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"Centralized And Decentralized Distributed Power generation In Today's Scenario"

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Abstract: *This paper is an analysis of a rural distribution network to examine what are the benefits of centralized and decentralized generation. Decentralized or distributed power generation (DG) play an increasing role in the liberalized electricity market. Decentralized generation can have a significant impact on the power flow, voltage, profile, voltage stability and get better power quality for both the customers and electricity suppliers. We use load flow analysis to simulate the line condition of different feeders connected in rural area. In this paper, models of distribution system with considerable distributed power generation are discussed to improve the power quality and voltage stability and also present a framework for valuing ancillary service from the generator Vi2, reactive power this provide an improved plan and better utilities for the developing countries to get their system to meet dispersed load while optimizing for renewable and other decentralized source.*
Keywords *-Distributed power generation, Network Modeling, Load flow analysis, Voltage profile and distribution losses.*

I. Introduction

The Electrical power system is traditionally designed and operated in large amount of power one way from the generation units through transmission and distribution network, rural electricity supply in India has been logging in term of service measured by hours of supply the conventionally , power plant have been large, centralized units a new trend is developing toward distribution energy generation. The industrial and commercial traffic in many state are high enough that many such user are switching to captive power generation typical using diesel generation. India wind based generation capacity is approximately 1,100MW though its location is specific. Biomass based power has a potential of 17,000MW from agro residues and an additional 5,000MW from co-generation. Presently India has more than 2,000 small scale (<100KW) biomass, gasifier reciprocating for a total generation capacity of 35MW the generation capacity from biogas/rice husk is more than 300MW. In the past, due to the economy of scale power generating station were often large and their capacities in the range of 150. 1000MW, ever larger in some case. Clearly such type of big power station required large facility including land and personnel need to operate and high capital. Moreover, since these big power station cannot be constructed close the load center for some obvious region there is a need for long extra high voltage.(EHV) or Ultra high voltage transmission line include transmission line and substation need bulk amount of money and resources for design, construction operation and maintenance[1]. Distributed generation is currently being used by some customer to provide some of all their electricity needs. For example some customer use DG to reduce demand charges imposed their electric utility. A number of DG can be organized to form micro grid (MG) which can either run parallel to the grid or stand alone. Many other application of DG exist the current trend of regulated electricity market, where as transmission generation and most important distribution system. Prospect for Distribution Generation (DG) is high. A number of advantage and climate of current electricity; currently favor the application of DG's therefore there are many issue needs to be considered before allowing the distributed generation to operate the power system [1].

In general the term "Distributed Generation" include all the use of small electric power generation whether place on the utility system. On the other hand "Dispersed Generation" is basically a subset of distribution generation that is located at customer facility or off the utility system. Usually the generation facility in very small range 10 to 250KW is classified as dispersed generation. Based on the technology used for electricity generation DG can be classified into different type:

Some of customer application of DG:-

1. Standby emergency power.
2. Improving the quality of supply and increase reliability.
3. Permitting customer to generate electricity while serving their thermal and cooling loads.
4. Meeting continuous power premium power or co-generation needs of the residential market.

5. Sell excess generation back on the grid, when there is a surplus of power especially during the peak hour.

However in order to use DG for various application in technically feasible and economically manner, therefore they have to be placed in suitable location.

II. Networking modeling:

The existing power system network should maintain stability while it is delivering power to the load [2].

1. **Stability:**
   The bulk amount of power is generated by using the conventional source where the generators are Synchronous Generator.

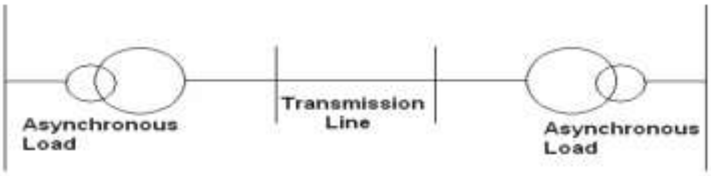


figure 1.0: Asynchronous System

figure 2.0: Synchronous System

The stability is divided into two regions:-

i) Steady State Stability
ii) Transient State Stability

Definition:

It is the property of synchronous machine to deliver the maximum power by maintaining synchronization with the externally connected transmission line

