Middle-East Journal of Scientific Research 23 (6): 1127-1136, 2015
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2015.23.06.22209

GA Implemented for Distribution Generation Parameters in Ieee and Indian Utility System

[1]C. Nayanatara, [2]J. Baskaran and [3]D.P. Kothari

[1]Research Scholar, Sri Sai Ram Engineering College
[2]Adhiparasakthi Engineering College, India
[3]Director - Research, MVSR Engineering College, Hyderabad, India

Abstract: The introduction of Distributed Generation (DG) devices for power system improves the stability, reduction in losses and increase in the cost of generation. In this paper Genetic Algorithm (GA) is used to optimize the various parameters. The various parameters taken into consideration are their type, location and size of the DG devices. The simulation was performed on a distribution system with various types of DG's and modelled for steady state studies. The optimizations results are simulated using GA. The results reveal the benefits of the proposed method, for solving simultaneous optimization problems of DG devices in a power system network.

Key words: Distributed Generation · Genetic Algorithm · Customer Benefit · Congestion · Power Loss · Location · Size

INTRODUCTION

DG means a small-scale power station for the need for satisfying local load different from a traditional or large Central power plant. Right from traditional to non traditional there are various methodologies used in the application of DG. The DG introductions have technical merits in fuel cells, photovoltaic, biomass, wind, geothermal and gas turbine. It includes voltage profile improvement, loss reduction and improves system reliability.

In a highly congested area the benefit of DG is more predominant. The location of DG should be carried out considering its size and location. The placement should be optimal in order for maximum customer benefit and minimum congestion of DG implemented in the network. The improper placement will lead to reduction in system losses and sometimes it may even collapse the entire system.

The two broad paradigms for maximizing welfare is cost free and none cost free methods. The marginal cost involved is nominal (not capital cost) in the former method. The later method includes generation rescheduling and prioritization and curtailment of loads/Transactions. This paper takes the objective of all possible four cases and the results obtained are analysed by GA and MGA.

The benefits of DGs in power system are justified by numerous techniques.. The location of DG placement on the basis of Location Marginal Pricing (LMP) is proposed by (Wang & Nehir 2004) [1]. The investment planning strategy was given by (Zareipour *et al.,* 2004) [2]. The optimization technique GA for placement of DG to reduce the losses. (Celli & Pilo 2001) [3] have used a penetration level assessment for the placement of DG. Modelling of different DG units based on power flow studies by using backward/forward algorithm is proposed by (Moghadass *et al*., 2009) [4]. Modelling of distributed generations in a three phase distributed load flow and modelling of wind farms is derived from (Ackermann T. *et al*., 2001) [5].

The objective of this paper is to develop an algorithm for finding and choosing the optimal location of DG devices, for power loss reduction, which relieves congestion and customer benefit maximization, based on Generation rescheduling, load curtailment and with generation rescheduling with load curtailment with DG devices. Placing the DG devices of various types in

Corresponding Author: C. Nayanatara, Research Scholar, Sri Sai Ram Engineering College, India.

various locations has multiple advantages. For the proposed objective function simultaneous optimization of location and size is determined. The problem is analysed by GA and MGA (Baskaran & Palanisamy 2006) [6, 7]. The simulated result are analysed with four cases in which effectiveness is also justified among all methods.

Rest of the paper is organized as follows: mathematical expressions for finding optimal sizes and location are discussed in Section 2. Section 3 represents the objectives of distributed generation planning with problem formulation. Section 4 presents GA implementation for optimal sizing of DG and Section 5 gives simulation studies and numerical results obtained. The contributions and conclusions are summarized in Section6.

Mathematical Modelling of DG Devices

DG Devices: The DG size is very important for placing in a particular bus as the losses are decreased to a minimum value and starts increasing above the size of DG (i.e. the optimal DG size) at that location [5]. The increase in size leads to maximize the losses value and it may overshoot the losses of the base case. The proper location of DG plays an important role in minimizing the losses, maximizing the customer benefit and minimizing the voltage deviation index. The modelling of DG is very important to achieve the objective.

The Unity power factor modelling is done in PV cell, wind as a variable reactive model and gas turbine is modelled as a constant voltage model. A DG source has a constraint and it can be formulated as.

$$P_G^{min} \leq P_G \leq P_G^{max}$$

Considering the output with reactive power of the DG, as it plays a major role, the bus connected to the DG can be modelled in three major cases [8-20] based on their characteristics in terms of real and reactive power delivering capability as follows:

- Case 1: Real Power injection by DG
- Case 2: Reactive Power injection by DG
- Case 3: Real Power injection but Reactive Power consumption by DG.

