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# Analysis of measured data at the point of complaints to power quality

***Abstract***. *Electricity is one of the most important energy that uses both in the home and in industry. For good and seamless use of electricity are important its quality. Deteriorating power quality is increasingly becoming an important problem for the industry and service companies. The poor quality of electricity to distribution companies must also contend with complaints to power quality. A significant increase in the production of energy from renewable sources such as wind energy, leads to the need to explore new ways of energy systems and their potential effects on the quality of electrical energy. It must be known reliability and responsiveness to changes in the network. Power quality and respect for the parameters given standard ČSN EN 50160th Renewable electricity has to design, connect and operate the power system in place, which will have negative feedback effects on the distribution network and to be reliable.*

***Streszczenie.*** *Pogarszająca się jakość energii staje się coraz bardziej istotnym problemem dla przemysłu i usług. Spółki dystrybucyjne muszą również zmagać się z roszczeniem do jakości zasilania. Znaczący wzrost produkcji energii ze źródeł odnawialnych, takich jak energia wiatru, prowadzi do konieczności poszukiwania nowych sposobów systemów energetycznych i ich potencjalnych wpływów na jakość energii elektrycznej. (**Analiza danych pomiarowych z punktu widzenia skarg dotyczących jakości energii**)*

**Keywords:** complaints, supply, wind power, power quality, distribution system.
**Słowa kluczowe:** skarga, zasilanie, wiatr, jakość energii, system dystrybucji.

## Introduction

Electricity generation using winds no modern affair, but just is the opposite. This method of obtaining and transformation of energy goes deep into the history of mankind. However, due to the progress and the gradual electrification of the wind turbines have become a vehicle for the conversion of wind energy into electrical energy. Further development of a major surge in electricity consumption occurred in making the rules, regulations and standards governing, inter alia, the qualitative characteristics of electricity. Nowadays, power producers complies with standard EN 50160, according to which I will analyze the measured data from the turbine Vestas V90 - 2.0 MW, depending on the operation of wind power plants. On 16 3rd 2013 reported distribution companies' complaint to power quality due to alleged voltage unbalance in the location of the plant. This analysis should serve to clarify the possibility of such a complaint from the impact of wind farms and also to illuminate the issues of the impact of wind power to the grid and the selected parameters electricity. The analyzed wind turbine consists of four-pole asynchronous generator rotor windings brought out the rings.

## The causes of complaints on the quality of electricity

The cause of complaints electricity by electricity consumers may be several. Among the reasons that may lead to complaints for power quality, harmonics include the creation of a network, fluctuations in voltage, voltage unbalance and power interruptions to customers.

All these causes that lead to the emergence of complaints about the quality of electricity, can lead to large losses for both the electric power customer and as a supplier of electricity.

All complaints arising from the power quality must be verified energy supplier, who will determine whether there is a legitimate reason for complaint on power quality. The legitimacy of the claim to power quality electricity supplier informs the customer of electricity and in the event that a claim is justified and must take corrective action. All power quality parameters, which are compared in reclaiming the power quality are given in EN 50160$^{th}$. [4]

## Number of complaints on the quality of electricity in the first half of 2013

Number of complaints on the quality of electricity in each year varies. In the first half of 2013 were a total of 233 complaints about power quality. All of these complaints were dealt electricity distributor.

Table 1. Number of complaints in Northern Moravia in the first half of 2013

| Month | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Number | 76 | 43 | 39 | 34 | 22 | 19 |

Table 1 shows the number of complaints about the quality of electricity in the first half of 2013. The table shows the decreasing number of complaints. For the following measurement and evaluation, were used reported complaints on the quality of electric power, which was recorded in March 2013.

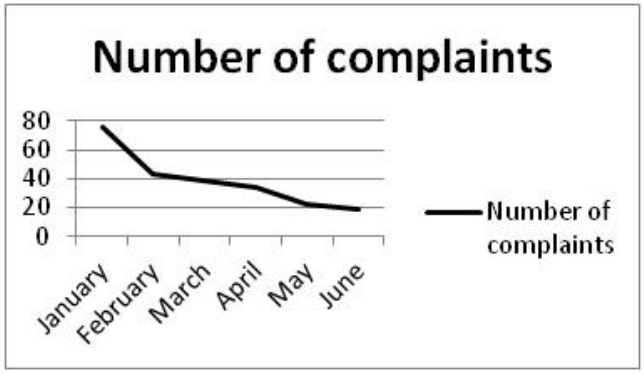


Fig. 1 - Number of complaints in the first half of 2013

Figure 1 shows the decreasing number of complaints about the quality of electricity in the first half of 2013. The largest number of complaints was in the month of January, which saw a total of 76 complaints. In the month of March there were only 39 complaints about the quality of electric power, which is half the number. In the month of June there were only 19 complaints about the quality of electrical energy.

