International Journal of All Research Education and Scientific Methods (IJARESM)
ISSN: 2455-6211, Volume 4, Issue 3, March- 2016, Impact Factor: 2.287

Literature Study on Generation Scheduling and unit commitment problems in Power System

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ABSTRACT

This paper provides a literature review on generation scheduling and prediction issues in power system. Best generation arrangement tries to minimise the price of power production whereas satisfying the varied operation constraints and physical limitations on the ability system parts. The thermal generation scheduling downside will be thought of as installation management downside acting over totally different time frames. The unit commitment part determines the optimum pattern for beginning and motion down the generating units over the selected programming amount, whereas the economic dispatch part worries with allocation of the load demand among the on-line generators. in a very hydrothermal system the best programming of generation involves the allocation of generation among the hydro electrical and thermal plants therefore on minimise total operation prices of thermal plants whereas satisfying the varied constraints on the hydraulic and installation network. This paper reports on the event of genetic algorithmic program computation techniques for the answer of the short term generation programming downside for power systems having each thermal and hydro units. These basic algorithmic program models will be increased, exploitation similar downside decomposition, and hybridization techniques, leading to economical generation programming algorithms.

Keywords: Generation scheduling, Unit commitment, short term.

I. INTRODUCTION

Unit commitment (UC) is is a non-linear, mixed-integer combinatorial optimization problem. Low-cost solutions to this problem will directly translate into low production costs for power utilities. As the size of the problem increases, it becomes a very complex, hard to solve problem. Multiple optimization approaches have been applied over the past years, such as the priority ordering methods, dynamic programming Lagrangian relaxation the branch-and-bound method, and the integer and mixed integer programming. Other, more recent methods are from the field of artificial intelligence, such as the expert systems neural networks fuzzy logic genetic algorithms and simulated annealing. Many of these approaches are either purely heuristic (e.g. priority ordering) or semi-heuristic (e.g. simulated annealing), thus are often very sensitive to choice of architecture, manual parameter tuning, and different cost functions. On the other hand, analytical methods can also introduce critical shortcomings [1].

The branch-and-bound algorithm, for instance, suffers from an exponential growth in execution time with the size of the UC problem,. In addition, using approximations for making it tractable for large scale systems causes solutions to be highly sub-optimal. Therefore in our work, we take an analytical approach to the problem, while assuring it will not become intractable nor highly suboptimal in large scale systems. Such a model is aimed to describe a decision making process, where outcomes of the process are partly random and partly under the control of the decision maker. In this work we assume that generation cost functions of the different generators are known to the decision maker [2].

Generation Scheduling

The generation scheduling function is one of the core components of a modem power system energy management system (EMS). The EMS helps in the determination of the generation level of each unit by minimising utility wide production costs while meeting system and unit constraints. The generation scheduling function has to satisfy the main objective of economics, which involves an optimization of cost over a future period of time. The economic dispatch sub function which optimizes operation cost over a much shorter time interval is embedded in the generation scheduling function. Figure 1. shows how the generation scheduling functions fit in the overall EMS structure of a modern power system control [3].

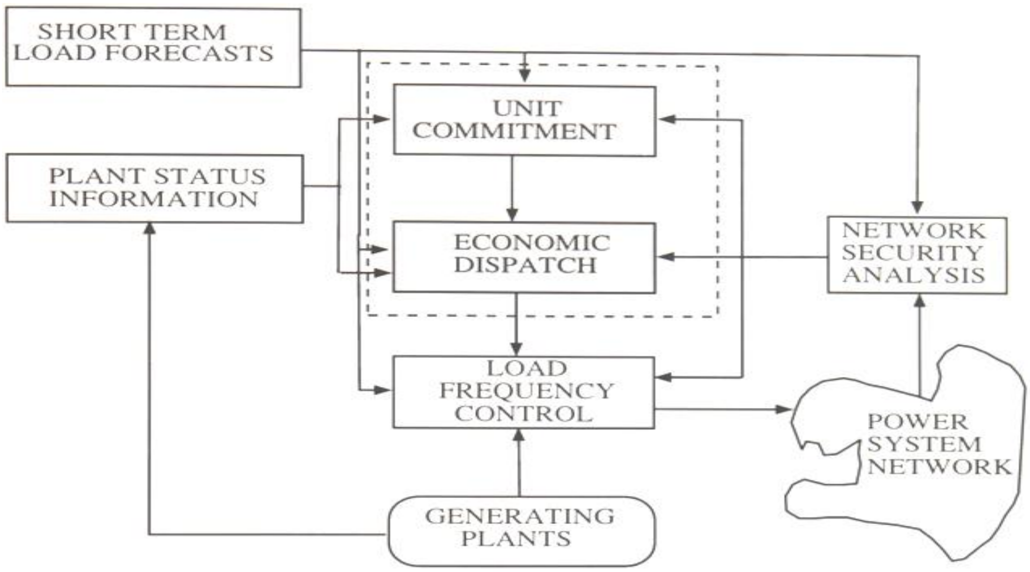

Figure 1. Generation scheduling and control functions in a modern EMS

The advances in computer hardware and communications technologies makes real time plant and network data available for the generation scheduling and control functions. Most generating units are now equipped with on line performance monitoring equipment that can provide very accurate up to date information about the equipment performance. This means that unit performance characteristics used in generation scheduling can be more accurately determined [4]. The ideal generation scheduling system for the present day EMS system should:

- incorporate real time plant information in modelling plant characteristics,
- take into consideration real and reactive power system constraints,
- satisfy environmental considerations,

These requirements call for reliable and robust optimisation algorithms.