The primary energy of DG may be injected to grid by a synchronous or asynchronous electric machine which is directly connected to the grid or by means of power electronic interface or a combination of electric machine and power electronic interface. The modeling of different DGs is done as follows:

Modelling of PV Cell: The conversion of solar Energy into Electrical energy is done by PV system. Their DC power output is converted via an inverter into AC power so that it is compatible with grid. The DG model depends on control circuit and in general it is designed to control P and V independently it is modelled as a PV node. When P and Q are controlled independently it is modelled as a PQ node.

The power factor is unity and the necessary condition for minimum loss is given by equation 2.

$$P_i = P_{DGi} - P_{Di} = \frac{1}{A_{ij}} \sum_{\substack{j\neq 1 \\ j\neq i}}^{n} [(A_{ij})P_j - B_{ij}Q_j) \quad (1)$$

From the above equation we obtain the following relationship

$$P_{DGi} = P_{Di} - \frac{1}{A_{ij}} \sum_{\substack{j\neq 1 \\ j\neq i}}^{n} [(A_{ij})P_j - B_{ij}Q_j) \quad (2)$$

A_{im} and B_{ij} = loss coefficients.
P_j = real power injected to bus j
Q_j = reactive power injected to bus j
N = number of buses

Synchronous Compensators Such as Gas Turbines: The type 2 Dg has synchronous condenser and it supply only reactive power to improve voltage profile. The optimal DG placement is determined by differentiating the loss equation on either side with respect to Q_i. The power factor for type 2 will be zero and the optimal DG size for every bus in the system is given by equation 3.

$$Q_{DGi} = Q_{Di} - \frac{1}{A_{ij}} \sum_{\substack{j\neq 1 \\ j\neq i}}^{n} [(A_{ij})Q_j - B_{ij}P_j] \quad (3)$$

Modelling of Wind Turbine: In an induction generator both active and reactive powers are functions of slip.

$$P = P\ (V, s)$$
$$Q = Q\ (V, s) \quad (4)$$

where P and Q are the active and reactive produced, the induction generator slip is denoted by‘s’ and the bus voltage is ‘V’. Assuming the dependency of Q is very low and P is constant the expression (5) can be reduced as follows:

$P = P_s$ = constant
Q = f (V)

$$Q = \sqrt{(E_q|X_d)} - P^2 - \frac{V^2}{X_d} \quad (5)$$

No load voltage Eq is maintained constant and X_d is the synchronous reactance and V is the generator terminal voltage. The parameters of wind turbine include cut-in wind speed and rated wind speed and typical values of them are 3.5m/s, 25m/s and 14m/s.

$$P_{wind}(t) = 0.5\alpha\rho(t) A v(t)^2 \quad (6)$$

where α is the Albert Betz constant, ρ(t) is air density, A is area swept by turbine rotor and v(t) is the wind speed. Maximum power rating of wind station is fixed by taking averages of all day powers calculated by using the equation. For this type of DG the power factor varies between 0 to 1. The maximum DG capacity for renewable DGs like Solar and Wind is calculated from the average power estimated by irradiance and wind speed. The average power generated by the wind turbine is 0.471p.u [10].

Objectives of Distributed Generation Planning

Social Welfare Maximization: The task if independent system operator is to improve the maximum welfare and it is the difference between the benefit to consumers and the total generation cost of production. The schedule has to be developed to set the generation level in order to obtain an economic objective function.

The objective function is formulated as a difference between the quadratic benefit curve submitted by the buyer (DISCO) and quadratic bid curve supplied by seller (GENCO) minus the quadratic cost function supplied by DG owner.

$$Max\ TSW = \sum_{i=1}^{ND}(d_i P_{Di}^2 + e_i P_{Di} + f_i) - \sum_{j=1}^{NG}(a_j P_{Gj}^2 + b_j P_{Gj} + c_j) - \sum_{k=1}^{NG}(g_k P_{DGk}^2 + h_k P_{DGk} + l_k) \quad (7)$$

Subject to operational constraints, such as real and reactive power balance, voltage profile limits and the power flow limits. The objective function represents the Total Social Welfare (TSW).

P_{gj} and P_{DGK} are the active power output of generator and Distributed generator K,
a_j, b_j; c_j;g_k h_k and l_k are the cost coefficients.

