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Profit based unit commitment and economic dispatch of IPPs with new technique

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ABSTRACT

Each generation company may have number of generating units of different fuel consumption characteristics, some generating units consume more fuel as compared to other units this directly effects the production cost and profit of the company. Production cost and profit of the company is also affected by unit commitment and economic dispatch. Each and every power generation company wants to maximize/increase profit, same is the case for independent power producers (IPPs). Profit can be maximized by changing the unit commitment and economic dispatch strategy. Previously it was achieved in such a way that production cost goes to minimum level. But as the competition in power market is going to increase day by day IPPs trend of UC solution is toward achieving maximum profit. Previously achieved solution by LR–PBUC is slow and may face convergence problem. In this paper, we will see the way how a GENCO or IPP can earn more by UC on the base of profit, with minimum computational time and always with some final solution. Hamiltonian method has been used for ED. To demonstrate the effectiveness of the PBUC achieved and Hamiltonian economic dispatch, it will be tested on two test cases. Profit and computational time comparison of proposed technique with already available/techniques for evaluation of performance are also presented.

1. Introduction

With the advent of restructured system it is possible for power generation companies and independent power producers (IPPs) to consider such a scheme/schedule in which they supply the amount of power that is near to the predicted load demand and spinning reserve [1]. The objective of the generation companies and IPPs is to generate and sale the energy with maximum profit to survive in the competitive environment [2,3]. This leads us to develop and implement those techniques of committing the units that are based on maximizing the profit instead of minimizing the production cost as the case was in previous years [4]. This technique is known as profit based unit commitment (PBUC). It increases the profit of company; as a result Power Company can compete in a better way.

2. Profit based unit commitment

With the idea of PBUC, unit commitment problem (UCP) defined in a new way and with modified constraints because now our target is to maximize profit instead of minimizing production cost. Different techniques were proposed by researchers for PBUC. A hybrid method of Lagrange Relaxation (LR) and Evolutionary Programming (EP) has been used by Pathom Attaviriyanupap for profit based unit commitment in competitive power market environment [5]. Yuan and Yuan implemented the Particle Swarm Optimization (PSO) technique for profit based UC under deregulated electricity market [6]. Chandram and Subrahmanyam introduced new approach with Muller method for PBUC with small execution time [7]. For generating units having nonlinear cost function Mori and Okawa proposed the new hybrid Meta-heuristic technique for profit based unit commitment [8]. Amudha and Christober Asir Rajan presented effect of reserve in PBUC using Worst Fit Algorithm [9].

According to the above discussion in PBUC, our objective is to maximize Power Company's profit. So:

$$\text{Max. profit} = \text{Revenue} - \text{Total production cost} \tag{2.1}$$

Modified and unchanged constraints in achieving above objective for IPPs according to the new scenario can be defined as:

(i) Demand constraints

$$\sum_{i=1}^{N} A_{it} \cdot B_{it} \leqslant C_t, \quad t = 1, 2, 3, 4, \ldots, T \tag{2.2}$$

(ii) Reserve constraints are

$$\sum_{i=1}^{N} D_{it} \cdot B_{it} \leqslant SRt, \quad t = 1, 2, 3, 4, \ldots, T \tag{2.3}$$

