IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 3 (March. 2018), ||V2|| PP 88-96

A Holistic Review on Combined Economic Emission Dispatch in Power System

Naresh Kumar Yadav
Electrical Engineering Department, Deenbandhu Chhotu Ram University of Science & Technology Murthal (Sonepat)

Abstract—In electrical systems, the objective of CEED issue is to search for an optimum schedule for the entire generators to reduce the functioning fuel cost when gratifying all types of parameters, namely, generation capacity factors and load demand balance factor. Anyhow, with the growing public awareness on the environmental issue occurred by fossil fuels, it is vital not only to be concerned for economic gain but also to deal with the emission issue of fossil fuels. As a result, the objective of emission must also be concerned. Accordingly, this survey intends to review various topics to solve CEED issues in system network. Accordingly, the performance measures and the maximum performance achievements are also analyzed and demonstrated in this survey. In addition, the algorithmic classification for the surveyed papers is analyzed and described. Finally, the research issues of the suggested model are also discussed briefly.

Keywords—EED; Generation capacity; Fuels; Algorithms; Performance measures.

Nomenclature:

Acronyms	Description
ED	Economic Dispatch
GU	Generating Units
EED	Economic Emission Dispatch
LM	Lagrangian Multiplier
FLC	Fuzzy Logic Control
ANN	Artificial Neural Network
MPSO	Modulated Particle Swarm Optimization
POZs	Prohibited Operating Zones
VPE	Valve Point Effect
PSO AWL	PSO with Avoidance of Worst Locations
PSO GIDN	PSO along with Gradually Increasing Directed Neighborhood
MARL	Multi-Agent Reinforcement Learning
GA	Genetic Algorithm
HD	High Dimensional
CNO	Collective Neurodynamic Optimization
PNN	Projection Neural Network
Dy-NSBBO	Dynamic non-dominated sorting multi-objective Biogeography-Based Optimization
DEED	Dynamic Economic Emission Dispatch
NOP	Non-convex Optimization Problem
MG	Microgrid
I/O	Input-output
EELD	economic emission load dispatch
PEVs	Plug-in Electric Vehicles
MOBBO	Multi-objective Biogeography based Optimization
MO-DEELDP	Multi-objective EELD
SDP	Semi-definite Programming
NGPSO	New Global PSO
BSA	backtracking search algorithm
CEED	Combined Emission Economic Dispatch
PV	Photo Voltaic
BFPA	Binary Flower Pollination Algorithm
eFPA	Euclidean Affine Flower Pollination Algorithm

TTPS	Tuticorin Thermal Power Station
OAPD	Optimum Active Power Dispatch
EMA	Exchange Market Algorithm
FPA	Flower Pollination Algorithm

I. INTRODUCTION

ED [1] [2] issue has turned out to be an essential task in the planning and operation of power system. In the normal functioning of power systems, it is predictable that a huge number of pollution emissions would be generated by the GU [3]. It extends against the environmental preservation regulations and strategies from the government that enforces the electric consumptions and power generators to pay close consideration to the environmental consequence of power producing plants. For this reason, the GU's are assigned based on the necessitation of controlling the emissions of pollution and reducing the total fuel costs [4] [5] [6]. The combined problem of emission and fuel cost is generally termed as the EED [7] [8] [9]. It is very multifaceted to resolve owing to a nonlinear function and a huge count of parameters. ED [10] [11] handles the optimum generation schedule of existing generators so that the entire generation cost is reduced within the system parameters [12] [13].

Well recognized long-established approaches such as lambda iteration method, gradient method, quadratic programming, linear programming, LM method, classical method depending on co-ordination formulations are deployed to resolve EED [14] [15] [16] issues. On the other hand, these traditional techniques necessitate the incremental cost [26] curves to be rising monotonically. Basically, the I/O features of the GU's [17] [18] [19] is extremely non-smooth and nonlinear. Throughout the previous decades, numerous techniques and researches had handled with EED issues [20]. Accordingly, FLC has obtained more attention in control applications. On the contrary, with the traditional approaches, FLC [27] manipulates the control action with respect to linguistic rules strained from the performance of a human operator rather than the algorithm produced from a system model [21] [22]. However, it needs additional fine tuning and simulation prior to operation. In addition, numerous other techniques such as ANN has disadvantages and advantages [23]. The features of the system are improved by ANN, however, the major issue lies in the extended training duration, choosing count of layers and amount of neurons in every layer [24] [25].

