frontiers | Frontiers in Energy Research

TYPE Editorial
PUBLISHED 16 January 2023
DOI 10.3389/fenrg.2022.1027434

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Smart Grids, a section of the journal Frontiers in Energy Research

RECEIVED 25 August 2022
ACCEPTED 21 October 2022
PUBLISHED 16 January 2023

CITATION
Yu H, Bai L, Zhou Y, Zhang S and Zhang R (2023), Editorial: Integration and digitalization of urban energy systems. *Front. Energy Res.* 10:1027434.
doi: 10.3389/fenrg.2022.1027434

Editorial: Integration and digitalization of urban energy systems

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KEYWORDS

editorial, urban energy system, integration and digitalization, coordinated planning, operation control, artificial intelligence

Editorial on the Research Topic
Integration and digitalization of urban energy systems

Introduction

The rapid growth and expansion of modern cities have raised new concerns about energy sustainability, motivating a profound transformation of conventional urban energy systems (Maroufkhani et al., 2022). The integrated energy system (IES) that incorporates multiple energy carriers such as electricity, heating, and natural gas, as well as various renewables, is believed to be a promising approach to ensuring efficient, reliable, and clean energy supply for citizens (Jiang et al., 2021). Emerging information technologies such as big-data analysis, edge computing, 5G, and artificial intelligence (AI) accelerate the innovations in the energy sector and make digitalized energy systems a hot topic. The combination of advanced energy and information technologies will enhance the performance of urban IES in different stages such as planning and design, energy management, operation and control (Zhang et al., 2022), system maintenance, and market trading (Lee et al., 2019).

This Research Topic is organized to introduce the recent advances in the research of the integration and digitalization of urban energy systems. Finally, eight papers have been accepted for this Research Topic, which can be sorted into the following three categories: 1) Coordinated planning and reliability evaluation methods; 2) Operation control and energy management under uncertainties; and 3) Application of artificial intelligence technologies. The three sections below introduce the primary research work and contributions of the papers covered in each category.

Coordinated planning and reliability evaluation methods

With the extensive integration of high-penetration renewable energy resources, reliability evaluation is essential for planning and analyzing urban energy systems (Zhao et al., 2022). Besides, it is necessary to consider additional factors, such as market mechanisms and new energy conversion equipment when planning (Ravi et al., 2022).

Guo et al. establish a planning model with the objective of total economic and environmental costs minimization in consideration of hydrogen-storage technology investment. The results show that hydrogen investment can alleviate the burden of carbon emissions.

Xiao et al. present a new feeder link planning method for the distribution network, which can improve total supply capability (TSC). Compared with the traditional backward-optimization method, the proposed method also has advantages in the aspect of feeder-link efficiency and feeder distribution balancing.

Zhang et al. establish a restoration optimization model of AC/DC hybrid distribution network considering network reconfiguration and control modes of voltage source converter (VSC). Based on this model, a reliability evaluation method combining failure mode and effects analysis method is developed.

Operation control and energy management under uncertainties

The integration of volatile distributed generation (DG) and various demand-side resources with uncertainties makes the operation more complex and challenging (Lv et al., 2019). Thus, it is important to investigate the optimal control and energy management methods to deal with the uncertainties (Zhang et al., 2021).

Mu et al. consider the heat storage property of building envelope as a flexibility resource to support the energy scheduling of building energy system (BES), and establish a day-ahead optimal interval scheduling model for the PV-BES, aiming at minimizing the electricity energy purchase cost.

Wang et al. present a daily optimal scheduling model for ADNs to motivate the DGs to actively participate in the operation optimization. Constraints are specifically designed to consider the charge and discharge times of the energy storage systems.

Zhang et al. develop a stochastic model predictive control (MPC) approach-based energy management strategy for energy storage systems (ESS). A non-parametric probabilistic prediction method embedded in time series correlation is adopted to describe the uncertainty of load demand and PV output.

Application of artificial intelligence technologies

Artificial intelligence technologies, due to their superior learning capabilities, adaptability and portability, have been commonly used in urban energy systems in recent years. It is becoming a key component in the digitalization of urban energy systems.

Gong et al. design a neural network algorithm based on multi-feature fusion to identify low-voltage series fault arcs. The arc characteristic is extracted by wavelet analysis, Fourier transform, current cycle difference method and current cycle similarity derivation method.

Wang et al. develop a spatial electric load forecasting method based on the high-level encoding of high-resolution remote sensing images, which can achieve more accurate spatial load forecasting (SLF) in regions with insufficient historical data.

Conclusion

The papers in this Research Topic cover various technical solutions for integration and digitalization of urban energy systems, such as system planning considering hydrogen-storage technology, flexible operation control under uncertainties, and application of artificial intelligence. The research will facilitate the flexible interactions between urban energy systems and various city sectors such as intelligent transportation, smart buildings and communities, and thus promoting the holistic digitalization of urban energy systems.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Acknowledgments

Authors would like to acknowledge the National Natural Science Foundation of China (51907139, 51961135101, 52011530127), which have made this Frontiers Research Topic possible.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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