Guest Editorial
Special Issue on Power Quality in Smart Grids

SMART grid (SG) is usually described as a power system utilizing information and communication technology (ICT) and advanced monitoring systems to improve the grid performance and offer a wide range of additional services for the consumers. Some of the main features of such a grid are self-healing from power disturbances, efficient energy management, automation based on ICT and advanced metering infrastructures (smart metering), integration of distributed power generation, renewable energy resources and storage units as well as high power quality and reliability. In this regard, the concept of microgrid is brought to the stage as one of the main building blocks of the future SGs.

In the context of SG, Power Quality (PQ) has emerged as one of the most important issues. Although PQ is not a new topic in electrical systems, it deserves special attention in modern grids mainly due to the following reasons:

- increasing application of sensitive loads and control processes in recent years;
- proliferation of different nonlinear and single-phase loads which may adversely affect the PQ;
- availability of advanced metering, sensing and control functionalities in SGs which can be utilized to provide a desirable PQ level for consumers.

Thus, measurement, analysis, and compensation power quality problems (e.g., harmonics, resonances, unbalances, sags, flickers, and so on) are of great importance.

In this special section on Power Quality in Smart Grids, we have 14 high-quality papers that cover the following four topics:

- analysis of power quality problems;
- control schemes for enhanced power quality;
- advanced methods for power quality assessment;
- synchronization techniques.

These topics and the papers included are explained in the following sections of this Guest Editorial.

I. Analysis of Power Quality Problems

In this section, methods and analyses are proposed to assess or evaluate the power quality impact of using more power electronics systems and other smart devices into the electrical grid. The following three papers are included in this Section:

- "Impact of Modern Electronic Equipment on the Assessment of Network Harmonic Impedance," by D. Chakravorty *et al.*, provides a methodology to visualize the impedance variation within a cycle due to the power electronics switching. Further, three indices are proposed to quantify this impedance variation.
- "Power Quality Concerns in Implementing Smart Distribution-Grid Applications," by M. Bollen *et al.*, maps the expected power quality consequences of introducing several smart distribution-grid technologies and applications, such as: microgrids, advanced voltage control, feeder reconfiguration and demand-side management.
- "Common-Mode and RF EMI in a Low-Voltage DC Distribution Network with a PWM Grid-Tie Rectifying Converter," by P. Nuutinen *et al.*, investigates common-mode (CM) and radio frequency (RF) electromagnetic interferences (EMI) in a low-voltage direct current (LVDC) distribution network. LVDC distribution being a novel approach to public electricity distribution, a research site was set up in a public rural-area distribution network to enable comprehensive studies concerning the LVDC distribution.

II. Control Schemes for Enhanced Power Quality

In order to improve the power quality in microgrids and smart grids, active power filters, inverters and other power electronics-based equipment need superior controllers. This section includes the following eight papers:

- "Design of a Thyristor Controlled LC Compensator for Dynamic Reactive Power Compensation in Smart Grid," by C.-S. Lam *et al.*, presents a thyristor controlled LC compensator for dynamic reactive power compensation. Compared with the traditional static var compensators, it can significantly mitigate the injection of harmonic currents.
- "Power Quality Conditioning in LV Distribution Networks: Results by Field Demonstration," by H. Hafezi *et al.*, proposes a new system solution to improve the PQ level in LV distribution networks by using an Open Unified Power Quality Conditioner. It consists of a single or three-phase AC/DC power converter installed at the customer side and a single/three-phase AC/DC power converter in the MV/LV substation.
- "Using Smart Impedance to Transform High Impedance Microgrid in a Quasi-Infinite Busbar," by G. Lambert-Torres *et al.* proposes an application of a hybrid active power filter to change the microgrid bus impedance forcing it to behave as a quasi-infinite

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bus, without increasing active power capacity of the microgrid.

- "Centralized Control of Distributed Single-Phase Inverters Arbitrarily Connected to Three-Phase Four-Wire Microgrids," by D. Brandao *et al.*, proposes a technique to control the power flow among different phases of a three-phase four-wire distribution power system by means of single-phase converters arbitrarily connected among the phases. The objective is to improve the power quality at the point-of-common-coupling of a microgrid, to enhance the voltage profile through the lines, and reduce the overall distribution losses.
- "Reactive Power Flow Control for PV Inverters Voltage Support in LV Distribution Networks," by A. Molina-Garcia, proposes a reactive power flow control pursuing photovoltaic systems active integration in LV distribution networks. The inverter control system is enhanced by a suited harmonic compensation feature, improving the power quality at the point of common coupling.
- "Power Quality Constrained Optimal Management of Unbalanced Smart Microgrids during Scheduled Multiple Transitions between Grid-Connected and Islanded Modes," by K. H. Youssef, proposes a novel power quality constrained optimization framework for smart microgrids for scheduled multiple transitions between grid-connected and isolated modes. The optimization takes into account cost of power interruptions to loads with different priorities, maximum benefit from renewable energy sources, steady-state frequency deviation during islanding, and power-sharing among dispatchable generators.
- "Power Quality Enhancement of Smart Households using a Multilevel-THSeAF with a PR Controller," by A. Javadi *et al.*, contributes to improvement of power quality for a modern single phase consumer, and focuses on integrating of a compensator with energy storage capacity to ensure a continuous supply. A proportional plus resonant (P+R) regulator is implemented in the controller to prevent current harmonic distortions of various nonlinear loads to flow into the utility.
- "Optimization of Standalone Microgrid Considering Active Damping Technique and Smart Power Management using Fuzzy Logic Supervisor," by F. S. Tidjani, presents the control of a fuzzy logic based energy management system applied to an islanded microgrid. The paper develops a new approach to eliminate damping resistor and replaced it by an active damping control without using any additional sensor and to reduce the size of the output filter, based on the shift of the resonant frequency and the optimal choice of the active damping coefficient.

III. Advanced Methods for Power Quality Assessment

The assessment of power quality through smart meters and phasor measurement units is a new powerful tool in smart grids. Two relevant papers are included in this section:

- "Syncretic Use of Smart Meters for Power Quality Monitoring in Emerging Networks" by M. Albu *et al.*, proposes an alternative PQ-framed aggregation algorithm to be implemented in smart meters. In this way smart metering can become an enabler of real-time voltage control required in active distribution grids.
- "A Fast Harmonic Phasor Measurement Method for Smart Grid Applications" by S. Jain *et al.*, proposes a parametric method, estimation of signal parameters using a rotational invariance technique is used to estimate harmonic phasors applied to the IEEE Std. C37.118.1 for synchrophasors.

IV. Synchronization Techniques

Finally, the synchronization of power electronics converters in microgrids is crucial to reconnect those small grid systems to the smart grids, and presented in the following paper:

- "Synchronization of Power Inverters in Islanded Microgrids using an FM-modulated Signal" by I. Patrao *et al.*, a synchronization technique is proposed based on frequency modulation to be transmitted thus being robust against noise. The demodulation is performed with low computational load to synchronize the grid-forming power electronics converters of a microgrid.

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