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Optimization And Comparison Of Economic Load Dispatch Problem With The Proposed Traditional Technique

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Abstract-The Economic Dispatch (ED) problem is widely used and constitutes a very important optimization task that must be undertaken on a daily basis in the operation of power systems. Economic dispatch is the short-term determination of the optimal output of a number of electricity generation facilities, to meet the system load, at the lowest possible cost, subject to transmission and operational constraints. So The main goal when dealing with Economic Dispatch tasks is to find the optimal schedule that produces the desired power outputs for all the generating units, and minimizes the total fuel cost, while satisfying some constraints. But another goal associated to the previous one, is to obtain the desired schedule as fast as possible. Generally economic dispatch is solved without accounting to transmission constraints, however, in deregulated power system environment Economic load dispatch (ELD) has the objective of generation allocation to the power generators such that the total fuel cost is minimized and all operating constraints are satisfied. A number of traditional methods are using for solving ED and other power system problems. During the last decade soft computing methods like PSO proposed, Evolutionary Strategy and GA method have been increasingly proposed for complex optimization problems. This paper proposes GAMS technique in which premature convergence is avoided by tuning the parameters for enhanced global and local search. This paper reviews and comparisons the performance of the PSO, GA and Evolutionary algorithm variants with proposed solver The General Algebraic Modeling System GAMS for economic load dispatch on single 40 units standard test system is included for validate the results.
Index Terms: Optimization, Modelling Language, Economic load dispatch, GAMS

I. INTRODUCTION

A maintain a better economy and reliability of the power system, economic load dispatch is one of the best options for generating companies as the main task for them is to ensure that the electrical energy requirement from the customer is served while low the cost of power generation, the total demand must be optimally shared among all the generating units with an objective to minimize the total cost while satisfying operational constraints on system. ELD is a process of allocating the optimal combination of generation to all generating units in the power system so that the total generation cost of system is minimized, while satisfying the load demand and system equality and inequality constraints. It is defined as the operation of generation facilities to produce energy at lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities [1].In an electrical power system, a continuous balance must be maintained between electrical generation and varying load demand, while the system frequency, voltage levels, and security also must be kept constant. Furthermore, it is desirable that the cost of such generation be minimal. In addition, the division of load in the generating plant becomes an important operation as well as an economic issue which could be solved at every load change (1%) or every 2-3 minutes [2]. The objective is to find the real and reactive power scheduling of each power plant in such a way as to minimize the operating cost. This means that the generators real and reactive powers are allowed to vary within certain limits so as to meet a particular load demand of plant with minimum cost fuel, also known as cost functions may present economic costs, system security or other objectives. Efficient reactive power planning enhances operation as well as system security [3]. Over the past few decades, as an alternative to the conventional mathematical approaches, many salient methods have been developed for Economic Load Dispatch problem such as evolutionary programming [4-5], particle swarm optimization [6-7], and Genetic algorithm [8], BBO [9], DE [10] FE [11-12].Recently covariance matrix adapted evolutionary strategy has been proposed problems. Large dimension problems are difficult to optimize using soft computing methods, as these techniques take a long time to converge; on the other hand, traditional methods like the GAMS solver computes the best result almost instantaneously. These results prove that the proposed method is capable of getting higher quality solution including mathematical simplicity, fast convergence, and robustness to solve hard optimization problems.

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There has been phenomenal growth in mathematical programming techniques and development of computer codes to solve large scale optimization models over the past four to five decades. One of the most popular and flexible languages among these is the General Algebraic Modeling System (GAMS) [13-14].

