Distributed Generation allocation in Distribution System using Optimization Techniques

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Abstract

Today in all over world changes their power sector Areas from Conventional Grid to Smart Grid for the purpose of scheme voltage maintained, decline in Systems Power sufferers, emissions and consistency enhancement. The power hammering in a delivery structure is considerably far above the ground since lesser voltage and high current, compared to that in a high voltage transmission system, for that we choosing method is the only one DG assignment is used to discover the finest DG location and size which equivalent to the greatest sufferers cutbacks. The future method is tested on the 26-bus radial distribution Systems. In this manuscript we planned two algorithms are particle swarm optimization (PSO) and Bat Algorithm (BA) for reduce power losses in radial distribution systems also results are compared.

1. Introduction

Outstanding to restriction on fossil fuel capital, another solution to conventional huge energy station are in top priority in current times to gather the increasing power insist of the prospect. Furthermore huge energy stations are dispirited because of some ecological troubles. At the same time renewable energy resources have been considered as the greatest substitute to conventional fossil fuels. The dimensions of renewable energy based power generators would be extremely little as compared to enormous fossil fuel based power plant. Formally, they are fitting for scenery up at down voltage sharing structure, close to energy consumable centers

With the fast enlarge of DG incursion, distribution systems are being transformed from passive to active networks. In general, DG units are tiny in size and modular in arrangement. Consequently, their impacts on distribution system operation, control, and stability vary depending on their locations and sizes [1], [2]. One of the majority positive impacts of DG is the capability to lessen the distribution system losses [3]. At the same time unsuitable DG allotment may direct to increased system losses and system operation costs [4], [5]. This also one of the main reason of the electrical power losses in electric power systems are degenerate in distribution systems due to heavy currents flowing in primary and secondary feeders. Because of this situation require to develop well-organized apparatus to facilitate the optimally different DG types are assign in distribution systems for reducing losses.

Several figure of approach planned for assignment and sizing of DG units. Chiradeja and Ramkumar [6] existing a universal approach and put of indices to review and enumerate the methodological benefits of DG in terms of voltage outline development, line loss lessening and environmental impact reduction. Khan and Choudhry [7] developed an algorithm based on logical approach to get better the voltage outline and to reduce the power loss under arbitrarily distributed load situation with low power factor for single DG as well as multi DG systems. Hung et al. [8][9] used an better analytical method for identification of the best location and optimal power factor for placing multiple DGs to attain loss reduction in large-scale primary. For optimal placement of DG, Mithulanathan et al. [10] K.Umamaheswari,Dr.V.Venkatachalam [18] presented a genetic algorithm based approach to minimize the real power loss in the system and found a significant lessening in the scheme loss. The best sizing and sitting of DGs was investigate by Ghosh et al. [10] to reduce both cost and loss with appropriate weighing factors using Newton-Raphson (NR) load flow method. Ziari et al. [11] planned a discrete particle swarm optimization and genetic algorithm (GA) based approach for best planning of DG in distribution network to reduce loss and get better reliability. Kamel and Karmanshahi [12] and S.Sathiya, Dr.K.Sundararaju[14] optimal sizing in feeders,Gokulakrishnan, B., Govindaraj [19] future an algorithm for optimal sizing and sitting of DGs at any bus in the distribution system to reduce losses and found that the total losses in the distribution scheme would reduce by nearly 85%, if DGs were located at the optimal locations with best sizes.

2. Problem formulation

The real power loss lessening in a distribution scheme is mandatory for well-organized power system operation. The loss in the system can be calculated by equation (2.1) given the system working condition [2].

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n} Aij\left(P_iP_j + Q_iQ_j\right)Bij(Q_iP_j - P_iQ_j) \qquad 2.1$$

where

$$Aij = \frac{R_{ij\cos(\delta i - \delta j)}}{V_iV_j} \qquad 2.2$$

$$B_{ij} = \frac{R_{ij\sin(\delta i - \delta j)}}{V_iV_j} \qquad 2.3$$

Where Pi and Qj are net real and reactive power injection in bus ‘I’ respectively, Rij is the line resistance between bus’I’ and ‘j’ Vi and δi voltage and angle at bus ‘I’ respectively.

