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Editorial
Special Section on Invited Papers in 2021 on Emerging Topics in the Power and Energy Society

I. INTRODUCTION

THE publication of the 2020 Special Section of Invited Papers on Emerging Topics in the Power and Energy Society (PES) received broad interest from diverse readers of the PES community. We continued to publish the special section for another year. After a rigorous peer-review process, a total of 13 papers [A1]–[A13] were accepted for publication in this invited section of the IEEE OPEN ACCESS JOURNAL OF POWER AND ENERGY (OAJPE) in 2021.

Each paper has been led by at least one senior expert from academia, industry or government with diverse geographical locations, and the papers have covered a variety of emerging topics. Nine papers reported their latest research results [A1]–[A9], and four papers provided authoritative reviews of past works combined with visionary insights into their respective topics [A10]–[A13].

II. RESEARCH PAPERS

In [A1], Rahman *et al.* first discussed the participation of Grid-interactive Efficient Buildings (GEB) as active elements in microgrid energy management. Then, the authors proposed a framework of GEB for efficient, safe, reliable, and secure microgrid management, with the presence of photovoltaic (PV) generations and energy-efficiency applications. A case study was provided to demonstrate the proposed framework.

In [A2], Cerna *et al.* proposed a load factor assessment algorithm, called MIQCP, for optimal scheduling of electrical loads in residential, commercial, and industrial sectors. The proposed model also considers the uncertainties of consumers' habits, information related to loads, energy prices, and the technical constraints of the grid. It was demonstrated and verified in a test electrical grid with different types of consumers and loads, and the results showed significant energy and cost savings.

In [A3], Sarajpoor *et al.* proposed a clustering framework for time aggregation of wind and load data, which can preserve the shape of both datasets as well as their joint behavior. A case study considering a wind source, an energy storage system, and two conventional generators was performed in this study to demonstrate the performance improvement based on the proposed clustering approach.

In [A4], Essakiappan *et al.* presented from multiple U.S. national labs and research institutes a multi-site securely networked experimental platform to evaluate OpenFMB, a framework that enables interoperability, distributed intelligence, and control at the grid-edge; and potentially improves grid resiliency. The OpenFMB platform was developed at three sites using standards-based approaches and open-source tools for cost-effective and timely adoption.

In [A5], Chen *et al.* proposed a dispatch model considering probabilistic transient stability constraints and high-penetration wind power. A machine-learning approach was also proposed to convert the probabilistic transient stability constraints to explicit dispatching constraints in order to avoid extensive transient simulation. The algorithm was tested on modified IEEE 68-bus and 300-bus systems to validate the effectiveness of the proposed algorithm.

In [A6], Guo *et al.* proposed a self-dispatch algorithm for real-time decisions based on presently available information. The proposed algorithm employs the Lyapunov optimization framework to maximize the long-term average revenue of wind-storage integrated power plants. Predictions of uncertain electricity prices and wind outputs are not needed in this algorithm. A numerical study validated the performance of the proposed algorithm.

In [A7], Chaspierre *et al.* addressed the dynamic reduced-order equivalent model of distribution networks with inverter-based generators. The proposed identification algorithm handles the cases when the operating conditions of the active distribution network (ADN) vary. The accuracy of the equivalent model was demonstrated in an unstable scenario typical of voltage instability, and its use was illustrated in a large-scale application with numerous instances of the ADN equivalent attached to the IEEE Nordic transmission test system.

In [A8], Cifuentes *et al.* proposed a new fault location approach, which differs from classic solutions based on impedance, traveling wave, or machine learning. The proposed approach employs the fault's transient intermediate frequency response and then characterizes transient responses to features related to fault locations that can be fitted using a polynomial regression. The full algorithm was verified with an EMT simulation study in PSCAD.

In [A9], Borghetti *et al.* evaluated the contribution of the lightning electromagnetic pulse (LEMP) on the overvoltages due to direct lightning strikes to overhead power lines, which has been disregarded in conventional approaches. The paper also explored the LEMP effect on the probability of flashovers on different phases. Studies based on EMTP and three-dimensional finite-difference time-domain (3D-FDTD) show a significant increase in the expected number of multi-phase flashovers.

III. REVIEW AND VISIONARY PAPERS

In [A10], Wang *et al.* reviewed applications of synchrophasor data using the low-rank property for reliable data recovery. Recovery techniques related to low-rank property including the matrix method, the tensor method, the adaptive filtering method, and machine learning were also reviewed. Then, the authors provided a review of typical applications such as missing data recovery, bad data detection, and disturbance recognition.

