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SOME ASPECTS OF WIND TURBINES CONNECTION TO THE GRID

Keywords: wind turbines, grid connections, conditions of connection, energetic law, short-circuit ratio

Abstract: In a paper authors describes a few aspects of wind turbines cooperation with an electrical network (grid). Basis to the real possibilities of connection, authors makes a commentary to the polish energetic law. Shown is the differnce between two points of view, according to ratio R_{sc}

1. INTRODUCTION

Wind has been used as a source of power for many thousands of years. Wind power was first used to move boats with sails, to grind grain and pump water. Traditional uses of wind power, converted energy from wind currents into mechanical. In modern wind turbines, wind moves impellers that rotate a generator, thereby creating electricity. A lot of modern turbines are large-scale, utility-connected, wind-driven power stations. When are configurated in wind, are becoming competitive with traditional electric plants.

Most popular wind energy converter of today has a constant turbine speed of 30 to 50 rpm, a gearbox and a four- or six-pole induction generator, directly grid-connected. This concept is very simple, reliable and it can be made of standard components.

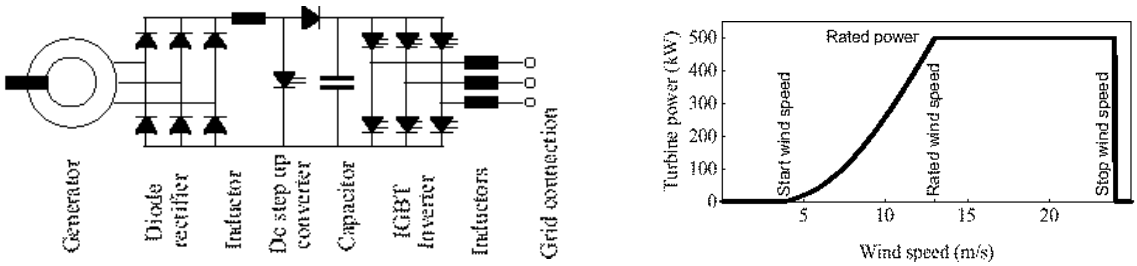

Fig. 1 The structure of described wind turbine, power curve

Turbines with the structure like above, during its grid installation process and even normally work, give to specialists an important question: how much the voltage quality will be affected by the uneven power production and by the connection of the wind turbines to the grid. Wind systems can affect transmission and distribution systems by altering the design power flow or causing voltage fluctuations, power pulsations, harmonics, flickers etc.

With better knowledge of specific power quality problems associated with wind turbine installations, it may be possible to utilise the grid better and still maintain good power quality

2. SOME POSSIBILITIES OF CONNECTION TO THE GRID

Polish wind turbines market is not already exist, however questions and problems like above are very actual. According to the polish energetic law, before becoming of grid connection conditions, each of investor should made a technical expertise on a theme: influence of a new connected turbine on the grid (polish notation: Dz. U. Nr 85 poz. 957 – dated 13.10.2000 y.). The shortage of experiences with so new (in Poland) source of energy such wind generators, makes a lot of afraids and controversions.

There is well knowing that the operation of wind turbines has an impact on the power quality of the connected grid. Depending on the grid configuration and the type of wind turbine used, different power quality problems may arise.

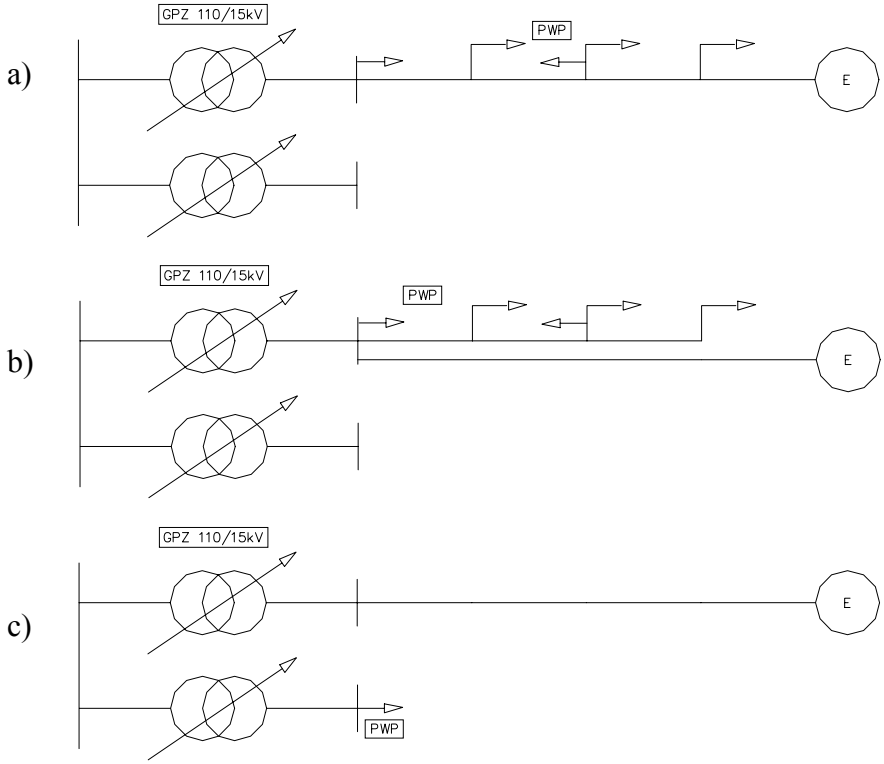

Fig. 2 Structures of grid connections as a proposal for the polish conditions
a – to the medium voltage network, commonly with another users
b – with the separately made line of 15kV to the same section in main transformer
c – with the separately made line to separate main transformer 110/15 kV

The choice of above option, voltage value, type of grid or node of connection, depends of new connected installation in ratio to parameters of energetical system

All wind turbines have an uneven power production following the natural variations of the wind. If the wind turbine is operating at fixed-speed, the tower shadow and wind speed gradients will result in fluctuating power. The power fluctuations caused by the turbine may cause flicker disturbances. In order to evaluate the significance of flicker, measurements and subsequent flicker calculations must be performed. In the case of variable-speed wind turbines, one drawback is the injection of harmonic currents into the grid. Depending on the type of inverter used, different orders of harmonics are produced.

