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"Improvement Of Power Quality In Distributed Generation System Using Optimization Techniques"

[1]Vishal Patidar,[2]Raghunandan Singh Baghel
[1]MTech Scholar,[2]Assistant Professor
[1]School of Engineering & Technology
[1]Vikram University, Ujjain, India

Abstract: The distributed generation (DG) generates electrical power in the distribution networks or on the network user side. In distribution networks, DGs have significant role to perform for reduction of real power and enhancing the stability in voltage of power system. Distribution companies find that it is an effective way of minimizing losses, handling the great cost of energy that is not supplied or preventing or delaying the expansion of the network. But, precise positioning and sizing of DGs in network is the crucial problem because in case the position of DGs is not appropriate, then the increased size can cause a big risk and loss for system. The installations of DG require special attention and studies to enhance the reliability and performance of the system. When the DGs are placed optimally, it can minimize the cost of operation and network losses and enhances the power quality. In order to determine the optimum size and location of DGs, various approaches have been introduced in the literature. Thus, various approaches were proposed till now for optimal placement and sizing of DGs, however, they do not provide the optimal results for voltage stability enhancement and power loss reduction. Therefore, in proposed work, three approaches are presented i.e. PSO-Sim, PSO and GA, for the optimal placement and sizing of DG units. These approaches are proposed with the intention to improve the voltage stability and minimize power loss by optimal placement of DGs. The implementation of these approaches is performed in IEEE-33 bus test system. The performance of the proposed approaches is analyzed in terms of three different parameters i.e. VSI, voltage profile and power losses, and the obtained results demonstrates the efficiency of GA approach over other two proposed approaches.

Index Terms–PSO, MATLAB, Voltage Stability, Load Flow, Distribution Generation, Artificial Neural Networks.

I. INTRODUCTION

Power system is an interconnection of networks working together to fulfill the load demand. Power system consist of generation, transmission and distribution sectors. Generators generates the power and this power is transmitted through transmission lines to the distributor end. This centralized generation system was built centuries ago to fulfill the demand which was only required to supply small loads (e.g. lighting loads, radio, television etc.).

In this ever-changing world now the scenario has changed, industrial loads has increased abruptly and so do household appliances. To supply this increased load various new generators and transmission lines are established in recent times but the dependence of modern era on electricity is increasing exponentially also, it requires set up of new transmission lines, towers and more importantly generating units alongside with other power system components. This process is tedious and also not pocket friendly therefore, system is operated near to its stability limits. Not only India, but whole world requires the solution for this problem. India as being on the developing economy requires an economical approach to solve this problem. This gives new avenues for research in this direction. One of the new ideas which became more effective is de centralized generation.

This allows to generate power near demand by using different methodologies (e.g. Photo Voltaic (PV), Wind Turbine (WT), Combined Heat and Power system (CHP) etc.).

Advantages of distributed generators

(1) Reduced Loss: - In power systems, the need to transmit electrical energy to a large distance brings huge losses with it. Losses are unavoidable entity in any system but these can be brought down to a permissible limit. DGs are used near load where power has to be consumed and so, the losses in transmitting electrical energy are reduced.

(2) Cost: - DGs can be easily installed in a small place and can generate substantial amount of energy.Also, the installation cost and the operation cost of DGs are very less as compared to a traditional power plant. Renewable energy-based DG can have very low operating cost e.g. a solar PV based DG only require regular battery maintenance as fuel cost is null and same is with other renewable energy based DGs.

(3) Time saving: - Installation of DGs is not so complex and time consuming as compared to the installation of a traditional power plant.

(4) Reduce Peak demand: - DGs supply power to the loads and can help in reducing peak demands. This will lead to lesser shortage of electricity and lesser unwanted power cuts.

(5) Electrification of remote and inaccessible areas: - DGs provide the best solution to electrify the remote and inaccessible areas where traditional grid cannot be operated because DGs do not require a bulk amount of equipment to install. Another add on to this is that renewable type DG do not require fuel to operate. Hence, ease of electrification is possible.

(6) Reduced emission: - Use of renewable type DGs is environment friendly as it does not produce harmful greenhouse gases. Hence, contributing in reduced levels of emission.

