# OPTIMAL PLACEMENT OF DISTRIBUTED GENERATION USING GENETIC ALGORITHM APPROACH

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***Abstract-*** Deregulation of the electricity sector has created many opportunities to develop new technologies. Dispersed generation is one of those technologies to meet the ever-increasing demand of electricity. The term "Dispersed Generation" refers to small-scale electric generation units close to the point of consumption. The advantages could be maximized by proper positioning of DG units at optimum location with ideal capacity and suitable type of DG unit. Distribution generation allows collection of energy from many sources and may give lower environmental impacts and improved security of supply. The applications of distributed generation (DG) models is raising in current smart grids and power devices. A significant issue with DGs is their particular optimal area and dimension within the circulation system. This paper involves the use of particle swarm optimization (PSO) in conjunction with genetic algorithms suggested for sizing and optimal placement of DG models to be able to decrease network blockage. The purpose of such models includes minimization of the operation and investment costs and voltage profile improvement. The IEEE 30-bus test program can be used to illustrate the potency of the recommended comparison with ANN. The proposed approach decreases the cost and loss due to its global and local forecast.

***Keywords:*** *Distributed or Dispersed generation, Deregulated generation, Transmission and Distribution.*

## I. INTRODUCTION

Generally, the term Distributed or Distributed Generation refers to any electric power production technology that is integrated within distribution systems, close to the point of use. Distributed generators are connected to the medium or low voltage grid [15]. They are not centrally planned and they are typically smaller than 30 MWe (DTI 2001) [16]. The concept of DG contrasts with the traditional centralised power generation concept, where the electricity is generated in large power stations and is transmitted to the end users through transmission and distributions lines (figure.1). While central power systems remain critical to the global energy supply, their flexibility to adjust to changing energy needs is limited. Central power is composed of large capital-intensive plants and a transmission and distribution (T&D) grid to disperse electricity.

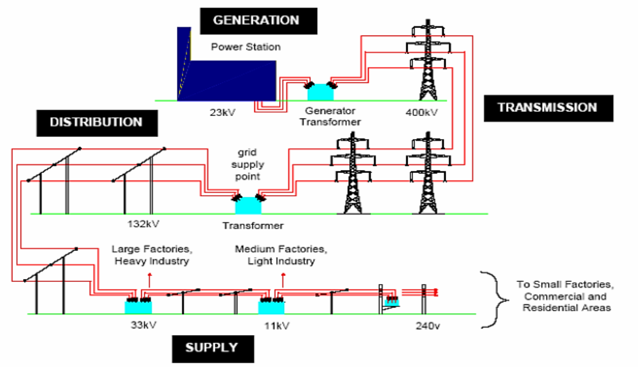


**Figure 1:** General Electric Power System [12]

A distributed electricity system is one in which small and micro generators are connected directly to factories, offices, households and to lower voltage distribution networks. Electricity not demanded by the directly connected customers is fed into the active distribution network to meet demand elsewhere. Electricity storage systems may be utilised to store any excess generation [14]. Large power stations and large-scale renewables, e.g. offshore wind, remain connected to the high voltage transmission network providing national back up and ensure quality of supply. Again, storage may be utilised to accommodate the variable output of some forms of generation. Such a distributed electricity system is represented in figure 2.

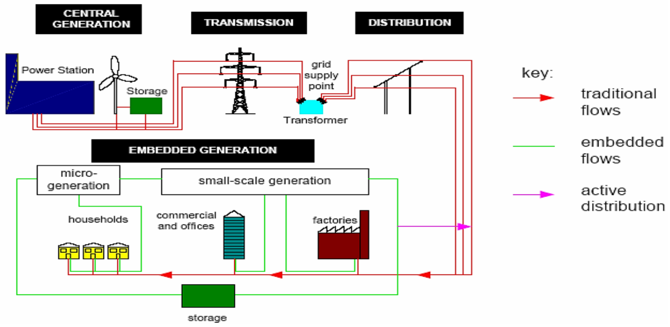


Figure 2: A Distributed Electricity System [12]

Distributed generation complements central power by (1) providing in many cases a relatively low capital cost response to incremental increases in power demand, (2) avoiding T&D capacity upgrades by locating power where it is most needed, and (3) having the flexibility to put power back into the grid at user sites. Significant technological advances through decades of intensive research have yielded major improvements in the economic, operational, and environmental performance of small, modular gas-fuelled power generation options. Forecasts predict a total 520GW from newly installed DG around the globe by 2030 [16].