The objective of the placement techniques is to minimize the total power loss, mathematically, the objective function can be written as:

$$Minimize \qquad P_L = \sum_{k=1}^{N_{sc}} Loss_k \qquad 2.4$$

Subject to the Power Balance Constraints

$$\sum_{i=1}^{N} P_{DGi} = \sum_{i=1}^{N} P_{Di} + P_L \qquad 2.5$$

Voltage Constraints:

$$V_{imin} \leq V_i \leq V_{i\,max}$$

Loss k is sharing loss at section k, NSC is total number of sections, PL is the real power hammering in the scheme, PDGi is the real power generation DG at bus i and PDi is the power insist at bus i

3. Power Losses Reduction Methods

There are several algorithms accessible to explain the multifaceted optimization crisis. Mainly referred are particle swarm optimization (PSO) and bat algorithm (BA)

A. Particle Swarm Optimization

PSO algorithm is a inhabitants based optimization algorithm provoked by usual association of animals resembling the schooling actions of fish and the searching manners of birds. PSO is based on the interface of dissimilar particles (members) of the inhabitants or Swarm.

In PSO each element has recollection and each element is a probable solution. They cooperate with each other and be in motion towards global best (gbest) location by altering their rapidity and position. The step by step execution of PSO is shown below

1) Choose the no. of particles for multidimensional search process in PSO. Generally good value of element is from 20 to 40.

2) Initialize each element with arbitrary point and rapidity, and assign them a casual vector of PDG, QDG and discrete value bus places within the specified confines.

3) Every element evaluates the goal function (fitness) value using Newton Raphson load flow. Element will regulate its velocity to have superior solution according to best fit element.

4) Recognize the best fit element in the swarm. If local fitness (p) value is better than current best fitness (pbest) value then fitness current set

5) If current fitness is better than global best (gbest) fitness then set pbest=gbest

6) Modernize particles velocity and position using (13) and (14) till the stopping criterion is met and gbest will be the optimal solution.

$$\left(V_{in}^{(t+1)} = w * v_{in}^{t} + c_1 * rand * \left(p_{best\ in} - x_{in}\right)\right) + c_2 * rand * \left(p_{best\ in} - x_{in}\right) \qquad 3.1$$

$$X_{in}^{(t+1)} = x_{in}^{t} + v_{in}^{(t+1)} \qquad 3.2$$

Everyplace w is the inertia weight, which facilitate local and global explore capacity. c1 and c2 are cognitive and common behavior constituent respectively. They are also called speeding up constant as they are accountable for pulling each particle towards pbest and gbest position.

B.Bat-Inspired Algorithm

Bat algorithm is a bio-inspired algorithm. It was proposed in 2010 by Xin-She Yang [13]. This algorithm exploits the echolocation behavior of the bats. Surrounded by all species of bats, microbat uses the echolocation regularly. Bat emits sonar signal to find prey, detect article and keep away from obstacles. These emitted sonar signal, when hit an article spring up back echoes. This time holdup of emitted and echo signal is sensed by bats to establish the size and location of objects. Bats also varies loudness and pulse rate of emitted signal depending upon the nearness to prey. There are some idealized rules to be fallowed while using bat algorithm:

• All bat uses echolocation to identify obstacles and differentiate between barriers and prey.

• Initially bats has random velocity Vi at position Xi having frequency fixes at f min, with varying loudness A0 and wavelength λ. They robotically adjust their pulse rate and loudness depending upon the proximity to prey.

• A0 varies from a very high value to a fixed minimum value Amin. Explanation and mathematical formulation of Bat Inspired Algorithm [13], is explained in following steps:

Step1. Population Bat population is initialized arbitrarily in search space. Superior rate of population is in between 10 to 40. Fitness is found according to idea function and these values are updated by varying velocity, pulse rate and loudness. In this simulation population is taken as 20.

