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EVALUATION OF WIND POTENTIAL AND THE ENERGY USED IN CLUJ-NAPOCA

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Abstract: *This article is provided a method of estimating the amount of usable wind potential in Cluj-Napoca area. Illustration is made by processing wind speed data provided by the NMA (National Meteorological Administration) for the meteorological station in Cluj-Napoca in November- December 2012 and January 2013. This estimate can be made for any month of the year. This estimate can be made for any month of the year. Wind speed is the main parameter that must be taken into account in any energy projects. This parameter must be followed at least one year.*
Key words*: wind potential, air density, wind turbine.*

1. INTRODUCTION

The increasing prices of solid fuels and oil, the nuclear crisis from Fukushima that occurred in March 2011, led to orientation in alternative energy. For 2015 it is estimated by experts that wind power will ensure a saving of 23.7 billion euro, an amount that would otherwise have been spent to produce electricity from coal 15.1 billion euro, natural gas 6.4 billion euro, oil 1.7 billion euro. In 2020 it is estimated that we will save 87 billion euro due to wind energy. These estimates are based on data from the International Energy Agency (IEA International Energy Agency) and the World Wind Energy Council (Global Wind Energy Council). [4]

In our country, in Dobrogea are already built wind farms totaling 600MW. Construction of a 69 MW wind farm in Cernavoda was completed in May 2011. Energy provided by the wind turbine can power 70,000 households and cost $ 200 million. Based on the evaluation and interpretation of data records in Romania can be mounted wind turbines with a capacity of 14,000 MW, which means a power input of about 23,000 GWh / year, about 10% of gross electricity consumption in the country. [4]

The EWEA Report (European Wind Energy Association) shows how the use of wind energy will contribute to a substantial reduction of carbon dioxide emissions, which will allow the EU objective to reduce these emissions by 80-95% in 2050. The report sets out how much you need to increase the amount of electricity supplied by wind turbines to fulfill this purpose.

In 2020 most EU countries will have to at least triple the electrical power of wind turbines to reach a total installed capacity of 230 GW, covering 15.7% of the EU electric energy. One can say that the future looks favorable for wind turbine industry. There is an increasing demand for electricity from wind sources, as these sources of energy are renewable and sustainable. It is estimated that wind power will continue to be the fastest growing in the field of power generation, with over 10,000 MW annually worldwide. Since the wind turbines will be produce at a larger size, countries that produce electricity from wind will achieve considerable savings. Currently, efforts are made to make the driving systems of the wind turbines more

reliable and with a longer lifetime. Standardization activities in this field will continue to take place within ISO, IEC and the joint working group ISO / IEC JGW, developing international standards to support the rapidly growing industry. [4]

2. WIND RESOURCES

To determine the wind potential of a site is insufficient to know only the average wind speed. [2] We must know both the power density of the wind in that place and the distribution probability of the wind. Data about the average wind speed at different heights above the ground is relatively easy to find, but we cannot find detailed data from which to deduce the exact wind potential. Moreover these comprehensive data describing the wind potential of a given location, the Weibull power distribution or probability distribution, are only a better or worse approximation, so that once detected the area of interest are measured directly on the place at least one year. [2]

NMA has an average wind speed map from 2006 (Fig. 1.) This map should be used for information, because every individual sites has a different wind potential and varies greatly from case to case occurring turbulence due to terrain, buildings, forests, vegetation around, even if they are in the distance.

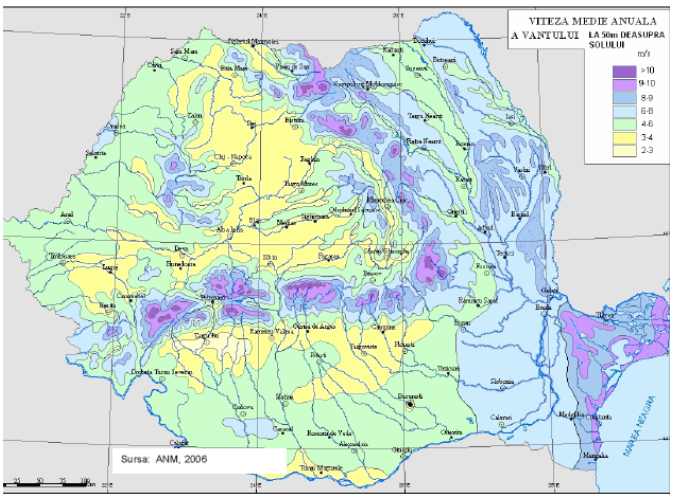

Fig. 1 Wind map developed by NMA in 2006. [7]

3. EVALUATION OF WIND POTENTIAL IN CLUJ-NAPOCA

3.1 Definitions

The amount of energy traversing a unit area, normal to the direction of the wind, in one unit of time, is called flux density energy:

$$P = \frac{\rho . v^2}{2} \qquad (1)$$

Where: ρ- density of air;
v- is the wind speed.

