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NEGATIVE IMPACTS OF PHOTOVOLTAIC ELECTRIC STATION OPERATION FOR DISTRIBUTION OF ELECTRICAL ENERGY IN SOBRANCE

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Abstract: Photovoltaic power plants recorded in the world of very rapid increase in installations connected to the distribution network. Although they are referred to as the cleanest sources of electricity, their unpredictability causes major problems for distribution network operators. If the current commissioning rate continues, PV power would lead to the modification of several aspects of power system and could influence the stability of the system. The report is dealt to a problematic of negative impact photovoltaic electric stations installed in location Sobrance for distributing electric energy. The main task and idea of the report is advert to the positive and negative impact of installation photovoltaic electric stations on base of measurement of real operation.

1 Introduction - Electricity transmission and distribution systems in the Slovak Republic

The current form of the Slovak power system has been built since the 1950s on a transmission voltage of 220 kV, later on 400 kV. This transmission system is a compact total, whose core mission is to transfer power from large power generators and interstate transmissions (Figure 1). The distribution network has a very complex structure that provides long-distance transmission and distribution of electricity to consumers. For long-range transmission, the voltage at the plant is transformed into a very high voltage of 110 kV, 220 kV or 400 kV. individual power plants are by overhead line connected to electrical network. The lines interconnect individual sources and transformer stations so that the energy transfer can be operatively controlled depending on the instantaneous electricity consumption in different areas, even in the event of a fault in some part of the network [1].

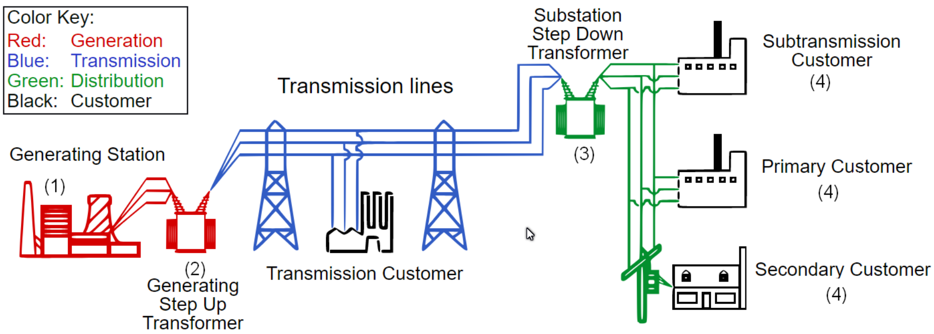

Figure 1 Scheme of power transmission from power plant to user [1]

The electric energy leaves electric power plant (1), the voltage increases in the transformer station (2). Electric energy is transfer by electric wiring. Voltage is transformed down at the place of use (3) and the electrical connections transported electrical energy to consumers (4).

Transmission system is subsystem of Slovak electricity system which connects all major entities operating in the Slovak electricity system and ensures a decisive share of foreign cooperation. The transmission system consists of interconnected, particularly high-voltage, very high-voltage power lines, electricity installations necessary for the transmission of electricity in the demarcated area, interconnected power lines and electricity installations needed to connect the transmission system with the transmission system outside the demarcated area. The transmission system also includes measuring, protection, control, signalling, information and telecommunications equipment necessary for the operation of the transmission system.

The distribution system consists of interconnected very high voltage electric lines up to 110 kV, including high voltage or low voltage, and electricity equipment needed to distribute electricity to a limited area; the distribution system shall also include electrical wiring and power equipment which provides for the transport of electricity from a part of the territory of the European Union or from a part of the territory of third States to a defined territory, unless such wiring or electrical equipment interconnects the national transmission system with the transmission system of a Member State of the European Union; with a third country transmission system [2].

2 Distribution network

At the transformer station, very high voltage is transformed into a high voltage of 110 kV, some of electrical energy is distributed to big companies of heavy industry and to the transducer ensuring the supply of electrified railway lines. The remaining part is distributed to consumers (light industry, cities, municipalities) where it is transformed to 22 kV. The last transformation to a low voltage of 230 V and 400 V occurs in the businesses, municipalities and neighbourhoods themselves [3-4].

