Chapter 14
Short-Term Generation Scheduling Solved with a Particle Swarm Optimizer

Víctor Hugo Hinojosa Mateus
Universidad Técnica Federico Santa María, Chile

Cristhoper Leyton Rojas
Universidad Técnica Federico Santa María, Chile

ABSTRACT

In this chapter, a particle swarm optimizer is applied to solve the problem of short-term Hydrothermal Generation Scheduling Problem – one day to one week in advance. The optimization problems have been formulated taking into account binary and real variables (water discharge rates and thermal states of the units). This proposal is based on a strategy to generate and keep the decision variables on feasible space through the correction operators, which were applied to each constraint. Such operators not only improve the quality of the final solutions, but also significantly improve the convergence of the search process due to the use of feasible solutions. The results and effectiveness of the proposed technique are compared to those previously discussed in the literature such as PSO, GA, and DP, among others.

INTRODUCTION

One of the most important priorities in all economic environments is the efficient use of variables, with the objective of minimizing production costs to obtain a product or final service. The electricity generating companies invest significant amounts of money in fuel (diesel, coal, gas, etc.). For example, a thermal unit with a level of power of 10 000 MW, may spend close to US$7.784 million in fuel per year (Wood, 1996) with the fuel cost of 82.81 US$/bbl. So, in the electric industry, the
most important priorities for the responsible agents are cost reduction and safe operation of the electric power system, considering the efficient use of the various types of fuels to generate electric power.

Customer load demands in electric power systems are subject to changes because human activities follow daily, weekly and monthly cycles. Sufficient generating units must be committed in order to satisfy the load in electric power systems. By committing enough generating units to withstand the peak load demand and by keeping these units on at times, we provide a solution for the generation scheduling. However, turning units off when they are not required can have a great impact and save a lot of money. Therefore, the way hydro, fuel, wind, geothermal, and solar are scheduled is an important topic in electrical power systems. We need to satisfy the load while operating the power system economically.

The hydrothermal generation scheduling problem depends on determining a secure operation strategy subject to a variety of constraints. The limitations in the water storage capacities in the reservoirs, together with the stochastic nature of their readiness, present a complex challenge. A profitable schedule of generation in a hydrothermal system involves sharing it among the thermal and hydraulic units in such a way that the total operating cost of the thermal units is minimized.

The efficient scheduling of available energy resources for satisfying load has become an important task and has been extensively studied because of its significant economic impact. The problem of finding the energy production of every power plant (hydro, nuclear, thermal and renewables) in all sub-periods of a given planning period is subject to a variety of technical constraints. Decisions to be made are coupled in time; for instance, future reservoir storage depends on the previous operation of the system. Generations of plants must be coordinated: not only the necessary constraints, such as load power balance and reserve, but also the characteristics of the power system (for instance hydro plants in cascade). In addition, uncertainties of both load and hydrological conditions have to be managed at the same time.

GENERATION PLANNING MODELS USED IN POWER SYSTEMS

Planners need a set of basic elements for the problem formulation.

Hydrothermal Generation Scheduling Problem (HGSP)

In hydrothermal generation power systems, the well-timed allocation of hydro energy resources is a very complex task that requires probability analysis and long-term consideration, because if water is used now, it will not be available in the future, thus increasing the future operation costs of the power systems.

The problem of minimizing the operational cost of a hydrothermal system can be reduced essentially to that of minimizing the fuel cost for thermal plants under the constraints of the water available for hydro generation in a given period of time.

In thermal generation power systems, the decision variables are modeled as integers, i.e., ON and OFF. For an exhaustive overview of short-term thermal scheduling until 2011, the reader may review the survey (Inostroza, 2011).

In this study, the HGSP is decomposed into three subproblems, namely, the hydrothermal coordination problem (HCP), the unit commitment problem (UCP), and the economic dispatch problem (EDP). In this way, the HGSP involves three main decision stages, usually separated using a time hierarchical decomposition, which is shown in Figure 1.

In hydrothermal generation systems, the cyclical nature of water flows and load, as well as the validity of model assumptions, suggest splitting
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