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Editorial

Electrification of Smart Cities

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1. Introduction

Electrification plays a critical role in decarbonizing energy consumption for various sectors, including transportation, heating, and cooling. Several essential infrastructures are incorporated in smart cities, including smart grids and transportation networks. These infrastructures are complementary solutions to the development of novel services, offering enhanced energy efficiency and energy security.

The purpose of this Special Issue is to collect high-quality papers that address issues related to cutting-edge technologies employed by smart cities undergoing electrification. Some of the topics of interest for this Special Issue include:

- The electrification of building environments and transportation systems;
- The role of smart grids in smart cities and their impacts;
- The influence of ICT and IoT infrastructures incorporating big data on smart cities' electrification;
- Market, services, and business models for smart cities' electrification;
- Standards for smart cities' electrification and their implementation;
- The integration of advanced smart grid technology in smart cities, including in terms of energy storage, demand-side management, and distributed energy resources.

2. Short Summary of the Papers

The variation of energy consumption in transportation and the main influencing factors of decomposition contribute to reducing transportation energy consumption and realizing the sustainable development of the transportation industry. Yuan, Jiang, and Lai [1] proposed an improved decomposition model according to the factors governing the direction of change based on existing index decomposition methods. The influencing factors of transportation energy consumption are quantitatively decomposed according to a transportation energy consumption decomposition model. The contributions of transportation turnover, transportation structure, and transportation energy consumption intensity changes to the variation of transportation energy consumption are quantitatively calculated. The results demonstrate that there is great energy conservation potential in the adjustment of transportation structures and that transportation energy intensity is the main factor of energy conservation.

Hasan et al. [2] presented the optimization and tuning of a simulation framework to improve its simulation accuracy while evaluating the energy utilization of electric buses under various mission scenarios. The simulation framework was developed using a low-fidelity (Lo-Fi) model of a forward-facing electric bus's (e-bus) powertrain to achieve the fast simulation speeds necessary for real-time fleet simulations. The measurement data required verification that the proper tuning of the simulation framework was provided by the bus's original equipment manufacturers (OEMs), and these data were obtained from

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various demonstrations of 12 m and 18 m buses in the cities of Barcelona, Gothenburg, and Osnabruck.

Recently, the increasing winter load peak has applied great pressure on power grids. The demand response on the load side helps alleviate the expansion of the power grid and promote the consumption of renewable energy. However, the response of large-scale electric heat loads to the same electricity price curve leads to new load peaks and regulation failure. Guo and Gong [3] proposed a grouping-coordinated preheating framework based on a demand response model that realizes the integration of information between the central controller and each regulation group. A thermal parameter model of a room and a performance map of an inverter air conditioner/heat pump are integrated into the demand response model. In this framework, a coordination mechanism is adopted to avoid regulation failure, an edge computing structure is applied to consider the users' preferences and plans, and a grouped and parallel computing structure is proposed to improve computing efficiency.

Communication networks in power systems constitute a major component of the smart grid paradigm. These networks enable the automation of power grid operation and self-recovery in negative contingencies. However, this dependency on communication networks attracts cyber threats. An adversary can launch an attack on a communication network, which, in turn, can influence a power grid's operation. Such attacks may constitute the injection of false data into system measurements, the flooding of communication channels with unnecessary data, or the interception of messages. The use of machine learning to process data gathered from communication networks and the power grid is a promising solution for detecting cyber threats. Agnew et al. [4] presented a co-simulation of cyber-security for a cross-layer strategy. The advantage of such a framework is the augmentation of valuable data, which enhances the detection and identification of anomalies in the operation of a power grid. The framework is implemented on the IEEE 118-bus system. The system is constructed in Mininet to simulate a communication network and obtain data for analysis. A distributed three-controller software-defined networking (SDN) framework is proposed that utilizes an Open Network Operating System (ONOS) cluster. According to the findings of our recommended program, it outperforms a single SDN controller framework by a factor of more than ten times the throughput.

Multi-view subspace clustering has drawn significant attention in the pattern recognition and machine learning research communities. However, most of the existing multi-view subspace clustering methods are still limited in two aspects. (1) The subspace representation yielded by the self-expression reconstruction model ignores the local structural information of the data. (2) The development of subspace representation and clustering are used as two individual procedures, thereby failing to account for their interactions. To address these problems, Duan et al. [5] proposed a novel multi-view subspace-clustering method fusing local and global information for one-step multi-view clustering.

The city of Tampere in Finland aims to be carbon-neutral by 2030 and seeks to determine how the electrification of public transport would help achieve this climate goal. Thus far, research has covered topics related to electric buses, ranging from battery technologies to lifecycle assessment and cost analysis. However, less is known about electric city buses' performance in cold climatic zones. Vehviläinen et al. [6] collected and analyzed weather and electric-city-bus-related data to ascertain the effects of temperature and weather conditions on the electric buses' efficiency. Data were collected from four battery-electric buses and one hybrid bus as a reference. The buses were fast-charged at a market and slow-charged at a depot. The test route ran downtown.