***1.1 Types of DG***

The process of Dispersed generation is defined as a decentralized type of power plant that helps in feeding the power grid at the distribution level sized from 10 to 150 MW. It represents a concept of building a highly efficient (small) power plants along the grids that are already existing [4][5][6]. There are various advantages of using dispersed generation as these are small as compared to the centrally-stationed plants that are typically built, it can be used in emergency conditions, and as they depend on renewable or natural gas resources, the generators used are very less noisy and low-polluting which makes the use of such generation suitable for generating onsite at the location of the consumer [3,10]. Some of the most commonly used DG units have been listed as follows

**Table 1:** DG Types based on size and efficiency

| Type of DG units | Size (kW) | Electrical Efficiency (%) |
|---|---|---|
| Small Fuel Cell | 1-300 | 30-50 |
| Micro Turbines | 30-300 | 25-30 |
| Micro CHP | 1-10 | 30+ |
| Hydro Fuel Cell | 400-20,000 | 65-70 |
| Automotive Fuel Cell | 30-60 | 50-80 |

***1.2 DG: Technologies***

*1. Microturbines:* Microturbines promise low emission levels, but the units are currently relatively expensive. Obtaining reasonable costs and demonstrating reliability will be major hurdles for manufacturers. Microturbines are just entering the marketplace, and most installations are for the purpose of testing the technology.

*2. Reciprocating engines:* The engines range in size from less than 5 to over5,000 kW, and use diesel, natural gas, or waste gas as their fuel source. Reciprocating engines are being used primarily for backup power, peaking power, and in cogeneration applications.

3. Photovoltaics: Commonly known as solar panels, photovoltaic (PV) panels are widely available for both commercial and domestic use. Panels range from less than 5 kW and units can be combined to form a system of any size. They produce no emissions, and require minimal maintenance.

*4. Industrial combustion turbines:* A mature technology, combustion turbines range from 1 MW to over 5 MW. They have low capital cost, low emission levels, but also usually low electric efficiency ratings. Development efforts are focused on increasing efficiency levels for this widely available technology. Industrial combustion turbines are being used primarily for peaking power and in cogeneration applications.

*5. Wind turbine systems:* Wind turbines are currently available from many manufacturers and range in size from less than 5 to over 1,000 kW. They provide a relatively inexpensive (compared to other renewables) way to produce electricity, but as they rely upon the variable and somewhat unpredictable wind, are unsuitable for continuous power needs.

*6. Fuel Cells:* Fuel cells are not only very efficient but also have very low emission levels. A fuel cell operates like a battery. It supplies electricity by combining hydrogen and oxygen electrochemically without combustion. The few fuel cells currently being used provide premium power [14].

***1.3 DG: Barriers***

The DG installation barriers are categorized into three parts described in the below section.

*1. Economic Barriers:* These represent a major type of barrier to the process of installing a DG. In the present scenario, the DG owner gets a large amount of profit from the power that is generated, whereas the operator of the DG (DGO) with whom the unit is connected to the grid faces the problems related to cost upgradation and unpredictable implications of the power supplied to the grid. Therefore, the DGO considers it as a matter of nuisance rather than a benefit or opportunity. Moreover, it does not help the independent customers or householder to expect the working of such generation units on the daily basis.

*2.Technical Barriers:* This basically represents the barriers related to power quality (PQ) issues as the concept of PQ denotes a very powerful tool of the electrical engineering field. In relation to DG, the PQ issues include the flickering level, amplitude of the steady state voltage, and the presence of harmonics faced or experienced by the users.

*3. Protection Barriers:* Such type of distribution systems has to perform like a host to deal with a distributed form of generation and this poses various implication related to protection based on unwanted islanding, selectivity, reliability, and short-circuit (SC) levels. So, while implementing the DG's these upper and lower limits should be strictly kept in mind.

***1.5 DG Planning***

***1.5.1DG Setup***

In general, the idea of a distributed type of generation identifies with any electrical power creation innovation that will be joined inside appropriation frameworks, close to the point of utilization. The distributed generators will in general be joined to the intermediate or maybe a matrix having low voltage. These sorts of items are usually smaller and may not be arranged centrally [1, 9]. The distribution network utilizing DG bids various complementary aspects, for example, line-losses reduction, expelling air-borne contaminations including whole costs as a result of upgraded productivity, just as progress of the account-based on voltage, quality of electrical power, reliability of the framework, and safety efforts [7, 11]. Both replenishable and non-endless advances can be used for the purpose of DG. Because of developing innovations just as expanding size of DGs, that in return plays a generous and furthermore topical-based phenomenon in the framework of power, there is as anyway positively no widespread official concession to the meaning of DGs.

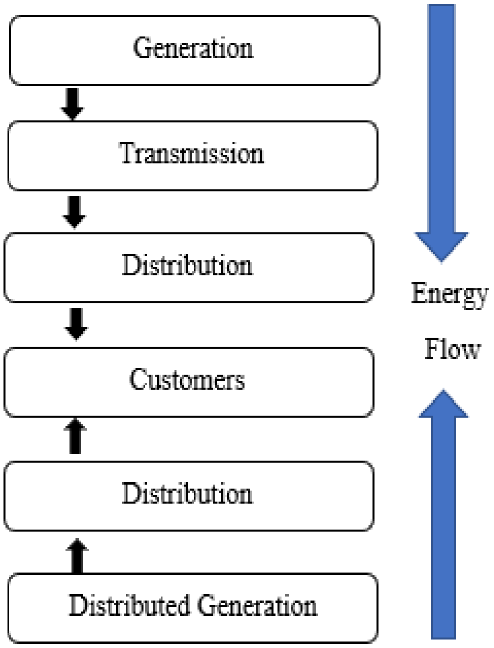


**Figure 1.3:** DG Set up

***1.5.2 DG Planning Objectives***

Most of the DGP targets were to limit the loss of real power in the system. What's more, other specialized records, for example, loss or reactive power, voltage profile, capacity of MVA, complete turning hold, reduction in power flow in basic line were utilized as target work as solitary or multi objective for enhancement. The point by point discourses are displayed as the following [8]:

*1. Minimize line loss:* DGP manages the optimised placement of DG, to get most extreme advantage by limiting all out real total power in the framework. The essential definition for minimization of loss was finished with the idea that an entirety of all nodal infusions of network power signifies network losses and f as the objective function was communicated as:

$$f = \sum_{i=1}^{n} P_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (1)$$

where, Pi represents the power-based nodal injection at bus i, and n signifies the buses in total number.

*2. Maximize Capacity of Distributed Generation:* The target for ideal (optimal) placement of DG is usually taken as an augmentation of DG limit. The capacity of generation is distributed over the system buses with the end goal that none of the specialized requirements is broken. The system-based objective function is as per the following:

$$= \sum_{i=1}^{N} P_{DGi} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots .. (2)$$

where, $(P_{DGi})$ is the ith bus DG limit, and N presents the arrangement of potential areas. Deprived of loss of all-inclusive statement, it is expected that there occurs a single generator at every bus.

*3.Maximization of social profit and welfare*: In [9], the issue is defined with two particular target capacities, to be specific, maximization of profit and maximization of social welfare. Social welfare is characterized as the contrast between absolute advantage to customers minus total production cost [13]. The associated objective function in conjunction with social welfare has been planned as quadratic advantage bend put together by the purchaser (DISCO), Bi(PDi) less quadratic offer bend provided by merchant (GENCO), Ci(PDi)less the quadratic cost capacity provided by DG proprietor C(PDGi).

$$f = \sum_{i=1}^{N} \left(B_i(P_{Di}) - C_i(P_{Di}) - C(P_{DGi})\right) \dots\dots\dots\dots\dots\dots\dots .. (3)$$

The maximization formulation-based profit is given as follows:

$$Profit_i = \lambda_i \times P_{DGi} - C(P_{DGi})$$

where, $P_{DGi}$ signifies the size of DG at I node; $\lambda_i$ signifies the LMP i.e. locational marginal price at the ith node after the placement of DG; $C(P_{DGi}) = a_{DGi} + b_{DGi}(P_{DGi}) + C_{DGi}(P_{DGi})^2$ signifies the characteristic cost of DG at ith node point.

*4. Comprehensive-objective:* It intends to limit cost of different parts, for example, DGs speculation, DGs working expense, and absolute instalments toward making up for the losses of the framework. In the study provided by El-Khattam et al. 2005, the objective-function based total investment depends on the model of chain formulation. It intends to limit the working expenses and investment of competitor neighbourhood DGs, instalments in the direction of obtaining the required additional DISCO power, instalment in the direction of loss services compensates just as the speculation cost of other picked fresh amenities for various situations. The DISCO can possess the accompanying choice to serve its interest growth.

- Scenario A: Buying the essential additional energy from the primary framework and tapping it to the network of distribution through its intersection substation with principle grid.
- Scenario B: Buying the additional energy from a current inter-tie and conveying it to its territory of network distribution.
- DG Capitalizing: an option for tackling DSP issue deprived of the requirement for upgrading feeder. The target capacity utilized in [11] is as per the following:

$$J = \sum_{i=1}^{N} C_{fl}(S_{DGi}^{Max} + BK)\sigma_{DGi} + 8760 \sum_{i=1}^{T}\sum_{i=1}^{M} \beta' \, C_{ri} S_{DGi} + 8760 \sum_{i=1}^{T} \beta' \sum_{i=1}^{TN} M \sum_{j=1} \frac{\Delta V_y^2}{|Z_y|}.pf.C_e + Cost\ of\ Scenario - A\ or + Cost\ of\ Scenario - B \ldots\ldots \quad (4)$$

Cost of Scenario-A is as follows:

$$C_A = \sum_{i=1}^{SS}\sum_{u=1}^{TU} C_{iu}\sigma_{iu} + \sum_{i=1}^{TN}\sum_{j=1}^{M} C_{ij}\sigma_{ij} + 8760 \sum_{i=1}^{T} \beta' \sum_{i=1}^{TU} pf C_e \ S_{iu} \, C_{iu} \ldots\ldots (5)$$