The system considers the demand of ith customer P_{Di} term with energy benefit coefficients d; e;$_i$ and f $_i$ representing demand elasticity. ND and NG are the number of demands and generators, respectively. Therefore, the above equation maximizes the difference between total benefit and total cost (i.e. social welfare)

Equality Constraints: The modelling of transmission network is done by balancing the power equation at each node in the network.

$P_i = P_{gi} + P_{DGi} - P_{di}$
$Q_i = Q_{gi} - Q_{Di}$

Inequality Constraints: Generation limits. Generating limits are specified as upper and lower limits for the real and reactive power outputs.

Real power generation limits:

$$P_{Gi}^{min} \leq P_{Gi} \leq P_{Gi}^{max}$$

Reactive power generation limits:

$$Q_{Gi}^{min} \leq Q_{Gi} \leq Q_{Gi}^{max}$$

Line Flow Limit: The constraint validates for the absolute power flow both at sending and receiving ends of particular line to be within the upper limit of the line.

$$S_{ij} \leq S_{ij}^{max}$$

$$S_{ji} \leq S_{ji}^{max}$$

Bus Voltage Limit: Voltage limits refer to bus voltage to remain within an allowable narrow range of levels.

$$V_i^{min} \leq V_i \leq V_i^{max}$$

For base case OPF,

$P_{DGi} = 0$

For load bus,

$P_{gi} = 0$

where,

N = total number of buses in the system;
P_{Gi} = total real power generated at bus i;
P_{Di} = total real power demand at bus i;
P_{DGi} = the power supplied by the DG at bus i.
V_i = the voltage at bus i;
δi = the power angle at bus i;
Bij & Gij = the susceptance and the conductance of the line ij;
Q_{gi} = reactive power generated at bus i;
P_{Gi}^{max} and P_{Gi}^{min} = upper and lower real power generation limits of generator at bus i;
Q_{Gi}^{max} and Q_{gi}^{min} = upper and lower reactive power generation limits of generator at bus i;
V_i^{max} and V_i^{min} = upper and lower limits of voltage at busi;
S_{ij} & S_{ji} = the complex power transfer from bus i to bus jand from bus j to bus i;

The bus having the maximum customer benefit and minimum cost will be the optimum location of DG [11].

Loss Minimization: The Optimal allocation of distributed Generation includes planning to obtain maximum benefit by minimizing total real power loss in the system (Elgerd, 1971). The loss in the system is the total energy management which can be calculated using the below equation.

$$P_L = \sum_{i=1}^{N}\sum_{j=1}^{N}[\alpha_{ij}\ (P_iP_j + Q_iQ_j) + \beta_{ij}(Q_iP_j + P_iQ_j)] \quad (8)$$

$$where\ \alpha_{ij} = \frac{r_{ij}}{V_iV_j}\cos(\delta_i - \delta_j)$$

$$\beta_{ij} = \frac{r_{ij}}{V_iV_j}\sin(\delta_i - \delta_j)$$

$$Z_{ij} = r_{ij} + jx_{ij}$$

are the ij^{th} element of $[Z_{bus}]$ matrix.

$$\alpha_i = \frac{\partial P_L}{\partial P_i} = 2\ \alpha_{ii}\ P_i + 2\sum_{\substack{j=1\\ j\neq i}}^{n}[(\alpha_{ij})P_j - \beta_{ij}Q_j) \quad (9)$$

Sensitivity Index is evaluated at each bus by using the values obtained from the base case load flow. The bus having lowest loss sensitivity factor will be best location for the placement of DG.

Congestion Minimization: Congestion is the important factor that can affect power trade in the transmission network. If enough capacity is available on the transmission system, we can allocate the power supply and demand so as to maximize social welfare. As the margins of transmission capacity become scarce, there is a greater chance that the trade have to be altered because of congestion.

The CONgestion INDex(CONIND) is given by;

$$\text{CONIND} = \sum_{k\in B}\beta_k\ (P_k\ \div P_k^{max})^2 \quad (10)$$

where P_k is the active power flow on branch k and P_k^{max} is the capacity; B is the set of all branches. By minimizing the above equation, power flows can be kept away from congestion as much as possible. β_k ($0 \le \beta_k \le 1$) represents the weighting factor which varies between 0 to 1 that reflects the relative importance of the congestion in the network. At any instant transmission systems can fall into emergency operating conditions if a major fault occurs. The objective of congestion Index is to take action or control measures to relieve congestion of transmission networks. The bus having the minimum congestion percentage will be also the optimum location of DG.

