

Implementation of a New Methodology for ELD Problems

Ramesh Chevuru¹, G. V. Martheswar²

¹Sri Venkateswara University College of Engineering,
Tirupati, Andhra Pradesh, India

²Sri Venkateswara University College of Engineering,
Tirupati, Andhra Pradesh, India

Abstract: Now a day's an electrical utility wants to maximize its profit; the optimization of economic dispatch is of economic value to the network operator. So, objective is to optimize the total cost of the plant. The ELD problem in a power system to determine the least generation of all the operating generators which will minimize the total fuel cost of the plant. This paper introduces a bio-inspired and novel technique optimization algorithm called BAT ALGORITHM to solve economic dispatch problems and enhancing the convergence property to obtain results quickly. The proposed method has good convergence property and better in quality of solution than PSO and IWD reported in recent literature. BAT algorithm is easy to implement and priority in terms of accuracy and efficiency compared with other algorithms.

Keywords: ELD, PSO, IWD, BAT Algorithm, Convergence.

1. Introduction

Since an engineer is always concerned with the cost of products and services, the efficient optimum economic operation and planning of electric power generation system have always occupied an important position in the electric power industry. The classic problem is the economic load dispatch of generating systems to achieve minimum operating cost. For the purpose of optimum economic operation of this large scale system, modern system theory and optimization techniques are being applied with the expectation of considerable cost savings.

The economic load dispatch (ELD) is an important function in modern power system like unit Commitment, Load Forecasting, Available Transfer Capability (ATC) calculation, Security Analysis, Scheduling of fuel purchase etc. Intelligent methods are iterative techniques that can search not only local optimal solutions but also a global optimal solution depending on problem domain and execution time limit. Among these methods, some of them are genetic algorithm (GA) [7] and [8], evolutionary programming (EP) [9] and [10], dynamic programming (DP) [11], tabu search [12], hybrid EP [13], neural network (NN) [14], adaptive Hopfield neural network (AHNN) [15], particle swarm optimization (PSO) [3] and [15], etc. In this paper the BAT ALGORITHM is proposed as a methodology for economic load dispatch. It requires less computation time and memory and the results are compared with the iteration methods PSO and IWD.

2. Economic Operation of Power System

The Economic Load Dispatch (ELD) can be defined as the process of allocating generation levels to the generating units, so that the system load is supplied entirely and most economically. In the conventional methods, it is difficult to solve the optimal economic problem if the load is changed. The fuel cost curve in the active power generation, takes up a quadratic form, given as:

$$F(P_{gi}) = a_i P_{gi}^2 + b_i P_{gi} + C_i \text{ Rs/hr} \quad (1)$$

Where a_i, b_i, c_i are cost coefficient for i^{th} unit.

$F(P_{gi})$ is the total cost of generation

P_{gi} is the generation of i^{th} plant

The optimization problem can be therefore be stated as:

$$\text{Minimize: } F(P_{gi}) = \sum_{i=0}^{NG} F_i(P_{gi}) \quad (2)$$

2.1 Economic load dispatch with losses

Over long distances, the transmission losses are a major factor and affect the optimum dispatch of generation. The transmission power loss P_L for the objective function is thus formulated as:

$$P_L = \sum_{i=0}^{NG} \sum_{j=0}^{NG} P_{gi} B_{ij} P_{gj} \text{ MW} \quad (3)$$

Where

B_{ij} are the loss coefficients or B-coefficients

P_{gi} and P_{gj} are the real power generations at i^{th} and j^{th} buses respectively. The transmission loss formula of Eq. (3) is known as George's formula. Using the Lagrange multiplier λ , the augmented function is,

$$L(P_{gi}, \lambda) = F(P_{gi}) + \lambda (P_D - P_L - \sum_{i=1}^{NG} P_{gi}) \quad (4)$$

Equation (4) shows that the minimum cost is obtained when the incremental cost of each plant multiplied by its penalty factor is same for all plants.

Finally the P_{gi} can be solved by following

$$P_{gi} = \frac{-\sum_{j=1}^{NG} 2B_{ij} P_{ij+1} - \frac{b_i}{\lambda}}{\frac{2a_i}{\lambda} + 2B_{ii}} \quad (5)$$

For any particular value of λ , above equation can be solved iteratively by assuming initial values of P_{gi} 's. Iterations are stopped when P_{gi} 's converge within specified accuracy.