Wind turbines have caused no major power quality problems in EU-countries grids. This owes to the guidelines followed by the EU-countries utilities when connecting wind turbines to a grid. These guidelines are described in IEC 61400-21 and DEFU report KR 111-E. West-european realities of electrical systems and especially experiences, already made some used main possibilities (groups) of wind turbines and farm connection to the grid.

- Connection to the grid 10, 15 or 20 kV for wind farms with the total power less than 25MVA
- Connection to the grid 110 kV for wind farms with the total power between 25MVA and 130 MVA
- Connection to the grid 220/380 kV for wind farms with the total power more than 130 MVA

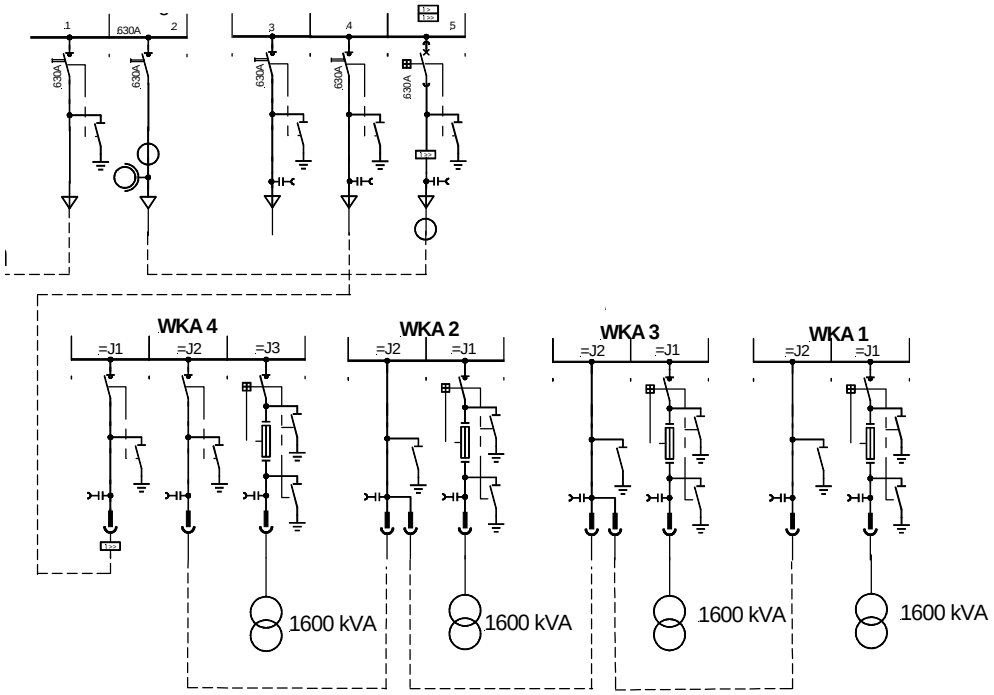

Fig 3. Electrical scheme of wind farm, connected to the grid

3. AN IMPORTANT RATIO

It is generally recommended in many european countries, as a main condition of connection and cooperation with the grid, that the ratio between the short-ciruit capacity of the grid and the installed wind turbine power should be at least 20 (even to 40). Polish regulations makes this ratio more rigoristic, f.e. in Western Pomerania awaited ratio is 50! The answer for a question about the reason of this value is not very simple, but in authors' opinion, a well made technical expertise can change that point of view in every example.
Work of wind plant is hard connected to the variations of active, passive power and resulting from here hesitations of voltage.
In aim of turbine's work optimization, so case of cooperation with the grid, these hesitations should be reduced to the maximum level of $(\Delta U/\Delta U_P)_{max}$.
To achieve this target, reducing of ratio between wind plant's power in relation to short-circuit power in a point of common annexations is neccessary.
To what really value? According to [8] there is possibility to achieve a coefficient of R_{sc} value less than 20. When k=R/X= 0.2..0.4, tg φ_E =0.4 and given variation of power at level 16 %, there is possibility to lowering of coefficient to a dozen or so!
k- proportion between resistance and reactance of line coupling point and main substation and the reactance of line connected common coupling point with the system
R_{sc} – short-circuit ratio;

$$R_{sc} = S_k / S_r \qquad (1)$$

S_k – short-circuit power at the point of common coupling

S_r – short-circuit power of wind turbine
According to [4] the short-circuit power at the point of common coupling needed for a single switching operation should be determined from the voltage variation (k_u (ψ_k)) specified by manufacturer

$$S_K \geq 25 \cdot k_u (\psi_k) \cdot S_r \quad (2)$$

If the voltage variation factor is unknown, the current spike factor (k_i) may be substituted instead

$$k_i \leq 0.04 \cdot R_{sc} \quad (3)$$

What it means? Minimal value of R_{sc} ratio is at the level of 30! And it means, that in case of using of this technical report [4], the costs of investor are growing up. Is it really necessary?

4. CONCLUSIONS

Presented in this paper some view for possibilities of connecting to the grid, problems and difficulties with law and right coupling or cooperation with energetic systems, normally consist as an integral part of technical expertise owe to be made in a process of every investition. An expertise of influences,as above, can reduce or can growing the costs of investors. An intention of authors is to show, that this question is very important, and even popular opinions and reports are not optimal every time.

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