Emerging Technologies in the Electrification of Urban Mobility

Kai Liu 1,*, Jiangbo Wang 1 and Wei (David) Fan 2

1 School of Transportation and Logistics, Dalian University of Technology, Dalian 116024, China; jiangbo_wang@dlut.edu.cn
2 Department of Civil and Environmental Engineering, University of North Carolina at Charlotte, Charlotte, NC 28223-0001, USA; wfan7@uncc.edu
* Correspondence: liukai@dlut.edu.cn

1. Introduction

The Paris Agreement limits the long-term global warming goal to well below 2 and preferably to 1.5 degrees Celsius relative to preindustrial levels. The transportation sector, as one of the major sources of greenhouse gas emissions, has been given high expectations in terms of achieving the goal of energy conservation and emission reduction. To date, surface transportation systems are in the early stages of electrification. However, as the level of electrification progresses, an increasing number of challenges will emerge. In the meantime, more innovation and emerging technologies will also accompany us during the transition and completion of the transportation electrification process.

Therefore, this Special Issue is devoted to the emerging technologies of transportation planning and management during the electrification process of urban mobility. This Special Issue is intended to encourage scholars and experts to systematically discuss the possible ways of accelerating the electrification of urban mobility and the effects/mechanisms of the involved endogenous and exogenous factors in the transportation system, and finally, to provide potential policy references for urban transportation planning and management during the entire process.

Prospective authors are invited to submit original contributions that include but are not limited to the following topics of interest:

- Emerging challenges in the transition of transportation electrification.
- Intelligent vehicle-to-grid systems.
- Policy incentives in terms of the penetration of electric vehicles in private and public transportation markets.
- Advanced energy management systems of the road network.
- Intelligent operation and maintenance systems of infrastructure.
- Explorations of new service patterns in the transition phase of electrification.
- Agent-based simulation systems.
- Intelligent information systems that address extreme driving range anxiety.
- Incentive strategies that help shape ‘healthy’ driving and charging habits.
- Energy consumption efficiency measurement and improvement.

A total of nine papers were finally accepted and published. These papers can be loosely categorized into three sections: (1) Electric Vehicles Energy Management Optimization; (2) Strategies for New Energy Vehicles; and (3) Intelligent Transportation Systems. In this article, we provide a brief overview of the published papers.

2. Overview of Contribution

2.1. Electric Vehicle Energy Management Optimization

Reference [1] analyses the simultaneity factor (SF) or peak power of public electric vehicle charging stations with different recharging strategies. The study found that the choice of charging strategy had a massive impact on the electricity grid. Price-optimized
recharging strategies created high power peaks, while the "naive" charging strategy caused limited stress. The authors concluded that price optimization did not significantly reduce electricity purchase costs compared to peak-related network expansion costs.

Reference [2] proposes a data security access control algorithm for the electric vehicle Internet of Vehicles (IoV) based on blockchain technology. The algorithm utilizes a double-chain architecture and a long short-term memory neural network to analyze the risk of communication behavior. The experimental results showed that the algorithm achieved high security with a low success rate of data tampering.

Reference [3] addresses the problem of electric bus battery swapping station (BSS) location. The study proposes a hybrid traffic assignment method based on a genetic algorithm and the Frank–Wolfe algorithm to optimize the location of BSSs. The results showed that the hybrid method outperformed traditional methods in terms of suitability for electric buses during peak hours.

Reference [4] focuses on the reduction in driving range and performance degradation of electric vehicles at low temperatures. The study developed an external battery heating system and utilized a fuzzy logic control algorithm to optimize the heating power provided by the battery pack. The simulation and experimental results showed that the proposed fuzzy logic control algorithm significantly improved the driving range at low temperatures compared to the maximum power heating method.

2.2. Strategies for New Energy Vehicles

Reference [5] analyses the impact of new energy vehicle (NEV) development on China’s crude oil imports. The study finds that, while NEVs have the potential to reduce oil demand in the transportation sector, their effect on limiting crude oil imports has not yet emerged. The study suggests that policy implications should focus on crude oil demand, supply, and China’s oil price mechanism.

Reference [6] explores development strategies for NEV platforms in automotive companies. It identifies the significance of NEV platform development and classifies NEV platforms into different categories. The study suggests that new dedicated electric platforms and compatible platforms are the leading solutions for automotive companies. It also emphasizes the importance of joint development and shared use as the primary development model for the future of the automotive industry.

Reference [7] focuses on the evaluation of electric bus charging services. This highlights the need for a comprehensive evaluation framework to support the actual operation of charging stations. The study proposes an evaluation system based on the analytic hierarchy process (AHP) and Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS). The results demonstrate the effectiveness of the evaluation system in improving the competitiveness of charging stations and providing guaranteed charging services for electric bus fleets.

2.3. Intelligent Transportation Systems

Reference [8] proposes a novel intelligent platoon transit system (IPTS) based on electric modular vehicles (EMVs). The study highlights the limitations of traditional transit systems in meeting time-varying demands and high-quality service requirements. The IPTS aims to overcome these constraints by enabling the adaptive adjustment of capacity and seamless transfers. The article discusses three application scenarios and the multistage development of the IPTS system, taking into account factors such as fluctuating travel demand levels, bus occupancies, and automation levels of EMVs.

Reference [9] addresses the challenge of optimizing traffic efficiency and energy savings in unsignalized, multi-intersection road networks. The article proposes a distributed and hierarchical optimal control architecture consisting of a cloud decision layer and a vehicle control layer. The cloud decision layer utilizes distributed model predictive control (DMPC) for optimizing traffic efficiency, while the vehicle control layer utilizes DMPC for optimizing energy savings. Simulation tests demonstrate the feasibility and effectiveness
of the proposed method, showing significant improvements in traffic efficiency and energy savings compared to baseline methods.

3. Final Thoughts

The Special Issue covers contributions in the field of electric vehicles and intelligent transportation systems. These studies provide valuable insights into the impact of charging strategies on the electricity grid, the security of data access control in electric vehicle networks, the optimization of battery swapping station locations, and the improvement of the driving range at low temperatures. Furthermore, the papers also shed light on development strategies for NEVs, the evaluation of electric bus charging services, and the implementation of intelligent transportation systems. The Guest Editorial Board hopes that this Special Issue contributes to the advancement of sustainable transportation and provides potential policy references for urban transportation planning and management.

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