbors as well as the administrative rules and criteria of the country of implementation.

3. Initial situation

The noise contributed by the wind turbine must be compared to the noise already present in the surroundings before installation of the wind turbine which is dependent on several parameters such as the wind-induced noise by the foliage of the trees or by turbulence around obstacles, and the anthropic or biological activity. We understand here that the

residual noise level will be most probably dependent on the season.

The so-called „residual noise level“ can be measured but the measurement setup must be chosen with care otherwise artifacts will corrupt the collected data. Noise levels in the environment are usually measured using a 90 mm foam windscreen at the microphone. Whereas this screen appears to be efficient at low wind speeds, it does not protect the microphone from gusts which can induce very high levels at the microphone. The use of a secondary wind screen has shown that measurements with up to 10 m/s at the microphone can be realized. The standard IEC 61400-11 shows an example of secondary wind screen on a plate on the ground. Whereas this configuration is well suited for the measurement of noise coming from a high sound source, it may not be suitable for the measurement of sound sources close to the ground.

4. Propagation model

During the environmental impact assessment, an atmospheric propagation model is used to derive the expected noise level at the surroundings from the sound power level at the wind turbine. The method described by ISO 9613-2 is well accepted in Germany. In some other countries it is subject to discussion but no agreement could be reached so far between acousticians about the preferred method for this application.

5. Human perception

Since, in the end, the neighbors who have a word to say about the authorization of a wind farm project are humans, the particularities of human hearing perception have to be considered if a dependable

decision is needed. A first well known and widely accepted criterion is the so-called "A" frequency weighing of the noise spectrum. Other phenomena are however of importance which are considered e.g. by the German regulatory framework: a) the masking of some tone components by others and b) the selectivity of the hearing system with the concept of critical band.

The noise of wind turbines can be subject to slight amplitude or spectral modulations as the rotor is turning and the blades are passing by the tower. This particular feature of the noise is sometimes a cue for the association of noise with wind farms.

This issue is still much discussed in some countries and an agreement on how to assess this effect is still lacking. One of the difficulties is that the level of disturbance is very much dependant on the environmental conditions.

These concepts have been investigated in the past within the realm of psychoacoustics and experience shows that they address the issues which really matter when the acceptance of a wind farm project is at stake.

6. Regulatory framework

In a given country, a specific regulatory framework is needed which comprises the following levels: a) the legislative level where the rights and objectives for the well-being of people in their environment are established, b) the administrative level where the procedures for the interpretation and implementation of the law are defined while balancing the sometimes conflicting interests of the involved parties, c) the normative level where the assessment procedures are settled, d) the practical level where the assessments are performed.

Some countries will favor a top-down approach, others a bottom-up one. As a matter of fact, the so-called German "working group on wind energy noise" has provided to the upper levels c), b) and a) valuable knowledge gained from extensive field applications [1][3][4][6][7][12] which

has been considered for the definition of the regulatory framework where possible.

7. Towards a stable decision

A wide development of wind energy use can only be achieved if the procedures are fair, effective and lead to stable administrative decisions. With these principles in mind, a set of rules has been defined in Germany. The sound power level of the wind turbine can be determined with an uncertainty in the range of +/- 1 dB. The uncertainty of the accepted propagation model is estimated to be within the range of +/- 3 dB. The assessment focuses on the maximum immission noise levels, i.e. at higher wind speeds and as a consequence, the high variability of the residual noise level is not much of a concern. The decision criteria consider the perceptive issues such as the so-called "tonality".

In the implementation of these procedures as implied by the Federal Pollution Control Act [1], an upper confidence level has to be determined. If this level lies below the immission reference value with a 90% probability, the decision for a building permission is considered to be stable.

8. Other countries

The history and definition of the regulatory framework is specific to each country. In some countries such as France, the decision threshold is very dependent on the residual noise level which is subject to large temporal and seasonal variations [15]. In other countries, the assessment is derived from the sound power level of the source at a specific wind speed irrespective of the evolution of the sound power level of the wind turbine beyond this wind speed. For some wind turbine types, the maximum sound power level is limited but for others, the sound power level might keep increasing along with the wind speed beyond the wind speed range which has been considered for the acoustic study. This might lead to excessive sound pressure levels at some immission points.