Synchronization: Magnetic Coupling

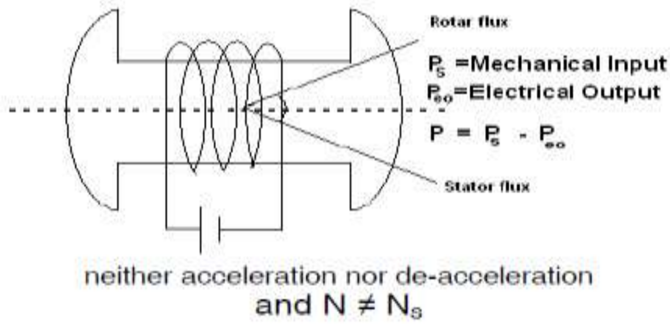


figure 3.0 Magnetic Coupling

So initially the air gap flux is magnetized flux, then the machine is stable.

Steady State Stability: - The steady state stability is the stability of the system under condition of gradual or relatively slow change in load. As the oscillation made by the roter, are very small so that the position of the rotor is almost in the stable condition. Hence the steady state stability of the synchronous machine will be analyzed by considering the static mode of the synchronous machine [2].

Static Modeling: Power transfer equation of impedance or reactance network in a phase manner with respect to neutral under the assumption that the synchronous generator in a star configuration [6][7].

Power at the load

$$S = VI^*$$
$$S = V[\frac{\mathcal{E}-\mathcal{V}}{X}]^*$$
$$S = V\angle 0 [\frac{\mathcal{E}\angle\delta - \mathcal{V}\angle 0}{X\angle 90^0}]^*$$
$$S = \frac{|\mathcal{E}||\mathcal{V}|}{|X|}(\angle 90^0 - \delta) - \frac{|V|^2\angle 90^0}{|X|}$$

Real power transfer or Electrical output

$$Pe = \frac{|\mathcal{E}|-|V|}{|X|}\sin\delta \quad \text{Static model}$$

P=Pmax, steady state stability limit The steady state limit of the synchronous machine is nothing but an angle stability i.e. if the angle can go beyond 900, the synchronous machine is unstable and the angle is less than 900, the synchronous machine is stable[3].

Dynamic Modeling: Dynamic modeling is nothing but due to sudden large variation of the load because of the occurrence of the fault, the change in the rotor angle will be high. Hence the transient stability of the synchronous machine will be analyzed with respect to rotor characteristics. It can be developed by taking the mechanical equivalent of the synchronous machine and it is also called as a dynamic model. The dynamic model is nothing but the study of the principal of kinematics of the rotating system [3].

III. Methodology:

Distributed generation can be placed in distribution feeder for minimizing real power losses[2][4]. Loss sensitivity factor or artificial intelligent techniques. Such as genetic algorithm or traditional optimization techniques. Improper selection of size could increase losses, in practice the load ability of distribution system is limited by voltage drop as most of distribution feeder are long and operating at low voltage level. In other word at maximum loading points, busses or loading nodes would experience a severe voltage drop the node which would experience maximum rate of change of voltage with respect to load increase is called the "weakest node" of the system by identifying this node and controlling the voltage of this node by DG will increase the load ability of the system, there are many ways to identify the weakest bus in a power system [4].

The weakest bus of a network transmission or distribution is based on static voltage stability. For stability, the index Lj[4] must not be violated for any node j. An L-assume a value between 1 and 0. An L of zero indicate a strong bus in term of voltage stability. The higher value of L indices are indicative of most critical buses and thus maximum L-indices (Lmax) are an indicator of proximity of the system, the indicator L is a quantitative measure for estimation of the distance of the actual state of the system to stability limit using the load flow result the L-index is computed as

$$Lj = |\, I - \sum_{i=1}^{i=j} fji(Vi \mid Vj)\, | \quad \text{------ (i)}$$

Where J=g+1,…….., n and all the term with the sigma on the RHS of eq (i) are complex quantities, the value of fji are obtained from the y bus matrix.

$$\begin{bmatrix} I_G \\ I_L \end{bmatrix} = \begin{bmatrix} Y_{GG} Y_{GL} \\ Y_{GG} Y_{LL} \end{bmatrix} \begin{bmatrix} V_G \\ V_L \end{bmatrix} \text{--- (ii)}$$

Where I_G,I_L,V_G,V_L represent the current and voltage of the generator node and load node. Rearranging the above equation

$$\begin{bmatrix} V_L \\ I_G \end{bmatrix} = \begin{bmatrix} Z_{LL} F_{LG} \\ K_{LG} Y_{GG} \end{bmatrix} \begin{bmatrix} I_L \\ V_G \end{bmatrix} \text{----- (iii)}$$

