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An Efficient Tool for Mitigating Voltage Unbalance with Reactive Power Control of Distributed Grid-Connected Photovoltaic Systems

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Abstract : With the rapid increase of grid-connected PV systems over the last decades, genuine challenges have arisen for engineers and professionals of energy field in the planning and operation of existing distribution networks with the integration of new generation sources. However, the conventional distribution network, in its design was not expected to receive other generation outside the main power supply. The tools generally used to analyze the networks become inefficient and cannot take into account all the constraints related to the operation of grid-connected PV systems. Some of these constraints are voltage control difficulty, reverse power flow, and especially voltage unbalance which could be due to the poor distribution of single-phase PV systems in the network. In order to analyze the impact of the connection of small and large number of PV systems to the distribution networks, this paper presents an efficient optimization tool that minimizes voltage unbalance in three-phase distribution networks with active and reactive power injections from the allocation of single-phase and three-phase PV plants. Reactive power can be generated or absorbed using the available capacity and the adjustable power factor of the inverter. Good reduction of voltage unbalance can be achieved by reactive power control of the PV systems. The presented tool is based on the three-phase current injection method and the PV systems are modeled via an equivalent circuit. The primal-dual interior point method is used to obtain the optimal operating points for the systems.

Keywords : Photovoltaic system, Primal-dual interior point method, Three-phase optimal power flow, Voltage unbalance
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