Editorial for the Special Issue on Emerging Technology and Advanced Application of Energy Storage in Low-carbon Power Systems

With the increasing concern about climate change, environmental pollution, and sustainable development, the energy system is evolving towards a low-carbon form powered by a large share of renewable energy. Renewable generation from wind and solar is intermittent and volatile, posing great challenges to the secure and economical operation of power systems which requires simultaneous balance between power demand and supply. In this regard, various energy storage, including battery, pumped storage, compressed-air storage, flywheel, supper-capacitor, etc., are recognized as indispensable technologies to deal with the intermittency from renewables and facilitate the low-carbon transition of power systems. Energy storage can be implemented in different parts of the power supply chain from generation-side to grid-side and demand-side, and can benefit the power system operation in multiple time scales from seasonal energy balance to near-real-time stability control.

This special issue seeks to inspire ideas related to emerging energy storage techniques and their application to power systems, with a broad spectrum of research topics including modeling, control, and design regarding single storage stations, as well as planning, operation, the market mechanism for the system-level integration of vast and diversified storages. Topics of interest include, but are not limited to, 1) Techno-economic analysis of emerging storage techniques for power system application. 2) Modeling, state estimation, health prognostic, and charge control for battery storage systems. 3) Data science, AI, machine learning, and digital twins for energy storage modeling and control. 4) Design and control of efficient power converters for energy storage integration. 5) Seasonal energy storage systems for long-term balance. 6) Stability support from inverter-based energy storage. 7) Optimal dispatch of energy storage in power systems with a high share of renewable generation. 8) Planning and configuration of energy storage in low-carbon power systems. 9) Market design and pricing mechanism for the integration of energy storage. 10) Energy sharing and transactive energy for demand-side energy storage. 11) Aggregation and control of generalized energy storage from flexible loads and multi-energy systems.

The call for paper of the CJEE Special Issue on Emerging Technology and Advanced Application of Energy Storage in Low-carbon Power Systems was published in September, 2022, 4 papers were accepted after rigorous reviews. These accepted papers address different challenges with innovative solutions.

The first paper “Experimental study on the effect of state of charge on failure propagation characteristics within battery modules” by K. Li et al. carried out an experimental study on the effect of state of charge (SOC) on failure propagation characteristics within battery modules. The research found that a higher SOC would reduce the average failure propagation time between two adjacent cells and lead to more violent thermal runaway propagation. These results can provide references for the thermal safety design of energy-storage battery modules.

The second paper “Resilience-oriented valuation for energy storage amidst extreme events” by Y. Wu et al. proposed a resilience-oriented valuation method for energy storage amidst extreme events. A two-stage emergency dispatch model for optimizing power system operations under extreme conditions and a resilience value index are proposed for energy storage, which provides valuable strategies for configuring different energy storage systems and capacities.

The third paper “Value evaluation method for pumped storage in the new power system” by Y. Peng et al. proposed a value evaluation method for pumped storage in the new power system. A multidimensional value quantitative model was constructed according to the overall system benefits, including the economic, safety, social,

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and environmental benefits generated by the superposition of the multiple functions of pumped storage power stations. The results show that the value of pumped storage power stations increases with the development of the new power system and the value structure is closely related to power grid characteristics.

The fourth paper "Fast solution method for large-scale unit commitment problem with long-term storage" by B. Li et al. proposed a fast solution method for large scale unit commitment problem with long-term storage. A Bi-level optimization approach is proposed to solve a long-term unit commitment with LTS based on time horizon splitting, which reduces the computation time significantly.

We appreciate the effort from all authors who had submitted papers and we appreciate reviews from Associated Editors and reviewers. Many thanks to all Guest Associate Editors for their diligence and support:

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