2.2 Economic load dispatch with valve point loading

The real input-output characteristics display higher-order nonlinearities and discontinuities due to valve-point loading in fossil fuel burning plant. The valve-point loading effect has been modelled in as a recurring rectified sinusoidal function. Mathematically, economic load dispatch problem considering valve point loading is defined as:

Minimize operating cost:

$$F(P_{gi}) = \sum_{i=1}^{NG} (a_i P_i^2 + b_i P_i + c_i + |d_i * \sin\{e_i * p_i \text{ min} - p_i\}|) \quad (6)$$

Where

a_i, b_i, c_i, d_i, e_i are cost coefficients of the i^{th} unit.

Subject to:

- (i) The energy balance equation given by

$$\sum_{i=1}^{NG} P_{gi} = P_D + P_L \quad (7)$$

- (ii) The inequality constraints given by

$$P_{gi}^{\text{min}} \leq P_{gi} \leq P_{gi}^{\text{max}} \quad (8)$$

3. Particle Swarm Optimization

Particle Swarm Optimization (PSO) is one of the modern heuristic algorithms, which can be effectively used to solve nonlinear and non-continuous optimization problems. It is a Population-based search algorithm and searches in parallel using a group of particles similar to other AI-based optimization techniques.

3.1 Basic particle swarm optimization

The position of each particle is represented by P and also its velocity is expressed by V . Each particle knows its best value so far (p_{best}) and its position. Moreover, each particle also knows the best value so far in the group (g_{best}) among p_{best} . The modified velocity and position of each particle can be calculated using the current velocity and the distance from best previous position of each particle ($P_{b_{ij}}$) to best particle among all the particles in the group (G_j). Velocity and position of each particle can be modified by the following equation:

$$V_{ij}^{r+1} = WV_{ij}^r + C_1 R_1 (P_{b_{ij}}^r - P_{ij}^r) + C_2 R_2 (G_j^r - P_{ij}^r) \quad (9)$$

$$(i=1, 2, \dots, NP)(j=1, 2, \dots, NG)$$

$$P_{ij}^{r+1} = P_{ij}^r + V_{ij}^{r+1} \quad (10)$$

Where

V_{ij}^r is the velocity of j^{th} member of i^{th} particle at r^{th} iteration.

$$V_j^{\text{min}} \leq V_{ij}^r \leq V_j^{\text{max}}$$

P_{ij}^r is the current position of the j^{th} member of i^{th} particle at r^{th} iteration

W is the weighing function or inertia weight factor

C_1, C_2 are the acceleration constants

R_1, R_2 is random number between 0 and 1

NP is the number of particles in a group

NG is the number of member in a particle

The velocity is usually limited to a certain maximum value. PSO using Eq. (9) is called the g_{best} model. The particles in the swarm are accelerated to new positions by adding new velocities to their present positions. The new velocities are calculated using Eq. (11) and positions of the particles are updated using Eq. (12).

$$V_{ij}^{\text{new}} = WV_{ij} + C_1 R_1 (P_{b_{ij}}^{\text{best}} - P_{ij}) + C_2 R_2 (G_j^{\text{best}} - P_{ij}) \quad (11)$$

$$(i=1, 2, \dots, NP)(j=1, 2, \dots, NG)$$

$$P_{ij}^{\text{new}} = P_{ij} + V_{ij}^{\text{new}} \quad (12)$$

Suitable selection of inertia weight w provides balance between global and local explorations, thus requiring less iteration on average to find a sufficiently optimal solution.

3.2 Algorithm for ELD using PSO

The search procedure for calculating the optimal generation quantity of each unit is summarized as follows:

1. In the ELD problems the number of online generating units is the 'dimension' of this problem. The particles are randomly generated between the maximum and the minimum operating limits of the generators and represented using Equation as follows

$$P_{gi} = [P_{i1}, P_{i2}, P_{i3}, \dots, P_{id}] \quad (i = 1, 2, 3, \dots, n)$$

Where, n means population size, d is the number of generator, P^{id} is the generation power output of d^{th} unit at i^{th} particle. The dimension of a population is ($n * d$). These genes in each individual are represented as real values.

2. To each individual of the population calculate the dependent unit output from the power balance.

3. Calculate the evaluation value of each particle P_{gi} in the population using the evaluation function given by equation (2).

4. Compare each particle's evaluation value with its p_{best} . The best evaluation value among them p_{best} is identified as g_{best} .

