A mixed integer second-order cone programming based active and reactive power coordinated multi-period optimization for active distribution network

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Accepted for publication on 18\textsuperscript{th} February 2016

With increasing penetration of distributed generation (DG), power fluctuation of DG may lead to over voltage violation and cascading tripping of DGs. Active and reactive power coordinated dynamic optimal dispatch can significantly mitigate these violations. A three-phase active and reactive power coordinated dynamic optimization model is proposed in this paper, whose control variables include the output power of DG, charge and discharge operation of ESS, operation strategy of static VAR compensation (SVC) and capacitor banks (CB). Since the original problem is nonconvex and hard to solve, a second-order cone relaxation based distflow is introduced. This model is formulated as a mixed integer second-order cone programming (MISOC) problem, which can be used to optimizing var-volt of three-phase active distribution networks efficiently and exactly.

In this paper, distflow power flow equations are used to describe the power balance constraints in radial distribution networks. Active and reactive power coordinated dynamic optimization model, considering the operations of DG, ESS, SVC and CB, is a large scale nonconvex mixed integer nonlinear programming problem. For solving this problem optimally and efficiently, the second order cone relaxation is introduced to release the nonlinear distflow power flow equations. Then the original model is transformed into a MISOC whose objective function is minimizing network losses. The MISOC can be solved effectively by interior-point method.

An active and reactive power coordinated dynamic optimization program is developed, which is based on Matlab-YALMIP platform with MOSEK and Bonmin solver. Numerical tests on a modified IEEE 33 case with solar radiation data generated from NREL Homer are analyzed. Numerical tests on IEEE 33-bus system demonstrate the optimality, exactness and efficiency of the proposed model.

Keywords: mixed integer second-order cone programming (SOCP), active and reactive power coordination, multi-period optimization, active distribution network (ADN)