Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 03, March -2018

A HYBRID BPSO-ST SWARM INTELLIGENCE APPROACH FOR RESOLVING ECONOMIC LOAD DISPATCH PROBLEM IN POWER SYSTEM

Atinder pal Singh[1], Harkamal Deep Singh[2]

[1,]*Department of Electrical Engineering,GGS college of modern Technology (Kharar,Pb), I.K.Gujral Punjab Technical University, Jalandhar, India*

Abstract—*The increment in the demand of real power on the distribution power system has an effect on cost of the power generation systems. The main purpose is to arrange the total demand amid committed generating units with lesser fuel cost by utilizing the intelligent mechanisms. This study develops a hybrid mechanism based on Binary Particle Swarm Optimization (BPSO) and State Transition (ST) to optimize the performance of the power units at lesser cost. The BPSO-ST is evaluated by using the 6 different power units. A comparison analysis is performed among Lambda Method, Genetic Algorithm (GA), Particle Swarm Method (PSO) and BPSO-ST method in the terms of total power loss, total generated power and total cost incurred. The results prove that the BPSO-ST outperforms the other ELD optimizing techniques.*

Keywords—*Economic Load Dispatch, BPSO, State Transition, Power Generation, Transmission Loss, Total cost.*

I. INTRODUCTION

In power industry, Electrical power industry is considered as one of the trending areas in which competitive market and vibrant are restructured in terms of different industry aspects. There is increase in necessitate optimal dispatch power generation cost due to ever budding electrical energy demand, energy resources paucity and progressions in the industry. The optimization method provided by owing economic load dispatches results in power demand division economically among online generators by satisfying various constraints. There is considerable saving in amount of money by optimum dispatch and excessive power generation cost. The dispatch of optimal generation is considered as one of the most critical problem in power system engineering. In every day system operation operators commonly used this technique and as reactive and real power is allocated to the power system using this technique that helps in reducing overall system efficiency and cost to obtain optimal state [1]. The Economic Load Dispatch (ELD) problem allocates the real power to units of online generator that helps in reducing system cost. Number of researchers have proposed different optimization algorithms and have also used existing algorithm for the purpose of solving ELD problem. PSO i.e. Particle Swarm Optimization is an optimization technique that is less complex with respect to the performed calculations. The compensation of PSO is that it is quite simple, less complex in calculations, highly vigorous, and fast convergence. PSO is used for solving optimization problems in various fields. ELD is one of the problems that can also solved by implementing PSO. Economic Load Dispatch is a concept that facilitates economic conditions of a power system during the planning process. ELD is a process which is an aid to deciding that how to diminish the power generation cost and to attain the effective power system. It was prepared by dispatching existing electrical sources to transmission of load to system. This paper was a kind of review study to the ELD using PSO [19]. Thus PSO is proved to be one of the prominent mechanisms to resolve the issue of ELD but still faces some issues such as lack of efficiency etc.

II. PROBLEM FORMULATION

To optimize the ELD in a power generation unit is one of the major issues to resolve. The concept of economic dispatch is persistence of the optimal output corresponding to the power generation units to fulfill the requirement of system load with respect to the lower cost at various transmission and operational constraints. The problem of ELD is derived from the issue of optimal power flow. The goal of ELD is to assign a power generation level to the assembled power generation units in order reduce the total cost and power loss. The total cost refers to the expenses incurred on fuel for power generation. The total cost is evaluated by defining each and every unit in power generation systems. The power generation units with lower cost, lower power loss and optimized power generation level is said to be more effective and efficient power generation system. ELD has been the hot topic among researchers during last few years and still the research is going on in this domain to find out the optimal and best solution. For this purpose various optimization algorithms has been used but did not able to generate the optimized output. Thus there is a need to develop a optimized solution for resolving economic load dispatch in power generation systems by satisfying rest of operational and transmission constraints.

III. PROPOSED WORK

The hybrid optimization mechanism is developed to overcome the issues of ELD. The hybridization is done by collaborating the swarm optimization based BPSO algorithm and ST algorithm. The focus of the study is to generate the optimized power at the price of lowest power generation cost, lesser power loss etc. In traditional ELD techniques the PSO optimization algorithm was utilized along with the other techniques such as GA etc. But the evaluated performance was not quite effective thus, in proposed work, the PSO is replaced by BPSO and the ST is merged with it to make it more efficient. The proposed work is initiated to satisfy the both equality and non-equality constraints of the power generation units. This section represents the working of BPSO-ST in a step by step manner.

