LOCATION OF DG BASED ON SENSITIVITY FACTOR IN DEREGULATED ENVIRONMENT USING PSO ALGORITHM

DR.S.Venkatesan
Department of EEE
K.L.N College of Engineering
Madurai
svneee@gmail.com

V.Angelin Hephzibah
Department Of EEE
K.L.N College of Engineering
Madurai
angelinhephzibah71994@gmail.com

***Abstract*—This paper is mainly to locate the DG based on Sensitivity factor using PSO algorithm .Particle Swarm Optimization (PSO) has became one of the most popular optimization methods in the domain of Swarm Intelligence. Many PSO algorithms have been proposed for distributed generations (DGs) deployed into grids for power delivery and reliability to consumers .The Objective of this paper is to obtain the location of DG based on sensitivity factor which has been taken into account of congestion relief and to maximize the Social Welfare and to minimize the loss and this is to enhance the efficiency of competitive wholesale energy market. The proposed method is illustrated by IEEE 30 bus system.**

Keywords—Matlab , Linear sensitivity factor , Distributed Generation , PSO algorithm , Social Welfare

I INTRODUCTION

In today's market based power system, the increased power exchanges among the market participants leads to intensive use of transmission system resulting in frequent congestion. Congestion constraints least expensive generation companies to serve the consumers. Under these circumstances, high cost generators need to be dispatched. Locational Marginal Pricing (LMP) is the incremental change in price in a bus in an electrical power system for a unit change in the demand at the same bus. Locational marginal pricing reflects the value of the energy at the specific location and time it is delivered. LMP consists of three components: generation marginal cost, cost of transmission congestion, and losses. LMP tends to attain higher value in areas under congestion. The declines in the costs of small-scale electricity generation brought by technological innovations coupled with shifts in fuel price, automation and control, the changing economic and regulatory environment have resulted in a renewed interest in distributed generation (DG) [3]

Distributed generation (DGs) is going to play a major Role in power systems worldwide .The importance of DGs in future smart grids increases considering the fact that DGs will have a role in system security, reliability, efficiency and quality[2,4]. Installation of DGs directly close to the load can help to relieve the transmission congestion which in turn reduces the congestion component of LMP.[1] Since, distributed generation can also be expensive; they must be optimally placed in the network[5].

There are different methods to minimize the power loss like DG placement, capacitor placement, load balancing etc.. The distributed generation has been defined by many researchers but in general a distributed generation is nothing but a small generator which is connected at the consumer terminal [6]. Placement of DG is an important factor because improper location may cause power loss. DGs capability can be used to clear voltage stability problems, as a cause of the most recent blackouts. Considering that most DGs are located at the distribution level, determination of the best locations for installing DGs to maximize their benefits is very important in system design and expansion [7]. The optimal size and an effective methodology to identify the corresponding optimum location for multiple DG placements for minimizing the total power losses in primary distribution systems. These are based on the exact loss formula and loss sensitivity factor and voltage deviation index [8]. DG installation at non- optimal places can lead to increase in system losses which imply increase in costs and hence having a negative impact opposite to the desired. It is solved by the optimal distributed generation placement problem in radial distribution systems with the objectives to reduce annual energy losses and node voltage deviations[9]. A wide number of loads are addressed by Distributed Generators and have better efficiency . DG is assumed to participate in real time wholesale electricity market. The problem of optimal placement, including size, is formulated for two different objectives, namely, social welfare maximization and profit maximization technology based on IEEE 30 bus system [10, 12]

Active power loss minimization plays a very vital role in increasing the efficiency of power system. Numerous methods are there for minimization of active power loss in radial distribution using PSO [13]. The optimal planning i.e. optimal location and sizing of distributed generation. The system overall generating cost and the nodal price are more economical. Also the reduction in losses (active and reactive power loss) and the improvement in overall performance are more effective than the other's work which is given in the results using 30-bus radial system [11].

II. DISTRIBUTED GENERATION

In order to meet the very increasing demand in the deregulated and restructured power system, with the constraints on new generation plants and transmission lines, distributed generation(DG) has emerged as an efficient alternative .Changed government policies and increased availability of small capacity generation technologies are supporting the increased development of distributed generation. Integration of DG in distribution system provides significant benefits to the system such as voltage support, loss reduction, transmission and distribution capacity release and improved system reliability .

