DISTRIBUTION SYSTEM BLACKSTART AND RESTORATION USING DERS AND DYNAMICALLY FORMED MICROGRIDS

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OVERVIEW

Extreme weather events have increasingly caused long-duration outages in distribution systems, highlighting the need for innovative blackstart and restoration strategies. Traditional blackstart approaches rely on blackstart units to form multiple microgrids (MGs), sequentially energize non-blackstart units, and restore loads. However, these methods often lead to isolated MGs whose operation is constrained by the limited energy capacity of typical blackstart resources, such as battery energy storage (BES)-based grid-forming inverters (GFMIs). This seminar presents a holistic blackstart and restoration framework that enables synchronization among dynamic MGs and with the transmission grid (TG). A virtual synchronous generator–based control strategy is introduced to predict the frequency response of GFMIs to load pick-up events using only initial and final quasi–steady-state points. Furthermore, synchronization switching conditions are developed to represent synchronizing switches within a linearized branch flow model. Building on these developments, a bottom-up blackstart and restoration framework is designed that accounts for the switching configuration of the distribution system, energizing and synchronizing switches, DERs with grid-following inverters, and BES-based GFMIs under frequency security constraints. The proposed framework is validated on the IEEE 123-bus system for scenarios involving two and four GFMIs under varying transmission grid recovery times.

BIO

Dr. Salish Maharjan received his PhD in Electrical and Computer Engineering from the National University of Singapore in 2020. He is currently a Research Assistant Professor with the Department of Electrical and Computer Engineering at Iowa State University. His research interests include distribution system modeling, stability analysis, and optimization and control for techno-economic operation and resilience enhancement. He is the recipient of the Best Paper Award at the 2023 and 2025 IEEE Power & Energy Society General Meetings.