1. The implementation of proposed work is started from generating the initial population.
2. After generating the initial population next step is to perform the fitness evaluation corresponding to the generated population.
3. From evaluated fitness value, perform a check for the best fitness value and if it is achieved then save it.
4. Apply BPSO to update the initially generated population.
5. Now apply State Transition optimization algorithm to optimize the population.
6. If the best fitness us achieved than save it otherwise go to step 2 and generate the population again, this process will continue until the best fitness is achieved.

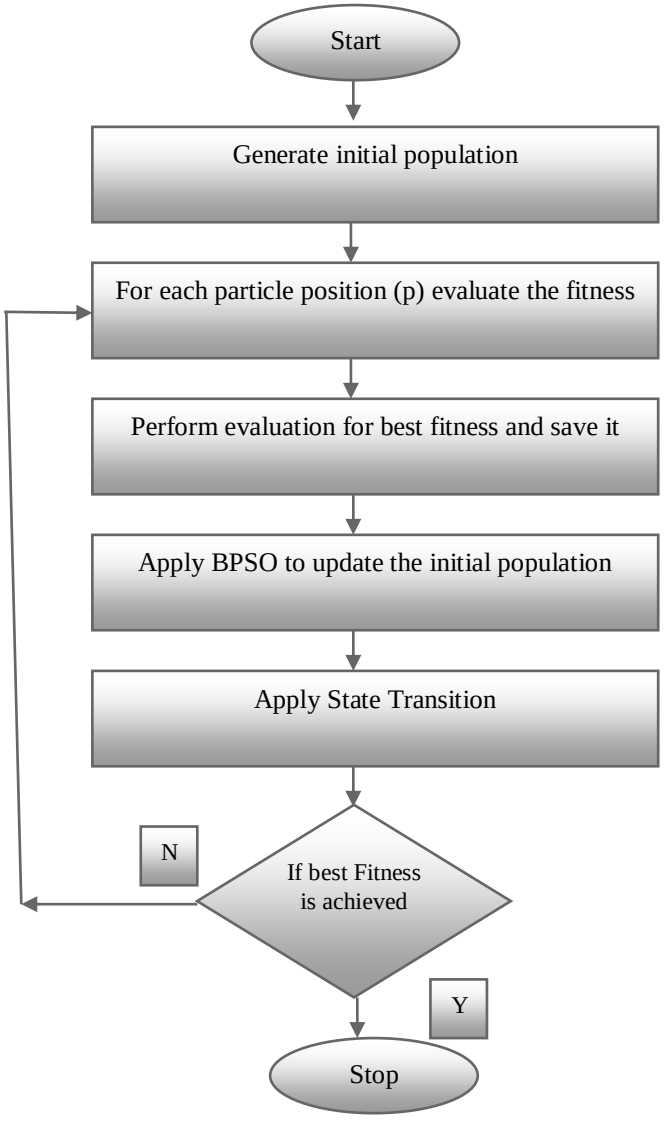

Figure 1 Work flow diagram for proposed ELD solution model

IV. RESULTS AND EXPERIMENTS

The BPSO-ST is simulated in MATLAB by considering 6 different power generation units. The analysis of proposed work is done in the terms of total power generation, total power loss and total cost incurred on power generation. The power generation amount of BPSO-ST corresponding to all power units is represented in the graph given in fig 2. The amount of power generation varies from 0 to 200Mw. On the basis of the graph, the power generation amount for P1 is 14Mw, P2 is 91Mw, P3 is 99Mw, P4 is 145Mw, P5 is 181Mw and P6 is 185Mw. On the basis of the observed facts, it is proved that the BPSO-ST is quite able to generate the optimized power.

