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"AN STUDY OF OPTIMIZATION METHODS FOR ECONOMIC LOAD DISPATCH ISSUES"

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ABSTRACT

In this study, grid-tied photovoltaic systems—power-generating devices connected to power grids—are being designed as a grid-integrated solar wind hybrid energy system to drive loads and increase system efficiency and dependability. creating an inverter control that reduces the amount of distortion in both the voltage and current waveforms. Electricity expanded rapidly throughout the world after invention. Electrical power systems in the world have grown larger and more geographically expansive with many interconnections between neighbouring systems. India has also grown in production of electricity. India has recorded impressive rates of economic growth in recent years.

Key Words: *Grid system, Solar System, hybrid system, Electricity, power-generating devices.*

I. INTRODUCTION

Electrical power sectors play a significant task in national growth of economy. Increase in generation of electricity has led to its extensive use in all the sectors of economy. The growth in all sectors increases very rapidly and hence the demand of electricity increases in the same ratio. The demand rate of electrical power is very large as compared to generation of power. Since electrical power system has limited power generation and hence at the same time it is very difficult task to satisfy demand of all electrical consumers. It is also very difficult task to provide electric power at a reasonable rate of price. So that it is required to reduce the total generation cost of the electrical power plants and fulfil the load demand.

Power system has several generating power plants. In each generating power plant have several generating units. The total demand of the system is supplied by different generating power plant, at any particular of time. Economic load dispatch problem identified the generated output power of each generating power plant, and output power of each generating unit within a generated power plant in such a way to minimize the overall generation cost to provide the system load demand and not violate the constraints limits.

In the economic load dispatch the generations are not fixed but they are allowed to take the limitswithin certain circumstances so as to fulfil load demand with minimum fuel cost. Economic load dispatch problem is really the solution of a large number of load flow problems and choosing the one which is optimal in this way that it operates on minimum generation cost. Since total cost of generation is a function of the individual generation of the sources which can take values within different constraints, the cost of power generation is depends on the operating limits.

With appropriate planning and design of power plant can be operate economically and efficiently. Economic load

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dispatch used for analysis, planning and design of the power System which operate economically and efficiently. Economic load dispatch also used for the study of transient stability and contingency studies of the power plant. Power system fuel cost problem numerically can be analysed by use of economic load dispatch. To obtaining the minimize total generation cost of thermal generating unit is the most important objective of the economic load dispatch, while satisfying the operational constraints.

Conventional economic load dispatch would be considered as linear model and many algorithms were proposed by researchers for the solution of such linear model, such as lambda-iteration method, the base point, linear method, nonlinear method, gradient method and interior point method etc. but unfortunately, the characteristics of modern units input output are highly nonlinear because of valve point loadings, prohibited operating zones and ramp rate limits etc. Resulting in multiple local minimum points in the cost function. So, the characteristics of ELD problem have to be approximated to meet the requirements of the conventional optimization algorithms. So that, such type of methods may lead to huge loss of revenue and time. The classical gradient-based techniques failed in solving these types of problems. Most recent trends for research, therefore, use new evolutionary optimization techniques to solve the ELD problem i.e. GA, ES and EP. These evolutionary algorithms (EAs) techniques are based on the social as well as biological and natural selection of genetics. Flexibility and robustness is the main advantages of the new optimization techniques.

In this work we have considered various test data of IEEE standard bus system like six generating unit with different load demand and these test data are solved by like PSO, WIPSO.

