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Integrated PV–BESS-Fed High Gain Converter for an LED Lighting System in a Commercial Building

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Abstract: The demand for electricity is rapidly growing and renewable energy sources such as solar, wind and tidal energy can compensate the demand to a substantial level. Among these, solar energy is abundant, scalable and is cheaper. The generated energy can be used in an efficient way if the DC output is directly supplied to the load instead of converting it to AC. Every electrical system is capable of operating in DC and, for example, energy efficient Light Emitting Diode (LED) lights have become popular as they provides more lumens with less power consumption and also can be directly operated from DC. LED lighting system in large commercial buildings has irradiance levels which vary sigificantly during operation. Extracting maximum power from the energy system and maintaining constant voltage output at different loads is another challenge. This paper proposes a solar Photo Voltaic (PV)-based energy system including Battery Energy Storage System (BESS) for supplying LED lamps to a commercial building through a modified high gain Luo converter. The Perturb and Observe control algorithm has been used for maximum power extraction from a PV cell whereas PI (Proportional Integral) controllers maintain constant output voltage from PV–BESS against different irradiance levels. To supply the desired voltages to the LED lighting system, a modified high gain Luo converter is designed. To make the output voltage constant at different load currents, PI and Sliding Mode Controllers (SMC) are designed with the help of the state-space average model. It is found that the sliding mode controller outperforms the PI controller in terms of behavior in the transient period and tracking capability. The system is simulated using MATLAB/Simulink®. The Sliding Mode Controller has a 95% less transient period and is 75% faster in tracking capability when compared to other controllers. The system could be incorporated with the PV source to obtain green energy.

Keywords: PV panel; modified high gain Luo converter; battery management system (BMS); sliding mode control

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1. Introduction

In recent years, due to the depletion of fossil fuels and increased demand of electrical energy, renewable energy sources are widely used for power generation. Additionally, policymakers around the world are emphasizing the ill effects of burning fossil fuels leading to climate change. As a result, the world is moving towards green energy and the energy sector is using both renewable and traditional energy sources to supply the increasing demand [1]. Among the different renewable sources of energy, solar energy has become popular as it is available in abundance in countries such as India with less maintenance, scalability and steady decline in the price of photovoltaic components. This leads to solar power generation being clean, environmentally friendly and having a low cost per unit energy generation. Solar energy, which is greener, cleaner and sustainable and distributed