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Integration, Optimum Placement and sizing of DG with Distribution Systems for Loss Minimization

Surbhi Bakshi[a], Tilak Thakur[b], Rintu Khanna[c]

[a]Research Scholar (surbhi_pec@yahoo.com), [b] Professor, , [c]Associate Professor
Deptt. of Electrical Engg, PEC University of Technology, Chandigarh, India

***Abstract*: In particular, concerns about security of supply and reliability along with the integration of new energy resources are presenting a number of new challenges to system operators. One of the major changes that are being seen is the connection of significant levels of generation to the distribution system for the first time. This Distributed Generation (DG) is forcing a re-examination of the manner in which the distribution system is planned and operated. Distribution networks are now used as a means to connect geographically dispersed energy sources to the electricity system, thereby converting what were originally energy delivery networks, to networks used both for the delivery and harvesting of energy. This methodology brings many benefits, but has to address some of the challenges. The main is to find the optimal location and size of DG units between them. A further methodology is presented which maximizes the amount of energy that may be reaped from a given area, while taking account of the available energy resources, connection costs, losses, voltage management and the technical constraints. The optimal energy allocation is determined for a sample section of network, illustrating the implementation of the methodology and the scope for non firm access to the distribution network. This paper attempts to optimize the technology to solve the problem of optimal location and size through the development of multi-objective particle swarm. The problem has been reduced to a mathematical optimization problem by developing a fitness function considering losses and voltage distribution line. Fitness function by using the optimal value of the size and location of this algorithm was found to be minimized. IEEE-14 bus system are being considered, in order to test the proposed algorithm and the results show improved performance in terms of accuracy and convergence rate.**

Keywords: Distributed Generation Integration, Multi-objective Particle Swarm Optimisation, Optimal Sizing, Solar.

I. Introduction

Novel technologies are being required from the power company to facilitate the user with high quality power which is both reliable and cost-effective. Appeared, because of its low cost of electricity for non-traditional growing interest, it is environmentally friendly, due to increased awareness of emission control, which has become an important factor [1], [2], [3]. The introduction of DG presents a number of new challenges to distribution network operators (DNOs). The traditional planning and operational practices now have to be re-examined, in light of the increasing amounts of DG. Indeed, it can be seen that DG has implications for the three guiding concepts of T&D systems given above. The first concept was that it is more economical to produce electrical power in large amounts. This is also being somewhat challenged, in that it is now proving economical to produce power from distributed energy resource. Secondly, it is more economical to move power at higher voltage and this has lead to a relatively small number of large centrally operated generation plants in systems. The increased proliferation of DG means that there is less need for these high voltage networks as the generation may be connected more cheaply to the lower voltage network, which is in turn closer to the load. Secondly, it is still true that the higher the voltage the higher the capacity and cost, but it is because of this very fact that smaller generators are now connecting to the distribution system. There are three basics principles of distribution planning. Firstly, the system must reach the end consumer, i.e. there must be a line connecting the consumer to the network. This factor shapes the structure of the system and leads to many of the constraints and challenges faced by power distribution planners. Secondly, the system must have enough capacity to meet peak demand, i.e. the system must be planned to meet all extreme operating points rather than the average. Thirdly, the reliability of supply must be kept at very high levels. Reliability of 99.975% is typically required in most distribution systems, i.e. approximately 2 hours of service interruption is acceptable each year. To achieve this level of reliability requires protection, control equipment and a level of redundancy. All of this leads to reliability accounting for 50% of the cost of most T&D systems. The combined result of these three principles was that distribution systems and the whole power system were highly developed with a larger degree of redundancy built into it. However, with the liberalization of the electricity industry and the introduction of electricity markets, these principles are being influenced by the need for cost effectiveness. DG is now connecting and it has now become necessary to operate the distribution system closer to its maximum capacity. This pressure to get more out of the existing assets can pose problems in terms of security of supply and reliability. Operating a system closer to its limits is not inherently detrimental, but it does inevitably lead to a number of network issues or constraints which should be considered. This paper identifies the use of multi-objective particle swarm optimization optimum value size and placement of the additional DG units i.e. the size of the bus and the best location in order to obtain the ultimate goal. Multi-objective optimization including seeking the optimal value, so that the voltage and the loss is the best way to optimize the weight and importance depends on various factors such as the type of power required quality and economic requirements, etc. [15] for obtaining data in IEEE bus 14.

This paper is organized as follows. The proposed methodology to determine the optimal size of DGs at the selected locations is defined in Section II and the helpfulness of the proposed method is verified with the simulation results in Section III. Finally, the conclusions are given in Section IV.

II. Proposed methodology

The objective is to maximise generation capacity subject to the constraints outlined below. This methodology ensures optimal use of the existing network assets, thus helping to meet the renewable energy targets in a cost effective manner. Generation capacity should be allocated across the buses such that none of the technical constraints are breached and the capacity maximized. Therefore the proposed objective function is as shown in Equation (1).

$$J = \sum_{i=1}^{N} P_{DG\,i} \qquad (1)$$

Where P_{DGi} is the DG capacity at the i_{th} bus and N is the number of buses. Without loss of generality, it is assumed that there is one generator connected at each bus

The position of the unit for the problem statement defined above is initialized in IEEE-14, system bus 1-14 for a random integer value. All solutions are looking to check the feasibility of space and initialization process is repeated until a feasible solution. Each particle is updated according to the rules and checks the validity of the group, and only those particles that are feasible will remain unchanged, and the rest will be rejected. This process continues until the maximum or minimum error criterion iteration conditions are achieved.

