

Incorporating DSO's Situational Awareness in Resilience-Oriented Distribution System Planning

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One of the key distinctions between extreme weather events and random events in distribution systems is the level of predictability. The distribution system operator (DSO) can anticipate the upcoming extreme weather event and its effects, which is impossible in random events. Thus, the DSO can prepare the system by taking appropriate actions to tackle the upcoming event. This characteristic provides the DSO with operational situational awareness (SA) against extreme weather events. Considering this DSO's capability in evaluating the system resilience against extreme weather events results in a more realistic resilience estimate. This paper proposes a model for resilience-oriented distribution system planning (RODP) in which the value of the DSO's SA is considered and modeled (namely, SA-RODP). The proposed two-stage stochastic model is formulated as a mixed-integer linear programming (MILP) problem. In the first stage, hardening sections and installing emergency distributed generations (DGs), battery energy storage systems (BESSs), and automatic switches are modeled. The second stage contains the DSO's decisions corresponding to operation scenarios. These decisions are made in two successive operation periods, namely, the preventive operation period (before the event to prepare the system) and the emergency operation period (during and after the event to mitigate the effects of the event). The DSO's decisions in the preventive operation period are made according to each scenario, reflecting the DSO's SA. The objective function of SA-RODP comprises the investment costs of the first stage and the expected operation cost of the second stage. The model constraints include the investment constraints and power flow and operational requirements constraints in each scenario. The model's effectiveness is validated by several numerical simulations on the IEEE 33-bus test system. SA-RODP model simultaneously reduces the required investment cost and boosts the system resilience compared to conventional RODP frameworks in which the DSO's SA is not considered. Further, this model increases the DSO's capability to confront extreme weather events.