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Editorial: Key technologies of smart energy system optimization

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Editorial on the Research Topic
Key technologies of smart energy system optimization

Introduction

Since entering the 21st century, the development of related technologies in the field of energy has made unprecedented breakthroughs. The application and development of renewable energy have created sufficient favorable conditions for cleaner and low-carbon development of the energy system. At the same time, the use of distributed energy sources such as electric vehicles and storage devices in daily life tends to be generalized. The problem of grid-connected renewable energy, as well as the rapidly changing demand side of various kinds of distributed energy, have led to the critical requirement for the rapid response ability of the energy system because the conventional energy system is unable to meet the requirements of the energy field in this new era. Therefore, the construction and optimization of a smart energy system combining energy and information technology have become important measures to further promote the development of the energy field at this stage.

In order to effectively promote the construction and optimization of a smart energy system, the low-carbon operation of a comprehensive energy system, a comprehensive energy economic benefit analysis, and comprehensive energy load predictions should be further researched. Figure 1 shows an example of a smart energy system.

This Research Topic comprises four research articles. The main research content includes the modeling and analysis of energy economic management, the load forecasting method of energy systems, and the adjustment of time-of-sale price and grid regulation.

The article by Liu et al. proposes an economic energy management strategy based on deep reinforcement learning to solve the optimal-scheduling problem of microgrids in order to achieve efficient and economical operation. The strategy introduces a deep deterministic policy gradient to solve the Markov decision process for the established real-time economic energy-management problem of power grids, based on the uncertainty of power demand, load demand, and electricity price of the energy system. The distributed generator and storage facilities are carefully regulated and scheduled to obtain the lowest operation costs and the optimal power generation benefit.

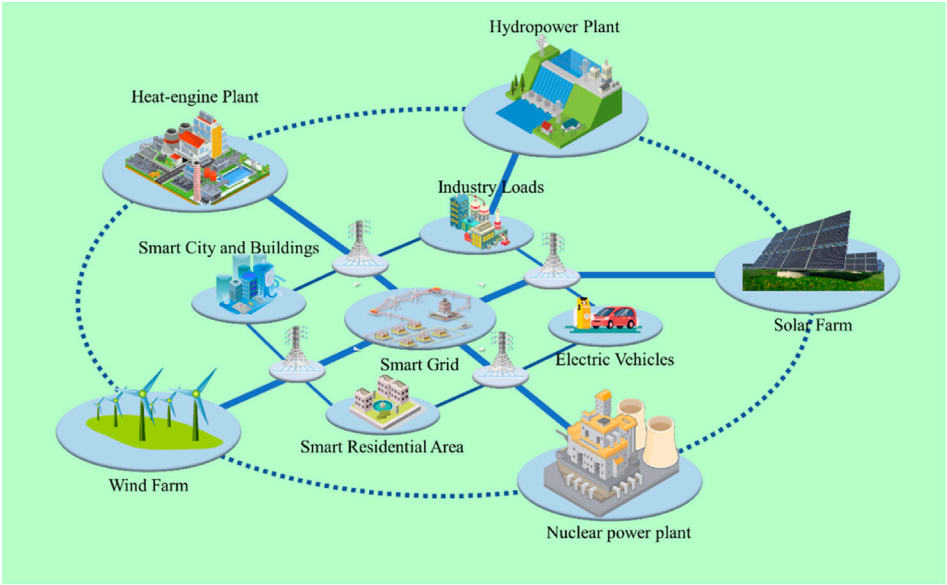

FIGURE 1
The smart energy system.

The scheduling of power generation and load is one of the key problems in optimizing the operation of smart energy systems. The smart energy system consists of a microgrid composed of varieties of distributed renewable energy and a traditional grid. Their combined operation is characterized by intermittence, randomness, and volatility, the balance of supply and demand is difficult to control, and economic operation is difficult to achieve. It is critical to solve these problems to achieve operation optimization of the smart energy system.

The article by Zhang et al. constructs an ambiguity set to improve the robustness of the model based on the distributional robust optimization framework. According to the proposed model, it has better robustness for analyzing power load with strong volatility and uncertainty, and can properly solve the uncertainty problem faced by the load prediction.

The construction of new energy systems introduces various distributed loads. The diversity and uncertainty of load types on the demand side bring great challenges to the formulation of a rational production plan on the supply side. At the same time, load forecasting is affected by multiple factors such as natural conditions and social factors, and therefore, there are inherent difficulties and obstacles to achieving accurate forecasting. Consequently, improving load forecasting in the smart energy system is critical in order to solve the problems of the supply and demand balance of the energy system.

The article by Wang et al. proposes a regulatory mechanism for real-time pricing of electricity prices in power systems. This mechanism can be well applied to the smart energy system and can not only meet the needs of power grid regulation and operation but also ensure optimal economic benefits for energy system operation. The application of this mechanism can achieve optimal control operation of the new power system, including source, network, load, storage, and other complex subjects, along with improvement of the stability of the power grid.

The peak-valley time-of-use electricity price of the power system is based on the load variation, which divides the time of the day into several periods and sets different price levels for each period. In this way, customers are guided to reasonably arrange and plan their times of power consumption to achieve peak-cutting and valley-filling, which would maximize the efficient utilization of energy system resources. Therefore, the reasonable formulation of a time-of-use electricity price monitoring mechanism can facilitate energy saving and resource utilization of the smart energy system.

The article by Wang et al. proposes a model predictive control method. This method is suitable for the soft open point system and can effectively improve system robustness, real-time compensation of system perturbation, and current harmonic suppression. It also improves system performance and is anti-interference.

For the long-term development of the energy field, the construction and optimization of the smart energy system is an important future area of research.

Author contributions

DZ: Resources, Supervision, Writing–original draft, Writing–review and editing. HG: Writing–review and editing. HZ: Writing–review and editing. TA: Writing–review and editing.

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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.

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