This survey has reviewed various works related to the CEED issues. Accordingly, various performance measures adopted in each work are described, and along with it, the maximum performances achieved by the various works are also portrayed by this survey. Here, various algorithmic classifications, which are adopted in the surveyed papers, are analyzed and demonstrated. The paper is organized as follows. Section II analyzes the various related works and reviews done under this topic. In addition, section III describes the various analyses on CEED issues, and section IV presents the research gaps and challenges. At last, section V concludes the paper.

II. LITERATURE REVIEW

A. *Related works*

In 2018, Huijun *et al.* [1] have suggested a hybrid bat algorithm to resolve the CEED issue with power flow parameters. Here, a random black hole design was established to make sure that every element in present solution could be restructured with a predetermined feasibility. This was significant in improving the searching capability; it also manages with HD systems, particularly power systems in large-scale. Furthermore, the variety of population was raised and it impulsive convergence was avoided. As a final point, arithmetical samples were offered to validate the advantage of the implemented algorithm.

In 2016, Abdelaziz *et al.* [2] have introduced a MPSO technique to resolve the EED issue of power units. The traditional PSO was improved for enhanced exploitation and exploration of the searching space. The efficiency of the introduced PSO was established on three benchmark test GU systems that concern numerous operational restraints such as, POZs and VPE. The results of application and their evaluation with other prevailing approaches illustrate that the introduced MPSO was capable of solving the EED issues of thermal units.

In 2017, Karl *et al.* [3] has suggested numerous PSO constraints to the DEED crisis. DEED dilemma is a multi-objective crisis in which the objective was to solve two contradictory intentions, namely, emissions and cost. The PSO variants that were tested consist of the PSO AWL, diverse topologies as well as the PSO GIDN. The consequences demonstrates that the PSO AWL provides better results than the SPSO for each implemented topology. The outcomes were further distinguished with MARL and conventional GA and the improved results were obtained.

In 2017, Tiancai *et al.* [4] proposed a CNO system that merges PNN and heuristic technique, which was suggested to optimize the setting up of an electrical MG together for reducing the increased emission and generation expenditure. As the intention has non-derivative points taking into account of VPE, differential inclusion scheme was adopted in the PNN design which was established to manage with them. In particular circumstances, the local convergence for the required issue was scrutinized. Moreover, the potential of technique was established in a complex condition, in which banned operating zones and transmission loss was measured. Moreover, the dynamic distinction of load demand was regarded and the best possible setting up of generators within a day was defined.

In 2017, Haiping *et al.* [5] have established a novel Dy-NSBBO scheme to resolve multi-objective dynamic EELD that considers the mass combination of PEVs, like MO-DEELDP issue. Subsequently, a novel MO-BBO was introduced that adopts the memory-based selection and change detection tactics in the MO-BBO technique to reinforce the dynamic performance. Moreover, the simulation study displays that the established process was capable to bring significant environmental and economic aids to power system and it also offers viable charging schemes for PEVs aggregators and policy creators.

In 2017, Dexuan *et al.* [6] have presented a NGPSO model to resolve the EED issues. NGPSO was varied from the conventional PSO algorithm in two features. Moreover, a modest penalty function was deployed to enable the gratifications of EED's parameters. Depending on such developments in PSO, high-quality objective functions can be achieved for EED issues. In addition, certain illustrations were selected to verify the outcomes of three enhanced PSOs on resolving EED issues. Moreover, investigational outcomes demonstrate that NGPSO was the most effectual method for resolving CEED problems.