Cost of Scenario-B is as follows:

$$C_A = \sum_{i=1}^{TN}\sum_{j=1}^{M} C_{ij}\sigma_{ij} + 8760 \sum_{i=1}^{T} \beta' \sum_{i=1}^{TU} pf C_{int} \ (S_{int}) \, S_{int} \, \sigma_{int} \ (S_{int}) \ldots\ldots\ldots (6)$$

and

$$\beta' = \frac{1}{(1+d)'} \ldots\ldots\ldots\ldots \quad (7)$$

The calculation above discussed various factors like DG unit backup capacity (BK), cost of investment (Cf ), price of electricity market (Ce), rate of discount (d), cost of operation (Cr ), transformer cost ( $C_{iu}$ ), feeder cost (Ci,j), energy introduced by intertie (Sint), intertie cost of power (Cint), substation number (SS), total number of buses (TN), load buses number (M), energy produced from source DG (SDG), substation i and transformer u in dispatched power (Siu), increment interval of time (t), planning horizon year (T), binary decision variable-based based transformer u in ith substation ($\sigma_{iu}$), DG-based binary variable decision ($\sigma_{DG}$ ), substation transformers in total (TU), impedance-based feeder segment (|Zij|), power factor of the system (pf), binary variable decision of feeder i to j (σij), Limit of DG capacity ($S_{DGimax}$), binary decision-based variable intertie ($\sigma_{int}$ ) were measured [11, 12].

## II. RELATED WORK

D.B Prakash et.al [1] proposed another use of WOA i.e. Whale Optimization Algorithm with a point of discovering ideal position and size of Distributed Generation (DGs) for multi-goals. Multi-targets incorporate minimization of power loss, improvement of voltage profile and working cost-based minimization exposed to constraints of inequality and equality. Proposed technique has been exhibited on 69-bus and 33-bus radial test frameworks. Henrique S., et.al [2] proposed the study with the main objective of demonstrating the DG analysis as a voltage and volt/var control (reactive power control) instrument or equipment in the test performed on the distribution system. A control equipment was used that consisted of inverter frequency of the photovoltaic generation system which operated with traditional equipment performing a voltage control. Here, a software named Open Distribution System Simulator (OpenDSS) was in use for attaining the desired results along with a standardized (IEEE 13-bus) system. Janmejay Sharma, et.al [3] conducted a review planning of distribution generation relating to the networks of distribution and the distinct performance levels based on power system analysis like minimizing the losses generated by the real and the reactive power of the system which enhances or updates the system's stability, load ability, security, reliability, capacity of transferring the power, flexible operation bandwidth, reduce short circuit capacity and the oscillations, provides support of real and the reactive power, and provides great environment friendly transmission. The research basically relies on the current status DG planning from different perspectives of the system. It is a very useful approach for the researchers to deeply analyze the performance of the system. Sanjeevikumar Padmanaban, et.al [4] proposed a study that provided the basic insights of operation in a fuel cell technology and the various distinct applications of power electronics (PE) systems. With the expansion of the current, the cell voltage of fuel was reduced slowly (bit by bit) due to the occurrence of losses in the fuel cell. It was really difficult to handle large ratings of the fuel cell without any kind of its regulating mechanism. For the better utilization of the technology, the issues linked with the structural planning of the fuel cell and the type of arrangements have been used at a greater extent. This research consisted of improving the fuel cell-based reliability, the integration of storage systems, and the enhanced research methods. In addition, this study addressed the utilization process of a particular processor energy unit application based on certain characteristics of fuel cells. Rajendran, et.al [5] conducted a study based on distinct types of DGs with the optimized single or multiple installations that were used to regard the growth annually in the system of the load, with the satisfaction of system constraints (operational). A pre-determined growth in the annual system load was considered with the main aim of reducing or minimizing the system loss of the total real power, and it consisted of determining the sizing and the optimal location of the DG using a configuration (hybrid-form) of weight-improved particle swarm optimization, generally known as WIPO along with GSA that is gravitational search algorithm jointly forming hybrid an algorithm based on WIPO-GSA. A 33-bus radially distribution system was taken to observe the effects of the growth rate of load. The results illustrated that there was a good improvement in the capacity of carrying a load of feeder-based sections, a huge reduction in real and reactive power loses, and an enhancement in voltage profile of the system. Here, at the same time, the economic benefits of DG on the annual growth of the system were established. Antoniadou-Plytaria, et.al [6] presented a review on decentralized and distributed form of voltage control of the distribution (smart) networks, which summarized the control models and thereby classify the best suitable methodologies adopted for the use. Additionally, it commented on certain issues that must be addressed for its future use. Jalali, et.al [7] conducted their research dealing with the problem related to distribution system optimized planning that consisted of DG placement, conductor sizing, and shunt capacitor sizing. A new approach, PSO optimized Binary selective method was used that was capable to handle binary, selective, and continuous variables. At the same time, it enlightened the main focus on distribution system planning. The main objective of the problem was to reduce or minimize the cost of the system. The points that were taken into account includes the cost of energy, inflation rate, cost of energy, and load growth rate. The main test was performed on a 26-bus system. Alireza Soroudi et.al [8] presented a dynamic multi-objective model for distribution network expansion, considering the distributed generations as non-wire solutions. The proposed model simultaneously optimizes two objectives namely, total costs and technical constraint satisfaction by finding the optimal schemes of sizing, placement and specially the dynamics (i.e., timing) of investments on DG units and/or network reinforcements over the planning period. An efficient heuristic search method was proposed to find non-dominated solutions of the formulated problem and a fuzzy satisfying method was used to choose the final solution. The effectiveness of the proposed model and search method were assessed and demonstrated by various studies on an actual distribution network. Gautam Durga et.al [9] Consumer instalment, assessed as a result of LMP (locational marginal price) and burden at every load-bus, was projected as additional positioning to recognize for applicant nodes for placement of DG. The rankings proposed scaffolds designing parts of framework activity and monetary parts of market activity and go about as great pointers for the position of DG, particularly in a market domain. It additionally expected a few cost-based qualities so as to give a situation of assortment of DGs accessible in the market. For every cost trademark DG, an ideal optimised arrangement and size is recognized for every one of the goals. The proposed technique was tried in an altered IEEE 14 transport test framework. Quezada, et.al [10] presented an approach in order to calculate the energy losses (annually) when different concentration and penetration levels of DG gets connected to the distribution type network. Additionally, various impacts have been calculated considering the wind power, combined heat and power, fuel cells, and photovoltaics. The results have shown that variation in energy losses that seemed to be a function of the penetration level of DG has presented the U-shape characteristics trajectory. Moreover, high loss reduction can be expected if the units of DG get more dispersed along the feeders of the network. In the context of technologies related to DG, it was noted that the wind power shows the worst type of behavior in curing the losses. In the end, the DG units along with reactive power control have provided the better network for controlling losses and the voltage profile. El-Khattam, et.al [11] presented a survey on DGs approaches which would change the working operation of electric power systems. This research was based on the important concepts, the definition of DGs, and their working constraints fair enough to help in understanding the regulations methodology of DGs. For the process of implementation, the economic and the operational benefits were also considered. Here, the researcher's main objective was to provide a comprehensive survey which would add new types and classifications related to DG technologies, types and the applications. Thomas Ackermann et.al [15] discussed the relevant issues and aims at providing a general definition for distributed power generation in competitive electricity markets. In general, DG can be defined as electric power generation within distribution networks or on the customer side of the network. In addition, the terms distributed resources, distributed capacity and distributed utility were discussed. Network and connection issues of distributed generation were presented, too

