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An Analysis of the Best DG Placement Based on Reducing Power Losses and Improving Distribution System Voltage Stability

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ABSTRACT: Due to existing transmission line contingency, financial loss of utilities, and power system outages, power loss minimization and voltage stability improvement are key topics of power systems. Among capacitor placement and network reconfiguration, optimal Distributed Generation (DG) allocation is one of the greatest approaches to improve the efficiency of the power system. On the basis of optimal DG allocation, power system operators and researchers have put forth their efforts to solve the distribution system problem of power loss, energy loss, voltage profile, and voltage stability. An attempt has been made to synthesize existing methodologies and present a detailed discussion that can assist energy planners in determining which objectives and planning aspects require additional attention for optimal DG allocation for a specific region or in a given scenario.

KEYWORDS: Distributed Generation (DG), Distribution System, Power, Voltage Stability.

I. INTRODUCTION

It is vital to reduce total power loss in the distribution system in order to improve overall power delivery efficiency. This can be done by carefully deploying Distributed Generators with the best radial distribution system value. The usage of distributed generators on primary distribution feeders is commonplace in most countries. The Distributed Generators placement challenge's purpose is to determine the ideal locations and sizes for Distributed Generators to minimize power loss and maximum annual savings. Distributed generating has been a research topic for several decades. There is a lot of study being done in this area [1]. In practice, DGs are introduced at the distribution level and placed at the consumer end. The capacity and structure of the distribution system are used to rate DG [2]. Although several scholars have described distributed generation, it is essentially a small generator connected to the consumer interface in general. The DG's position is crucial since it can cause voltage instability if it is not properly positioned [3].

II. DISTRIBUTED GENERATION

According to a literature review, distributed generation has primarily been defined in terms of capacity or location. The authors of this research have followed the definition of distributed generation, which is defined in terms of location with no restrictions on capacity or type of DG technology employed. However, as Pepermans suggests, there can be a variety of different criteria that can be used to define DG. Figure 1 depicts a few of these. Five major factors have significantly increased interest in distributed generation, according to the International Energy Agency (IEA), including advancements in DG technologies, constraints on the construction of new transmission lines, increased customer demand for highly reliable electricity, electricity market liberalization, and climate concerns [12].

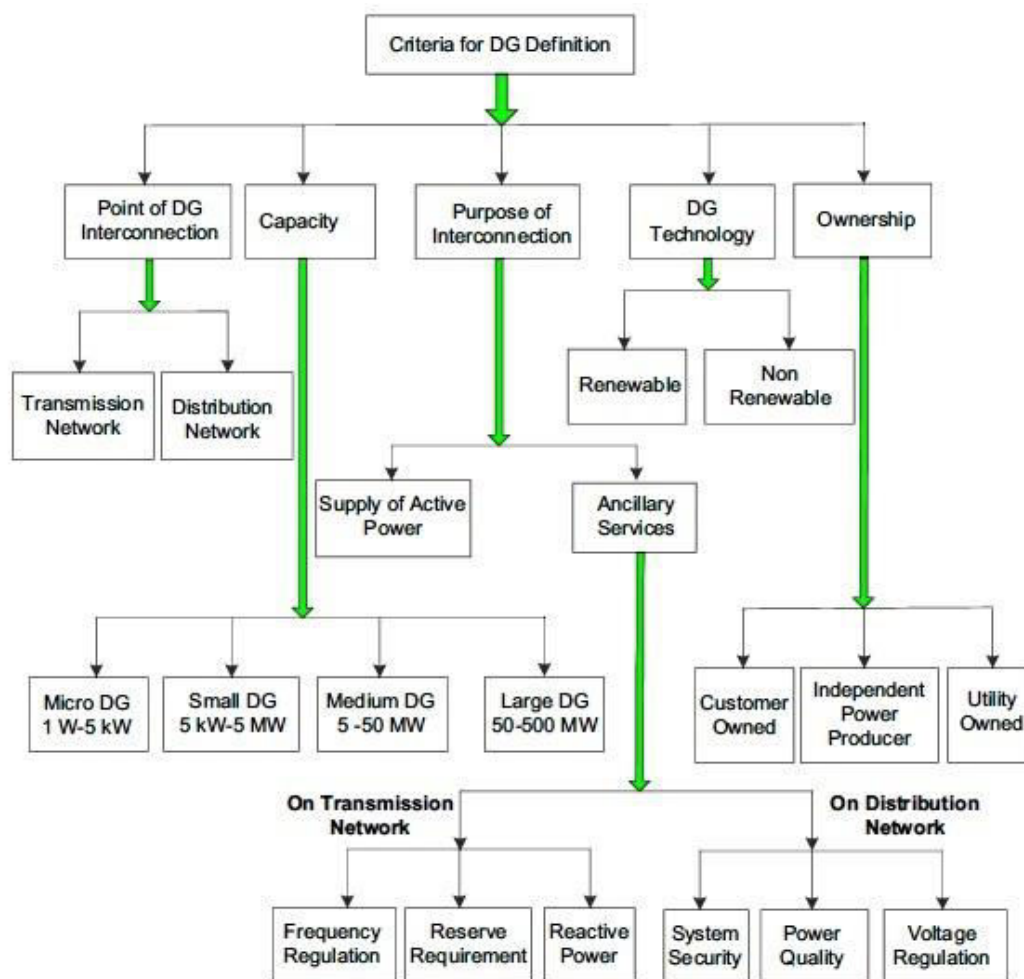


Figure 1. Criteria for classification of DG [12].

