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# Review of Power System Economic Load Dispatch Problem Optimization Techniques

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***Abstract* - Economic operation of power systems or frameworks is met by meeting the load demand through optimal scheduling of force era. Minimization of fuel cost is the primary type of optimal power flow issues. Real power generators of various generators are the control variables in economics load dispatch (ELD) issue. Optimal real power scheduling will ensure economic advantages to the power framework administrators and reduce the release of polluting gasses. Previously, various conventional optimization calculations are misused for taking care of the optimal power flow issues. This article mainly studies the economic dispatch problem (EDP) in smart grid. The purpose of this problem is to minimize the total power generation cost under the conditions of balance between supply and demand and power generation capacity constraints.**

***Index Terms* - Economics, Optimization, Load Dispatch, Power System, Real power.**

## I.INTRODUCTION

Today electrical power plays an exceedingly important role in all walks of life of an individual as well as the community. The development of various sectors such as transportation, industrial, agricultural, entertainment, information and communication sectors etc depend on electrical energy. In fact, the modem economy is totally dependent on the electricity as a basic input. This is turn has led to the increase in the number of power generating stations and their capacities and the consequent increase in power transmission lines which connect the generating stations to the load centers. Interconnections between generating systems are also equally important for reliable and supply quantity of power system which also provide flexibility in system operation. Among different issues in power system operation, economic load dispatch (ELD) and optimal power flow (OPF) problem constitute a major part. For interconnected systems, the main goal of the Economic load Dispatch is to find the real and reactive power scheduling in order to reduce the cost function of different generating units in the power system. Hence, for economic operation of the system, the total load demand must be optimally shared among all the generating units with an objective to minimize the total generation cost [1].

Economic load dispatch (ELD) is a procedure to schedule the optimal combination of generation of all generating units in power system so that the total generation cost of system is minimized, while satisfying the load demand, system equality and inequality constraints. Economic load dispatch explores the best way to minimize the current generator operating costs.

The essential operation constraints are the power balance constraint, that is, the total generated power being equal to the load demands plus the transmission losses on the electrical network, and the power limit constraints of the generating units. The problem of economic operation of a power system or optimal power flow (OPF) is the allocation of the load (MW) among the various units of generating station and among the various generating stations in such a way that, the overall cost of generation for the given load demand is minimum. This is an optimization problem, the objective of which is to reduce the power generation cost function subject to the satisfaction of a given set of equality and inequality constraints. For a given load demand, power flow study can be used to calculate active and reactive power generations, line flows and losses. The study also furnishes some control parameters such as the magnitude of voltage and voltage phase differences.

The economic scheduling problem can be understood as an outcome of multiple power flow studies, where a particular power flow study result is considered more appropriate in terms of cost of generation. The solution to this problem cannot be optimal unless otherwise all the constraints of the system are satisfied. The problem of economic operation of the power system involves two sub-problems, namely, unit commitment (UC) and economic dispatch (ED). While unit commitment (UC) is an off-line problem, economic dispatch (ED) is an area of online concern. The commitment decisions are made many weeks or months in advance. The decision to commit a generating unit to be able to produce electricity means that the power utility is willing to incur fixed costs related to unit startup in order to have that generating plant ready and available to produce electricity in real time. Generators with large start-up costs or long minimum-run times (such as large combustion turbines and nuclear power plants) cannot run optimally if their output is determined using a single-period analysis (a "period" in the electric power industry usually refers to a length of time of about an hour). Instead, their operation must be scheduled over a longer time horizon of days or even weeks.

A power utility would need a forecast of demand weeks in advance before turning on a generator with a long minimum run time. They would need to look at the demand forecast over that period of weeks and decide the lowest-cost mix of generation plants that would meet the demand. This decision is referred to as the unit-commitment decision. While the process of dispatching generation plants to meet customer demands within a specified control footprint is known as "economic dispatch" or "optimal power flow."

literature survey

X. Pu et al.,[1] proposed, a hybrid algorithm (PSOGSA) in this work, and two adaptive weighted update strategies are introduced into the optimization process to improve the search accuracy of the hybrid algorithm. At the same time, we added variable mutation probability to solve the problem that particles are easily be trapped in local optimum. In order to verify the effectiveness of the two improved hybrid algorithms, the two algorithms are applied to the power system economic load dispatch (ELD) problem. Power generation cost optimization performance tests are computed for three groups of power systems with different unit numbers.

J. Yan et al.,[2] presents the economic dispatch problem (EDP) in smart grid. The purpose of this problem is to minimize the total power generation cost under the conditions of balance between supply and demand and power generation capacity constraints. A distributed continuous-time solver is proposed, which only requires the sign of relative dual variable information between neighbors, which ensures the privacy of the generators. In addition, the algorithm does not require initialization and allows online changes of network topology, load, etc.

