STORAGE SYSTEM TOPOLOGIES FOR VARIOUS RENEWABLE ENERGY SOURCES

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ABSTRACT

Hybrid electricity storage systems are becoming essential for efficiently managing renewable energy sources and enhancing the stability of power grids. As the adoption of renewables expands, these systems are crucial for balancing supply and demand, mitigating intermittency issues, and ensuring grid reliability. This paper offers an in-depth review of different system configurations used in hybrid storage systems, emphasizing the significance of understanding and optimizing their intricate designs.

Recent technological advancements have paved the way for the development of innovative storage system topologies, including redox flow batteries, solid-state lithium-ion batteries, and supercapacitor-based systems. Each of these technologies presents distinct advantages: redox flow batteries are notable for their scalability and extended cycle life, solid-state lithium-ion batteries provide high energy density and enhanced safety, while supercapacitors excel in applications requiring fast charging and discharging. Nonetheless, these innovations also face challenges, such as the high costs and manufacturing complexities of solid-state lithium-ion batteries, as well as the lower energy density characteristic of supercapacitors.

Evaluating the advantages and limitations of these advanced topologies is critical for guiding future research and development. The strategic integration of these technologies can result in more resilient, efficient, and cost-effective hybrid storage systems. This evolution is essential for supporting the global shift towards sustainable energy, ensuring that hybrid systems not only meet current demands but also pave the way for future innovations in renewable energy management.

Keywords: Hybrid electricity storage systems, Renewable energy management, Power grid stability, Advanced storage topologies, Technological advancements.

INTRODUCTION

Battery electric vehicles (BEVs) are key to reducing CO2 emissions in personal transportation, but their broader adoption depends on improvements in range, acceleration, and energy recovery. Hybrid energy storage systems, which combine high power (HP) and high energy (HE) storage units, offer a promising solution. Traditionally, these systems have relied on DC/DC converters for integration. However, this paper examines reconfigurable topologies that could potentially eliminate the need for these converters [1].

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