Performance Analysis of Lithium-Ion Battery Systems for Renewable Energy-Based EV Charging

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Abstract: *The global transition toward sustainable energy and clean transportation has brought Electric Vehicles (EVs) and renewable energy sources such as solar and wind to the forefront. However, integrating renewable energy with EV charging stations poses several challenges, primarily due to the intermittent nature of renewables. Lithium-ion (Li-ion) battery systems offer an effective solution to store excess renewable energy and supply it on demand, thereby ensuring reliable EV charging infrastructure. This research focuses on evaluating the performance of Li-ion battery systems in such applications. By modeling and simulating key performance parameters—including energy efficiency, charge/discharge behavior, degradation, and cost-effectiveness—this study provides an in-depth analysis of how Li-ion batteries support renewable-based EV charging. Furthermore, different system architectures and battery sizing techniques are explored to identify optimal configurations for off-grid and hybrid energy systems. The findings support the practical feasibility of Li-ion-based energy storage as a cornerstone in the advancement of green transportation.*

Keywords: Lithium-Ion Battery, Electric Vehicles, Renewable Energy, Battery Energy Storage System (BESS), Performance Analysis, Solar PV, Wind Energy, EV Charging Infrastructure, Battery Degradation, Off-grid Systems