Step2. Movement of bats Here, updating of the parameters of bats take place in search spaces:

$$f_i = f_{min} + (f_{max} - f_{min}) * rand \quad 3.3$$

$$v_i^t = v_i^{t-1} + (x_t - x_0) * f_i \quad 3.4$$

$$x_i^t = x_i^{t-1} + v_i^t \quad 3.5$$

Where xi t , and vi t , are current position and velocity of ith bat where as x* is the current gbest position (solution). In this simulation range of parameter is considered as; loudness (A) [2, 0], frequency (f) [0, 2] and pulse rate r [0, 1].

Step3. confined search by random walk For local search part a answer is arbitrarily selected among the best solutions then casual walk is used to generate a new solution locally around that solution using (18).

Step4. The pulse emission and loudness

$$x_{new} = x_{old} + \varepsilon A^t \quad 3.6$$

The pulse emission and loudness Usually, loudness decrease (Ai) and pulse emission rate (ri) increases as bat found its prey or near to prey.

$$A_i^{t+1} = \alpha A_i^t \quad 3.7$$

$$r_i^{t+1} = r_i^0[1 - \exp(-\gamma t)] \quad 3.8$$

Step5.Optimal solution Rank the solution as per their fitness values and best fitness value is updated as gbest.

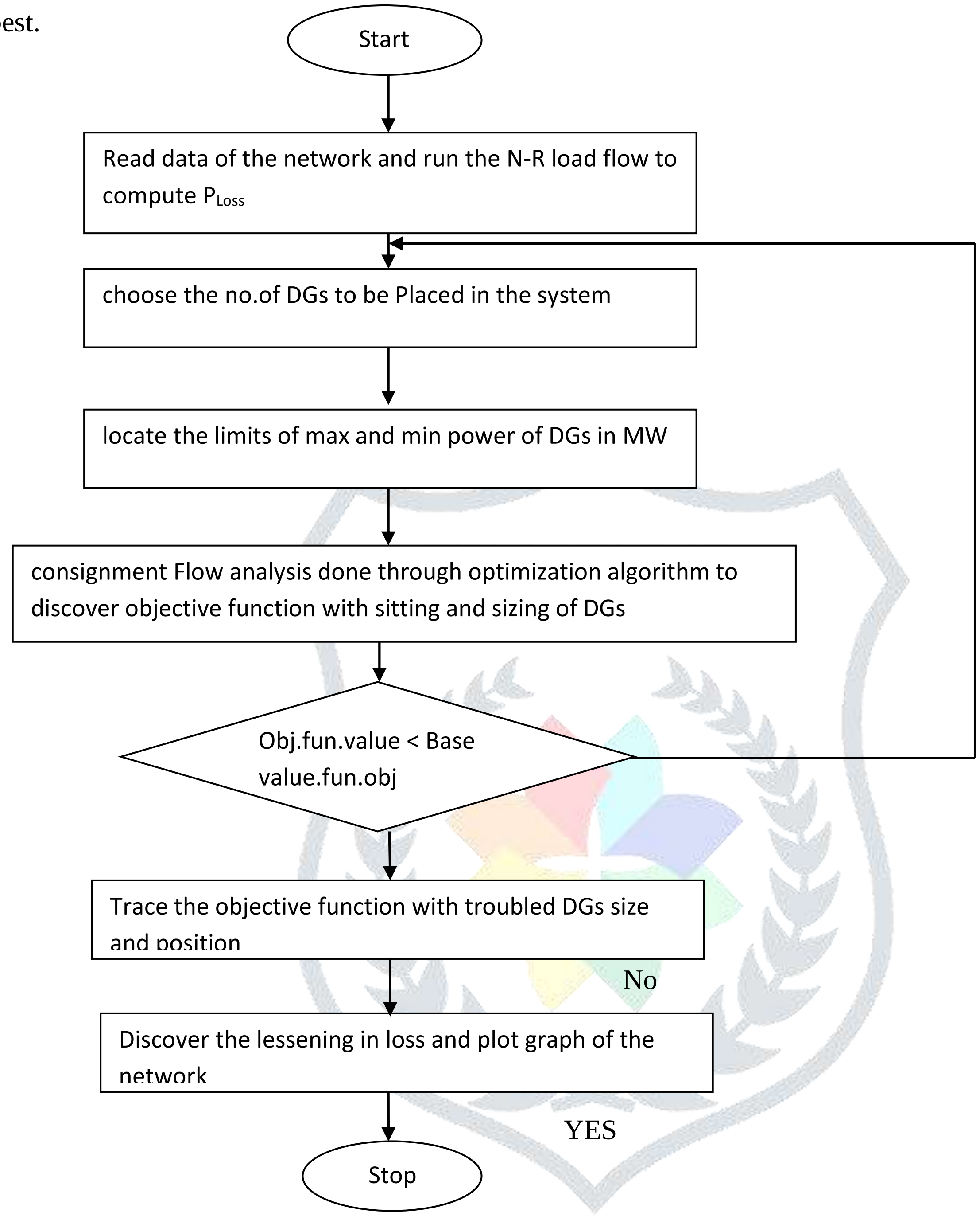


Fig 1 Flow chart for finest sitting and Sizing of DGs

7) In the every iteration DGs location and size are arbitrarily selected. Frequency, Velocity and position are updated using (15), (16) and (17).

8) Objective function is calculated as in step6.

9) If the obtained OF is a smaller amount than current best solution then obtained OF is consider as new current solution and update loudness.

10) Duplicate step6 to step9 until the maximum iteration is reached.

11) Pick the best (minimum) objective function surrounded by all solutions and corresponding position and DGs size are considered as finest.

12) The best (minimum) objective function is compare with base case for Loss drop calculation.

4. Simulation Result and Discussion

A scheme is chosen from one piece of the PEA central station distribution set-up. The single line picture of the arrangement is illustrated in Fig. 2. The 26-bus scheme has 25 sections with the total load of 8.49 MW and 5.28 MVAR. The novel total real and reactive power losses of the system are 11.68 kW (0.14%) and 26.08 kVAR (0.49%), correspondingly.