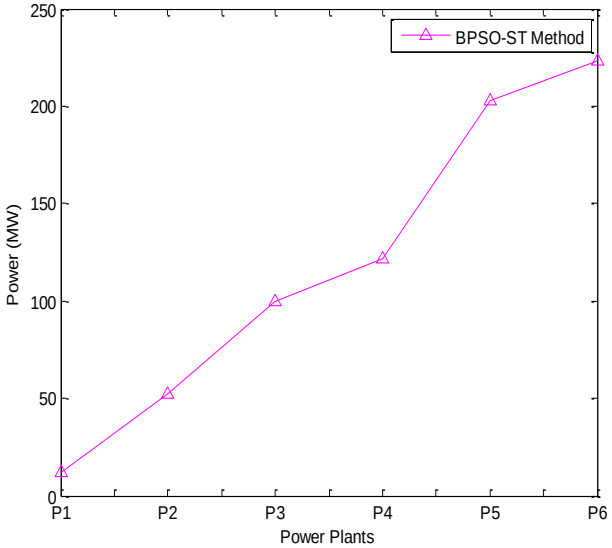

Figure 2 Power Generation by 6 power plants

The graph in fig 3 shows the overall cost that is incurred on power generation system while implementing the proposed work. The overall cost is evaluated on the basis of the number processing iterations. The x axis in the graph shows the number of iterations that starts from 0 and ends at 20. The corresponding y axis calibrates the data for power generation cost per hour. The graph illustrates that the cost incurred on power generation by proposed work is getting lower with the increment in the number of iterations.

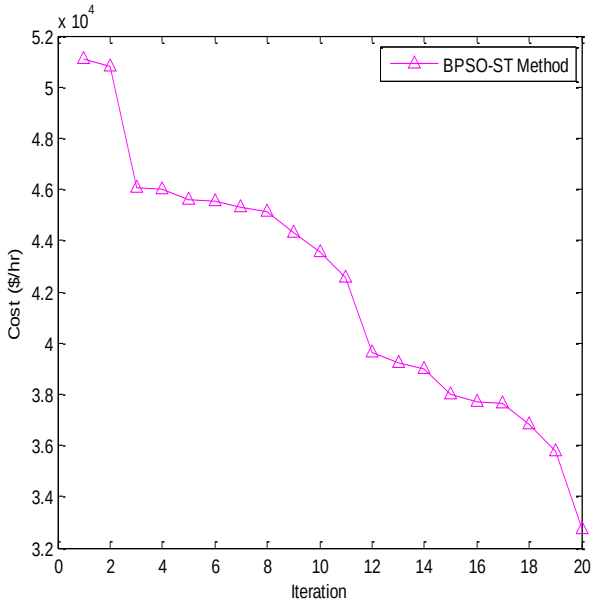

Figure 3 Cost of Power Plant

Similarly, fig 4 delineates the graph corresponding to the fitness value that is observed while implementing the BPSO-ST optimizing technique for ELD. The fitness value is analyzed on the basis of the iterations. From the graph it is concluded that at the iteration 2 the fitness value is 0.9682 initially, but it starts falling as the iteration gets increased and at reaching 20^{th} iteration, the fitness value is achieved to 0.6244. the decrement in the fitness values proves that the BPSO-ST is able anough to generate an optimal solution for the power generation system.

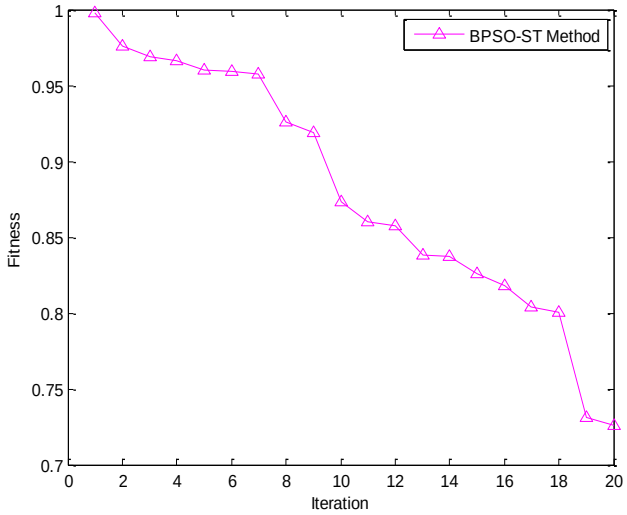

Figure 4 Fitness value achieved by proposed work

The fig 5 presents the graph for total power loss with respect to the given number of iterations. As there are total 20 iterations run by the proposed work, the power loss is 37.92Mw initially and then it reaches to the 12.97Mw at last iteration. The fall in total power loss depicts that the BPSO-ST suffers from less power loss