Traditional distribution systems are designed to operate with unidirectional power flow i.e. .from source to load .integration of DG in distribution system alters the power flow and imposes a different set of operating conditions on the network. This may lead to problems such as reverse power flow, voltage rise, increased fault levels and instability .Before placement of DG ,it has to be ensured that the size and location have to be proper .it has been observed that the installations of DGs of improper size at non optimal [places may result in increased system losses and overall cost thereby nullifying the very purpose of connecting it to the system This underlines the importance of optimal placement of DG allocation.

However selection of the best places for installations and the size of the DG units in large distribution system is a complex combinatorial optimization problem and can be interpreted as a mixed integer nonlinear optimization problem .Solution criteria or objectives vary from one application from another and are also subjected to different constraints complexity of optimization problem Increases. Though loss minimization voltage profile improvement are the objectives which have been mostly reported in the literatures shows some of the various objectives of DG placement and sizing which have been considered in different studies in the literature.

There are several different types of resources and technologies that can be such as wind ,solar, fuel cells hydrogen and biomass .The power flow models of DG's vary with types of DGs. DGs are generally categorized as five typed of DGs as follows:

Type 1: DGs supplying real power only

Certain types of DGs will produce real power only. For example, photovolatic systems convert solar energy into electricity giving DC power output.

Type 2: DGs supplying reactive power only

For DG such as a synchronous condenser, it provides only reactive power to improve network conditions.

Type 3: DGs supplying real power and consuming reactive power

Here the work consider that the DG will supply real power and in turn absorb reactive power. In case of the wind turbines, induction generator is used to produce real power and reactive power gets consumed in the process.

Type 4: DGs supplying real power and reactive power

With the use of interfacing power, DGs like fuel cell, current controlled photovolatic produces both real and reactive power. Synchronous is also used to produce real and reactive power.

Type 5: DGs regulating the bus voltage

In case of micro turbine DGs, the voltage at the bus to which DG is connected will always be fixed. Real power injected by the DG will be found and required reactive power to support the bus voltage will be provided via power electronic interface devices.

Depending upon the types, DG can be modeled as PQ or PV node in power flow studies. DG modeled as PQ node is incorporated as negative PQ load in the power flow solution. At the end of each iteration in the power flow, the injected reactive power at PV nodes is updated as follows:

$$Q_{i+1} = Q_i + \Delta Q \qquad (1)$$

Where I is the iteration count

$$\Delta Q = X^{-1} \Delta V \qquad (2)$$

Where X is the n ✕ n positive sequence reactance matrix corresponds to PV nodes and n is the number of the nodes. The diagonal element x_{ii} is the sum of positive sequence reactance of all line sections between PV node i and the root node. The off diagonal elements x_{ij} are calculated as former but for the sharing path between two nodes and root node. ΔQ is then n ✕ 1 power injections vector correspond to unconverged PV nodes. This repeated until convergence is achieved.

III. PROBLEM FORMULATION

The objective function is then to maximize the total social welfare (TSW) which also equals to minimize the total social cost. Depending upon the number of goals to be achieved satisfying the operating constraints, the optimization problem can exhibit in one of the two forms namely single objective optimization problem and multi objective problem.

Maximize the Cost Function is given by,

$$\max \sum_{i=1}^{N} B_i(P_{Di}) - C_i(P_{Gi}) - C(P_{DGi}) \qquad (3)$$

Alternatively, the maximization problem can be formulated as a minimization problem with multiplying the objective function by -1.

$$\min \sum_{i=1}^{N} C_i(P_{Di}) - B_i(P_{Di}) + C(P_{DGi}) \qquad (4)$$

Where,

P_{Di} = The real power Demand at bus i

P_{Gi} =The real power generated at bus i

P_{DGi} = The power supplied by the DG at bus i

The Line Outage Distribution Factor is given by,

$$d_{l,k} = \frac{\Delta f_1}{f_k^0} \qquad (5)$$

Where,

$d_{l,k}$ =Line Outage distribution factor when monitoring line l after an outage on line k.

Δf = Change in MW flow on line.

f_k^0 = Original flow on line k.

The power on line l and line k, the flow on line l with link out can be determined using “d” factors.

$$\hat{f}_l = f_l^0 + d_{l,k} f_k^0 \qquad (6)$$

Where,

f_l^0 , f_k^0 = Preoutage flows on lines l and k

$\hat{f}_l$ = Flow on line l with k out

CONSTRAINTS:

The objective function is subjected to the following constraints.