One of the recorded complaints about the quality of electric power was complaints that occurred at the location of wind turbines Vestas v90 - 2 MW. After reporting this complaints were placed portable analyzers BK-Elcom in the

substation of wind turbines. The measured power quality parameters were recorded and were used to assess whether a given wind turbine could affect, or could have been the cause of this complaints on power quality.

**Specifications turbines Vestas v90 - 2 MW**

Windward power tilt mechanism, active routing wind and three-leaf rotor diameter of 90 m OptiSpeedTM use the technology, which allows the device to operate at optimum speed and optimize its performance. All the plants of this type are also fitted OptiTip ®, which is a system developed for optimizing the rush angle. OptiTip ® has always set the blades to an angle that is specific wind conditions ideal. This contributes to an increase in electricity production and to minimize noise emissions.

The main shaft transfers the energy transfer through the generator. The transmission is a combination of a planetary gear transmission with front helical teeth. Since the transmission of energy, is transmitted through the composite connector on the generator. Generator facility is designed as a four-pole asynchronous generator rotor windings brought out the rings. Middle-voltage step-up transformer is placed in a special room at the end of the engine room. It is a structure with the use of dry resin, which was developed specifically for use in wind turbines.

Systems OptiTip ® and OptiSpeedTM optimize performance for each of the wind speed, independent of the temperature and the air density. At high wind speeds, ensures that energy production does not exceed the rated power.

Wind turbine is equipped with a braking system that, if necessary, stops the rotation. The system adjusts the rotor blades and activated while the hydraulic parking brake. The parking brake is located on the high speed shaft. All functions of the power control and regulate the microprocessor control unit.

The control system is equipped with sensors that ensure safety and optimal operation. Drive mechanism for making blades is by three hydraulic cylinders - one for each rotor blade one. The hydraulic unit in the engine room supplies hydraulic pressure tilting mechanism and braking system. Both systems are equipped with hydraulic accumulators that provide network outages regulated and safe shutdown. Four electric rotary drive mechanisms ensure the rotation of the engine room at the top of the tower. Engine cover made of fibreglass protects all components from rain, snow, dust, sun, etc. Access to the engine room of the tower allows the central hole. The engine is installed service crane system with capacity of 800 kg. Crane can be extended to carry up to 9500 kg.

Readings wind is evaluated computer which automatically controls and monitors the operation of VE and passes both remote and local reporting of operating and fault conditions. Life wind electricity is designed and constructed for 20 years. [3]

**Description of measurement**

During March and April, were installed portable analyzers BK-Elcom three measuring points. Measurements were carried out simultaneously at the place where the wind turbine is connected to the distribution network, as well as in the distribution substation transformer and high voltage. This allows us to determine whether the operation of wind turbines affects the surrounding system and how. Due to interrupt measurement, weather conditions, etc., were selected period, from which all available data from all measuring points. This is the period from 20.3. to April 3, 2013. Were evaluated waveforms, long-term and short-term flicker, and harmonic distortion and compared these with allowable values in EN 50160th

To determine the effects of rear-connected wind power were realized measurement performance balance beam distribution network, which is controlled wind turbine is connected. Simplified wiring diagram wind electricity is shown in Figure 2

Measuring point 1 was at the outlet of the reference beam distribution network in the substation 110/22 kV. Measuring point No. 2 was placed in a distribution transformer (DTS) between wind electricity and MV and measuring point No. 3 was in the connection of wind power plants to the distribution network.

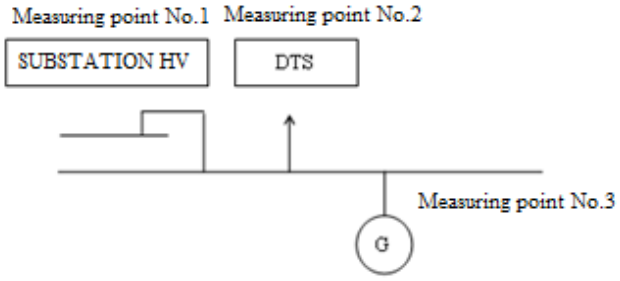


Fig. 2 Simplified diagram of the measurement

## Selected parameters of electric energy

As mentioned above, the operation of wind power plants can be expected to influence the parameters of the distribution system. Interaction between the distribution system and analyzed wind turbine is defined in the point of common coupling.

