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Optimal Placement of Micro Distribution Generator in Micro-Grid for Loss Minimization Using PSO

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ABSTRACT

The major aim of DG optimal placement is obtaining the best DGs units sizes and locations so as to have optimum operation and planning of the distribution network system while considering DG capacity constraint. This paper addresses the issues related to the improvement of voltage profile and power loss reduction by integrating DG units. The technique was applied to optimally placed optimum DG unit size in distribution systems for the improvement of candidate bus voltage and reduction of power loss in the system. The technique proposed was simulated on IEEE-10 bus and IEEE-13 bus standard test system, and the obtained results show that the proposed method is strong and effective for optimal placement of DG units.

KEYWORDS

Distributed Generation, Optimal Placement, Optimal Size, Particle Swarm Optimization, Radial Distribution System

1. INTRODUCTION

The availability of renewable energy resources in developing countries is playing a decisive role in the economic growth of the nations; recent studies have shown that there is a positive relationship between the levels at which the countries are developing and the level at which their energy consumption is increasing (Timothy,2020). The present world's energy reserves are very limited; therefore it's quite impossible to continue relying solely on existing conventional sources of energy. With everyday increasing energy demands and abrupt reduction in fossil fuel, the need for a cleaner environment and reduction in greenhouse gases emissions enhance the necessity of DG(Vikas,2016). The use of distributed energy resources has over the years brought many incentives as a result of changes in the generation and transmission paradigm. DG resources more specifically the ones with facilities based on the recent technologies (PV Arrays, wind energy, fuel cells, micro-turbine, etc.) have a significant role in supporting the available energy supply to meet demand. DGs involve small capacity power that sizes not less than 10kW up to 10 MW that is usually connected at major load centers (Mustapha, 2020).

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Utility are been economically penalized due to high losses in the system (if the losses go beyond the standard limit) whereas it makes a profit if the losses are less. In addition to that, the efficiency of energy transmission to the end-users is significantly reduced as a result of high active power loss in the MG (Shashank,2020). Hence, active power loss drop has gained more attention from utilities. Also, reactive power loss reduction is an important objective of DG optimal placement. Furthermore, distribution system planning by optimal placement helps in reducing resistive (I^2R) and imaginary (I^2X) losses as well as drops in the voltage magnitude level in the distribution network. These utilities are now seeking recent technologies that will provide highly efficient, reliable, and high-quality power to their customers in a restructured power industry. This brings rapid and continuous development in DG integration globally; this is because of its smaller size, low cost, and high potentiality of lesser environmental impacts (Pandian, 2018).

The main motivation to carry out this work is that lower the efficiency of Micro Grid (MG), and to improve it DG plays a vital role. With DG the MG owners will have an access to the DNS as an independent energy producer. MG with DG units to provide better efficiency of the systems and guaranteeing adequate security and reliability levels. But the integration of DG into the systems also increases the level of uncertainties involves in the systems planning and operation. Hence, the need for suitable methods to be developed to study and predicts system's performance. Several factors need to be defined for the design of MG with DG units, these factors include, the preeminent technology to be used, the capacities of the DG, its number, its location, and network connection methods, etc. The DG has many impacts on the systems operating behavior such as power losses, system reliability, voltage profile, environmental impacts, and many more. Hence these impacts need to be carefully evaluated. Therefore these motivate the authors to come with this methodology for the best position and optimum capacity of DG in MG.

This manuscript presents a novel technique by applying PSO along with Backward/Forward sweep load flow analysis to determine the optimal size and site of DG in the MG by using the PSO algorithm. A fitness function is developed, mitigation of power loss is considered as the objective, and bus voltage profile improvement is treated as a constraint of the optimization function. The developed technique is validated on the IEEE-13 bus and IEEE-10 bus standard radial test systems.

The manuscripts systematized as follows; introduction of the concept is discussed in the first section, in the second section a detailed review of past works related to DGs optimal placement in distribution systems were presented, then the general overview of the proposed methodology is given in the third section, in which the first part contains an overview of the LFA techniques and the second part is about the PSO techniques and finally the last part is about the application of the proposed technique for DG placement. Section 4 contains problem formulation for the proposed method, and in section 5, a detailed discussion of the results obtained from testing of the proposed techniques on IEEE standard bus systems was presented and analyzed. Finally, in the last 6th section, a detailed conclusion based on the results obtained is presented.

2. LITERATURE REVIEW: DG PLACEMENT TECHNIQUES

In current era, the field of optimum DG placement is becoming an area of interest to many power system engineers and researchers because of its numerous benefits. One of the benefits of optimal DG placement is that it gives the utility operators the ability to regulate and control system parameters such as voltage profile of the systems, improve power quality, and perform peak demand shaving, better the reliability of the system, also other than its operational benefits in the MG, proper placement of DG has a crucial role on environmental impacts (Pandian,2019). Therefore, optimum sizing, best location as well as continuous monitoring of DG must be taken into account. In power distribution systems, proper placement of DG has a crucial role in environmental impacts. Therefore, optimal placement and sizing as well as continuous monitoring must be taken into account (Pandian, 2020).

Transient Electromagnetic Phenomena–Standardization and EMC Requirements–Mitigation Techniques

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