1. Bus Voltage Limits:

It is well known that a small change in nodal voltage affects the flow of reactive power whereas active power practically does not change. Further, the operating voltage at each node must be in safety range as given below

$$V_{i\min} \le V_i \le V_{i\max} \qquad (7)$$

Where,

$V_{i\min}$ and $V_{i\max}$ = minimum and maximum voltage limits

V_i = Voltage at ith node.

2. Feeder Capacity Limits :

Power Flow in each branch must be less than or equal to its Maximum Capacity as given below

$$|I_i| \le I_{i\max} \qquad (8)$$

Where,

$I_{i\max}$ = Maximum Current Capacity

I_i = Current

3. Power Flow Equation:

Total active power generation must be equal to the sum of total active power losses and total active load. Similarly sum of the total reactive power generation

Must be equal to the sum of total reactive power losses and total reactive load as given by the following equations

$$\sum P_{i_{gen}} = P_L + \sum P_{i_{load}} \qquad (9)$$

$$\sum Q_{i_{gen}} = Q_L + \sum Q_{i_{load}} \qquad (10)$$

Where,

$\sum P_{i_{gen}}$ = Total Active Power Generation

$\sum Q_{i_{gen}}$ = Total Reactive Power Generation

P_L = Total Active Power Loss

Q_L = Total Reactive Power Loss

$\sum P_{i_{load}}$ = Total Active Load

$\sum Q_{i_{load}}$ = Total Reactive Load

ALGORITHM:

Step 1: Input line and bus data, and bus voltage limits.

Step 2: Calculate the loss using distribution load flow based on backward-forward sweep.

Step 3: Randomly generates an initial population (array) of particles with random positions and velocities on dimensions in the solution space. Set the iteration counter k = 0.

Step 4: For each particle if the bus voltage is within the limits, calculate the total loss using equation (1). Otherwise, that particle is infeasible.

Step 5: For each particle, compare its objective value with the individual best. If the objective value is lower than Pbest, set this value as the current Pbest, and record the corresponding particle position.

Step 6: Choose the particle associated with the minimum individual best Pbest of all particles, and set the value of this Pbest as the current overall best Gbest.

Step 7: Update the velocity and position of particle using equations (6) and (7) respectively.

Step 8: If the iteration number reaches the maximum limit, go to Step 9. Otherwise, set iteration index k = k + 1, and go back to Step 4.

Step 9: Print out the optimal solution to the target problem. The best position includes the optimal locations and size of DG, and the corresponding fitness value representing the minimum power loss.

The PSO algorithm is able to reach a good solution by finite steps of evolution steps performed on a finite set of possible solutions.

IV. SIMULATION RESULTS

The proposed method has been established on IEEE-30 bus system. The value of sensitivity factor at each bus is calculated by using the OPF formulation of the Newton Raphson Method to determine the optimal wheeling transaction. The OPF calculates the different electricity prices for different nodes in the network using the cost curve of supplier and buyer. Using multipliers lagrangian the nodal prices of the nonlinear equality constraints are obtained. The marginal cost provides relieve for the congestion.

IEEE 30 BUS SYSTEM:

The system used in this study is modified IEEE 30 bus system. It consists of 6 generators, 24 loads and 41 Transmission line. The generating units connected on buses are 2, 3, 5, 8, 11 and 13 with slack bus on node 1. The benefits of the bidder are the increasing function for the supplier bids and decreasing function for the customer bids.

The price difference indicates the active line constraints and losses in the transmission system. The independent power producers are located in specific nodes and the remaining buses are considered as load bus. The losses in the lines are neglected in the DCOPF and sensitivity factor values at each bus are equal. Although the DCOPF model could provide high level of power flow accuracy it has several other limitations.

CASE 1:

In this Case first consider the generator data, bus data, generator cost data and other power flow constraints of the IEEE 30 bus system. Generator Data consist of maximum and minimum value of generation and cost coefficient values. From the collected data run the OPF and obtain the DG values from it and then check out the tolerance limit. The inputs given to the OPF are generator and customer bids. The base case OPF evaluate the demand and prices at each node. Using the cost curve of supplier and buyer the base case OPF calculates the different electricity prices for different nodes in the network. The system is free from congestion for its base case which is checked by calculating complex power flow in transmission line using Newton-Raphson load flow method. The value of Sensitivity Factor is calculated at each node.

The Energy component is the same for all locations and equals to the system balance shadow price. At the reference bus, loss factor is zero and all shift factors is zero. This means that both loss and congestion components are always zero at the reference bus. As the result, the price at the reference bus always equals to the energy component: DG energy is equal to the DG reference. Congestion components equal zero for all locations if there are no binding constraints. The loss component is the marginal cost of additional losses caused by supplying an increment of load at the location. There is no overflow transmission line for the base due to the system is free from congestion. Table 1 show that the LMP value at each bus is nearly same indicating that the system is free from congestion.

