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Editorial: Data-based resilience-oriented planning and operation of multi-energy systems

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Editorial on the Research Topic
Data-based resilience-oriented planning and operation of multi-energy systems

Background and objective

Recently, there is an increasing number of extreme events such as natural disasters, malicious attacks, etc., all over the world (Yang et al., 2023). For example, Hurricane Maria, struck the Caribbean in September 2017, leaving a trail of destruction and devastating impacts on various islands, particularly Puerto Rico (Kwasinski et al., 2019). It can be observed that those events could destroy the current emerging multi-energy systems and cause huge economic losses or even threaten the safety of human beings (Li et al., 2023). Besides, for extreme events, there can be massive historical data, so it is meaningful to take advantage of the fast-developing machine learning methods to obtain a both reliable and resilient operation framework (Xie et al., 2020).

This Research Topic aims to provide a data-based, cost-effective, and resilience-oriented operation scheme for multi-energy systems. To start with, the system modeling is designed with the intensive coordination of heterogeneous energy, then, a resilient operation scheme is developed to alleviate the negative effects of extreme events. In the end, machine learning-based algorithms will be employed to provide online smart operation solutions to reduce economic losses.

Paper summary

The Research Topic currently includes 5 papers. 1 paper is on resilience-oriented operation, 3 papers are on reliable and robust operation and the last 1 is on dynamic stability. All contributions to this Research Topic focus on one or more of the research areas listed in this Research Topic.

Resilience-oriented operation

To deal with the uncertainties from renewable energy sources for the multi-energy system in remote rural areas, An et al. in analyze the possible operational risks regarding renewable generation and then introduce the condition value at risk to quantify the risk cost. On this basis, stochastic programming based on a multi-energy microgrid planning model that minimizes the investment cost, operation cost, and risk cost, while considering the physical limitations is presented. The simulation shows that the presented configuration model can balance the investment cost and risk cost, which effectively enhances the system's ability to cope with uncertainties and fluctuations. Finally, by adjusting the risk-related parameter, the conservativeness of the planning scheme can also be changed.

Reliable and robust operation

To improve the economic effectiveness, resilience, and environmental protection of energy systems under source-load uncertainty, a real-time low-carbon dispatch method for the wind-thermal-hydro-storage integrated system is proposed in Qiu et al. To deal with the source-load uncertainty, a stochastic robust optimization approach is applied for the resilience operation. Finally, case studies show the effectiveness of the proposed scheduling method in reducing the energy supply cost. The study in Xie and Li presents a low-carbon economic dispatch model for the multi-energy system. Firstly, a hydrogen energy-based multi-energy system is modeled to refine the utilization process of hydrogen energy. Secondly, the carbon emissions of different energy chains are analyzed. Finally, a staged carbon trading mechanism is adopted for emission reduction. The final goal is to minimize the operation cost. The results show the effectiveness of the proposed method in reducing the overall cost. To make full use of the abilities of renewables in reactive power optimization, a detailed model for power regulation capabilities of wind turbines and photovoltaic units is introduced in Ma et al. At first, the power system model with renewables integration is formulated using AC power flow. The wind turbines and photovoltaic units are modeled according to their operating characteristics. An improved DC power flow model is adopted to handle the non-linear characteristics of the power system. Further, a multi-objective reactive power optimization model is employed to minimize the power generation cost, wind and solar power curtailment, and voltage offset at the same time. Finally, numerical case studies are conducted which demonstrate that the participation of renewables in reactive power regulation can improve the operational economy and voltage stability.

Dynamic stability

Currently, quasi-dynamic energy flow computation has become a critical tool to determine the states of the multi-energy system. It could help improve MES' operation efficiency and issue a security warning. However, it would suffer from fake oscillations, divergence, etc. Thus, in Lu and Yang an accurate and efficient method for quasi-dynamic energy flow computation is proposed. Using a scheme with total variation decreasing property, the numerical instability in solutions of thermal dynamics can be effectively reduced. At last, numerical tests are performed in the famous Barry Island system and the advantages of the proposed method in both efficiency and accuracy are validated.

Author contributions

JG: Conceptualization, Writing–original draft, Writing–review and editing. MS: Investigation, Writing–original draft, Writing–review and editing. EL: Conceptualization, Writing–original draft, Writing–review and editing. SL: Investigation, Writing–original draft, 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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