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Editorial

Renewable-Based Microgrids: Design, Control and Optimization

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1. Introduction

To achieve carbon neutrality by 2050, additional measures must be taken, including the extensive incorporation of renewable energy sources (RESs). Additionally, we must pave the way for new market and grid structures that facilitate the integration of these clean technologies, along with initiatives for demand response (DR), electric vehicles (EVs), and energy storage.

In this context, microgrids (MGs) have emerged as a highly valuable framework. Specifically, a microgrid can be described as a small-scale network equipped with local power generation capabilities, typically connected to a larger power grid but being capable of operating independently [1]. As a result, microgrids offer numerous opportunities for various entities to optimize the utilization of local resources while ensuring a reliable electricity supply in remote and isolated areas [2].

2. Design Control and Optimization of Renewable-Based MGs

For the effective advancement, integration, and implementation of renewable-based MGs in existing power systems, the development of appropriate tools for their optimal design and control is crucial. This Special Issue aims to gather the latest advancements in this field, particularly focusing on optimization tools with various objectives. A total of 16 papers were submitted to this Special Issue, out of which, 10 were accepted for publication, indicating a 62.5% acceptance rate. This demonstrates the significant interest of the research community in this particular topic.

The first paper, authored by S. Panda et al. [3], presents a comprehensive overview of the recent advancements in modern DR initiatives and their interaction with renewable sources and energy storage systems. The second paper, written by A. Malki et al. [4], proposes a procedure based on metaheuristic algorithms to identify the key parameters of photovoltaic (PV) modules. It should be emphasized that accurately determining these parameters is crucial for the development of advanced optimization tools in PV-based systems. Another paper [5], authored by S. Mikkili et al., investigates electronic converters, specifically focusing on the performance analysis of a modular multilevel converter with NPC sub-modules. Such converters have numerous applications in PV-based systems.

The main focus of this Special Issue is the development and study of various optimization tools. These tools have been specifically designed for potential application in MGs. The majority of the papers in this issue concentrate on different strategies for the management of energy in systems that rely on renewable sources. For example, H. Kraiem et al. [6] compare two metaheuristic methodologies aimed at enhancing the autonomy of PV-battery

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systems. Z. Xu et al. [7] present a cooperative multi-objective optimization approach for DC multi-MG systems, where multiple MGs work together to achieve common goals. Furthermore, authors in [8] introduce a novel optimization methodology applied to a real case study conducted in Alrashda Village in Egypt. Lastly, M. Espitia-Ibarra et al. [9] introduce a linear-programming methodology for optimal energy management in MGs, notable for its efficient computational performance, making it suitable for online applications.

The previous references primarily focus on electricity systems and do not take into account other energy forms like hydrogen or heat. However, it is essential to consider the interaction between various energy carriers for the future development of renewable energy systems. It has been extensively demonstrated that different energy vectors such as gas, electricity, or hydrogen can effectively interact and offer numerous advantages through established technologies like power-to-gas systems or microturbines [10]. In this Special Issue, a paper is dedicated to multi-energy MGs [11]. It presents an energy management strategy for a thermal–gas–electricity MG, employing Mixed-Integer Linear Programming as the underlying methodology.

While the aforementioned references primarily concentrate on energy management strategies applicable during the operational phase of the system, the successful development of MGs necessitates thorough planning, highlighting the significance of optimal design tools. This Special Issue includes two papers centered around the optimal planning of renewable-based MGs. The first paper authored by H. Abdel-Mawgoud et al. [12] proposes an optimal strategy for integrating PV and storage systems into distribution networks. Notably, this reference takes into account uncertainties in generation and demand, which is crucial in MGs in which the intermittent behavior of renewable generation increases environmental risks and uncertainties. Conversely, reference [13] by A. Almaleh et al. focuses on resilient aspects, specifically aimed at enhancing the autonomy of MGs, particularly in the face of severe weather events or natural disasters.

3. Future Challenges and Perspectives

Despite the closure of this Special Issue, we still anticipate further comprehensive research will be carried out in this field. Specifically, there is a continuing need for investigations into energy management techniques that address uncertainty in renewable-based MGs. Additionally, the integration of EVs into these systems is considered a promising area for future research. Lastly, cooperative game-based methodologies are expected to gain prominence in addressing emerging topics such as MG clusters in the coming years [14].

Conflicts of Interest: The authors declare no conflict of interest.

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