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Abstract

Widespread use of distributed energy resources in distribution networks and the introduction of microgrids concept have led to changes in power system structure. On the one hand, these changes bring advantages for the power system such as power loss reduction, increased reliability. On the other hand, some challenges arise in power system operation process. Due to activation of distribution networks, dependency of requested loads of distribution networks to local marginal prices are increased. As a result, uncertainty in load profile is increased. Furthermore, neglecting active nature of distribution networks in conventional power system operation processes cause unnecessary congestions. This congestion result in an inappropriate evaluation of local marginal prices and benefits to generation companies and consumers are distorted, thereby possibly impairing the fairness of system operation. Consequently, conventional procedures of power system operation which consider distribution networks as a constant load are not suitable for power system operation.

In this dissertation, power system operation optimization considering distribution networks and microgrids is formulated. The new formulation could bring advantages and solve technical issues regarding activation of distribution networks. Besides, it maximizes economic efficiency of the power system. solving this optimization in a centralized manner is impossible because i) computation burden of the problem because of numerous component of the system, ii) centralized operation demands expensive and complex communication infrastructure to connect all components of the system which are located in a vast geographical area into a control center. Therefore, it is obligatory to operate power system in a decentralized manner. To solve operation optimization in a decentralized manner, this optimization is decomposed into three categories of optimizations using decomposition algorithms. These categories include optimization of independent system operator, optimizations of distribution network operators and optimizations of microgrid operators. To achieve a comprehensive and optimal scheduling, it is necessary to have a coordination between operators of different levels. Coordination between operators is carried out through the interrelating variable. Power exchange between each two grid and, local marginal prices and distribution local marginal prices are used as interrelating variables. It is necessary to exchange interrelating variable to obtain an agreement at the end of the scheduling process on the value of the interrelating variables.

Convergence and optimality of the proposed method has been shown with its implementation on modified 6 and 24 bus systems. The results achieved from testing the proposed method on 6 and 24 bus systems shows that the schedule obtained from the proposed method is consistent with the schedule obtained from the centralized method with acceptable accuracy. Sensitivity analysis shows that the proposed method is robust against the changes in different parameters of the system.

Keywords

Active distribution network, decentralized operation, microgrid.