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Despite these advantages, managing microgrids presents significant challenges. One of the primary issues is the need for sophisticated control and optimization strategies to balance supply and demand, ensure power quality, and manage the intermittency of renewable energy sources. Additionally, the integration of diverse DERs with varying operational characteristics requires advanced coordination and communication frameworks. These challenges are compounded by the need to meet regulatory standards and ensure economic viability.

Each SMG in a multi SMG cluster behaves as a voltage source inverter with a high inertia. Power management and control strategies are the main challenges, particularly in islanded mode operations. Many methods have been proposed to analyze the power-sharing strategies for AC and DC MGs. The droop control method is widely used but it has adverse effects when parallel connecting DGs. A combination of the conventional droop loop and the virtual impedance loop can solve this issue (Li et al. 2019).

The study in Nejabatkhah and Li (2015) investigated the autonomous management of microgrid power for systems with multiple distributed generation (DG) units, addressing concerns related to real and reactive power. This study highlights the importance of evaluating DG unit-network interactions, stability after islanding operation, control parameter optimization, and microgrid control design.

To address the challenges posed by the integration of renewable energy sources and microgrids, this article presents a novel approach that employs power management techniques, hybrid DC microgrid systems, and control algorithms for maximum power point tracking (MPPT) and DC link voltage. The key contributions of this study are as follows:

Three algorithms, designed for specific applications, were devised. The DC-DC algorithm optimizes photovoltaic systems, the AC-DC algorithm generates wind energy, and the bidirectional inverter control algorithm works in a variety of applications.

This approach is effective for supplying electrical power to critical and noncritical DC loads, with a straightforward hardware implementation that does not require high processing power. The ON/OFF switching-based control enhances stability by regulating the DC bus voltage levels and allows the injection of excess power into the grid or absorption of power shortage from the main grid.

The rest of this paper is structured as follows: Sect. "Controller algorithm for Multiple voltage buses of microgrid" mathematically models the proposed AC/DC microgrid system. Sect. "Proposed energy management" offers a comprehensive explanation of the proposed control methods for the AC/DC microgrids. Sect. "Simulation results" presents the suggested energy management strategy and evaluates it, along with its interpretation. Lastly, Sect. "Conclusion" concludes the paper and emphasizes its limitations and potential future research directions in this field.

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Web: https://sumthingtasty.co.za/contact-us/
Email: energystorage2000@gmail.com
WhatsApp: 8613816583346