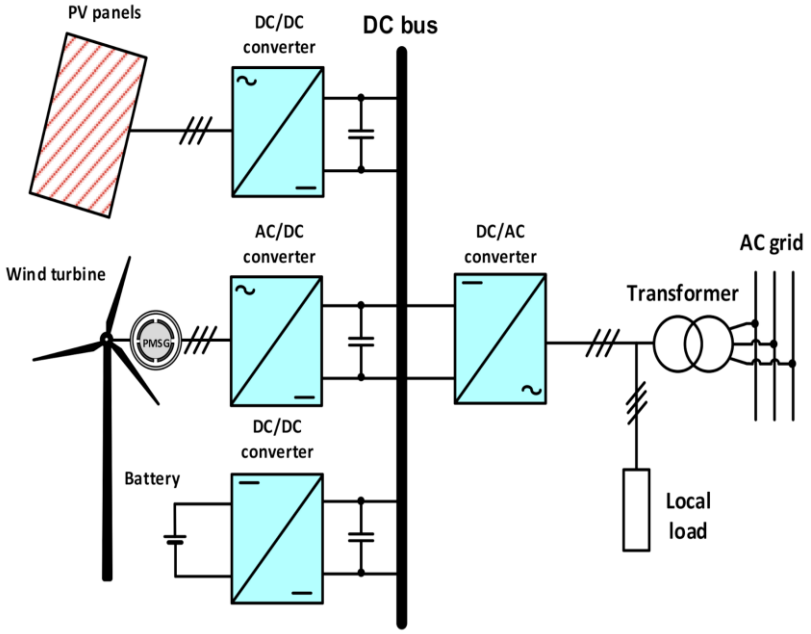

Fig. 1 Hybrid Energy System

Wind energy is a clean energy source that can be used to generate electricity through wind farms and generators. Wind turbines are fan-shaped fans that rotate in response to wind, with a pivot point oriented with the flow direction. Solar power systems consist of solar panels, photovoltaic modules, and a power storage battery. Offshore wind is available all day, while renewable radiation is only accessible during the day. The Winds Sunshine Hybrid Energy system combines wind and sun energy, generating energy virtually all year round. A transmission line or grid tie inverter (GTI) converts DC voltage to AC, connecting photovoltaic systems to the grid. GTIs work similarly to traditional stand-alone DC-AC SMPS, but with better control algorithms and safety features.

GTIs circuits typically contain one to three phases, dependent on power and incoming voltage levels. The fundamentals of functioning of a 3-grid tie converter are illustrated in the schematics picture below. Reduced input (such as 12V) in grounding circuits can benefit from this layout.

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The boost converter, which consists of inductor L1, MOSFET Q1, diode D1, and capacitor C2, raises the voltage source first. According to the National Electric Code®, if a PV array is rated for greater than 50V, one of the input electric power buses must be grounded. The NEC®, on the other hand, provides for several exclusions, which we will describe further below. Although either of two buses can theoretically be attached to the earth, it is generally the negatives one. It's necessary to keep in mind that in distribution networks, if the DC input has a conductivity passage to grounding, the output AC conductor should be insulated from the DC.

Power generation plant consist many generating units, having their own characteristic and operating parameters, are used to meet the total demand. Generally the operating cost of these generators is not proportional with their output. Hence distribution of the total load among generating units is challenge for power utilities. It becomes complex when utilities try to account for the transmission loss and seasonal changes.

Electrical power systems are designed and operated to meet the continuous variation of power demand. In power system, minimization of the operational cost is very important. ELD is a method to schedule the power generator outputs with respect to load demands, and to operate the power system most economically, or in other words, we can say that the main objective of economic load dispatch is to allocate the optimal power generation from different units at the lower cost possible while meeting all system constraints.

Over the years, many efforts have been made to solve the economic load dispatch with constraints or multiple objectives through various mathematical programming and optimization techniques. In this chapter presenting a deep review of the different ELD model such as linear ELD, non-linear ELD, dynamic ELD, ELD model incorporated with renewal energy sources like wind and solar system, multi-objective ELD, ELD with environmental Emission etc. solved by Classical methods, heuristic evolutionary techniques, hybrid methods etc. used for the solutions of such ELD models.

II. LITERATURE REVIEW

In literature many classical methods known as deterministic algorithms were listed such as Lagrange multipliers [11,], Leaner programming method (LP),[5], Quadratic programming (QP)[10], Parametric quadratic programming [9], Harmony search method [12], and Pattern search programming[8] used for the solution of economic load dispatch problem.

Authors of [9] proposed parametric quadratic programming (QP), the modified quadratic programming and the recursive quadratic programming algorithm for the solution of single objective ELD problem. Linear programming technique is a powerful and practical optimization techniques [5] used for the solution of ELD problem. Fan et al. proposed practical strategy based on Quadratic Programming (QP) techniques to solve the real-time ELD problem with a quadratic objective function based on the unit's cost curves in quadratic or piecewise quadratic forms.