GA Approach for Optimal Placement and SIZING OF DG: Heuristic methods may be used to solve complex optimization problems. Thus they are able to give a good solution of a certain problem in a reasonable computation time, but they do not assure to reach the global optimum. The GA's (Genetic Algorithm) start with random generation of initial population and then the selection, crossover and mutation are produced until the best population is found.

A Genetic Algorithm is based on global searches technique and the mechanisms of natural selection and techniques. The disadvantage of GAs is the high processing time consumption due to their evolutionary concept, due to their evolutionary concept, based on random processes that cause the algorithm to be quite slow. In general a MGA can work with small populations (nearly 5 to 10 individuals) and this reduces the processing time. The frequent reproductions occurring inside a small population, where the desirable genetic characteristics emerges quickly, also avoid the mutation process because after a certain number of generations, the best chromosomes are maintained and the remaining ones are randomly selected generated ones. Accordingly, some numbers of individuals are selected for such a group. Then the grouping is repeated and individuals are selected to form couples to begin the crossover [21].

Objective Function: The main objective of this paper is to study the effect of placing and sizing the DG in all system indices. Multi objective optimization is performed by combining the all indices with appropriate weights. The Objective Function is given as

$$F\ (Min) = (W_{1*}PL + W_2{*}TSW + W3{*}CONIND) \quad (11)$$

Subjected to the constraint

$$\sum_{k=1}^{2} W_K = 1$$

where $W_k \in [0,1]$

The weights are indicated to give the corresponding importance to each impact indices for the penetration of DGs. In this analysis Total Social Welfare (TSW) and Power Loss (PL) is given equal weight of 0.5.

Encoding: The main objective of the optimization is to find the best locations for the given number of DG devices within the defined constraints. The configuration of DG device is obtained by three parameters: the location of the devices, their types and their rated values. Each individual is represented by N_{DG} number of strings, i.e. and number of DG devices to be used for this optimization problem.

The first values of each string indicate the location information i.e., the node in which the DG should be connected and can take values from 1 to number of load buses in the network [22].

The second value of the string represents the type of the device. PV Cell for 1Wind Turbine for 2 Gas turbine for 3 and zero for no device is connected.

The last value represents the DG size and can take values from 0 to 10MW.

Initial Population: The initial population is generated from the following parameters. [N_{DG} is the number of DG devices to be located, the possible location of the devices i.e., $N_{location,}$ types of the devices i.e., N_{types}.

The first, a set of N_{DG} number of strings are produced. For each string the first value is randomly chosen from the possible locations $N_{location}$.

The second value, which represents the types of DG devices, is obtained by randomly drawing numbers among the selected devices.

The third value of each string, which contains the rated values of the DG devices, is randomly selected between +1 and -1. To obtain the entire initial population, the above operations are repeated N_{ind} times. The objective function is computed for every individuals of the population.

The objective function is defined in order to quantify the impact of DG devices on the state of power system network. The inverse of the objective function is used to compute the fitness value of each individual in the population.

Fitness = 1/Objective function + 1

Reproduction: The biased Roulette wheel selection is used in this paper for reproduction, according to their fitness values; the individual is selected to move to a new generation.

Crossover: Crossover is a technique which is used to rearrange the information between the two different individuals and produce new one. The crossover is applied in each successive generation with a certain probability, known as the crossover fraction or rate. A large crossover rate decreases the population diversity, but in this problem a higher exchange of genetic material is needed. In this paper two point crossovers is employed and the probability (P_C) of the crossover is 0.75.

Mutation: The mutation rate is highly connected with the crossover fraction. The mutation mechanism used in this study implies generating a random gene number and flipping the bit found at that position. Mutation is used to random alteration of bits of string position. The probability of mutation is less than 0.05.

Simulation Results: The power flow studies are carried out with the help of VC++ software package. The modified distribution system which has 30 nodes and 32 segments is used to verify the effectiveness of the proposed algorithm. It is assumed that all the loads are fed from the substation located at node1. It consists of 30 buses, totalling 4.43MW of real power and 2.73 MVAR of reactive power loads respectively. The initial value of $n_{DG,}$ which indicate the number of DG devices to be simulated, is defined as: PV cell is 1, Wind Turbine is 2 and Gas Turbine is 3. In the proposed optimization study for considering the power system network, the different types of DG device and their optimal locations allow maximization in customer benefit and reduction in losses. Also the buses which have different voltage ranges are tabulated in Table 1.

