ENVIRONMENTAL IMPACTS OF WIND POWER PLANTS IN TECHNOLOGICAL ASPECTS, NOISE AND SHADOW IMPACTS, AND PHOTOMONTAGE

L. TÓTH, N. SCHREMPF, A. KONCZ
Department of Energetics, Szent István University,
Faculty of Mechanical Engineering,
Páter K. u. 1., Gödöllő, H-2103, Hungary
Tel.:+36 28 522-000,E-mail: Toth.Laszlo@gek.szie.hu;
Schrempf.Norbert@gek.szie.hu;
Koncz.Annamaria@gek.szie.hu

Abstract

The impact on environment is an important element of the planning and settling process of wind power plants. In our work we examined a wind farm with 10 MW output according to the aspects of noise, shadow and view. Noise and shadow impacts can be exactly measured, standards and guidelines include the steps of examination. View is a subjective element. The impacts of it can be shown with photomontages for the affected. The impact on the environment has to be considered in the early stages of wind farm planning for the later successful constructing and settling.

Keywords

Environmental impacts of wind power plants, noise, shadow, photomontage

Introduction

The planning of wind farms is made on the basis of several objective and subjective aspects. In the planning process during the examination of environmental impacts the measurable and non-measurable impacts have to be taken into consideration and have to be analyzed at once. In the following compilation we examined shadow and noise impacts of wind power plants with methods used in international practice and we also made the photomontage of the planned wind farm. In our work we used the internationally recognized WindPro planning program.

Material and method

The calculation method of WindPro's Decibel module

At the calculations irrespective of number of wind power plants the following data are needed as basic data at each type :

- The location of wind power plant(s) (x,y,z coordinates),
- The tower height of wind power plant(s),
- The amount of noise emission (LWA, ref),
- The individual noise emission, and impulse-like noise emission of wind power plant(s),
- Give corner coordinates of noise sensitive areas,
- Definition of allowed noise level on noise sensitive areas, with increased attention to critical noise level (at rest time),
- Noise level of surroundings,
- The used calculation model.

The ISO 9613-2 standard deals with noise level calculation models in WindPro: „Attenuation of sound during propagation outdoors" The 9613-2 2. point of the standard „A general method of calculation." The usage of ISO 9613-2 makes the calculation with octave data possible in the case of wind power plants. If octave data are available and put in the WindPro catalogue those are automatically used at calculations. [1.] EMD INTERNATIONAL (2006)

The available octave data makes the consideration of noise reductive ground effects possible. This is the reason why the orographic model of examined area is practical in usage.

The implication of natural and artificial noise reductive environmental elements at noise sensitive objects such as schools, kindergartens, holiday areas, social and medicinal institutions is important in the modeling process.

The determination of the expected long-term mean noise-level:

$$L_{AT}\,(LT) = 10 * \lg \sum 10^{0,1(LATi\,-\,Cmet\,+\,KTi\,+\,Kli)},$$

where

L_{AT}: Resulting noise at noise critical point
L_{ATi}: Noise at noise critical point from noise source i
i: Idex for all noise sources from 1-n
K_{Ti}: Addition for pure tone content for a noise source i, depends on the local rules
K_{Ii}: Addition for impulse tone content for a noise source i, depends on the local rules
C_{met}t: Meteorological correction witch is determined by means of the equation:
C_{met}: 0, for dp<10 (hs+hr)
C_{met}: C0[1-10(hs+hr)/d_p] for d_p>10
d_p: Distance between noise source and recipient projected on level terrain.
[1.] EMD INTERNATIONAL (2006)

The C0 factor with the value from1 to 5 depends on the meteorological status. There are cases when the amount is bigger than 2 dB. In WindPRo these values can be individually determined. [1.] EMD INTERNATIONAL (2006)

On Figure 1 the conclusions of the calculation are shown. It can be seen that there is no surplus of noise load on the settlement near-by the wind farm. The result of the calculation improves in this case, because the main range of wind direction is in between West and North so the produced noise draws away from the noise sensitive area.

Important parameters are the wind speed values of the created map. The noise map shows noise emission of the applied wind power plant at the 95 % of its nominal power and at 10 km/h wind speed.