In [A11], Nguyen *et al.* provided a comprehensive review of frequency response when a considerable number of renewable power plants are integrated into the system leading to a low-inertia grid. Effects on frequency stability, penetration limit, and reliability were discussed. Improvements for energy storage systems were elaborated on for future opportunities to mitigate the impact of renewables.

In [A12], Dong *et al.* discussed the challenges of the paradigm change from conventional fossil fuel-based generation to renewables. They envisioned digitalized future energy systems (DFES) in an interdisciplinary perspective to ensure secure, reliable, affordable, and sustainable electrical energy delivery. Six key research themes, including energy storage integration, transportation electrification, robust physical connection, cyber systems and security, social-political-economic frameworks, and legal-regulatory frameworks, were proposed to address the interdisciplinary challenges of DFES.

In [A13], Saha *et al.* opened the discussion by reviewing several space programs to build permanent, manned bases on the Moon. Then, available technologies for a space microgrid on the Moon were discussed. Specific characteristics of power generation, consumption, and storage technologies in the space microgrids on the Moon were elaborated. Finally, a control framework for autonomous, reliable, and safe operation of space microgrids was discussed.

IV. CONCLUSION

This special section of 13 invited papers covers emerging topics including load management, dispatch and control of renewable energy and energy storage, synchrophasor measurement, fault location, lighting protection, inverter-based generations, distribution networks, microgrids, and digitalization of future grids. We are confident that these papers will be valuable literature for future research in the PES community.

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APPENDIX: RELATED ARTICLES

[A1] S. Rahman, A. Haque, and Z. Jing, "Modeling and performance evaluation of grid-interactive efficient buildings (GEB) in a microgrid environment," *IEEE Open Access J. Power Energy*, vol. 8, pp. 423–432, 2021.

[A2] F. V. Cerna, M. Pourakbari-Kasmaei, E. Naderi, M. Lehtonen, and J. Contreras, "Load factor assessment of the electric grid by the optimal scheduling of electrical equipment—A MIQCP model," *IEEE Open Access J. Power Energy*, vol. 8, pp. 433–447, 2021.

[A3] N. Sarajpoor, L. Rakai, J. Arteaga, and H. Zareipour, "A shape-based clustering framework for time aggregation in the presence of variable generation and energy storage," *IEEE Open Access J. Power Energy*, vol. 8, pp. 448–459, 2021.

[A4] S. Essakiappan *et al.*, "A multi-site networked hardware-in-the-loop platform for evaluation of interoperability and distributed intelligence at grid-edge," *IEEE Open Access J. Power Energy*, vol. 8, pp. 460–471, 2021.

[A5] Y. Chen, S. M. Mazhari, C. Y. Chung, and S. O. Faried, "A preventive dispatching method for high wind power-integrated electrical systems considering probabilistic transient stability constraints," *IEEE Open Access J. Power Energy*, vol. 8, pp. 472–483, 2021.

[A6] Z. Guo, W. Wei, L. Chen, Y. Chen, and S. Mei, "Real-time self-dispatch of a remote wind-storage integrated power plant without predictions: Explicit policy and performance guarantee," *IEEE Open Access J. Power Energy*, vol. 8, pp. 484–496, 2021.

[A7] G. Chaspierre, G. Denis, P. Panciatici, and T. Van Cutsem, "A dynamic equivalent of active distribution network: Derivation, update, validation and use cases," *IEEE Open Access J. Power Energy*, vol. 8, pp. 497–509, 2021.

[A8] N. Cifuentes and B. C. Pal, "A new approach to the fault location problem: Using the fault's transient intermediate frequency response," *IEEE Open Access J. Power Energy*, vol. 8, pp. 510–521, 2021.

[A9] A. Borghetti, K. Ishimoto, F. Napolitano, C. A. Nucci, and F. Tossani, "Assessment of the effects of the electromagnetic pulse on the response of overhead distribution lines to direct lightning strikes," *IEEE Open Access J. Power Energy*, vol. 8, pp. 522–531, 2021.

[A10] M. Wang *et al.*, "Review of low-rank data-driven methods applied to synchrophasor measurement," *IEEE Open Access J. Power Energy*, vol. 8, pp. 532–542, 2021.

[A11] N. Nguyen, D. Pandit, R. Quigley, and J. Mitra, "Frequency response in the presence of renewable generation: Challenges and opportunities," *IEEE Open Access J. Power Energy*, vol. 8, pp. 543–556, 2021.

[A12] Z. Y. Dong and Y. Zhang, "Interdisciplinary vision of the digitalized future energy systems," *IEEE Open Access J. Power Energy*, vol. 8, pp. 557–569, 2021.

[A13] D. Saha *et al.*, "Space microgrids for future manned lunar bases: A review," *IEEE Open Access J. Power Energy*, vol. 8, pp. 570–583, 2021.