5. Modify the Velocity of each particle by using the Eq. (9)

6. Check the velocity constraints of the members of each particle from the following conditions:

If $V_{ij}^{r+1} > V_j^{\max}$, then $V_{ij}^{r+1} = V_j^{\max}$
 If $V_{ij}^{r+1} < V_j^{\min}$, then $V_{ij}^{r+1} = V_j^{\min}$
 Where $V_j^{\max} = -0.5 P_j^{\max}$
 Where $V_j^{\min} = +0.5 P_j^{\max}$

7. Modify the position of each particle using the Eq. (10). P_{ij}^{r+1} must satisfy the constraints, namely the generating limits, described by equation (8). If P_{ij}^{r+1} violates the constraints, then P_{ij}^{r+1} must be modified towards the nearest margin of the feasible solution.

8. If the evaluation value of each particle is better than previous pbest, the current value is set to be pbest. If the best pbest is better than gbest, the best pbest is set to be gbest.

9. If the number of iterations reaches the maximum, then go to step 10. Otherwise, go to step 2.

10. The individual that generates the latest gbest is the optimal generation power of each unit with the minimum total generation cost.

4. Intelligent Water Drops

4.1. Introduction

The IWD algorithm was first introduced by Dr. Shah-Hosseini in the year 2007 [9]. The algorithm so far was successfully implemented to the Travelling Salesman problem, n-Queen puzzle, Multidimensional Knapsack problem (MKP) [9], Smooth trajectory planning [10], Robot Path planning [11], Vehicle routing problem [12] and Economic Load Dispatch problem [13]. It is a nature-inspired optimization algorithm inspired from the natural water drops which change their environment to find the near optimal or optimal path to their estimation, ocean or pond. The processes that happen between the water drops of a river and the soil of the river bed formed the basis for this algorithm. IWD algorithm falls in the category of Swarm-Based Optimization algorithms.

4.2. Basic intelligent water drops

We can develop an artificial water drop which possesses the same functionality as a natural water drop. This artificial water drop can be termed as Intelligent Water Drop or IWD for short. The IWDs in the IWD algorithm are created with two main properties:

1. The amount of soil it carries, Soil (IWD).
2. The velocity that it possesses, Velocity (IWD).

Both of these properties change as the IWD flows in its environment. Consider an IWD moving in discrete finite-length steps in its environment, from its current location i to its next location j , the IWD velocity, velocity (IWD), is increased which is nonlinearly proportional to the inverse of the soil between the two locations i and j , $soil(i, j)$, as shown in equation

$$\Delta \text{Velocity(IWD)} \propto^{NL} \frac{1}{soil(i,j)} \quad (13)$$

Here, nonlinearly proportionality is denoted by \propto^{NL} . One possible formula, according to [14] is given in eq. (4.2) in which the velocity of the IWD denoted by $vel^{IWD}(t)$ is

updated by the amount of soil, $soil(i, j)$, between the two locations i and j :

$$\Delta \text{vel}^{IWD}(t) = \frac{av}{bv + C_v \cdot soil2\alpha(i,j)} \quad (14)$$

Again the parameters in this equation, a_v , b_v , c_v and α are constant velocity updating parameters that are set for a given problem. The updated velocity of the IWD, $vel^{IWD}(t+1)$ after reaching node j will be equivalent to $vel^{IWD}(t) + \Delta \text{YHO}(t)$. The amount of soil carried by the IWD, $soil(IWD)$, is increased by removing some soil from the path joining the two locations i and j . The amount of the soil added to this motion can be considered as a linear motion and thus the duration of time for the IWD can be calculated by simple laws of physics for linear motion. Thus, the time taken is inversely proportional to the velocity of the IWD, velocity (IWD), and also to the distance between the two positions, $d(i, j)$.

4.3 The pseudo code of the IWD is as follows

```

Step1. Static and dynamic Parameters initialization.
Step2. Put all IWDs on the first node.
Step3. Update the velocity of the IWD.
Step4. Select an edge to reach to the next node.
Step5. Compute the amount of soil ( $\Delta soil$ ) which is gathered by the IWD.
Step 6. Update the edge soil and the IWD soil.
Step7. IF have all IWDs completed their solutions THEN GOTO step 8 ELSE GOTO Step 4.
Step 8. Find the elitist IWDs.
Step 9. Perform the local search on elitist IWDs.
Step 10. Update the global best solution.
Step 11. IF all Elitist IWDs produce the same results THEN GOTO Step 2. ELSE Return the global best.
END
    
```

5. Bat Algorithm

5.1 Introduction

Bat Algorithm is a metaheuristic optimization algorithm developed by Xin-She Yang in 2010. The Bat algorithm based on the echolocation behaviour of bats.