Table 2 show that the Transmission lines overflow is zero for the base case. The Sensitivity factor calculation is repeated for every five minutes because load connected in the power system is dynamic. Here the objective function value is obtained as14911.360 $/hr for this base case.The load may increase or decrease causing the spatial difference of LMP to vary which is explained in case 2.

CASE 2:

The base case load is 283.4MW is then increased to 333.4MW by increasing the load at node 9. In this case congestion occurs due to load connected at bus 9. The overall cost of system also increases. Hence congestion value is calculated. Now the values differ at every node as the generator contributions to each bus varies. This change in values gives the economic signal indicating the spot of congestion. The negative value of Sensitivity Factor indicates that that node base lower demand compared to generation is present at that node. The higher value of LMP indicates that more generation is pressed by demand at that bus.

Table 2 Indicates that the bus number 10 has higher value of Sensitivity Factor to all other buses which highlights the highly congested spot in the IEEE 30 bus system. This highly congested spot is well suitable for the optimal IPP placement in order to relieve the congestion in the deregulated electricity market. In this case congestion occurs due to the load connected at bus 9 so that the Transmission line over flow will occur at the Line number 7 and 41. In the line number 7, 160 MW wants to be transferred from the sending bus number 4 to the ending bus number 6.Due to congestion there will be overflow and so that Instead of 160 MW there will be a flow of 174.9714 MW, there is additional flow of 14.9714 MW in the line number 7.Similarly in the line number 41 there will be an overflow of 9.6238 MW. Table 4 show that the overflow of Transmission line number 7 and 41 due to congestion.

TABLE 1: Base Case of Transmission line Overflow for IEEE 30 Bus System

Line no	Send bus	End bus	Line limits	Line flow	overflow
1.0000	1. 0000	2. 0000	130.0000	73.2006	0
2.0000	1. 0000	3. 0000	130.0000	33.0365	0
3.0000	2. 0000	4. 0000	65. 0000	17.3186	0
4.0000	3. 0000	4. 0000	130.0000	30.0218	0
5.0000	2. 0000	5. 0000	130.0000	51.8389	0
6.0000	2. 0000	6. 0000	65. 0000	22.6191	0
7.0000	4. 0000	6. 0000	90. 0000	28.5863	0
8.0000	5. 0000	7. 0000	70. 0000	22.6638	0
9.0000	6. 0000	7. 0000	130.0000	42.9269	0
10.0000	6. 0000	8. 0000	32. 0000	26.4534	0
11.0000	6. 0000	9. 0000	65. 0000	15.5655	0
12.0000	6. 0000	10.0000	32. 0000	4.3026	0
13.0000	9. 0000	11.0000	65. 0000	26.1090	0
14.0000	9. 0000	10.0000	65. 0000	11.0301	0
15.0000	4. 0000	12.0000	65. 0000	13.9284	0
16.0000	12. 0000	13.0000	65. 0000	30.7585	0
17.0000	12. 0000	14.0000	32. 0000	7.3696	0
18.0000	12. 0000	15.0000	32. 0000	15.6235	0
19.0000	12. 0000	16.0000	32. 0000	4.3092	0
20.0000	14. 0000	15.0000	16. 0000	1.0452	0
21.0000	16. 0000	17.0000	16. 0000	6.1108	0
22.0000	15. 0000	18.0000	16. 0000	2.1485	0
23.0000	18. 0000	19.0000	16. 0000	3.5362	0
24.0000	19. 0000	20.0000	32. 0000	13.0657	0
25.0000	10. 0000	20.0000	32. 0000	15.6548	0
26.0000	10. 0000	17.0000	32. 0000	15.5012	0
27.0000	10. 0000	21.0000	32. 0000	17.8405	0
28.0000	10. 0000	22.0000	32. 0000	7.8318	0
29.0000	21. 0000	22.0000	32. 0000	3.8282	0
30.0000	15. 0000	23.0000	16. 0000	7.0561	0
31.0000	22. 0000	24.0000	16. 0000	5.0239	0
32.0000	23. 0000	24.0000	16. 0000	2.7523	0
33.0000	24. 0000	25.0000	16. 0000	1.6359	0
34.0000	25. 0000	26.0000	16. 0000	1.7024	0
35.0000	25. 0000	27.0000	16. 0000	6.4649	0
36.0000	28. 0000	27.0000	65. 0000	20.7021	0
37.0000	27. 0000	29.0000	16. 0000	5.7348	0
38.0000	27. 0000	30.0000	16. 0000	6.0250	0
39.0000	29. 0000	30.0000	16. 0000	3.0280	0
40.0000	8. 0000	28.0000	32. 0000	0.8164	0
41.0000	6. 0000	28.0000	32. 0000	20.2295	0