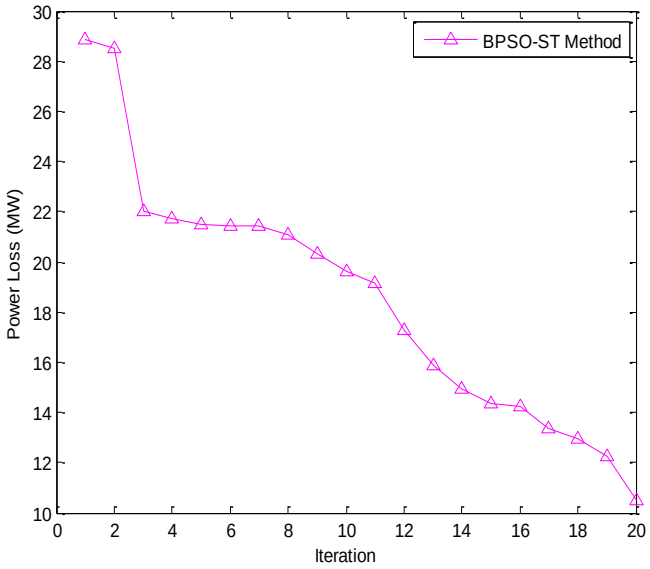

Figure 5Power Loss in case of proposed work with respect to iterations

The comparison among traditional and proposed work is shown in graph below. The comparison is drawn on the basis of the power generation by the system corresponding to the different power units. The Lambda method, GA method, PSO method and BPSO-ST method is considered for the contrast study. The y axis in the graph calibrates the data for power generation that varies from 0 MW to 250 MW. The curve in blue color presents the performance of the Lambda method, the curve in black color shows the performance of GA method, curve in red color shows the performance corresponding to the PSO method and curve in magenta color shows the performance of BPSO-ST method. The graphs make it sure that the proposed work has best power generation in comparison to the traditional optimization techniques. The Table 1 comprised of the power generation by the all of the optimization technique in all power plants. On the basis of the values of the table, it is concluded that the BPSO-ST is the optimization technique that optimizes the power generation to a better level in contrast to all of the techniques.

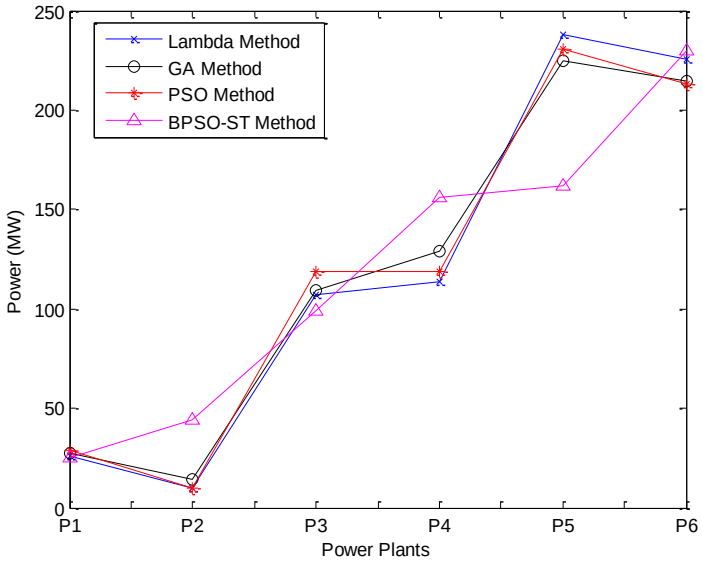

Figure 6 Comparison of proposed and traditional optimization approaches

Table 1
Power Generation with respect to the different power plants

Power Plant	Lambda Method	GA Method	PSO Method	BPSO-ST Method
P1	25.7526	27.2960	28.8101	25
P2	10	14.3795	10	44
P3	106.9487	109.5430	118.9583	99
P4	113.9719	128.7011	118.6747	156
P5	238.1334	224.5443	230.7630	162
P6	225.39	214.9074	212.7449	230

