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Enabling resiliency using microgrids with dynamic boundaries

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Abstract-

With the increased frequency of adverse weather and manmade events in recent years, the issue of the power distribution system (PDS) resiliency has become drastically important. Microgrids with various types of distributed energy resources (DERs) have capabilities to enhance the PDS’s resiliency against high impact low probability (HILP) events. Resiliency is defined as the ability of the system to keep supplying critical loads even during and after extreme contingencies. This paper presents a systematic method to segmentize parts of a PDS into microgrids with flexible boundaries to enhance resiliency and mitigate negative impacts from anticipated threats. The method is aimed at anticipation and preparation to HILP events in advance: alternative flexible boundaries of the microgrids must be preplanned during normal operation and dynamically changed prior to or during disturbances. The Mixed-Integer Linear Programming (MILP) is formulated and applied to select switching actions to adjust microgrids’ boundaries as well as to supply critical loads, while meeting system constraints. Networked microgrids are merged and reconfigured as necessary to maximize supply to critical loads, driven by a factor-based resiliency metric, which is obtained using the Analytical Hierarchy Process (AHP). The modified IEEE 123 bus system was utilized for validation of the proposed method. Compared with the traditional fixed-boundary microgrids, this approach determines the most resilient network configuration to supply high-priority critical loads. The developed method can be employed in power system planning, operation, and in decision-making to enhance operational resiliency and invest in system upgrades appropriately.

Index Terms- Power system resiliency; Analytic hierarchy process; Automated switches; Distributed energy resources; Graph theory; Microgrid with dynamic boundaries

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