## III. THE PROPOSED METHOD

**Step 1:** Initialize the Load/Power.

**Step 2:** Initialize the Load flow.

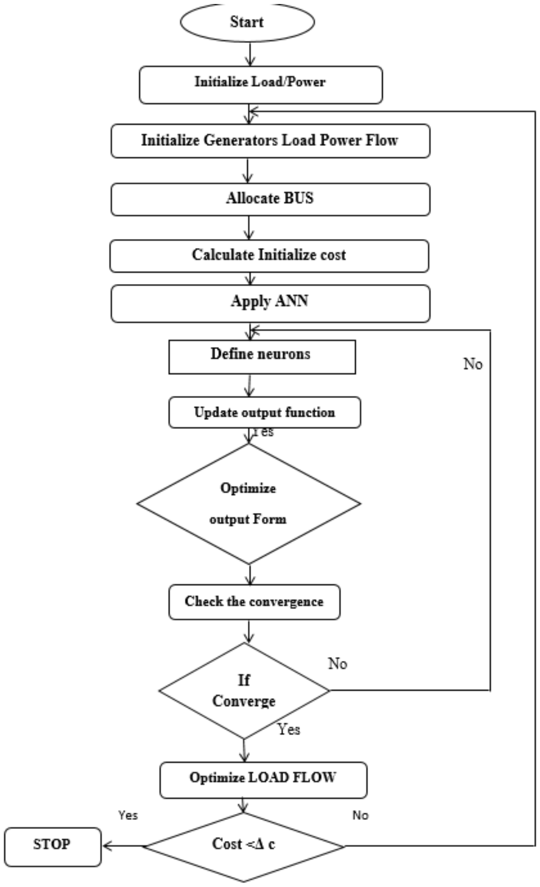
**Step 3:** Allocate the generators and calculate the cost.

**Step 4:** Apply the GA for Prediction.

**Step 5:** If output of GA is optimized neurons

**Step 6:** Check the convergence. If converge then check the cost features otherwise again initialize the Neurons and Repeat the step 5.

**Step 7:** If cost is less than $\Delta$ C then stop.



**Proposed algorithm**

**GA**

**Step 1:** Initialize the load/ power.

**Step 2:** Allocate the generators.

Step 3: Calculate the Initialize cost.

Step 4: Apply n-layer LAYERS.

Step 5: Pooling of function and generalize the matrix.

