Impact of Renewables on System Protection and Impact of IEEE Std 2800-2022 Requirements

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OVERVIEW

The increased integration of renewable Inverter-Based Resources (IBRs) such as wind, solar, and battery storage in the bulk power system leads to challenges for reliable operation of system protection. Traditionally, protective relays have been designed and set with the expectation of high fault currents and dynamic behavior dominated by synchronous generators. Short circuit analysis tools and models have also been developed over several decades around these assumptions. Nevertheless, these assumptions may no longer hold under IBRs, due to the different short circuit and dynamic characteristics of these resources.

Specifically, IBRs cannot provide fault currents significantly higher than their nominal current without additional increase in their power electronic hardware rating. Further, their fault response is highly dependent on often proprietary and non-universal inverter control scheme. These differences may lead to misoperation of protective relays, i.e., they may operate unnecessarily/unpredictably or fail to operate where they should. This seminar studies the impact of renewables on a variety of protective relay schemes including:

- Line distance protection
- Negative sequence quantities-based protection elements
- Line current differential protection
- Phase comparison protection
- Power swing protection
- Rate-Of-Change-Of-Frequency (ROCOF) protection
- Memory-polarized protective relay elements.

For each protection function, potential misoperation scenarios are identified, and recommendations are suggested to address the misoperation issue. The objective is to provide an improved understanding of the way renewables may negatively impact the performance of traditional protection schemes as a first step towards developing future remedial solutions ensuring effective protection under high share of renewables.

The seminar will also talk about the recently approved IEEE Standard 2800-2022 which establishes "technical minimum requirements for the interconnection, capability and performance of inverter-based resources (solar, wind & storage plants, including those connected via VSC-HVDC like offshore wind) interconnected to transmission and sub-transmission systems." Specifically, the presentation will review scope, purpose, and specified requirements with focus on voltage ride-through and fault current injection requirements and the impact on system protection.

BIO

Dr. Aboutaleb Haddadi received his PhD in electrical and computer engineering from McGill University, Montreal, QC, Canada, in 2015. Since 2020,

he has been with EPRI as a Senior Technical Leader where he leads R&D activities related to bulk system and distributed renewable energy resources modeling and system integration impacts. Aboutaleb is the Chair of CIGRE working group C4.60 and is further active in a number of working groups of IEEE Power and Energy Society, Western Electricity Coordinating Council, and North American Electric Reliability Corporation. His research interests include: renewable resource integration, power system protection, and power system modeling and simulation.