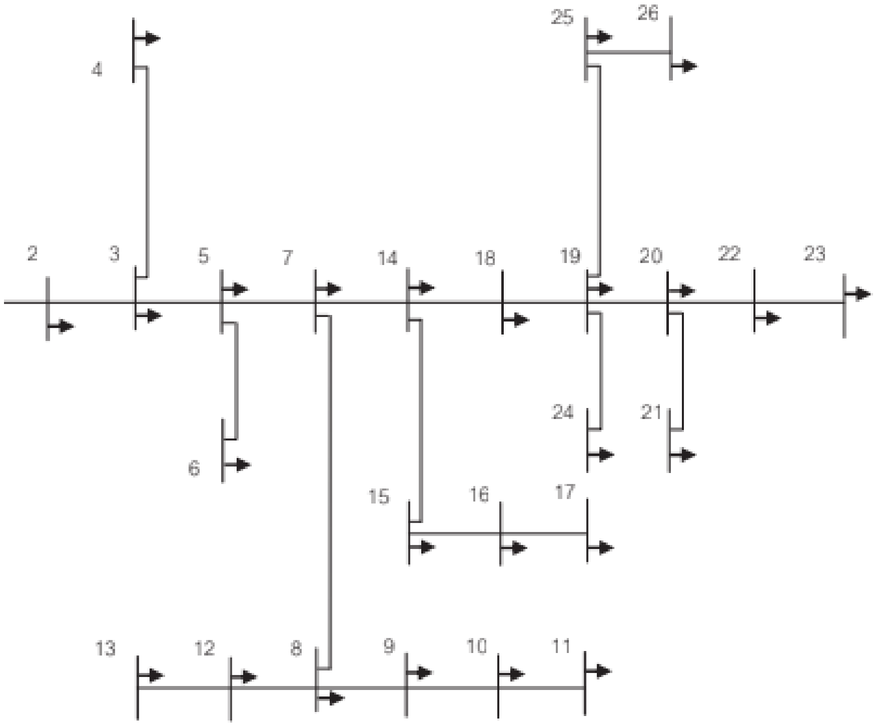


Fig 2 26 Bus Systems for DG Allocation

Case 1:PSO Algorithm

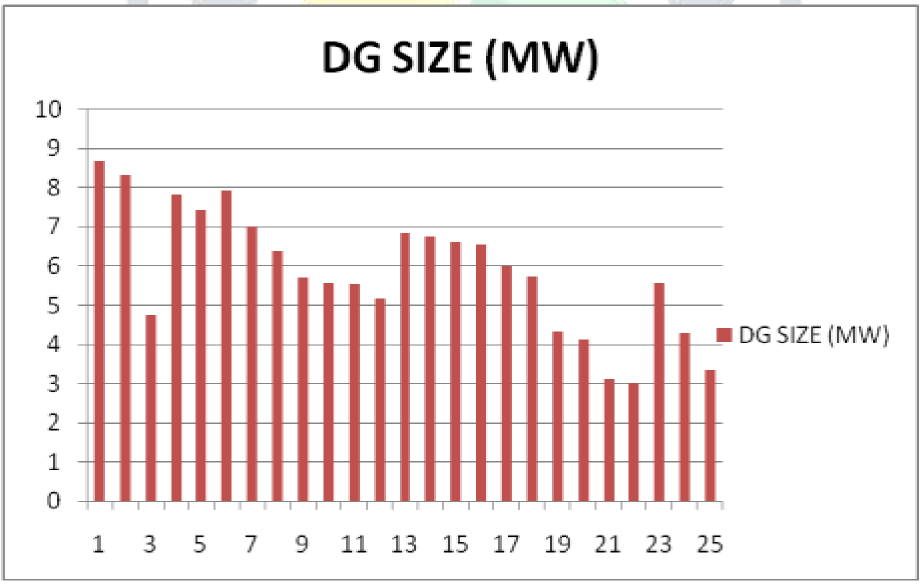
Table 1 DG Allocation in MW in different Bus Locations using PSO