5.2 Echolocation behaviour of bats

Bats are the only mammals with wings and have the capability of echolocation. They emit a very loud sound pulse and listen for the echo that bounces back from the surrounding objects. Their pulses vary in properties and can be correlated with their hunting strategies, depending on the species. Most bats use short, frequency-modulated (FM) signals. The typical range of frequencies for most bat species are from 25KHz to 100KHz. When hunting for prey, the rate of pulse emission can be increase up to 200 pulses per second, when they fly near their prey.

Microbats use the time delay from the emission and detection of the echo. The time difference between their two ears, and the loudness variations of the echoes will build up the three dimensional scenario of the surrounding.

They can detect the distance and orientation of the target, type of the prey and even the moving speed of the prey.

$$A_i^{t+1} = \alpha A_i^t \tag{20}$$

5.3 Idealized rules for BAT Algorithm

- All bats use echolocation to sense distance, and they also know the food/prey and the obstacles, in some magical way.
- Bats fly randomly with velocity V_i at position X_i with a fixed frequency f_{min} , varying wavelength λ and loudness A_0 to search for prey. They can automatically adjust the wavelength (or frequency) of their emitted pulses and adjust the rate of pulse emission r in the range of $[0, 1]$, depending on the distance of their target.
- Although the loudness can vary in many ways, we assume that the loudness varies from a large (positive) A_0 to a minimum constant value A_{min} . In addition to these simplified assumptions, we also use the following approximations. In general, the frequency f in a range of $[f_{min}, f_{max}]$ corresponds to a range of wavelengths $[\lambda_{min}, \lambda_{max}]$. For simplicity, we can assume f is within $[0, f_{max}]$. We know that higher frequencies have shorter wavelengths and travel a shorter distance. The rate of pulse emission can be simplified in the range of $[0, 1]$, where 0 means no pulse at all, and 1 means maximum rate of pulse emission.

5.4 Movement of bats

The movement of the bats depending upon the velocity changes with respect to time step. The new solutions x_i^t , and velocities v_i^t , at time step t are given by;

$$f_i = f_{min} + (f_{max} - f_{min}) * \beta \tag{16}$$

$$v_i^t = v_i^{t-1} + (x_i^t - x_*) * f_i \tag{17}$$

$$x_i^t = x_i^{t-1} + v_i^t \tag{18}$$

Where, $\beta \in [0, 1]$ is a uniformly distributed random vector. x_* is the current global best location (solution), which is located after comparing all the solutions among all the n bats. We can choose f_{min} , f_{max} depending upon the domain size of the optimization problem. Initially, each bat is randomly assigned a frequency within the range $[f_{min}, f_{max}]$.

For the local search, once a solution is selected among the current best solutions, a new solution for each bat is generated locally using random walk;

$$x_{new} = x_{old} + \epsilon A^t \tag{19}$$

Where, $\epsilon \in [-1, 1]$ is a random number, while $A^t = \langle A_i^t \rangle$ is the average loudness of all the bats at this time t .

5.5 Loudness and pulse emission

The loudness A_i and the rate of pulse emission r_i are updated accordingly as the iterations proceed. Once a bat has found its prey loudness decreases and rate of pulse emission increases. Assume $A_{min} = 0$, means that a bat has just found the prey and temporarily stop emitting any sound.

$$r_i^{t+1} = r_i^0 [1 - \exp(-\gamma t)] \tag{21}$$

Where, α and γ are constants.

5.6 Pseudo code for BAT Algorithm:

```

BEGIN
Objective function f(x), x = (x1, x2, x3, . . . , xd)T
Initialize the bat population xi, (i = 1, 2, 3. . . n) and vi
Define pulse frequency Qi at xi
Initialize pulse rates ri and loudness Ai
While (t < Max. number of iterations)
Generate new solutions by adjusting frequency
fi = fmin + (fmax - fmin) * beta
and updating velocity vit = vit-1 + (xit - x*) * fi
and updating location xit = xit-1 + vit
if (rand > ri)
Select a solution among the best solutions
Generate a local solution around the selected best solutions
end if
Generate new solutions by flying randomly
if (rand < Ai & f(xi) < f(x*))
Accept the new solutions
Increase ri and decrease Ai
end if
Rank the bats and find the current best x*
end while
Post process results and visualization
END
    
```

6. Case Study and Results

6.1 Case study on 6 thermal unit systems

The different methods discussed earlier are applied to one six thermal unit system to find out the minimum cost for any demand. Results of BAT Algorithm are compared with the conventional methods Particle Swarm Optimization (PSO) and Intelligent Water Drop (IWD). In this case the only transmission losses and prohibited zone constraints are considered. The maximum number of iterations has been taken as 500. All these simulation are done on MATLAB 2011 environment.