Where F_{LG}=[-Y_{LL}][Y_{LG}] are required value. The F_{LG} matrix to obtain by the specific [Y_{LL}] matrix L_u decomposition technique. The L-indces for a given load condition are computed for all load buses solving for vector.

$$[Z_{tj}] = [Z_g + 1, j .....Z_{jj}, ...Z_{nj}] \text{ ------ (iv)}$$

Corresponding j[th] load bus, from the solution.

$$\begin{bmatrix} Y_{g+1} .....Y_g + 1, j ....Y_{g+1}, n \\ Yi,_{g+1} ..Y_{ij} ....Y_{in} \\ Yn, g+1 ..Yn, j ....Ynn \end{bmatrix} \begin{bmatrix} Zg+1, j \\ Zjj \\ Znj \end{bmatrix} = \begin{bmatrix} 0 \\ 1.0.0.0 \\ 0 \end{bmatrix} \text{ -------- (v)}$$

Obtain the vector $[f_{ji}]=[f_{ji},........,f_{jg}]$ from the product of matrix.

$$[Z_{g+1,j} ....Z_{jj} ....Z_{nj}] \begin{bmatrix} Y_{g+1,1} ....Y_{g+1,g} \\ Y_{j,1} ....Y_{jg} \\ Y_{n,1} ....Y_{n,g} \end{bmatrix} \text{ -------- (vi)}$$

The equation for L-index for j[th] node can therefore be written as

$$L_j = \left| 1.0 - \sum_{i=1}^{i=g} F_{ji} \frac{V_i}{V_j} \angle \theta_{ji} + \delta_i - \delta_j \right|$$

$$L_j = \left| 1.0 - \sum_{i=1}^{i=g} \frac{V_i}{V_j} (F_{ji}^r + jF_{ji}^m) \right| \text{ -------- (vii)}$$

$$L_j^2 = \left[1.0 - \sum_{i=1}^{i=g} \frac{V_i}{V_j} F_{ji}^r \right]^2 + \left[\sum_{i=1}^{i=g} \frac{V_i}{V_j} F_{ji}^m \right]^2$$

Where

$$F_{ji}^r = F_{ji} \cos(\theta_{ji} + \delta_i - \delta_j)$$
$$F_{ji}^m = F_{ji} \sin(\theta_{ji} + \delta_i - \delta_j)$$

The direct and continuation techniques are typically used to identify the location of saddle-node, the maximum loading point in transmission and distribution system can be associated with saddle node bifurcation [5] the load flow jacobian become zero. Since the DG is capable of dispatching both real and reactive power they can decrease the total current by the feeder from the sub-station [6]. The feeder begin with a 66/11KV sub station there are total 128 buses out of which there are 74 load buses. Each load bus has a step down transformer for either 440V or 220V and the transformer rating are 25KVA, 63KVA, 75KVA or 100KVA.

Details of the distribution feeder's	
1. Substation Transformer	66/11KV
2. Total number of busses	128
3. Number of load busses	74
4. Peak load	3MW
5. Transformer in the feeder	25KVA, 63KVA, 75KVA, 100KVA

Table 1.0

The buses are numbered in a sequential manner but due to the branching of the network, higher number of node is not necessarily further away from the substation.

IV. Calculation:

Voltage Stability and Distribution Losses Graph.

1. Pv curve or nose curve at few busses for the base case (applicable of DG to enhance load ability of dg a case study).

Assumption for the 3 Phase AC Load Flow Analysis

AC load flow study

1) Our online load: the fraction of sanctioned load that is connected at any instant between 0.3 to 0.75.

2) Power factor: The load power factor is not known so I varied it parametrically between 0.7 and 0.95.

3) Transformer losses: I have ignored the losses in each of the transformer because of non-availability of data.

