

Key technologies and applications for preventing and controlling grid-connected security risks of massive distributed resources

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Keywords: distributed resources, demand side management, grid-connected security risks, risk management

Abstract

In recent years, the penetration rate of new energy sources, including distributed photovoltaics, has continued to increase. The large-scale adoption of various power electronic loads, including electric vehicle charging stations and frequency conversion equipment, has profoundly changed the form and operating characteristics of traditional power grids. As a result, the sources, risk formation mechanisms, and transmission paths of network security risks associated with massive distributed resources are becoming increasingly complex and variable. Problems such as localized voltage over-limits and reverse power flows from distributed power sources, leading to heavy overloads of distribution equipment, harmonic pollution, and three-phase imbalance, are becoming increasingly prominent. Their impact is no longer limited to the distribution network level, but rather presents a risk trend of extending from the distribution network to the larger power grid, posing a severe challenge to the overall safe and stable operation of the power system. Therefore, it is urgent to overcome the key technical bottlenecks in the prevention and control of network security risks associated with massive distributed resources, comprehensively improve the proactive defense and coordinated management capabilities of network security risks, optimize the security boundaries and adaptability of distributed resources connected to the power grid, promote coordinated safety governance between the grid and loads, and provide solid support for building a safe, reliable, and efficient new power system.

This presentation begins by introducing the current development status of large-scale distributed resources and the security challenges that pose for grid-connected systems. The research scope and boundaries in the field of grid-connected security for distributed resources are then defined. Key technologies and applications for preventing and controlling grid-connected security risks are discussed in detail, including risk mechanism modeling and simulation, risk perception and identification, risk assessment and early warning, fault localization and tracing, and collaborative emergency response technologies. Finally, the main points of the presentation are summarized, and future directions for grid-connected security risk prevention and control of distributed resources are outlined.