Distribution Generation: an Approach To Improve Voltage Profile

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***Abstract*— At present state, the electric utilities is a challenge as well as an opportunity for diversity of technologies but it's encounter the future of the regulation. All of the numerous parts of an electric power system, consumer recognize closely with the distribution subsystem due to its vicinity and reflectiveness on a daily basis. Latest development has stimulated the entry of power generation and energy storage at the distribution level. Both, Distributed resources and load management will be used by a distributed utility to obtain its goal. Integration of Distributed generation into present utility can result in numerous benefits. Which consists of improved voltage profile, better total energy efficiency, relieved transmission and distribution overcrowding, voltage support and delayed investments to enhance existing generation, transmission, and distribution systems. Benefits are not limited to utility. These benefits are diverged to whole system which include utility and consumer. The Distributed Generation has shaped a task and a prospect for developing various new technologies in power generation. This research work converses the primary factors that have prompt accumulative interest in Distributed generation. Distributed generation enhance system voltage profile and hence mends power quality. This research work investigates the optimal value of the DG capacity to be connected to the existing system. Newton-Raphson load flow solution is used to determine the line voltage stability index. It's calculates accurately the vicinity of the operating point to get the voltage collapse point and hence authenticates the importance of the recommended method. However, The mention method is tested on a standard IEEE 5-bus system and the results are obtained using MATLAB.**

I. INTRODUCTION

Distributed generation can imagine as —taking power to the load. Distributed generator has capability to produce electricity with high proficiency and less pollution. In the present work DG installed at or near the load. Generally, Distribute generator varied from 5KW to 100MW. Due to absence of moving parts in fuel cells and photovoltaic's cell have quite low maintenance cost. Some of the important points are listed below.

- There is flexibility for consumers to choose tailored power supplies to suit their requirements.
- Arrival of several technologies with condensed environmental impacts and high transformation efficiencies.
- With the help of advanced power electronic, reliability and power quality of system can be enhance .
- With the help of algorithmic language of computer the power flow, consumer requirements, load, demands and no. of components can be effectively control.

Various Distributed generation technologies are seeking attention of the researcher and it's under various phases of development. This consist turbines, gas turbines, diesel engines, photovoltaic systems (PV), gas-fired IC engines, wind energy conversion systems (WECS), and fuel cell systems. Various researcher shows that Wind energy is the most reasonable between all renewable energy technologies. A number of benefits can be drawn-out by integrating Distributed Generation into a present utility. These are line loss reduction, relieved transmission and distribution congestion, peak shaving, reduced environmental impacts, increased overall energy efficiency and voltage support. The DG has created eclectic task and an opportunity to develop new technologies in power generation. The research work shows the primary factors that prolong the interest in Distributed Generation. The research work shows that DG reduces line losses, increases system voltage profile. Hence allegedly improves power quality. Benefits of using DG are measured using Voltage Profile Improvement Index (VPII).

II. REMUNERATIONS OF THE DISTRIBUTEDGENERATION

In order to gauge and quantify the advantages of distributed generation appropriate mathematical models should be used at the side of distribution system models and power flow calculations to reach indices of advantages. Among the numerous advantages three foremost advantages are considered:

i. To recede in line losses.
ii. Ameliorate the Voltage stability.
iii. Enhancement of voltage profile.

III. PROBLEM FORMULATION

To Investigate the optimal location of DG a standard IEEE 5-bus system have been consider . A MATLAB program algorithm has been developed for power flow analysis.

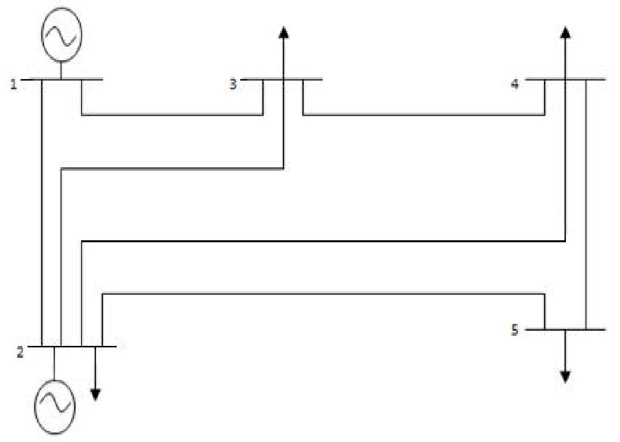

Fig .1 A Standard IEEE 05-Bus System

Tables 1and 2 shows the line data and bus data respectively. The 100MVA base is considered.