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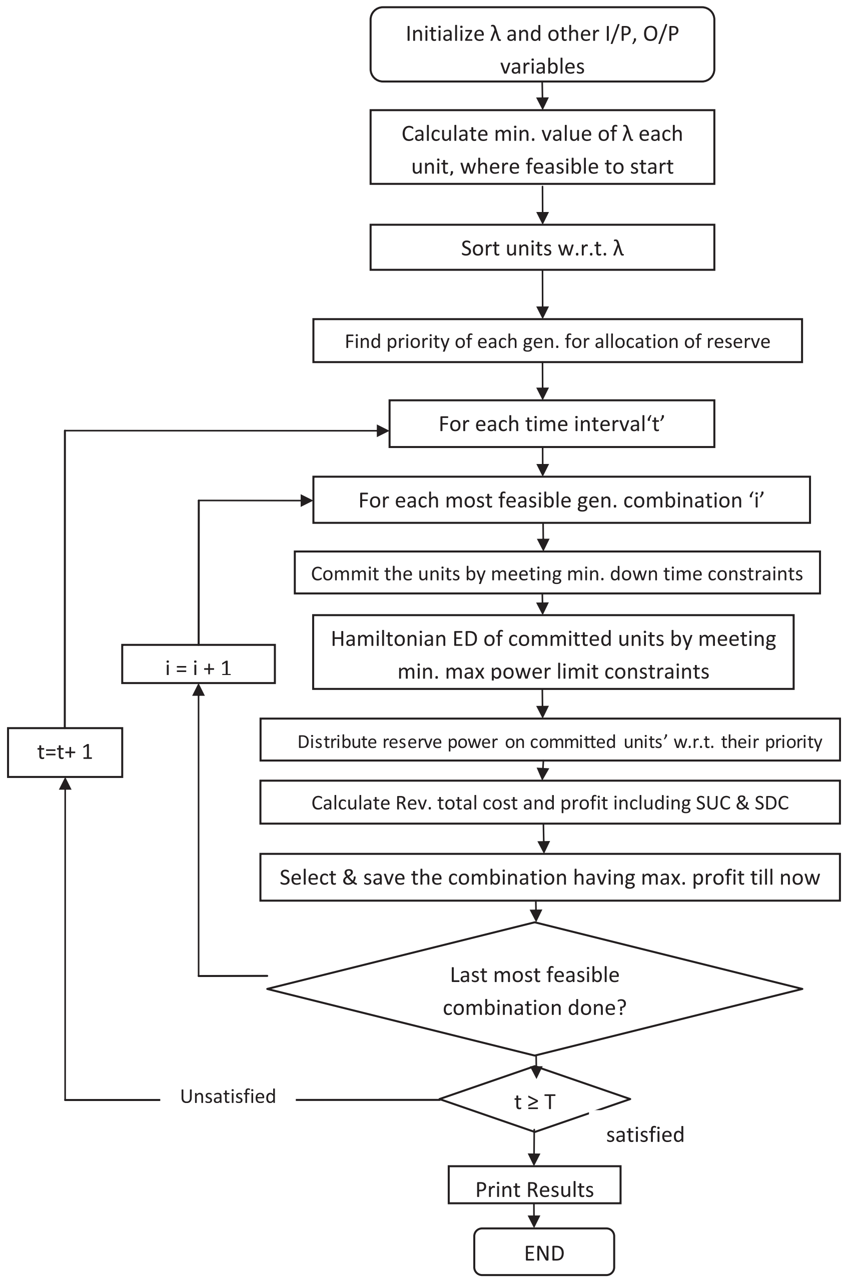

Fig. 1. Flow chart of complete strategy.

(iii) Power limit constraints

$$0 \leqslant D \leqslant A_{i\max} - A_{i\min}, \quad i = 1,2,3,4,\ldots,N \tag{2.4}$$

$$D_i + A_i \leqslant A_{i\max}, \quad i = 1,2,3,4,\ldots,N \tag{2.5}$$

(iv) Minimum down times constraints

$$B_{it} = 0 \quad \text{for} \sum_{t-T_{down=1}}^{t-1} (1 - B_{it}) < T_{idown} \tag{2.6}$$

(v) Minimum up time constraints

$$B_{it} = 1 \quad \text{for} \sum_{t-T_{up}}^{t-1} B_{it} < T_{up} \tag{2.7}$$

(vi) Start up cost constraints

$$\text{SUC} = \text{constant} \quad \text{if } B_i, (t-1) = 0 \quad \text{and } B_{it} = 1 \tag{2.8}$$

(vii) Shut down cost constraints

$$\text{SDC} = \text{constant} \quad \text{if } B_i, (t-1) = 1 \text{ and } B_{it} = 0 \tag{2.9}$$

There are many types of payments in power market. We have only considered the Payment for Power Delivered. In this case payment will be made when power will be used actually; revenue and cost can be calculated as [1]:

$$\text{Revenue} = \sum_{i=1}^{N}\sum_{t=1}^{T}(A_{it} \cdot SPt)B_{it} + \sum_{i=1}^{N}\sum_{t=1}^{T} r \cdot RPt \cdot D_{it} \cdot B_{it} \tag{2.10}$$