Table 1: Voltage deviation table with and without DG

S.No	Voltage Range (p.u)	Total Number of Buses (Bus Number) Without DG	With DG
1	0.51-0.64	4(3,6,15,29)	NIL
2	0.65-0.74	6(2,13,17,21,22,28)	NIL
3	0.75-0.84	7(1,5,8,9,11,2325)	NIL
4	0.85-0.95	9(7,12,16,18,19,24,26,27,30)	02(4,13)
5	0.95-1.05	4(4,10,14,20)	25(1,2,3,5,6,7,8,9,10,12,14,15,16,17,19,20,21,22,23, 24,25,26,28,29,30)
6	1.05-1.1	NIL	3(11,18,27)

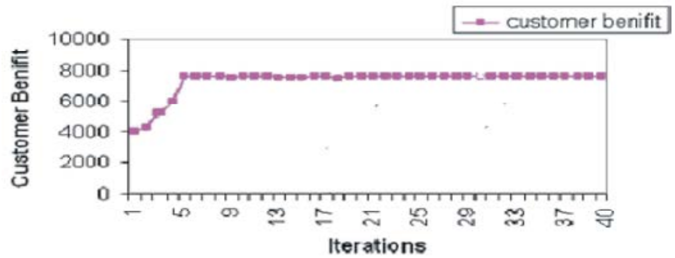

Fig. 1: Iteration (vs.) customer benefit

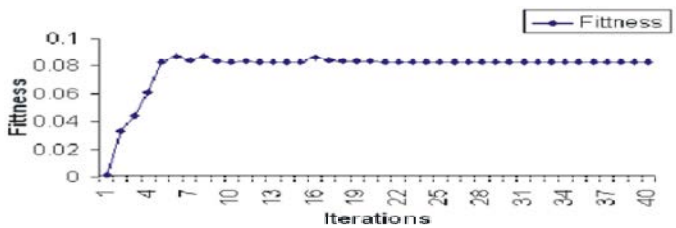

Fig. 2: Iteration (vs.) Fitness

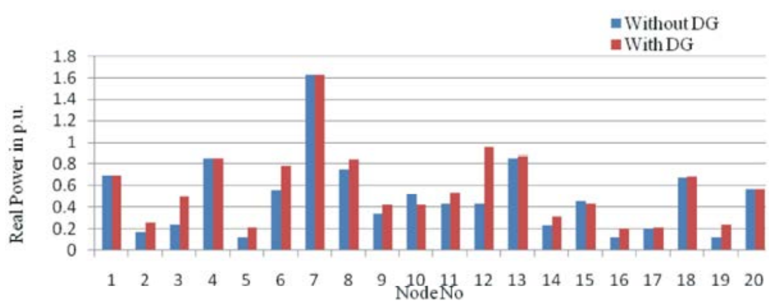

Fig. 3: Normal loading conditions with and without DG

The convergence characteristic of fitness function is shown in Fig. 1 and 2. It is seen that the convergence function converges smoothly to the optimum value without any abrupt oscillations. This shows the convergence reliability of the proposed algorithm. From the graph it can also be inferred that the customer benefit becomes almost constant after some iterations.

The location of DG device in various lines is simulated using GA, MGA and FSA and the rated value for PV cell/wind turbine/gas turbine is automatically chosen and the corresponding increase in Total Social Welfare and the reduction in loss are also tabulated in Table 2. The solutions found by the simulated annealing clearly indicate more locations; also the power loss reduction and welfare maximization is efficient

The given load data are taken as 100% loading conditions and the loading capability with and without DG is analysed and it is given in Fig. 3. The loading capability is increased to twice the normal loading condition and the real power flows in various lines is given in Fig. 4.

The Power loss with and without DG for different loading conditions is tabulated in Table 2 and the optimal corresponding size of the DG is also indicated. The bus number and the corresponding DG size and real power loss is given in Fig. 5.

