OPTIMAL UNIT COMMITMENT METHODS OF POWER SYSTEM

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ABSTRACT

Unit Commitment helps in making decision that which unit should be running in which period so as to satisfy the varying demand of electricity. In case of electricity the load is higher during the daytime especially in evening when industrial loads are high, lights are on and lower during the night and early morning when most of the population is asleep. Unit commitment helps in deciding which generating unit should be on i.e. to bring the unit up to speed, synchronize it to the system, and connect it so it can deliver power to the network. The paper describes different method used to solve the unit commitment problems. All these methods have some weakness, a comprehensive algorithm that combines the strength of all the methods and overcome each other's weakness would be a suitable approach for solving unit commitment problems.

Keywords : *Unit commitment, Lagrange relaxation, Priority list.*

I. INTRODUCTION

The demand and supply of electricity need to be balanced. As demand for electricity has weekly and seasonal patterns, power plants need to be scheduled carefully to meet this fluctuating demand. This scheduling is known as unit commitment. Due to the different constraints existing on the operation of thermal power plant, solution of this optimization problem is difficult. A number of methods have been developed in last few years for solution of this problem.

The aim of this paper is to setup an adequate UC optimization tool that is able to cope with variable and low net demand profiles in an efficient way. As the total load of the power system varies from one day to another, the electric utility has to decide in advance which generators to startup up and the sequence in which the operating units should be shut down and for how long. The proposed mathematical approaches are priority list, dynamic programming lagrangian relaxation. Dynamic programming and lagrangian relaxation are used extensively to develop industry grade unit development programs. The major advantage is the requirement of reasonable computation time when compared to other mathematical approaches.

II. SOLUTION METHODOLOGIES FOR UNIT COMMITMENT

Unit commitment problem is very challenging optimization problem. This is because of the huge number of possible combinations of ON/OFF status of the generating units of the power system. Solution to these problems have been developed by several exact and approximate methods. Some of the existing solution methods have been discussed below:

A. Priority List

A simple but sub optional approach to the problem is to impose priority ordering, wherein the most efficient unit is loaded first to be followed by the less efficient units in order as the load increases. The priority order is based on the average production of each unit, neglecting minimum up-or-down time, startup cost, etc. most priority list schemes are built around a simple shut down algorithm that might operate as follows:

- During dropping of the load, determine whether dropping the next unit on priority list will leave sufficient generation to supply the load plus spinning reserves requirement. If not, continue operating, if yes go to next step.
- Determine the time in number of hours before the dropped unit will be needed again for service.
- If number of hours is less than the minimum shut down time, then keep the unit as it is and go to last step, if not go to next step.
- Calculate the two cost, first is the hourly production for the next ‘h’ hours with the unit in up-state. Second is same sum but for ‘down state ‘and add in the start-up cost for either cooling the unit or banking it, it should be shut down otherwise keep it on.
- Repeat the same procedure for the next unit on the priority list and continue for the other units.

Various enhancements in the priority list method can be made by grouping units or making combinations of two or more units.

B. Dynamic Programming

It states that whatever the initial state and initial decisions are, the remaining decisions must not be affected by the first decision. This method can be used to solve problems in which many decisions are need to be taken in defining the optimum operation of the system, which consist of different number of stages. However it is suitable only when the decision at the later stages do not affect the operation at the earlier stages. It has many advantages, but the main advantage is the reduction in the size of the problem.

The foisting of priority list arranged in order of average cost rate would result in correct dispatch and bond if

- No load cost are zero
- Unit input- output characteristics are linear.
- There are no limitations
- Start-up cost are in fixed amount.

The basic steps in preparing the UC table using DP approach:

- Start randomly with consideration of any two units
- Arrange combine output of two units in discrete load levels.
- Determine the most economical combination of the two units. It is observed that at each level, the economic operation is to either run a unit or both the units with certain load sharing between them.
- Obtain the cost curve of the two units that can be treated as the cost curve of the equivalent unit.
- Now Add third unit and repeat the procedure, note the operating combination with third unit are not required to be worked out resulting in computational savings.
- Repeat the process till all available units are exhausted.

The main advantage of this approach is having optimal way of loading ‘k’ units, it will be easy to find the optimal way to load ‘k+1’ units.

C. Lagrange’s Relaxation

The Dynamic Programming method has many disadvantages for large power systems with many generating units. This is due to the necessity of forcing the dynamic programming solution to reduce the number of combinations that must be tested in each time period.

In Lagrange's method all these disadvantages disappear. It is a numerical method based on Dual optimization approach. This method dissolves the linear programming problems in master problems and more manageable sub problems. The sub problems can be linked to Lagrange's multiplier which can be added to master problem to get the dual problem. This dual problem is then solved.

For obtaining the optimum solution, unit commitment problems are changes in terms of the cost function, set of constraints associated with each unit and the set of system constraints, into one primal problem and one dual problem. Primal sub problem is the objective function of the unit commitment problem and Dual problem incorporates the objective function and the constraints multiplied with the Lagrange multipliers.

The Lagrange relaxation procedure solve the unit commitment problem by 'relaxing' or ignoring the coupling constraints as if they did not exist. This is done through Dual optimization.

III. CONCLUSION

An Optimal Unit Commitment will result in enormous savings of power grid. The paper discuss the various solutions like Dynamic Programming, Lagrange Relaxation to solve unit commitment problems. However numerous solution methodologies exist, thinking of more efficient and computationally faster strategy is still relevant.

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