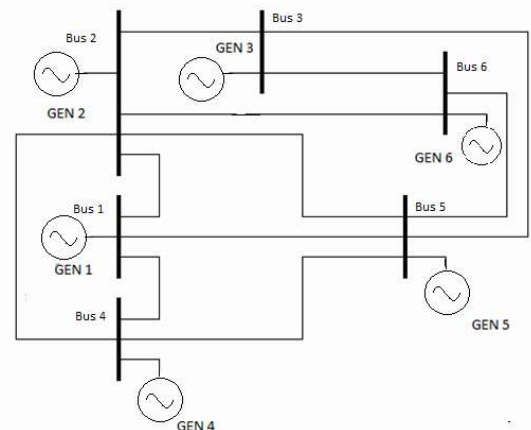


Figure 1: Single line diagram of 6-unit thermal plant

Table 1: capacity and coefficients data of six unit thermal system

unit	P_{gmax} (MW)	P_{gmin} (MW)	a_i RS/MWh ²	b_i RS/MWh	c_i MW
1	500	100	0.0070	7	240
2	150	50	0.0090	11	200
3	200	50	0.0080	10.5	220
4	120	50	0.0075	12	120
5	300	80	0.0090	8.5	220
6	200	50	0.0095	10	200

The Six generating units considered are having different characteristic. Their cost function characteristics are given by following equations:

$$F1 = 0.0070 P1^2 + 7 P1 + 240 \text{ RS/Hr}$$

$$F2 = 0.0090 P2^2 + 11 P2 + 200 \text{ RS/Hr}$$

$$F3 = 0.0080 P3^2 + 10.5 P3 + 220 \text{ RS/Hr}$$

$$F4 = 0.0075 P4^2 + 12 P4 + 120 \text{ RS/Hr}$$

$$F5 = 0.0090 P5^2 + 8.5 P5 + 220 \text{ RS/Hr}$$

$$F6 = 0.0095 P6^2 + 10 P6 + 200 \text{ RS/Hr}$$

Table 2: Prohibited zone limits of six unit system

Unit	Zone-1	Zone-2
1	210-240	350-380
2	80-90	110-120
3	90-110	140-150
4	75-85	100-105
5	150-170	210-240
6	90-110	140-160

According to the constraints considered in this work among inequality constraints only active power constraints are considered. There operating limit of maximum and minimum power are also different. The unit operating ranges are:

$$100 \text{ MW} \leq P1 \leq 500 \text{ MW}$$

$$50 \text{ MW} \leq P2 \leq 150 \text{ MW}$$

$$50 \text{ MW} \leq P3 \leq 200 \text{ MW}$$

$$50 \text{ MW} \leq P4 \leq 120 \text{ MW}$$

$$80 \text{ MW} \leq P5 \leq 300 \text{ MW}$$

$$50 \text{ MW} \leq P6 \leq 200 \text{ MW}$$

The transmission line losses can be calculated by knowing the loss coefficient. The B_{ij} Coefficient matrix is given by

$$B_{ij} = \begin{bmatrix} 0.0224 & 0.103 & 0.0016 & -0.0053 & 0.0009 & -0.0013 \\ 0.0103 & 0.0158 & 0.0010 & -0.074 & 0.0007 & 0.0024 \\ 0.0016 & 0.0010 & 0.0474 & -0.0 & -0.0060 & -0.0350 \\ -0.0053 & -0.0074 & -0.0687 & 0.3464 & 0.0105 & 0.0534 \\ 0.0009 & 0.0007 & -0.0060 & 0.0105 & 0.0119 & 0.0007 \\ -0.0013 & 0.0024 & -0.0350 & 0.0534 & 0.0007 & 0.2353 \end{bmatrix}$$

and

$$B_{i0} = [-0.0005 \ 0.0016 \ -0.0029 \ 0.0060 \ 0.0014 \ 0.0015]$$

$$B_{00} = 0.0011$$

6.2 PSO method

The Parameters $c1$, $c2$ and inertia weight are selected for

best convergence characteristic. Here, $c1 = 2.0$ and $c2 = 2.0$. Here the maximum value of w is chosen 0.9 and minimum value is chosen 0.4. the velocity limits are selected as $V_{max} = 0.5 * P_{max}$ and the minimum velocity is selected as $V_{min} = 0.5 * P_{min}$.