TABLE 2: Transmission line overflow for IEEE 30 bus system after adding 20MW DG at bus number 9

Line No	Send Bus	End Bus	Line Limits	Line Flow	Overflow
1.0000	1. 0000	2. 0000	130. 0000	63.1717	0
2. 0000	1. 0000	3. 0000	130. 0000	27.0639	0
3. 0000	2. 0000	4. 0000	65. 0000	27.0639	0
4. 0000	3. 0000	4. 0000	130. 0000	15.0288	0
5. 0000	2. 0000	5. 0000	130. 0000	45.5235	0
6. 0000	2. 0000	6. 0000	65. 0000	40.6762	0
7. 0000	4. 0000	6. 0000	160. 0000	174.9714	14.9714
8. 0000	5. 0000	7. 0000	70. 0000	19.7976	0
9. 0000	6. 0000	7. 0000	130. 0000	116.7266	0
10.0000	6. 0000	8. 0000	62. 0000	58.3503	0
11.0000	6. 0000	9. 0000	85. 0000	52.7723	0
12.0000	6. 0000	10.0000	32. 0000	22.5804	0
13.0000	9. 0000	11.0000	65. 0000	27.3469	0
14.0000	9. 0000	10.0000	65. 0000	14.9008	0
15.0000	4. 0000	12.0000	65. 0000	14.5123	0
16.0000	12. 0000	13.0000	65. 0000	47.6785	0
17.0000	12. 0000	14.0000	32. 0000	8.8594	0
18.0000	12. 0000	15.0000	32. 0000	21.6334	0
19.0000	12. 0000	16.0000	32. 0000	15.6957	0
20.0000	14. 0000	15.0000	16. 0000	2.3239	0
21.0000	16. 0000	17.0000	16. 0000	12.1439	0
22.0000	15. 0000	18.0000	16. 0000	11.4853	0
23.0000	18. 0000	19.0000	16. 0000	8.3554	0
24.0000	19. 0000	20.0000	32. 0000	5.6703	0
25.0000	10. 0000	20.0000	32. 0000	7.2875	0
26.0000	10. 0000	17.0000	32. 0000	8.5025	0
27.0000	10. 0000	21.0000	32. 0000	16.5641	0
28.0000	10. 0000	22.0000	32. 0000	7.0553	0
29.0000	21. 0000	22.0000	32. 0000	5.5416	0
30.0000	15. 0000	23.0000	16. 0000	5.4971	0
31.0000	22. 0000	24.0000	16. 0000	4.8420	0
32.0000	23. 0000	24.0000	16. 0000	2.9271	0
33.0000	24. 0000	25.0000	16. 0000	11.3881	0
34.0000	25. 0000	26.0000	16. 0000	4.2653	0
35.0000	25. 0000	27.0000	16. 0000	14.3715	0
36.0000	28. 0000	27.0000	65. 0000	31.0286	0
37.0000	27. 0000	29.0000	90. 0000	29.6838	0
38.0000	27. 0000	30.0000	16. 0000	7.0910	0
39.0000	29. 0000	30.0000	19. 0000	17.9817	0
40.0000	8. 0000	28.0000	32. 0000	0.7126	0
41.0000	6. 0000	28.0000	110. 0000	119.6238	9.6238

Before line contingency the occurence of congestion is zero. The value of fuel cost is 768.330 ($/hr) and the social welfare is 14876.912 ($/hr) time taken by it is 0.3013sec.

After line contingency the occurrence of congestion is 5.0555MW this is done by removing the transmission is line. Now the value of fuel cost is 25586.932 ($/hr) and the value of social welfare is14872.912 ($/hr).

In order to remove the congestion , Distributed generation is added using sensitivity factor i.e line distribution outage factor .Now the congestion is removed and its value is zero and the value of social welfare is12665.23 ($/hr). The value of fuel cost is 500.021($/hr) .

