Guest Editorial: Achieving an Integrated Smart Power Grid and Intelligent Transportation System

The electric vehicle (EV) industry has rapidly grown throughout the last decade. The transition from refuelling vehicles at petrol stations to using public EV charging stations or private EV charging devices will continue to have a large impact on transportation infrastructure and systems. In recent years, many studies have been conducted on charging infrastructure planning, smart charging and vehicle-to-grid (V2G) technologies throughout electrical engineering and other engineering communities. However, there are still insufficient interdisciplinary solutions to efficiently integrate the electric power grid with transportation systems. To sustain the current rapid growth of the EV market, further innovative research using data and advanced information technologies, e.g. data mining, machine learning, and next-generation communication technologies, is needed to achieve integrated smart power grids and intelligent transportation systems.

In this Special Section, we invited the latest research on the modelling, planning, operation, and market mechanisms for integrating smart power grids and intelligent transportation systems. Six papers have been selected for the final publication in this Special Section. They address different aspects of EV charge modelling and smart charging strategies at different scales covering household, parking lot, microgrid and urban city areas. The optimal planning of charging facilities within a city is dealt with in one paper. The optimal hydrogen supply for fuel cell cars from a combined energy system is studied in the last paper.

In the paper ‘Optimised controlled charging of electric vehicles under peak power-based electricity pricing’, by Simolin, et al., an EV charging control method for detached and attached households is presented, which utilizes real-time measurements to minimize charging costs of up to two EVs in a single household. The effectiveness of the proposed control algorithm has been tested with commercial EVs through hardware-in-the-loop simulations.

Irshad, et al. in their paper ‘Stochastic modelling of electric vehicle behaviour to estimate available energy storage in parking lots’ presents a stochastic model for evaluating the aggregated energy storage capacity of parking lots, i.e. shopping center parking lot and workplace parking lot. The available energy storage capacities of EVs are estimated hourly based on the real data from several sources. Results obtained in this paper show that the estimated aggregate storage capacity for parking lots closely follows the occupancy of EVs and is relatively insensitive to the charging rate.

In the paper ‘Combined economic emission based resource allocation for electric vehicle enabled microgrids’, by Umoren, et al., the electric vehicle as a service (EVaAS) framework is introduced. A combined economic emission optimization model is built for mitigating demand-supply mismatch in microgrids considering dispersed EVs, where the problem is formulated as a bi-objective optimization problem. Simulation results show that EVaaS is cost-effective for short-term demand and supply balancing in microgrids.

Fenner, et al. in their paper ‘Quantification of peak shaving capacity in electric vehicle charging – findings from case studies in Helsinki Region’, studies the charging optimization strategies for peak load reduction. The work is based on historical charging records including around 25,000 charging sessions at various charging places in the metropolitan area of Helsinki. It is found that the peak charging loads can be reduced by up to 55%. The potential of smart charging is dependent on the parking time. Two charging optimization strategies, i.e. individual optimization and field optimization, are presented and their performances are compared.

Duan, et al. in their paper ‘Planning of plug-in electric vehicle fast-charging stations considering charging queuing impacts’ focuses on EV fast-charging station planning considering the impacts of waiting and driving time on EV owner’s decision. A cost minimization planning method of PEV fast-charging stations is proposed and solved by the genetic algorithm-based methodology. To consider the influence of waiting and driving time at each charging station on EV owners, an iterative algorithm is proposed to obtain the equilibrium with given locations and sizes of charging stations. The effectiveness of the proposed method is verified by using the real trajectory data of taxis in Beijing.

In the paper ‘Optimal operation of multi-vector energy storage systems with fuel cell cars for cost reduction’, by Tang, et al., fuel cell cars are studied for their hydrogen supply optimization. An optimal operation strategy is proposed for a local multi-vector energy storage system, which includes batteries, borehole thermal storage, the power to gas system and fuel-cell car system. The optimization includes two stages, i.e. an approximate optimal operation plan for borehole heat storage systems in the following year and a day-ahead robust optimal plan for all storage systems. Simulation results show that the combined energy system can provide hydrogen to fuel cell cars and significantly save power costs for customers.

As the Guest Editors of this Special Section, we would like to sincerely thank all the authors who submitted their papers in this new research area. We are also grateful to the contributions from the reviewers who worked on the submitted papers. Especially, we appreciate IET Smart Grid Editor-in-Chiefs, Prof Vince Poor and Dr Hongjian Sun, and the Editorial Office for their support throughout the editorial process.

Guest Editorial Biographies

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Dr. Zechun Hu is an associate professor with the Department of Electrical Engineering, Tsinghua University, Beijing, China. He received the B.S. and Ph.D. degrees in electrical engineering from Xi’an Jiaotong University, Xi’an, China, in 2000 and 2006, respectively. After graduation, he worked with Shanghai Jiao Tong University, Shanghai, China. From 2009 to 2010 he was a Research Officer with the University of Bath, Bath, U.K. In 2010, he joined Tsinghua University.

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Dr Chenghong Gu currently is a Lecturer with the Department of Electronic and Electrical Engineering, University of Bath. Previously, he was EPSRC Research Fellow with the University of Bath. He received the Master's degree from the Shanghai Jiao Tong University, Shanghai, China, in 2007 and PhD degree from the University of Bath, U.K, in 2010, both in electrical engineering. His major research interest is in the multi-vector energy system, smart grid planning and operation, power economics and markets.

Dr Gu's research has been supported by UK funding agency (EPSRC), the industry (NPG, NGC, and WPD), and the UK government (DECC). He now is the Subject Editor IET Smart Grid.

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