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Bibliographical Survey on Economic Load Dispatch Problems

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INTRODUCTION

India is a very fast-growing economy among the developing nations in the world and has proved its stability during the major world economic recession in 2008. The Indian electricity sector plays a vital role in the economic growth of the country and hence the Indian economic growth rate has reached just above 8 %. India has a total installed power generation capacity of 2, 74,818 MW as of July 2015 but there is a gap of 20% between power demand and power generation during the peak hours of power consumption. Power system planning is critical for the electricity sector to have proper generation expansion to bridge this gap and hence the system efficiency and reliability can be improved. The problems in the vertically integrated power market and restructured power markets such as Unit Commitment (UC), Economic Dispatch (ED), Emission Dispatch (EmD), and Combined Economic and Emission Dispatch (CEED) are some of the key issues in power system planning.

Economic dispatch is an important optimization problem that aims at scheduling the committed power generating units to meet the load demand at minimum operating cost while satisfying the equality and inequality constraints. Though the core objective of the problem is to minimize the operating cost while satisfying the power demand, several types of physical and operational constraints such as Prohibited Operating Zones (POZ) and Ramp Rate Limits (RRL) make the ED problem highly nonlinear in nature [1].

Power system security analysis is the process of detecting whether the power system is in a secure state or an alert state. A secure state implies that the load is satisfied and no limit violations occur under the present operating conditions. Economic dispatch with line flow constraint introduces the aspect of system security to the classical economic dispatch by bringing in the line flow and voltage limit constraints.

In this problem, system reliability and cost-efficiency are two conflicting objectives in nature. The solution methodology should find out a compromising solution between these objectives. Security analysis is introduced to the economic study of an electric power system in the form of security constraint which has to be satisfied [2].

LITERATURE SURVEY

A study of literature on ED problems with POZ and RRL, Economic Dispatch with line flow and voltage limit constraints, the Economic and Emission Dispatch problems, and Profit Based Unit Commitment problem reveals that many mathematical programming methods and optimization techniques have been applied to solve these optimization problems. They are Lambda iteration, Linear Programming (LP), Interior Point (IP), Dynamic Programming (DP), and Gradient methods. Recently, with the emergence of artificial and computational intelligence techniques, attention has been given to solving power system planning issues by Evolutionary Computing (EC) techniques. EC techniques like Cuckoo Search (CS), Firefly Algorithm (FA), Artificial Neural Networks (ANN), Genetic Algorithm (GA), Evolutionary Programming (EP), Particle Swarm Optimization (PSO), and hybrid algorithms have been addressed in the literature for solving the above nonlinear power system optimization problems.

Classical Optimization Techniques:

Different classical optimization techniques were used to solve the ED problems. In the conventional ED problem, the cost function for each generator was represented by a single quadratic function and was solved using a lot of mathematical programming-based optimization techniques.

Lambda Iteration and Lagrange Relaxation Methods: A Lambda iteration method propagated by Wood & Wollenberg [3] was found useful in solving the ED problem. Since the lambda iteration method requires a consistent problem formulation, it cannot be openly applied to ED problems with discontinuous prohibited operating zones. In the units with prohibited operating zones, the zones divided the operating region between the minimum and maximum limits into sub-regions to form non-convex sub-regions and the associated ED problem were thus non-convex optimization problems. Thus, it was found that the conventional Lagrange Relaxation approach cannot be directly constructive.

Linear Programming and Interior Point Methods: Somuah & Khunaiz [4] presented the Linear Programming (LP) method to solve the economic dispatch problem taking into consideration of spinning reserve and other security constraints. In this paper, two methods are secondhand in the solution of the problem. The first method is a QP technique combined with an LP re-dispatch technique. The second method uses an LP formulation of the dynamic dispatch problem based on the Dantzig-Wolfe was tested on four different test systems and the results are compared with other methods. Irisarri et al [5] reported an Interior Point (IP) method to solve the economic dispatch problem considering generator limits, reserve constraints, line flow limits, and ramp-rate limit constraints. The proposed method was tested on the IEEE-30 bus network over 168 hours and the convenience of the

structured interior-point formulation was recognized.

Evolutionary Computing Methods:

Evolutionary computing techniques are a recent class of algorithms to solve nonlinear optimization problems. Methods such as the genetic algorithm, particle swarm optimization, evolutionary programming, etc. are used by many researchers to solve ED problems.

Particle Swarm Optimization: Zwe-Lee Gaing [6] suggested a Particle Swarm Optimization (PSO) algorithm for solving the economic dispatch problem considering ramp -rate limits, prohibited operating zones, power balance equation, and generator limits constraints. The schedule of the proposed PSO method was tested on three different test systems and the result obtained was compared with the Genetic Algorithm (GA) in terms of the solution quality and computation efficiency. The experimental result shows that the proposed PSO method was better than GA for solving ED problems.

Mohammadi-Ivatloo et al [7] presented Iteration PSO with Time-Varying Acceleration Coefficients (IPSO-TVAC) for solving non-convex economic dispatch problems taking into consideration the valve-point effects and prohibited operating zones. The proposed IPSO-TVAC method was validated on standard three different test systems and the results were compared with other optimization algorithms which are presented in the references.

Park et al [8] reported the concept of PSO as an economic dispatch problem with nonsmooth cost functions. The recommended method provides high probability solutions for a 3-unit test system and quasi-optimums for a 40-unit test system. The proposed methodology was shown to be superior compared to conventional numerical methods, Artificial Neural Network (ANN), and EP methods

Evolutionary Programming: Hong-Tzer et al [9] recommended the EP technique to solve economic dispatch problems considering non-smooth fuel cost functions. The recommended method was demonstrated on two example power systems and the results were compared with dynamic programming, simulated annealing, and GA methods.

Nidul Sinha et al [10] solved the ED problem using various EP techniques considering the power balance equation, generator limits, and valve point loading effects. The main objective of this paper was to expand and study the various EP techniques for ELD problems (i) Classical EP with Gaussian mutation (CEP) (ii) Cauchy-mutation-based EP called fast EP (FEP) (iii) mean of Gaussian and Cauchy mutations with scaled cost (MFEP) (iv) Gaussian and Cauchy mutations with scaled cost(IFEP). Then the proposed techniques are tested on 3, 13, and 40 unit test systems, and the results were compared in terms of solution quality.

CONCLUSION

This paper has tried to review some of the publications in the area of economic dispatch problems. Non-linear characteristics of the generators such as prohibited operating zones and ramp-rate limits constraints are considered. From this study, it can be concluded that the various approaches have been discussed in the area of Economic Dispatch problems for finding a better solution for the non-linear economic dispatch problems.

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