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EDITORIAL
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Editorial: Security and Resilience Enhancement of Future Smart Grid: Models and Methods

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Editorial on the Research Topic

Security and Resilience Enhancement of Future Smart Grid: Models and Methods

The modern power systems are moving towards the future smart grid where increasing penetration of renewable energy sources (RES) and power electronics is expected. While enabling the realization of low-carbon power systems, the high penetration of RES reduces the security margin and resilience of power systems against extreme events and disturbances. Meanwhile, power systems suffer from increased vulnerabilities and security risks due to the growing integration of information and communication technologies (ICT) in this ongoing transformation. As the consequences of power system interruptions can be disastrous, enhancing the security and resilience of power systems with practical methods has become a critical topic for the power industry.

With high penetration of renewables and deep integration of ICT in power systems, many challenges require further research to achieve secure and resilient operations of the power grids. State-of-the-art techniques and technologies are needed to prepare the power systems for potential threats from extreme events and disturbances. Thus, this Research Topic focuses on the emerging models and methods for the security and resilience analysis and enhancement of future power systems with high penetration of renewables, power electronics and ICT.

This Research Topic includes four articles on the resilient control and stability analysis of grid-tied power electronic systems, resilience assessment of synchrophasor communication network (SCN), and security risk analysis of communication networks for power systems. They are summarized as follows.

On the resilient control front:

To achieve resilient control of the grid-tied inverters for photovoltaic (PV) systems, Liu et al. proposed an equivalent input disturbance (EID) based current controller to mitigate the disturbance due to non-ideal grid voltage and dead-time effect in the paper entitled *Equivalent Input Disturbance-Based Control Design for Three Phase Dual-Stage Grid-Tied Photovoltaic System Considering Dead Time Effect*. By estimating and compensating the lumped disturbance, the proposed EID based current control strategy achieved effective disturbance rejection as demonstrated in the simulations.

On the stability analysis front:

In the paper entitled *Describing Function Analysis of Sustained Oscillations in Grid-tied Voltage-source Converter with Double Saturation Limiters*, Huang et al. established the models of sustained oscillation phenomena of the double saturation limiters in grid-tied voltage-source converters based on the describing function by considering the dynamical response of the saturation limiters, and

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provided a method to evaluate the amplitude and frequency of the sustained oscillations with the describing-function-based Nyquist criterion. The results presented in the paper clearly demonstrate the impacts of the saturation limiters on the sustained oscillations in power electronic-based power systems.

On the resilience assessment front:

In the paper entitled *Resiliency Estimation of Synchrophasor Communication Networks in a Wide Area Measurement System*, Appasani et al. presented a quantitative metric to estimate the resilience of SCN, and proposed a multi-objective model for the optimal placement of phasor measurement units (PMUs) and phasor data concentrator (PDC) to improve the resilience of SCN and observe the power system with the minimum number of PMUs. Based on the resilience estimation metric, the proposed method aimed to assist in the proper planning and placement of the communication infrastructure in a wide area measurement system (WAMS) which can enhance the resilience of the power grid.

On the risk analysis front:

In the paper entitled *Power 5G Hybrid Networking and Security Risk Analysis*, Jiang et al. proposed a hybrid networking architecture of 5G and power communication network after analyzing the security, delay, independence, cost, and staffing of five different 5G networking construction plans. Meanwhile, the authors performed a security risk assessment on the hybrid 5G and power communication networking model to analyze the risks introduced by 5G technology to power grids in the paper.

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The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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