THE ADVANCEMENT OF WIND POWER PLANTS IN THE CZECH REPUBLIC

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ABSTRACT

The Czech Republic is about to experience a boom of wind power aimed at increasing the share of electricity generated by renewable energy sources. Wind power plants' various operating states can affect the power system stability and the quality of supplied electrical energy, they can lead to voltage fluctuation at the connection point, line overloading and violating the n-1 criterion. In order to compensate for such phenomena, the transmission system operator buys ancillary services and dispose of sufficient power reserve. All such situations involve considerable costs.

1. INTRODUCTION

Increasing energy consumption, environmental protection and, in particular, limited reserves of fossil fuels are the incentives for replacing existing energy sources by renewable energy. This effort is supported by the European Union and the Czech Republic pledged to increase electricity generation from renewable energy sources to 8 percent of the total generation by 2010. Wind power plants (WPP's) are one of such renewable sources that could help fulfill the commitment.

State financial support of renewable energy sources (RES's) in the Czech Republic is defined by the price decisions of the Energy Regulatory Office. Producers can choose between a fixed energy purchase price and so-called green bonus, which is a contribution to the market purchase price of electricity. Many investors are, mainly because of these state subsidies, interested in building small groups of WPP's as well as whole wind farms.

Besides having advantage of being a renewable energy source, wind power plants are specific from the point of view of the operation of the power system, which must be respected in power system dispatching.

2. AVAILABLE WIND ENERGY POTENTIAL IN THE CZECH REPUBLIC

Wind energy potential depends on geographical and climatic conditions in a given region. It can be determined from long-term measuring data of the Institute of Atmospheric Physics of the Academy of Sciences of the Czech Republic. It is estimated that available wind energy potential in the Czech Republic corresponds to a power of about 2700 MW.

So far, there has been no experience with the operation of numerous WPP's connected to the power system in the Czech Republic, but it can be concluded from the experience in other countries – particularly in Germany, Denmark and Spain – that it is an important phenomenon in power system operation requiring increased attention. Problems are mainly due to weather fluctuation resulting in sudden and swift changes in supplied power. Such sudden changes can lead to the lack of power in the power system, but they can also be at the origin of many other undesirable phenomena such as line overloading, voltage fluctuation in areas close to the connection point and decreasing the transmission capacity of interstate lines. To deal with such situations, the Czech transmission system operator (ČEPS) must buy ancillary services and dispose of sufficient power reserve. This involves a considerable financial loss of the transmission system operator that will have its repercussions on the final consumer.

3. WIND POWER PLANTS IN THE CZECH REPUBLIC

Today, about 100 wind power plants with a total installed capacity of approximately 150 MW are operated in the Czech Republic. Given the considerable interest of investors, a boom of wind energy can be expected in the following years. Existing wind power plants in the Czech Republic are connected to low voltage and medium voltage networks. The year 2007 saw the first wind farm put into operation (Kryštofovy Hamry in the Ore Mountains), with an installed capacity of 42 MW, connected to the 110 kV network. Demands of investors concerning connecting new wind power plants to the grid increase year by year. They went from 600 MW in 2001 to 1622 MW in 2007 [2]. Judging by the projects presented by investors, the highest increase in WPP's installed capacity can be expected in the years 2008 to 2010. Then the number of new WPP's should slow down. Further increase of the installed capacity is supposed to come after 2015, it will be due to repowering, i.e. replacing the existing WPP's by new power plants with a higher unit output and efficiency. This will require their connection to high voltage networks.

It is supposed that WPP's installed capacity will increase to about 850 MW in 2010, which will correspond to generated energy of about 1100 GWh. 180 MW will be connected to the transmission system, 670 MW to distribution networks. Estimated additional costs of the ČEPS company and distribution system operators due to the operation of WPP's of such installed capacity are about 260 million €. The part of costs necessary for connecting WPP's – up to 440 million € – must be added to this sum. The assumed average capacity factor is 15 % and the utilization of generated electricity for covering losses is about 70 %. Relatively high connection costs are given by the fact that WPP's are to be built in areas with low network density.