II. ECONOMIC LOAD DISPATCH PROBLEM FORMULATIONS

The operation of a modern power system has become very complex. It is necessary to maintain frequency and voltage within limits in addition to ensuring reliability of power supply and for maintaining the frequency and voltage within limits it is essential to match the generating of active and reactive power with the load demand. For ensuring reliability of power system it is necessary to put additional generation capacity into the system in the event of outage of generating equipment at some station. Over and above it is also necessary to ensure the cost of electric supply to the minimum. Therefore, the task of load control centre is to keep the exchange of power between various zones and system frequency at desired value. The objective of the economic dispatch problem is to determine the generated powers P_i of units for a total load of P_D so that the total fuel cost, F_T for the N number of generating units is minimized subject to the power balance constraint and unit upper and lower operating limits. The objective is

$$Min F_T = \sum_{i=1}^{N} F_i(P_i) \tag{1}$$

where F_i is the total fuel cost for the i^{th} generator (in \$/h) which is defined by,

$$F_i(P_i) = (a_i P_i^2 + b_i P_i + c_i) \tag{2}$$

where a_i, b_i and c_i are the fuel-cost coefficients of the i^{th} unit. Two constraints are considered in this problem, i.e., the generation capacity of each generator and the power balance of the entire power system.
Static ELD problem can be stated as minimization of eq. (3.1) subject to

A. Power Balance Constraint

$$\sum_{i=1}^{N} P_i - (P_D + P_L) = 0 \tag{3}$$

B. Unit Operating Limits Constraint

$$P_i^{\min} \le P_i \le P_i^{\max} \qquad i = 1,2,\ldots, N \tag{4}$$

For a given total real load P_D the system loss P_L is a function of active power generation at each generating unit. To calculate system losses, methods based on penalty factors and constant loss formula coefficients or B-coefficients [12] are in use. The latter is adopted in this paper as per which transmission losses are expressed as

C. Minimization Of Transmission Losses

$$P_L = \sum_{i=1}^{N} \sum_{j=1}^{N} P_i B_{ij} P_j + \sum_{i=1}^{N} B_{oi} P_i + B_{oo} \tag{5}$$

D. Area-Wise Power Balance Constraint

In MAED problem the power balance constraints need to be satisfied for each area. The power balance constraints for area q neglecting losses can be given as

$$\sum_{i=1}^{Nq} P_{iq} = \left(P_{Dq} + \sum_{j}^{Mq} T_{jq} \right) = 0 \tag{6}$$

for q=1,2……..M (areas). For the q^{th} area , P_{Dq} is the load demand , T_{jq} is the tie- line flows from other areas, N_q are number of generating units and Mq represents the number of tie-lines connected to the q^{th} area.

E. Unit Ramp-Rate Limit Constraints

When the generator ramp rate limits are considered, the operating limits are modified as follows:

$$Max\ (P_i^{\min}, P_i^{o} - DR_i) \le P_i \le Min\ (P_i^{\max}, P_i^{o} + UR_i) \tag{7}$$

The previous operating point of i[th] generator is P_i^o and DR_i and UR_i are the down and up ramp rate limits respectively.

III. PROPOSED TECHNIQUE OF GENERAL ALGEBRAIC MODELING SYSTEM

The General Algebraic Modeling System (GAMS) is specifically designed for modeling linear, nonlinear and mixed integer optimization problems [13]. The system is particularly very advantageous with large, complex problems. GAMS allow the user to concentrate on the modeling problem by making the setup simple. GAMS are especially useful for handling large, complex, one-of-a-kind problems which may require many revisions to establish an accurate model. The user can change the formulation quickly and easily, and can even change from one solver to another. Similarly the use can easily convert from linear to nonlinear optimization option with little trouble [14]. The optimization solver, in GAMS modelling system solves the different problems of linear, nonlinear and mixed integer optimization problems. The basic structure of a mathematical model coded in GAMS has the components: sets, data, variable, equation, model and output the tool kit in GAMS gives algorithms for each category of problem. GAMS also have the unique feature of providing a common language that can make use of a variety of solvers.

A. The General Algebraic Modeling System Tool Kit

The tool kit in GAMS embodies several man-years of research that has gone into developing and fine tuning the algorithms in each category of problems. GAMS also have the unique feature of providing a common language that can make use of **a** variety of solvers developed by dement research group/companies. GAMS provide powerful solvers for the following classes of optimization problems.

