Croatia: Wind electricity projects, costs and benefits

Categories : SEE Energy News

Date : September 28, 2015

So far in the power system of Croatia, a total of 346.45 MW of installed capacity was built into 16 wind farms, or 176 wind turbines, connected mostly to the transmission network (84% of total installed capacity), and partly to the distribution network (16% of total installed capacity). VE power ranges from 6 MW to 43 MW. Due to technical limitations, Croatian Transmission System Operator (HOPS), introduced a possible WPP integration quota of approximately 400 MW, which is significantly less than the overall interest of investors who have expressed their intention to build a wind power larger than 3,000 MW. Currently two more WPP are under construction, including the expansion of an existing one, so that the possible integration quota will soon be reached, and the total installed wind power capacity will amount to 420 MW.

In the ten-year period of construction of the first WPP, HOPS has gained significant experience regarding the operation of wind farms and their impact on the power system. It turns out that they are not a stable source of energy in the long term (annual output more predictable than hydropower), but with significant variations of production in intraday or hourly time domain, because of which they cause the need for additional secondary and tertiary P/f control reserve. Wind power plants are usually away from the existing electricity grid and their network connection can cause significant cost. In the Croatian case, since the wind power are concentrated in a relatively small area (Dalmatia, Lika), mostly in the range of about 250×100 km2, their major construction would cause increased extensive costs of network development of 400 kV and 220 kV. HOPS also puts additional technical requirements on wind turbines for the production of reactive power and maintenance of voltage in the connection nodes, as well as on the behavior of the wind turbine in the event of short circuits in the network.

Over the past 10-year period there have been some barriers that are only partly removed regarding WPP integration in the power system, and removal of the remaining would significantly facilitate the management of the system with higher WPP share, as for example introducing obligatory planning WPP, the introduction of a WPP balancing mechanism, clear way of buying off unpredictable production, the position of the WPP in the market model and so on.

In the 2011 – 2014 period WPP in Croatia produced a total of 1.7 TWh, or about 10% of the total annual electricity consumption in Croatia. They were in a state of rest less than 1% of the time, which proves that certain production from WPP can almost always be expected. Average annual production hour (MWh/h) typically accounts for about 20% of the total installed wind power capacity. The average hour power generation in 2014 was 83.3 MWh, maximum hourly output was 306.2 MWh, achieved 12/27/2014 at 23.00, with the maximum achieved utilization factor of installed capacity of up to 88.4%. Maximum daily production in 2014 was 6,656 MWh and was recorded on 05/11/2014, and on that day 15% of total consumption in Croatia was settled. Maximum hourly coverage consumption by wind power generation in 2014 accounted for 22.5% and it was realized on 16/11/2014 at 5.00. In 2014, WPP settled for the 16.2 days of Croatian consumption.

Annually, WPP are a relatively stable source of energy, as shown in utilization factor of the previous figure by months for the period 2011 – 2014. The monthly utilization factor is calculated as the ratio of the total energy produced in a given month and the product of installed capacity and number of hours in a month. In the Republic of Croatia the average of that factor is about 0.26, which is equivalent to operation of 2277 hours at full installed capacity and means a distinct locations wind power in Croatia. Based on past experience, it can be concluded that the annual volatility of the wind is less than the variability of hydrological conditions. However, for system management the critical factor is hourly and interhourly variability of wind, not monthly or yearly. In the period 2011 – 2013 the sum of the deviations of wind (positive and negative) was 419 GWh, or 44.7% of total production.

To activate the control reserve power and frequency (P/f control) relevant factor are deviations of wind power production, defined as the difference between the projected production and actual production of electricity in the observed time unit. At the same time it should be noted that certain variations of wind power generation in the secondary region is negligible (no increase in primary control reserves), but they are significant in a minute and 15-minute period (visible impact on the secondary and fast tertiary reserve). The forecasting system of wind power production has been installed in HOPS since 2011, so its performance is improving from one year to another. WPP owners have no production predictions obligation, nor financial implications of production variations. Forecast of WPP production is carried out one day ahead (D-1) for each hour of the day, and replan is done an hour in advance on day D.