In 2016, Delshad and Nasrudin [7] has established the an approach using BSA for resolving an EED issue, which was formulated as an optimization issue. BSA was a recently established evolutionary process with a single control factor to resolve arithmetical optimization issues. The multi-objective BSA, which was established and offered here, exploits an exclusive external archive to store pareto front. The issue of EED was further resolved by weighted sum technique that merges the intents of the issue into a single objective. Accordingly, the outcomes were distinguished with those of other approaches, and the extraordinary performance of BSA has been confirmed.

In 2107, Shilaja and Ravi [8] have adopted a new process for enhancing the EED problem, depending on CEED for PV and thermal power GU's. According to CEED approach, for enhancing the EED BFPA and eFPA has been exploited for resolving the optimization issue. In addition, the power demand data was obtained from India in the district of TTPS. Finally, the simulation outcomes were confirmed, and the evaluations have been made with conventional schemes to offer improved results.

In 2016, Abhishek *et al.* [9] have introduced an OAPD crisis by means of a most currently established optimizer known as EMA. The crisis was designed as both multi-objective and single-objective issue. The EMA technique can be applied for the global optima by means of its two major aspects, namely, oscillated and balance market phase, all including exploration and exploitation. The advanced search capacity of EMA was effectively utilized here to accomplish different objectives. The method was executed in MATLAB, and the outcomes attained by means of EMA were distinguished with various schemes detailed in the presented paper. Simulation outcomes reveal the ability of EMA regarding its computational robustness and effectiveness.

In 2016, Abdelaziz *et al.* [10] have implemented a FPA to resolve ELD and CEED inconveniences in power systems. An evaluation of the computed results by means of the suggested FPA was executed to substantiate its efficiency in opposition to various conventional algorithms. Moreover, the dominance of the implemented FPA distinguished with various schemes was illustrated even for power systems at large scale taking into account of VPE.

In 2015, VinayKumar *et al.* [11] have implemented a MPSO process to resolve the EED crisis occurring in thermal units. The velocity of particles modulation was regulated by establishing a condensed function in PSO. The contradictory objectives of the EED crisis were implemented by fuzzy membership functions that were subsequently optimized by means of implemented PSO. The efficiency of the suggested PSO was verified in view of numerous functioning constraints such as POZs, and VPE consequence. The outcomes of application and their assessment with erstwhile conventional methods demonstrate that the implemented MPSO was capable for solving EED crisis of thermal generating units.

In 2014, Benasla *et al.* [12] have adopted Spiral Optimization Algorithm SOA for resolving the CEED issue. The suggested scheme was manipulated as a multi-objective issue by regarding the emission objectives and cost of fuel for GU's. In addition, the adopted scheme has been executed on three test systems with diverse constraints and several cost curve nature. So as to observe the efficiency of the adopted scheme, its outcomes were distinguished to those stated in the literature. Those outcomes were quite promising, and it shows the superior applicability of SOA for CEED issue.

In 2014, Jubril *et al.* [13] have formulated a SDP model for resolving the multi-objective EED problem. The emission functions and fuel cost were addressed by polynomial functions of high order, and this was exposed to be a more precise demonstration of the EED issue. The consequential SDP issue was further resolved at diverse degrees of estimation. Moreover, the implemented approach was analyzed by performing simulations and the outcomes attained were distinguished with the traditional schemes. The outcomes reveal that SDP has inherent superior convergence features and it offers improved Pareto front exploration.

In 2014, Basu [14] had established a non-dominated sorting GA-II for resolving fuel constrained EED problem of thermal generating units. The generation agenda was evaluated to that what would cause if fuel constraints were discarded. The evaluation demonstrates that fuel utilized can be effectively controlled by regulating the power output of several generating units so that the power system functions within its fuel restrictions and within contractual parameters. It has been known that one of the two objectives may be raised while others may be minimized to provide the equivalent power demand, however, this may well recompense for the penalty. In addition, arithmetical outcomes for two test systems have been offered, and the test outcomes were distinguished with those attained from conventional schemes.

