A Review on Impact of Power Losses & Enhancing of Techno-Economic Feasibility in a Radial Urban Distribution system

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Abstract **- As the world's energy consumption has risen at an exponential rate. Coal, oil, and gas are all conventional energy sources that are gradually diminishing. As a consequence, there is an urgent need to conserve what we have and to explore alternative sources of energy. So the future of power systems is motivated by the necessity to preserve the conventional energy resources and also the impact of climatic change on the greenhouse gasses in the atmosphere. This could be a huge challenge for the modern electricity generation and transmission infrastructure. Distributed generations will therefore attract a lot of attention (DGs). Different renewable energy resources combine with diverse conventional sources and energy storage in distributed generation integration, which is one of the main principles in upcoming power system network. The maximum amount of loss arises in this system. Various Simulative modelling, Analytical modeling, as well as Metaheuristics modeling for an ideal placement of DG have been derived and they are offering improved accuracy and convergent. Loss reduction strategies in distribution generation are being researched in order to provide better quality, which results to increased system stability and reduced annual downtime expenditures. As a result, understanding the consequences of DG losses on the electrical distribution system is a crucial and complicated process.**

Index Terms **- Distribution Generation (DG), Distribution Network, Loss Minimization Techniques, simulation modeling.**

I.INTRODUCTION

A centralized model sustained electrical systems until a few years ago. A system with gigantic power plants and high-power generators connected to the transmission network was described. Transmission is a system which is used to deliver the power from the generating station to the End-user. Generally transmission takes place over a longer distance with a higher voltage rating. Once the power is been transmitted to the nearby places of the end-user, it's essential to disperse it among a bigger number of lines, each of which is shorter in length also with unsatisfactory performance. From the technical aspect and regulating the voltage level is advantageous from an economic standpoint. The distribution system is made up of all of these networks including substations. The distribution network was once called a passive network because it did not have any generator units attached to it. The power flow from the transmission to the distribution network was unidirectional in this circumstance. The blending of DG into distribution system results in enhancing the system accessibility and sustaining the system reliability. There is also a probability in expansion in the complexity of the system and due to inappropriate positioning of the Distributed Generation in the system to entire distributed system will be exposed to unknown problems. Distribution system losses account for roughly 70% of all power system losses [21]. So to modulate these losses, DGs integrated to the distribution system will be a course of action. Distribution Generations can be either conventional source of energy or of non-conventional source of energy. Despite that with the increased environmental concerns, conventional energy-based Distribution Generations are picking up more crucial. Conventional

energy source based Distribution Generation possess numerous beneficial in techno-economical aspect and also in environmental concern. Estimating the effect of DG integration to improve the system's performance, especially reliability and loss minimization, is becoming more essential in the contemporary distribution network due to an increase in demand for reliable and quality power supply. Enhancement in system reliability and minimization of the system losses can be obtained only by selecting the best placing and sizing of the DGs [3]. This, in turn, will have a favorable effect on the voltage profile and overall power quality, precise load system ability and also improving the system security. Which in turn lead to reduction in capital investments, downtime and annual maintenance costs, operational and fuel cost. Distribution generation may be of renewable energy based or non-renewable energy based but as we know renewable based energy sources has its own advantages over the distribution system based on non-renewable energy. Even if the system is based on renewable energy, it may have drawbacks if it is not installed in the proper location it may cause a negative setback in the power system like increase in losses, damage to protective devices and also poor power quality in the distribution system. So to overcome this drawback optimal selection of DG's and allocating of DG's has been dealt within the literature using different techniques. Analytical Techniques are much preferred for small systems and they don't have much effectiveness when subjected to the complex system. For vast and complicated systems, many meta-heuristic procedures are created that yield a good conclusion. Multiple simulation techniques are utilized by manipulating different power system simulation software which gives a desired output to end up at the appropriate conclusion based on the simulation output. A retrospect on DG integration simulation techniques are monopolized in various publications focusing on loss reduction, reliability improvement of distribution system has been presented in this paper. Various types of software are been used to conduct researches and to arrive at the desired conclusion from the simulation output.

