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Editorial: Urban multi-energy system networks with high proportion of renewable energy

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Editorial on the Research Topic
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Introduction

Faced with environment pollution and climate change, it is essential to develop advanced low-carbon energy system based on renewable sources. Micro-energy networks with a high proportion of renewable energy are one of the most important methods to achieve the complementary use of renewable energy and fossil energy with high efficiency of energy utilization. Research on urban-level energy networks would be an important step for applying and integrating renewable sources. Faced with high penetration rate of renewable energy, the robust ability and safety operation are challenging from both sides of energy generation and the electrical grid. Meanwhile, the increasing number of electrical and fuel cell powered vehicles put additional difficulties for optimization and scheduling. Therefore, research on urban energy systems with a high proportion of renewable energy is extremely valuable.

This Research Topic ("Urban Multi-energy System Networks with High Proportion of Renewable Energy") aims to look into the key problems existing in the integrated multi-energy network system for the urban level and provide a detailed theoretical basis and experimental data for the design and operation of integrated micro-energy networks at the international academic level. The Research Topic received several submissions within the field of renewable energy systems, including modeling and optimization, grid supply, the interaction between grid and EV/fuel cell cars, and advanced controlling strategy of off-grid/grid-connected microgrid systems, *etc.*

Low-carbon development of energy

Feng et al. modeled the natural gas system, power system, and their coupling components, and proposed a low-carbon economic control framework based on MASAC. The objective was to minimize both operational costs and carbon emissions. Simulation

results using a nodal system demonstrated that this method significantly reduces costs and emissions compared to traditional approaches. Hu et al. developed a low-carbon scheduling model for electric vehicles that considers carbon quotas and dynamic electricity pricing. A two-level scheduling framework was applied to solve the model. Simulation analysis confirmed that the model reduced carbon emissions by 10.13 tons and user costs by 451.11 RMB. Yahya et al. investigated the potential of converting waste tires into synthetic fuels in Saudi Arabia using vacuum pyrolysis technology. This method not only reduces landfill pollution but also decreases CO_2 emissions by 2.5 tons per ton of carbon recovered.

Power facilities control methods

Sai Eswar et al. proposed a renewable energy-based microgrid system for electric vehicle (EV) charging stations. They adopted a hybrid optimization approach (DOA-SBNN) to predict load demand and manage microgrid fluctuations. A four-phase inductively coupled interleaved boost converter (FP-ICIBC) and a fractional-order PID controller (FOPID) were designed to enhance power management efficiency. Experimental results demonstrated that this method outperformed existing technologies in terms of energy efficiency, total harmonic distortion (THD), and computation time. Wu et al. proposed a Virtual Synchronous Generator (VSG) control strategy, integrated with Energy Storage Systems (ESS) and PV, to enhance system inertia. Results showed that the proposed PV-VSG method can increase PV penetration by 57.5% compared to scenarios without VSG. Kumar et al. proposed a novel method for coordinated voltage and frequency regulation in isolated hybrid power systems (IHPS). A PI-TISMC controller was designed to coordinate inertial sources and suppress system oscillations.

International energy cooperation and policy

Yan et al. analyzed the necessity of cooperation between China and South Africa in the field of renewable energy, particularly solar and wind power. They identified key international challenges in energy development and proposed policy recommendations to support renewable energy collaboration between the two countries, contributing to South Africa's low-carbon transition.

This research project brings together pioneering studies focused on advancing the greening of energy systems. It addresses key challenges such as low-carbon equipment operation, stable device control, and international energy cooperation—factors that are particularly beneficial for the development of urban energy systems with a high share of renewable energy. Moreover, these studies contribute to a broader understanding of the role that urban decarbonization plays in achieving sustainable and efficient system operation, which could promote academical cooperation and communication in the future.

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