II. LITERATURE REVIEW

Voltage stability is one of the most researched topics of modern time. Numerous papers can be found in the literature which discusses voltage stability of the distribution system. These papers are studied for implementation of this work.

1. S. Hadavi1, et al., "Optimal Placement and Sizing of DGs Considering Static Voltage Stability": In the studies of power system, the problem of voltage stability in the distribution networks is regarded as the most significant issue. The condition of heavy load can result in quick voltage drop and instability in voltage. In the presented paper, a new VSI (voltage stability index) was utilized for identifying the bus which is most sensitive to a voltage collapse in RDN (radial distribution network). In this paper, the DG implementation was studied for increasing the margin of voltage stability of the DN (distributed network). In order to determine the best possible size and location of DGs, GA (Genetic Algorithm) was utilized. The testing of the proposed approach was performed on IEEE 33-bus DN and 19 bus DN. The results of simulation provide the design of proposed approach feasibility.

2. M. Dixit, et al., "Optimal placement and sizing of DG in Distribution system using Artificial Bee Colony Algorithm,":The optimum sizing and placement of DG in RDN, was presented in paper to minimize the entire power loss and to increase the system voltage profile. In this study, the determination of DGs optimum placement and optimal size were the 2 most significant parts. The IVM (Index Vector Method) method was used in this to identify the DGs location and ABC (Artificial Bee Colony) optimization algorithm was used to find optimal DG size. The DGs were placed on the single and multiple allocations at various power factors. The proposed approach was verified on the standard 15-bus and 33 bus RDN. The comparative analysis between single and multiple DG with respect tovoltage profile, real power loss, at various power factors were also presented.

3. Amin Khodabakhshian and Mohammad HadiAntisugar, "Simultaneous placement and sizing of DGs and shunt capacitors in distribution systems by using IMDE algorithm", [42]: Author in the paper [42] had presented a novel optimization mechanism called IMDE for optimization of position and finding the DG size and capacitors in the network in parallel. Function of objective was considered for reducing the losses in power and expenses facilitating that bus voltage and line current be in their corresponding constraints. IEEE 33 and 69 bus standards were used for demonstration which shows the superiority and efficacy of the projected method when this was compared with existing algorithms.

III. OPTIMIZATION METHOD

Several Optimization methods (i.e. Genetic algorithm, golden search section, particle swarm optimization, hybrid PSOGSA etc.) are discussed in the literature. But, many of these methods are too complex to implement alsoHence, a compromise between complexity and convergence is obtained in Particle swarm optimization. So, to solve this optimal placement and sizing problem we will be using particle swarm optimization. There are numerous papers available in the literature which discusses the voltage stability problem of the distribution system. But, there are only some of the papers which connects the above problem along with the power loss problem of the distribution system. Also, this analysis is performed by using GA in. We will use a new GA approach in which we will place DG on one by one basis.

Voltage stability in power system

In the power system, voltage stability is explained as a capability of a system that maintained the suitable voltage at all the required buses in the power system at normal conditions and after experienced the irruption. The voltage of the system is stable when it is operated at the normal condition but when any interruption or fault can arrive in the system then the voltage of the system becomes unstable that results in the uncontrollable decrease in voltage. Sometimes the stability of the voltage is known as load stability.

Due to the instability of the voltage, a system should undergo the voltage collapse if the future interruption equilibrium voltage is near the load then it may be limited. The collapse in the voltage is described as an important part of the system in which the method provides the voltage instability benefits of the minimum voltage profile. Voltage collapse should be a partial or total blackout. The names such as voltage collapse and voltage instability are used interchangeably.

Classification of Voltage Stability-The Voltage stability should be explained into two categories. These are

1. Small-disturbance Voltage Stability

2. Large-disturbance Voltage Stability

Small-Disturbances Voltage Stability – If the power system is operating and has a small type of interruptions then it is called small disturbances voltage stability. The voltage near the loads cannot remain close or change to the pre-disturbance values. The theory of this stability is interlinked to the steady-state and can be evaluated with the help of the small-signal model of the system.

