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A Review of Optimal Placements & Capacity Determination Approaches for Distributed Networks (DG's)

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Abstract: In modern Era distribution generation has a core of any electrical system whether it has to be generation, distribution, and transmission. So the power distributed network system more aggressive on an integration of distributed generation and play a progressive vital role in recent time. Generally, the main motive of the finding the optimal placement or finding optimal location and size of distributed generation to generate better DG's capacity constraints. But the system suffered with mixed integrating problem and also traditional ways not seems to be appropriate for mixed integration problem. The finding of optimal placement and capacity for distributed network electrical system has to be an interested topic for any researchers. This paper present a review study of optimal placement and capacity determination approaches for distributed generation in distributed network system and finding the appropriate algorithm for solving the mixer integration problem.
Index Terms: DG's, Optimal Capacity, Optimal Location, Optimal Placements, and Distributed Network.

I. INTRODUCTION

It has been noticed that the demand of electrical power has rapidly increases by the global population so resultant get a in an exaggerate generation. To meet the demand value we have to more focus on generation unit for client satisfaction then we have to think about alternatives techniques to meet the limit of demand of electrical power by the global population. Due to increasing consideration of demand of electrical power also affect the environment and coal source of energy which have limited. So for achieving these sort of limit of power supply demand, generation segregated into small generation unit generally known as distributed generation or dispersed generation. These distributed generation totally based on utilization of natural source or renewable energy sources like wind, bio, and reservoir. On other hand we can say that the these small distributed generation unit has environment friendly and solving the problem of increasing demand of power supply by serving the power as per demand by using natural renewable resources [1-2]. Distributed generation, also referred to as dispersed generation is a small scale generation being used to meet the ever increasing demand of electricity. Distributed energy is generated by small grid connected generators known as distributed energy resources (DER). Conventional power plants such as thermal, nuclear, hydro power plants are centralized whereas distributed generation resources are decentralized, located near to the load centers. Distributed generation prominently uses renewable resources such as solar power, wind energy, biomass, small hydro and photovoltaic systems. Various other technologies may also be adopted in distributed generation such as fuel cells, battery, micro turbines, small gas turbines and reciprocating engines [1-3]. This section describe the introductory part of the topic, rest of the paper as follows section II describe the recent development, section III discusses the related work and problem formulation or statement describe in the section IV, and concluded paper in the section V.

II. RECENT DEVELOPMENT

There were several approaches developed in the field of determination of optimal location or placement and optimal capacity of distribution generation units, discusses as follows; For avoiding or eliminating the faults level constraints which considerable, the system used gradient search methodology that basically an optimal filter of distribution generation in distributed meshed network [7-8]. A linear programming model adopted by the researcher for resolved the problem of optimal flow in distributed generation [9]. A linear programming shows that the linear behavior of the system i.e. totally based on energy harvesting used for distribution generation. Another method was developed using sequential quadratic programming to resolve the ODGP [10]. The power distributed system which had non-linear load with all power operational conditions made some complex problem for optimal flow, a mixed integer number non-linear programming (MINLP) suitable approach to resolve these complex problem and allocating the optimal placement or location to distribution generation efficiently like solar, wind and bio-mass [11-12]. Genetic rule (GA) associate with an improved variant of GA are projected for DGs optimum filler. GA is applied to resolve associate ODGP drawback with reliable ness constraints in [13]. GA is employed to resolve associate ODGP that considers variable power focused load models [14], distributed hundreds [15], and constant power. The ODGP drawback is resolved by the Tabu Search (TS) technique for the case of uniformly distributed [4]. TS at the same time solves ODGP and optimum placement of reactive power sources [16]. A continual random ODGP model is resolved by a GA additionally as by a combined TS and scatter search [17]. Particle Swarm improvement (PSO) is applied to resolve associate ODGP model in distribution system with non-unity power issue considering variable power load models [18]. An improved PSO is projected for optimum placement of assorted weight unit varieties that inject real power and inject or absorb reactive power. A hybrid GA and PSO is usually recommended in [19].