The calculation method of WindPro's Shadow module:

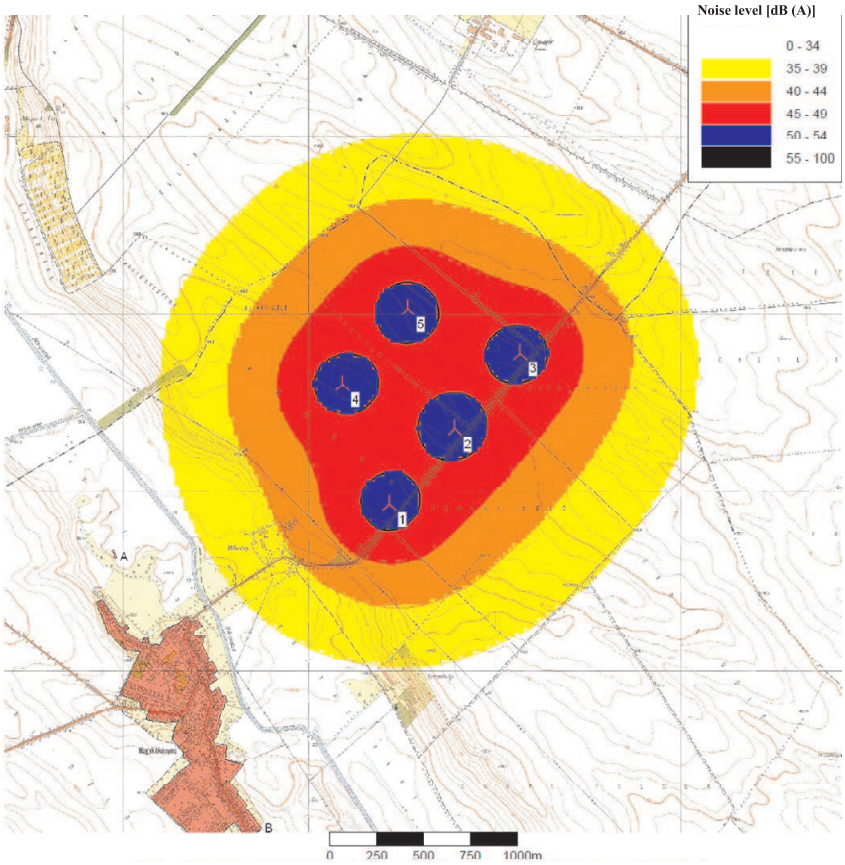
Shadow is a calculation module of WindPro with which the areas and time intervals affected with shadow impacts caused by wind power plants can be calculated. These calculations are on the basis on the worst case. Worst case means: when at daytime the sky is completely clear and sunny and the power plant is working.

At present only Germany has guidelines and limit values for shadow impact calculation. The limit values in the German guidelines are described by two factors:

- The angle of the Sun over the horizon must be at least 3 degrees,
- The blade of the wind power plant must cover at least 20 % of the Sun.

In Sweden and Denmark there are no official guidelines for describing the shadow impact but due to practical considerations the maximum allowed shadow impact interval is 10 hours/year. [1.] EMD INTERNATIONAL (2006), [3.] EMD INTERNATIONAL (2006)

The shadow map on Figure 2 is based on the worst case model mentioned above. In reality the result can be only better. According to the planning the result of the wind farm is lower than the maximum allowed yearly amount of overshadow interval. The colored lines show Iso-lines of the overshadowed area with the proportion of overshadowed hours/year.



Scale: 1:25000

The central coordinate of map in Geo WGS84 coordinate system: E.l.: 19°36'58,82" N.l.: 47°44'59,14"

Planned new wind power plant Noise sensitive area (**Marked with A, B)**

Figure 1. The noise map of the planned wind farm (WindPro 2.5)

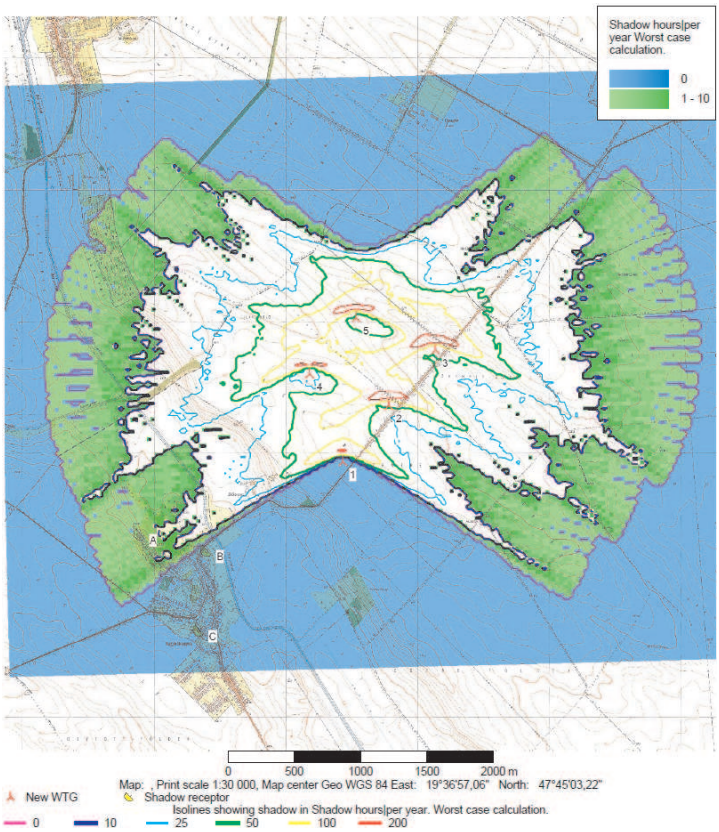


Figure 2. The shadow map of the planned wind farm (WindPro 2.5)