Water distribution infrastructure (WDI) has been well established and significantly improves living quality. Nonetheless, aging WDI poses a challenging worldwide problem entailing the wasting of natural resources, leading to direct and indirect economic losses. The total losses due to leaks are valued at USD 7 billion per year. However, Wei et al. [7] developed a multi-classification multi-leak identification (MC-MLI) scheme to combat this problem. In this MC-MLI scheme, a novel adaptive kernel (AK) program is developed to adapt to different WDI scenarios. The AK program improves overall identification capacity by customizing a weighting vector and transforming into the extracted feature vector. Afterwards, a multi-classification (MC) scheme is designed to facilitate efficient adaptation to potentially hostile inhomogeneous WDI scenarios. The MC scheme comprises multiple classifiers for customizing the network to different pipelines.

Solar forecasting plays a crucial role in the renewable energy transition. Major challenges related to load balancing and grid stability emerge when a high percentage of energy is provided by renewables. These can be tackled by new energy management strategies guided by power forecasts. Bendiek et al. [8] presented a data-driven and contextual optimization-forecasting (DCF) algorithm for solar irradiance that was comprehensively validated using short- and long-term predictions in three US cities: Denver, Boston, and Seattle. Moreover, step-by-step implementation guidelines with which to follow and reproduce the results were proposed.

Fault-cause identification plays a significant role in transmission line maintenance and fault disposal. With the increasing types of monitoring data, i.e., micrometeorology and geographic information, multiview learning can be used to realize the fusion of information for better fault-cause identification. To reduce the amount of redundant information in different types of monitoring data, Jian et al. [9] proposed a hierarchical multiview feature selection (HMVFS) method to address the challenge of combining waveform and contextual fault features. To enhance the discriminant ability of the model, an ε-dragging technique is introduced to enlarge the boundary between different classes. To effectively select the useful feature subset, two regularization terms, namely, l2,1-norm and Frobenius norm penalties, are adopted to conduct hierarchical feature selection for multiview data.

Demand response programs (DRs) can be implemented with fewer investment costs than those incurred in power plants or facilities and enable us to control power demand. Therefore, they are widely regarded as an efficient option for power supply–demand-balancing operations. On the other hand, DRs bring new difficulties regarding the evaluation of consumers' cooperation and the setting of electricity prices or rebate levels while reflecting their results. Takano et al. [10] presented a theoretical approach that calculates electricity prices and rebate levels in DRs based on the framework of social welfare maximization. In the authors' proposal, the DR-originated changes in the utility functions of power suppliers and consumers are used to set a guide for DR requests. Moreover, optimal electricity prices and rebate levels are defined from the standpoint of minimal burden in DRs. Through numerical simulations and a discussion of their results, the validity of the authors' proposal is verified.

The construction and operation of wind turbines have become important aspects of the development of smart cities. However, a fault in the main drive chain often causes wind turbine outages, thereby seriously impacting the normal operation of wind turbines in smart cities. To overcome the shortcomings of the commonly used main drive chain fault diagnosis method, which only uses a single data source, Xu et al. [11] proposed a fault feature extraction and fault diagnosis approach based on data source fusion. By fusing two data sources, that is, the supervisory control and data acquisition (SCADA) real-time monitoring system data and the main drive chain vibration monitoring data, the fault features of the main drive chain are jointly extracted, and an intelligent fault diagnosis model for the main drive chain in the wind turbine based on data fusion is established.

Lai et al. [12] presented a new coordinated operation (CO) framework for electricity and natural gas networks that considers network congestion and demand response. A credit rank (CR) indicator for coupling units was introduced, and gas consumption constraint information of natural-gas-fired units (NGFUs) was provided. A natural gas network operator (GNO) delivers this information to an electricity network operator (ENO). A major advantage of this operation framework is that frequent information interaction between GNO and ENO is unnecessary. The entire framework contains two participants and three optimization problems, namely, GNO optimization sub-problem-A, GNO optimization sub-problem-B, and ENO optimization sub-problem.

Blockchain technologies have received considerable attention from academia and industry due to their distinctive characteristics, such as data integrity, security, decentralization, and reliability. However, their adoption rate is still low, which is one of the primary reasons behind conducting studies related to users' satisfaction and adoption. Determining the factors impacting the use and adoption of blockchain technologies can efficiently address their adoption challenges. Alshamsi, Al-Emran, and Shaalan [13] performed a systematic review of blockchain technologies to offer a thorough understanding of what impacts their adoption and discuss the main challenges and opportunities across various sectors. Of the 902 studies collected, 30 empirical studies met the eligibility criteria and were thoroughly analyzed. The results confirmed that the technology acceptance model (TAM) and technology–organization–environment (TOE) model were the most common models for studying blockchain adoption.

The upward trend of adopting Distributed Energy Resources (DER) reshapes the energy landscape and supports the transition toward a sustainable, carbon-free electricity system. The integration of the Internet of Things (IoT) in Demand Response (DR) enables the transformation of energy flexibility, stemming from electricity consumers/prosumers, into a valuable DER asset, thus placing consumers/prosumers at the center of the electricity market. Andriopoulos et al. [14] showed how Local Energy Markets (LEM) act as a catalyst by providing a digital platform where the prosumers' energy needs and offerings can be efficiently settled locally while minimizing grid interaction. This paper unveils how IoT technology, which enables the control and coordination of numerous devices, further unleashes the flexibility potential of the distribution grid, offered as an energy service to both the LEM participants and the external grid.

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