Large-disturbance Voltage Stability – To control the voltage in the large disturbance then it is troubled with the stability of the system for example loss of generation or loss of the load or system faults. To calculate this type of stability it required the examination of the dynamic behavior of the system over enough period to attain such type of devices as under load tapchanging transformers, current limiters, and generator field. These voltage theories can be calculated through the non-linear time-domain simulations that add proper modelling.

Voltage stability limit It can be described as the restricted stage in the system beyond that no amount of reactive power injection should be increased the voltage of the system to its normal state. If the power system voltage stability should be maintained then it should only be managed by the reactive power injections.

The power transmission over the lossless line is given by:

$$P = \frac{V_s V_r}{X} \sin \delta$$

P=$VsVrX$ sin δ Here, P is the power transferred per phase [1]

Vr is the receiving-end phase voltage

X is the transfer reactance per phase

Vs is stands for sending-end phase voltage

δ is stands for the phase angle between Vs and Vr.

IV. RESULTS AND DISCUSSION

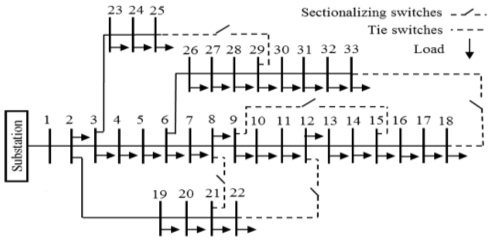

Figure- Bus single line diagram

In figure below, the bus test system is represented on which the proposed approaches are implemented. It consists of total 33 bus number and the values of nominal load on each of the bus number are recorded in table.

Table: Nominal load of IEEE bus system

Bus Number	Nominal load	
	P (KW)	Q(KVAR)
1	0	0
2	100	60
3	90	40
4	120	80
5	60	30
6	60	20
7	200	100
8	200	100
9	60	20
10	60	20
11	45	30
12	60	35
13	60	35
14	120	80
15	60	10
16	60	20
17	60	20
18	90	40
19	90	40
20	90	40
21	90	40
22	90	40
23	90	50
24	420	200
25	420	200
26	60	25
27	60	25
28	60	20
29	120	70
30	200	600
31	150	70
32	210	100
33	60	40

The table shown above represents the nominal load values of each bus number of 33-bus system. Now, after implementing the proposed approaches on this bus test system, their performances are analyzed in terms of different parameters i.e. voltage magnitude (voltage profile), voltage stability index (VSI) and power losses. Also, these parameters are analyzed in terms of without DG and with DG. The results of all the three approaches, obtained with respect to these factors are represented and discussed as below

PSO-Sim

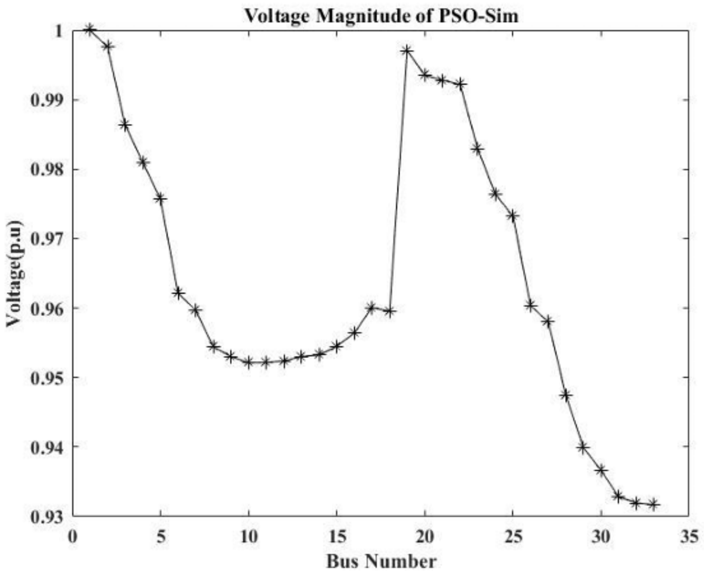

Figure: Voltage magnitude of PSO-Sim

Firstly, the results for PSO-Sim approach are represented. The graph shown in figure represents the voltage magnitude of PSO-Sim approach. In the graph, the y-axis calibrates the value of voltage which has a range from 0.93 to 1 and x-axis represents different bus numbers ranging from 0 to 35. As represented in the graph, at initial bus numbers, the voltage magnitude decreases gradually, and after bus number 10 it shows a gradual increase in the graph and then steep increase between bus 15 and 20, however, after bus 25 it then decreases gradually with increase in bus number.