Obviously, this large flux density varies in time and in space. For a given location, the temporal mean of the energy flow density, in a large enough T time interval defines the wind potential of the site.

$$\varepsilon = \lim_{T\to\infty}\left(\frac{1}{T}\right)\int_0^T P(t)dt \qquad (2)$$

Sometimes there is used the term wind potential and average annual energy which is crossing the unit area normal to the wind direction:

$$E = \int_0^T P(t)dt \qquad (3)$$

with T = 1 year = 8760 hours.

From the expressions above, we deduce that the possible energy to capture is dependent on the cube of the wind speed; hence the importance of more precise wind speed and duration for a given wind speed location.

To calculate the wind speed we start from the data provided online by the NMA on wind speed. The data on wind speed were downloaded on wind speed over the three months (November, December and January) with maximum values , minimum and weighted average values from local weather station. Figures 2, 3, 4 is the wind speed in the three months. Given the randomness of weather phenomenon called wind it requires a statistical processing of the data.

We take into account the weighted average wind speed because the duration of a certain intensity is very important.

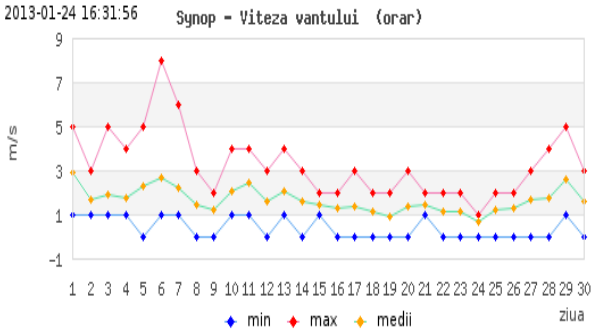

Fig. 2 Winds in Cluj in November 2012 [8]

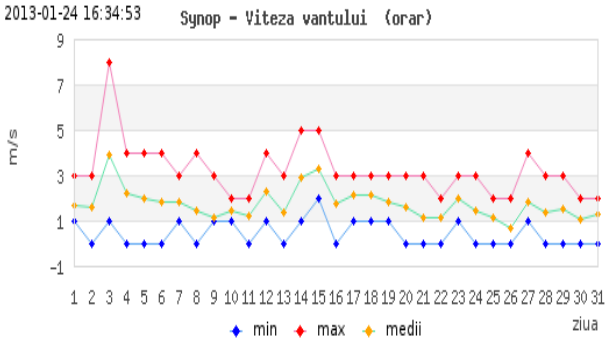

Fig. 3 Winds in Cluj in December 2012 [8]

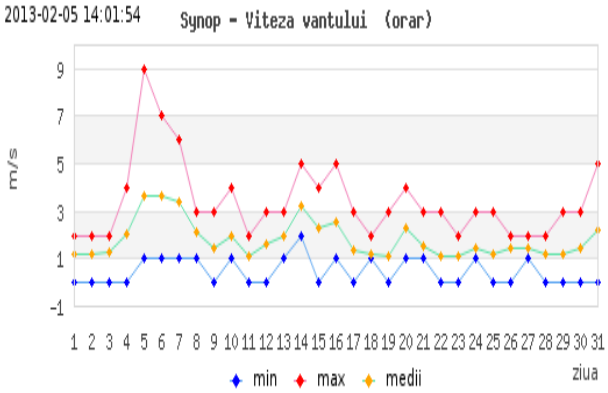

Fig. 4 Winds in Cluj in January 2013 [8]