2.1 Services in the electricity supply system

In addition to providing power and power to its transmission and distribution, utilities must also provide customers with additional services. In addition to providing power and amount (kW, kWh), the quality of the supply too. This means keeping the voltage, frequency, reliability, voltage purity (higher harmonic and sinusoidal deformation), overvoltage prevention and so on. These services are provided by both the manufacturer (power plants and power companies) and distribution companies. Independent manufacturers, industry producers, municipal companies as well as customers can also be involved in reinsurance. The issue is discussed and modified in the Decree of the Regulatory Office for Network Industries No. 275/2012 Coll., Laying down quality standards for electricity transmission, electricity distribution and supply [5].

When providing relevant services, it is necessary to observe on the needs of the customer as a customer of electrical work and performance. With regard to end appliances, lighting, computer technology, the primary requirement is a stable frequency and compliance with standard voltage. The fundamental requirement for maintaining the frequency is to maintain a balance between production and consumption throughout the power system, which implies a stable operation of power plants and power grid. This implies the need to provide both control power and continuous reserve power. At the same time, the agreed voltage level must be maintained. This requires a suitable network structure as well as means for regulating reactive power [6-8].

Based on customer requirements in the electrical supply system, we can define the following important services:

- Active power control;
- Continuous reserve power;
- Voltage compliance (reactive power control);
- Voltage hardness (voltage fluctuations);
- Disaster Recovery Equipment;
- Emergency provisions and emergency measures;
- Traffic control.

Against frequency deviations outside the very narrow band, the primary reserve control of the power plant part is activated in a decentralized manner with an activation time of a few seconds and a maximum duration of 15 min. The primary control power is generated by all members, i.e., within the specified range and field of the key. regardless of the cause of the change in frequency. The time-limited disposable primary control power is then replaced by secondary control with a activation time of several minutes and a total duration in hours. It acts selectively only in the regulatory region where the power deviation occurred. Regulatory mechanisms and reserve maintenance mean that the system's performance balance is always balanced.

To maintain voltage quality, the operator must dimension and operate the network to have sufficient reactive power sources and appropriate control equipment. In addition, all network customers, i. manufacturers and customers adhere to regulatory requirements for technical boundary conditions, i. cos phi, current harmonic components, unbalance, load variations, etc. The necessary capacitance and inductive power is typically produced in the compensating devices or taken from the power plants. In exceptional cases, reactive power may be produced by the customer.

It follows from the above that renewables cannot practically ensure the maintenance of frequency and power balance and thus important services in the electricity supply system. Put simply, this "work" for photovoltaic power plants must be done by conventional power plants in the system. It depends on the ratio of installed power of photovoltaic power plants (non-renewable RES) and conventional power plants [9,10].

3 Description of the monitored PV plant

Electricity is produced by photovoltaic cells based on monocrystalline. Produced DC current is changing to alternating current in inventor with required parameters electrical network ~ 230 / 400V 50 Hz. The power output is through the 0.4 kHz / 22 kV transformer station of 1000

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kVA and the high voltage line connection. The measuring and control technology is concentrated in the dispatching facility. Own night power is 7 W, at operation 599 W. Estimated lifetime of the building is 25 years.

The building features a set of 5,400 pieces of "Eoplly" 125S-185 PV modules with monocrystalline silicon cells with a unit power of 185 Wp, which are stationary on a metal structure anchored in a 35 ° ground. The total installed power is 999,000 Wp. Each string is connected to Solutronic inverters, 158 Solplus 55 and 1 Solplus 50 each. The maximum output and nominal AC power is 5.7 kW each. Cabling is halogen-free copper type FLEX-SOL, cables are laid in bundles - surface mounting. Transformation is provided by the Betonbau UK 3048 type block transformer for the TOHn 399/22 1000 kVA transformer. MV switchgear is Schneider Electric type SM6 with SF6 insulation. It contains the DM1-A input field, the GBC-B 630 A measurement field, the QM 200 A input field. The measurement is made on the MV side. There is a 4-quadrant LZQJ meter with a member for automatic data collection and data concentrator. The operation is automatic, unattended, autonomous.

Specific risk, resp. the fact to be taken into account in the operation of the node not only in Sobrance is the construction of renewable resources, namely PV power plants, for the construction of which are favourable conditions in the given region.