III. LITERATURE SURVEY

For the past few decades, distributed generation has been a research issue. This is an area where a lot of research is being done. The term "distributed generation" was coined by R.C. Dugan and T.E. Mc Dermott [7]. Generally, distributed generators integrated with utility distribution networks will be smaller than 10 MW. Larger units are usually connected directly to transmission lines and will almost certainly be commercial power generators. On distribution systems, the units will normally be no more than 1 or 2 MW. These would mostly be placed by the utility or by end users. Distributed generation (DG) [1] is a term used to describe this kind of generation.

MCV Suresh and Edward J. Belwin [1] describe a hybrid method for determining the best locations and sizes of DG units in distribution networks using a Fuzzy and one rank cuckoo search algorithm (ORCS). The results of testing the suggested approach on IEEE 15-bus, 33-bus, and 69-bus test systems are reported. J. Shanmugapriyan et al. [2] describe a method for determining the best location for multi-type DG in a distribution system. Using the distributed generation suitability index, the particle swarm optimization (PSO) method and differential evolution (DE) are used to determine the right position and size of DG (DGSI).

According to Dasarathan Sattianadan et al. [3], the ideal location of the DG is determined by VSI, and the size of the DG is determined by trial and error to minimize real losses. To reduce losses, the Genetic Algorithm (GA) is utilized to simultaneously find the position and size. The Voltage Stability Index (VSI) determines the ideal location of the DG, and the optimal size of the DG is obtained using the differential evolution algorithm, according to N. Karuppiah et al. [4]. The DG is placed at the weakest bus, as identified by the VSI, and it is sized using the Differential Evolution Algorithm to account for active and reactive power losses.

For optimal sizing and simultaneous positioning of DG units of various sorts, Muhammad Irfan et al. [5] present a methodology based on a chaos-assisted gravitational search algorithm. The suggested technique is put to the test on



three conventional test systems (12-, 33-, and 69-bus test systems) as well as a practical feeder from Pakistan's Lahore Electric Supply Company (LESCO). G. Srinivasan [6] suggests using Autonomous Group Particle Swarm Optimization (AGPSO) to optimize the allocation and sizing of capacitors with and without NR in four different scenarios, all while meeting operating restrictions. This study also investigates the positioning and sizing of Distributed Generation (DG) units from single to three ideal nodes in capacitive compensated optimal DN to determine the influence of real power injection on additional power loss reduction.

Firas M.F. Flaih presented a modified PSO method to increase distribution system performance by lowering real power loss through reconfiguration. This algorithm is used to determine which switches must be opened in order to minimize power loss [9]. The PSO technique is also used to determine the best location for DG in the distribution network in order to increase voltage stability and systems short-circuit levels [10]. For optimal placement of DG in the distribution system, an analytical technique based on the power sensitivity index has been suggested [11]. As the number of DGs expanded, this strategy caused the problem to become more complex.

IV. COMPARISON OF TECHNIQUES

A comparison of different approaches has been shown in Table 1 [12].

Optimization technique	Benefits	Drawbacks
Analytical technique	<ul style="list-style-type: none"> ▪ Computing time is short. ▪ Easy to implement. ▪ Non-iterative in nature. ▪ Unlike other techniques, does not pose convergence problems. 	<ul style="list-style-type: none"> ▪ When problem becomes complex, assumptions used in order to simplify problem may override accuracy of solution. ▪ Lacks robustness.
Genetic algorithm	<ul style="list-style-type: none"> ▪ Can rapidly locate solutions, even for large search spaces. ▪ Works with discrete and continuous Parameters. ▪ Bad proposals do not affect end solution negatively as they are discarded. ▪ Very useful for complex and loosely defined problems. ▪ No derivatives needed. 	<ul style="list-style-type: none"> ▪ Repeated fitness function ▪ Evaluation for large and complex problems may be time consuming ▪ May not suggest best solution always, possibility of trapping into local optima. ▪ Lack of accuracy, not suitable when a high quality solution is required.
Tabusearch	<ul style="list-style-type: none"> ▪ Has explicit memory. ▪ Allows non-improving solution to be accepted in order to escape from a local optimum. ▪ Applicable to both discrete and continuous solution spaces. ▪ Effective for larger and complicated problems as compared to other approaches. 	<ul style="list-style-type: none"> ▪ Too many parameters to be determined. ▪ Number of iterations could be very large ▪ Global optimum may not be found and largely depends on parameter settings
Particle swarm optimization	<ul style="list-style-type: none"> ▪ No overlapping and mutation. ▪ Simplified calculation. ▪ Adopts real number code and it is decided directly by solution. 	<ul style="list-style-type: none"> ▪ Cannot work out problems of scattering and optimization.

V. CONCLUSION

The recent trend of Optimal Allocation of DG (OADG) with many objectives functions such as voltage stability enhancement, voltage profile improvement, power loss reduction, and their multi-objective approach was described in this study. Specific planning limitations and planning elements have been considered by the researchers, each with its own distinct characteristics. Nonetheless, the systematic method for dealing with distribution system planning concerns remains an unresolved question for scholars. All of the ideas offered by their searchers in the studied literatures will



assist energy planners and utilities in increasing distribution system performance in terms of loss minimization, voltage stability and voltage profile enhancement, and system load capacity maximization.

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