Step 6: Apply the ANN

With optimization model $\boldsymbol{min_{\omega,\xi,Q} P(\omega,\xi)}$ we describe the model of ANN Prediction.

$$\boldsymbol{min_{\omega,\xi,Q} P(\omega,\xi_r) = \frac{1}{2}\omega^g\omega + \frac{1}{2}\gamma\sum_{r=1}^{n}{\xi_r}^2}$$

$$\boldsymbol{s_r[\omega^t\phi(u_r) + Q = 1 - \xi_r, r = 1,2,\ldots..,n}$$

$$\boldsymbol{\xi = (\xi_1,\xi_2,\ldots\ldots.\xi_n)}$$

Where

$\boldsymbol{\xi_r}$←Slack variable

Q←Offset

$\boldsymbol{\omega}$←Support vector

$\boldsymbol{\gamma}$ ←Classification parameter for balancing the model complexity and fitness error.

Then, describing the classification decision function:

$$\boldsymbol{F(z_r) = sgn(\sum_{r=1}^{n}\alpha_r s_r L(q,q_r) + Q)}$$

Step 7: Make learning and testing Model.

Step 8: Analyze the COST.

## III. THE PROPOSED METHOD

### *3.1 Proposed Methodology*

**Step 1:** Initialize the Load/Power.
**Step 2:** Initialize the generator Load_Power.
**Step 3:** Allocate the generators and calculate the cost.
**Step 4:** Apply the PSO for optimization.
**Step 5:** If output of PSO is optimized then check the convergence otherwise genetic algorithm starts it working with the following steps.

- *(a)* Initialize the chromosomes.
- *(b)* Cross over between chromosomes.
- *(c)* Apply Roulette Selection.
- *(d)* Check Optimization. If optimize then go to convergence Check otherwise loop is running until Objective form is not obtained.

**Step 6:** Check the convergence. If converge then check the cost features otherwise again initialize the particles and Repeat the step 5.
**Step 7:** If cost is less than Δ C then stop.

### *3.2 Proposed methodology: Flowchart*

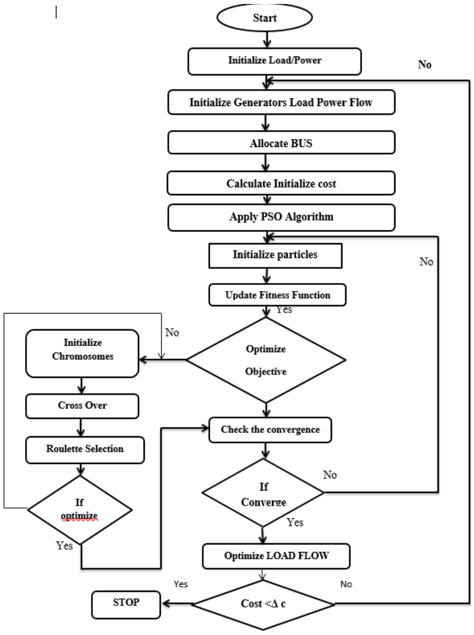


Figure 7: Proposed Design

### *3.3 Proposed Algorithm*

```
PSO_G.A
Step 1: Initialize the load/ power.
Step 2: Allocate the generators.
Step 3: Calculate the Initialize cost.
Step 4: In PSO model for each particle i in S do
Step 5:     for each dimension d in D do
Step 6:     //initialize each particle's position and velocity
Step 7:       $x_{i,d}=Rnd(x_{max}, x_{min})$
Step 8:     $v_{i,d}=Rnd(-v_{max}/3, v_{max}/3)$
Step 9: end for
Step 10: //initialize particle's best position and velocity
            $v_i(k+1) = v_i(k) + \gamma 1_i(p_i - x_i(k)) + \gamma_{2i}(G - x_i(k))$
        New velocity
            $x_i(k+1) = x_i(k) + v_i(k+1)$
  Where
   i- particle index
   k- discrete time index
   $v_i$ –velocity of i^th particle
   $x_i$ – position of i^th particle
   $p_i$- best position found by i^th particle(personal best)
  G- best position found by swarm (global best, best of personal bests)
  $G_{(1,2)i}$- random number on the interval[0,1]applied to the i^th particle
Step 11: $pb_i=x_i$
Step 12: // update global best position
Step 13: if $f(pb_i) < f(gb)$
Step 14:    $gb = pb_i$
Step 15: if the output is optimize then check the converge otherwise follow Genetic algorithm for optimize results.
Step 16: Population← initialize Population
Step 17: Evaluate the population.
Step 18: $S_{Best}$← get best solution from population.
Step 20: while (! Stop condition())
    Parents ← select parents(Population, $Population_{Size}$)
    Child← $\emptyset$
    For($Parent_1 Parents_2 \in Parents$)
    $Child_1 Child_2 \leftarrow Crossover(Parent_1 Parents_2 \in P_{Crossover})$
            $Children \leftarrow Mutate(Child_1, P_{mutation})$
            $Children \leftarrow Mutate(Child_2, P_{mutation})$
            End
            Evaluate the Population of Children
            $S_{Best} \leftarrow get\ best\ solution\ (Children)$
            Population← $replace\ the\ least\ fit\ population\ (children) with\ new$
    End
      Return ($S_{Best}$)
Step 21: Check the convergence. If results are converged then optimize features are the output.
Step 22: Check the cost and stop.
```

## IV. RESULT ANALYSIS

### *4.1 Result Analysis*

In this paper, analysis of different approaches of congestion and loss reduction with or without Distributed generator has been considered. In table 1 and other experiment we have used IEEE30 bus system. Table 1 represents the PI sensitivity base congestion in 3-Φ, 6 lines of distributed system.