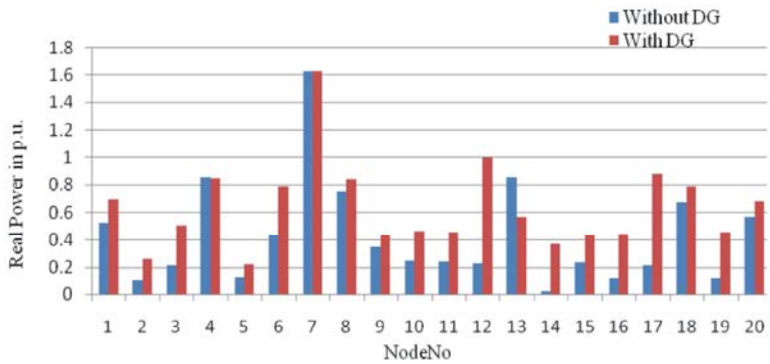

Fig. 4: Twice the Normal loading condition with and without DG

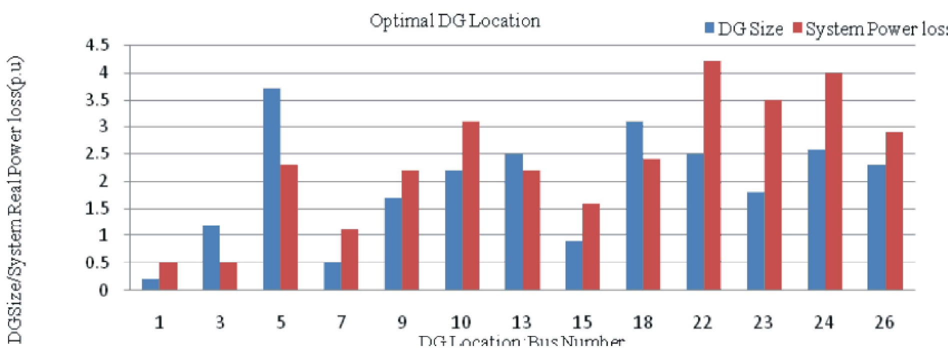

Fig. 5: Loss with DG size

Table 3: Loss with loading conditions

Types of load	Bus location	Optimal DG Size(p.u)	Power loss with DG	Power loss without DG
Peak Load	12	0.68	7.32	11.43
Medium Load	7	0.47	5.21	8.56
Low Load	21	0.13	2.56	4.89

Table 4: Optimization of DG Parameters

GA					
Line	Device	Rated value in MW	TSW (in %)↑	Power Loss (in %)↓	Congestion (in %)↓
1	3	3.16	2.8	1.1	
2	2	2.98	3.7	5.45	
4	1	3.34	9.67	56.89	
7	3	2.6	13.74	0.61	
9	2	1.6	12.89	5.87	
15	2	2.1	17.89	17.67	
16	3	1.98	12.78	11.89	
18	2	2.72	25.87	6.78	
21	3	2.1	13.89	7.99	
22	1	3.76	9.78	32.97	
23	1	3.98	8.43	41.27	
28	3	3.1	33.89	82.89	

Table 5: Generation cost and real power for 4 cases

Case studies	Load Increased	Generation Cost in ($/hr)	Real Power loss in MVA
Case (i)	130%	983.67	16.78
Case (ii)	150%	985.23	23.89
Case (iii)	150%	984.89	19.27
Case (iv)	155%	988.78	28.11

Table 6: Generation Rescheduling (140↑)

Bus No	GA
Total Generation (MW)	283.39
Total Load (MW)	278.67
Loss (MVA)	32.56
Time (sec)	0.56
Objective Function	982.07

Table 7: Generation rescheduling with DG Devices (150↑)

Bus No	GA
Total Generation (MW)	267.73
Total Load (MW)	262.21
Loss (MVA)	15.72
Time (sec)	0.11
Objective Function	874.32

Table 8: Generation rescheduling with load Shedding (155↑)

Bus No	GA
Total Generation (MW)	271.74
Total Load (MW)	269.02
Loss (MVA)	19.88
Time (sec)	0.13
Objective Function	949.21

Table 9: Generation rescheduling with load shedding and DG Devices (155↑)

Bus No	GA
Total Generation (MW)	288.12
Total Load (MW)	285.33
Loss (MVA)	21.63
Time (sec)	0.14
Objective Function	996.57

The location of DG device in various lines is simulated using GA and the rated value for PV cell/wind turbine/gas turbine is automatically chosen and the corresponding increase in Total Social Welfare, reduction in loss and congestion minimization are also tabulated in Table 3. The results reveal that the close proxity of the results obtained by two methods. But comparatively GA gives more number of lines and better than MGA.

IEEE 30 bus system and for Indian NTPS system are considered as a test system in this work and on comparing both there is not much difference in the accuracy of the result and on a closer look into them Simulated annealing outperforms the GA. The following case studies are addressed for both the test cases.