II. DISTRIBUTION GENERATION

B. An Overview of DG.

The phrase "distribution generation" refers to a small-scale generating unit that's placed at the end-user side. It differs from the conventional central generation concept in that it can be positioned near end users within an industrial area or within a building. Because of the rising popularity in DG in recent years, non-identical varieties of DGs have been fully developed. The size, fuel type, and efficiency of DG units vary, and they are related with two technologies: conventional energy technology and non-conventional energy technology. Reciprocating engines, combustion turbines, and fuel cells are examples of conventional energy technologies.

TABLE 1
DG CLASS BASED ON CAPACITIES AND TECHNOLOGY

Sl. No.	Class of DG	Capacity range	DG technologies
1	Micro DG	1 kW – 5 kW	Solar PV, Micro hydro, Wind turbine, Fuel cells..
2	Small DGs	5kW ≤ 5 MW	Small hydro, Fuel cells, Wind turbine, Tidal Biomass, IC engines
3	Medium DGs	5 MW ≤ 50 MW	Solar thermal & PV, geothermal, IC engines, Bio-mass, Hydrogen energy systems.
4	Large DGs	50 MW ≤ 300 MW	Solar thermal & PV, Hydrogen energy system, hydro.

B. Impact of DG.

The addition of DG to the electrical system may affect the electricity generation reliability and have an impact on the distribution system's operation, considering voltages and power flows. It can also impact the reliability and quality of the power supply in the electrical system. The positioning of Distributed Generation in the system, the category of DG, appropriate sizing, and the number of DG with the required rating are all critical elements to consider when integrating DG into the distribution system. Each one of these factor impact the system functionality. Careful selection of all the above through suitable analysis and studies will ensure quality and reliable supply to the consumers. This will also enhance the character of the voltage furthermore it also decreases the losses in the system. Therefore it becomes necessary to analysis effect of distribution generations integration including the above factors. Many researches have investigated the optimal placement of DG in the networks; there are methods for deciding the ideal positioning of the DG to bring out the best performance in the distribution system. Regardless, in practice, the technician may only have restricted authority on the real time position of the DG,

Since this constantly lean on factors for example like availability of site, along with construction and planning acceptance concerns.

III. DISTRIBUTED GENERATION INTEGRATION IN A DISTRIBUTION SYSTEM

Available methods for analysing the impact of DG integration into the electrical system can be broadly classified into Analytical techniques, classical techniques (non- heuristic), simulation techniques, meta-heuristic techniques, and hybrid approach. Numerous techniques have been illustrated for the solution of DG integration. All these techniques will be having substantial benefaction for the ideal placement of Distribution Generations as well as ideal size in the distribution network. Respective available algorithms under the above techniques are given in the literature [21, 22] except for simulation techniques. Many works are carried out to examine the consequences when the Distributed Generations are blended into the distributed network concerning different parameters using simulation procedures using appropriate software.

A. Analytical Techniques.

The Analytical technique refers to the methods which are used to troubleshoot by manipulating suitable mathematical modelling for the occurred crisis. It is the mathematical representation of the system under research. The numerical solution is being used to obtain the solutions. This method contributes appropriate speed with less factual along with fewer data processing. These are ideally suited for miniature and less complicated system. Analytical techniques are not well suited for larger systems, due to their less arithmetical effectiveness. Certain importance modelling method in order to analyse Distribution generations Fusion constitute Two/Third golden rule, perceptive factor analysis; Eigen-value based analysis, iterative methods, etc. Considerable types of methods are been described in literature for solving the ideal Distributed generation placing and sizing. The conclusion for ideal Distribution Generation placing and rating, and this type is illustrated by considering voltage sensitivity index along with the reduction of losses demonstrated in[3] for IEEE-14 bus using the analytical method. Voltage index sensitivity and Distributed Generation classification as well as capacity in order to select the bus load on the bases of reduction of losses that affect the selection of the load bus. The influence of element disrupts the reliable of the Distribution network with the addition of the DGs. It is observed using the fault hazard method analysis in real-time distribution system in Indonesia [12]. The ideal location with ideal sizing of DGs is described in [15]. Based on sensitivity of loss factor and enhancement of voltage profile thus the impact of DG placing involves complete power system losses and voltage of a distribution system is scrutinized, and the method is dependable for 33-radial bus networks of the system.

