Distributed Voltage Regulation of Smart Distribution Networks: Consensus-Based Information Synchronization and Distributed Model Predictive Control Scheme - DTU Orbit (30/09/2019)

This paper proposes a distributed voltage control (DVC) scheme for smart distribution networks with high penetration of inverter-based distributed generators (DGs), aiming to optimally coordinate DG units and on load tap changer (OLTC) transformer to regulate the voltages within the feasible range. The proposed scheme consists of two important parts: 1) distributed information synchronization (DIS) framework and 2) distributed model predictive control (DMPC)-based voltage control scheme. The DIS framework is established based on the consensus protocols to synchronize the specific information about the critical bus voltages and potential OLTC actions. The DMPC-based voltage control scheme is presented, in which each DG unit only exchanges information with its immediate neighbors and solves the local optimal control problem. Two control modes are designed to better deal with different operating conditions. In the normal mode, only the reactive power outputs of DG units are optimized to mitigate the voltage deviations. In the corrective mode, both of the active and reactive power outputs of DG units are optimally controlled to correct the severe voltage deviations. To mitigate the mutual interaction between the DGs and OLTC, the potential actions of OLTC are predicted and considered in the optimization problem of each units. The control performance of the proposed scheme was demonstrated using a real medium-voltage (MV) distribution network with two feeders under both normal and large-disturbance conditions.

General information
Publication status: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Electric Power Systems, Shandong University
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Pages: 58-65
Publication date: 2019
Peer-reviewed: Yes

Publication information
Volume: 111
ISSN (Print): 0142-0615
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Original language: English
Keywords: Consensus protocol, Distributed generator (DG), Distributed model predictive control (MPC), Smart distribution network, Voltage control
DOIs:
10.1016/j.ijepes.2019.03.059
Source: PublicationPreSubmission
Source ID: 170998707
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review