In 2008, Palanichamy and Sundar [15] had implemented an analytical approach depending on mathematical design for resolving economic, emission, and combined EED issues by a single objective function. In addition, the implemented scheme was deployed to different realistic systems at varied loads, and the result of the realistic system was offered by the presented technique.

III. REVIEW ON VARIOUS CONSTRAINTS

*A. **Performance Measures***

The performance measures contributed in each paper are described in this section. Here, emission, fuel cost, time, power demand, power generation and other constraints were attained from each contribution. Emission was measured in [1] [3] [5] [7] [11] [12] [13] [14] and fuel cost was deployed in [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [14] [15], which offers the highest contribution. In addition, time factor was adopted in [1] [7] [10] [12] [15] and power generation was analyzed in [2] [3] [4] [7] [9] [10] [12] [14] [15] that offers about second highest contribution. In addition, load was deployed in [4] and [6], and power demand was adopted in [8] and [13]. The other measures such as fuel cost minimization, temperature, emission minimization were implemented in [6] [8] [9] and [10]. The diagrammatic representation of the performance measures is given by Fig. 1.

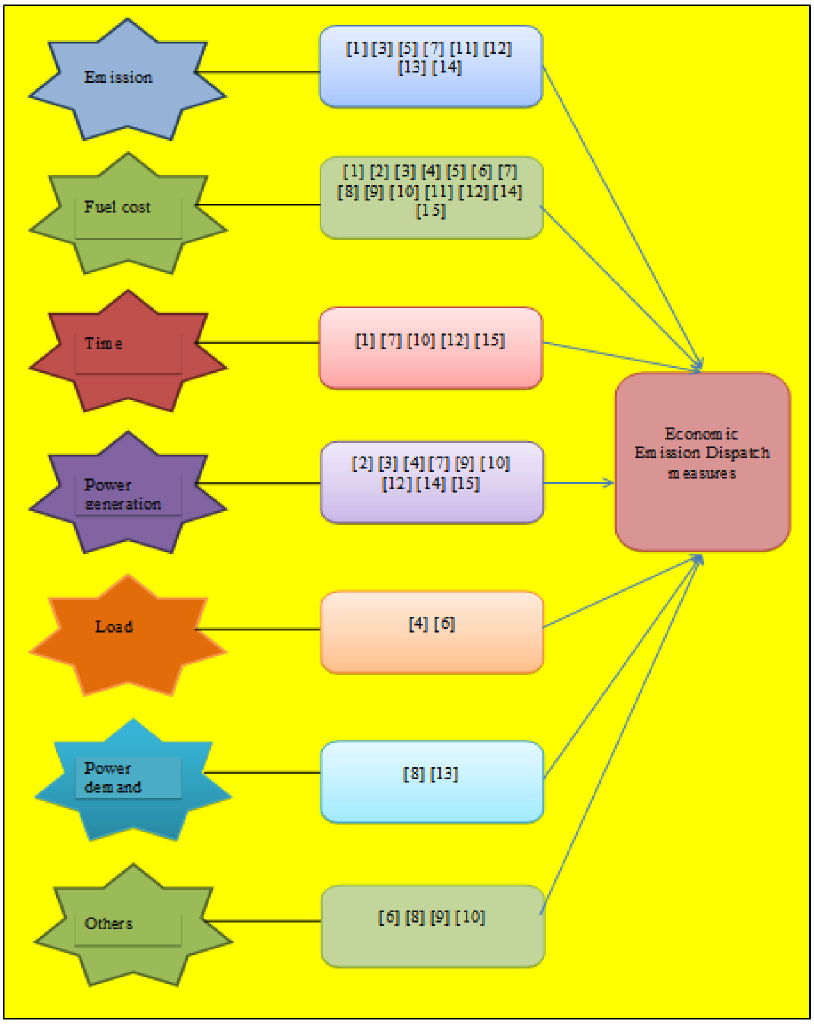

Fig. 1: Various performance measures of the reviewed works

B. ***Algorithmic Classification***

The various algorithms adopted in each reviewed paper includes BA algorithm, FPA algorithm, PSO algorithm, CN algorithm, BBO algorithm, BS algorithm, EAFPA algorithm, EM algorithm, SO algorithm, semidefinite programming, GA algorithm, B-coefficient algorithm. Accordingly, BA algorithm was adopted in [1], and FPA algorithm was adopted in [2] and [10]. PSO algorithm was implemented in [3] [6] and [11], and CN algorithm was implemented in [4]. In addition, BBO algorithm was suggested in [5], and BS algorithm was deployed in [7]. Accordingly, EAFPA algorithm was implemented in [8], and EM algorithm was adopted in [9] respectively. SO algorithm and semidefinite programming have been implemented in [12] and [13] correspondingly. In addition, GA algorithm was implemented in [14], and B-coefficient algorithm was implemented in [15]. The demonstration of the various schemes is given by Fig. 2.