Table 3: Six Unit System by PSO method

Power demand (MW)	500	900	1100	1236
P1	223.75	355.56	411.99	473.97
P2	50	67.768	88.237	117.23
P3	50	136.91	171.28	181.74
P4	50	50.117	57.403	64.419
P5	80.55	203.19	255.24	287.83
P6	50	95.385	129.41	157.02
Power Loss	3.80	8.94	13.56	19.21
Total Gen cost (RS/Hr)	6114.8	10709	13268	15477
Elapsed time (sec)	10.057	10.048	10.408	10.520

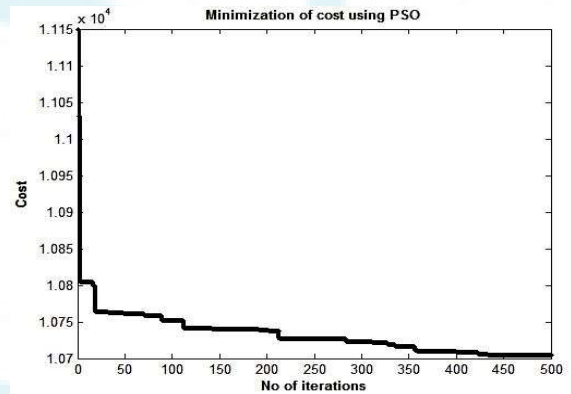


Figure 2: Cost curve of 900MW demand by PSO method

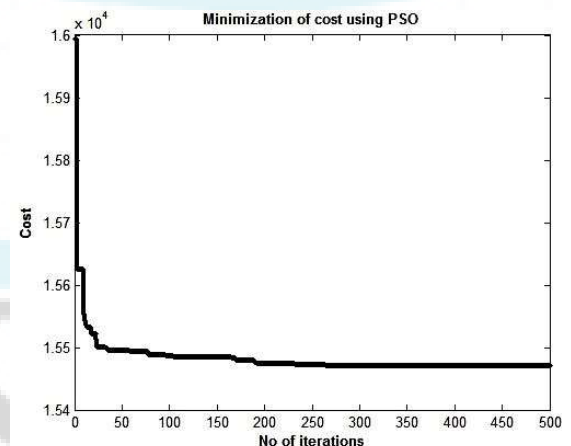


Figure 3: Cost curve of 1263 MW demand by PSO method

6.3. BAT Algorithm method

The parameters of algorithm used for simulation are selected for best convergence characteristic. Here, $n = 100$ (size of population), $N_{gen} = 500$ (no of iterations), $A = 0.9$ (loudness), $r = 0.1$ (rate of pulse emission), $Q_{min} = 0$ and $Q_{max} = 2$ (frequency). There are 100 no of bats are selected in the population. For different value of n and N_{gen} , the cost curve converges in the different region. So, the best value is taken for the minimum cost of the problem. If the no of bats are increased in population then cost curve converges faster. It can be observed the loss has no effect on the cost characteristic.

Table 4: six unit system by bat method

Power demand (MW)	500	900	1100	1236
P1	139.14	265.91	475.81	500
P2	69.67	61.513	110.07	150
P3	52.228	57.666	120.97	200
P4	133.94	163.26	153.34	164.54
P5	86.649	219.47	155.49	80
P6	142.08	151.31	105.8	200
Power Loss	13.15	19.78	21.05	31.30
Total Gen cost (RS/Hr)	24431	11186	13609	15472
Elapsed time (sec)	7.68	7.65	7.96	8.15