Case (i) Generation Rescheduling (140 ↑)
Case (ii) Generation Rescheduling with DG Devices (150 ↑)
Case (iii) Generation Rescheduling with load shedding (155 ↑)
Case (iv) Generation Rescheduling with load shedding and DG Devices (155 ↑)

IEEE30 Bus System: The table below indicates the Generation cost and Real Power Loss for different case studies and the comparison is done with three methods and it is tabulated in Table 4.

The result below gives the total generation, total load, loss, objective function and the corresponding time taken for the simulation is indicated. It is observed that FSA takes lesser converging time than GA.

Indian Ytility-NTPS23 Bus System: The Indian utility Neyveli Thermal Power Station (NTPS)-23 bus test system is shown in Figure. A 100 MVA. 400 KV base is chosen. All the case studies are analysed.

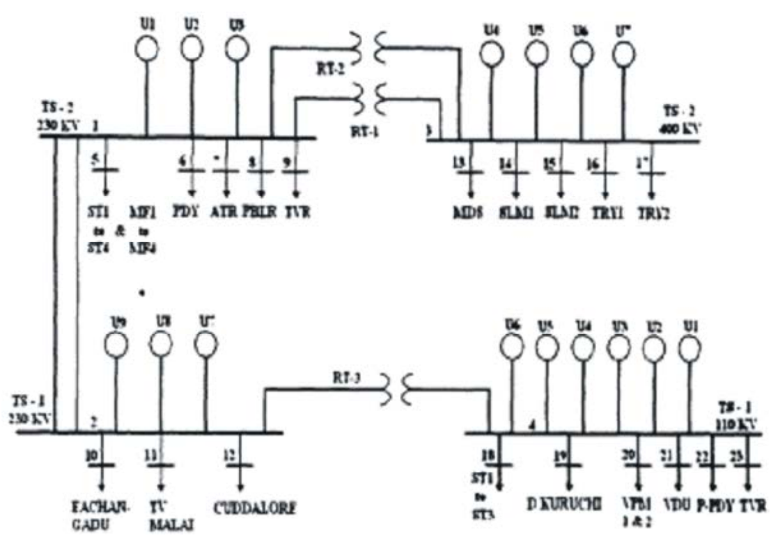

Table 10: Generation cost and real power for 4 cases

Case studies	Load Increased	Generation Cost in ($/hr)	Real Power loss in MVA
Case (i)	130%	643.56	16.78
Case (ii)	150%	665.78	23.89
Case (iii)	150%	672.41	19.27
Case (iv)	155%	643.34	28.11

Table 11: Generation Rescheduling (140↑)

Bus No	GA
Total Generation(MW)	225.78.
Total Load(MW)	222.78
Loss(MVA)	6.89
Time(sec)	0.18
Objective Function	1087.99

Table 12: Generation rescheduling with DG Devices(150↑)

Bus No	GA
Total Generation(MW)	278.45
Total Load(MW)	234.99
Loss(MVA)	41.78
Time(sec)	0.57
Objective Function	1789.08

Table 13: Generation rescheduling with devices (155↑)

Bus No	GA
Total Generation(MW)	298.67
Total Load(MW)	278.90
Loss(MVA)	20.198
Time(sec)	0.12
Objective Function	1044.879

Table 14: Generation rescheduling with load shedding and DG load Shedding (155↑)

Bus No	GA
Total Generation(MW)	268.97
Total Load(MW)	263.53
Loss(MVA)	19.78
Time(sec)	0.19
Objective Function	2018.99

The result below gives the total generation, total load, loss, objective function and the corresponding time taken for the simulation is indicated. It is observed that FSA takes lesser converging time than GA. Also all the cases are addressed separately and the total load and loss and the objective function are simulated using VC++ software for GA The results indicate the superiority of GA in terms all aspects.

CONCLUSION

In this paper, a proposed method is found to be more efficient for solving for the locations of a given number of DG devices in a power system. Three different types of DG devices are simulated for energy management: PV, wind and Gas Turbine. A sample 30 bus distribution system has been tested and also an Indian utility system has been taken for consideration for Customer benefit maximization and loss minimization in which significant improvement in the system performance is justified. Furthermore, the location of DG devices, their types and rated values are optimized for different loading conditions simultaneously by Genetic Algorithm.

The reduction of overall system real power loss and increase in customer benefit significantly improves the system performance. The comparison reveals the GA superiority over as there is a reduction in the search space and in the execution time; also it changes to reach the global optimal location. This is suitable for searching for several possible solutions simultaneously.