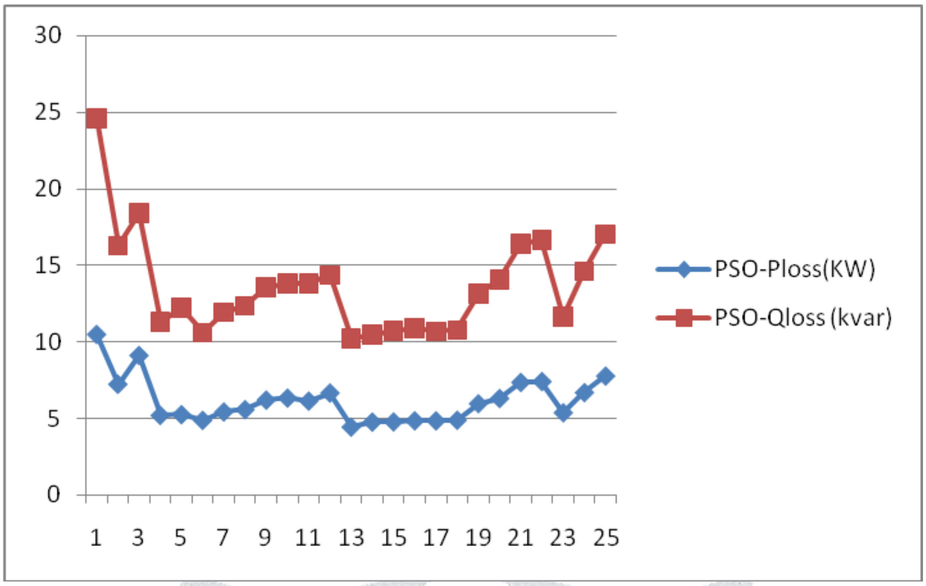
BUS NUMBER	DG SIZE (MW)	Ploss(KW)	Qloss (kvar)
2	8.6850	10.4780	24.5681
3	8.3355	7.2254	16.2538
4	4.7521	9.1044	18.3641
5	7.8400	5.1881	11.2798
6	7.4411	5.2336	12.2010
7	7.9400	4.8657	10.5689