Table 1: Line Data

Line No.	From Bus	To Bus	Line Impedance		Half Line Charging Susceptance
			Resistance	Reactance	
1	1	2	0.02	0.06	0.030
2	1	3	0.08	0.24	0.025
3	2	3	0.06	0.18	0.020
4	2	4	0.02	0.18	0.015
5	2	5	0.04	0.12	0.015
6	3	4	0.01	0.03	0.010
7	4	5	0.08	0.24	0.035

Table 2: Bus Data

Bus No.	Bus Voltage		Generation		Load	
	| V |	δ (degrees)	P_G	Q_G	P_D	Q_D
1	1.060	0	0	0	0	0
2	1.000	0	0.4	0	0.2	0.1
3	1.000	0	0	0	0.45	0.15
4	1.000	0	0	0	0.4	0.05

In present work N- R method used for Power-flow analysis. The Power-flow analysis of the standard IEEE 5-bus system has been Consider. In present work DG has been installed at each individual bus. Readings has been taken at each individual bus. Voltage profile improvement index (VPII) has been formulated at each bus. Equate the voltage profile improvement index at 5% pu DG, at 10%pu DG and 15% pu DG of total real load. A program of MATLAB developed and Voltage profile improvement index for the buses calculated.

IV. ATTRIBUTES CONSIDER

- If Voltage profile improvement index is less than one, than Distribution Generator is not beneficial.
- If Voltage profile improvement index is equal to one, than Voltage profile remains the same, Hence Distributed Generator has no impact
- If Voltage profile improvement index is greater than one, than Voltage profile will improve, Hence Distributed Generator will be productive.
- The value of Distributed generator is 5%, 10%and 15% of the total real load.
- Since Load is Star-connected so line current is equal to phase current.
- At a particular power factor load absorbs real power.
- DG delivers real power at a leading or lagging or unity power factor.
- V_P is the RMS load phase voltage. is the reference phasor, The load complex power is , therefore, the current absorbed by load is:

$$I_L = \frac{P_L - jQ_L}{3V_P}$$

V. VOLTAGE PROFILE IMROVEMENT INDEX

The voltage profile is improved at various buses due to the addition of DG. The Voltage Profile Improvement Index (VPII) computes the augmentation in the voltage profile(VP) with the addition of Distributed Generator . Mathematically, Voltage profile improvement index(VPII) = Voltage profile with Distributed Generator/ Voltage profile without Distributed Generator. Based on this definition, the following attributes are:

- If VPII < 1 then Distributed Generator is not useful
- If VPII = 1 then Distributed Generator has not impose any impact on the system voltage profile,
- If VPII > 1 then Distributed Generator augment the voltage profile of the system.

The general expression for VP is given as,

$$VP = \sum_{i=1}^{N} V_i L_i K_i$$

Where

V_i is the voltage magnitude at bus i^{th} in pu,

L_i is the load represented as complex bus power at bus i^{th} pu

K_i is the weighting factor for bus i^{th} and

N is the total number of buses in the distribution system.

The weighting factors are decided on the basis of significance and criticality of various loads. No predominant approach can be considered at the present time. Starting with a set of equal weighting factors, variations can be made. According to the analysis, the value of weighting factor that will lead to the most satisfactory voltage profile on a system-wide basis can be selected. It should be observed that if all the load busses are equally weighted the value of K_i is given as: $K_1 = K_2 = K_3 = K_4 = \frac{1}{N}$. In present work assign equal weightage to all buses. Theoretically, Distributed Generator can be placed anywhere in the system. Therefore, VPII can be used to eclectic location for Distributed generator. In general, the peak value of VPII implies the optimal location for placement of DG. The influences of amount and importance of load at every bus can be observed from voltage profile index. DG ameliorates the occurrence of a low-load bus with important load to have a strong impact. Generally, weighting factors are assumed on the basis on the importance/criticality of load at each bus.

