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EDITORIAL

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Optimal operation and control of smart energy systems

1 | INTRODUCTION

Smart energy systems can provide a promising solution to the challenge of increasing demand and environmental concerns. On the energy supply side, renewable generating units are developed rapidly around the world that require intelligent control for efficient and safe operation. From the perspective of demand side, massive flexible distributed energy resources are leveraged to provide regulation resources by utilizing grid edge and Internet of Things (IoT) technologies. Regarding overall system operation, the concept of integrated energy system is developed by realizing the efficient utilization of coupled energy components. However, the uncertainties and interactions between suppliers and consumers can bring about diverse emerging operation and control issues. Besides, the deep involvement of IoT devices also makes smart energy systems more vulnerable. Therefore, achieving coordinated optimization and robust control of smart energy systems is highly important. This Special Issue focuses on collecting advanced research to improve the flexibility and resilience of smart energy systems by addressing the impact of distributed resources uncertainties, system operating risk, and carbon emissions.

For this Special Issue, 10 papers were accepted for publication after rigorous peer-review process. The Guest Editorial Board expresses its gratitude to all the contributing authors for presenting their latest works in this Special Issue and the anonymous peer reviewers for their valuable suggestions to guarantee the quality of these papers.

2 | REVIEW OF TOPICS IN THIS SPECIAL ISSUE

This section summarizes the topics and the papers selected for this Special Issue.

2.1 | Control strategy of distributed resources

The first article, entitled "Distributed event-triggered secondary control for microgrids applicable to directed communication graph" by Zhang et al.,[1] presents a novel distributed control strategy to reduce the communication requirements for microgrids. The proposed method's stability is proved using the Lyapunov function, which can be a promising solution for microgrids with limited communication resources.

The second article, entitled "Active power control strategy based on characteristic curve fitting for photovoltaic sources" by Cai et al.,[2] introduces an active power control strategy based on the characteristic curve-fitting method. Under different irradiations and power references, the photovoltaic sources can operate flexibly not only in the maximum power point tracking mode but also adaptively according to the power dispatch reference.

2.2 | Optimal operation of energy systems under uncertainties

The third article, entitled "Wasserstein-metric-based distributionally robust optimization method for unit commitment considering wind turbine uncertainty" by Chen et al.,[3] investigates the grid unreliability resulting from uncertainties in wind turbine output power. Considering the uncertainty in wind power, the Wasserstein metric for ambiguity set is utilized to reflect the probabilistic distribution. Furthermore, the proposed method can control the sample size and the confidence of the Wasserstein ambiguity set radius. Numerical simulations using a modified version of the IEEE 6-bus system show that the proposed method can flexibly adjust the robustness and economy of optimization decisions.

The fourth article, entitled "Two-level scheduling of an active power distribution network by considering demand response program and uncertainties" by Rahnama et al.,[4] analyzes the relationship between power supply with high renewable energy penetration and power demand. This study conducted a hierarchical model to simulate the mutual influence of microgrids in a multi-microgrid system, taking into consideration the distribution network decision-making. Under dyadic theory and KKT conditions, the above two-level nonlinear optimization problem is transformed into a one-level linear problem, which improves the solution efficiency.

The fifth article, entitled "A multi-objective optimization approach to designing window and shading systems considering building energy consumption and occupant comfort" by Nazari et al.,[5] presents a novel optimization method for windows that takes into account both building energy consumption and occupant comfort. The results show that north facades provide the lowest amount of thermal comfort and consume the least amount of energy.

2.3 | Defect detection and risk evaluation of energy systems

The sixth article, entitled "Real-time risk assessment of cascading failure in power system with high proportion of renewable energy based on fault graph chains" by Chen et al.,[6] proposes a cascading failure risk analysis framework based on the cascaded graph neural network to address the stochasticity and complexity of cascading faults in power systems with high renewable energy penetration. On this basis, the fault graph chain is introduced to characterize the fault propagation. The simulation results of the IEEE 39 bus system ensure the real-time and accurate assessment of the risk of cascading faults.

The seventh article, entitled "BERT-TriF: An inductive short text classification model for power equipment defect records" by Ye et al.,[7] proposes a text classification model for power equipment defect records. The model extracts text semantic category features to classify text for power equipment defect records. The simulation results indicate that the model performs well in terms of classification accuracy, robustness, and generalization compared with the benchmark deep learning model.

2.4 | Low-carbon economical energy systems

The eighth article, entitled "Model building of urban energy system and effect analysis of green low-carbon transition under the background of carbon peaking and carbon neutrality" by Zhao et al.,[8] discusses the energy system, taking into account the stochastic nature and fluctuation of renewable energies and electric vehicles. The model takes the expansion and decommissioning of electric vehicles and various conversion devices into account. The case study shows that the proposed model is effective in improving both the economic and renewable energy consumption rate of urban energy systems.

The ninth article, entitled "CVaR-based method for optimizing the contract bidding strategy of PV power stations" by Xu et al.,[9] investigates a contract bidding methodology by considering bidding volumes and bidding prices for photovoltaic power stations. The method includes three key aspects, generating scenarios based on Latin hyper-cube sampling, optimization under conditional value at risk, and alternate iterative calculation. Simulation results reveal the effectiveness of the proposed method in avoiding photovoltaic power station risks and increasing stable revenue.

The tenth article, entitled "Unified multi-objective optimization for regional power systems with unequal distribution of renewable energy generation and load" by Zhao et al.,[10] proposes a novel method using the unified multi-objective optimization to integrate diverse strategies into a comprehensive problem for allocating renewable energy throughout all subgrids. Moreover, the global-individual overall optimization is conducted with a unified economic indicator, where the 24-h rolling solution framework is designed to update the decision based on the latest prediction of wind power output. Based on the validation and achievement of this work, the improved MOO can be seen as a very promising research direction to solve the real-world large system optimization problem.

3 | CLOSING REMARKS

The 10 papers published in this Special Issue provide a comprehensive overview of state-of-art research in smart energy systems. They focus on addressing distributed energy uncertainty, reducing system operational risk, and minimizing carbon emissions to enhance the flexibility and reliability of smart energy systems. We hope that this Special Issue can provide valuable insights into the latest research and advancements in the field of optimal operation and control of smart energy systems.

Finally, we wish to express our gratitude to the journal Editorial Office for providing us the opportunity to organize this Special Issue. Furthermore, we would like to pay tribute to the journal editorial and associate editors for their professional and timely handling of the manuscripts, and the production team for their prompt and proficient technical assistance. It has been a great pleasure working with all of you on this Special Issue.

AUTHOR CONTRIBUTIONS

Hongxun Hui: Conceptualization (lead); project administration (lead); resources (lead); supervision (lead); validation (lead); writing – original draft (lead); writing – review and editing (lead). **Tao Chen:** Conceptualization (equal); resources (equal); validation (equal); writing – original draft (equal); writing – review and editing (equal). **Han Wang:** Conceptualization (equal); resources (equal); validation (equal); writing – original draft (equal); writing – review and editing (equal). **Sheng Wang:** Conceptualization (equal); resources (equal); validation (equal); writing – original draft (equal); writing – review and editing (equal).

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest relevant to this article.

DATA AVAILABILITY STATEMENT

No data were used for the research described in the article.

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