III. RELATED WORK

A combination of analytical and GA methods has been proposed in this paper for multiple DG unit's allocation in the distribution system to minimize system losses. The proposed method has used the GA to find the optimal location for DGs installation and an analytical novel formulation has been used to determine the DG capacities. The proposed method has been compared with IA, LSF, and ELF methods in terms of loss reduction. The results illustrate that the proposed method reaches the lowest losses compared with other methods [1]. The optimal allocation of DG is a vital factor in the proper functioning of the power system network. Employing DG at an optimal location has several advantages such as, voltage profile improvement, reduction of system losses and enhancement of power system reliability and stability. This paper suggests a Newton Raphson based load flow method to choose proper position of DG. In this paper, a single DG source of capacity 2 MW is integrated in the system which is delivering real power only. This is an example of a solar photovoltaic cell which delivers real power only. This method is implemented on three different IEEE bus systems. The results of this method presented in this paper are demonstrating the applicability of this technique in different network systems. The results clearly show the voltage profile improvement and reduction of system real losses and reactive losses when the DG source is placed at an optimal location. A comparative study can be done by using other evolutionary algorithms like PSO, GA and meta-heuristic methods [2]. This paper methodology allows solving the problem of the fixed costs allocation of a distribution network, with large penetration of DER, in particular of DG and DR resources. The Kirschen's tracing method and a variant of the MW-mile method are used to determine the impact of the energy resources and for the allocation of fixed costs. The developed scenarios focus on the study of the implementation of several DR approaches, as well as the impact that each DR approach can have on the allocation of fixed costs of a distribution network. For the developed scenarios, the DR approaches are implemented in two different ways, namely individually and simultaneously. For both scenarios, it can be seen that the DR approaches with a greater contribution and allocation of fixed costs are DR constant, linear and quadratic approaches. Thus, it can be seen that the different types of consumers have higher participation in DR events whose remuneration is one of these three approaches. Also, it is seen that when the DR approaches are implemented individually the consumers have higher participation than when the DR approaches are implemented simultaneously [3]. In what concerns the impact that the DG resources have in the distribution network, it can be seen that the presence of several DG has high impact in the branches of network, ensuring a significant share of fixed costs, mainly in the branches far from the bus where the external suppliers inject energy.

Losses and ENS and costs associated with DGs are three important parameters in distribution systems that the planners are trying to reduce them. In this paper, at first, an approach for ENS calculation in the presence of DGs and storage systems is proposed. Then, the problem of minimizing of two of above parameters is established via simulating of DSR problem along with the optimal DG allocation and sizing problem, which is solved by the NSGA-II algorithm. This solution approach allows the losses, ENS and costs of each topology to be separately optimized under specific loads and constraints. The proposed algorithm is applied on two test systems and the effectiveness of this algorithm is then verified by the analysis of the results. The best topologies are shown in the frame of a set (front). As well, the proposed algorithm can be extended to optimize other objectives like either the system parameters or reliability indices. This feature can be useful for planners to improve the performance of distribution systems [4].

In this paper [5], weaker buses are detected by voltage stability indices (*FVSI and LQP*) for IEEE 33 and 69 bus systems. It is observed from the results that placing a DG on the weaker bus/area/zone gives maximum technical and financial benefit to the system as compared to healthier bus/area/zone. Therefore, to reduce the computational burden, the search space for the optimal allocation of DG can be restricted only to the weaker zone of the network. The new objective function is developed considering both technical (loss and voltage profile) and economical (benefit to cost ratio) aspects. An EPSO method is proposed for optimal allocation of DG while considering practical operating constraints. A significant improvement of voltage profile, considerable economic benefit and reduction of line loss is obtained from the optimal allocation of DG. The results are analyzed and compared with other popular PSO techniques and it can be concluded from the test results, that the proposed EPSO algorithm is reliable, and effective with respect to computational efficiency and solutions quality.

Table I Taxonomy and contribution of the reviewed optimal DG placement Models

Ref. No.	No. Of Dg's	Design Variables	Load Profile	Load Model	Objective	Objective Function	Contribution
06	Single	Location + Size	One load level	Variable power	Multiple	Multi Objective	Multi objective ODGP, considering voltage rise issue and voltage dependent load, is solved by an interactive trade off methods.
07	Multiple	Type + location + size	Probabilistic	Probabilistic	Single	Min cost	A continuous stochastic ODGP model considering wind power volatility and load uncertainty utilizing the moment method.
08	Multiple	Location + size	One load level	Constant power	Single	Min power loss	An ABC method is proposed to compute the optimal DG unit's location, size, and power factor.
09	Multiple	Type + location + size	Probabilistic	Probabilistic	Multiple	Multi objective with weights	A monte-Carlo simulation embedded GA solve an ODGP with uncertainties represented by probability distribution functions.
10	Multiple	Location + size	Multi load level	Constant power	Single	Min cost	Simultaneous allocation of DGs and remove controllable switches considering a quantized multilevel load model.
11	Single	Location	One load level	Constant power	Single	Min cost	The optimal location of DGs is based on system reliability cost that is evaluated by a probabilistic approach.
12	Multiple	Location + size	One load level	Constant power	Single	Max voltage limit load ability	An ODGP model that maximize the voltage limit load ability is solved by a heuristic method based on continuation power flow.
13	Multiple	Location + size	One load level	Constant power	Multiple	Multi objective with weights	ODGP is solved by a hybrid GA-PSO, Where the GA searches the site of DG and the PSO optimizes the size of DGs.
14	Single	Location	Multi load level	Constant power	Single	Min power loss	An ODGP method based on the ranking of non-supplied energy and a method based on the ranking of power losses in lines.
15	Multiple	Number + location+ size	One load level	Constant power	Multiple	Goal objective index	ODGP, with a precise DG power flow model for wind turbines, is formulated as a single objective goal programming problem.
16	Multiple	Location	Multi load level	Constant power	Single	Max profit	ODGP is formulated as a bi-level programming problem solved by Chu-beasley GA codified to avoid non-feasible solutions.
17	Multiple	Location + size	One load level	Constant power	Single	Min cost	A hybrid model, which employs discrete particle swarm optimization and optimal power flow, is proposed for the ODGP problem.
18	Multiple	Size	One load level	Constant power	Single	Max DG capacity	Method to increase wind penetration level by placing new wind generation at voltage stability strong wind injection buses.