8	7.0133	5.4124	11.8940
9	6.3887	5.5621	12.3207
10	5.7017	6.1882	13.5214
11	5.5582	6.3154	13.7784
12	5.5500	6.1229	13.7994
13	5.1663	6.6482	14.3401
14	6.8375	4.4226	10.1819
15	6.7454	4.7512	10.4569
16	6.6185	4.7624	10.6785
17	6.5424	4.8364	10.8450
18	5.9940	4.8275	10.6678
19	5.7256	4.8699	10.7512
20	4.3177	5.9521	13.1213
21	4.1434	6.2939	14.0471
22	3.1214	7.3442	16.3576
23	3.0140	7.4005	16.6279
24	5.5774	5.3629	11.6253
25	4.2879	6.6790	14.5678
26	3.3315	7.7596	17.0134

The smallest amount power hammering occur in bus 14 (4.56 kW and 10.20 kVAR). The proposed method PSO can diminish hammering by 61% of its original loss.

The planned style was run on a 26 bus test system. The impact of installing DG in the case study network with best allotment and sizing is presented Table 1. Reduce the total power loss depends on the location and size of DG.





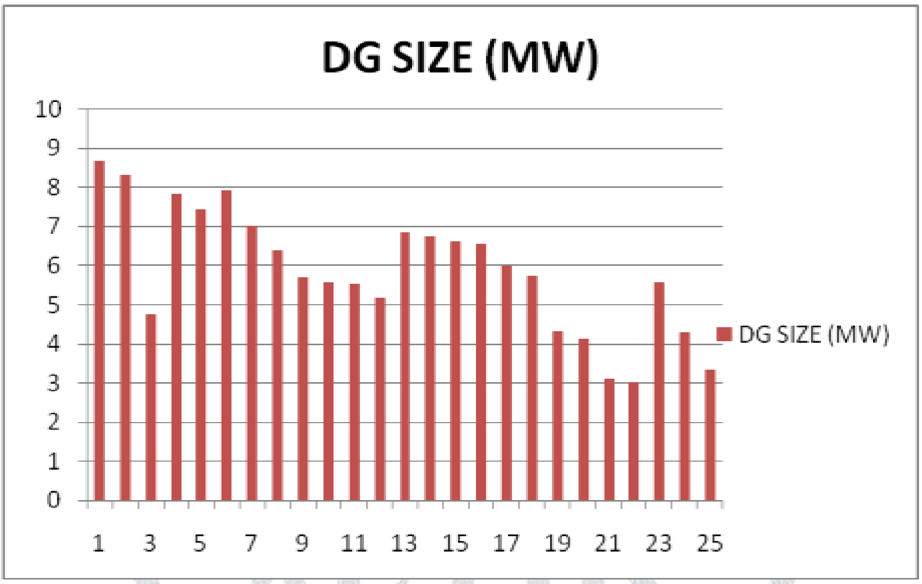
Case 2: BAT Algorithm

By using BAT Algorithm DG is allocation of different bus places for Power Losses calculatation.

