RES Load Diagram Analyses - Step Towards Virtual Power Plant

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Overview

The integration of new renewable energy sources in large scale, especially intermittent ones, into the existing power grids has become nowadays one of the biggest challenges for the energy sector. The increasing electricity production from RES is causing significant problems within the power grid and several EU states have already introduced various restrictions on intermittent RES.

These problems result mainly from the low predictability and high volatility of electricity production and they don´t affect only the stability of power grid but also the price of electricity on the market as well as the needed amount of system and auxiliary services. Therefore future benefits from successful RES integration can be extensive. One promising way how to integrate and even promote RES and its future development is the concept of virtual power plant.

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Methods

The crucial issue of renewable energy sources integration is their high volatility and limited predictability. The more we are able to describe the specific behavior of each individual type of RES the higher the penetration of RES can be.

Based on this premise thorough analyses of production diagrams of several small hydro and PV power plants in the Czech Republic have been conducted. The analyses are based on descriptive characteristics and other statistical methods. The data was described especially by using time series analysis and the analysis of stochastic component.

Results

The above mentioned mathematical methods were applied as a case study on two different kinds of renewable energy sources – photovoltaic power plants and small hydro power plant. The analyzed time series were at least one year long in case of PV and three years in case of small hydro power plant. By using statistical methods the stochastic component of production have been particularly assessed, which is crucial for predictability improvement and of course for further use.

In the case studies model describing power diagram has been created and validated by stochastic analysis. In the Fig.1. the diagram of three years production from small hydropower plant can be seen (daily averages). At first sight constant trend with a certain amount of variability can be observed. We had data from years 2008-2011, so model has been created based on data from 2008-2010 and then on data from 2011 tested, as can be observed in the Fig.2.

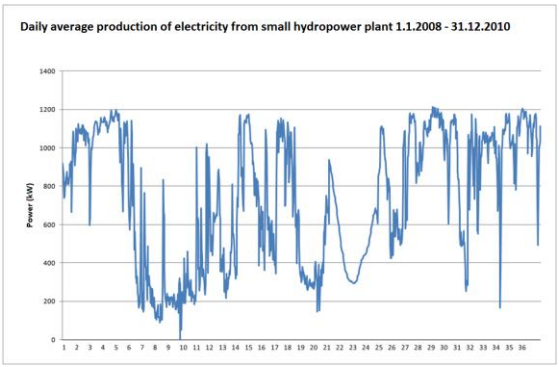

Fig. 1 Daily average production from small hydropower plant from years 2008-2010

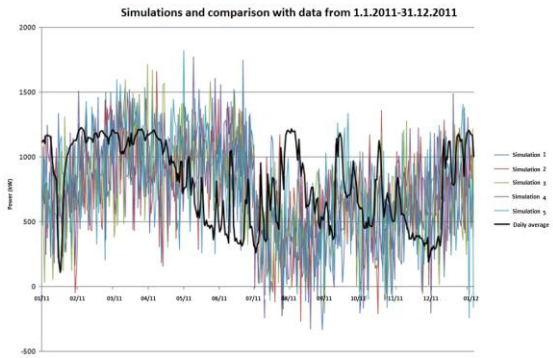

Fig. 2 Comparison of model with simulated komponent with real data from year 2011

Then aggregation of diagrams was provided and we have evaluated the differences in variability before aggregation and after, which resulted in decrease of variability. However for the needs of general virtual power plant concept all renewable sources should be described according to our proposed methodology.

Conclusions

It was proved than aggregated diagram of portfolio of sources has certainly different characteristics than each diagram separately. This concept of virtual power plant brings many advantages beside of a separate production, for example improvement of prediction and getting of smoother diagram. That is very important, because it leads to reduction of backup power sources requirement, reduction of a system services requirement and last but not least improvement on energy market. Also very important issue is decrease of marginal costs to cover the residual demand as above mentioned, which is in direct relation to final electricity price.

Therefore this concept of virtual power is becoming a highly discussed topic. For its operation, however, is necessary to know the character of the individual diagrams and their variability. Then these diagrams can be aggregated and using mathematical tools the contribution of this aggregation can be assessed. One approach to this concept is based on the stochastic programing. Our paper provides the methodology for such description and afterwards tests this approach on two case studies.

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