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Energy Efficiency Optimization and Economic Analysis of Vehicle-to-Grid (V2G) Systems in Electric Vehicles

The rapid adoption of electric vehicles (EVs) presents new opportunities for energy management and grid stability through Vehicle-to-Grid (V2G) technology. V2G enables bidirectional energy flow between EVs and the power grid, allowing vehicles to store excess energy and return it to the grid when needed. This interaction helps balance electricity supply and demand, reduces peak loads, and enhances the integration of renewable energy sources. However, optimizing energy efficiency and assessing the economic feasibility of V2G systems remain critical challenges.

Energy efficiency in V2G operations depends on various factors, including battery performance, charging and discharging strategies, grid demand patterns, and renewable energy penetration. Smart charging algorithms, predictive energy management, and real-time data analytics can significantly improve the efficiency of V2G systems. Moreover, economic analysis plays a crucial role in determining the financial viability of V2G, as it involves cost-benefit assessments for EV owners, utilities, and grid operators. Factors such as battery degradation, electricity price fluctuations, and incentive policies must be considered to develop an optimal economic model.

This paper explores energy efficiency optimization strategies in V2G systems and conducts a comprehensive economic analysis. It examines the technical challenges, potential cost savings, revenue generation opportunities, and policy implications of V2G deployment. By integrating advanced energy management techniques and financial models, this study aims to provide insights into maximizing the benefits of V2G while ensuring sustainability and economic feasibility.