III. Simulation Results and Discussion

The problem statement discussed is simulated with the help of MATLAB for IEEE 14 bus system. 100 particles are considered and simulation for 30 iterations. The particles and the divergence between iterations progress can depicted in Figure 1.

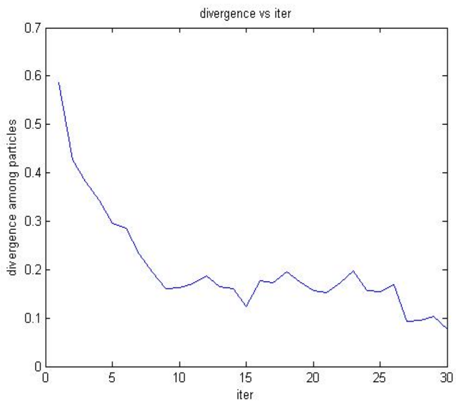

Figure 1: Plot of Divergence of Particles

It was observed that divergence reduces the iteration progress. The reason behind this is the fusion of the particles. As the best value in the PSO algorithmic search, particles starts fusing together to reduce the value. Table 1 described the best results for the IEEE 14 bus system.

Table I: Showing optimized values

Bus System	14
Optimal Bus No	14
Loss(MW) without DG	4.2
Loss (MW) With DG	3.3063
Optimal Size (kW)	32.1839

IV. Conclusions and Future Scope

An effective solution to the optimal size and use of a multi-objective particle swarm optimization technology for integrated DG unit location is proposed. The optimal values of the parameters can reduce losses and improve voltage profile significantly. The algorithm is designed such that it increases the capacity of the initial exploration and avoids falling into local minimum and maximum values. The optimization algorithm is based on multi-dimensional fitness functions. Future work includes further investigation of the impact of the objective function and other parameters.

References

[1] Acharya N, Mahat P, Mithulananthan N,(2006) “An analytical approach for DG allocation in primary distribution network”, Int J Electr Power Energy Syst., Vol.28,pp.669–678.

[2] Ajjarapu V, Christy C,(1992) “The continuation power flow a tool for steady state voltage stability analysis”, IEEE Trans Power Syst.,Vol.7.pp.416–423.

[3] Borges C, Falcao D,(2006) “Optimal distributed generation allocation for reliability, losses, and voltage improvement”, Int J Electr Power Energy Syst., Vol.28,pp.413–420.

[4] Ghosh S, Ghoshal SP, Ghosh S,(2010) “Optimal sizing and placement of distributed generation in a network system”, Int J Electr Power Energy Syst., Vol.32,pp.849–856.

[5] Gözel T, Hocaoglu MH,(2009) “An analytical method for the sizing and siting of distributed generators in radial

systems", Electr Power Syst., Res ,Vol.79, pp.912–918.

[6] Haesen E, Espinoza M, Pluymers B, Goethals I, Thong V, Driesen J, et al,(2005) "Optimal placement and sizing of distributed generator units using genetic optimization algorithms", Electr Power Qual Util J,Vol.11,pp.97–104.

[7] Hedayati H, Nabaviniaki Sa, Akbarimajd a,(2000) "A new method for placement of DG units in distribution networks", In: 2000 IEEE PES power systems conference and exposition, pp. 1904–1909.

[8] Hedayati H, Nabaviniaki Sa, Akbarimajd a,(2008) "A method for placement of DG units in distribution networks", IEEE Trans Power Delivery, Vol.23, pp.1620–1628.

[9] Khalesi N, Rezaei N, Haghifam M-R,(2011) " DG allocation with application of dynamic programming for loss reduction and reliability improvement", Int J Electr Power Energy Syst., Vol.33, pp.288–295.

[10] Kim KH, Song KB, Joo SK, Lee YJ, Kim JO,(2008) "Multiobjective distributed generation placement using fuzzy goal programming with genetic algorithm", Eur Trans Electr Power, Vol. 18, pp.217–230.

[11] Lomi A, Hien NC, Mithulananthan N,(2009) "Application of distributed generation to enhance loadability of distribution system, a case study", In: 2009 IEEE PES/IAS conference on Sustainable Alternative Energy (SAE). Valencia IEEE. pp. 1– 7.

[12] Mithulananthan N, Oo T, Phu LV,(2004) "Distributed generator in power distribution placement system using genetic algorithm to reduce losses",Thammasat Int J Sci Technol., Vol.9:pp.55–62.

[13] Mithulananthan N, Oo T,(2006) "Distributed generator placement to maximize the loadability of a distribution system", Int J Electr Eng Educ., Vol.43,pp.107–118.

[14] Nara K, Hayashi Y, Deng B, Ikeda K, Ashizawa T,(2001) "Optimal allocation of dispersedgenerators for loss minimization", Electr Eng Jpn., Vol.136,pp.1–8.

[15] Nasser G.A. Hemdan, Michael Kurrat,(2011) "Efficient integration of distributed generation for meeting the increased load demand", Electrical Power and Energy Systems, Vol.33,pp.1572–1583.