The support of renewable sources in Slovakia is mainly due to the fact that the distribution company is obliged to preferentially connect the renewable source to the distribution system; surcharge and assumption of responsibility for deviation. According to the applicable technical regulations, the connection of the power supply to the system must not cause a voltage increase of more than 2% at the connection point compared to the pre-connection condition. The stated "connectivity" is directly related to the size of the short-circuit power at the point of connection, which presents the hardness of the grid at that location. The short-circuit power in the Sobrance ES on the 22 kV busbars is about 150 MVA.

Figure 2 illustrates the operation of the 22 kV VN network in which renewable sources are installed, namely PV plants. The coverage of the daily consumption diagram (blue curve) is the sum of the supply from the power supply station (in this particular case EN Sobrance) and the supply of electricity produced in the PV power plants (red curve). The nature of the PV plant shown in the daily diagram is reminiscent of a sinusoid, of course, with a peak at noon, when the maximum of daylight is reached. A key aspect of network operation is the deviation. The figure shows the deviation that was caused by the failure of part of the PV plant's production due to alternating cloud.

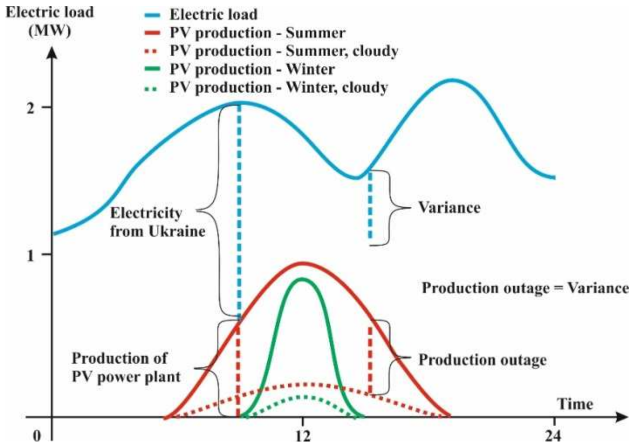

Figure 2 Daily load diagram - illustration of networking with PV plant in different modes

Figures 3, 4 and 5 show the course of electricity supply from a PV power plant with an installed capacity of 999 KW in location Ostrov to the grid.

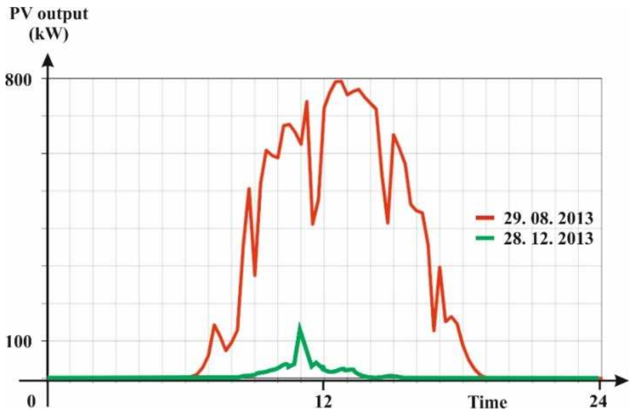

Figure 3 Photovoltaic power station Ostrov - daily consumption patterns on selected days

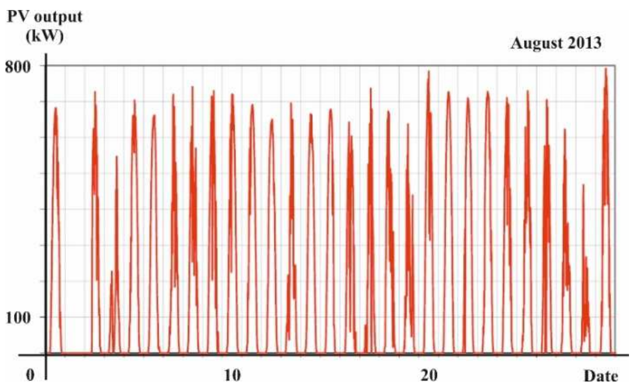

Figure 4 PVPS Ostrov - monthly consumption August 2010

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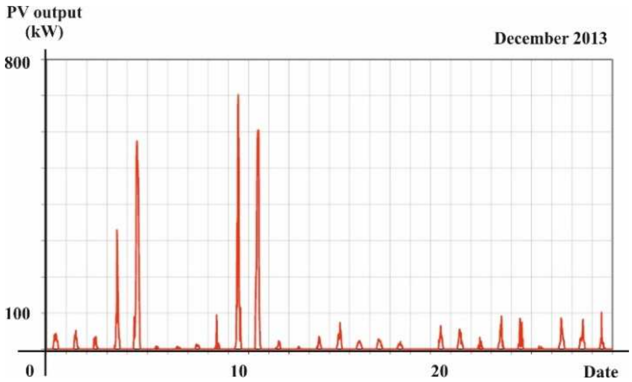

