REACTIVE POWER MANAGEMENT FOR VOLTAGE STABILITY ENHANCEMENT AND COORDINATED FACTS CONTROLLER/SWITCHED SHUNT DISPATCH

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ABSTRACT

In this thesis, we examine the issue of reactive power management on a large power system. Reactive power management is a higher level of control that focuses on the long term. Our goals are to maintain voltage stability and coordinate the dispatch of shunt FACTS controllers with mechanically switched shunts. FACTS controllers currently in operation are only coordinated with switched capacitor banks to reset the reactive power output of the FACTS controller to a desired steady-state setpoint, which is typically zero.

We review the literature on recent shunt FACTS controller installations, specifically on operational experience and practical usage of FACTS controllers. We also focus for how FACTS controllers are typically coordinated with mechanically switched shunts and any other devices in the network.

We also review the literature on voltage stability indices and their derivation, utility, and applicability to the problem of reactive power management. We discuss the similarities and differences among the different indices and identify the ones which provide the most information.

Next, the reduced Jacobian modal decomposition is studied. We demonstrate that its dominant eigenvectors can be used to predict voltage changes for a small perturbation in reactive power. We also discuss that the eigenvectors contain information about which buses are most critical to maintaining voltage stability.

Finally, we propose a reactive power management framework where the reactive power dispatch is formulated as a mixed-integer programming problem. In our formulation, we penalize reactive power output deviations, excessive adjustments of the FACTS voltage reference parameter, and toggling of switched shunts to minimize mechanical wear. This framework is highly flexible to the number and location of FACTS devices and switched shunts, and allows for the treatment of both fixed var and voltage control modes in the optimization.