Linear programming (LP) variants of simplex methods and Interior Point methods
Non-linear programming (NLP)
Variants of Gradient methods
Linear mixed integer programming (MILP)
Non-linear mixed integer programming (MINLP)

GAMS are a modeling system for optimization that provides an interface with a variety of different algorithms. Models are supplied by the user to GAMS in an input file in the form of algebraic equations using a higher level language. GAMS then compile the model and interfaces automatically with a "solver" (i.e., optimization algorithm). The compiled model as well as the solution found by the solver is then reported back to the user through an output file. The simple diagram below illustrates this process show in Fig 1.

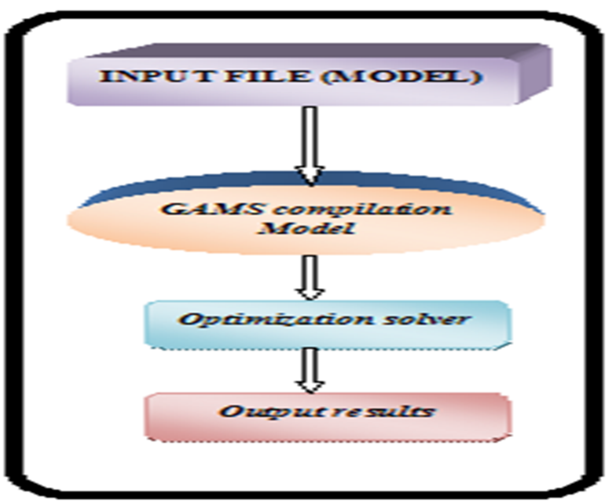

Fig 1 optimization solver

The format of the input files is not rigid (although the syntax is) as the reader will verify with the GAMS listings provided in this case study. Also, there is a rather large number of keywords so as to provide the flexibility for handling simple and complex

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Models.

B. Programmer Features Of GAMS

The model is independent from the solution method, and it can be solved by different solutions methods by only changing the solver efficient handling of mathematical optimization problems.

Simplify model building and solution process. Increase productivity and support maintainable models, Support of decision making process

The translation from the mathematical model to GAMS is almost transparent since GAMS has been built to resemble mathematical programming models.

IV. SIMULATION RESULTS AND DISCUSSION

The coefficient of fuel cost and maximum and minimum power limits are given in appendix section [15]. The power demand is to be 8550 (MW).The comparisons of best results to GA and PSO with GAMS are shown in table-1.The detailed corresponding to results is shown in table-2.

Table 1 Results using GAMS for 40 generator test system

Parameter	Power output	Parameter	Power output
P1	66.870	P21	550.000
P2	120.000	P22	550.000
P3	190.000	P23	550.000
P4	32.416	P24	550.000
P5	30.364	P25	550.000
P6	140.000	P26	550.000
P7	300.000	P27	550.000
P8	300.000	P28	10.000
P9	300.000	P29	10.000
P10	130.000	P30	10.000
P11	94.000	P31	20.000
P12	94.000	P32	20.000
P13	125.000	P33	20.000
P14	239.670	P34	20.000
P15	232.227	P35	18.000
P16	232.227	P36	18.000
P17	232.227	P37	20.000
P18	500.000	P38	25.000
P19	500.000	P39	25.000
P20	550.000	P40	25.000
Total Time 0.016 sec			
Total Cost Of 40 Unit System Cost ($/H) 114620			

TABLE 2 Comparison of three methods best result (PD 8550 MW)

METHODS	LOAD DEMAND	MINIMUM COST
PSO method	8550	121430
GA method	8551.32	13,070
Proposed algorithm	8550	116943
GAMS	8550	114620

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V. CONCLUSION

In this paper, a new approach to solve economic load dispatch problem using GAMS technique method is used. The GAMS technique provides an optimal solution with less computational time. The GAMS technique improves the computational time. The PSO algorithm gives specified load demand with minimum fuel cost and increased power output for each unit. Therefore, in future the GAMS technique will be most important and efficient technique to solve the large optimization problems with lower transmission losses because the GAMS technique is simpler in structure than other methods