The photomontage of the wind farm:
The main parameters needed at making the photomontage:
- The geometry of the wind power plant,
- The coordinates of the place where the photo is taken,
- The date when the photo was taken,
- The main parameters of the photo,
- The factors which influenced the natural lighting conditions when the photo was taken.

[1.] EMD INTERNATIONAL (2006), [4.] EMD INTERNATIONAL (2006)

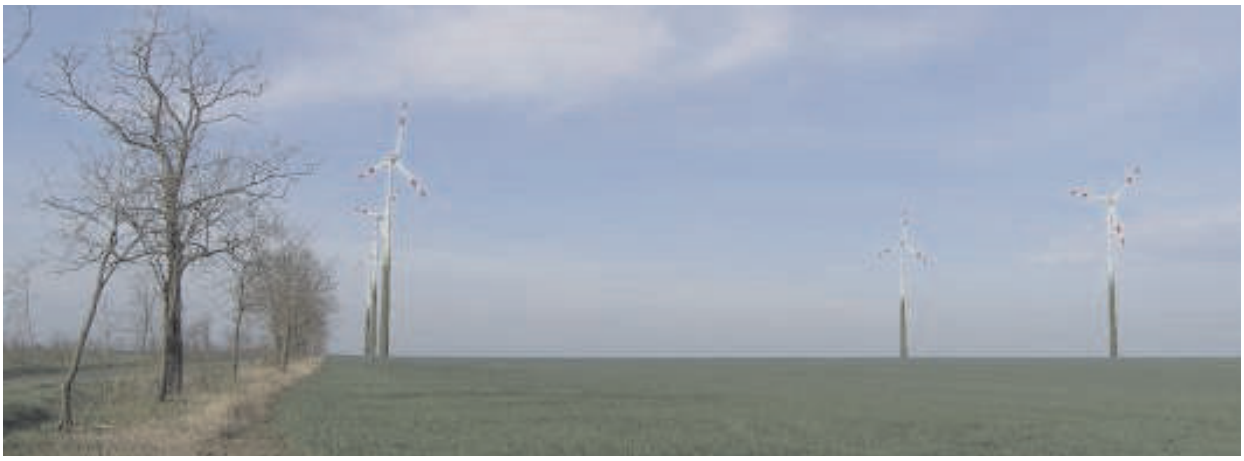


Figure 3. The wind farm from direction east at 270° wind direction, at 8:00 a.m.

Figure 4. The wind farm from direction east at 315° wind direction, at 8:00 a.m.

Figure 5. The wind farm from direction west, seen from the nearest settlement at 270° wind direction, at 2:00 p.m.

Figure 6. The wind farm from direction west, seen from the nearest settlement at 315° wind direction, at 2:00 p.m.

The making of the photomontage is practical from the direction of those objects where changes or aesthetic loss of value is expected (objects such as dwelling houses, community centers, cultural or historical memorials).

Results and calculations

At the examination of the noise impact we found that at far bigger wind speed than expected the noise emission level does not exceed or even reach the allowed maximum level at the given area.

The shadow impact, assuming the worst case can be perceived at certain parts of the settlement, but it does not exceed the limit of 10 hours/year according to the guidelines. At simulation of the real case the area affected by the shadow impact is far from the center of the settlement. If the natural lighting conditions of the area are monitored long-term and according to this we calculate the size of the overshadowed area a map which shows the real case can be constructed.

The impact of the view is subjective and opinions spread about it. There are people in favor of and also those who are against it. At this examination it is important to consider that with a usage of a modern and environment friendly technology we produce clear energy for our everyday purposes and this is worth for making compromises.

Literature

[1.] EMD INTERNATIONAL (2006):Wind PRO 2.5 User Guide, Aalborg, Dänemark, 453 p.

[2.] EMD INTERNATIONAL (2006): Decibel, Lärmimmissionen, Aalborg, Dänemark, 4p.

[3.] EMD INTERNATIONAL (2006): Shadow, Schattenwurf, Aalborg, Dänemark, 6 p.

[4.] EMD INTERNATIONAL (2006): Fotomontage, Aalborg, Dänemark, 1p.