

WIND POWER PLANTS AND THEIR IMPACT ON ELECTRIC POWER SYSTEM

Jozef Dudiak, Dušan Medved'

ABSTRACT

This paper deals with impacts on transmission power system from wind power plans. The aim of this paper is to divide advantages and disadvantages of wind energy and their usage for generation of electricity. With generation of electricity from this renewable energy source is connecting many negative effects, which are described in second part of this paper.

1. INTRODUCTION

Wind energy is globally the most important type of renewable energy sources that are used to generate electricity. Using wind is one of the oldest methods of obtaining energy. Traditional representatives of the wind energy resources are classic windmills. Modern wind turbines have a propeller either a fixed or adjustable with leaves which have variable angle. Prop drive via a gearbox, mostly asynchronous generator. Last conceptions have mastered the synchronous generator that is connected directly to the propeller, without gear and supplies energy to the grid through the inverter. There are currently installed machines with capacity 750-1000 kW. A power turbine from 2 to 10 MW is now also emerging even though anticipated to occur after the period of 2020. Smaller turbines of 10 to 500 kW will continue to install the retail investors, which also consume that energy. Due to favorable pricing of such alone consumers position to implement such activities in raising electricity prices becoming more widespread. Currently in the world installed capacity of wind energy resources are more than 13 000 MW. By the years of 2020 - 2030 is planned to increase this potential in Europe to around 150 000 MW, so that the average supply from these sources will be 10 % of consumption.

2. VIEW ON WIND ENERGY AND ITS IMPACT ON POWER SYSTEM

2.1. *Generally about the wind energy*

Advantages of using wind energy:

Electricity production in wind power does not create any harmful emissions or waste. Does not have negative impact on human health and the production is not dependent on the price of feedstock and also has low operating cost? Here is the possibility of utilizing wind energy in developing countries or underdeveloped countries because the intensity of service is very low. Public opinion is in favour of the construction and use of wind power because it produces no emissions and imposes no threat to the environment in case of emergency.

Disadvantages of using wind energy:

The biggest disadvantage is its dependence on the current weather situation. Another disadvantage is the small wind power (normal capacity is about 0.5 to 1 MW). Wind farms are not currently able to use wind speed larger than 30 ms^{-1} . If the wind exceeds this limit, then it is necessary to stop the plant to avoid damaging the rotor blades. Most of the power plant is also able to use wind energy to the speed of less than 3 ms^{-1} . Major disadvantage is also difficulty on the strength of the materials used for

construction and with it associated high costs. When turning the rotor blades generates noise, visual impact on the scenery is often negative.

2.2. The impact of wind power plants on power system

Connecting wind power to networks of high voltages is specific, due to their different characteristics compared with traditional power plants.

Method of connecting wind turbines to the network depends on many factors:

- **size of unit installed capacity of wind power** depends on the weather conditions up to power 2.5 MW in the country, and up to 5 MW in close proximity to marine coast,
- **the total installed capacity of wind power** is a crucial parameter for determining the voltage level of the network to which the power will be connected, respected abilities of transmission system in the different voltage levels (up to 5 MW, 22 kV, 5-80 MW, 110 kV and above 80 MW, 220 kV and 440 kV),
- **the number of towers and wind farm size** has an impact on method of outgoing power, the interaction of wind aggregates to the electricity supply,
- **distance to the nearest station to which wind power is to be connected** is critical for the power connection up to electricity system.

Operation of the wind power has impact on quality of electricity:

Flicker (voltage fluctuations) – wind park can work across its range of operating modes. The resulting voltage in the region is strongly influenced with not only the compensation of individual machines, but the whole wind farm.

