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EDITED AND REVIEWED BY
ZhaoYang Dong,
City University of Hong Kong, Hong Kong SAR, China

*CORRESPONDENCE
Sumit Kumar Jha,
sumitkumarjha00@gmail.com

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# Editorial: Demand side management in microgrids

Sumit Kumar Jha[1]*, Almoataz Abdelaziz[2,3], Deepak Kumar[4] and Bidyadhar Subudhi[5]

[1]School of Electrical and Computer Sciences, IIT Bhubaneswar, Khordha, Odisha, India, [2]Faculty of Engineering and Technology, Future University in Egypt, Cairo, Egypt, [3]Faculty of Engineering, Ain Shams University, Cairo, Egypt, [4]Department of Electrical and Electronics Engineering, Birla Institute of Technology, Ranchi, India, [5]School of Electrical Sciences, IIT Goa, Ponda, India

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Editorial on the Research Topic
Demand side management in microgrids

As the demand for sustainable and efficient energy solutions grows, there is a growing emphasis on innovative strategies, such as demand-side management, to optimize energy consumption and improve system efficiency. Recognizing and nurturing the next-generation of leaders in energy research is critical to advancing these innovations and ensuring a sustainable energy future.

This Research Topic focuses on adopting demand-side management (DSM) strategies within decentralized microgrid structures, enabling consumers to align their consumption patterns with grid utility requirements. Currently, 10 papers have been accepted for this Research Topic, addressing areas such as advanced control algorithms for DSM implementation, techno-economic analysis of microgrids, efficient microgrid energy management system designs incorporating demand response programs, advanced DSM frameworks for microgrids featuring smart load monitoring and intelligent load controllers to minimize peak demand and energy costs, and short-term energy prediction techniques. By showcasing the key findings and innovations across these ten diverse articles, this Research Topic aims to deepen the understanding of current advancements in energy research and their potential contributions to a sustainable future.

Ou Ali et al. tackle the challenge of forecasting energy consumption in smart homes using AI-driven approaches. They propose two hybrid deep learning models, ConvLSTM and CNN-LSTM, and compare their performance with baseline LSTM and CNN models. Results from real-world data reveal that ConvLSTM delivers significantly improved prediction accuracy over various time horizons.

Ji et al. investigate low-carbon economic dispatch for multi-regional integrated energy systems with a joint demand response mechanism. Their model integrates energy conversion, carbon trading, and green certificate mechanisms to minimize costs and emissions, with simulation results showing a reduction in total system cost and carbon emissions by 14.03% and 26.04%, respectively. In another study, Ji et al. propose a low-carbon economic dispatch strategy for integrated energy systems, incorporating price-based and substitution-based demand response models along with a green certificate-carbon trading mechanism, demonstrating its effectiveness in reducing system operating costs and emissions. Basu et al. tackle reactive power compensation in power systems by optimizing capacitor placement through various evolutionary programming techniques. Their approach is tested on isolated microgrids with renewable energy sources and electric vehicles, aiming to minimize real power loss both with and without demand response programs. Basu et al. propose demand response strategies to optimize reactive power compensation (RPC) in microgrids through capacitor allocation and sizing using evolutionary programming methods. This approach reduces real power loss in isolated microgrids, showcasing the advantages of demand response programs in enhancing system efficiency with diverse renewable energy sources.

Zarei et al. propose a multi-objective optimization framework for the optimal power flow problem, utilizing demand response as a cost-effective solution to power plant expansion. The framework incorporates short-term demand forecasting through LSTM networks and optimizes the allocation of energy storage systems and load aggregators. Numerical results demonstrate a 22% reduction in system costs, a 10% decrease in peak demand, and a 2% reduction in voltage variation, all with minimal impact on customer convenience. Additionally, Ghadi et al. introduce a hybrid GA-SFLA algorithm to optimize the placement and reconfiguration of energy storage systems, electric vehicles, and distributed generation in distribution networks. Simulation results demonstrate notable enhancements in network resilience, loss reduction, and operational cost efficiency compared to alternative optimization techniques.

Meng et al. propose a decentralized control strategy for thermostatically controlled loads (TCLs) to assist in power system frequency regulation. The strategy employs a data-driven method to model TCL power and incorporates a measurement error correction technique. Simulation results demonstrate its effectiveness in reducing frequency fluctuations.

Basu et al. enhance power system performance by applying FCJHPDEED and JHPDEED with DSM, incorporating renewable energy sources such as solar PV, wind, and pumped hydro storage. Their findings indicate that solutions without fuel constraints lead to reduced costs and emissions compared to those with fuel constraints. Moreover, Jianyuan et al. enhance power system performance by improving load identification with a Residual Attention Network (RAN) that converts one-dimensional signals into two-dimensional images, enabling better classification and recognition. This approach boosts accuracy, alleviates energy shortages, and optimizes grid management on the user side. Bustos-Brinez et al. introduces a methodology for substation data analysis that enhances power system performance by identifying consumption patterns, analyzing distribution, and detecting anomalies. Tested on data from Colombian substations, this approach supports real-time monitoring and load forecasting, offering critical insights for electricity distribution decision-making.

This Research Topic underscores the pivotal role of demand-side management strategies within decentralized microgrid structures in driving sustainable energy solutions. The ten articles featured in this Research Topic span a broad spectrum of energy research, showcasing the diversity and depth of current advancements in the field. Together, these studies delve into advanced forecasting techniques, low-carbon economic dispatch models, and innovative optimization frameworks, delivering notable improvements in system efficiency, cost savings, and carbon emissions reduction. Key contributions include hybrid AI models for energy forecasting, demand response strategies for reactive power compensation, and decentralized control approaches for frequency regulation. By tackling critical challenges and presenting innovative solutions, these works contribute significantly to building a more resilient and sustainable energy future.

## Author contributions

SJ: Conceptualization, Investigation, Writing – original draft, Writing – review and editing. AA: Data curation, Supervision, Validation, Writing – original draft, Writing – review and editing. DK: Conceptualization, Formal Analysis, Supervision, Validation, Writing – original draft, Writing – review and editing. BS: Investigation, Supervision, Validation, Writing – original draft, Writing – review and editing.

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