Table 1 Congestion Lines

| FROM BUS | TO BUS | PI SENESTIVITY |
|---|---|---|
| 5 | 7 | -14.853 |
| 9 | 11 | 0 |
| 19 | 20 | -6.457 |
| 24 | 25 | -1.142 |
| 25 | 27 | -4.694 |
| 8 | 28 | -0.613 |

Figure1, figure 2 and figure 3 represents the IEEE30 bus system on current, power and voltage using the concept of Newton Raphson. It presents variation in every bus. Table 2 shows the real and reactive power losses using DG and without DG with different power factors. Figure 4 and figure 5 shows the comparison of real and reactive power loss. Both losses reduce when DG is different.

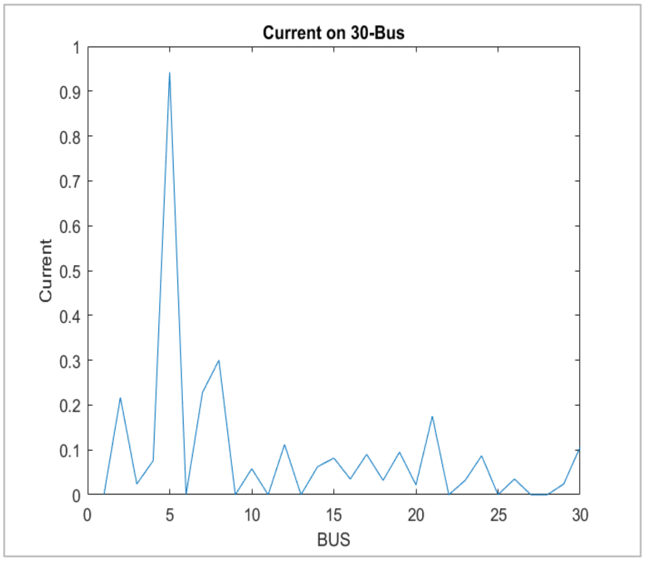


Figure 1: Current Distribution

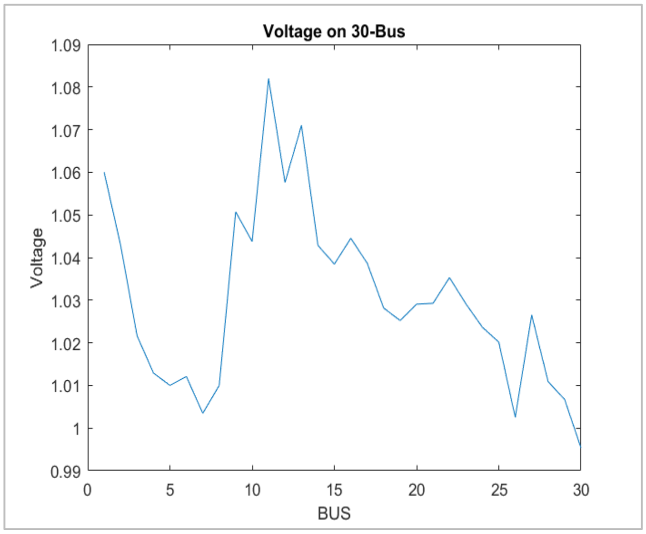


Figure 2: Voltage Distribution

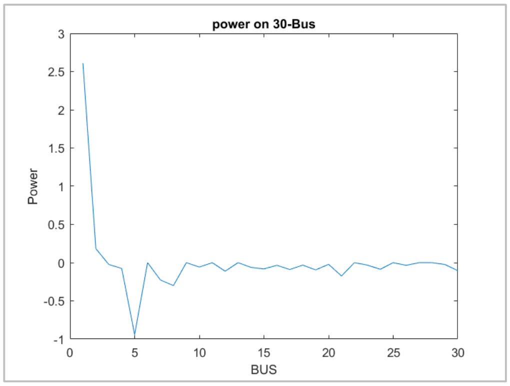


Figure 3: Power Distribution

Table 2 Distribution of losses

| LOSSES | 7.5MVA | 17.5MVA | 27.5MVA | without DG |
|---|---|---|---|---|
| REALLOSSES (PF=0.8) | 16.34 | 14.34 | 12.34 | 17.528 |
| REALLOSSES (PF=0.83) | 15.45 | 13.45 | 11.23 | 17.528 |
| REALLOSSES (PF=0.86) | 14.34 | 13.23 | 11.1 | 17.528 |
| REALLOSSES (PF=0.89) | 13.23 | 12.34 | 10.34 | 17.528 |
| REALLOSSES (PF=0.9) | 13.13 | 12.23 | 9.23 | 17.528 |
| REACTIVE LOSS (PF=0.8) | 67.45 | 69.34 | 62.34 | 68.88 |
| REACTIVE LOSS (PF=0.83) | 66.23 | 67.45 | 60.34 | 68.88 |
| REACTIVE LOSS (PF=0.86) | 67 | 66.34 | 58.45 | 68.88 |
| REACTIVE LOSS (PF=0.89) | 68 | 65.34 | 56.45 | 68.88 |
| REACTIVE LOSS (PF=0.9) | 66 | 63.45 | 67.45 | 68.88 |

