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Editorial: Planning and Operation of Hybrid Renewable Energy Systems

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Editorial on the Research Topic

Planning and Operation of Hybrid Renewable Energy Systems

Renewable energy sources such as wind and solar power have attracted worldwide attention as ways of addressing energy shortages and carbon emission issues, meaning they have become largely integrated into power systems. However, the utilization of renewable energy brings great challenges in terms of the planning and operation of the power system due to its uncertainty and intermittency. Hybrid renewable energy systems (HRESs), which combine different kinds of renewable energy sources, make the system more complex to plan and operate. On the other hand, the characteristics of several renewable energy provide an opportunity to take advantage of and achieve better planning and operations.

This Frontiers Research Topic aims to present state-of-the-art studies on the planning and operation of HRESs. A total of 22 papers were accepted to this collection after careful peer-to-peer review, covering the following three categories.

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PLANNING OF HYBRID RENEWABLE ENERGY SYSTEMS

To minimize the curtailment of renewable energy, power to hydrogen (P2H) plays an important role in improving renewable energy integration. Wang et al. propose a two-stage stochastic mixed-integer nonlinear planning framework to decide on P2H sizing and siting to reduce the total capital and operational costs. In deciding the locations of pumped storage plants, photovoltaic and wind power, Qing et al. introduce a bi-layer planning optimization model to reduce the cable cost and the distribution network operation cost. Wang et al. studied both the energy generation benefits and investment costs of a large-scale photovoltaic plant in undertaking its economic evaluation. Batteries also play an important role in the utilization of renewable energy, and Wang et al. provide reasonable investment suggestions for the stepwise utilization of retired power batteries based on economic boundary value models. To enable optimal crop growth and maintain low operation costs, Tian et al. optimize the capacity of the combined cooling, heating and power supply, energy storage, and air source heat pump.

SCHEDULING OF HYBRID RENEWABLE ENERGY SYSTEMS

To better undertake the energy scheduling of HRESs, the characteristics of renewable energy should be taken into account. One way to do this is to improve the prediction accuracy, as outlined in the work by Li et al., and another is to consider its uncertainty. With the consideration of the

uncertainty of renewable energy sources, the energy of the data center microgrid is scheduled in the contribution by Zhu et al. to minimize the operation cost and maintain system stability. Since multiple energy sources make the system more complex and hard to obtain the optimal schedule, Tian et al. and Wang et al. design solving algorithms for scheduling optimization and these algorithms improve the computation efficiency. In addition, the HRESs should be scheduled in the normal condition and Wang et al. and Xiong et al. achieve fault detection based on a neural network.

CONTROL OF HYBRID RENEWABLE ENERGY SYSTEMS

With the increasing penetration of renewable energy generation, the frequency stability of a power grid is significantly threatened, Yang et al. and Xu et al. boost the frequency nadir and guarantee rapid frequency stabilization. Liu et al. contribute to the transient stability of the HRESs. For the voltage challenge, Wang et al. investigate the dual-loop voltage–current control to manage voltage sags and Shang et al. enhance grid voltage dynamics. As new energies are integrated into the grid, the harmonics become more serious, Suo et al. introduce a multi-time-scale harmonic mitigation method based on model predictive control and Li et al. adopt the neutral-point potential control of interleaved parallel three-level inverters. Li et al. improve the converter design method to reduce the current total harmonic distortion of the grid side. In addition, to obtain a stable wind turbine output, a pitch control strategy is proposed in the work by Shao et al. Li et al. control the charging and discharge of batteries to improve the operation stability and economy of a DC microgrid. Zhao et al. designed an active impedance to suppress the resonance of the multi-inverter parallel system to improve power quality.

Overall, recent years have seen great progress in the planning and operation of HRESs. However, there are still many challenges and opportunities related to the further integration of renewable energy sources, and the theory and technology of HRESs need to be further investigated.

AUTHOR CONTRIBUTIONS

WH wrote the draft and other authors gave the suggestions and did the proofreading.

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