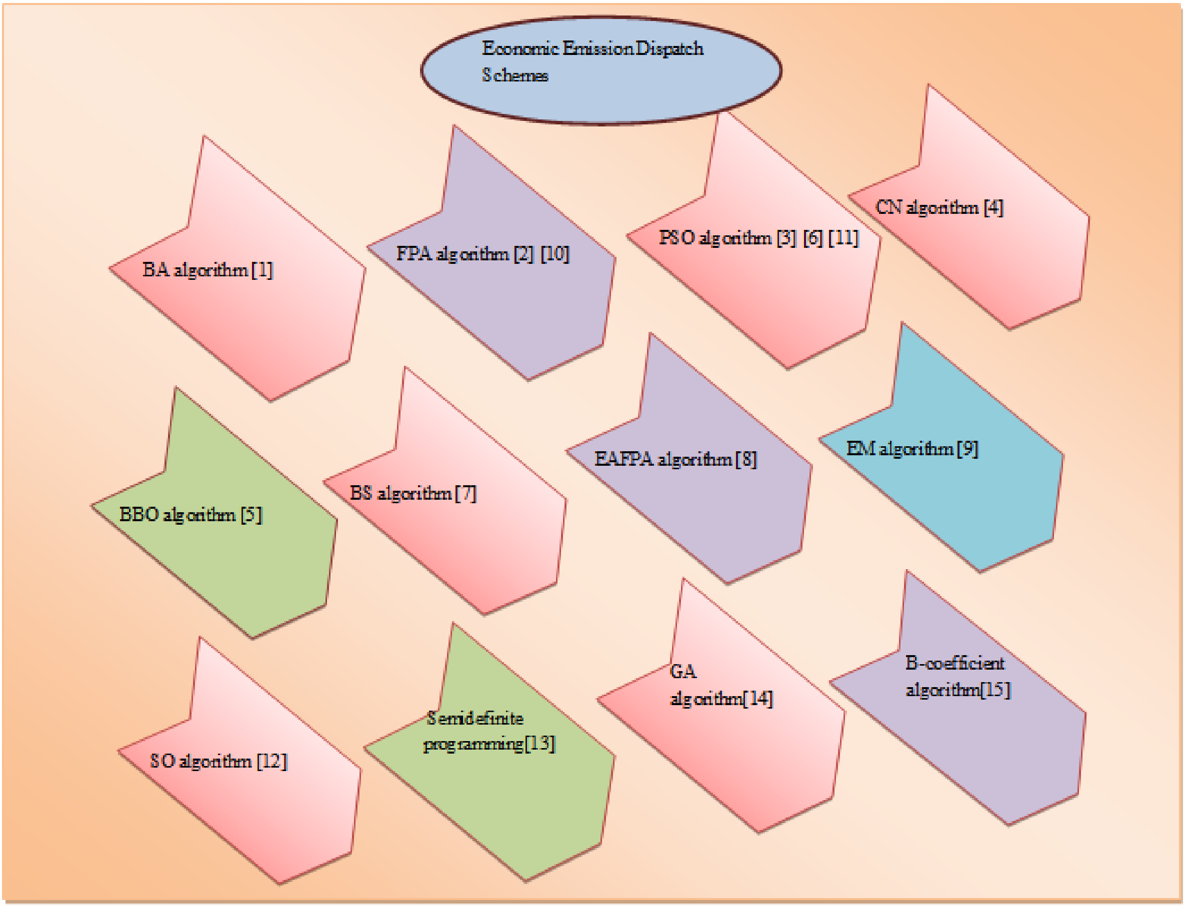

Fig. 2: Various schemes of the reviewed works

C. ***Maximum Performance Achieved***

The maximum performance achieved by various performance measures is given by Table I. The maximum emission measure attained by the reviewed works is 0.194ton/h, which is adopted in [7] and the optimal fuel cost is 600$ that is adopted in [4]. In addition, reduced time was achieved as 0.016Sec in [11], and power generation was attained at 2500MW in [6]. Also, Load and Power demand has been measured in [4], which attains a value of 1820MW and 1216MW respectively. Moreover, Fuel cost minimization and Emission minimization has been exploited in [6], and it has attained optimal values of 605.99MW and 0.194 correspondingly. Accordingly, Solar radiation, temperature, and fuel cost efficiency were deployed in [8], and they have obtained better values of 5.45W/m^{2}, 23^{0}celcius and 0.152$/MWh respectively. Moreover, generator voltage and objective function have attained better values of 0.95p.u and 3620$ and they were attained from [9] and [10] correspondingly.

TABLE I. MAXIMUM PERFORMANCE ACHIEVED BY THE REVIEWED WORKS

Measures	Maximum performance achieved	Citation
Emission	0.194ton/h	[7]
Fuel cost	600$	[4]
Time	0.016Sec	[11]
Power generation	2500MW	[6]
Load	1820MW	[4]
Power demand	1216MW	[4]
Fuel cost minimization	605.99MW	[6]
Emission minimization	0.194	[6]
Solar radiation	5.45W/m^2	[8]
Temperature	23^{0}celcius	[8]
Fuel cost efficiency	0.152$/MWh	[8]
Generator voltage	0.95p.u	[9]
Objective function	3620$	[10]

D. *Cost Analysis*

The cost analysis of the surveyed works is demonstrated by Table II. The various types of costs such as emission cost, fuel cost, and generation costs were determined in each paper are described in this section. Accordingly, emission cost was adopted in [3] [4] [5] and [7] that has offered about 26.67% of the entire contribution. In addition, fuel cost was determined in [1] [2] [6] [8] [9] [10] [11] [12] and [15] that offers about 60% of the entire contribution. Moreover, the generation cost has been deployed in [5] and [14], which has been offered about 13.33% of the total contribution.