A new multi-objective optimization, MOSST, was presented [27]. It is an adaptation of the method for single criterion function optimization. The solution provided by MOSST is a family of points known as the Pareto-optimal set.

Improved harmony search method proposed by the articles of [12] for solving economic load dispatch problems. The harmony search method mimics a jazz improvisation process by musicians in order to seek a fantastic state of harmony.

Classical methods have their own drawbacks such as algorithmic complexity, needs linear mathematical model of problem, convergence characteristics that are sensitive to initial conditions, suffers from bad initial termination and optimality criteria and many more.

The problem of the economic dispatch is highly nonlinear, where more than one local optimum exists. Hence the classical optimization techniques are not suitable for such a problem. Hence it becomes essential to develop optimization techniques that are efficient to overcome these drawbacks of classical approaches and handle such

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complexity.

Many research articles proposed modern evolutionary techniques for the solution of economic load dispatch problem. Most of the proposed evolutionary techniques were population based optimization techniques, relying on initial randomization associated with logical patterns. These techniques have fast conversation and able to provide global solution of the ELD problem.

In literature many heuristic evolutionary algorithms are listed such as differential evolution (DE)[23], genetic algorithm (GA) [13] particles warm optimization (PSO) [7], MPSO[6], SHO-PSO[19], neural network[18],[29], BBO[15], and ES[28] used for the solution of nonlinear ELD problem.

The interior point methods, in general, suffer from bad initial, termination, and optimality criteria and in most cases, are unable to solve nonlinear and quadratic objective functions. To overcome the problem of interior point methods [108] proposed improved quadratic interior point (IQIP) method offers great improvements in speed, accuracy, and convergence in solving multi-objective and multi-constraint optimization problems. a self-dual (SHSD) linear programming (LP) interior point algorithm for the solution of ELD problem with security constrained. The interior point method that can obtain an optimal solution for the security constrained economic dispatch problems while taking into account of the power flow constraints.

Heuristic approaches have their own advantages such as they are derivative-free, capable of solving optimization problems without requiring convexity, independent of the initial solution, and have the ability to provide global solution of the ELD problem.

Genetic algorithms approach proposed by the authors of [13] for solving Economic Load Dispatch (ELD) problem.In year 2005 proposed genetic algorithm (GA) and an improved genetic algorithm with multiplier updating (IGA_MU) respectively can efficiently search and actively explore solutions, and the MU is employed to handle the equality and inequality constraints of the ELD problem.

Fuzzy based techniques were proposed by [2] Genetic algorithm [3], micro GA, and PSO proposed by [16], Levenberg marquardt algorithm proposed by [18] in 2006, based on the multi layer feed forward neural network, and a modified bacteria foraging algorithm (BFA) for the solution of ELD problem with environmental emission. ABC algorithm inspired by foraging behaviour of honey bees proposed to solve combined economic and emissions dispatch problems is presented [30], in 2011.

PSO has attracted many attentions and been applied in various power system optimization problems such as economic dispatch [22]. Authors of [7], [16], proposed a particle swarm optimization approach to economic load dispatch problems with non-smooth objective functions.

For the satisfaction of this goal of ELD problem authors [31] proposed an efficient constriction particle swarm optimization (CPSO) with mutation mechanism, they also considered many non-linear characteristics of the generator, such as ramp rate limits and valve-point loading effects in their study.

New version of the classical particle swarm optimization (PSO), improved particle swarm optimization (NIPSO) [29], probability distribution and chaotic sequences in PSO[25], modified particle swarm optimization (MPSO)[6], self-organizing hierarchical particle swarm optimization (SOH_PSO) [19], a quantum-inspired version of the PSO (QPSO) using the harmonic oscillator potential well (HQPSO)[24], hybrid particle swarm optimization (HPSO), Novel particle swarm optimizer [14], were used for solution of ELD problem.

Typically in simulated annealing method, a higher cost feasible solution is accepted with temperature dependent probability, but other solutions are accepted deterministically. Article [26] presented a new approach to unit

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commitment problem using absolute stochastic simulated an annealing method. In every iteration, a solution is taken with a certain probability. However, all the solutions, both higher and lower cost, are associated with acceptance probabilities.

