Abstract of Ph.D. Thesis
" Control of Solar PV-BES-Wind Based Standalone and Grid Connected AC Microgrids With Synchronization"
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Abstract

This thesis presents a comprehensive approach to controlling solar PV-BES-wind-based standalone and grid-connected AC microgrids with synchronization. Throughout this research, various configurations pertaining to solar PV-based microgrids are investigated, taking into account the specific needs of low and medium-income consumers in both urban and rural settings. Furthermore, the exploration of microgrid configurations is expanded to include solar PV-BES-wind-based systems, leading to the development of a novel structure that optimizes the benefits of existing frameworks in a cost-effective manner. Additionally, the thesis delves into the feasibility of employing synchronous reluctance generators (SyRGs) as a cost-effective alternative to PMSGs for small-scale WES, further enhancing the affordability and accessibility of renewable energy solutions.

To confront emerging power quality challenges stemming from nonlinear loads, this thesis devises innovative control strategies. These strategies leverage the architecture of traditional control algorithms, providing effective solutions with ease of implementation. In response to synchronization challenges, the thesis introduces improved filter algorithms that demonstrate enhanced responsiveness while maintaining low computational complexity. Consequently, these advancements address the limitations inherent in existing synchronization algorithms.

Furthermore, power management schemes are meticulously crafted to align with specific consumer and application needs, considering practical constraints of system. These schemes encompass a range of aspects, including providing grid support by ensuring that any increase in PCC voltage remains within predefined standards.

In the context of DG-based standalone microgrids, this thesis proposes innovative control strategies based on multimode operation to minimize the utilization of DG sets. These strategies entail the operation of microgrids in both standalone mode and DG-connected mode, with the latter being activated exclusively during emergencies. Upon the microgrid's ability to fulfil load demand through RES and BES, the DG-connected mode is promptly deactivated. To address technical challenges associated with seamlessly transitioning microgrid operation between different modes in multimode operation-based grid-connected microgrids, robust and straightforward solutions are developed. Furthermore, these solutions are extended to DG-based standalone microgrids to facilitate seamless transitions between standalone operational mode and DG-connected mode.

To validate the performance of the proposed microgrid configurations and engineered control strategies, simulations are conducted using MATLAB/Simulink in MATLAB 2017B software. The response of the microgrids and their controls is thoroughly examined in this virtual environment. Subsequently, hardware implementation and real-time analysis are employed to further investigate the performance of the configured microgrids and their control strategies, aiming to validate the simulated results. The obtained findings conclusively demonstrate the successful achievement of the defined objectives outlined in this thesis work.