RESEARCH PAPER | Engineering | Volume : 4 | Issue : 4 | Apr 2014 | ISSN - 2249-555X

Comparative Analysis of The Estimated and Actual Values of Wind Farms Parameters

KEYWORDS: wind potential, wind energy, hourly utilization

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ABSTRACT *The article presents an analysis of wind potential, based on measurements of wind for nine different locations for three years. The article defines the expected amount of electricity generated in the current environment. A comparison of the calculated and actual values of the produced amount of electricity utilization of installed capacity and time utilization of wind plants built in areas where measurements were performed.*

Introduction:
The preparation of wind energy assesment, includes wind resource assessment and wind potential analysis techniques for its absorption determination of projected electricity production, economic analysis of the profitability of the project and recommend the most suitable option for construction. Resource estimate is preceded by preliminary measurements of wind. Along with wind assesment shall be prepared environmental analysis, which determines the compatibility of the constructed object of the nearby protected areas.

For each wind turbine the power curve is known. It allows to determine the estimated amount of electricity which will be produced at the wind turbine installation in specific operating conditions. Having data on the parameters of the wind and the power curve of the wind power plant the coefficient of installed capacity is estimated. The annual utilization hours of wind power plant is also estimated (Muselli M., et al.; Nedeltcheva S., 2004).

The aim of the study is to summarize the results of calculations carried out for nine sites, for which have been conducted wind measurements for three years to determine the estimated electricity production, utilization of installed capacity and time utilization of wind farms. A comparison is done of estimated and actual parameters of wind farms built in places where measurements were performed, allowing to make generalizations about their real conclusions and about the usability and accuracy of the applied models.

Methodology for conducting wind assesment
The main analyzed indicators in wind assements are:

- The electricity production for a year;
- The coefficient of utilization of the installed power;
- The annual utilization of power plant.

The main criterion for selecting a type of wind farm is the amount of electricity produced for a year.

The coefficient of utilization of wind farms reach levels comparable to water plants. This factor has a probabilistic nature and varies during different seasons.

Annual utilization of wind farms, as determined at the preliminary studies is compared with the regulated value. To be profitable a wind farm it is recommended to be constructed at annual utilization of over 2000 h.

The average wind speed is recorded every 5 min. The statistical sampling of data has 288 observations per day. This yields a complete picture of wind parameters in research area.

From the measurement are determined the parameters of the theoretical Weibull distribution given in Table 1.

Confirmation of received parameters is performed by processing the observations of wind speeds for a period of 30 years provided by the nearest meteorological station.

The wind potential of a height of 50 m, is determined by the data of the objects studied and is shown in Table 1, the wind energy of an area of 1 m^2 and the annual utilization is shown in Table 2.

Table 1. The wind potential of a height of 50 m

Object of study	Average wind speed for a year v_{cp}, m/s	Webull parameters	
		A, m/s	k
1	2,15	2,37	1,01
2	3,2	3,49	1,08
3	4,5	4,85	1,17
4	5,2	5,9	1,85
5	5,3	5,8	1,81
6	5,6	6,1	1,83
7	6,2	6,85	1,84
8	6,8	7,15	1,88
9	7,8	7,92	1,97

Table 2. Wind energy for area of 1 m^2 and hourly utilization of wind farms for a year

Object of study	Wind energy for a area of 1 m^2, W/m^2	Hourly utilization for a year, h
1	-	-
2	-	-
3	200	750
4	180	900
5	180	930
6	200	990
7	260	1860
8	360	2650
9	400	3360

Volume : 4 | Issue : 4 | Apr 2014 | ISSN - 2249-555X

The accumulated information is about time intervals for which the wind speeds within the operating range of the turbine is used to determine the expected energy production for the same period of time (Nedelcheva,2006).

A comment of obtained results:

- Measurement data on the flat part (object 1) shows average wind speed of 2,35 m/s. Below these conditions, wind Power Plants will be unprofitable, because it will be loaded on average 5% of their nominal power and will operate under 450 h per year. However, two wind Power Plants are built and put into operation in the region in 2003 and 2004. A comparison of the predicted values of the electricity production of the model and the actual values of the electricity produced are shown in Table 3 and 4.
- The measurements carried out in two locations in the mountains show average annual rate of less than 5 m/s, insufficient to build a profitable wind Power Plants, six of the surveyed areas have wind speeds above 5 m/s, but in fact the appropriate wind speed is observed only 10-15% of the time. On object 4 with an average wind speed of 5,2 m / s are built eight wind Power Plants.
- Te mountain areas are of particular interest with an average annual wind speed, respectively 6,2 and 6,8 m/s at an altitude above 1000 m as the wind potential to meet the needs of wind energy (objects 7 and 8). For now on Object 7 are built 4 Wind Power Plants.
- Only one of the measurement sites (site 9) with an altitude 1500 m the average wind speed is more than 7 m / s, and the annual utilization hours of 3360 h. With similar wind potential are recommended for wind Power Plants. In this case, however, access to the area is difficult, there is no infrastructure, which would inhibit the operation of wind Power Plants. Moreover, the measured wind speed values exceeding the maximum speed for which the facilities are sized, which makes the place favorable for wind Power Plants (Nedeltcheva, 2006).

Table 3. Comparing the utilized power, expressed in% of the nominal power obtained during modeling and real data of wind power plants

Object studied	Utilized power, %		
	Model	Measurment	Error, %
1	3,15	3,09	-1,95
4	12,5	12,8	2,34
5	12,6	12,9	2,32
6	15,4	15,7	1,91
7	17,3	17	-1,76

Table 4. Comparison of hourly utilization in modeling process and real data obtained in exploitation process of wind power parks

Object studied	Hourly utilization, h		
	Model	Measurmen	Error, %
1	435	427	-1,87
4	900	885	1,69
5	930	905	-2,76
6	990	965	-2,59
7	1860	1890	1,58

Results:

The errors using models for determining the expected energy production, utilization on installed capacity and hourly utilization does not exceed 2.8% of the actual measured values.

The sample data for monthly electricity production from wind Power Plants built in the places where the measuring is sufficient (9 years for site 1, 8 years for site 4 and 6 years for site 5, 6 and 7) to confirm that the models are adequate.

The wind farms installed in area with average wind speeds above 5 m/s work with no more than 17% of its installed capacity in the windiest seasons.

The wind farms installed in area with average wind speeds below 5 m/s work with only 5% of it installed power.

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