VI. RESULTS

The following result are obtained when DG of values 5%,10% and 15% pu of total real load is placed at different buses .

TABLE 3: VOLTAGE PROFILE IMPROVEMENT INDEX(VPII) WITH INSERT 5% DG OF TOTAL LOAD

S. NO	CASE NO	BUS NO	VOLTAGE PROFILE IMPROVEMENT INDEX(VPII) WITH INSERT 5% DG OF TOTAL LOAD
1	1	2	1.000025
2	2	3	1.007527
3	3	4	1.009587
4	4	5	1.014073

TABLE 4: VOLTAGE PROFILE IMPROVEMENT INDEX(VPII) WITH INSERT 10% DG OF TOTAL LOAD

S. NO	CASE NO	BUS NO	VOLTAGE PROFILE IMPROVEMENT INDEX(VPII) WITH INSERT 10% DG OF TOTAL LOAD
1	1	2	1.000052
2	2	3	1.007526
3	3	4	1.009589
4	4	5	1.014072

TABLE 5: VOLTAGE PROFILE IMPROVEMENT INDEX(VPII)WITH INSERT 15% DG OF TOTAL LOAD

S. NO	CASE NO	BUS NO	VOLTAGE PROFILE IMPROVEMENT INDEX(VPII) WITH INSERT 15% DG OF TOTAL LOAD
1	1	2	1.000080
2	2	3	1.007526
3	3	4	1.039737
4	4	5	1.014072

TABLE 6: ASSESSMENT OF THE DIFFERENT VOLTAGE PROFILE IMPROVEMENT INDEX

CASE NO.	BUS NO.	VOLTAGE PROFILE IMPROVEMENT INDEX WITH INSERT 5% DG OF TOTAL LOAD	VOLTAGE PROFILE IMPROVEMENT INDEX WITH INSERT 10% DG OF TOTAL LOAD	VOLTAGE PROFILE IMPROVEMENT INDEX WITH INSERT 15% DG OF TOTAL LOAD
1	2	1.000025	1.000052	1.000080
2	3	1.007527	1.007526	1.007526
3	4	1.009587	1.009588	1.039737
4	5	1.014073	1.014072	1.014072

VII. CONCLUSION

After evaluating the voltage profile improvement index at every bus, the research work concluded that voltage profile improvement index value is peak at bus no. 5, case no.4 with 5% DG. Voltage profile improvement index is peak when placed DG is 5% of total active load. Voltage profile is augmented with DG but at some buses, improvement is plinth like bus no. 3 case no. 2 .It is articulate from the analysis that heavily loaded bus voltage profile is augmented more than the lightly loaded bus at bus no.5, case no.4 with 5% DG of total active load, the voltage profile enhancement is maximum. at bus no.3, case no.2 the voltage profile improvement index value is plinth with 15% DG. Although, with 5% and 10% Distributed Generation of total real load, the value of voltage profile improvement index is improved at bus no.3. But in comparison to the other buses the value of voltage profile improvement index is plinth, when Distributed Generation placed at lightly loaded bus. The Distributed Generation impose impact at those buses which are heavily loaded. Therefore placement of Distribute Generation is not the assurance for augmentation of voltage profile; it's come in picture for the eclectic location and factors like its weighting factor, power factor etc.

VIII. FUTURE SCOPE

This research work ameliorates the voltage profile at the buses by installing the DG. Line loss can be recede using this approach and also voltage stability and power quality can be enhanced. The simulation model can be established using this approach in future and results can be investigated.

