

WIND POWER PLANT - BOGDNACI AND ITS IMPACT ON THE PRICE OF ELECTRICAL ENERGY IN MACEDONIA

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Abstract

The paper presents the impact from the new planned wind power plant Bogdanci on the price for the end users of electrical energy in Republic of Macedonia. In the next years, 50 MW wind power will be installed in the Macedonian electric power system. Production of electricity from wind power plants is unpredictable and of stochastic nature i.e. depends on the weather or the wind speed at the appropriate locations. Output of wind power plants is changing every minute, thus changing in the hourly level can be from 0 - 100%, even several times depending on the occurrence of winds. Changes in output of wind power plants, leads to increased demand for operational reserve in a power system. Preferential price of electrical energy from the wind power plants and increased operational reserve in the electric power system will have big impact on the final price of electrical energy in Republic of Macedonia.

Keywords

Wind power plants, power system, price of electrical energy, operational reserve

1 INTRODUCTION

Total consumption of energy in the Republic of Macedonia is around 120,000 TJ annually. In primary energy consumption, oil accounts for 30%, coal for about 52%, natural gas 2-3%, and the remaining around 15% are hydro energy, wood and geothermal energy. Domestic energy production covers about 55% of demand and 45% are provided from imports. The total installed capacity for electricity production is 1 570 MW, with annual production of around 6 500 GWh. Installed capacity from thermal power plants are 1 010 MW with annual production of 5 000 GWh, and installed capacity from hydro power plants are 560 MW with annual production of around 1 500GWh.

Tab.1 TPP in Republic of Macedonia

	Number of units	Installed power (MW)
TPP Bitola	3 x 225	675
TPP Oslomej	1 x 125	125
TPP Negotino	1 x 210	210
Total	5	1010

Tab.1 HPP in Republic of Macedonia

Name of SHPP	Installed power (MW)	Number of aggregates
Vrutok	164	4 x 41
Tikves	112	4 x 28
Spilje	84	3 x 28
Kozjak	80	2 x 40
Globocica	42	2 x 21

Raven	18	3 x 6
Vrben	12	2 x 6
Total	512	20

Geographical and weather conditions in Republic of Macedonia do not allow installation of large wind power plants in power system. However there are certain locations where wind speed and its stability, giving the possibility for installing wind power plants.

The Vardar river basin from Kumanovo to Gevgelija is considered to be the most favorable area for wind energy applications. Other areas of possible importance are the Pelagonia region, Kriva Palanka, Ohrid and other mountain areas.

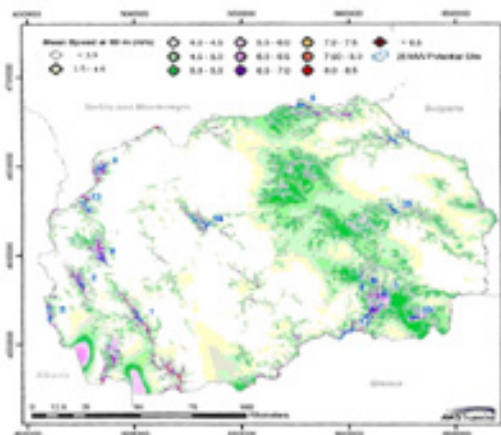


Fig.1 Map of winds in the Republic of Macedonia, made with satellite shots

According to the Strategy of utilization of renewable energy sources in Republic of Macedonia till year 2020 and Energy Law and the Decision of the Regulatory Commission of the Republic of Macedonia, the maximum planned installed capacity of wind power plants in the electric power system is from 150 to 180 MW, with annual expected electrical energy production from 300 to 360 GWh, and the overall electricity produced from wind power plants must be purchased by the market operator with a price of 89 €/MWh. At the end, these costs will be calculated into the cost for using the electricity market, which are paid from the end users of electricity in the Republic of Macedonia.

The question subject of discussion in this paper is what is the impact of 50 MW installed wind power plant Bogdanci and the annual expected electrical energy production of 120 GWh, with a preferential tariff of electricity produced, on the price of electricity in Republic of Macedonia (Fig. 2).

Bogdanci Wind Farm will be located in the south-eastern part of Macedonia, near to the Vardar river, close to the border with Greece. Average wind speed measured during a period of three years was 7 m/s at 50 m above ground. The proposed project activity will contribute to expand the green energy generation in Macedonia, and will be first of its kind.

According to the decision of the ERC in 2012, the cost for using the electricity market is 0.0187 den./kWh or 0,3 €/MWh. In this price, the impact of produced electrical energy from renewable energy sources is 85.65%. In this price are not included costs for operating reserves (ancillary services) resulting from the production of electricity from renewable sources.