Variable	Value or Range
On-line load	35%-75% of the sanctioned load
Power factor	0.70-0.95 lagging

Table 2.0

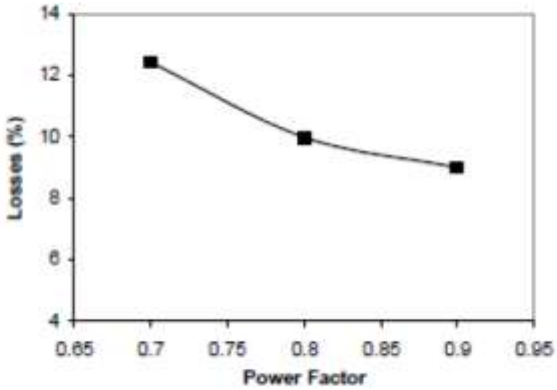
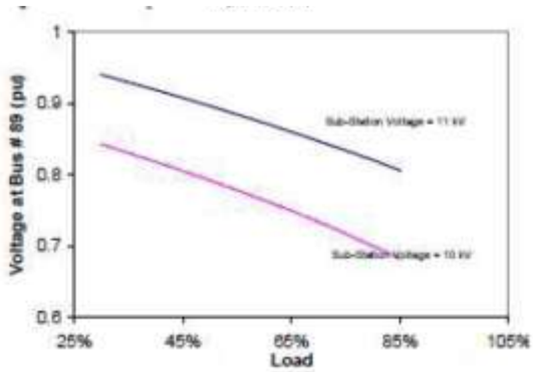


figure 4.0

(Fig 4.0) technical distribution loses in the feeder { D.P.G rural India – A case study}

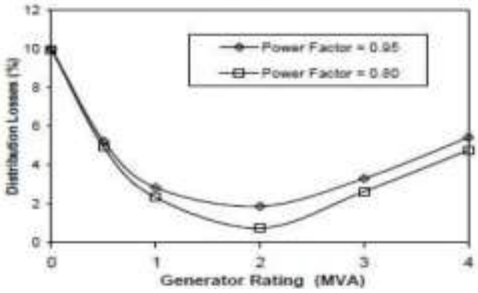


(figure 5.0)

(fig 5.0) voltage at under different load when the sub station voltage all 11KV or 10KV. To rectify the high losses as well as poor voltage stability.

1) Increasing the voltage for distribution reducing I2R losses.
2) Reducing the length for distribution.
3) Using decentralized power for providing real and reactive power.

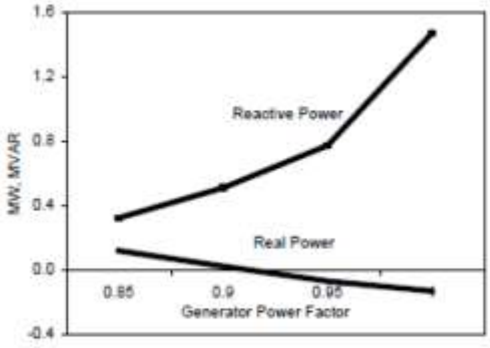
(Fig 6.0) shows the technical distribution losses as a function of the generator MVA rating. There is a dramatic reduction in the losses from the base care of 10% without the decentralized generator As the MVA rating is increased further there is surplus power generation in the feeder and there is a net export of real power to the grid in the particular figure the two instance where the generator power factor are 0.95 and 0.8. in the later case, the generator is also supplying reactive power and this is modeled using a generator capability curve [9].



(figure 6.0)

Fig 6.0 technical distribution losses for different MVA rating of the generation 0 – 4MVA for two generator power factor 0.8 and 0.95.

In the above figure is it also possible to determine the optimal location of the generator so as to minimize the losses.



(figure 7.0)

In the above Fig 7.0 the power transaction with the grid when a 3MVA generator is installed and the system is set to the following: load 60% power factor 0.8. The real power drawn from the grid decrease as the generator power factor increase and the power factor of 0.9 (lagging).

Therefore, the exact size and location a decentralized generation improve the quality of power supplied to the feeder and also reduce the distribution losses.[10][11]. The load flow studies of the rural distribution feeder showed that under most circumstances, the distribution losses decreases when a decentralized supplies power. This is because of the reactive power and voltage support provided by the decentralized generator.

II. Conclusion:

A methodology is presented in the paper for distributed power generator for a particular location in the distributed system for enhancing the load flow in the present system. I examined the distributed power generation in rural India north-west. I under took the case study based approach and carried out AC load flow for the feeder, and the weakest buses among all the buses. There is a possibility of setting up rural micro grid to decrease the distribution losses (I2R). Finally, I assessed the present policies of utilities for calculating the real and reactive power and conclude that it is unscientific and ignore the benefits of decentralized generation and ignore the benefits of decentralized generation to the utility in term of voltage stability and lower losses. Based on result and discussion, it can be concluded that DG can improve the steady state and voltage profit and also stability performance of the power system.

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