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OPTIMIZED ENERGY MANAGEMENT IN GRID-INTEGRATED ELECTRIC VEHICLE CHARGING SYSTEMS WITH ENHANCED GREY WOLF ALGORITHM CONTROL

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Abstract

This work presents an optimized bi-directional converter designed for Grid-to-Vehicle (G2V) and Vehicle-to-Grid (V2G) charging systems integrated with a photovoltaic (PV) system. The proposed converter facilitates efficient energy transfer between the electric vehicle (EV) batteries, the grid, and the PV system. The system allows bidirectional power flow, utilizing a Dual Active Bridge (DAB) DC-DC converter for battery charging/discharging and an AC-DC converter that acts as a rectifier in G2V mode and as an inverter in V2G mode. Additionally, the PV system, equipped with Enhanced Grey Wolf Algorithm (EGWO) based Maximum Power Point Tracking (MPPT) and a SEPIC converter which supplies power either to the EVs or the grid based on demand. The integration of this system enhances grid stability, promotes renewable energy utilization, and optimizes the energy flow between EVs, the grid, and the PV source. This hybridized approach to real-time optimization, adaptive load balancing, and the integration of sustainability goals makes this as a feasible solution in the domain of EV charging and grid stability.
By facilitating efficient energy exchange among renewable energy sources, electric vehicles, and the power grid, the proposed system supports a cleaner energy ecosystem. The enhanced utilization of photovoltaic power reduces dependency on fossil fuels, thereby lowering greenhouse gas emissions and contributing to climate change mitigation. Additionally, the intelligent energy management strategy minimizes grid stress and power losses, which enhances energy conservation and supports environmental sustainability objectives. This integration of smart control and renewable energy aligns with global efforts toward decarbonization and the development of green transportation infrastructure.

Key words: Dual Active Bridge Converter, sustainable energy, Enhanced Grey Wolf Algorithm, Grid-to-Vehicle, Vehicle-to-Grid

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