Evolutionary algorithms are heuristic methods that have yielded promising results for solving nonlinear, non-differentiable and multi-modal optimization problems in the power systems area [23]. Differential evolution (DE) is one of the recently developed evolutionary computation techniques, to minimize the nonlinear function, which is the total fuel cost of thermal generating units, subject to the usual constraints.

The problem of the economic dispatch is highly nonlinear, where more than one local optimum exists. Hence the classical optimization techniques are not suitable for such a problem. Hence it becomes essential to develop optimization techniques that are efficient to overcome these drawbacks of classical approaches and handle such complexity.

Many research articles proposed modern evolutionary techniques for the solution of economic load dispatch problem. Most of the proposed evolutionary techniques were population based optimization techniques, relying on initial randomization associated with logical patterns. These techniques have fast conversation and able to provide global solution of the ELD problem.

Equal embedded algorithm is also used to solve the ELD problem with prohibited zones and losses in [17] in 2006 and 2007 respectively. It is formulated based on numerical methods such as interpolation and Muller method. The proposed method was tested on a power system having 6 and 15 generating unit.

The direct search method is a simple and effective method for solving optimization problems that does not required any information about the higher derivative of the objective function. An improved evolutionary search (ES) method with binary successive approximation (BSA) approach proposed by [28], in 2007 used to solve ELD problem in power system by searching the generation of the committed units.

Bhattacharya et al. (2010) presented a biogeography-based optimization (BBO) algorithm [15], to solve both convex and non-convex economic load dispatch (ELD) problems of thermal plants. Pandi et al.(2011) presented a new evolutionary optimization algorithm to solve economic load dispatch problem with operational constraints using the improved harmony search algorithm[19]. Authors of [4], introduced Gravitational search algorithm (GSA) applied to economic load dispatch problem with valve point loading and Kron's loss in 2011.

The idea behind the hybridization is to enhance the solution quality by overcoming the limitations of each individual technique. Hybridization commonly divided the process (optimization) into two phases. The first phase, designated for the heuristic algorithm, aimed to explore the search-space without restrictions. In the second phase with a potential region discovered in the primary phase, a deterministic algorithm took over seeking to enhance the results. This routine is repeated until a termination criterion was met.

A hybrid approach incorporated artificial neural network using back propagation algorithm (BP)and fuzzy logic algorithm (Neuro-Fuzzy hybrid) proposed [20] in 2005 for the ELD problem to maximize the short and long term operations system performance considered generating limits, the transmission line constraints and the limited amounts of the capital available for new units and equipments.

A solution of the dynamic economic dispatch (DED) problem using a hybrid approach of Hopfield neural network (HNN) and quadratic programming (QP) introduced [1] in 2007. The hybrid algorithm is based on using enhanced HNN; to solve the static part of the problem; the QP algorithm for solving the dynamic part of the DED.

Coelho et al. (2008) suggested an alternative hybrid method [26]. The proposed hybrid method combines the

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differential evolution (DE), an evolutionary algorithm, with cultural algorithm based on normative and situational knowledge to solve the EDP associated with the valve point effect.

Interior point method and differential evolution (DE) are combined as hybrid algorithm [31] for solving economic load dispatch problem with valve point effect in 2011. A new hybrid system employed hybrid mechanism involving a quantum mechanics inspired particle swarm optimization (PSO) proposed [21] in 2011.

The main focus of this chapter is to review and summarize the various optimization techniques listed in the literature, used for the solution of economic load dispatch problem. Here also focused to provide a deep review of different variants of PSO used to solve the problem of economic dispatch.

III. PRROBLEM

Economic load dispatch occupies an outstanding place in power system operation and management. It aims to identify the best power outputs of on-line generating units so asto fulfil the load demand subject to satisfying constraints over finite dispatch period. Similar most of the complex engineering, the nonlinear and non-convex characteristics optimization problems are associated in the ELD problem. Therefore, it is possible that computational methods may yield a global solution which is the optimal solution of the ELD problem.

IV. CONCLUSION

The main objective of this thesis is to attain practical algorithms for optimal economic load dispatch, considering various equality and inequality constraints and environmental emission of electric power systems. Because this objective can be interpreted in a mathematical optimization problem, it is formulated as single objective as well as multi-objective optimization problem with equality and inequality constraints.

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