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Optimizing Electric Vehicle Parking: Cost Minimization and Voltage Profile Enhancement for Parking Lot Owners

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Abstract

The objective of this research is to minimize costs and enhance power quality, specifically the voltage profile, from the perspective of parking lot owners. Electric vehicle (EV) chargers in parking areas often generate a sudden increase in load during specific time periods, affecting charging costs. To optimize both cost and power quality within the network, we employ the particle swarm optimization (PSO) algorithm. The effectiveness of our proposed method is compared against existing approaches, such as the Monte Carlo method. Our results demonstrate that the voltage profile drop over 24 hours is significantly reduced using the proposed method compared to the Monte Carlo method. To validate our approach, we implement it in a sample network comprising 33 buses and present comprehensive and accurate results. Our research considers cost reduction and voltage profile enhancement as dual objectives, employing forward-regressive load spreading techniques within the MATLAB software environment. By addressing both goals, we contribute to minimizing expenses while improving the overall power quality of EV charging systems in parking lots.

Keywords: Electric cars, Electric Car Parking, Optimization Algorithm, Cost Reduction and Voltage Profile Improvement

I. Introduction

The rapid growth of electric vehicles (EVs) has necessitated the development of robust charging infrastructure, particularly in parking areas. Parking lot owners face a significant challenge of minimizing charging costs while ensuring a reliable power supply and optimizing the voltage profile. This paper presents a comprehensive research study that aims to address these challenges and provide practical solutions from the perspective of parking lot owners. The research proposes the utilization of the particle swarm optimization (PSO) algorithm [1-2], a powerful optimization technique, to optimize the cost and power quality of the EV charging network in parking lots. By intelligently scheduling and coordinating the charging process, the PSO algorithm can minimize charging costs while maintaining a stable and desirable voltage profile [3].

To evaluate the effectiveness of the proposed method, a comparative analysis is conducted against existing approaches, including the Monte Carlo method, which is commonly used in similar studies. The comparison highlights the superiority of the proposed PSO-based approach in minimizing voltage profile fluctuations and optimizing charging costs. In order to validate the proposed method, a sample network comprising 33 buses is used as a testbed. The implementation of the proposed approach on this network allows for accurate and comprehensive evaluation of its performance. The obtained results provide valuable insights into the impact of the proposed method on cost reduction and voltage profile improvement. By considering cost reduction and voltage profile enhancement as dual objectives, this research contributes to the development of efficient EV charging strategies for parking lot owners. The findings have the potential to guide decision-making processes for parking lot

cost reduction and voltage profile enhancement as dual goals, this research contributes to the advancement of EV charging strategies for parking lot owners. The findings offer valuable insights for decision-making processes related to parking lot infrastructure planning, enabling more cost-effective and reliable charging solutions for EV users. Future research directions may involve the application of the proposed method in larger-scale networks and the consideration of additional factors such as renewable energy integration and load forecasting. Overall, this study contributes to the ongoing efforts to optimize electric car parking systems, enhancing their economic viability and power quality to support the growing adoption of electric vehicles.

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