The DSO is a priority to ensure a stable supply of electricity if possible with constant system parameters.

In terms of quality of the supplied energy is to be monitored, in particular:

1. First Voltage changes.
2. Second Flicker - voltage fluctuations.
3. Total Harmonic Distortion

Ad1) Voltage changes

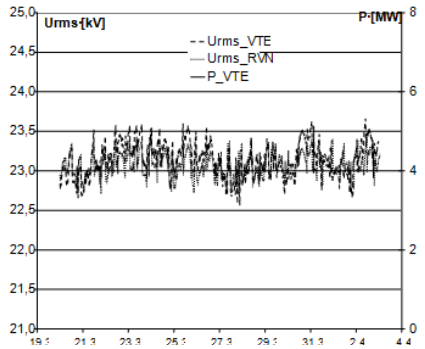


Fig.3. Relationship of high voltage for operation of Wind electricity

From the previous graphs 1 and 2 it is obvious that voltage waveforms are identical to the low voltage and the high voltage level. At the same time, we can notice that in all measuring points of the voltage is stable and there are no variations in time or not delivered at the time the wind power plant is running at full capacity 2 MW.

Generally, the period of operations in the growing and voltage and the voltage follows the change in power output.

We can therefore claim that wind power has adverse retroactive effect in terms of voltage.

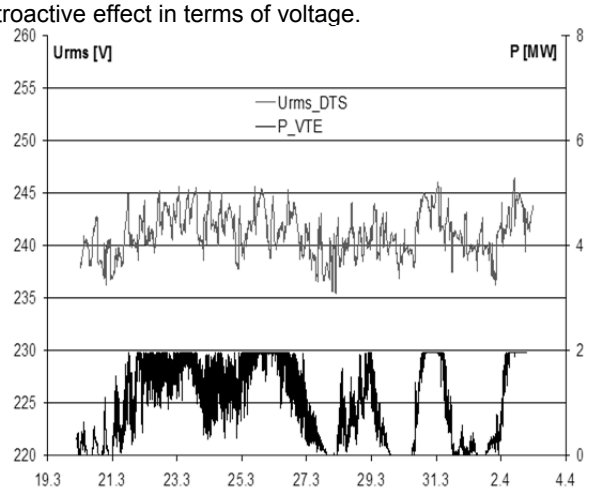


Fig.4. Dependence on the low voltage operation of Wind electricity

Ad2) Flicker - voltage fluctuations

Flicker is defined as the human eye perceptible variation of flux of light sources as a result of periodic dips in sub harmonic frequencies. These voltage changes are generally caused by changes in customer load or changes in generation capacity.

If we analyze the theoretical possibility of flicker that accompanies the operation of wind power, it is possible to identify two basic causes of its origin: the effect of wind gusts and wind power tube effect.

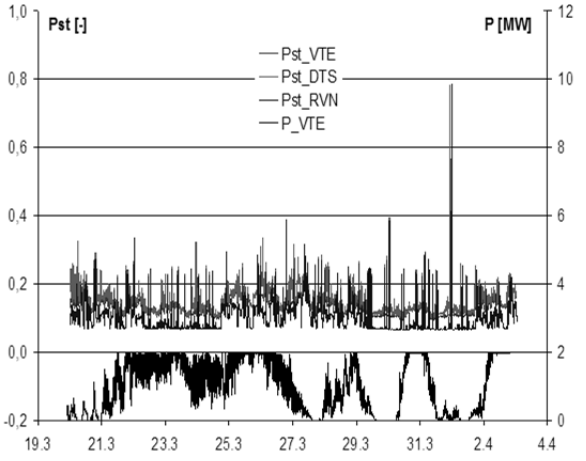


Fig.5. Dependence of short-term flicker severity level of the operation of wind electricity

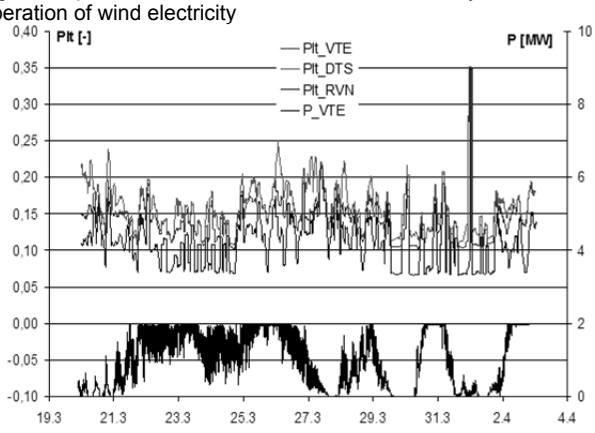


Fig.6. Dependence of long-term flicker severity level of the operation of wind electricity

