INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Electricity generation and transportation sectors are significant contributors to the increasing carbon foot print of the society. The utilization of greener generation technologies in both these sectors is the solution to the increasing carbon emissions. However, increased penetration of DERs in distribution networks brings new challenges in the operation and management of power system, among which voltage fluctuation is the most severe. In this thesis, a rule-based model predictive control-based centralized control approach has been developed that optimally coordinates the different entities, such as, actions of on-load tap changer, distribution static synchronous compensator, and active and reactive power set-points of PV and EV inverters to manage the node voltage variations and fulfill other objectives, such as minimizing energy losses and line congestions. To investigate different volt/var control devices based on different temporal characteristics, the proposed control strategy has been further converted to a two-stage control structure. The two functionalities of active distribution management system, i.e., demand response and conservation voltage reduction strategies are included in this two-stage voltage control methodology to enhance energy efficiency of the distribution networks. Due to the availability of on-board chargers, opportunities emerge for EV to provide services to the distribution network operators through vehicle-to-grid technology. Although EV infrastructure benefits the distribution system through V2G services, the increasing number of EVs creates congestion in the feeders, resulting in network overloading. Thus, a dual-stage centralized control strategy has been developed to mitigate voltage variations and line congestion. Further, a three-stage MPC-based centralized coordinated approach has been further developed to schedule charging of EV and volt/var devices. The approach aims at maintaining bus voltage magnitudes and SoC of EV battery within desired limits with minimal usage of control resources and cost of electricity consumption. The economic aspects of EV aggregators in charge scheduling and reserve scheduling have been further evaluated to add value to the third stage. Moreover, Furthermore, the reactive power set-points achieved from the centralized control scheme follow the integrated local Q(V) characteristics according to DER integration standards so as to establish the control problem as multi-level control structure. The 33-bus and 38-bus radial distribution networks are used to validate all the proposed control approaches.