Introduction to the Special Section on Distributed Generation and Microgrids

DRIVEN by economic, technical, and environmental reasons, the energy sector is moving into an era where large portions of increases in electrical energy demand will be met through widespread installation of distributed resources or what is known as distributed generation (DG). DG units can operate individually or in a microgrid mode. The latter is formed by a cluster of DG units connected to a distribution network to serve local and distributed loads in a systematic manner. Microgrids can operate in a grid-connected mode or in an islanded operation mode to boost the service reliability. The majority of distributed resources are interfaced to the grid via power electronic converters.

Large-scale integration of DG units, short- and long-term energy storage, and electronic control devices will be of significant impact on the structure, performance, planning, design, and operation practices of future power grids. Significant research efforts are needed to overcome integration barriers and help sustainable and clean DG technologies make their contribution to our energy system in a way that enhances the overall grid performance. In addition, those new electrical energy concepts also require for storage energy systems to be able to manage the energy near the consumption points. In this sense, power electronic systems are becoming important to integrate variable renewable energy sources such as photovoltaics or wind power generation. The use of power electronics lets us control the parts that compound a DG system, improving power quality and stability. Nowadays, DG scenario is very wide since not only is there a wide range of power ratting but also different kinds of storage energy systems. In addition, the digital signal processors are making real control techniques that could not be implemented in the past, allowing new power system configurations.

This "Special Section on Distributed Generation and Microgrids" of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS is provided. Researchers have been writing articles that cover a wide spectrum of the DG systems and microgrids; being approved for publication in this Special Section is a total of 42 papers (including a two-part paper) organized in the following eight topics.

Control of DG Units in Microgrids

The Special Section starts with a two-part state-of-the-art paper, five papers about droop control for parallel DG units in ac microgrids and, finally, a paper for the series connection of multiple units in dc microgrid.

Control of Grid-Connected DG Units

Three- and single-phase grid-connected voltage source inverters with optional local loads are studied in the next five papers.

Power Quality in DG Systems and Microgrids

Several power quality aspects in DG units and microgrid systems, such as voltage unbalance compensation, reactive power compensation, voltage support, direct power control, and harmonic compensation, are discussed in the next seven papers.

Power Electronics for DG Units

Topologies and control of dc/dc, ac/dc, and dc/ac power converters for interface energy storage systems and dc and ac buses in DG applications are proposed in the next eight papers.

Photovoltaic DG Systems

Different aspects with regard to photovoltaic DG systems, such as multistage topologies, inverters, microinverters, microgrids with the capability to operate in both grid-connected and islanded modes, and energy storage integrated photovoltaic microgrid systems, are shown in this five-paper group.

Wind-Powered DG Systems

Wind turbines and distributed wind power microgrids are presented in this group of the next three papers, covering single and parallel-connected power electronic converters for grid-connected and islanded applications.

Protection in DG and Microgrids

Protection systems are important in DG systems, particularly in microgrids, in which the power flow is bidirectional. The next three papers study new protection schemes for single and multiple units.

Energy Management and Optimization in Microgrids

Finally, the following three papers close the Special Section by proposing energy management systems for microgrids and optimization according to the location of each DG unit.

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