A. M. Shaheen et al.,[3] The equality constraints by supplying the total loading of power and heat is are maintained. In addition, the inequality operational bounds of power only and heat only units are satisfied while the dynamic operational bounds of cogeneration units are not jeopardized. Three test systems are analyzed to estimate the MRFOA performance for solving the EPHD problem in CES, which involve 5 units, 7 units, and 48 units. It is worth noticing that the optimal solutions demonstrate MRFOA capability, feasibility and efficiency of better solutions obtained in terms of TFC compared with other optimization methods and the ability of implementation of MRFOA on EPHD issue in CES.

M. Zaery et al.,[4] presents a fully distributed finite-time control strategy to optimize the load power dispatch of islanded DC microgrids (MGs) in a finite-time manner. In which, based on the finite-time consensus protocol, a power optimizer is developed to realize MG's optimal operation by matching the incremental costs (ICs) of all the distributed generators (DGs) within a finite settling time. Moreover, the finite-time voltage regulator restores the average voltage across the MG to preserve the power balance among generation and demand. The developed controller achieves an improved performance with an accelerated convergence rate, which is important for MGs with a high penetration level of renewable distributed generators (RDGs), over the conventional distributed secondary controllers.

M. K. Arpanahi et al.,[5] The proposed framework has been studied on two test power systems including IEEE 14-bus integrated with three IEEE 69-bus and IEEE 118-bus integrated with thirty IEEE 69-bus test systems. Simulation results confirm the efficiency and effectivity of the proposed framework in terms of economic benefits, technical aspects such as power losses, and congestion management compared with the independent operation of transmission and distribution systems. If compared with a centralized approach and other decentralized methods, computational advantages are also confirmed, such as achieving the optimal solution with reasonable accuracy and time.

M. Ellahi et al.,[6] presents a hybrid metaheuristic optimization algorithm developed to solve the Economic Dispatch Problem (EDP) encountered in different combinations of power plants. The algorithm is developed by assimilating the prominent features of Particle Swarm Optimization (PSO) and Bat Algorithm (BA) and improves cost reduction and convergence with lesser computational time. The developed algorithm is employed for the solution of EDP consisting of only Renewable Energy Sources (RESs) implemented at various locations in Pakistan. The all RES based EDP consists of scenarios composed of sub-scenarios having no constraints, with time-varying loads and multi-area economic dispatch (MAED).

X. Li et al.,[7] presents a granular computing method (GrC) for the economic dispatch (ED) problems with valve-point effects to reduce the computational dimension and improve the solving accuracy. The computing process of the GrC is composed of the coarse granular computing and the fine granular computing which are connected with the load demand and optimized with the intelligent algorithm. For the purpose of improving the computational accuracy, a new granularity partition strategy is introduced in this work to cluster generating units into several fine granules based on their own peculiarities.

R. Hao et al.,[8] dispatch algorithms are carried out by a centralized controller, a practical DED scheme is proposed in this paper to achieve the optimal dispatch by appropriately allocating the load to generation units while guaranteeing consensus among incremental costs. The ED problem is decoupled into several parallel sub-problems by the primal-dual principle to address the computational issue of satisfying power balance between the demand and the supply from the distributed regional power system. The feasibility test and an innovative mechanism for unit commitment are then designed to handle extreme operation situations, such as low load level and surplus generation. In the designed mechanism, the on/off status of units is determined in a fully distributed framework, which is solved using the piecewise approximation method and the discrete consensus algorithm.

J. Yu et al.,[9] presents a recently proposed Jaya algorithm is implemented on the economic load dispatch problems (ELDPs). Different from most of the other meta-heuristics, Jaya algorithm needs no algorithm-specific parameters, and only two common parameters are required for effective execution, which makes the implementation simple and effective. Simultaneously, considering the non-convex, non-linear, and non-smooth characteristics of the ELDPs, the multi-population (MP) method is introduced to improve the population diversity. However, the introduction of the MP method adds extra parameters to the Jaya algorithm, hence a self-adaptive strategy is used to cope with the tuning problem for extra parameters.

C. A. Oliveira De Freitas et al.,[10] Economic-emission load dispatch uses the fuel cost variables and gas emission in a minimized way to obtain an optimal operation in generation units in a power plant, guaranteeing the supply of demand. The first variable is definitive to ensure business continuity and the second to comply with environmental legislation and no degradation of the environment. This paper analyzes the use of a new computational optimization algorithm based on the cultural algorithm (CA), improved with local search techniques simulated annealing and Tabu search, using data from a real power plant with 10 generators and the system of the IEEE with 13 generating units.

J. Zhao et al.,[11] A modified cuckoo search (CS) algorithm is proposed to solve economic dispatch (ED) problems that have nonconvex, non-continuous or non-linear solution spaces considering valve-point effects, prohibited operating zones, transmission losses and ramp rate limits. Comparing with the traditional cuckoo search algorithm, we propose a self-adaptive step size and some neighbor-study strategies to enhance search performance. Moreover, an improved lambda iteration strategy is used to generate new solutions.