The graph in fig 7 shows the comparison of proposed and existing optimization techniques for optimizing the performance of the power generation systems. The comparison is done on the basis of the optimized power generated by the system. The graph
Delineates that the BPSO-ST is more efficient to generate the optimized power generation system. The proposed work generates the 716 MW, Lambda system generates the 720 MW, GA method generates the 719 MW, and PSO generates the 719 MW. Thus it is proved that the more optimized power is generated by the BPSO-ST method.

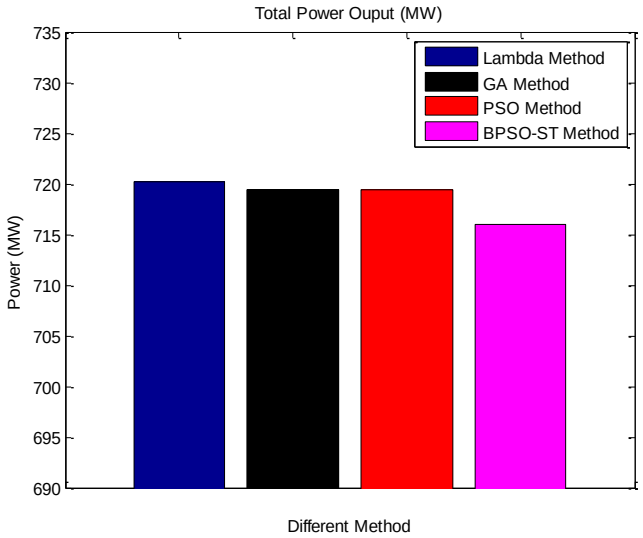

Figure 7 Comparison of optimization techniques with respect to the Power Generation

Table 2
Power Generation

Techniques	Value
BPSO-ST	716MW
PSO	719MW
GA	719MW
Lambda Optimization	720MW

The graph in fig 8 shows the comparison of BPSO-ST method with rest of the considered optimization technique in the terms of total generation cost incurred on the system. The objective of the ELD system is to reduce the total power generation cost to make it more feasible for the customer. The graph below illustrates that the generation cost of BPSO-ST optimization technique is quite lower in comparison to the Lambda method, GA and PSO.

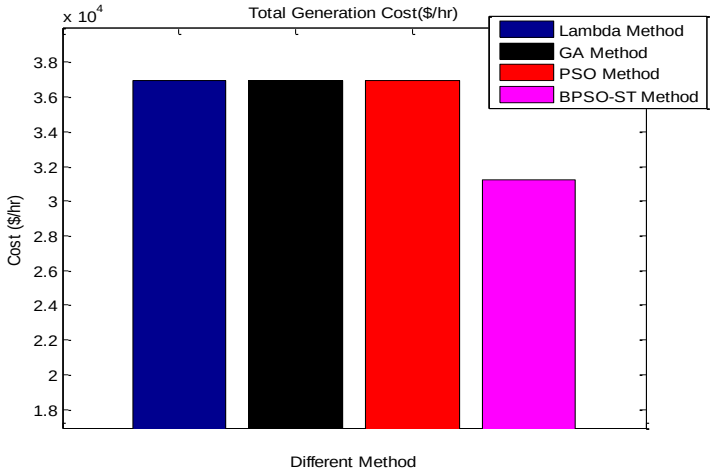

Figure 8 Comparison of optimization techniques with respect to the Total Generation Cost

Table 3
Total Generation Cost

Techniques	Cost($/hr)
BPSO-ST	31223.4026
PSO	36912.20
GA	36924
Lambda Optimization	36937.75

The comparison graph in fig 9 depicts the total power loss in BPSO-ST, PSO, GA and Lambda optimization techniques. The total power loss should be low always in a power generation system. The obtained total power loss in BPSO-ST is 9.754851MW and it is much lesser than 19.4318MW, 19.3714MW, 20.19MW in PSO, GA and Lambda optimization respectively.

