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# Novel Control Strategy for Enhancing Microgrid Operation Connected to Photovoltaic Generation and Energy Storage Systems

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**Abstract:** Recently, the penetration of energy storage systems and photovoltaics has been significantly expanded worldwide. In this regard, this paper presents the enhanced operation and control of DC microgrid systems, which are based on photovoltaic modules, battery storage systems, and DC load. DC–DC and DC–AC converters are coordinated and controlled to achieve DC voltage stability in the microgrid. To achieve such an ambitious target, the system is widely operated in two different modes: stand-alone and grid-connected modes. The novel control strategy enables maximum power generation from the photovoltaic system across different techniques for operating the microgrid. Six different cases are simulated and analyzed using the MATLAB/Simulink platform while varying irradiance levels and consequently varying photovoltaic generation. The proposed system achieves voltage and power stability at different load demands. It is illustrated that the grid-tied mode of operation regulated by voltage source converter control offers more stability than the islanded mode. In general, the proposed battery converter control introduces a stable operation and regulated DC voltage but with few voltage spikes. The merit of the integrated DC microgrid with batteries is to attain further flexibility and reliability through balancing power demand and generation. The simulation results also show the system can operate properly in normal or abnormal cases, thanks to the proposed control strategy, which can regulate the voltage stability of the DC bus in the microgrid with energy storage systems and photovoltaics.

**Keywords:** microgrid; photovoltaic; storage systems; control strategy; islanded mode



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## 1. Introduction

Global warming and carbon dioxide emissions, attributed to traditionally used energy sources, have become severe issues in the world for the last few years. Hence, the improvement of renewable energy sources (RES) has gained great research interest to mitigate and reduce such risks. Some RES, such as photovoltaic cells or wind turbines, are well-developed since they are clean and cost-effective [1–3]. However, other sources such as fuel cells and biomass are still in their growth stage [4].

Microgrid systems, which are classified as AC or DC microgrids, could merge RES with household and industrial loads [5–7]. The differences between both types of microgrids as well as their advantages are deeply discussed in the literature [8,9]. In fact, power electronic devices (PED) have recently become a must in grid integration, since photovoltaic systems