TABLE II. COST ANALYSIS ACHIEVED BY THE REVIEWED WORKS

Sl.no	Citation	Emission cost	Fuel cost	Generation cost
1	[1]		✓	
2	[2]		✓	
3	[3]	✓		
4	[4]	✓		
5	[5]	✓		✓
6	[6]		✓	
7	[7]	✓		
8	[8]		✓	
9	[9]		✓	
10	[10]		✓	
11	[11]		✓	
12	[12]		✓	
13	[13]			
14	[14]			✓
15	[15]		✓	

IV. RESEARCH GAPS AND CHALLENGES

The major aim of electric power systems was to offer high-quality, consistent supply of power to the customers at the least feasible cost when functioning to meet up with the constraints and limits enacted on the GU. This articulates the EED issue for discovering the best combination of the output power of the entire online GU's, which reduces the cost of fuel while satisfying a set of an inequality and equality parameters. As the cost of power generation is unreasonable, an optimal dispatch may affect the economy. With a growing consciousness of the environmental pollution triggered by thermal power plants, controlling the emission of contaminants is turning out to be a critical problem in EED in current years. The traditional EED not meet the protection necessities of environments, as it only considers reducing the overall fuel cost. The multi-objective generation dispatch handles EED effect as challenging objectives that necessitate certain reasonable transaction between objectives to arrive at an optimum solution. This articulates the CEED issue with an intention to dispatch the electric power by regarding both environmental and economic concerns. Practically, the real world I/O characteristics of the GU's are extremely non-smooth, nonlinear and discrete in common due to several effects. Therefore the resulting EED still remains as a challenging NOP that needs to be enhanced.