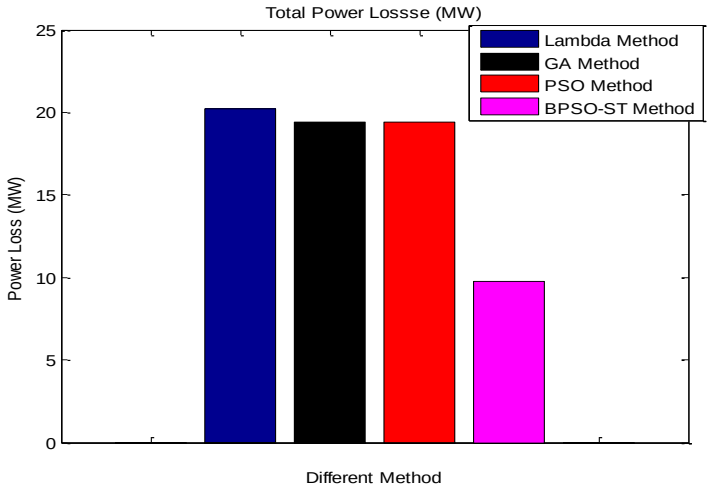

Figure 9 Comparison of optimization techniques with respect to the Total power loss

Table 4
Total Power Loss

Techniques	Total Power Loss(MW)
BPSO-ST	9.754851
PSO	19.4318
GA	19.3714
Lambda Optimization	20.19

V. CONCLUSION

Economic Load Dispatch is the process known for distributing load in such a way so that economic cost of the power system should be used less and requirement of the consumer fulfilled. Thus in this work different optimization algorithms have been studied which can be used to evaluate proper distribution of load over the power systems. Evaluation has been done between PSO, GA, Lambda optimization and proposed hybrid BPSO-ST which ensures that BPSO-ST outperforms among them. Different parameters such as total power output, total generation cost and total power loss have been discussed. These parameters conclude that BPSO-ST is efficient, effective and optimized than other optimization technique. As various optimization algorithms have been evaluated in this work where BPSO-ST declares as an efficient technique.
In future, more amendments can be done by collaborating the chaotic map search mechanism with present work in order to enhance the procedure of population generation. This will be an aid to consider multiple cases also.

ACKNOWLEDGEMENT

I am lacking words to express my deep sense of gratitude and regard to my guide Mr. Harkamal Deep Singh (Assistant Professor, Department of Electrical Engineering, GGS College of Modern Technology, Kharar, (I. K. Gujral Punjab Technical University)) for providing me inspiration, encouragement, kind co-operation and esteemed guidance.

REFERENCES

[1]. Hardiansyah, Junaidi, Yohannes MS, Solving Economic Load Dispatch Problem Using Particle Swarm Optimization Technique, Intelligent Systems and Applications, Vol 12, pp 12-18, 2012,
[2]. Indrajit N. Trivedi , Motilal Bhoye , R. H. Bhesdadiya , Pradeep Jangir , Narottam Jangir , Arvind Kumar, An emission constraint environment dispatch problem solution with microgrid using Whale Optimization Algorithm, IEEE, 2017
[3]. Anirban Dutta , Snigdhajyoti Das , Bhimsen Tudu , Kamal K. Mandal, A novel improved algorithm using Cuckoo Search for Economic Load Dispatch, IEEE, IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES)2017,
[4]. S. Gautham , J. Rajamohan, Economic Load Dispatch using Novel Bat Algorithm, IEEE, International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), 2017
[5]. Uma Sharma , Beaulah Moses, Analysis and optimization of economic load dispatch using soft computing techniques, IEEE, International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT),
[6]. Abhisek Mondal , Deblina Maity , Sumit Banerjee , Chandan Kumar Chanda, Solving of economic load dispatch problem with generator constraints using ITLBO technique, IEEE, Students' Conference on **:** Electrical, Electronics and Computer Science (SCEECS), 2016,
[7]. G Dwivedi Sandeepdhar , Srikant Rout , Hemanta Badhai , Milan Swain , Aniruddha Bhattacharya, Differential search algorithm for different economic dispatch problem, IEEE, International Conference on Energy, Power and Environment: Towards Sustainable Growth (ICEPE),2016,
[8]. Deblina Maity , Sumit Banerjee , Chandan Kumar Chanda , Sabyasachi Samanta, Implementation of quassi-oppositional TLBO technique on economic load dispatch problem considering various generator constraints, IEEE, 3rd International Conference on Electrical Energy Systems (ICEES), 2016,
[9]. Dipankar Santra , Arindam Mondal , Anirban Mukherjee , Krishna Sarker, Hybrid PSO — ACO technique to solve economic load dispatch problem, IEEE, IEEE International Conference on **:** Research in Computational Intelligence and Communication Networks (ICRCICN), 2016,
[10]. Pedro P. Vergara , Ricardo Torquato , Luiz C. P. da Silva, Towards a real-time Energy Management System for a Microgrid using a multi-objective genetic algorithm, IEEE, Power & Energy Society General Meeting, 2015,
[11]. Kishan Bhushan Sahay , Nimish Kumar , M. M Tripathi, Implementation of different optimization techniques to solve ELD problem, IEEE, Power India International Conference (PIICON), 2015,
[12]. Sunanda Hazra , Provas Kumar Roy , Anupam Sinha, An efficient evolutionary algorithm applied to economic load dispatch problem, IEEE, Third International Conference on Computer, Communication, Control and Information Technology (C3IT), 2015,