The method for the assessment of the acoustic impact of a wind farm project is hence very dependent on the country of application. The framework developed in Germany is worth considering for countries willing to foster a wide development of wind energy application.

9. References

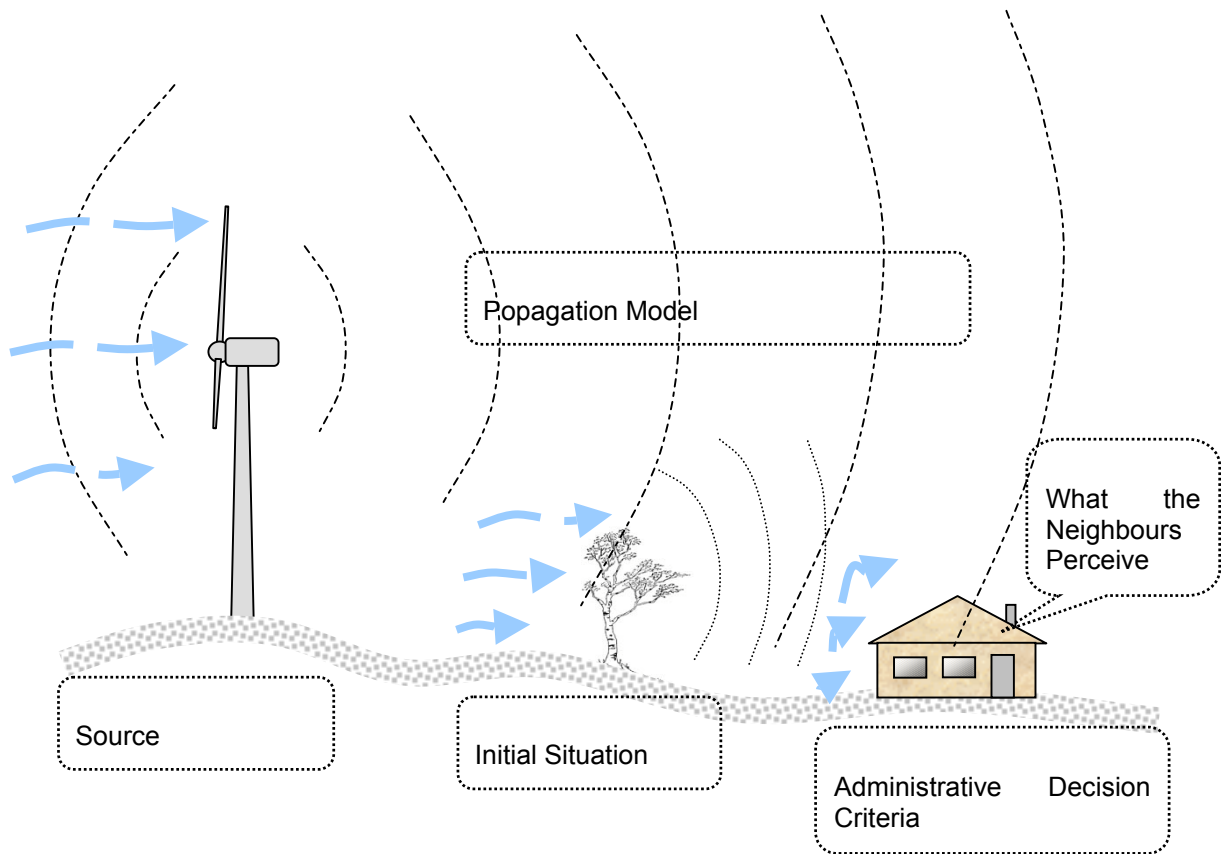
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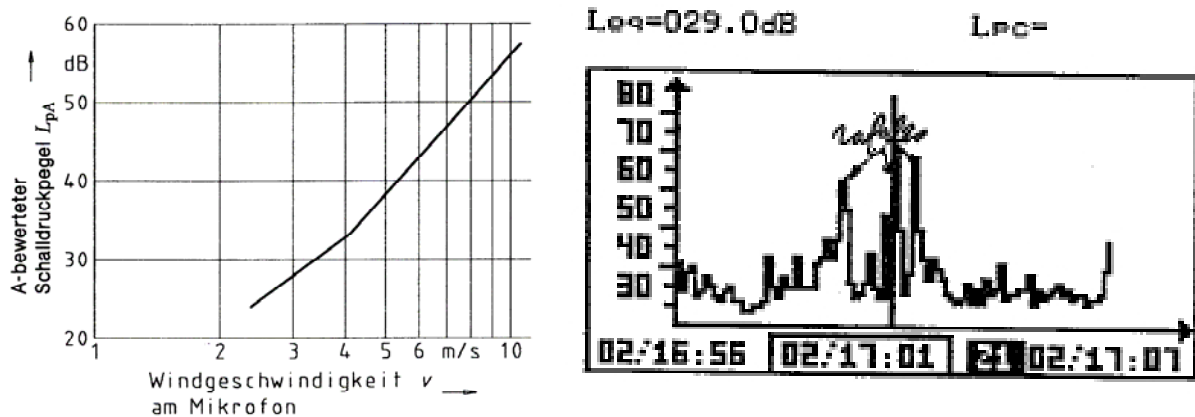
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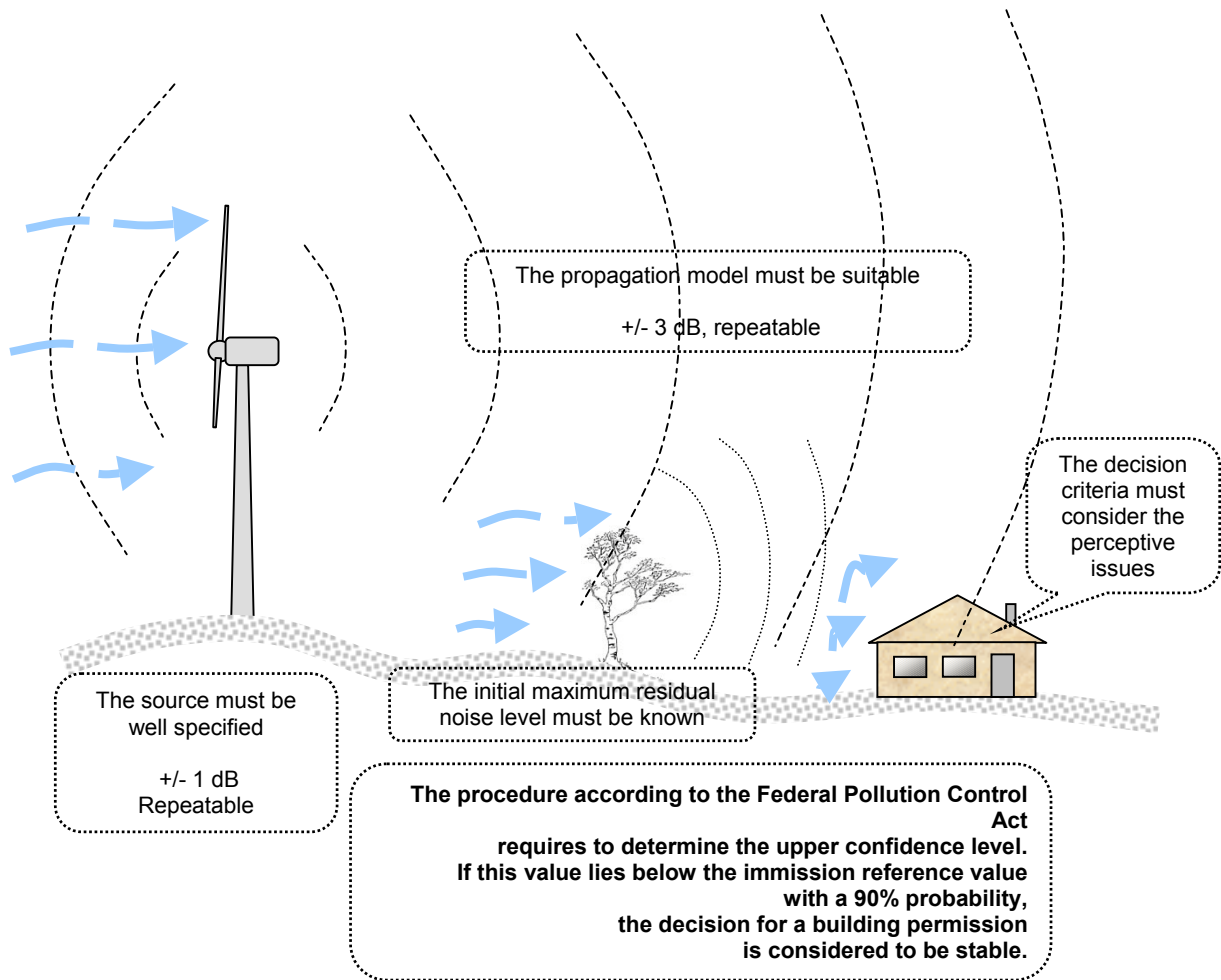