V. CONCLUSION

The burning of fossil fuels discharges numerous harmful gases that cause damage to living organisms on earth. In addition, it increases the level of global temperature. With the rising awareness on environment, Gencos were needed to manage the release of contaminants. Moreover, power industry was enforced to control the level of emission under certain parameters. EED intends to control the cost of generation and minimize the effect of waste gas, while the emission cost and fuel cost were unsatisfied with one another. Accordingly, in this survey, numerous papers were analyzed, and the related techniques adopted in each surveyed paper were described. In addition, the performance measures focused in each paper were illustrated, and along with it, the maximum performance measures attained were also illustrated. Thus the survey provides the detailed analysis of the CEED problems from the reviewed papers.

REFERENCES

[1]. Huijun Liang, Yungang Liu, Fengzhong Li, Yanjun Shen, “A multiobjective hybrid bat algorithm for combined economic/emission dispatch”, International Journal of Electrical Power & Energy Systems, vol. 101, pp. 103-115, October 2018.
[2]. A.Y. Abdelaziz, E.S. Ali, S.M. Abd Elazim, “Implementation of flower pollination algorithm for solving economic load dispatch and combined economic emission dispatch problems in power systems”, Energy, vol. 101, pp. 506-518, 15 April 2016.
[3]. Karl Mason, Jim Duggan, Enda Howley, “Multi-objective dynamic economic emission dispatch using particle swarm optimisation variants”, Neurocomputing, vol. 270, pp. 188-197, 27 December 2017.
[4]. Tiancai Wang, Xing He, Tingwen Huang, Chuandong Li, Wei Zhang, “Collective neurodynamic optimization for economic emission dispatch problem considering valve point effect in microgrid”, Neural Networks, vol. 93, pp. 126-136, September 2017.
[5]. Haiping Ma, Zhile Yang, Pengcheng You, Minrui Fei, “Multi-objective biogeography-based optimization for dynamic economic emission load dispatch considering plug-in electric vehicles charging”, Energy, vol. 135, pp. 101-111, 15 September 2017.
[6]. 6. Dexuan Zou, Steven Li, Zongyan Li, Xiangyong Kong, “A new global particle swarm optimization for the economic emission dispatch with or without transmission losses”, Energy Conversion and Management, vol. 139, pp. 45-70, 1 May 2017.
[7]. Mostafa Modiri-Delshad, Nasrudin Abd Rahim, “Multi-objective backtracking search algorithm for economic emission dispatch problem”, Applied Soft Computing, vol. 40, pp. 479-494, March 2016.
[8]. C. Shilaja, K. Ravi, “Optimization of emission/economic dispatch using euclidean affine flower pollination algorithm (eFPA) and binary FPA (BFPA) in solar photo voltaic generation”, Renewable Energy, vol. 107, pp. 550-566, July 2017.
[9]. Abhishek Rajan, T. Malakar, “Optimum economic and emission dispatch using exchange market algorithm”, International Journal of Electrical Power & Energy Systems, vol. 82, pp. 545-560, November 2016.
[10]. A.Y. Abdelaziz, E.S. Ali, S.M. Abd Elazim, “Combined economic and emission dispatch solution using Flower Pollination Algorithm”, International Journal of Electrical Power & Energy Systems, vol. 80, pp. 264-274, September 2016.
[11]. Vinay Kumar Jadoun, Nikhil Gupta, K.R. Niazi, Anil Swarnkar, “Modulated particle swarm optimization for economic emission dispatch”, International Journal of Electrical Power & Energy Systems, vol. 73, pp. 80-88, December 2015.
[12]. Lahouaria Benasla, Abderrahim Belmadani, Mostefa Rahli, “Spiral Optimization Algorithm for solving Combined Economic and Emission Dispatch”, International Journal of Electrical Power & Energy Systems, vol. 62, pp. 163-174, November 2014.
[13]. A.M. Jubril, O.A. Olaniyan, O.A. Komolafe, P.O. Ogunbona, “Economic-emission dispatch problem: A semi-definite programming approach”, Applied Energy, vol. 134, pp. 446-455, 1 December 2014.
[14]. M. Basu, “Fuel constrained economic emission dispatch using non dominated sorting genetic algorithm-II”, Energy, vol. 78, pp. 649-664, 15 December 2014.
[15]. C. Palanichamy, N. Sundar Babu, “Analytical solution for combined economic and emissions dispatch”, Electric Power Systems Research, vol. 78, no. 7, pp. 1129-1137, July 2008.
[16]. 16. Hossein Narimani, Seyed-Ehsan Razavi, Ali Azizivahed, Ehsan Naderi, Mohammad Rasoul Narimani, “A multi-objective framework for multi-area economic emission dispatch”, Energy, vol. 154, pp. 126-142, 1 July 2018.
[17]. Yousef ali Shaabani, Ali Reza Seifi, Masoud Joker Kouhanjani, “Stochastic multi-objective optimization of combined heat and power economic/emission dispatch”, Energy, vol. 141, pp. 1892-1904, 15 December 2017.

