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Editorial

Special Issue on Microgrids

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1. Introduction

Integration of renewable energy sources in the electrical power system is key for enabling the decarbonization of that system. The connection of renewable generation to the electrical system is being performed in a centralized form (large renewable power plants like wind or solar power plants connected at the transmission system) and in a decentralized manner (through the connection of dispersed generation connected at the distribution system). The connection of renewable generation at distribution levels, together with other generating sources as well as energy storage systems (the so-called DER, Distributed Energy Resources) close to consumption sites, is promoting the development of microgrids: DER installations that have the capability to operate grid connected and grid isolated. The uncertainty and variability of the renewable energy sources that integrate microgrids, as well as the need for coordination with other energy sources, pose challenges in the operation, protection, control, and planning of microgrids. The five selected papers published in this Special Issue propose solutions to address these challenges.

2. Conclusions

The authors from [1] propose overload control strategies for four-wire inverters in low voltage AC (Alternating Current) microgrids. The developed strategies provide a fast and appropriate fault current limitation in both operation modes, grid connected and grid isolated. The strategies are validated through simulations using Matlab/Simulink and real experimental results are obtained from CENER (The National Renewable Energy Centre) experimental ATENEA four-wire AC microgrid, showing time responses in the order of two-three grid cycles for all cases.

The authors from [2] propose a reliability evaluation method for multi-energy microgrids, understood as energy systems with multiple energy vectors that can operate autonomously. A reliability factor is integrated in a planning economic model for these types of systems. The impacts of several equipment configuration schemes on planning and reliability are addressed. A planning-operation optimization model is proposed to ensure the energy supply, determining the output power of the generating and storage units of the microgrid.

In [3], the optimal operation of isolated microgrids, taking into account frequency constraints, is addressed. In particular, a new stochastic optimization method is designed to maximize photovoltaic generation in microgrids combining photovoltaic generation, diesel generation, and energy storage. The optimization problem is formulated including a minimum frequency constraint, which is obtained from a dynamic study considering maximum load and photovoltaic power variations. To maintain the mixed integer linear formulation of the optimization problem, this constraint is defined through a linear regression. Three complete days are simulated to verify the proper behavior of the system under the proposed optimization scheme. The system is validated in a laboratory-scaled microgrid.

While [1–3] focus on a single microgrid, [4] proposes a hierarchical optimization method for the energy scheduling of multiple microgrids connected to the distribution grid with participation in the energy market. The optimization procedure is separated into two stages. The first stage is focused on the optimal operation of each microgrid in the next hour and uses a mixed integer programming formulation. The second stage uses the output from the first and allows the market operator to establish an internal price incentive mechanism (based on Stackelberg Game theory) for the next hour. The goal of the energy market operator is to maximize its profits, taking into account the demand responses of the microgrids. It is shown that based on this optimization, the microgrid operator and the energy market operator can achieve larger benefits.

Last, but not least, [5] focuses on the load frequency control of islanded microgrids consisting of diesel engines, renewable sources, and storage devices. For developing the proposed control, the concept of fractional calculus is combined with sliding mode control. Hardware-in-the-loop tests show that the proposed controller allows frequency fluctuations to be avoided and ensures a more robust operation of the microgrid compared to other techniques.

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