19	Multiple	Location + size	Time varying	Constant power	Multiple	Multi objective with weights	A two stage iterative method exploiting information on the time varying voltage magnitude and loss sensitivity factor at each node.
20	Multiple	Location + size	One load level	Constant power	Single	Min power loss	ODGP considering voltage stability is solved by differential evolution in conjunction with incremental bus voltage sensitivities.
21	Multiple	Location + size	One load level	Constant power	Single	Min power loss	An improved analytical method compute the optimal location and size of multiple distributed generation units.
22	Multiple	Location + size	Multi load level	Constant power	Single	Min power loss	Network reconfiguration and optimal DG placement are dealt simultaneously and solved by harmony search method.
23	Multiple	Size	Time varying	Probabilistic	Single	Min cost	ODGP considering the uncertainty and variability associated with the output power of renewable DG as well as load.
24	Multiple	Type + location + size	Time varying	Probabilistic	Single	Max voltage index	ODGP to improve voltage stability considering the probabilistic nature of both the renewable resources and the load demand.
25	Multiple	Type + location + size	Multi load level	Constant power	Single	Max DG capacity	ODGP of inverted based and synchronous based DGs considering standard harmonic limits and protection coordination constraints.

IV. PROBLEM FORMULATION

There are two main Objectives for problem formulation. Minimize the system loss cost and improve the voltage profile.
The trouble is to determine allocation and size of DG, which minimizes the distribution energy losses for a fixed variety of DGs and a specific total potential of DGs. Therefore the following assumptions are hired in this method:

A. *The maximum number of installable DGs is given (D).*
B. The total installation capacity of DGs is given (Q).
C. The possible locations for DG installation are given.
D. The upper and lower limits of node voltages are given.
E. The current capacities of conductors are given.

For loss minimization, the objective function is given by

$$Min\ f = \sum_{i=1}^{n} P_i$$

Where Pi = Nodal injected power at bus i.
n = Total no. of buses.
If the entire injected strength of distributed era is constant C MW, this equality constraint have to be expressed in shape of a penalty feature.
The Objective function can be formulated as

$$Min\ f = \sum_{i=1}^{n} P_i + \alpha \sum_{k=1}^{L} \left(P_k - C\right)$$

Constraints: Maximum no. of DGs

$$\sum_{l=1}^{M} \sum_{g=1}^{N} \left(n_{gl}\right) \le D$$

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Total capacity of DGs

$$\sum_{l=1}^{M}\sum_{g=1}^{N}\left(G_g \times n_{gl}\right) \le Q$$

Only one DG can be installed in one installation position

$$\sum_{g=1}^{N}\left(n_{gl}\right) \le 1$$

Upper and Lower voltage limit

$$Vi \le Vn \pm \Delta Vn$$

Current capacity limit

$$I_i \le I_i^{\max}$$

$(i = 1, ...n \quad K = 1, ...L ,\ l = 1, ...M ,\ g = 1, ...N)$

Where

P_i : Nodal injection of power at bus i at the jth feeder,

P_k : Load power of bus k at the jth feeder,

V_i : Magnitude of voltage of bus i,

V_n : Nominal magnitude of voltage in the network,

G_g : Capacity of the g^{th} DG,

n_{gl} : 0-1 variable for determining whether one DG with gth capacity is allocated at the *l*th location. (1: allocated, 0: not allocated),

n : Total number of buses,

L : Total number of load buses,

M : Total number of DG location candidates,

N : Total number of capacity types of DGs,

α : Penalty weight of equality constraint,

D : Maximum number of DGs in the distribution network,

Q : Total installation capacity of DGs,

C : Total injected power of dispersed generations in the distribution network,

ΔV : Maximum permissible voltage deviation,

I_i : Current of i^{th} section.