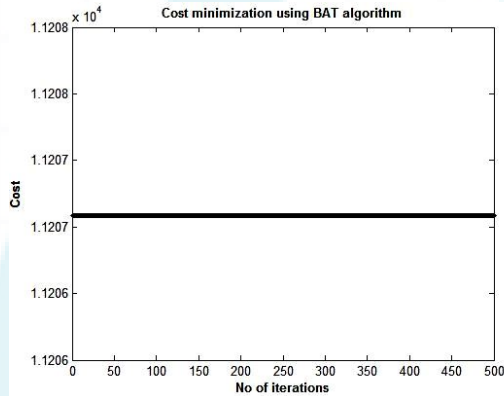


Figure 4: Cost curve of 900MW demand by BAT Algorithm method

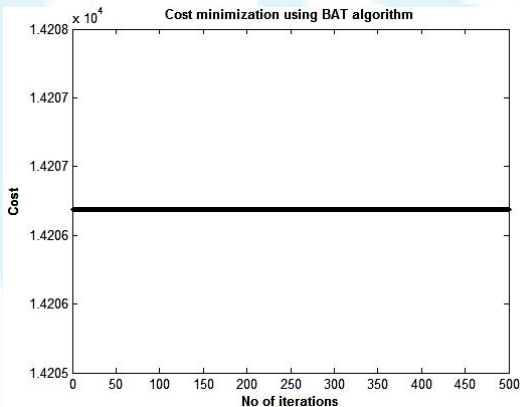


Figure 5: Cost curve of 1100MW demand by BAT Algorithm method

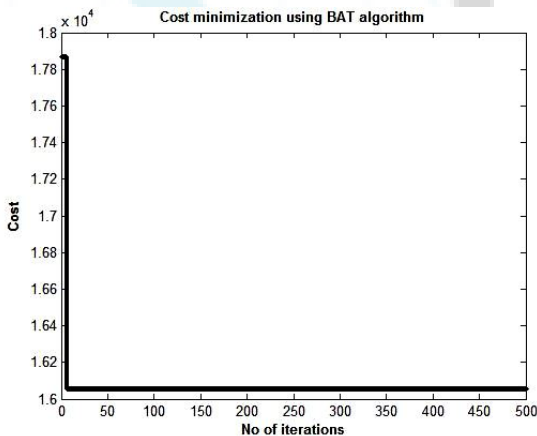


Figure 6: Cost curve of 1263MW demand by BAT Algorithm method

6.4 IWD Method

Table 5: six unit system by IWD method [16]

Power demand (MW)	1236
P1	447.49
P2	173.32
P3	263.47
P4	139.09
P5	165.47
P6	87.12
Power Loss	12.98
Total Gen cost (RS/Hr)	15450
Elapsed time (sec)	10.79

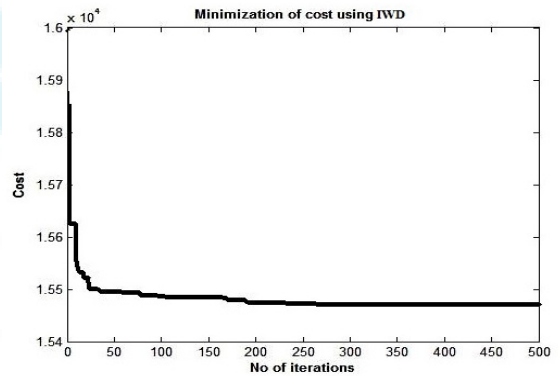


Figure 7: Cost curve of 1263MW demand by IWD method

6.5. Comparison of methods at 1236 mw

Table 6: comparison of three methods

Power demand (MW)	BAT	PSO	IWD
P1	500	473.97	447.49
P2	150	117.23	173.32
P3	200	181.74	263.47
P4	164.54	64.419	139.09
P5	80	287.83	165.47
P6	200	157.02	87.12
Power Loss	31.30	19.21	12.98
Total Gen cost (RS/Hr)	16012	15477	15450
Elapsed time (sec)	8.15	10.520	10.79

It has been observed that based on results obtained from table 6, The BAT algorithm is very efficient and takes very less time to convergence around 8.15 sec where as in PSO takes around 10.52 sec to converge. Bat algorithm has been compared with the PSO, IWD algorithms and it has been found that, it gives minimum cost of 16,012 Rs/hrs with minimum loss of 31.30 MW at 1263 power demand. The convergence characteristic of the BAT method for 6-unit system is shown in Figs (1-7). All the methods give the minimum cost are not always equal. The performance depends on randomly generated particle in PSO, The static and dynamic parameters in IWD and bats movements in BAT ALGORITHM. Sometimes PSO gives better result and sometimes BAT gives better result. But convergence is

good in BAT ALGORITHM compare to remaining exist methods.

7. Conclusion and Future Scope

The most economical operation of modern power systems is allocate the optimal power generation from different units at the lowest cost possible while meeting all system constraints. Economic Load Dispatch (ELD) is a method to schedule the power generator outputs with respect to the load demands. Economic Load dispatch problem here solved for a six thermal unit system with only transmission losses considered. The three different methods are performing in the MATLAB environment. The problem of six units system when transmission losses are solved by three different methods. In conventional methods better cost is obtained but the problem converges when parameters varied randomly. The cost characteristic takes many numbers of iterations to converge. In BAT ALGORITHM the cost characteristic converges in less elapsed time when compared with PSO and IWD methods. In BAT ALGORITHM the selection of parameters are very important. The best results were obtained when number of population is decreased. In BAT ALGORITHM method selection of parameters are important. So, the parameters may be optimized by using the ANN method. Any other method can be applied with PSO to improve the performance of the BAT method. Here the loss co-efficient are given in the problem. The work may be extended for the problem where transmission loss co-efficient are not given. In that case the loss co-efficient can be calculated by solving the load flow problem.

