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Editorial

Advances in Power and Energy Management for Distribution Systems with High Penetration of Distributed Energy Resources

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This Special Issue is dedicated to exploring cutting-edge methodologies and innovative solutions pertaining to the integration of distributed energy resources (DERs) into modern distribution systems, as well as the active control and management of these evolving electrical networks.

With an increasing global emphasis on sustainability and the adoption of renewable energy sources, distribution systems are undergoing a transformative influx of DERs, such as solar panels, wind turbines, electric vehicles, and energy storage systems. At the same time, the requirements for reliability and resiliency in power systems are becoming more stringent, compelling electric utilities to adopt innovative solutions to meet these critical demands effectively.

To address these challenges, two key technological frameworks have emerged as central to this transformation: Advanced Distribution Management Systems (ADMSs) and Distributed Energy Resource Management Systems (DERMSs).

ADMSs serve as the operational cornerstone of modern distribution grids. They integrate real-time monitoring, control capabilities, and advanced analytics to optimize grid operations, enhance reliability, and bolster grid resilience. In tandem, DERMSs are instrumental in the integration and active management of DERs and microgrids within distribution networks. DERMSs provide utilities with the tools to fully leverage the potential of DERs, enabling grid operators to efficiently manage distributed energy generation, storage, and responsive demand.

Together, ADMSs and DERMSs form the backbone of utility efforts to balance supply and demand, reduce energy losses, and optimize overall grid performance while addressing the complexities introduced by high penetration levels of DERs. Our primary objective for this Special Issue was to showcase cutting-edge research and practical insights from leading researchers and industry practitioners in these domains, revealing the evolving landscape of power and energy management in distribution systems and promoting the development of sustainable and resilient energy infrastructure for the future.

This Special Issue comprises a total of seven articles, including six original research papers and one concise review. The contributing authors represent a diverse cross-section of the electric power sector, encompassing experts from industry, academia, and national laboratories. Their contributions span regions, including the United States, Europe, and Asia, offering a global perspective on advancements in power and energy management. We will now provide a brief overview of each paper included in this Special Issue.

The first article, "Generalized Distribution Network Data-Gathering Procedure for ADMS Deployment" [1], proposes a robust and scalable framework for data acquisition in distribution networks. This work emphasizes the importance of accurate and efficient data

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collection processes for the successful deployment of Advanced Distribution Management Systems (ADMSs), enabling reliable and optimal network operations.

The second paper, "Autoencoder-Driven Training Data Selection Based on Hidden Features for Improved Accuracy of ANN Short-Term Load Forecasting in ADMSs" [2], introduces a novel approach using autoencoders for selecting training datasets in artificial neural networks. This method enhances short-term load forecasting accuracy, a critical factor in effective energy resource management and grid optimization in ADMS environments.

In "Model Quality and Measurement Density Impact on Volt/Volt Ampere Reactive Optimization Performance" [3], the authors analyze the effects of model accuracy and measurement density on the performance of volt/VAR optimization processes in ADMSs and/or DERMSs. Their findings demonstrate that improving these aspects can significantly enhance the efficiency and stability of modern power systems.

"Interval Assessment Method for Distribution Network Hosting Capacity of Renewable Distributed Generation" [4] introduces an interval-based method for assessing the hosting capacity of distribution networks for renewable distributed generation. This innovative methodology is essential in ensuring the secure and efficient integration of renewables while preserving network reliability.

The article "Integrated Transmission and Distribution Co-Simulation Platform for Demonstration of Bulk Grid Services Using Distributed Energy Resources" [5] presents an innovative co-simulation platform bridging transmission and distribution networks. This platform supports the demonstration of bulk grid services enabled by DERs, facilitating the seamless integration of renewable energy sources into the power grid.

"Evaluation of Different Methodologies for Wave Energy Conversion System Integration into the Power Grid Using Power Hardware-in-Loop Emulation" [6] examines various methodologies for integrating wave energy conversion systems into distribution networks. Using power hardware-in-the-loop emulation, this study evaluates the reliability and efficiency of these integration approaches.

Finally, a short review paper, "Doubly Fed Induction Machine Models for Integration into Grid Management Software for Improved Post-Fault Response Calculation Accuracy—A Short Review" [7], explores the role of doubly fed induction machine models in grid management software, such as ADMSs and DERMSs. The authors focus on enhancing post-fault response calculation accuracy, which is crucial in maintaining grid stability in systems with high DER penetration and which often serves as a critical input for more advanced ADMS and DERMS applications, such as Fault Location, Isolation, Supply Restoration (FLISR), and Adaptive Relay Protection.

This Special Issue reflects the dynamic and interdisciplinary nature of power and energy management research. The contributions featured in this Special Issue span key topics, including data-driven analytics, optimization strategies, advanced simulation platforms, and renewable energy integration techniques. These papers lay the foundation for future advancements in managing distribution systems with a high share of DERs.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Bekut, D.; Švenda, G.; Kanjuh, S.; Koturević, V. Generalized Distribution Network Data-Gathering Procedure for ADMS Deployment. *Energies* **2024**, *17*, 6020. [CrossRef]
2. Pajić, Z.; Janković, Z.; Selakov, A. Autoencoder-Driven Training Data Selection Based on Hidden Features for Improved Accuracy of ANN Short-Term Load Forecasting in ADMS. *Energies* **2024**, *17*, 5183. [CrossRef]
3. Mendoza, I.; Pratt, A.; Padullaparti, H.V.; Tiwari, S.; Baggu, M. Model Quality and Measurement Density Impact on Volt/Volt Ampere Reactive Optimization Performance. *Energies* **2024**, *17*, 3707. [CrossRef]

4. Wan, D.; Peng, S.; Zhang, H.; Diao, H.; Li, P.; Tu, C. Interval Assessment Method for Distribution Network Hosting Capacity of Renewable Distributed Generation. *Energies* **2024**, *17*, 3271. [CrossRef]
5. Motakatla, V.R.; Liu, W.; Hao, J.; Padullaparti, H.V.; Kumar, U.; Choi, S.L.; Mendoza, I. Integrated Transmission and Distribution Co-Simulation Platform for Demonstration of Bulk Grid Services Using Distributed Energy Resources. *Energies* **2024**, *17*, 3215. [CrossRef]
6. Vujkov, B.; Dragić, M.; Žnidarec, M.; Popadić, B.; Šljivac, D.; Dumnić, B. Evaluation of Different Methodologies for Wave Energy Conversion Systems Integration into the Power Grid Using Power Hardware-in-Loop Emulation. *Energies* **2024**, *17*, 2826. [CrossRef]
7. Mitrovic, A.; Strezoski, L.; Loparo, K.A. Doubly Fed Induction Machine Models for Integration into Grid Management Software for Improved Post Fault Response Calculation Accuracy—A Short Review. *Energies* **2025**, *18*, 147. [CrossRef]

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