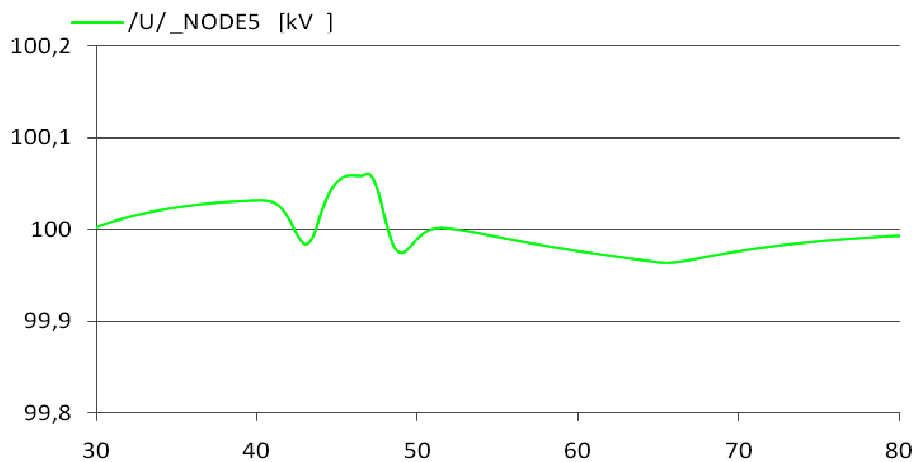


Figure 1 – Simulation of flicker in simulation program MODES

On Figure 1 we can see that at 40 s occurs an excitement flow of wind, we can monitor voltage fluctuations. The voltage is then stabilized to the desired value.

Higher harmonics – wind power plants are equipped with power control electronics, and therefore are often the source of interference in the network, especially for mass remote control (MRC).

The output of program MODES (Figure 2): This output can follow the progress of the generator and turbine speed, which at the time of 30 seconds leads to an increase in wind speed of about 20 % of the initial rate which was 9 ms^{-1} at the time of 40 seconds there is a wind excitation (sharp gusts of wind), we can observe that the active power and rotation speed suddenly increase. There is a depression on the initial wind speed at 50. second which is 9 ms^{-1} and the active power generator with power turbine is fixed at the baseline.

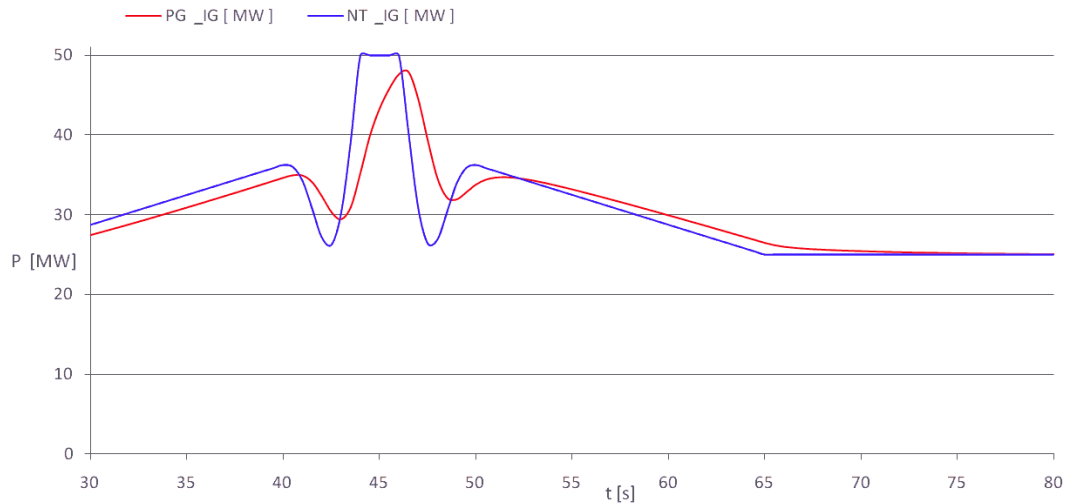


Figure 2 – Simulation of flicker in MODES (where: PG_IG – active power of wind power generator; NT_IG – performance of turbine (rotation speed))

