IMPACTS FROM WIND POWER PLANTS ON THE PRICE OF ELECTRICAL ENERGY IN MACEDONIA

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ABSTRACT

The paper presents the impact from the new planned wind power plants on the price for the end users of electrical energy in Republic of Macedonia. In the next years, 150 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.

1. INTRODUCTION

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.

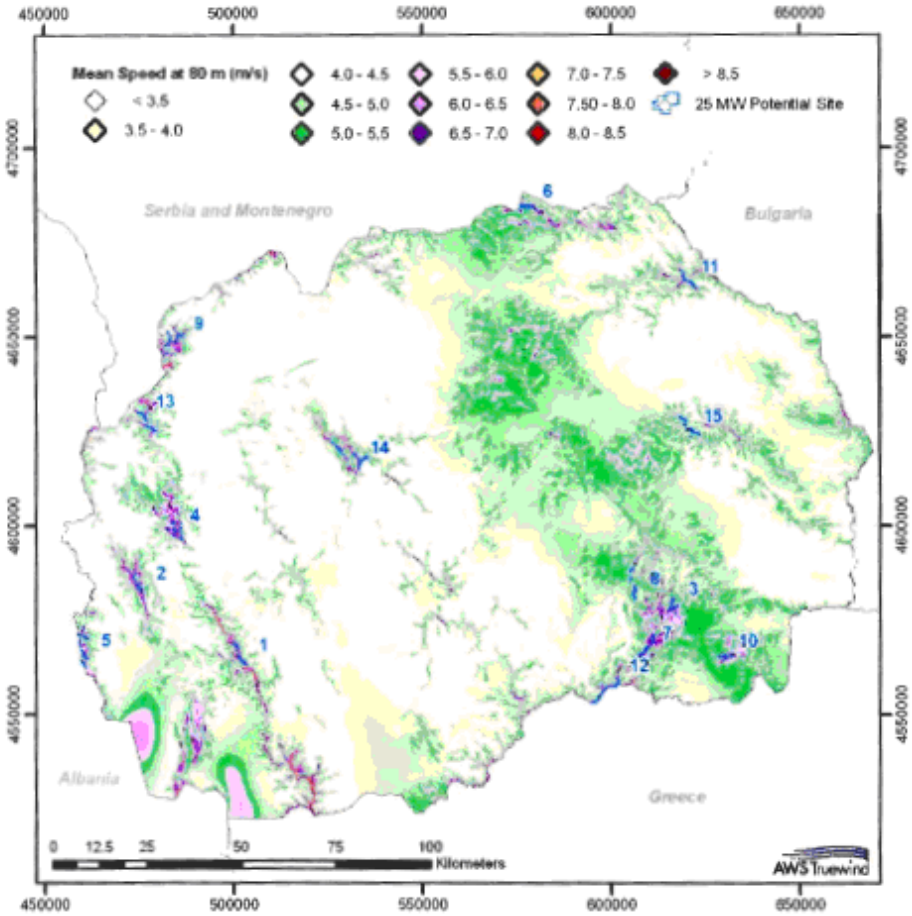

Fig. 1 Map of winds in the Republic of Macedonia, made with satellite shots

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 are the impact of 50 MW installed wind power plant 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.

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.

2. IMPACT FROM THE WIND POWER PLANTS ON THE SECONDARY RESERVE IN MACEDONIA

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.

Given the role of secondary regulation control, which is responsible to catch up dynamic imbalance in the planned production and the expected load, it is necessary in the section on dynamic changes in load to add the dynamic changes in the production of wind power which will affect on the secondary regulation reserve $SRV_{DYN,VTE}$.
Since there is no direct formula or dependence, those two parameters is not possible to be calculate directly. One way, these two parameters to be determined and to be close to the actual values is by using a geometric mean. Therefore we assume that the total need of secondary reserve will be:

$$SRV_T = \pm\sqrt{SRV_{ENTSO-E}^2 + SRV_{DYN,VET}^2}$$

$SRV_{DYN,VET}$ can be determined by using the statistical data on the change of production every 10 minutes, from previous years. Knowing that in Macedonia there are no wind power plants, then these data can only be extrapolated taking into account measurements of wind speed for a suitable location:

$$SRV_{DYN,VET} = \frac{R_\phi}{2} + \sigma$$

Where:

σ is standard deviation;

Rϕ is the arithmetic mean of the 10-minute values of the maximum and minimum value of power of wind power plants and is determined by:

$$R_\phi = \sum_i^n \frac{(MAX_{10\min} - MIN_{10\min})}{n}$$

Where:

MAX_{10min} is the maximum power in the i-th interval;

MIN_{10min} is the minimum power in the i-th interval;

n is the number of 10 minute followed intervals.

Standard deviation describes the width of the error and is calculated according to equation:

$$\sigma = \sqrt{\frac{\sum (R_i - R_\phi)^2}{n-1}}$$

Where:

Ri is the difference between the maximum and minimum power in the i-th interval;
n is the number of 10 minute followed intervals.

Because there are no statistics on the wind speed at 10-minute intervals for any location in the Republic of Macedonia, as data that can be used to determine the impact of wind power on secondary regulation reserve, the authors of the text took hourly data for the wind speed around Bogdanci and suppose that near Bogdanci is installed wind park with installed capacity of 50 MW.

For secondary reserve recommended by ENTSO-E, the authors suppose that is $SRV_{ENTSO-E}$ = 35 MW.
To determine $SRV_{DYN,VET}$ is necessary to determine the $R\phi$ and σ. According to the data available to the authors, values for $R\phi$ and σ are:

$R\phi$ = 24,11 MW
σ = 21,43 MW

And $SRV_{DYN,VET}$ is:

$SRV_{DYN,VET}$ = 33,5 MW

The total value of the secondary regulation reserve with the installation of 50 MW wind park would be:

SRVT = 48.5 MW

3. IMPACT FROM THE WIND POWER PLANTS 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 provide additional 5.913.000,00 € for operation reserves (ancillary services) for operation of 50 MW wind power plant.
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

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