This algorithm is an easy and practical method for the allocation of DG devices in large power system.

REFERENCES

1. Wang, C. and M.H. Nehrir, 2004. Analytical approaches for optimal placement for optimal placement of distributed generation sources in power systems, IEEE Trans Power Syst, 19(4): 2068-2076.
2. Zareipour, H., K. Bhattacharya and C.A. Canizares, 2004. Distributed generation: current status and challenges, IEEE Proceedings of NAPS.
3. Celli, G. and F. Pilo, 2001. Penetration level assessment of distributed allocation in MV distribution networks, in: 22nd IEEE PES International conference on Power Industry Computer Applications PICA 2001, Sydney, pp: 81-86.
4. Moghaddas, S.M. and Elahe Mashhour Tafreshi, 2009. Distributed generation modeling for power flow studies and a three phase unbalanced power flow solution for radial distribution systems considering distributed generation, Electric Power Systems Research, pp: 680-686.
5. Ackermann, T., G. Andersson and L. Soder, 2001. Distributed generation: A definition, Electr. Power Syst. Res., 57(3): 195-204.

6. Baskaran, J. and V. Palanisamy, 2006. Optimal location of FACTS device in a power system solved by Hybrid Approach, International Journal of Non Linear Analysis: Hybrid Systems and Applications, Elsevier Publication, 65(11): 2094-2102.
7. Baskaran, J. and V. Palanisamy, 2005. Optimal lacation of FACTS device in a power system network considering power loss using genetic algorithm, EE- Pubon Line Journal, pp: 7.
8. Chandrasekar Yammani, Sydulu Maheswarapu and Sailajakumari, 2012. Optimal placement of Multi DGs in distribution system with considering the DG bus available limits, Energy and Power, 2(1): 18-23.
9. Gautam, Durga and Nadarajah Mithulananthan, 2007. Optimal DG placement in deregulated electricity market. Electric Power Systems Res., 77: 1627-1636.
10. Elgerd, I.O., 1971. Electric Energy System Theory-An Introduction, McGraw-HillInc., New York.
11. Feijoo, A.E. and J. Cidras, 2000. Modeling of wind farms in the load flow analysis, IEEE Trans.Power Syst.
12. Gozel, T. and M.H. Hocaoglu, 2009. Än Analytical method for the sizing and sitting of distributed generators in radial system, Int. Journal of Electr. Power Syst. Res., 79: 912-918.
13. Ziari, Iman and Gerard Ledwich, 2012. Senior Member, IEEE, Arindam Ghosh, Fellow, IEEE and Glenn Platt,Integrated Distribution Systems Planning to Improve Reliability Under Load Growth, IEEE Transactions on Power Delivery, 27(2): 757.
14. Jabr, R.A. and B.C. Pal, 2009. Ordinal optimization approach for locating and sizing of distributed generation, IET Generation, Transmission and Distribution, 3(8): 713-723.
15. Khattam, W.E., K. Bhattacharya, Y. Hegazy and M.M.A. Salama, 2004. Optimal investment planning for distributed generation in a competitive Electricity market, IEEE Trans Power Syst., 19(4): 206-212.
16. Rau, N.S. and Y.H. Wan, 1994. Optimum location of resources in distributed planning, IEEE Trans Power Syst., 9(4): 2014-2020.
17. Shahidehpour, M., H. Yamin and Z. Li, 2002. Market Operations in Electric Power Systems, John Wiley & Sons, Inc.
18. Singh, R.K. and S.K Goswami., 2010. Optimum allocation of Distributed Generations based on Nodal pricing for profit, loss reduction and voltage improvement including voltage rise issue, International Journal of Electric Power and Energy Systems, 32(6): 637-644.
19. Zavadil, R., N. Miller and A. Ellis, 2005. Making connections, IEEE Power Energy Mag, 3(6): 26-37.
20. Zonkoly, A.M.E.I., 2011. Optimal placement of multi-distributed generation units including different load models using particle swarm optimization, IET Gener. Transm. Distrib, 5(7): 760-771.
21. Teng, J.H., Modelling distributed generations in three phase distributed load flow.
22. Akorde, M.F, H. Nizam, I. Aris and M.Z.A. AbKadir, 2011. A review of strategies for optimal placement of Distributed Generation in Power Distribution Systems, Research Journal of Applied Sciences, 5(2): 137-145.