Optimization Techniques in Unit Commitment
A Review

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Abstract- As the dynamics of technology change rapidly in the power industry, new methodologies and the enhanced version of existing approaches addressing these new technologies are flowing into the market. So there is an urgent need to keep a track of new techniques and the latest version of current algorithms used in the field of today's unit commitment problems. Some methods are focusing on speed and others on accuracy. There is always a trade-off among parameters in different techniques to minimize the total cost and maximize the profit.

This paper presents a review of some of the advanced methods and techniques used to minimize the problems in the field of unit commitment based on many published articles.

Index Terms- UC ,Optimization; PSO; TS; AI; NN

1. Introduction

In most of the power systems in network, the power requirement is basically fullfilled by thermal power generation.Several governing strategies are possible to meet the required power demand, which varies throughout the day. It is preferable to use an optimum or sub optimumn operating strategy based on economic parameter. Alternatively, the imperative parameter in power system operation is to meet the power demand at minimum fuel cost using an optimal mix of different power plants. Moreover, for the optimium dispatch of electric power to end users in a protected and economic manner, thermal unit commitment is considered to be one of the best available options. It is thus recognized that the optimal unit commitment of thermal systems results in a great saving for electric utilities. Unit Commitment is the problem of locating the schedule of generating units within a power system subjected to various constraints.

Maximize the profit
Subject to the inequality in load demand and other predefined constraints.
This paper summarizes different advanced methods used in the unit commitment problem solving technique.

2. General Background

Many power industries have daily load patterns which reflects extreme variation between peak and off peak hours. Because less electricity is used over weekends than weekdays ,at a lower rate between mid night and early morning than during the day If sufficient generation **to** meet the peak is kept on line throughout the day, it **is** possible that some of the units will be operating near their minimum generating limit during the off peak period. The problem confronting the system operator is to determine which units should be taken off line and for how long. So the general objective of the unit commitment problem is to minimize system total operating cost while satisfying all the constraints for a given security level can be met. Various approaches to solution of the optimal UC problem have been advanced. These approaches have ranged from highly complex and theoretically complicated methods to simple rule. The scope of operations scheduling problem will vary strongly among industries depending on their mix of units and particular operating constraints.

3. Methods and Techniques

3.1 Classical

Exhaustive Enumeration

Priority Listing

Dynamic Programming

Branch and Bound

Integer Programming

Linear Programming

Simulated Annealing

Lagrangian Relaxation

Tabu Search

Interior Point Optimization

3.2 Non-Classical

Expert Svstems

Fuzzv Svstems

Artificial Neural Networks

Genetic Algorithms

Evolutionarv Progamming

Particle Swarm Optimization

3.3 Hybrid Models

Methods based on Artificial Intelligence(AI) like Neural Network (NN), Genetic Algorithms (GA) ,Simulated Annealing (SA), Ants Algorithms, TabooSearch (TS), Particle Swarm Optimization (PSO) etc. are advanced growing methods**.**

4. Analysis of different techniques in UNIT COMMITMENT

4.1 An Improved Tabu Search Algorithm and PSO for Unit Commitment Problem Solving

Ahmad Ali Khatibzadeh et al[48] presented a enhanced version of TS and PSO in terms of accuracy and speed of solution. The theme of this method is determined more speed and less accuracy in terms of PSO method with numerical values.Numerical results signified the accuracy of improved TS .On the other hand, PSO technique had shown a better optimization but with a more time period than TS. Numerical output values indicate that TS is faster than PSO, but the PSO method lead to better response by shifting the cost function towards minimum end for generation**.**

4.2 Unit Commitment in Deregulated Power System using Lagrangian firefly algorithm

B.Rampriya et al[49] proposed a technique based on PBUC(satisfying the load is no longer an Obligation) by using Lagrangian firefly algorithm(LRFA),a meta-heuristic Algorithm to determine the unit ON/OFF schedule, power, spinning and non-spinning reserve generations of GENCOs. As deregulated power system has a different objective than that of traditional unit Commitment .PBUC has been evaluated to prioritize the importance of the profit without satisfying the system load and reserve constraints. The developed technique utilizes LR method to determine the status of the units by relaxing the coupling constraints into the objective function by using Lagrange multipliers.The relaxed problem is then decomposed into subproblems of each unit. The dynamic programming (DP)process is used to locate the optimal commitment for each unit. The Lagrange multipliers are updated using firefly algorithm (FA).The concluded schedule evidently maximizes the profit and the proposed algorithm is tested for a small unit test system and the simulations are carried out to show the performance of proposed methodology using MATLAB. The proposed algorithm can be extended to 'n' number of generating units. This proposed method assists GENCOs to make decision, how much spot power,spinning reserve and non-spinning reserve should be soldin electricity markets and how to schedule generators in order to receive the maximum profit.

4.3 Security-Constrained Unit Commitment using Mixed-Integer Programming with Benders Decomposition

Nalan Laothumyingyong et al[50l, proposed a noval methdology to determine the 24-hour unit commitment with minimum total generation cost subjected to power flow constraints in both normal operating and contingency state, which is assumed the security constrained unit commitment (SCUC by incorporating, the Benders'Decomposition technique.This technique is formulated by decomposing the problem into two parts: the master and the slaves.The master problem is mapped to UC problem contains integer variables showing the on-off status of the generating units, which can be optimized with Mixed-Integer(MI) Programming. The branch-and-cut method has been selected to fix the master problem. The slave contains two sub-problems: the power flow mismatch equations and the operating limits of power systems.If the conditions in any subproblems are subjected to any violation, the Benders Cuts corresponding to the violated constraints are added to the master problem and the mixed-integer unit commitment problem could be resolved. The results of typical unit commitment,security-constrained unit commitment under normal operating states and SCUC with contingency states are compared. The results show that the total generating costs of SCUC with contingency are higher than the others. However the committed units of that SCUC ensure that the system could still serve load when contingency occurs.

4.4 Profit Based Unit Commitment Problem under Deregulated Environment

Jacob Raglend et al[47], modeled an algorithm to solve the profit basedunit commitment(PBUC) problem under deregulated environment to figure out the optimal generation schedule with maximum profit by incorporating operational constraints in a restructured power system. Deregulation in power sector has positive symtoms on the efficiency of electricity production and distribution, offer lower prices, higher quality, a secure and a more reliable product. GENCOs run its own unit commitment in order to maximize its own profit based on the forecastedparameters like demand, reserve and MP.This noval approach is developed as per the market requirement as utilities always try to maximize a profit in the deregulated power and reserve markets as a market player.Unit commitment (UC) is an optimization problem of determining the schedule of generating units within a power system with a number of constraints. As UC schedule is having the dependency on the market price in the deregulated market(DM). Higher number of units are committed when the market price(MP) is higher. When more number of generating units are brought online more power is generated and participated in the deregulated market to get maximum profit. This new approach is based on GENCOs profit based unit commitment in a day ahead competitive electricity markets. A hybrid method between lagrangian multipliers and evolutionary programming is used to solve the PBUC problem. Single unit DP is used to solve PBUCP and lagrangian multipliers are updatedusing sub-gradient methodConstraints like Generations, spinning reserve, non spinning reserve are considered in the proposed framework. The proposed approach has been tested on IEEE-30 bus system with 6 generating units as an individual GENCO. The results obtained are quite optimized and useful in deregulated market.

5. Conclusion

This paper presents a review of the work published on the different advanced methods and innovative techniques used in UC optimization. Different elaborated methods are being used in today's international platform, being under enhancement and new techniques are being developed to minimize the cost and maximize the profit.

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