[13]. Ming ASun , Shaojie Cui , Yaoqun Xu, Economic load dispatch of power systems based on hysteretic noisy chaotic neural network, IEEE, Workshop on Advanced Research and Technology in Industry Applications (WARTIA), 2014,
[14]. Parmvir Singh Bhullar, "Particle Swarm Optimization Based Economic Load Dispatch with Valve point Loading", IJERT, vol 4(5), Pp 1064-1071, 2015,
[15]. Bhagyashree Hosamani,"Analysis of Economic Load Dispatch using fuzzified PSO", IJRET, vol 3(3), Pp 237-241, 2014
[16]. Nishant Chaturvedi,"A survey on Economic load Dispatch problem using Particle Swarm Optimization Technique", IJETAE, vol 4(3), Pp 188193, 2014,
[17]. Hamed Aliyari, Reza Effatnejad, Ardavan Areyaei, 2014, "Economic load dispatch with the proposed GA algorithm for large scale system" , journal of energy and natural resources, vol 3(1), Pp 1-5, 2014
[18]. Nguyen Trung Thang, August, "Economic Emission Load Dispatch with Multiple Fuel Options Using Hopfield Lagrange Network", IJAST, vol 57, Pp 9-25, 2013
[19]. Jaya Sharma, "Particle Swarm Optimization Approach For Economic Load Dispatch: A Review" , IJERA, vol 3(1), pp 13-22, 2013
[20]. Julia Tholath Jose, "Economic load dispatch including wind power using Bat Algorithm" , IEEE, International Conference on Advances in Electrical Engineering (ICAEE), 2014
[21]. Emmanuel Dartey Manteaw, Dr. Nicodemus Abungu Odero, December 2012, "Combined Economic and Emission Dispatch Solution Using ABC_PSO Hybrid Algorithm with Valve Point Loading Effect", IJSRP, vol 2(12), Pp 1-9, 2012
[22]. K. Senthil M.E, "Combined Economic Emission Dispatch uses Evolutionary Programming Technique", science direct, vol 19(6), Pp 1754-1762, 2012
[23]. B. Shaw, S. Ghoshal, V. Mukherjee, and S. P. Ghoshal, "Solution of Economic Load Dispatch Problems by a Novel Seeker Optimization Algorithm", IJEEI, vol 3(1), Pp 26-43, 2011
[24]. Arijit Biswas, Sambarta Dasgupta, Bijaya K Panigrahi, V. Ravikumar Pandi, Swagatam Das, Ajith Abraham and Youakim Badr, "Economic Load Dispatch Using a Chemotactic Differential Evolution Algorithm", Springer, Pp 252-260, 2009
[25]. M. Sudhakaran, P. Ajay - D - Vimal Raj and T.G. Palanivelu, "Application of Particle Swarm Optimization for Economic Load Dispatch Problems" , ISAP,, Pp 668-674, 2007

