Guest Editorial

Special Section on Smart Grid Technologies

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The electric industry is being transformed from a centralized network to one that is less centralized and allows more consumer interaction in the form of a smart grid.

There is also a strong commitment by most countries to reduce greenhouse gas emissions and global warming through the use of renewable energy resources. The locally available renewable resources, such as wind, solar, tidal waves, fuel cells, and biomass, can be used to meet the local demands through micro-grids. Micro-grids can be constituted of several distributed energy resources depending upon the availability of different renewable energy sources to supply reliable and stable power to the loads connected to the micro-grid. Depending upon the design, micro-grid can be operated either in parallel with the grid or in isolated mode. Constructing a self-sufficient intelligent micro-grid in urban or rural areas will reduce the dependency on the utility grid for electricity, maintain supply continuity, increase reliability and customer satisfaction, and reduce power losses in transmission and distribution of power.

As more and more intelligent sensors in the form of intelligent meters are being installed in the power system and together with intelligent control of power electronic converters in the distributed micro-grid systems, they lead to the development of future smart grid and smart energy systems.

A smart grid is a power transmission and distribution network that can incorporate millions of sensors all connected through an advanced, two-way communications, and data acquisition system to provide real-time monitoring, diagnosis, and control. Smart grid enables more efficient, reliable, and secure energy service, and facilitates grid-integration of renewable systems and energy storage, better routing of power, and demand management. The move to a smarter grid promises to change the industry's entire business model and its relationship with all stakeholders, involving and affecting power companies, regulators, energy service providers, technology and automation vendors, and all consumers of electric power.

It is our pleasure to present this Special Section on Smart Grid Technologies. In total, there are six papers accepted for publications covering wide areas of topics in smart grid technologies, from micro-grid, storage, power electronics, intelligent controller, reliability assessment and a novel array for solar cell.

We begin with an article on the introduction to future smart grid systems, covering topics such as the drivers for change, the need for renewable energy, leading to the development of micro-grid as a distributed power system that can be operated either in parallel with the grid or in isolated mode, the need for smart power electronics and energy storage systems to reduce the impact of fluctuation in power generation and loads, and finally the future development of the micro-grid system to smart grid and smart energy system with the introduction of more sensors, better communication and intelligence associated with information and communication technology (ICT).

This is followed by a paper describing an experimental micro-grid facility recently established at the Commonwealth Scientific and Research Organization (CSIRO) in Australia. This facility has three types of solar photovoltaic (PV) technologies, two types of wind power, a load bank, and three types of battery technologies, namely standard lead acid, the CSIRO-developed ultra battery, and a zinc-bromide flow battery, all connected as a micro-grid to supply the local load. The paper concludes by illustrating how micro-grids have a key role to play in the development of the smart grid.

The third paper describes the design of an intelligent controller for a smart grid system using a hybrid multi-agent framework for self-healing application following a large disturbance. The contribution of this framework is that it combines centralized and decentralized architecture together. In contrast to centralized controller, this framework will allow faster response during emergency control associated with catastrophic disturbances. In contrast to complete decentralized architectures, central controllers are advised of the decision of local controllers and are asked to judge the decision and asked to suggest more optimized solution.
The fourth paper describes a specific example of the application of a battery energy storage system to deal with the fluctuations in the wind power electricity generation in an integrated power system. The battery energy storage system provides a rapid response and enhances the performance under the fluctuation of wind turbine output and improves the voltage stability of the system.

The fifth paper describes the reliability assessment of a micro-grid consisting of wind and gas turbines using sequential Monte Carlo simulations. A Weibull distribution wind speed model was built to simulate the hourly wind speed of a specific site. A two-state reliability model of micro gas turbine and a load model from IEEE Reliability Test System (IEEE RTS) were also introduced to the reliability evaluation of the micro-grid.

Finally, the last paper describes the potential use of novel arrays of silver nanodisks for solar power application in a micro-grid system. The paper presents a study of the optical absorption and scattering properties of two-dimensional square silver nanodisks and shows that the use of such arrays may open up the way to increasing the photo-electricity energy transformation efficiency and the optical properties improvement of the solar cell.

As the guest editor for this special section, I would like to thank the authors for sending their contributions and to the reviewers for their expertise and commitment to the review process. I would also like to thank Dr. Jason Kang, the Executive Editor-in-Chief, and the Executive Staff of the Journal of Electronic Science and Technology for their wholehearted support.

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Dr. Sutanto is a senior member of IEEE. He was appointed as the Regional Representative of the Power Engineering Society of IEEE for Region 10, Asia-Pacific from 2001 to 2004. He has been invited to be the members of international advisory board for several international conferences. Now he serves as the General Chair of 2011 IEEE International Conference on Smart Grid and Clean Energy Technologies (IEEE ICSGCE 2011).