Table 1. Wind duration (hours) in November

Locality	V>1 m/s	V>3 m/s	V>5 m/s
Cluj-Napoca	672 hours		

Table 2. Wind duration (hours) in December

Locality	V>1 m/s	V>3 m/s	V>5 m/s
Cluj-Napoca	648 hours	72 hours	

Table 3. Wind duration (hours) in January

Locality	V>1 m/s	V>3 m/s	V>5 m/s
Cluj-Napoca	648 hours	96 hours	

From reading the data from the tables it can be seen that the area of Cluj-Napoca has low to moderate wind potential. In the tables shown above, is the average wind speed during three months. One can easily see that there are major differences from month to month. For wind speeds of 1-3 m/s, the number of hours / month is 648, about 89% of the time. Based on relations (1)-(3), we can say:

$$E = \frac{\rho}{2}\int_0^T \upsilon^3 dt \qquad (4)$$

in which it will be inserted weighted average speed as a function of time. Because the available speed values in nature are random, a proper calculation would require processing statistical data measurements. We calculated entirely from the equation (4) by making it worth the finite number of terms. In this sense, we used the expression:

$$E = \frac{\rho}{2}\tau\sum_{i=1}^{30}\frac{\upsilon_i^3 + \upsilon_{i+1}^3}{2} \qquad (5)$$

where: τ - throughout the day; v_i - Average wind speed on the "i" day. If the above relationship is inserted: ρ = 1293 kg/m3 (value of the air density at 0 ^{o} C under normal conditions). and τ = 86400 s, resulting in the potential value J/m2. This is the energy that has a current streak section with 1 m^2.

Following the calculations in Mathcad software gives us the following results:

For November 2012: E=2,933 KW·h/m^2

For December 2012: E=3,589 KW· h/m^2

For January 2013: E=4,381 KW· h/m^2

Where E- usable wind energy.

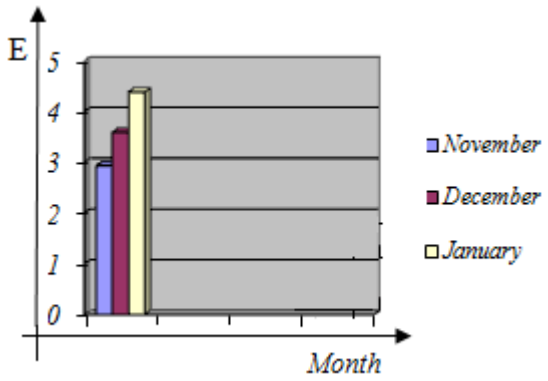

Fig. 5. Specific wind energy in the weather station in Cluj-Napoca

As a result, the potential of wind recorded in the area of Cluj-Napoca and in areas with similar wind potential, require for a better energy efficiency, the installation of wind turbines with a the startup speed below 3 m/s. Of course, we must not forget that this study is demonstrative. This does not mean that its results cannot be legally a signal and initiation into the problem. It may be that such a study can be expanded and amplified in several years.

This assessment can also be performed for any area in the country. Certainly in the mountains of Cluj, where the speed and frequency of the wind is greater, we will have higher energy efficiency.

4. Conclusions

After this study we can draw the following conclusions:

Romania has a good wind potential according to the map published by ANM wind, especially in the Black Sea, Dobrogea and northern Moldova.

Choosing the type and capacity of the wind turbine involves a prior analysis of the installation area, as it is not sufficient the analysis offered by commercial software.

Wind potential in the area of Cluj-Napoca is weak to moderate, wind speeds of 1-3 m / s, the number of hours / month is 648, about 89% of the time.

Wind potential in the area of Cluj-Napoca requires the implementation of low power turbine that starts at low wind speed of 1-2 m / s.

5. References:

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[8] www.meteoromania.ro/anm/?lang=ro_ro

Evaluarea potențialului eolian şi a energiei utilizabile în zona localitații Cluj-Napoca

Rezumat: În acest articol este redată o metodă de estimare a cuantumului utilizabil din potențialul eolian al zonei orașului Cluj-Napoca. Exemplificarea se face prin prelucrarea datelor privind viteza vântului furnizate de ANM, pentru stația meteorologică din Cluj-Napoca din lunile Noiembrie-Decembrie 2012 Şi Ianuarie 2013. Această estimare poate fi facută pentru orice lună a anului. Viteza vântului este principalul parametru de care trebuie să se țină seama în orice proiect bazat pe energie. Acest parametru trebuie urmărit cel puțin un an.
Cuvinte cheie: potential eolian, densitatea aerului, turbine eoliene.

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