IMPACT OF WIND POWER PLANTS INTEGRATION INTO ELECTRIC POWER NETWORK OF THE CZECH REPUBLIC

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ABSTRACT

In the latest years, number of wind power plants arose in our surroundings, especially in our neighbouring countries Germany and Austria. In accordance with European Union the Czech Republic must cover up at least 8% of domestic power production from renewable sources till 2010. The Czech Republic is land-locked country without large rivers and mountains, so the potential available for generating electric power is almost spent. Building-up new large water power plant is thus unreal. The Czech Republic has some potential in biomass production and cogeneration which is unchallenged for power network cooperation. But there is some hidden, unused potential in the Czech Republic. It is the energy of wind which is highly presented by environmentalist activists, but for the power-supply directors it is only a rising huge problem. In this paper are described power system troubles of wind power plants integration and their network cooperation.

I. INTRODUCTION

Wind power plants bring us absolutely pure and renewable source of electric power. At the same time, with increasing number of wind turbines connected to the electrical power network (and their continually raising nominal output), appear new problems with their system control. Variability of wind brings very fluctuating and unsteady supply of electricity which poses higher requirements on performance of electrical power networks and also amount of system services. In this paper are described main problems which can supply-directors expect with higher amount of wind power plants integrated into the Czech electrical power network in comming years.

II. CLASSIFICATION OF MAIN PROBLEMS WIND POWER PLANTS

As mentioned above, the Czech Republic is land-locked country, where are not so good wind conditions as in seaside lands. The locations, where we want to build up new wind farm, must satisfy severe limits. Outside protectionist's requirement, that the area must lie out of national parks, the average wind speed must be at least 5-6 $m.s^{-1}$[1]. In our land fulfill these claims only few locations especially in higher elevation above sea-level in mountains.

The estimated yearly production from wind energy in our conditions is about 1,34 TWh which correspond 850 MW of installed rated power. From these presumptions it is perceptible very low time of using wind power plants (also called capacity factor), which moves between 15 - 18 % [2]. For comparison, expected cap. factor for newly built offshore farm is about 50%.

On Figure 1 it is shown wind map of the Czech Republic and some areas where is expansion of new wind parks expected.

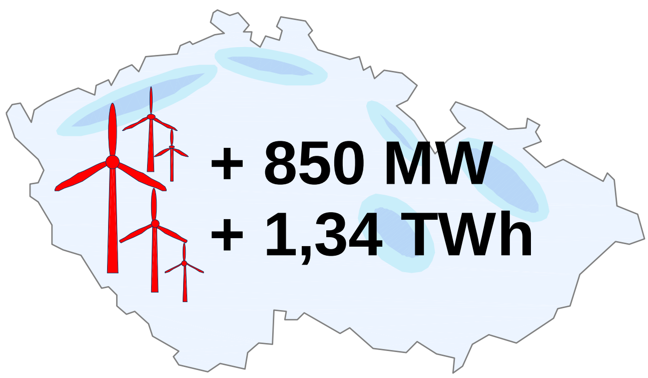

Figure 1. The estimated wind potential in the Czech Republic and expected location of new wind parks

Exactions of wind power integration and their dynamic operation often exceed possibilities of network, where wind farm is connected. These locations are mostly some inapproachable areas with mainly consumption character and very bad electrification. Local electric power network is common not able to lead out full rated power of wind farm. Full nominal output of these wind parks should in near future achieve even hundreds MW. It will be necessary to strengthen network in so-called bottle necks. These are some electrical elements in electric power network, which did not satisfy reliability criteria N – 1 in full operation of wind power farm.

During periods of very good wind conditions, for example by crossing meteorological front , wind farms could run-up in a very short time from minimal operation state to maximal nominal power output. On Figure 2 is shown example of this case from January the 18th 2007.

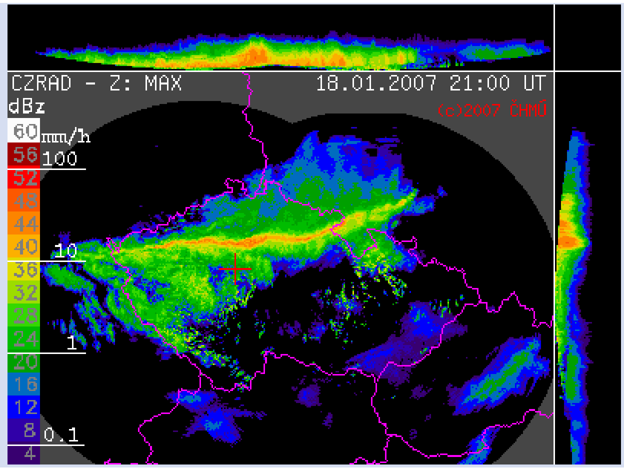

Figure 2. The meteorologic front crossing area of wind farm locations in very short time [6].

This situation should subsequently cause extraordinary operational states. In principle we can dissociate them into two basic groups. In the first case, an influence on small area is studied, where such sudden rising of supplied load should cause some disturbances as e.g. disproportionate voltage change in point of common coupling, overloading significant overhead line or increasing power losses and so on. These influences we should call *local disturbances*, because they usually did not expand out of node area where the wind farm is led out.

In the second one, these influences has much more larger impact on electrical power networks. So it is called *system disturbances* caused by wind farms and it is typical in the networks with huge amount of installed wind power plants and wind farms as e.g. Germany (E.ON Netz, Vattenfall, …), Denmark or recently Austria. In case mentioned above (i.e. crossing meteorological front or their passing) occur huge electric production from wind turbines in a small areas and it creates urgent demand of transfer relatively large amount of load into location with consumption character. This leads to high flows through transmission power network. These flows are usually not limited to power network of one state. These big changes of load transmissions are called loop flows.

