Harmonic Source Identification of a Distributed Generator, and Compensation of the Voltage Change Caused by Changing Generation

Bálint Hartmann[1] and Supervisor Author András Dán, Dr.[2]

[1] Graduate student at the Department of Electric Power Engineering
Budapest University of Technology and Economics
Budapest (Hungary)
E-mail: Hartmann.balint@gmail.com

[2] Professor at the Department of Electric Power Engineering
Budapest University of Technology and Economics
Budapest (Hungary)
Phone: +36 1 463 3019, e-mail: dan.andras@vet.bme.hu

Abstract. Energy industry is facing one of the biggest transition of it's history. The decreasing amount of fossil fuels, the reduction of emissions, the rising energy prices all advert renewable energy resources. The penetration of distributed generation has already begun, but the integration into the old network structure is still in it's infancy; the technological change is not yet followed by the needful aspect change. For this reason, extended investigation of the connection terms is indispensable.

In the present paper two aspects are examined. First, a computer model is created, and the verification process is done, using the method of harmonic source identification. The second part of the paper focuses on the steady voltage change caused by the connection of the generator. After simulations, the authors set a potential course to solve the problem, using only the built-in power electronic devices.

Keywords

Computer simulation, power quality, distributed generation, harmonic source identification, reactive power compensation

1. Introduction

Effects on line power caused by distributed generation can be very multiple – emission of harmonics, flicker, and the steady voltage change as the result of the connection all takes effect. The standards, that are in force nowadays, regulate the limit values for the majority of such measurable parameters, but contain nothing about control problems. In turn, a distributed generator deemed to have negative effects in a particular case might have positive ones under conditions. Modern power electronic converters are available at most grid connection points, but their role is restricted to inject the generated energy into the grid. The challenge of the future is to find the proper ways to take them into the control process.

The subject of the paper is an 800 kW wind generator, mounted in the periphery of the Hungarian village, Mecsér. The built-in power and the scheme of the grid connection characterize the Hungarian wind generators well. Based on the available measurements, a computer model was made for DIgSILENT PowerFactory, the paper contains the verification process. The root of the work is the harmonic source identification, which is often used in engineering; this method of measurement techniques is reviewed in detail in [1]. The computer model made can be used for further investigations.

The other objective of the paper is the examination of a control problem. The connection or the disconnection of a generator causes significant steady voltage change at the grid connection point. The current injected by the distributed generator is purely active, so the voltage change may be bigger than the permitted (2-3% commonly), depending for example on the momentary power generation or the state of the network. To avoid this phenomenon, the generator can be taken into the local voltage control process, using its power electronic devices. There is no generally accepted or recommended procedure to manage this situation, thus the aim of the paper is to set a potential course.

2. The Harmonic Source Identification

It is often said in daily life, that the best defence is prevention. In the present case it means, that we have to find the harmonic sources connected to the grid, determine the size of the currents and the share of each consumer in the voltage distortion. In absence of knowledge we could be disposed to believe, the generator in the highest degree causes the voltage distortion measured at the connection point. But we also know, that the harmonic current emission of the nowadays used power electronic converters is at a very low level.

The available measurement results were examined through harmonic source identification, to determine the true values. The final results have proven, that the contribution of the distributed generator is significantly lower than the background noise. Nevertheless the results are below the limits of the standard, so the generator suits all the expectations. The results were used in the computer model, so a system for further investigations is available.

3. Compensating the Voltage Change

For this part of the work our model was modified: a total 4 MW power plant was formed in form of 5 parallel devices. The grid connection or disconnection of such a generator results in yet a significant steady voltage change. The magnitude of this must stay below 2%. Using the DPL programming language of PowerFactory a script was written to calculate the necessary compensation. IN both cases, grid voltage prior to the connection was at nominal level, and the generation was purely active. During simulation the distance between the station and the generator was set to different values, so the result was a P-Q curve as a function of distance. The P-Q curve of the power electronic converters built in the generator was also available; it shows the compensation range for the generator side of the transformer.

This compared to the simulation results shows, that the generator by itself could keep the voltage below the 2% limit in every case, and below 1% for most of the cases. The latter one should be an object of regard, because new consumers/suppliers may connect to the grid in the future, so it is practical not to exhaust the limit with the first one. The authors summarize the market values for compensators of the same range.

4. Conclusion

The present paper proves on one hand, that the distributed generator contributes to the voltage distortion less than the background noise, so it is permitted to make a grid connection. On the other hand, a potential course is set for local voltage control. The authors conclude, that taking the power electronics of the generator into the process results adequate control, with only minor structural modification, and the total cost stays significantly lower than for other possible solutions. Future work will focus on micro generators connected to distribution network; market liberalisation will surely result in the connection of such devices in large number.

References

[1] A. Dán, T. Tersztyánszky, Gy. Varjú, *„Electric Power Quality" (Villamosenergia minőség)*, Invest-Marketing Ltd., Budapest, Hungary, 2006.

[2] MSZ EN Standard 50160, Voltage characteristics of electricity supplied by public distribution systems, 2001

[3] ***, „DIgSILENT PowerFactory Version 13.1 Manual", nov. 2005