References

[1] S. Biswal, A. K. Barisal, A. Behera and T. Prakash "Optimal Power Dispatch Using BAT Algorithm" IEEE Trans. Power Syst., 978-1-4673-6150-7/13/\$31.00_ IEEE.

[2] Saumendra Sarangia a thesis on "particle swarm optimization applied to Economic load dispatch", NIIT

[3] IEEE Committee Report, Present practices in the economic operation of power systems, IEEE Trans. Power Appa. Syst., PAS-90 (1971) 1768–1775.

[4] B.H. Chowdhury and S. Rahman, A review of recent advances in economic dispatch, IEEE Trans. Power Syst, 5 (4) (1990), pp. 1248–1259.

[5] J.A. Momoh, M.E. El-Hawary and R. Adapa, A review of selected optimal power Flow literature to 1993, Part I: Nonlinear and quadratic programming approaches, IEEE Trans-Power. Syst.

[6] D.C. Walters and G.B. Sheble, Genetic algorithm solution of economic dispatch with valve point loading, IEEE Trans. Power Syst., 8 (August (3)) (1993).

[7] D.C. Walters and G.B. Sheble, Genetic algorithm solution of economic dispatch with valve point loading, IEEE Trans. Power Syst., 8 (August (3)) (1993).

[8] Xin-She Yang (2010), "A New Metaheuristic Bat-Inspired algorithm in J R Gonzalez et al.(Eds.), Nature Inspired Cooperative Strategies for Optimization (NISCO 2010), studies in Computational Intelligence.

[9] N. Sinha, R. Chakrabarti and P.K. Chattopadhyay, Evolutionary programming techniques for economic load dispatch, IEEE Evol. Comput., 7 (February (1)) (2003).

[10] H.T. Yang, P.C. Yang and C.L. Huang, Evolutionary programming based economic dispatch for units with nonsmooth fuel cost functions, IEEE Trans. Power Syst.

[11] A.J. Wood and B.F. Wollenberg, Power Generation, Operation, and Control (2nd ed.), Wiley, New York .

[12] W.M. Lin, F.S. Cheng and M.T. Tsay, An improved Tabu search for economic dispatch with multiple minima, IEEE Trans. Power Syst., 17 (February (1)) (2002)

[13] P. Attaviriyanupap, H. Kita, E. Tanaka and J. Hasegawa, A hybrid EP and SQP for dynamic economic dispatch with nonsmooth fuel cost function, IEEE Trans. Power Syst., 17 (May (2)) (2002), pp. 411–416.

[14] X. S. Yang. Bat algorithm for multi-objective optimization. International Journal of Bio-Inspired Computation. 2011, 3(5): 267-274.

[15] A.I. Selvakumar and K. Thanushkodi, A new particle swarm optimization solution to nonconvex economic dispatch problems, IEEE Trans. Power Syst., 22

[16] Hamed Shah-Hosseini, "The intelligent water drops algorithm: a nature- inspired swarm-based optimization algorithm", International Journal of Bio-Inspired Computation, Vol.1, Nos. 1and2, pp.71-79, 2009.

[17] Shah-Hosseini. H, "Optimization with the Nature-Inspired Intelligent Water Drops Algorithm", Int. Journal of Intelligent Computing and Cybernetics.

[18] Rayapudi, S. R. (2011). An intelligent water drop algorithm for solving economic load dispatch problem. International Journal of EE E 5, 43-49.

Authors Profile



Mr. Ramesh Chevuru received the B.Tech degree in Electrical and Electronics Engineering from Sri Venketeswara University College of Engineering, Tirupati, Andhra Pradesh, India and he is currently pursuing M.Tech in the same Institution. He had 6 years experience in teaching as Assistant professor in C.R.E. College, Tirupati, Andhra Pradesh.



Dr. G. V. Marutheswar received the B.Tech, M.Tech and PHD degrees from Sri Venkateswara University College of Engineering, Tirupati, Andhra Pradesh, India. He is currently working as professor at EEE Department in Sri Venkateswara University College of Engineering.