Figure 5 PVPS Ostrov - monthly consumption December 2010

The following figure 6 represents the sampling diagram, measured at the electricity supply to ES Sobrance from ES Uzhgorod for the month of April 2013.

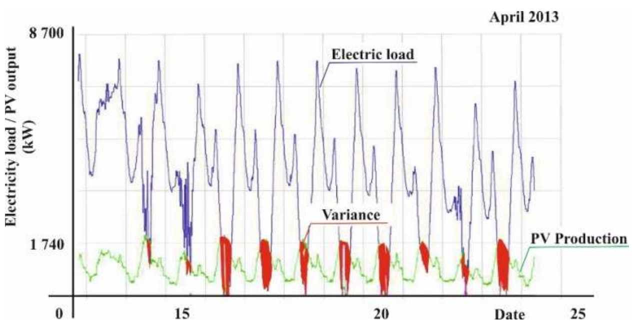

Figure 6 load curve in diagram 17. 4. 2013 - 23. 4. 2013 measured on electricity supply to EN Sobrance from EN Uzhgorod

It is clear from the diagram that with a gradual decrease in demand and increasing production from the PVP, the minimum load diagram is deepened and reaches a negative value on 15 April 2013. In practice, this means that part of the demarcated area of Sobrance creates a situation where electricity generation from PV plants exceeds the real consumption of customers and there is a reverse flow of electricity. This situation is considered technical and commercially incorrect.

This situation is the result of an overall decrease in electricity demand for both industrial and household customers and electricity generation from photovoltaic power plants. It is evident from the presented data and balances that such a situation arises because in the given area the installed capacity of renewable sources is approximately 10 MW comparable with the achievable maximum consumption. Rationalization measures only contribute to the reduction of demand. As mentioned, such an operating condition is not technically feasible and raises problems in the business area [11,12]. At the same time, the legislators assumed that electricity supplies from renewable sources would represent only a fraction of the total consumption in the Slovak distribution [13].

4 Conclusion

Part of the demarcated area "Sobrance" represents an almost laboratory example of the size of the area, the structure of the collection and the renewable sources built, to monitor the impact of the operation of renewable resources on the operation of the electricity distribution network in terms of both positive and negative impacts. The following can be noted:

- Considering the favourable conditions in the given area, a relatively large concentration of PV power plants arises, as well as the construction of combined facilities for electricity and heat production.
- The region has an agricultural character; there are few industrial customers with the required output of more than 100 kW.
- A significant share of consumption is made by households

Looking ahead, no significant increase in demand is expected. With regard to the economic crisis in particular, the construction of a logistics-agrarian complex in the Ostrov - Revištia site has been abandoned. It cannot be expected to increase the standard of equipment for household electrical appliances. Compared to the past, the share of direct electric heating of households as well as storage heating has significantly decreased (with respect to the proximity of a large employer Vojany Power Station, the inhabitants used advantageous rates for electric heating).

Electricity generation from PV plants is heavily dependent on the season, day mode and is subject to weather changes. Production is difficult to predict [14,15].

The disadvantage of PV power plants is that they supply only active energy resp. only active power. The reactive power required to operate a certain range of appliances must be subsidized from another source. For this reason, the public electricity network cannot only be operated with PV plants in the off-grid mode. PV power plants by their location represent decentralized sources of electricity. As a result, a high voltage power supply can "transport" electricity to a relatively remote customer at the cost of higher losses. The ideal situation in this respect is consumption at the production site. In view of the evolving potential of renewable - decentralized resources, the need to develop new solutions to ensure reliable operation within the prescribed limits and requirements at all tensions and using currently available resources can be expected. The optimal solution for such situations will be clearly the so-called SMART Networks and Solutions [16,17].

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Review process

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