Average forecasts error in 2011 was 11.8% of the total installed capacity, in 2012 it was 13.1%, and in 2013 9.8%. Minimum forecasts error in the studied period was 0% and maximum 78% of the installed wind power capacity. It is obvious that a clear trend of improving forecasts of wind still does not exist, which is partly conditioned by a short period of analysis, and the constant change of installed capacity and new plants when the forecast quality is substantially reduced. According to the experience of other countries, the authors estimate that in the coming short-term period this forecasts error of WPP production can be reduced to a level of about 5% by introducing better intraday re-planning and the introduction of financial responsibility for planning all WPP.

For running the electric power system total deviations from the plan (and not of installed capacity) are relevant, both on the production side and on the demand side (consumption). Experience in Croatia so far shows that the plan consumption deviations are still considerably higher than the WPP deviations from forecasts, which means that the dominant cause of the activation of secondary control reserve is still an error in predicting consumption (load), and not the variability of wind power plant production. Analysis of hourly variations of wind power generation and consumption in the 2011 – 2013 period indicates the possibility that the error in the forecasts are superimposed since 50% of the time there was a forecast discrepancy in the same directions (planned lower consumption and lower production of WPP than realized values), while the rest of the time errors were evened among themselves.

Inequality of production and consumption within the system in the moment will lead to the automatic activation of the secondary reserves within the system, and if it was not enough to cover this imbalance there will be minor or major deviations and planned exchange with neighboring control areas and blocks, which is unacceptable from the point of view of the system in the European interconnection. In case when secondary reserve is insufficient, tertiary reserve is manually activated periodically in order to release the prescribed secondary reserve.

The question is what proportion of inequality of production and consumption should be covered by the secondary reserve, and what proportion by tertiary reserve, and whether the part of discrepancies can be left uncovered in the hourly time domain and then balanced through the compensation with neighboring control areas on a weekly basis. The ideal case would be if there was enough secondary reserve within the system that automatically covers all inequalities, including those extremely large, but it was never realized due to high costs of maintaining such a large reserve, and other influential factors (e.g. hydrological conditions).

From the above described reasons HOPS is considering the introduction of probabilistic approach in securing the necessary secondary and tertiary reserves. Secondary reserve would stay defined by ENTSO-E formula and additional departures would be covered by fast tertiary reserve. Since the current situation within the secondary reserve power system of Croatia is limited to the amount of up to ± 65 MW (service provided by only three HPP), in the future additional conventional power plants should be included (primarily hydro and gas power plants) in automatic secondary regulation, which will decrease the need for rapid activation of tertiary reserves.

To illustrate there was a simulation of EES plants and hourly variations in production and consumption for a variety of time share when the available secondary and tertiary reserve can cover the total deviation (from 95% to 100% of the total annual time), which points to its possibilities of WPP integration into the Croatian power system in the existing state in the future. Ia-Assuming that in the future the same average omissions levels of forecasts and consumption of wind on an hourly basis will be maintained (2% of consumption in relation to the realized value of the reference hour, and 9.4% for WPP in relation to their installed capacity), and that at any moment HOPS has secondary reserve specific basis ENTSO-E formula available (calculated on an hourly level, depending on the hour load), we determine maximum tertiary reserve for balance (or fast tertiary reserve) which HOPS must have at its disposal in order to balance the total deviation of the system 95% of the time/year (5% of the time deviation will be greater than total control reserve), and in 99% and 100% of the time/year. In practice, this would mean that the secondary reserve at the hourly level is maintained in accordance with ENTSO-E requirement, while much of the discrepancies within the system are covered by additional tertiary reserve, therefore manually by order of the dispatcher. Such an approach would mean a relatively large number of additional activation of tertiary reserve on a daily basis, in accordance with the high cost of maintaining reserves and the activation, and dispatchers’ subjective capacity in managing the system and reducing the exchange deviations kept to a minimum.

Until the end of 2013 costs at balancing WPP was covered from fees for RES promotion and was about 4 mil€/year for the level of integration of approximately 250 MW. Integration of

400 MW of wind power in EES will cause additional control system cost amounting from 1.04 to 2.5mil.€/year depending on the WPP forecasts quality, while the integration of 800 MW WPP causes additional costs of 4.4 – 9.5mil.€/year, which causes additional cost of WP generation in the range of 1.19 €/MWh to € 5.4/MWh , transmits Serbia-energy.eu