Efficient solution of large scale multi-stage optimal power flow problems using interior point methods

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ABSTRACT

Renewable energy sources are becoming increasingly popular and they are integrated into todays electric power grids. This integration strongly encourages the storage of the energy in energy storage systems. The latter are beneficial for a number of reasons related to the power and load balance as well as control of the ramping of the generators. The optimal energy and power ratings of these devices are not known in advance and it is subject to optimization. We are interested in the efficient solution of the underlying optimal control problem, which is very large due to the time coupling of storage decisions at the intra-hour level. We present two algorithms for the efficient solution of the associated KKT linear systems on parallel architectures.

The first algorithm is a direct sparse solution technique, designed for parallel architectures in mind. It employs a reordering of the control variables to reveal a hidden arrowhead structure that allows the distribution of the system on several independent computing cores. The second algorithm employs an iterative Krylov-based solution technique using a preconditioner constructed by approximate Schur-type decompositions of the reordered KKT system. The merits of both algorithms are presented in detail for several realistic optimal power flow problems.