$I_i^{\max}$: Maximum current capacity of i^{th} section.

V. CONCLUSION

This paper presents an intensive description of the state of the art models and improvement ways applied to the ODGP drawback, analyzing and classifying current and future analysis trends during this field. The foremost common ODGP model has the subsequent characteristics: Combination of analytical and heuristic search methods for achieving high-speed and accurate convergence simultaneously. Considering the dependency of the active power flow of the slack bus to the active power generated by DGs as a new constraint in minimizing distribution network losses. Analytical solution of the problem for minimizing losses of the distribution network using a deterministic equation for DGs optimal output active power in terms of network loss coefficients and network demand. Considering the DGs active power, power factor, and location during minimization of distribution network loss, simultaneously.

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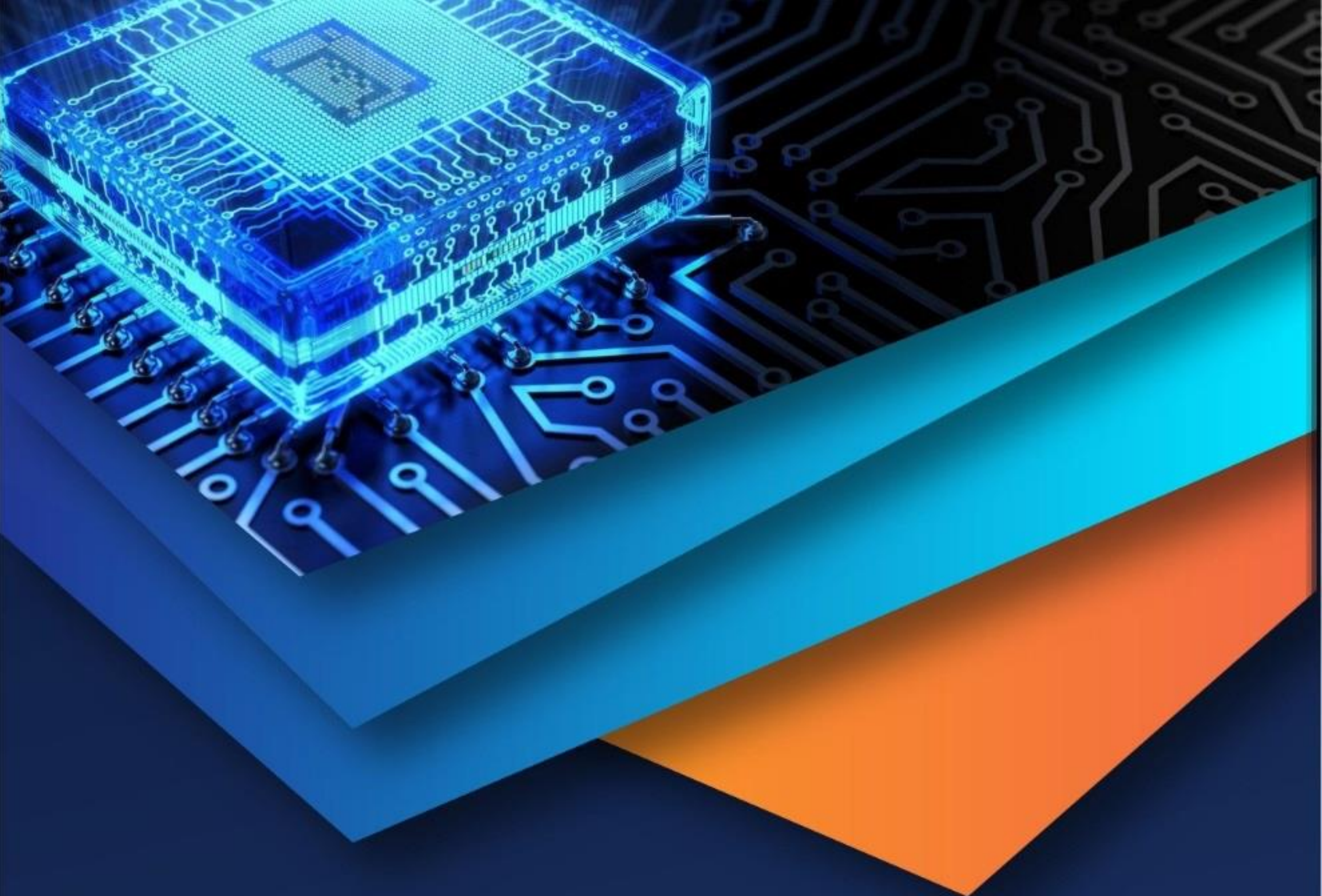

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