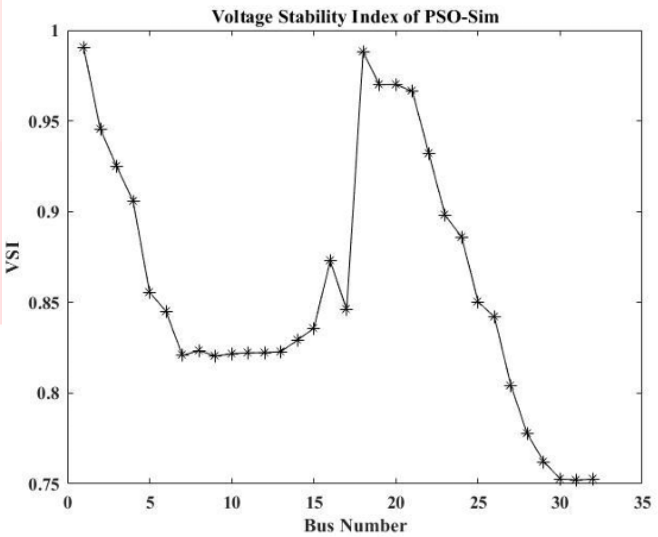

Figure: VSI of PSO-Sim

The analysis of PSO-Sim approach is also performed in terms of VSI, and the obtained result is represented graphically in figure. In the represented graph, values of VSI and bus number are shown along y-axis and x-axis, respectively.

Now, the voltage magnitude and VSI of the PSO-Sim approach by using DG and without DG are analyzed and the obtained results exemplified in figure respectively.

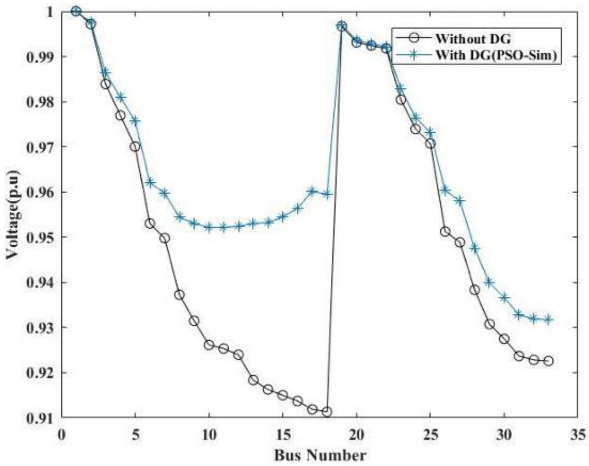

Figure: Voltage profile of PSO-Sim with DG and without DG

V.CONCLUSION & FUTURE SCOPE

DGs optimal placement and sizing has a great significant in the distribution system for the voltage stability enhancement and active power loss minimization. The non-optimal placement of the DGs can result in huge loss of system as well as cause instability in the system voltage. Therefore, placement and sizing of DGs is the most significant aspect which needs special attention. Number of approaches has been proposed in the literature for DGs optimum placement with the objective to reduce power losses, cost and enhance the voltage stability of the system. However, the existing approaches do not lead to achieve the optimal system for DGs placement with respect to enhancement of VSI, Voltage profile and power loss reduction. Therefore, in this paper, three approaches i.e. PSO-Sim, PSO and GA are presented in order that DGs can be placed and sized optimally so that enhancement can be done in the voltage stability of the system and the active power losses of the system can be minimized. The implementation of the proposed approaches is done in IEEE-33 bus test system. Three parameters i.e. voltage magnitude (voltage profile), VSI and power losses are taken into account to analyze the performance of proposed approaches.

