Guest Editorial: Introduction to the Special Section on Research on Power Technology, Economy and Policy Towards Net-Zero Emissions

The pursuit of net-zero emissions is not only a global imperative but also a transformative journey that requires multidisciplinary approaches and innovative solutions. It is a multifaceted challenge that demands innovation across technology, economics, and policy. The special section on "Research on Power Technology, Economy, and Policy Towards Net-Zero Emissions" of IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING includes cutting-edge research and pioneering efforts from various scholars dedicated to this cause.

In this special section, we present a collection of research papers that delve into the critical aspects of transitioning to sustainable energy systems. These papers collectively address the technological, economic, and policy-driven challenges and opportunities that lie ahead in our quest for net-zero emissions. (*Challenges and Pathways of Low-Carbon Oriented Energy Transition and Power System Planning Strategy: A Review*)

I. TECHNOLOGICAL INNOVATION AND INTEGRATION

A central theme in this special section is the advancement and integration of cutting-edge technologies to enhance the efficiency and sustainability of energy systems. Many of the papers focus on optimizing energy dispatch and storage, leveraging robust optimization models and sophisticated algorithms. These technologies are essential for managing the growing complexity of energy systems, especially with the increasing penetration of renewable energy sources. Several papers focus on the economic dispatch of integrated energy systems, emphasizing full-process carbon emission tracking and low-carbon demand response strategies. These technologies are crucial for managing the complexities of energy systems, particularly with the growing integration of renewable energy sources. (*Low-Carbon Economic Dispatch of Integrated Energy Systems Considering Full-process Carbon Emission Tracking and Low Carbon Demand Response; Renewable Energy Absorption Oriented Many□Objective Probabilistic Optimal Power Flow*)

Moreover, artificial intelligence (AI) and machine learning are also prominently featured, showing their role in optimizing energy management. The research demonstrates how AI-driven solutions can handle dynamic and uncertain environments, providing adaptive and efficient strategies for energy distribution and consumption. Papers discuss multi-agent deep reinforcement learning approaches for co-dispatching energy and hydrogen storage, illustrating how AI can provide adaptive and efficient strategies for dynamic and uncertain environments. (*Multi-Agent Deep Reinforced Co-Dispatch of Energy and Hydrogen Storage in Low-Carbon Building Clusters; Adaptive Static*

Equivalences for Active Distribution Networks with Massive Renewable Energy Integration: A Distributed Deep Reinforcement Learning Approach)

II. ECONOMIC MECHANISMS AND MARKET DESIGN

The special section also explores economic mechanisms and market designs that incentivize low-carbon energy production and consumption. One significant contribution is the proposal of novel spot electricity market designs that integrate carbon emissions considerations. These mechanisms ensure that economic incentives align with environmental goals, promoting the adoption of renewable energy. (*Spot Electricity Market Design Considering Carbon Emissions for a Power System with a High Penetration of Renewable Energy Generation; Adjustable Robust Low-Carbon Unit Commitment with Nonparticipative by Linear Programming*)

Additionally, the importance of regulatory frameworks is highlighted to support these market designs. Effective policies are crucial for driving market behavior towards cooperative and sustainable practices, facilitating the broader adoption of renewable energy technologies and reducing carbon footprints. (*A Blockchain-enabled Coalitional Game Framework for Carbon Emission Trading*)

III. POLICY AND STRATEGIC PLANNING

Policy and strategic planning are vital components of the transition to net-zero emissions. The research emphasizes the need for comprehensive policy frameworks that integrate multiple energy carriers and promote cross-sectoral synergies. Research in this special section emphasizes the need for strategic coordination across electricity, hydrogen, gas, and transportation sectors. Collaborative planning strategies are essential to harness the potential of integrated energy systems, enhancing resilience and efficiency. (*Low-Carbon Oriented Collaborative Planning of Electricity-Hydrogen-Gas-Transportation Integrated System Considering Hydrogen Vehicles; Exploring Carbon Equilibrium in Integrated Electricity-Hydrogen System*)

The studies provide valuable insights into how different energy sectors can work together to achieve deeper decarbonization and optimize resource utilization. Strategic production and trading in renewable energy certificate markets are analyzed, offering guidelines for efficient and transparent market design and regulation. (*Strategic Production and Trading in Renew□able Energy Certificate Markets: Existence, Uniqueness, and Efficiency of Market Equilibria; Locational Marginal Carbon Emission of Power Grids Approach: Optimal Scheduling of Recycling Electricity/Heat Rural Supply System based on Waste Feedstock*)

IV. DECENTRALIZATION AND DIGITAL INNOVATION

The role of digital innovation and decentralization in future energy systems is also a significant focus. Blockchain technology is explored for its potential to create

transparent, secure, and efficient energy markets. Decentralized trading platforms, supported by information entropy theory, are proposed to enhance market transparency and efficiency, enabling more democratized energy systems. (*Blockchain-based Renewable Energy Trading Using Information Entropy Theory*)

Digital innovations extend beyond trading to improve energy management and optimization, driving the transition to more resilient and adaptive energy systems. This special section demonstrates how these technologies can facilitate better coordination and management of energy resources, ultimately contributing to the sustainability goals.

V. CONCLUSION

The research presented in this special section provides a comprehensive overview of the multifaceted approaches required to achieve net-zero emissions. By integrating technological advancements, economic mechanisms, policy frameworks, and digital innovations, we can develop energy systems that are both efficient and resilient.

This body of work not only advances our understanding of the challenges and opportunities in the energy transition but also offers practical solutions and frameworks that can be implemented globally. The insights and findings presented here are expected to inspire further research, collaboration, and innovation, driving us closer to a sustainable and net-zero emissions future.

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