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Editorial

Special Issue: Control, Optimization and Planning of Power Distribution Systems

Gian Giuseppe Soma

Department of Electrical and Electronic Engineering, University of Cagliari, 09123 Cagliari, Italy; giangiuseppe.soma@unica.it

The use of renewable energy sources is moving the generation from the top to the bottom of power systems, where traditionally only loads existed. Active demand, distribution energy storage devices and electric vehicles will even more drastically change the way the distribution system will be operated.

In opposition to conventional approaches, modern distribution planning algorithms should emulate the new environment to produce expansion and strategic plans for guiding the evolution of systems in times of financial restrictions. In addition, the integration of smart grid operation within planning algorithms is the key point for proper distribution planning that allows integrating renewable resources and minimizing the cost for new electrical infrastructures.

A total of nine papers from various fields have obtained all new research outcomes that highlight innovations in the areas of control, optimization and planning of power distribution systems, and are presented in this Special Issue.

Liu et al. [1] submitted an important contribution about the defense capability of active distribution networks. In fact, with the continuous development of the active distribution network, the problem of security and stability has become increasingly prominent. In particular, a new multi-angle dynamic risk assessment index system based on the comprehensive vulnerability rate model is proposed in this paper. This paper has potential applications in the monitoring of ice disaster distribution network operation status and the prevention of power accidents based on defense strategies.

Li et al. [2] contributed to the Special Issue with a paper entitled, "Voltage Regulation in Distribution Systems". In this paper, an online reactive power optimization strategy based on the segmentation of multiple predicted load curves is proposed to address this issue, aiming to minimize network losses and, at the same time, to minimize reactive power-compensation device adjustment times. Due to fluctuating characteristics of loads, dynamic reactive power optimization over a certain time period is essential to provide effective strategies to maintain the security and economic operation of distribution systems.

The paper of Liu et al. [3] regards the power quality problems in distribution networks with a high level of renewable energy sources. The wide use of electric thermal storage heating equipment can promote distributed renewable energy utilization. However, an unplanned electric thermal storage heating equipment connection to the distribution network may cause serious power quality problems. A new method for equipment location and capacity is proposed, which considered the improvement of power quality and load demand characteristics of the distribution network.

Bazmohammadi et al. [4] present a paper entitled, "Stochastic Predictive Energy Management of Multi-Microgrid Systems". The cooperation of interconnected microgrids has been introduced recently as a promising solution to improve the operational and economic performance of distribution networks. In this paper, a hierarchical control structure is proposed for the integrated operation management of a multi-microgrid system. According to the simulation results, by adopting the proposed operation management

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strategy, a reduction of about 47% in the average unplanned daily power exchange of the multi-microgrid system with the main grid can be achieved.

The contribution of Mehrzadi et al. [5] presents forecast techniques to a microgrid application. In particular, the work presents an application of deep learning techniques to the dynamic positioning in maritime microgrids for a power management system. The power management system is used to control power generation and prevent power failure limitations. In this paper, a Levenberg–Marquardt algorithm based on a nonlinear recurrent neural network is employed for predicting thrusters' power consumption in sea-state variations due to challenges in power generation. Numerical analysis has shown that with the proposed method, the future load behavior can be predicted more accurately than that obtained from the traditional methods.

Dehghani et al. [6] discuss the topic of the operation of energy carriers. The increase in the energy demand requires careful and scientific planning around the energy provided by a variety of products, such as oil, gas, coal, electricity, etc. In this paper, a new study on the operation of energy carriers, called Energy Commitment, is proposed with the aim to set a pattern for the use of energy carriers to meet the energy demand, considering technical and economic constraints. The simulation was carried out on a 10-unit energy system supplied by various types of energy carriers that includes transportation, agriculture, industrial, residential, commercial and public sectors. Based on the simulated results, the Energy Commitment provides more information than the Unit Commitment and analyzes the network more efficiently and deeply.

The research proposed by Montoya et al. [7] addresses the problem of the optimal location and sizing of distributed generators in direct current distribution networks from the combinatorial optimization. A master–slave optimization approach is proposed in order to solve the problems of placement and location of distributed generators. The master stage applies to the classical Chu and Beasley genetic algorithm, whereas the slave stage resolves a second-order cone programming reformulation of the optimal power flow problem for DC grids. This master–slave approach generates a hybrid optimization approach, named GA-SOCP. Numerical comparisons with hybrid and exact optimization approaches reported in the literature demonstrate the proposed hybrid GA-SOCP approach's effectiveness and robustness to achieve the global optimal solution.

The paper of Di Fazio et al. [8] discusses the problem of optimizing the voltage profile of radially operated distribution systems by acting on the active and reactive powers provided by distributed energy resources. A novel voltage optimization procedure is proposed and a decentralized control strategy is adopted. A mathematical decomposition method based on the auxiliary problem principle is applied to formulate and solve a practical optimization problem in a decentralized architecture, which determines the active and reactive powers injected/absorbed by distributed energy resources to achieve the optimal voltage profile in an electric distribution system.

Finally, in the paper by Natale et al. [9], the authors propose an analytical quantification of how much the use of flexibility by the transmission system operator can influence the distribution system operator activities and the expected costs. The increasing penetration of distributed generation represents a trend at the distribution level that impacts the exploitation of existing distribution assets. In this context, the flexibility of distributed energy resources connected to the distribution systems may play an important role. The paper investigates the expected interactions between the use of flexibility for power system balancing and security and the operation of distribution systems. The final goal is quantifying the flexibility that the transmission system operator can procure from the distribution system without causing a harmful impact on the distribution network's operation.

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