[18]. B. Lokeshgupta, S. Sivasubramani, “Multi-objective dynamic economic and emission dispatch with demand side management”, International Journal of Electrical Power & Energy Systems, vol. 97, pp. 334-343, April 2018.
[19]. Naser Ghorbani, Ebrahim Babaei, Fahreddin Sadikoglu, “Exchange market algorithm for multi-objective economic emission dispatch and reliability”, Procedia Computer Science, vol. 120, pp. 633-640, 2017.
[20]. M. Amiri, S. Khanmohammadi, M. A. Badamchizadeh, “Floating search space: A New Idea for Efficient Solving the Economic and Emission Dispatch Problem”, Energy, 10 May 2018.
[21]. Dinu Calin Secui, “Large-scale multi-area economic/emission dispatch based on a new symbiotic organisms search algorithm”, Energy Conversion and Management, vol. 154, pp. 203-223, 15 December 2017.
[22]. Karl Mason, Jim Duggan, Enda Howley, “A multi-objective neural network trained with differential evolution for dynamic economic emission dispatch”, International Journal of Electrical Power & Energy Systems, vol. 100, pp. 201-221, September 2018.
[23]. Mostafa Kheshti, Lei Ding, Shicong Ma, Bing Zhao, “Double weighted particle swarm optimization to non-convex wind penetrated emission/economic dispatch and multiple fuel option systems”, Renewable Energy, vol. 125, pp. 1021-1037, September 2018.
[24]. Hithu Anand, Rengaraj Ramasubbu, “A real time pricing strategy for remote micro-grid with economic emission dispatch and stochastic renewable energy sources”, Renewable Energy, vol. 127, pp. 779-789, November 2018.
[25]. Tapas Kumar Panigrahi, Arun Ku. Sahoo, Aurobindo Behera, “A review on application of various heuristic techniques to combined economic and emission dispatch in a modern power system scenario”, Energy Procedia, vol. 138, pp. 458-463, October 2017.
[26]. A. Kumar, I. Maheshwari and N. K. Yadav, “Allocating the cost of reactive power by using modified value based approach and tracing method”, 2012 IEEE Fifth Power India Conference, Murthal, pp. 1-6, 2012.
[27]. D. Sharma, N. Kumar Yadav, Gunjan and A. Bala, “Impact of distributed generation on voltage profile using different optimization techniques”, 2016 International Conference on Control, Computing, Communication and Materials (ICCCCM), Allahbad, pp. 1-6, 2016.

IOSR Journal of Engineering (IOSRJEN) is UGC approved Journal with Sl. No. 3240, Journal no. 48995.

Naresh Kumar Yadav “A Holistic Review on Combined Economic Emission Dispatch in Power System” IOSR Journal of Engineering (IOSRJEN), vol. 8, no. 3, 2018, pp. 88-96.