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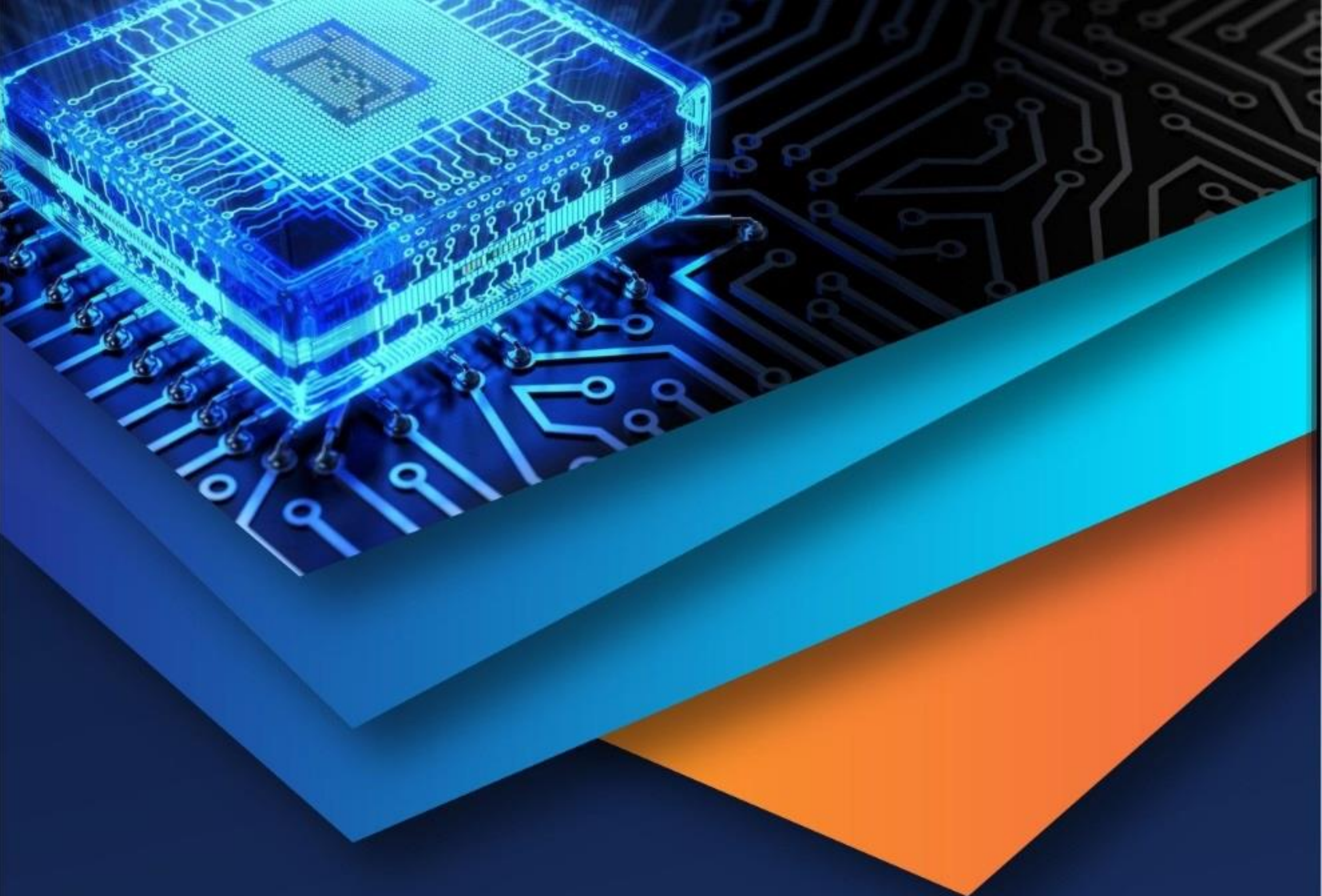

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