"Power Electronics in Smart Grids"

Classical production of electric energy is based on power systems with large power plants fed by fossil (coal, natural gas, and oil), hydro, or nuclear fuels. The produced electric energy is transmitted and distributed by systems which are basically unidirectional and passive, as the way of the energy transfer from production to the final users is considered. On the other hand, the smart grids (SGs) represent a quite new approach which can be broadly defined (there are a variety of SGs definitions) as "intelligent" electric power networks integrating a large number of conventional and unconventional (renewable energy sources – RES and energy storage systems) power sources and "active" users fully coordinated by an advanced management system. The SGs can be designed with the goal to achieve different targets such as:

- optimal use of RES,
- maximum use of the available energy at minimum cost,
- increasing of power quality by elimination of voltage sags, swells, higher harmonics, etc.,
- other innovative and useful service.

In SGs active users are also producers and are called "prosumers" which use the sophisticated load management system based on real-time tariff policies. In this context, the SGs are much more complex systems than the classical power networks and require an extensive research in many disciplines. The potential of SGs can be explored only by well-coordinated technical and economic issues based on a combination of sophisticated management algorithms, information and communication systems as well as power electronic converters.

Therefore, this Special Section is devoted to present and recent research trends in the application of power electronic converters in SGs. This Section is grouped in the following main categories.

OVERVIEW PAPERS

- G. Benysek, M.P. Kazmierkowski, J. Popczyk, R. Strzelecki: "*Power electronic systems as a crucial part of Smart Grid infrastructure – a survey*",
- A. Tomaszuk and A. Krupa: "*High efficiency high step-up DC-DC converters – a review*",
- M. Bobrowska-Rafał, K. Rafał, M. Jasinski, M.P. Kazmierkowski: "*Grid synchronization and symmetrical components extraction with PLL algorithm for grid connected power electronic converters – a review*",
- J. Dawidziuk: "*Review and comparison of high efficiency high power boost DC/DC converters for photovoltaic applications*".

THREE-PHASE AC-DC-AC AND MULTILEVEL CONVERTERS

- A. Sikorski, M. Korzeniowski: "*AC-DC-AC converter in a small hydroelectric plant*",
- R. Smoleński, M. Jarnut, G. Benysek, A. Kempski: "*CM voltage compensation in AC/DC/AC interfaces for smart grids*",
- M. Zygmanowski, B. Grzesik, J. Michalak: "*Properties of power conditioning system with a five-level cascaded converter and supercapacitor energy storage*",
- S. Karyś: "*Three-phase soft-switched inverter with coupled inductors, experimental results*".

These papers are dedicated to study properties of the three-phase grid connected voltage sourced converters (VSC) and multilevel converters which are widely used in the renewable energy production.

REDUCED GRID DISTORTIONS

- P. Mysiak and R. Strzelecki: "*A robust 18-pulse diode rectifier with coupled reactors*",
- A. Kasprzak, M. Orlikowski, D. Brodecki: "*Operation of voltage transformer in grids with distorted signals*".

These papers are devoted to study and investigation of operation under voltage dips and higher grid harmonics in grid voltage.

OTHER ISSUES OF POWER ELECTRONIC CONVERTERS

- K. Zymmer, P. Mazurek: "*Comparative investigation of SiC and Si power electronic devices operating at high switching frequency*",
- R.M. Miśkiewicz, A.J. Moradewicz: "*Contactless power interface for plug-in electric vehicles in V2G systems*".
- K. Kulikowski and A. Sikorski: "*Efficiency improvement due to direct torque and flux three levels three areas control method applied to small hydroelectric power plant*".

These papers discuss properties of new power devices based on SiC semiconductor, solution for contactless energy transfer and control for electric hybrid vehicles with "Vehicle-to-Grid" (V2G) capabilities for smart grids as well as problems related to efficiency improvement in small hydroelectric plants.

I would like to express my appreciation to the authors of this Special Section for the high quality of their work and cooperation during the review process. Also, I would like to thank all reviewers for their valuable comments and suggestions which contributed significantly to improve the paper quality. Special thanks to Prof. Tadeusz Kaczorek, Editor-in-Chief of the Bulletin of PAS, for giving me the opportunity to organize this Special Section.