Tham Xuan Nguyen

Title of the doctoral dissertation:

Enhancing operational capability of Islanded Microgrids through Optimal Multiple Droop-based DG Placements

Abstract:

Islanded microgrids, defined by their self-healing characteristics, are a crucial part of a state-of-the-art grid and support the vision of a resilient and sustainable infrastructure of the future.

Droop-based distributed and dispersed generators (DG) within microgrid off-grid operation mention DGs in a microgrid that use a control algorithm determined by the properties of frequency and voltage droop gains. These techniques allow DGs to regulate their production power in response to variations in voltage and frequency.

Robust methodologies are described by their systematic and resilient nature, aiming to yield stability, adaptability, and dependability in the face of shifting barriers and uncertainties. It is necessary to reach accurate and dependable findings in the analysis of electrical systems.

The Modified Backward-Forward Sweep (MBFS) load flow approach is a numerical method employed to determine the energy flow in the power grid and identify optimal operational points. The backward-forward sweep is a computational technique that verifies that the power flow equations, together with operational constraints, are met at each bus by starting at the termination of the electric power system (load nodes), moving backward to the source (generator nodes), and then forward again. The 'modified' in MBFS, an expansion of the conventional backward-forward sweep technique, aims to enhance the accuracy and speed of its convergence.

Distributed and dispersed generator with compact size is preferred for deployment in microgrid networks (MG), including both grid-on and islanded modes, due to economic and technical benefits. Operating in the islanded microgrid mode, the DGs within the system control the microgrid voltage frequency and magnitude inside the intended bounds. In this operational scenario, DGs frequently use the droop law to share power for load due to their advantages, including the low cost of control and communication systems, inherent flexibility, and expandability. Employing droop-based DGs in microgrid grid-off operations significantly advances the future grid.

The operation of DGs through the droop law in off-grid MGs offers many benefits, as mentioned above. However, variations in local load over time, along with inappropriate output power of droop-DGs throughout the operational process, impact power quality and

regulate system voltage and efficient energy use. For these issues, this thesis focusses on addressing the optimal planning of droop-DGs in an islanded MG, namely suitable droop parameters (size) and placement using robust methodologies such as the MBFS power flow approach, and Differential Evolution and Honey Badger techniques-based metaheuristic algorithms. The primary objective is to diminish lost power and gain bus voltage.

The number and positioning of DGs affect the extent of mitigation of lost power in distribution networks. Therefore, this thesis also investigates the effect of installing the appropriate multiple-droop-DG locations within an islanded MG, taking into account time-varying load, to maximise potential lost power minimisation and increase the islanded MG voltage profile. To this end, the proposed methodologies consisting of the MBFS load flow approach and the Differential Evolution technique are used to tackle the problem mentioned above.

The simulation results achieved provide evidence of the productivity and superiority of the suggested techniques in contrast to pre-existing works for the proposed problems.

Wrocław, 15.02.2024 ....

(place, date)

....

(signature of the doctoral student)