Although the Czech Republic has at the present time only 80 MW of installed wind power, loop flows caused by German wind farms loads transmission network of Czech republic by power losses and lowers their transmission capacity.

In spite of overloading cross-border lines and decreasing their transmission capacity, these huge flows should cause break up European interconnected systems UCTE because of their speedy character. Last this case happened in July 2006, when by good wind conditions occur disturbance on important overhead line on border Belgium and Germany and that account on broke up UCTE system in two separate island operation. On Figure 3. is shown how power flow from wind power plants in northern Germany and Denmark influence other neighbouring electrical network by large load transmission.

Loop flows are decreasing stability and reliability of electrical transmission network and causes considerable power losses also in other networks, than in the network where it originates. With larger amount of wind power integrated into electrical power network, transmission power system must be strengthen and new lines must be built up to ensure safe power distribution. It pays especially for bottle necks that threaten stability and safety of supply.

In the Czech Republic most of wind power plants are connected mainly into distribution network 110 kV will be installed in very near future This distribution network could suffer from fluctuating impact from wind farms so it is necessary to pay attention to this problem, especially in planning period.

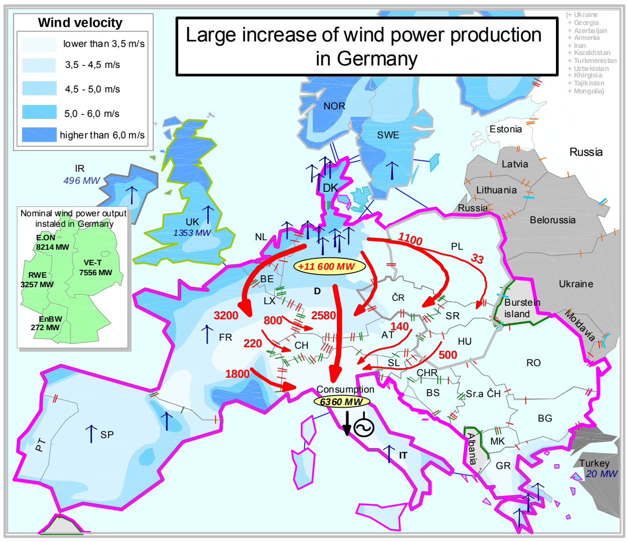

Figure 3. Circle flows caused by sudden wind production in the northern wind farms in Germany and Denmark.

III. SIMULATION OF PRESENT INFLUENCE WIND FARMS IN THE NORTHERN CZECH REPUBLIC

My simulations are made for the distribution voltage level 110 kV, where will be in near future installed most of planned wind farms. For the simulation of present influences of wind power plants chose program GLF was chosen. This program was developed by power research institute, cooperatong with university. Program GLF is capable solving analysis of high voltage and very high voltage electric networks as for example load flow analysis, reliability checks, short circuit calculations etc.

In my analyses I aimed to local disturbances in the location with the highest installed rating power of wind plants in the Czech Republic – location Prosenice. Total nominal output of wind plants in this area is about 63 MW. Power losses without operation of wind farms are 6,6 MW. Majority of electricity demand in winter season (460 MW) is supplied from transmission level by two transformers 220/110 kV (200 MVA). By common operation state is their loading on upper side of their range (91 %). By the good wind conditions should wind farms reduce their loading down to 77 %. It is because of low wind farms nominal output (32 MW, 27 MW, 2,3 MW and 2 MW). In the points of connection is electrical demand usually higher than the production of wind plants. Their dispersed production also lowers transmission power losses to 5,3 MW. In cases of larger wind parks it is expected bigger energy production than demand and also higher fluctuating, which should cause over-supply in the set location. This will lead to reverse power flows to upper voltage level, increasing power losses and higher transformers loading.

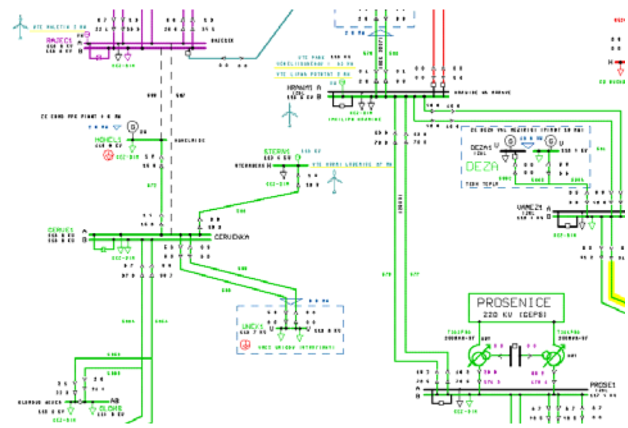

Figure 4. Part of simulating program GLF used for analysis of present influences wind farms on electric power network level 110 kV.

V. CONCLUSION

Huge impact of wind power plants integrated into electrical power network brings except pure electrical energy also lots of problems with their net cooperation. Large wind farms influence electric network by two ways. The first one is local disturbances as e.g. disproportionate change of voltage in point of connection or overloading transformers and overhead line. The second one are so-called loop flows over level transmission power network transcendent network one state.

At the present time is rated power of wind farms much lower than demand in area of their net connection, which has positive influence on electric power network. Thanks their dispersed production should wind farms lower power losses and transformer loading for a short time during good wind conditions.

The Czech Republic must yet prepare its electrical power network for impact of significant inrease of amount of wind power plants connected into its network.

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