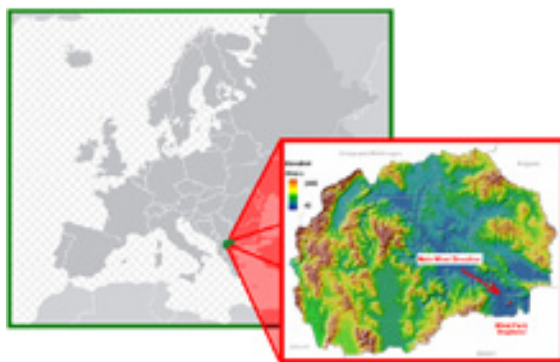


Fig.2 Wind Park Bogdanci location

2 IMPACT FROM THE WIND PARK BOGDANCI ON THE SECONDARY RESERVE

Production of electricity from wind power plants is unpredictable and stochastic nature i.e.

depends on the weather or the wind speed at the appropriate locations. Output of wind power plants is changing every minute, thus changing in the hourly level can be from 0 - 100%, even several times depending on the occurrence of winds. Changes in output of wind power plants, leads to increased operational reserve in a power system - on the size of the secondary reserve in the electric power system:

$$SRV_T = \pm \sqrt{SRV_{ENTSO-E}^2 + SRV_{DYN,WIND}^2} \quad (1)$$

Where: $SRV_{ENTSO-E}$ - is secondary reserve recommended by ENTSO-E for MEPSO - Macedonian Transmission system operator, and it is 35 MW.

$SRV_{DYN,WIND}$ - is dynamic fluctuations in electric power output from the wind power plants on the secondary reserve in the system.

$$SRV_{DYN,WIND} = \frac{R_\phi}{2} + \sigma \quad (2)$$

Where: σ - is standard deviation;
 R_ϕ - is arithmetic mean of the 10 minute values of maximum and minimum value of the power from wind power plants.

From the data available, standard deviation and arithmetic mean are:

$$R_\phi = 24,11 \text{ MW}$$

$$\sigma = 21,43 \text{ MW}$$

And:

$$SRV_T = 48.5 \text{ MW}$$

According to the data that were available for the authors, and according to calculations that were made, it was concluded that the installation of the wind park Bogdanci will contribute to increase the secondary reserve in electric power system of the Republic of Macedonia for additional 13,5 MW.

3 IMPACT FROM THE WIND PARK BOGDANCI ON THE END USERS PRICE OF ELECTRICAL ENERGY

If the price of the secondary reserve is 50 €/MWh (real price for secondary reserve), the Market Operator must to provide additional 5.913.000,00 € for operation reserves (ancillary services) for operation of 50 MW wind power plant Bogdanci.

The price for using the electricity market, with installation of 50 MW wind power plant in the Macedonian electric power system will be 0.1006 den./kWh or 1,64 €/MWh and the end users price will be 71,68 €/MWh which is increment of 2,34 %.

From here we can conclude that the real price of electrical energy from the wind power in Macedonia is not 89 €/MWh, but it is 138,27 €/MWh.

4 CONCLUSION

Production of electrical energy from wind power plants in the world is in constant growth. Their main disadvantage is inconsistency and stochastic nature of the wind speed that affects the electrical energy production and injection in the electric power system. For that reason operators of the electric power system have great difficulties to operate electric power system and to balance the electrical energy production and consumption in real time.

Therefore in future, MEPSO as a system operator responsible for normal functioning of Macedonian power system should increase ancillary services which will additional increase the electrical energy price for the end users. According the estimation, the real price for the wind energy in Republic of Macedonia will be not 89 €/MWh, but 138,27 €/MWh.

5 REFERENCES

- [1] JANICEK, F., et al. "Renewable energy sources 1". Technologies for the sustainable future. Bratislava FEI STU, 2007. ISBN 978 80-969777-0-3.
- [2] Cigre Working Group C4.601." Modeling and Dynamic Behavior of Wind Generation as It Relates to Power System Control and Dynamic Performance", August 2007, ISBN: 978-2-85873-016-2
- [3] SMITKOVA, M., ELESCHOVA, Z., HAJDUCEK, P., JANICEK, F., MINOVSKI, D., SARAC,, V., "National Centre for Research and Application of Renewable Energy Sources". ELEKTROENERGETIKA, Vol.4, No.2, 2011
- [4] SMITKOVA, M., POLONEC, L., "New Trends in Electricity Pricing Policy". Electric Power Engineering 2005. Technical University of Ostrava, Czech Republic, 2005. p. 150