Determining an Optimal Charging Plan for Electric Vehicles Considering Time-of-Use Pricing

Hilal Yılmaz
Assist. Prof. Dr., Department of Industrial Engineering
Bursa Technical University
Bursa, TÜRKİYE

Betul Yagmahan
Prof. Dr., Department of Industrial Engineering
Bursa Uludag University
Bursa, TÜRKİYE
hilal.yilmaz@btu.edu.tr, betul@.uludag.edu.tr

Abstract

Considering the long charging times, limited range of electric vehicles (EVs), and the limited number of charging stations, it is vital to check the feasibility of a route and make a charging plan, especially for long journeys. Charge planning of an EV includes the decisions of where, when, and how much the EV needs to be charged. Charging planning is one of the areas where decision support should be provided to EV drivers. Thanks to intelligent transportation system (ITS) technologies, it is now possible to receive information from charging stations, which plays an essential role in providing decision support to EV drivers. This study proposes an optimization model to find an optimal charge planning model for suitable routes that enables the EV to complete its journey without range anxiety. The proposed model determines where and how much charge is needed at the charging stations considering time-of-use (TOU) pricing. An integer linear programming model is developed based on the range coverage location model (RCLM), which determines the minimum number of charging stations the EV needs to visit. The proposed optimization model is tested on randomly generated problems. The test results show that the model can find the optimal charging plan in a reasonable time.

Keywords
Electric Vehicles, Charge Planning, Mixed Integer Linear Programming, Range Coverage Location Model, Time-of-Use (TOU) Pricing

Biographies
Hilal Yılmaz is an accomplished scholar and researcher with a focus on Industrial Engineering, particularly in Intelligent Transportation Systems. Graduating with honors from Karadeniz Technical University in 2016, Yılmaz pursued an integrated PhD at Bursa Uludag University, supported by the Turkish Council of Higher Education's 100/2000 Doctorate project in January 2017**.** Yılmaz completed her PhD in December 2022. Beyond research, Yılmaz gained leadership experience in the research group on autonomous vehicles at Bursa Uludag University named OTAGG as a project manager. Currently, Yılmaz is also team member in the software department at OTAGG. Yılmaz is currently an Assistant Professor at Bursa Technical University in the Department of Industrial Engineering.

Betul Yagmahan is a professor in the Department of Industrial Engineering at Bursa Uludag University. She received her Ph.D. degree in Industrial Engineering from Istanbul Technical University in 2005. She teaches and conducts

research in the areas of operations management, scheduling, lean, project management, optimization and machine learning. She has published papers in leading periodical journals such as Computers&Industrial Engineering, Expert Systems with Application, OMEGA-The International Journal of Management Science, Applied Soft Computing, Business Process Management Journal, Environment, Development and Sustainability, International Journal of Energy Research etc.