World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:19, No:02, 2025

Optimizing Electric Vehicle Charging Networks with Dynamic Pricing and Demand Elasticity

Authors : Chiao-Yi Chen, Dung-Ying Lin

Abstract : With the growing awareness of environmental protection and the implementation of government carbon reduction policies, the number of electric vehicles (EVs) has rapidly increased, leading to a surge in charging demand and imposing significant challenges on the existing power grid's capacity. Traditional urban power grid planning has not adequately accounted for the additional load generated by EV charging, which often strains the infrastructure. This study aims to optimize grid operation and load management by dynamically adjusting EV charging prices based on real-time electricity supply and demand, leveraging consumer demand elasticity to enhance system efficiency. This study uniquely addresses the intricate interplay between urban traffic patterns and power grid dynamics in the context of electric vehicle (EV) adoption. By integrating Hsinchu City's road network with the IEEE 33-bus system, the research creates a comprehensive model that captures both the spatial and temporal aspects of EV charging demand. This approach allows for a nuanced analysis of how traffic flow directly influences the load distribution across the power grid. The strategic placement of charging stations at key nodes within the IEEE 33-bus system, informed by actual road traffic data, enables a realistic simulation of the dynamic relationship between vehicle movement and energy consumption. This integration of transportation and energy systems provides a holistic view of the challenges and opportunities in urban EV infrastructure planning, highlighting the critical need for solutions that can adapt to the ever-changing interplay between traffic patterns and grid capacity. The proposed dynamic pricing strategy effectively reduces peak charging loads, enhances the operational efficiency of charging stations, and maximizes operator profits, all while ensuring grid stability. These findings provide practical insights and a valuable framework for optimizing EV charging infrastructure and policies in future smart cities, contributing to more resilient and sustainable urban energy systems.

Keywords : dynamic pricing, demand elasticity, EV charging, grid load balancing, optimization
Conference Title : ICIEEM 2025 : International Conference on Industrial Engineering and Engineering Management
Conference Location : Tokyo, Japan
Conference Dates : February 24-25, 2025

Open Science Index, Industrial and Systems Engineering Vol:19, No:02, 2025 publications.waset.org/abstracts/191997.pdf