So far, the influence of wind power plants on power flows in the transmission system has been negligible. Only some minor impacts in distribution networks have been observed.

Due to their nature, wind power plants cannot be used as a stand-by supply and, on the contrary, there must be a stand-by supply capable of replacing their capacity. This fact will require increasing dispatcher reserve as well as reserves in primary, secondary and tertiary control. It will lead to a higher demand for spinning and quick-start reserves and, consequently, to increasing their prices. Estimated amount of reserves is about 20 percent of WPP's installed capacity, 12 % in spinning reserves and 8 % in non-spinning ones.

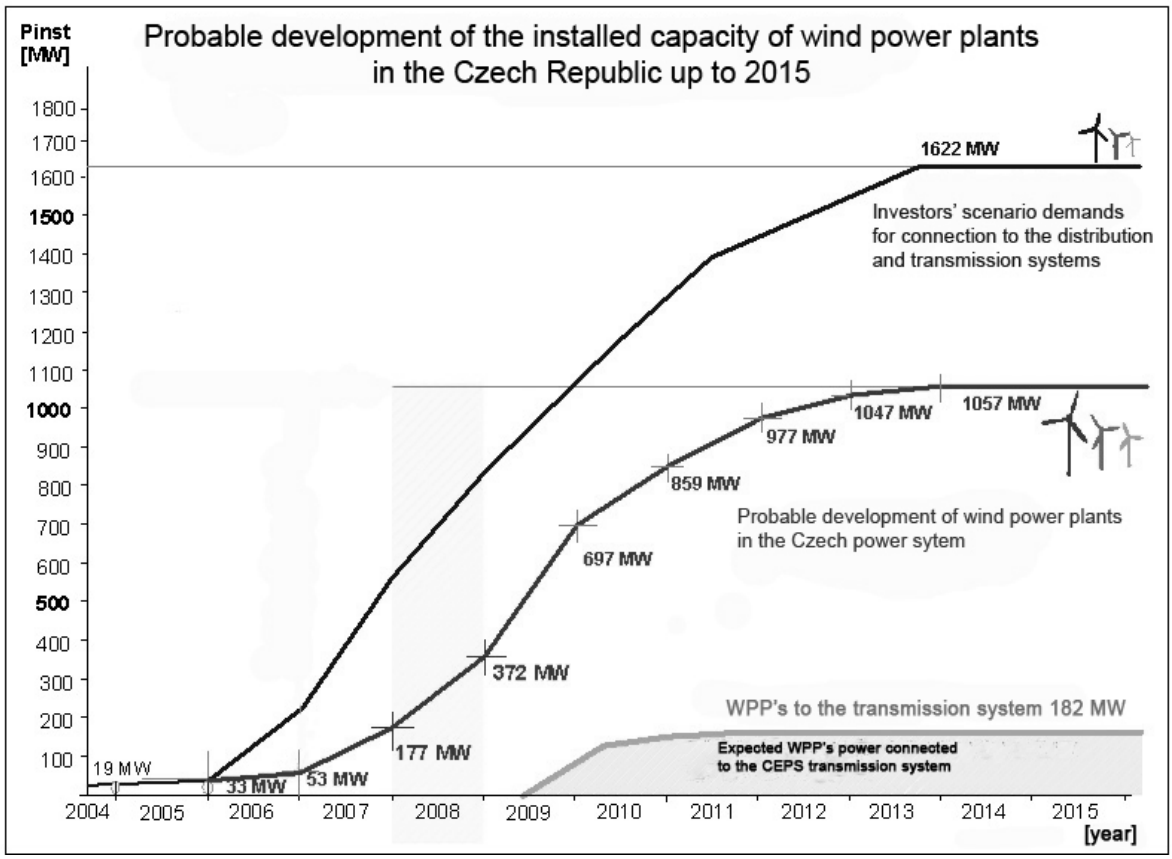

Fig 1: Probable development of the installed capacity of wind power plants in the Czech Republic up to 2015 [2]