*TABLE 3: shows the variations of congestion before and after adding DG***.**

Values	Before Line Contigency	After Line Contigency	After Adding DG using PSO Algorithm
Fuel cost	768.330 ($/hr)	25586.932($/hr)	500.021($/hr)
Social Welfare	14876.912($/hr)	14872.912($/hr)	12665.23 ($/hr)

V. CONCLUSION

The proposed method could specially identify the feasible transaction for the optimal placement of DG based on sensitivity factor using PSO algorithm and also maximize the social welfare using OPF with Newton Raphson load flow method. A sensitivity factor method related to congestion management has been used for DG allocation considering competitive nature. In this work the optimal allocation of DG has been computed to minimize the system loss. The sensitivity factor plays an important role in the deregulation electricity market. It also used to maintain the stable operation of transmission system without affect the buyers and sellers in the market. The location of DG at the higher node relieves the congestion. The Increase in DG values provides good signal for identifying the congested location and also provides the suitable location for DG which relieves the congestion and provides optimum wheeling transaction and Maximize the social welfare for bilateral transaction

ACKNOWLEDEGEMENT

The authors are grateful to the principal and management of K.L.N College of Engineering, Madurai, for providing all the facilities for the research work.

REFERENCE

[1] Pankaj Kumar Senior Member IEEE, Nikhil Gupta IEEE member, Anil Swarnkar IEEE, K.R Niazi IEEE (2014) “Discrete Particle Swarm Optimization for Optimal Distributed Generation placement distribution networks ” *IEEE TRANSACTIONS* vol .1, pp.4799-5141.

[2] J.Rajalakshmi, Dr.S.Durairaj (2016) “ Review on optimal Distributed Generation Placement using PSO Algorithm”*IEEE TRANSACTIONS* vol.978, No.1, pp.4673-6725.

[3] Nikhil Kumar ,V. Papiya Dutta ,Lexier (2010) “ Optimal Distributed Generation placement for Congestion mitigation and Social Welfare Maximization” *IEEE TRANSACTIONS* vol- 978 ,No.1 pp.4577-0419.

[4] A.Perizad ,A. Knazali ,M.Kalantar (2010) “Optimal Placement of Distributed Generation with Sensitivity Factor Considering voltage Stability and Losses indices” *IEEE TRANSACTIONS on Proceedings of ICEE* ,vol.978 No.1 ,pp.4244-6760.

[5] Madesh BM ,Dr.N.Kumar (2015) “Optimal Location and sizing Of Multiple Distributed Generation in Distribution System for Loss Reduction” proceedings on ISSN Vol-3,pp.2348-6734.

[6] Jagan Mohan ,T. Arul Dass Albert(2014) “Optimal Sizing and Sitting of Distributed Generators Using PSO guided Genetic Algorithm” *Advances in Computational Science and Technology*” Vol.10,pp. 709-720.

[7] Aashik Kumar BOHRE ,Dr.Ganga AGNITHOTRI ,Dr.Manisha DUKEY (2016) “The Optimal Planning of Distributed Generation using OPF and Butterfly –PSO (BF-PSO)” *Journal of Electrical Engineering*

[8] Punnet Sharma ,Jyotsna Mehra,Virendra Kumar (2014) “Line flow Analysis of IEEE bus System with the Load Sensitivity Factor”*International Journal of emerging Technique and Advances Engineering* Vol.4 ,pp.2250-2459.

[9] Lakshaya Bhat ,Anubhav Shrivastavar and Shivarudraswamy (2015) “Sensitivity Analysis for 14 bus System in a Distribution Networks with Distributed Generation” *Journal Of Electrical and Electronics Engineering* Vol.10,pp.21-27.

[10] T.Rambabu, P.Venkata Prasad (2014) “Optimal Placement and Sizing of Distributed Generation based on Power Stability Index in Radial Distribution System” *IEEE Transactions* Vol.973, No.1,pp.4799-4103.

[11] Priyanka Das (2015) “Optimal Sizing and Placement of Distributed Generation in a Radial Distribution System using Loss Sensitivity Factor and Firefly Algorithm” *International Journal of Scientific and Research and Management* Vol.3, pp.2611-2618.

[12] B. Lavanya, I.Satish Kumar (2014) “Optimal Placement of Distributed Generation using PSO/ OPF” *International Journal of Education and Applied Research* Vol.4, pp.2249-4944.

[13] D.B Prakar, C. Lakshminarayanan (2016) “Multiple Distributed Generation Placements in Distributed System for Power loss Reduction using PSO Algorithm” *ELSEIVER on Proceedia Technology* Vol.25, pp.755-792.