Table 2 DG Allocation in MW in different Bus Locations using BAT

BUS NUMBER	DG SIZE (MW)	Ploss(KW)	Qloss (kvar)
2	8.6850	10.5488	25.5681
3	8.3355	7.9554	16.5558
4	4.7521	9.8026	18.7461
5	7.8400	5.3581	11.7098
6	7.4411	5.2124	12.4520
7	7.9400	5.0657	10.9608
8	7.0133	5.7384	13.9940
9	6.3887	5.9851	12.8207
10	5.7017	6.5972	13.7355
11	5.5582	6.7374	13.9784
12	5.5500	6.4349	13.8994
13	5.1663	6.6582	14.6521
14	6.8375	4.6115	10.3230
15	6.7454	4.6556	10.5596
16	6.6185	4.7958	10.7095
17	6.5424	4.8444	10.8850
18	5.9940	4.8235	10.6487
19	5.7256	4.9699	10.7751
20	4.3177	5.9826	13.9413
21	4.1434	6.5093	14.0881
22	3.1214	7.6742	16.6577
23	3.0140	7.8005	16.8289
24	5.5774	5.4527	11.6343
25	4.2879	6.6890	14.5688
26	3.3315	7.7798	17.2112

The smallest amount power hammering occurs in bus 14 (4.6115kW and 10.3230 kVAR). The proposed method BAT can diminish loss by 33% of its original loss.



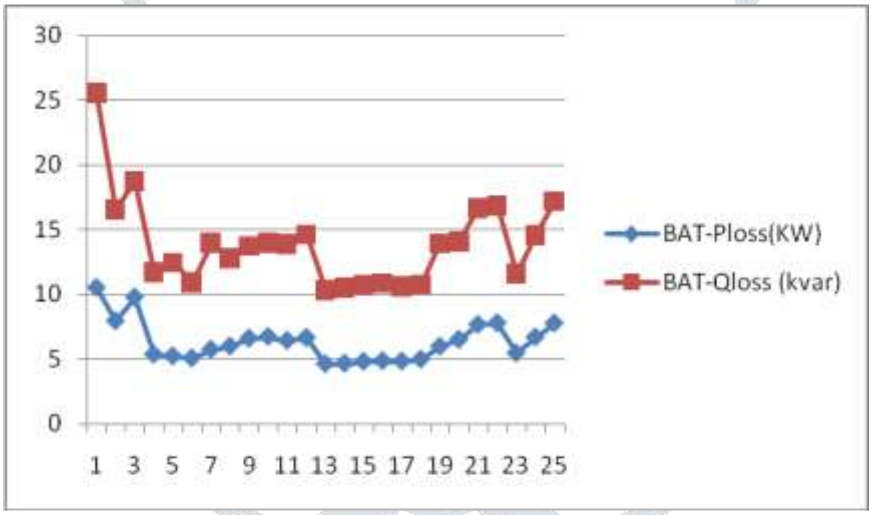


Table 3 Comparison between PSO and BAT algorithm for Power Losses

S.No	Algorithm	BUS Location	DG Size(MW)	Plosses(KW)	Q Losses(KVR)
1	PSO	14	6.8375	4.4226	10.1819
2	BAT	14	6.8375	4.6115	10.3230

REFERENCE

[1] R. A. Walling, R. Saint, R. C. Dugan, J. Burke, and L. A. Kojovic, "Summary of distributed resources impact on power delivery systems," IEEE Trans. Power Del., vol. 23, no. 3, pp. 1636–1644, Jul. 2008.

[2] T. Ackermann and V. Knyazkin, "Interaction between distributed generation and the distribution network: Operation aspects," in Proc. IEEE T&D Conf., 2002, vol. 2, pp. 1357–1362.

[3] D. Singh and K. S. Verma, "Multiobjective optimization for DG planning with load models," IEEE Trans. Power Syst., vol. 24, no. 1, pp. 427–436, Feb. 2009.

[4] Y. M. Atwa, E. F. El-Saadany, M. M. A. Salama, and R. Seethapathy, "Optimal renewable resources mix for distribution system energy loss minimization," IEEE Trans. Power Syst., vol. 25, no. 1, pp. 360–370, Feb. 2010.