4. ESTIMATION OF COSTS RELATED TO AN INCREASED SHARE OF WIND POWER PLANTS IN THE POWER SYSTEM

An exact estimation of costs caused by mass operation of wind power plants is a very complicated problem. It must be based on the experience of foreign companies such as E.ON, RWE and Vattenfall, while, at the same time, respecting the specific characteristics of the Czech power system. The most expensive will be wind power plants' connection to networks of different voltage levels, it includes network reinforcing and reconstruction. These are non-recurring costs. Then there are considerable costs due to the nature of wind power plants and their primary energy source – wind. Difficult prediction of supplied power has as a consequence the need of spinning and non-spinning reserves available in the power system, purchase of ancillary services and covering losses and fluctuations. Further losses can be seen in decreasing interstate transmission capacities for electricity

trade. Wind power plants do not need fuel and do not release any emissions, but their contribution to replacing the installed capacity of existing sources is minimal.

As it has been already mentioned, the expected increase in WPP's installed capacity will bring about considerable costs. These problems are being discussed at the moment, mainly by ČEPS, transmission system operator.

Preliminary estimates published in the study of the ČSRES (Czech Association of Regulated Electrical Power Engineering Companies) [4] shows that in 2010 there will be WPP's with an installed capacity of 182 MW connected to the transmission system and of about 633 MW connected to distribution networks. Financial consequences of WPP's for network operation can be divided as follows:

- additional costs due to a higher purchase price – estimated additional costs in both the transmission and distribution systems were reckoned to be 115 million €,

- ancillary services additional costs – increasing necessary regulating reserves (spinning reserves of about 106 MW, non-spinning 57 MW) will result in additional costs of about 58 million €,

- additional costs due to fluctuation compensation – they originate from a difference between the predicted and actual amount of generated power and, in case of WPP's, they are higher in comparison with other types of sources because of difficult and inaccurate prediction. Total additional costs due to fluctuation compensation in the transmission as well as in the distribution systems evaluated to be 86 million €.

By adding these partial costs, the total of 259 million € can be obtained. If the expected average capacity factor is 15 %, WPP's of an installed capacity of 815 MW will generate energy of 1110 GWh and the final price of electrical energy supplied by WPP's is 0.233 €/kWh, which does not include the costs for connecting WPP's to the transmission or distribution system.

Connection costs of a WPP or a wind farm depend significantly on the installed capacity and the voltage level of the connection point. Also, there is a considerable increase in specific costs if there is a need to build a connecting line **Chyba! Nenalezen zdroj odkazů.**. For illustration:

- Wind farm of an installed capacity of 100 MW can be connected to a 110 kV network at specific costs of 100,000 €/MW (it is probably not feasible from technical point of view, but it can be expressed in terms of costs) or 128,000 €/MW in case of a 220 kV network or 172,000 €/MW in case of a 400 kV network.

- On the contrary, 120,000 €/MW are specific costs for connecting a wind farm of an installed capacity of 80 MW to a 110 kV network or a wind farm of 105 MW to a 220 kV network or a wind farm of 140 MW to a 400 kV network. The given values of installed capacities are approximate.

It is clear from the above that the increasing share of wind power plants in the Czech power system will influence more and more the price of electrical energy.

5. CONCLUSIONS

Increasing number of wind power plants will help the Czech Republic fulfill its pledge to generate 8 percent of electricity from renewable energy sources. On the other hand, it brings about considerable investments and additional costs that will have their repercussions in the price of electricity for final consumers. The task is now to find necessary power reserve and its optimum distribution among individual types of ancillary services using mathematical models and the experience in neighboring transmission systems applied on the situation in the Czech Republic. It involves choosing an appropriate ratio between spinning and non-spinning reserves in thermal, gas-turbine and combined-cycle power plants and static reserves in hydroelectric power plants with respect to their starting speed. Also, it includes plans for development, reinforcement and reconstruction of the power system. Investors' demands are enormous, but not all of them will be able to be satisfied.

ACKNOWLEGEMENT

The paper includes the solution results of the Ministry of Education, Youth and Sport specific research project No 18184.

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