S. Ma et al.,[12] shows a environmental/economic dispatch (EED) problems play a salient role in the power system, which can be defined as a complex constrained optimization problem. Many different methods have been introduced to handle EED problems and got some inspiring positive results in the research. In this paper, a new multiobjective global best artificial bee colony (ABC) algorithm is proposed to tackle multiobjective EED problems. To manipulate this problem effectively, we propose a global best ABC algorithm to generate the new individual to speed up the convergence of the proposed algorithm. Afterwards, a crowding distance assignment approach is employed to evolve the population. Finally, a straightforward constraint checking procedure is used to tackle those different constraints of EED problems.

Economic Load Dispatch constraints

The economic load dispatch means the real and reactive power of the generator vary within the certain limits and fulfils the load demand with less fuel cost. The sizes of the electric power system are increasing rapidly to meet the energy requirement. So the number of power plants is connected in parallel to supply the system load by an interconnection of the power system.

In the grid system, it becomes necessary to operate the plant units more economically. The economic scheduling of the generators aims to guarantee at all time the optimum combination of the generator connected to the system to supply the load demand. The economic load dispatch problem involves two separate steps. These are the online load dispatch and the unit commitment.

The unit commitment selects that unit which will anticipate load of the system over the required period at minimum cost. The online load dispatch distributes the load among the generating unit which is parallel to the system in such a manner as to reduce the total cost of supplying. It also fulfils the minute to the minute requirement of the system.

## II.MATHEMATICAL MODEL

The economic load scheduling problem is one of minimizing a certain cost functions subject to a number of constraints. This power dispatch problem [1,2], is stated in this paper as follows:

$$\min\left\{\sum_{i=1}^{n_G} C_i\ (P_{Gi})\right\} \quad (1)$$

$$P_{Gi\,min} \le P_{Gi} \le P_{Gi\,max} \quad (2)$$

$$P_{ij} \le P_{ijM} \quad (3)$$

$$\sum P_{Gi} = P_D + P_L \quad (4)$$

where generally $C_i\ (P_{Gi})$ is quadratic curve:

$$C_i\ (P_{Gi}) = a_i + b_i P_{Gi} + c_i P_{Gi}^2 \quad (5)$$

Where ai, bi and ci are the known coefficients.

Obviously the constraint (2) is so called limits of generation, the constraint (3) the line power flow limit, and the constraint (4) reflects active power balance. This problem will be solved in the paper by the variable weights linear programming method. They will be considered the types of solutions, the first one with the use of load flow calculation is not necessary.

## III.OBJECTIVE

Following the variable weight linear programming method [1], the cost function (1) can be transformed in to following one:

$$\sum_{i=1}^{nG} \sum_{s=1}^{ki} C_i\ (P_{Gi,s}) \cdot\ x_{i,s} \quad (6)$$

$$\sum_{s=1}^{ki} x_{i,s} = 1 \qquad i = 1,....,nG \quad (7)$$

$$x_{i,s} \ge 0 \qquad s = 1,.....,ki \quad (8)$$

Following this notation the value of active generation $P_{Gi}$ is to obtain by:

$$P_{Gi} = \sum_{s=1}^{ki} P_{Gi,s} \cdot x_{i,s} \quad (9)$$

and the load balance equality constraint is transformed as follows:

$$\sum_{i=1}^{nG} P_{Gi,s} \cdot x_{i,s} = P_D + P_L \quad (9')$$

## IV.GENERATION CONSTRAINTS

The generation outputs are limited by the generation characteristics and should be in the region expressed by (2). In the variable coefficient programming method the constraint (2) has the following form:

$$P_{Gi}^{m} \le \sum_{s=1}^{ki} P_{Gi,s} \cdot x_{i,s} \le P_{Gi}^{M} \quad (10)$$

## V.LINE POWER CONSTRAINTS

To take account of the constraints (3) in the optimisation problem it is necessary to express the line power flow as a function of generation powers. The bus active injection powers Pp [1, 2, 3, 4, 5] are given by the following formula:

$$P_p = \sum_{q=1}^{n} \left\{ e_p (e_q \cdot G_{pq} + f_q \cdot B_{pq}) + f_p (f_q \cdot G_{pq} - e_q \cdot B_{pq}) \right\} \quad (11)$$

And the line active power is done by the formula:

$$P_{ij} = ( e_i^2 - e_i e_j + f_i^2 - f_i f_j ) G_{ij} + ( e_j f_i - e_i f_j ) B_{ij} \quad (12)$$

It is supposed to express (12) as a function of bus power injection at generation bus in following manner:

## VI. CONCLUSION

According to previous approaches another nature propelled calculation is actualized for various economic load dispatch issues. The calculation is simple to actualize and can be coded in any computer language. Power framework operation optimizing issues can be attacked with the assistance of this calculation. Power framework administrators can likewise utilize this calculation for different enhancement issues. Various approaches already developed, and research is continuing going on. In future the soft computing-based approach will be implemented using MATLAB software to enhance the performance.

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