Effect of wind gusts in the short-term variations of wind speed from its mean value eliminates the inherent inertia of rotating parts of the wind turbine, due to stronger gusts of more or less eliminates the power turbine control. Effect of wind power tube (mast) suppresses much worse. Tube for flowing a wind barrier that slows him. As a parameter determining the flicker is not applied directly to the voltage drop caused by the flicker, but variable called issue of flicker or a flicker severity. Distinguish between short-term (short term) flicker emission Pst, measured or computed at intervals of ten minutes long (long term) emission flicker Plt, determined the interval of two hours.

Generally, the more leaves the wind turbine, the emission is less flicker. Systems with frequency converter in most cases have lower emissions than systems with asynchronous generator connected directly.

Rules for the operation of the distribution system define the maximum allowed value long-term rate of flicker severity Plt and so it must not exceed 0.46. [1], [2]

Rotor inertia is so large that the value Pst is practically negligible and short-term change in speed or direction of the wind does not affect the voltage fluctuations in the distribution network around wind electricity.

Rules for the operation of distribution networks dictate that long-term flicker severity shall not exceed 0.46, which was fulfilled in the entire measurement period. Only the first April increased value $P_{lt}$ to 0.4 and only in two stages over a period of 2 hours, which was during the peak hours of wind electricity. The MV was a period of lowest value $P_{lt}$.

Ad3) Total Harmonic Distortion

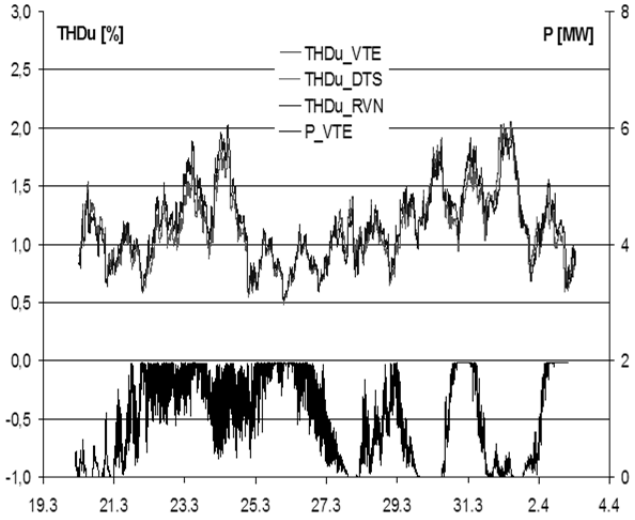


Fig. 7. Dependence THDU the operation of wind electricity

Total harmonic distortion, or if THDU is shown in Figure 5 It has a characteristic waveform that does not matter too much on the production of wind power, but rather the switching power supply, such as television sets. In this graph, we can see some regularity at intervals. These increases are in the afternoon until the evening, when the switch on these characteristic appliances. Nowadays, manufacturers indicate the value of the total harmonic factor not exceeding 5%. It should be sufficient to avoid adversely affecting other devices connected to the network. Size THDU in this case does not exceed 2%.

**Conclusion**

Complaints about the quality of electric power are a situation in which the distribution companies must contend. In the first half of 2013 was in Northern Moravia reported a total of 233 complaints about power quality. Highest Number of complaints in January, when it was suddenly Wind power with frequency inverters are currently the

optimal solution to achieve a balance between the needs of distribution networks and operators of wind turbines. Distribution system to which it is connected modern wind turbine with a synchronous cascade is not burdened by excessive adverse effects as was the case with older types of power squirrel cage induction generators. The wind turbines have become machines which are, in capital costs, payback period, durability, efficiency and utilization of wind ideal solution.

Size of input power has a direct influence on the voltage at the connection point. However, according to this measurement, there is no direct link between the supplied power and voltage fluctuations in the parent substation 110/22 kV, in which the reference beam is connected.

The value of the maximum permissible level of long-term flicker severity is 0.46. In our case the increased value Plt when averaging the values 1, 2, and third faze 0.35. This deviation can be understood rather as a network background.

When analyzing the total harmonic voltage distortion THDU No relation was found with changes in the power output of wind power factor and total harmonic distortion ranged from 0.5 - 2%.

In view of the reported complaints on the quality of electricity that the amount by measuring power quality parameters on wind power proves that the plant at the time of measurement does not affect the possibility of a claim. This was the conclusion of a distribution company that has identified this claim on power quality as unfounded complaint. It could be a possible local failure at the customer's electricity.

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