II. LITERATURE REVIEW

Li Maojun and Tong Tiaosheng [15] proposed a Gene Complementary Genetic Algorithm for Unit Commitment and constructed three kinds of genetic operators. The results of experiment show that the algorithm proposed in this paper is available for the UCP.

Ouyang and S. M. Shahidehpour [16] proposed the DP-TC algorithm and employed various heuristic strategies in the paper. Finally, experimental results are presented which support the methodology by utilizing a much smaller execution time while preserving the quality of the optimization.

One of the algorithm proposed in [17], known as DP-SC, uses a strict priority list search sequence to reduce the possible combinations at every stage. Another method by the same authors employs a fixed search window to truncate the priority list, in which only the truncated combinations are evaluated. This method, known as DP-TC, performs much better than DP-SC as an optimizer; however it requires a much longer processing time.

S. Jalilzadeh and Y. Pirhayati presented (2009) an Improved Genetic Algorithm (IGA) for UCP with lowest cost. A modified approach to the solution of unit commitment problem using genetic algorithms is proposed in this paper. Improvement in cost and quality of solution is obtained [18].

Madrigal et al. investigated the existence, determination and effects of competitive market equilibrium for unit commitment power pool auctions to avoid the conflict of interest and revenue deficiency [19].

H. T. Yang et al. [20] proposed a parallel genetic algorithm approach to solve unit commitment problem. In Nov. 1999, A Rudolf et al. proposed a genetic algorithm for solving the unit commitment problem of a hydro-thermal power system and was tested on a real scaled hydro thermal power system over a period of a day in half hour time steps for different genetic algorithm parameters.

Vikram Kumar Kamboj et al. [11-12] employed a new strategy for representing chromosomes and encoding the problem search space, which is efficient and can handle large size unit commitment.

Genetic algorithms (GA) are computational search techniques based on models of genetic change in a population of individuals bearing a close resemblance with the science of evolution and genetics. These models consist of three basic elements:

- A notion of fitness which governs the individual's ability to influence future generations,
- A reproduction operation which produces offspring for the next generation, through a selection and mating process and
- Genetic operators which determine the genetic makeup of the offspring.

The basic power of a GA arises from the concept of implicit parallelism, [Holland, 1975], [Goldberg, 1989] the simultaneous allocation of trials to many regions of the search space. This theory suggests that through the repeated process of selection, crossover and mutation, the schemata (building blocks) of competing hyper-planes decrease or increase their presence in the population according to the relative fitness of those strings. The basic genetic algorithm steps shown in Figure 2.

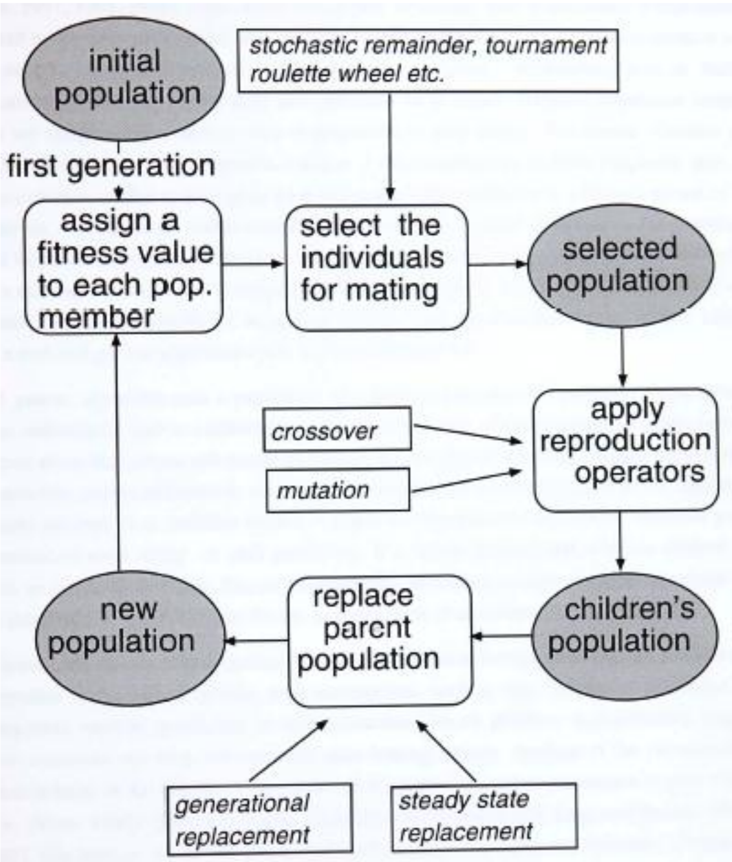

Figure 2: A typical genetic algorithm cycle

In the remainder of this chapter we provide a brief review of the historical development of genetic algorithms their theoretical foundations and the current state of research in this field. We focus on the theoretical developments and applications in fields related to power y terns operation and control.