B. Classical Techniques.

Classical techniques include optimization methods that are applied to larger distribution systems for finding an optimal solution with better accuracy compared to analytical methods. These minimization methods are applicable for emerged problem statement to maximize or minimize as per the given set of conditions and within the range of constraints. This methodology is developed for the optimal placing of Distributed Generators in the distribution network. These techniques include linear programming, dynamic programming, sequential quadratic programming, optimal power flow, continuous power flow, etc. Many of these techniques are illustrated in the literature and reviewed in the literature works [21, 22, and 23].

C. Meta-Heuristic Technique.

Metaheuristic techniques are based on smart intelligent methods and these types of approach are effective of providing accurate, energy-efficient and best possible solution for placing Distributed Generators. These methodologies have been evolved from artificial intelligence techniques and are most suitable for solving complicated problems in various fields. These stable techniques results in proximate solution for complicated problems. Some of the important algorithms adopted for solving DG integration problems fuzzy logic, ant colony optimization etc. Several of these techniques are illustrated in the literature and reviewed in the literature works [21, 22 and 23].

D. Hybrid Technique.

These techniques are using a combination of the two or even more optimization algorithms to mitigate that

problem and to obtain an optimal solution for placing Distributed Generators. These Techniques include a combination of flower pollination algorithm (FPA), Genetic algorithms with fuzzy logic, firefly algorithm, invasive weed optimization etc. [21].

E. Simulation Technique.

The simulation technique is a modelling approach that indicates sufficient information regarding the system performance under different conditions. The solution for the given problem is obtained by modelling the system using various different tools and carrying out the simulation under different scenarios of the practical importance of distribution systems. A simulation modelling technique is applied when an analytical formulation of a real problem cannot be achieved to the desired level. The simulation modelling approach provides results for specific use cases and conditions. The use cases are defined and specified by system planners and distribution network operators (DNOs). In order to balance the effect of numerical calculations, the simulation should be run many times for use cases with different sets of conditions and constraints, the simulations should be run again and again. These simulation techniques especially are accurate when the results are examined in real-time working systems under valid input presupposition. For better analysis, the analytical approach is preferred over the simulation approach, since the reality of the modelled system is validated using the simulation approach. A validated simulation result is acceptable in most of the case studies. Simulation techniques maybe Monte Carlo simulation, Markov modelling and simulation using suitable software. These simulation results will provide sufficient information regarding the system performance under various conditions of importance and case study results will serve as a reference for future works. For the study of the effect of DG integration in a distribution system, a handful of experimentations have been carried out by considering simulation studies of the test system under different scenario. Different test systems are considered in research and various scenarios are simulated to arrive at the conclusions.