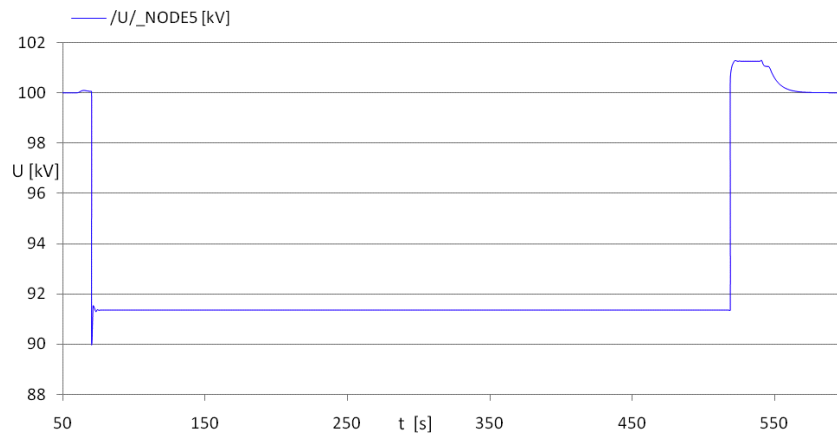


Figure 3 – Simulation of flicker in MODES

In this picture (Figure 3) we can see the progress of voltage in the case of an increase in wind speeds up to a critical value which for this turbine as for most other turbines is 30 ms⁻¹. When the wind speed reaches the value of the turbine the shuts down (at the time of 70 s) causing the voltage drop in the node, as it is on voltage regulation, so the voltage drops of about 8 kV and stabilizes when the winds subside (slow down the flow) below 30 kV leads to reconnection turbines at a time (522 s = 8,5 min.). Power plant was off just for 7,5 minutes (it was deliberately left in this way so that it can be seen that if there is a strong wind, so then wind power plant off and then turn on again causing voltage fluctuations in the network). After turning on of power plant again we can see the voltage increasing and the subsequent stabilization at any desired value.

3. CONCLUSIONS

Wind power plants belong to relatively new source of electricity for which there is a constant and rapid evolution of technology. Their main disadvantage however is the primary source of volatility that for them significantly affect the production of electricity. There is therefore a legitimate concern about the integration of wind power mainly in the transmission system operators who are responsible for managing the power system in real time and for maintaining balanced balance between production and consumption in every moment. One of the technical solutions to control the primary source of volatility and the variation of the power supply from wind farms is expected to improve prediction of wind speeds.

REFERENCES

- [1] *Kolcun, M.; Mešter, M.; Chladný, V.; Cimbala, R.; Rusnák, J. ; Tkáč, J.; Hvizdoš, M.:* Elektrárne, TUKE 2006, ISBN 80-8073-704-5
- [2] *Windpower: Veterná energia.* [online] [cited 22.6.2011] Available on the Internet: < <http://www.windpower.sk> >
- [3] *Veterná energia (prehľad):* [online] [cited 22.6.2011] Available on the Internet: < <http://www.energia.sk/tema/veterna-energia/veterna-energia/0561> >
- [4] *Medved', Dušan:* Možnosti zvýšenia účinnosti fotovoltaických panelov. In: Elektroenergetika. Roč. 4, č. 1 (2011), s. 29-32. ISSN 1337-6756. Dostupné na internete < <http://jeen.fei.tuke.sk/index.php/jeen/article/view/199/179> >

ACKNOWLEDGEMENT

This work was supported by project VEGA SR No. 1/0166/10.

Authors:

Bc. Jozef Dudiak
Technical University of Košice
Faculty of Electrical Engineering and Informatics
Student of Department of Electric Power Engineering
Mäsiarska 74, 042 01 Košice, Slovak Republic
E-mail: jozef.dudiak@student.tuke.sk

Ing. Dušan Medved', PhD.
Technical University of Košice
Faculty of Electrical Engineering and Informatics
Department of Electric Power Engineering
Mäsiarska 74, 042 01 Košice, Slovak Republic
E-mail: Dusan.Medved@tuke.sk
Tel: +421 55 602 3555
Fax: +451 55 602 3552