[5] P. S. Georgilakis and N. D. Hatziargyriou, "Optimal distributed generation placement in power distribution networks: Models, methods, and future research," IEEE Trans. Power Syst., vol. 28, no. 3, pp. 3420–3428, Aug. 2013.

[6] P. Chiradeja and R. Ramkumar. An approach to quantify the technical benefits of distributed generation. IEEE Transaction on Energy Conversion. 2004, 19 (4): 764-773.

[7] H. Khan and M.A. Choudhry. Implementation of distributed generation algorithm for performance enhancement of distribution feeder under extreme load growth. International Journal of Electrical Power and Energy Systems. 2010, 32 (9): 985-997.

[8] S.Sathiya, Dr.K.Sundararaju,N.Thenmozhi Optimization Techniques For Energy Management Systems For Smart Grid With Renewable Sources International Journal Of Pure And Applied Mathematics Volume 118 No. 20 2018, 2417-2425

[9] D.Q. Hung, N. Mithulanathan and R.C. Bansal. Multiple distributed generators placement in primary distribution networks for loss reduction. IEEE Transactions on Industrial Electronics.

[10] N. Mithulanathan, T. Oo and L. V. Phu. Distributed generator placement in power distribution system using Genetic Algorithm to reduce losses. Thammasat International Journal on Science and Technology. 2004, 9 (3): 55-62.

[11] S. Ghosh, S.P. Ghoshal and S. Ghosh. Optimal sizing and placement of DG in network system. International Journal of Electrical Power and Energy Systems. 2010, 32 (8): 849-856.

[12] I. Ziari, G. Ledwich, A. Ghosh, D. Cornforth and M. Wishart. Optimal allocation and sizing of DGs in distribution networks. Proc of IEEE Power and energy society general meeting. 2010:1-8.

[13] R.M. Kamel and B. Karmanshahi. Optimal size and location of DGs for minimizing power losses in a primary distribution network. Transaction on Computer Science and Electrical and Electronics Engineering. 2009, 16 (2): 137-144.

[14] S.Sathiya, Dr.K.Sundararaju,N.Thenmozhi Capacitor Situation In Distribution Systems For Real/Reactive Power Volume 118 No. 20 2018, 2403-2415

[15] D. Singh, D. Singh and K.S. Verma. Multi-objective optimization for DG planning with load models. IEEE Transactions on Power Systems. 2009, 24 (1): 427-436.

[16] Thomas Ackermann, Göran Andersson, Lennart Söder, Distributed generation: a definition, Electric Power Systems Research, Volume 57, Issue 3, 20 April 2001, Pages 195-204

[17] D.P. Kothari and J.S. Dhillon," Load flow studies", in power system optimization, 2nd ed. New Delhi, India: PHI, 2012, pp. 12-134.

[18] R.P. Payasi, A.K. Singh and D. Singh" Planning of different types of distributed generation with seasonal mixed load models" IJEST Vol. 4, No. 1, 2012, pp. 112-124

[19] J. Kennedy, R. Eberhart, " Particle Swarm optimizer," IEEE International Conference on Neural Networks (Perth, Australia), IEEE Service Center Piscataway, NJ, IV, 1995, pp1942-1984

[20] K.Umamaheswari,Dr.V.Venkatachalam "Optimal Power Factor Correction Controller for Single Stage Power Converter", International Journal of Applied Engineering Research (IJAER) ISSN 0973-4562 Volume 9, Number 23 (2014) pp. 21473-21499

[21] Gokulakrishnan, B., Govindaraj, T. Design and implementation of neuro fuzzy based STATCOM controller for improving power quality (2016) International Conference on Electrical, Electronics, and Optimization Techniques, ICEEOT 2016, art. no. 7754754, pp. 613-618. DOI: 10.1109/ICEEOT.2016.7754754