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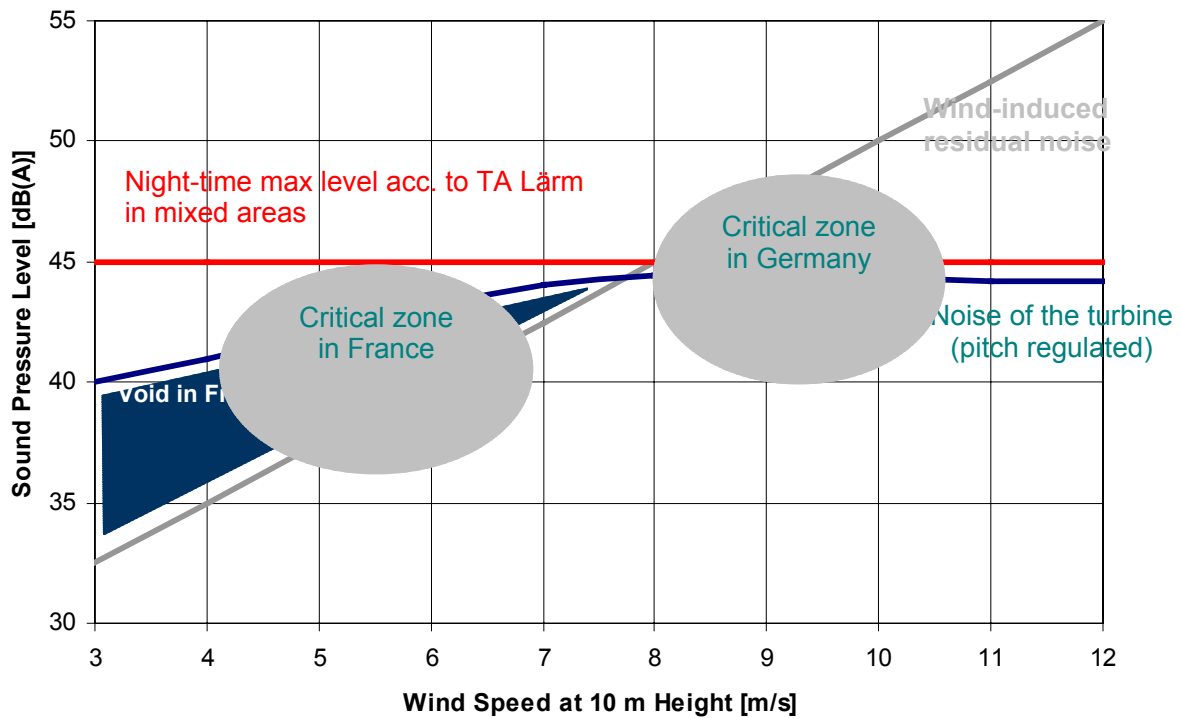
Picture 1: The assessment of the acoustic issues of a wind farm project should consider all aspects of source, propagation, residual noise, hearing perception and administrative criteria.



Picture 2: The assumption in the past (1991) was that the wind-induced noise level at the microphone, using a 90mm foam wind-screen is monotonously related to the wind-speed (left illustration). Experience shows however, that gusts can induce very high sound pressure levels due to flow-noise at the microphone in an otherwise very calm environment (right illustration). The use of a secondary wind-screen is recommended in order to effectively reduce the flow-noise.



Picture 3: The determination of the upper confidence level with a 90% probability is required in Germany.



Picture 4: The critical operational conditions of a wind farm project are country specific, depending on the administrative criteria in use in that country. Example shown: Germany and France.