REFERENCES

[1] Das D. (2004),"Maximum Loading and Cost of Energy Loss of Radial Distribution Feeders", International Journal of Electrical Power and Energy Systems, Vol.26, pp.307-314.

[2] Das D., Nagi H.S and Kothari D.P, (1994),"Novel Method for Solving Radial Distribution Networks", IEE Part C (GTD) Vol.141, No.4, 291-298.

[3] Eberhart& Kennedy (2009)," Optimization of Distributed Generation Capacity for Line Loss Reduction and Voltage Profile Improvement using PSO". Vol 10, No. 2, 41-48.

[4] Gonen, T. (1986), "Electric Power Distribution System Engineering", McGraw-Hill, New York. Grainger J.J.and Stevenson W.D., (1994),"Power System Analysis", McGraw-Hill, New York.

[5] Gubina Fand Strmcnik B. and Bishop M.T. (1997), "A Simple Approach to Voltage Stability Assessment in Radial Networks", IEEE Transactions on Power Systems, Vol.12, No.3, pp.1121—1128

[6] Hoff. T (2007), "Optimization of Distributed Generation Capacity for Line Loss Reduction and Voltage Profile Improvement" . Vol 20, No. 2, 40-47.

[7] Joss, Lee R.E., Bishop M.T. (2008), "Distribution System Line Loss Reduction through Enhanced Capacitor Location Techniques" IEEE Transaction on Power Systems, Vol. PWRD-1, No. 2. 190-197.

[8] Kumar Ram (2003),"An approach to enumerate the various power quality indices in terms of voltage profile, line loss reduction" IEEE Transaction on Power Systems, Vol. PWRD-1, No. 2. 190-197.

[9] Macken(2006),"Optimization of Distributed Generation Capacity for Line Loss Reduction and Voltage Profile Improvement using PSO. Vol 10, No. 2, 41-48.

[10] Manougian H.S., EI-Saadany E.F., Lamont L.A and Chaar EI. (2010) "Improving power loss reduction calculations for Distributed Generation planning" IEEE international conference on power and energy.

[11] Ponnavsikko and Rao and (2006),"Optimal Choice of Fixed and Switched Shunt Capacitors on Radial Distributors by the Method of Local Variations", IEEE Transactions on Power Systems, Vol. PAS-102, No.6, pp.1607-1615

[12] Ponnavsikko, M. and Prakasa, K.S.(1981), "Optimal Distribution System Planning", IEEE Transactions on Power Systems, Vol. PAS-100, No.6, .2969-2977.

[13] Ponnavsikko, M. and Prakasa, K.S.(1983), "Optimal Choice of Fixed and Switched Shunt Capacitors on Radial Distributors by the Method of Local Variations", IEEE Transactions on Power Systems, Vol. PAS-102, No.6, .1607-1615.

[14] Pregelj (2005),"Distribution system reconfiguration for loss reduction: An algorithm based on network partitioning theory" Vol.11, No-1,504-510.

[15] Quezada, Das D., and Pai M.A, (2004),"Maximum Loading and Cost of Energy Loss of Radial Distribution Feeders", International Journal of Electrical Power and Energy Systems, Vol.26, pp.307-314.

[16] Rahman T.K.A. and Jasmon, G.B., (1995),"A New Technique for Voltage Stability Analysis in a Power System and Improved Load Flow Algorithm for Distribution Network",

[17] Rao P.S Nagendra, (1985),"An Extremely Simple Method of Determining Optimal Conductor Sections for Radial Distribution Feeders", IEEE Transactions on Power Systems, Vol.PAS-104, No.6, 1439-1442.

[18] Sarfi, R.J., Salama M.M.A. and Chikhani, A.Y (2009),"Distribution System Reconfiguration for Loss Reduction: An Algorithm based on Network Partitioning Theory, IEEE Transactions on Power Systems, Vol. 11, No. 1. 504-510.

[19] Sauer P.W., Ghosh S. and Pai M.A, (1999), "Power system steady-state stability and the load-flow Jacobian", IEEE Transactions on Power Systems , Vol.5, No.4, 1374-1383.