Chapter 12

AN EQUIVALENCING TECHNIQUE FOR SOLVING THE LARGE-SCALE THERMAL UNIT COMMITMENT PROBLEM

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**Abstract:** This chapter presents a new efficient solution approach for solving the unit commitment schedule of thermal generation units of a realistic large scale power system. We base the approach on cardinality reduction by the generator equivalencing concept. This concept reduces the number of units in the large-scale power system to the lowest possible number based on the units’ fuel/generation cost and other physical characteristics, such as minimum up and down time, etc. with units having similar (almost the same) characteristics form one group. The reduced system consists of only each group of representative units and is first solved by the modified dynamic programming technique (one of the new solution methods developed by the authors). Another option is to use any of the standard unit commitment solution techniques. We obtain the overall solution to the original unit commitment problem of the entire system by un-crunching the solved reduced system based on certain rules. This chapter also presents test results for real-life systems of up to 79 units and comparisons with results obtained using Lagrangian relaxation and truncated dynamic programming (DP-TC).

1. **INTRODUCTION**

One of the most important problems in operational scheduling of electrical power generation is the unit commitment (UC) problem. It involves determining the start-up and shut-down schedules of thermal units to be used to meet forecasted demand over a future short term (24-168 hour) period. The objective is to minimize total production cost while observing a large set of operating constraints. The unit commitment problem (UCP) is a complex mathematical
optimisation problem having both integer and continuous variables. One obtains the exact solution to the problem by complete enumeration, which cannot be applied to realistic power systems due to its excessive computation time requirements [1,2]. In solving the unit commitment problem of a large system, the main cause of difficulty is the involvement of large number of units for commitment. The problem cannot be solved easily if all units are involved in the search for the optimal solution, since computational facilities could be exhausted. Research efforts have concentrated, therefore, on efficient, sub-optimal UC algorithms which can be applied to realistic power systems and have reasonable storage and computation time requirements. The basic UC methods reported in the literature can broadly be classified in six categories [3]:

- Priority list
- Dynamic programming
- Lagrangian relaxation
- Augmented Lagrangian relaxation
- Branch-and-Bound
- Benders decomposition

Since improved UC schedules may save the electric utilities substantial resources per year in production costs, the search for closer to optimal commitment schedules continues. Recent efforts include application of simulated annealing, expert systems, Hopfield neural networks and genetic algorithms to solve the UCP. References [4,5] give a survey of various approaches and their merits and demerits in this field. Some of these methods achieved a reduction of the computation requirement for large power systems. Researchers have yet to obtain an optimal solution to the problem for such systems.

There have been some past attempts in other areas such as coal modeling [6] to reduce a large-scale system to a smaller system. This chapter proposes a new, efficient solution approach to the UCP of a large-scale power system. The approach is based on cardinality reduction by generator equivalencing (hereafter called “equivalencing”), which reduces the number of units in the large-scale power system to the lowest possible number according to their similar fuel/generation cost characteristics and minimum up- and down-time characteristics. We first solve the reduced system using a modified dynamic programming technique [7] and then obtain an overall solution to the original unit commitment problem of the entire system by un-crunching the reduced solved system and using certain rules. The Appendix explains the modified dynamic programming (MDP) technique.