Table 2

An overview of Different DG Integration Simulation Techniques

Ref .No	Test System	Objective	Approach	Software	Parameters Considered
1	RBTS bus-2	Influence of Distributed Generation on distribution network Reliability.	Simulative	DlgSILENT Power Factory	Optimal DG size and improvement in reliability indices.
2	IEEE 69 BUS SYSTEM	To forecast the best placing along with the number of DGs of fixed and switched capacitors at different conditions.	Simulative	MATLAB	loss reduction, voltage profile and total P F.
3	33/11KV RSU	Enhancement of Distributed Generation Units to cushion the disadvantages regarding losses.	Simulative	ETAP 7.0	Energy loss and voltage profile without DG; with DGs at individual bus.
4	33/11KV RSU	The quantity of loss in each element have in distribution network.	Simulative	ETAP	Energy losses, Distribution network, Loss minimization, technological losses.
5	IEEE 14-bus system	Choosing the Bus loads based on sensitivity of Voltage, loss minimization	Analytical	MATLAB	Optimal DG size and type
6	IEEE 33 bus system	To replenish the required reactive and active power, to reduce the system reactive loss	Simulative	MATLAB	Ideal placing along with correct sizing the Distribution Generation, Capacitor & Reactive loss
7	IEEE 33 & 69 Bus System	Demonstrate the performance of M P S O examined with preceding modeling.	Simulative & analytical	MATLAB	Balancing of load and maintaining voltage supervision.

8	IEEE 33 bus System	To Modify M S C A to improve the Distribution Network behavior with the fusion of many DG in turn to govern the losses	Simulative	MATLAB	Multi-objective M S C Modeling technique Faster voltage constancy index with loss minimization.
9	IEEE 9& 39 bus system	To minimize active and reactive power losses with various kinds of DG	Simulative	MATLAB	P F Divergence in DG on placing and correct sizing in Distribution system.
10	IEEE 34-bus system	Minimization of system losses and improvement in reliability	Analytical	MATLAB	Optimal location and size
11	RBTS bus-2	Improvement of reliability of the system	Simulative	ETAP	Optimal location, size and number
12	33 bus radial system	minimization in real power loss and enhancement in voltage profile	Analytical	MATLAB	Optimal location and size
13	Real time feeder (Thanyaburi feeder)	Improvement in reliability indices	Simulative	DigSILENT Power Factory	DG location and size
14	5 bus system	Improvement in reliability indices with loss reduction and voltage profile improvement	Simulative	MI-Power	Optimal location and size
15	29 bus NE plan test system	Improvement in voltage profile and power loss reduction	Simulative	NEPLAN	Optimal location and size
16	RBTS bus-2 system	Improvement in reliability with DG and applying DSM	Analytical	MATLAB	Reliability with DG and DSM
17	IEEE 14-bus system	Improvement in voltage profile, reduction in losses and improvement in reliability	Simulative	ETAP	Optimal location and size
18	RBTS bus-2 system	Improvement in reliability with DG and applying DSM	Analytical	MATLAB	Reliability with DG and DSM

Based on the literature survey, Table-II provides the overview of different techniques along with test systems considered, objective considered in Simulation studies are carried using Neplan software in [15], using ETAP in [3, 4, 11, 17], DlgSILENT PowerFactory in [1, 13], using MiPower in [14] and using MATLAB in [2, 5, 6, 7, 8, 9, 10, 12, 16]. Concept of DSM has been considered in [13]. Diesel generator in [15] and wind in [11, 14].

IV.CONCLUSION

In the electrical network If DG is to move out of its present location, it needs to be integrated properly into the distributed network. Distributed Generations can involve the network costs and the benefits. So the existing analyses unveil the different types of techniques used to research on the effect of distributed generation embodiment on the distribution system concentrating primarily in simulation modelling. This article describes the fusion of the distributed generation in the distributed network and there effect to the reliability of the distribution network. The main goal is to enhance the reliability in the distributed network with the fusion of distributed generations in addition with other Distribution Generation advantages like loss minimization, improvement of voltage profile, improvement in power quality and also various economic and environmental privileges [5]. Diverse simulation modelling are available for researching on the Distributed Generation amalgamation and are discussed in the article. As observed Analytical modelling Techniques works better for small and less complex network so they are much quicker and take less time to derive the output. Despite the outcome their only suggestive as it is only simulative. But the classical modelling techniques is applicable to the larger system they prove more effective Heuristic techniques are more practical and

the results are near-optimal solutions for complex Distribution Generations in finding out the best placing and also the best fitting in the distribution network. For the concurrent values system can be simulated using the required toolbox to meet the desire placing and grading of Distributed Generation units that are to be interconnected.

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