We note that this is often not the case with European system operators, since in a European competitive electricity market, cost information is not available. However, in many other cases this information is indeed available, such as in some north American TSOs, and generation companies with multiple generation units (such a company would not know the characteristics of the power system, nevertheless it is not problematic since they do not play a role in our formulation). In addition, the UC problem can easily be extended to generate production schedules in a competitive market environment. Another paper shows the framework in which a traditional cost-based unit commitment tool can be used to assist bidding strategy decisions to a day-ahead electricity pool market. In general, European TSOs can approximate generation costs based on historical data (that include past and present bids they receive from generators) and market simulation. Also, in future work, the uncertainty in these approximations can be naturally expressed in our MDP model [7].

Generation scheduling and Unit commitment (UC) plays a major role in the daily operation planning of power systems. System operators need to perform many UC studies, in order to economically assess the spinning reserve capacity required to operate the system as securely as possible. The objective of the UC problem is the minimization of the total operating cost of the generating units during the scheduling horizon, subject to many system and unit constraints. The solution of the above problem is a very complicated procedure, since it implies the simultaneous solution of two sub problems: the mixed-integer nonlinear programming problem of determining the on/off state of the generating units for every hour of the dispatch period and the quadratic programming problem of dispatching the forecasted load among them.

When load forecasts and generators available for power are given, then there is a need to decide when each generator would be started up and shut down as fixed costs are involved in starting and stopping generators. So, the main objective is to minimize the operating cost while having enough capacity to track the load during changes and cover for random generator failures. The objective of the dispatch is to schedule the committed generators to meet the load, maintain voltages and frequency within prescribed tolerances an minimize operating cost without unduly stressing the equipments [8-9].

Conventional Economic Dispatch Methods

Economic dispatch belongs to the class of non linear optimisation problems composed of a non linear objective function and a number of equality and inequality constraints. It is not, in general, straight forward to compute, by classical calculus, the location of the optimum loading points for all the system units, that would minimise the system operating costs, when problem constraints, such unit minimum and maximum loading limits are considered. A number of linear and non linear programming techniques have been proposed for the solution of the dispatch problem. Happ, provides a comprehensive literature survey on economic dispatch solution techniques [10].

III. THERMAL GENERATION SCHEDULING PROBLEM

A number of estimates have shown that a 1 % reduction in power production costs can result in annual savings of up to one million dollars for each 1000 MW of installed capacity. This economic incentive has led to a concerted effort in the search for algorithms that can provide any improvements in system operation costs. The scheduling of thermal generators in a power system is the act of determining the optimum combination of the available units to supply a given load profile at minimum cost. Scheduling power system operation involves two basic economic decisions:

1. a unit commitment decision that determines which units should be brought on-line to meet the expected load demand and reserve requirements, and

2. an embedded economic dispatch decision that determines the most economic generation level for each of the committed (synchronised) units. In the unit commitment phase, the start up and shut down times of the units over the whole scheduling period must be specified.

3. Once units are committed, an economic dispatch phase allocates the load among the on-line units to satisfy the load demand at a given time interval, as described in chapter

4. The solution of the thermal generation scheduling problem involves a non-linear optimisation problem, consisting of both integer and continuous variables, with a large number of equality and inequality constraints.

Modeling of the Thermal Scheduling Problem

The thermal scheduling problem involves the determination of the start up and shut down times as well as the power output levels of all the system generating units at each time step, over a specified scheduling period T, so that the total start up, shutdown and running costs are minimised subject to a number of system and unit constraints. Obtaining an optimal schedule of generation involves the solution of a mixed integer non linear optimisation problem with a large number of constraints. Problem objective function the main objective of scheduling in thermal systems is to minimise system operation costs. The total production cost, F_T for the scheduling period is the sum of the running cost, start up cost and shut down cost for all the units and is given by,

$$F_T = \sum_{t=1}^{T} \sum_{i=1}^{N} FC_{i,t} + SC_{i,t} + +SD_{i,t} \tag{3}$$

where FC_i, SC_i and SD_i are running costs, start up costs and shut down costs respectively.

CONCLUSION

This paper provides a literature review generation scheduling and forecasting problems in electric power system. In the unit commitment phase, the start up and shut down times of the units over the whole scheduling period must be specified. Once units are committed, an economic dispatch phase allocates the load among the on-line units to satisfy the load demand at a given time interval. The solution of the thermal generation scheduling problem involves a non-linear optimisation problem, consisting of both integer and continuous variables, with a large number of equality and inequality constraints.

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