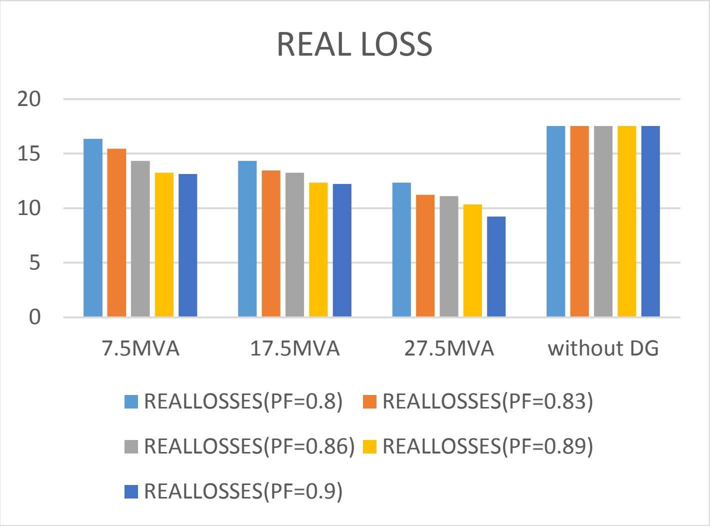


Figure 4: Distribution of Real Power Loss

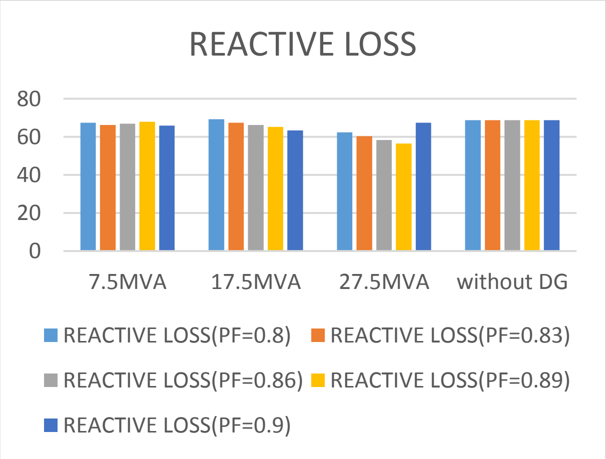


Figure 5: Distribution of Reactive Power Loss

Table 4 shows the comparison of ANN and PSO-GA base approaches for DG placement in IEEE 30 bus system. Figure 6 represents the voltage profile after applying the techniques of PSO-GA and ANN. PSO-GA helps in improving the power due to hybrid optimization process thereby improving the local and global degree of bus system but the technology of ANN focus over localized type of level. Hence, its effect on voltage and the other parameters have been presented just like the losses and cost presented in figure 7 and figure 8, where the losses and cost of the system gets reduced in the methodology of PSO-GA due to local and global approaches as discussed.

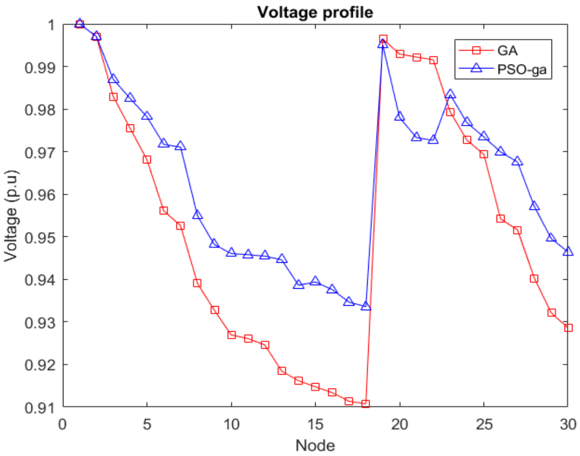


Figure 6: Voltage Profile

Table 4: Location-based parameters

| PARAMETERS | GA | PSO-GA |
|---|---|---|
| LOCATION | [9 19] | [24 28] |
| LOSS | 15.3422 | 12.333 |
| COST | 120 | 90 |
| DGSIZE | [10.23 7.45] | [7.23 6.45] |

## IV CONCLUSION

The results likewise indicate that DG devices definitely form a successful tool in dropping the loading of transmission lines. Moreover, with right direction as presented in the paper, DG units are effectively useful in reduction of program losses while increasing the reliability of the program simply by improving stresses and refining the entire voltage profiles on the transmission network path. The proposed methodology presents the reduced amount of cost as indicated by power factor.

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