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Editorial: Muti-energy integration towards energy decarbonization

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Editorial on the Research Topic
Muti-energy integration towards energy decarbonization

Global warming and energy resource scarcity caused by the widespread use of fossil fuels are urging humans to transition the current way of life and production into a more environmentally and efficiently sustainable mode. Among the candidates, through electrification, reconstructing various types of energy into a multi-energy system, so as to achieve the comprehensive use of various types of energy and reduce carbon dioxide emission, is a well-recognized feasible idea. Especially recently, with technological progress in fields of renewable energy such as solar and wind, this multi-energy integration model has been drawing significant interest from both practical and academical domains.

The salient difficulty of the multi-energy integration lies in how to harmonize various types of energy sources to achieve a stable power supply like that of a general fossil-powered generator. The back reason comes from the intrinsic operation complications of multi-energy systems. For instance, compared with the common fossil-based generators, multi-energy systems often have more operational goals, which not only contain electricity generation but also include heat supply, the minimization of overall environmental impacts, and others, let alone the lots of randomness of diverse renewable energy that needs to be dealt with.

In order to address the aforementioned challenges of multi-energy systems and utilize their merits, the Research Topic entitled "Multi-Energy Integration towards Energy Decarbonization," is organized, focusing on, but not limited to, the following issues:

- New concepts and ideas for multi-energy integration;
- New approaches and models of integration toward decarbonization;
- Design and planning of low/zero-carbon multi-energy systems;
- Operation and control methods of coupled energy systems;
- Policy incentives and market mechanisms for energy integration;
- Technical, economic, and environmental systemic analysis;
- Cyber-physical-social integration of energy systems.

Because of its innate stand-alone feature, the island energy system is the most characteristic of all integrated energy systems compared with the inland system. Besides, due to its natural independence from the big continental energy system, it is often an ideal place to test some models before rolling them out in inland areas. Song and Chen took

Chongming Island as an example, analyzed the necessity of island energy system transformation, and put forth a possible path and corresponding policies for turning the current energy system to the resilient, which included the orderly construction of hybrid renewable energy systems, and the promotion of distributed power generation and microgrid technology, etc.

Not only island energy systems but in fact, all integrated energy systems should adhere to the principle: full utilization of the potential of all energy sources in the region. The integration process of diverse energies is essentially an optimization issue. Around this thinking, Huang et al. looked at the issue of power-to-chemicals using solar energy, i.e., methane, methanol, and gasoline, through designing a molten-salt solar power tower (MSPT). In their suggested scheme, a bilevel optimization was proposed, which employed mixed-integer linear programming at the lower level for optimal sizes and operating strategies of technologies, and heat cascade use, and employing genetic algorithms at the upper level for optimizing the MSPT design. The relevant results indicate that in the scheme, the MSPT could take the advantage of cheap and massive thermal storage and operate a longer time with the aid of cost-effective and efficient molten-salt thermal storage.

Likewise, through proposing series optimization algorithms, Zhang et al. gave an assembled approach to deal with the impact of wind power on sub-synchronous state stability and the dynamic characteristics of the grid-connected system. This research is instructive in terms of addressing the challenges posed by wind power integration into the grid, particularly in the aspects of the clustering of wind farms and the optimization of controller parameters to enhance system stability. Also concerned with wind power, Kamel et al. discussed the issue of optimal plan of wind turbines and battery energy storage (BES) with regards to smoothing the intermittence of wind power. In addition, another considerable optimization issue for multi-energy system is that of multi-objective optimum scheduling. In the rissuesearch of Zhang et al., a multi-objective optimal dispatching model and the related solving way were developed with the optimization goals of minimizing system operation costs, reducing carbon emissions, and increasing exergy efficiency.

Finally, Wang and Zhang, standing on a macro-perspective, studied the impact of China's "comprehensive two-child" policy (UTCP) and "three-child" policy (TCP) on the age structure of Chinese families, and how such changes further affect households' demand for electricity, and proposed a power demand forecasting model considering the impact of the fertility policy. Their forecasting results indicated that, 1) the household-level old-age dependency ratio have a significant suppressive effect on the electricity demand; 2) for households without the pressure of old-age dependency, the China's "comprehensive two-child" policy's contribution to electricity demand is significant, while "three-child" policy's is limited; 3) under China's "comprehensive two-child" policy and "three-child" policy cannot fundamentally curb the declining trend of residential electricity demand of China in the long term.

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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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