Also, these parameters are analyzed in terms of two conditions i.e. without DG and with DG. The comparison analysis is performed between the proposed three approaches in terms of these considered parameters and the obtained results demonstrates that among three proposed approaches, GA is the most efficient one as it has highest voltage magnitude, highest VSI and low power loss as compared to other approaches, thus it can lead to achieve a system with high stability of voltage and minimum power loss.

VI.REFERENCES

[1] Anderson, Roger &Ghafurian, Reza &Gharavi, Hamid. ―Smart Grid The Future of the Electric Energy System J. Clerk Maxwell, A Treatise on Electricity and Magnetism‖, 3rd ed., vol. 2. Oxford: Clarendon, pp.68–73,2018.

[2] BayodRújula, A. A., Mur Amada, J., Bernal-Agustín, J. L., YustaLoyo, J. M., & Domínguez Navarro, J. A. ―Definitions for distributed generation: A revision‖,Renewable Energy and Power Quality Journal, 1(3),340–343,2005.

[3] B. Yu, J. Guo, C. Zhou, Z. Gan, J. Yu and F. Lu "A Review on Microgrid Technology with Distributed Energy," International Conference on Smart Grid and Electrical Automation (ICSGEA), Changsha, pp. 143-146,2017 ―Ministry of New and Renewable Energy Resources‖

[4] Mahmoud, G. A. ―Voltage stability analysis of radial distribution networks using catastrophe theory‖. IET Generation, Transmission and Distribution, 6(7), 612–618,2018.

[5] Esmaili, M. ―Placement of minimum distributed generation units observing power losses and voltage stability with network constraints‖,IET Generation, Transmission and Distribution, 7(8), 813–821,2013.

[6] H. Chen, J. Chen, and X. Duan, ―Reactive power optimization in distribution system with wind power generators,‖ Proceedings of the CSEE, vol. 28, no. 7, pp. 40-45, Mar. 2008.

[7] L. Mariam, M. Basu, F. Michael, ―A Review of Existing Distributed network,‖ Architectures Journal of Engineering‖, pp. 1-8,2013.

[8] Siemens Power Distribution & Control, Technical: Types of Power Distribution Systems, ED-1, vol. 18, (2007-2008), pp. 3-5.

[9] R. Sonderegger, D. Henderson, S. Bubb and J. Steury, "Distributed asset insight", IEEE Power and Energy Magazine, vol. 2, no. 3, pp. 32-39, 2004.

[10] T. S. Ustun, C. Ozansoy, A. Zayegh, ―Recent developments in distributed networks and example cases around the world—Areview,‖ Renewable and Sustainable Energy Reviews, vol. 15, no. 8, pp. 4030–4041, Oct. 2011.

[11] Ghosh S. and Sherpa K., ―An Efficient Method for Load−Flow Solution of Radial Distribution Networks,'' Proceedings International Journal of Electrical Power and Energy Systems Engineering, 2008.

[12] S. Sivanagaraju, J. ViswanathaRaoand M. Giridhar,―A loop based loop flow method for weakly meshed distribution network‖, ARPN Journal of Engineering and Applied Sciences ISSN 1819-6608, Vol.3,no.4,August 2008.

[13] Kumar A. and Aravindhababu, ―An Improved Power Flow Technique for Distribution Systems‖, Journal of Computer Science, Informatics and Electrical Engineering,Vol.3, Issue 1, 2009

[14] V. Mehta and R. Mehta, Principles of power system. New Delhi: S. Chand, 2005.

[15] E. Sortomme, S. S. Venkata, J. Mitra, ―Distributed network protection using communication-assisted digital relays,‖ IEEE Trans. Power Del.‖, vol. 25, No. 4, Oct. 2010, pp. 2789-2796.

[16] S. A. Saleh, ―Signature-coordinated digital multirelay protection for distributed network systems,‖ IEEE Trans. Power Electron.‖, vol. 29, No. 9, Sep. 2014, pp. 4614 4623.

[17] M. A. Haj-Ahmed, M. S. Illindala, ―Investigation of protection schemes for flexible distribution of energy and storage resources in an industrial distributed network,‖ IEEE Trans. Ind. Appl.‖, vol. 51, No. 3, May-Jun. 2015, pp. 2071-2080.