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Voltage Control Using Statcom in Dg Integrated With Distribution Network

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Abstract : *To increase the power generation, Distributed Generation (DG) based on Renewable Energy Systems (RES) such as PV Systems, Wind Energy Systems is extensively used. This paper proposes a method of integrating the DG with Distribution Network to maximize the penetrating DG Power into the Distribution Network. This method adopts power flow analysis & also uses STATCOM to control the variation in bus voltages in the distribution network. This method is implemented and tested using Power World Simulator on an IEEE 13-Bus industrial distribution system with different loading conditions, which results in a significant increase in a DG power generation.*
Keywords: *Distributed Generation, Optimization, Power Flow, Renewable Energy Systems, STATCOM*

I. Introduction

Distributed Generation (DG) is power generation system connected to distribution network to meet the increase in Load. DG includes various Renewable Energy Systems (RES) such as PV Systems, Wind Energy Systems, Fuel Cells Hydrogen Energy etc.,.
The Distributed Generation emerged as a way,

1. to integrate different power generation systems
2. to increase the DG reliability and security
3. to improve power quality
4. to improve the air quality with low GHG emissions of air pollutants

In addition, the distribution power generation system is cost effective as Renewable Energy Systems (RES) are cheaper to generate power. If the number of DG System increases in the distribution network, new control techniques should be implemented for the operation and management of the power, to maintain reliability and to improve the power quality. Therefore, the design of a new control technique[1], which considers different loading conditions of the distribution network, becomes of high interest for interconnection of DG System to the Distribution Network.

II. Optimization Techniques

In installing DG, it is necessary to consider the optimal placement and sizing. When installing DG integrated with distribution network, variation in voltage occurs. The various optimization techniques are discussed below,

1. Optimal Placement Of Dg

The Optimal placement process is a major role in installing DG in a proper place which results in better integration of DG with Distribution Network. Installing DG in a maximum load demand network is to reduce transmission loss & DG can also satisfy the Load demand. It is also to be considered on voltage constraints, when we install DG near Load.

2. Optimal Sizing Of Dg

When installing more number of DG near load, it will affect the bus voltage[2]. Due to reactive power absorption, it requires STATCOM to absorb excess reactive power. For real power flow, lesser installation of DG may not be sufficient to supply Load.

3. Power Flow Optimization

Optimal power flow[3,4] is the operation of transmitting the power system elements so as to reduce the steady state process while attending feasibility besides load. The design of the operation is given below. Assuming that, the following is known: Line Capacity, Transmission and Distribution Transformer Specification, Size of the Loads, Active and Reactive Power Generation Capabilities and other power system devices. The control variables c, which is controlled via optimization, is typically removal of the system operators:

1. Apparent power output of the Generator
2. Tap Changing Transformers and its Capabilities
3. VAR Compensating Devices
4. DC-Link Power Transfer Capabilities
5. Load Shedding Priorities

Initialization some s variables are,
1. Voltage Magnitudes at every Load,
2. Voltage Phase Angles at every Bus

III. Voltage Control Technique

In the equation of power flow, the variables are ‘c’ and ‘s’

$$\mathbf{EqCon(c,s) = 0} \qquad (1)$$

It can be analysed for an apparent power added and reserved from the bus. Operating limits of power system

$$\mathbf{ln\ EqCon(c,s) < 0} \qquad (2)$$

Capability[5] of active and reactive power generation having those constraints and voltage limit at buses, the variables s and c reduces the objective function,
By minimizing the objective function of the optimal power flow process goals to discover the variables s and c.

$$\mathbf{Minf(c,s)} \qquad (3)$$

1. Voltage Limitations

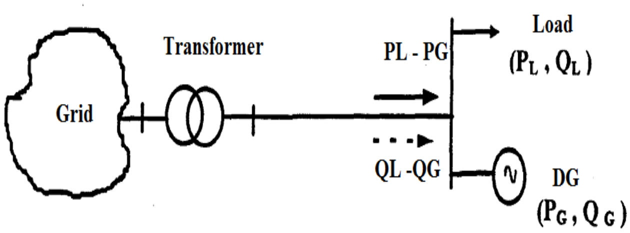

Fig 1. Radial System With Distributed Generator

Any system bus can be injected[6] by the amount of active and reactive power, amount of real and reactive power reserved from injected bus should equal to i^{th} bus. The power balance on the buses is formulated

$$\textstyle\sum_t (Pti + jQti) + \sum_g (Pgi + jQgi) + \sum_d (Pdi + jQdi) \qquad (4)$$

Where ‘t’ is transmission lines,
‘g’ is generators, and
‘d’ is loads connected to bus i.

P_{ti} ,$P_{gi,}$ P_{di} and $Q_{ti,}$ $Q_{gi,}$ Q_{di} are i^{th} bus injected the active and reactive power. By import or exports the above equation, from the external grid the i^{th} bus transferred the complex power.

Proper operation of the power system equipment and quality of supply requires the maintenance of the bus voltage close to nominal values. Quality of supply and equipment of power system operation in proper condition, requirement of nominal values are closes to bus voltage maintenance.

$$\mathbf{V_{min} < V < V_{max} \quad \text{for all buses}} \qquad (5)$$

Where Vmin and Vmax are lower limits and upper limits of the voltage bus V nearby the esteemed value.By regulation on quality of supply, policies of planning, environmental concerns, technological limitations, in most distributed generation applications are the installation of new Distributed generation capacity is limits, our analysis we have constant power factors

$$Cos\emptyset g = \frac{Pg}{\sqrt{Pg2+Qg2}} = Constant \qquad (6)$$

IV. Simulation

1. Method Of Determination For Voltage Profile For Each Node

In this paper, the amount of DG power inject into each node is determined by the optimal power flow method of the whole power distribution system. The optimal power flow method is set up a voltage margin can be fully observed to a sudden voltage variation.

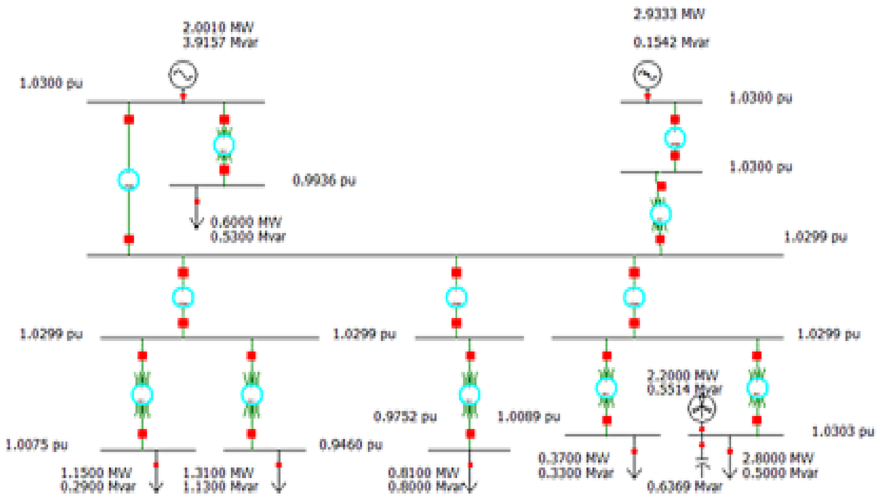

Fig 2. 13-Bus Industrial Distribution System

2. Simulation Results

Voltage distribution[7] on each node of the distribution network at full load condition is shown in Fig 3. The control states of SVR are shown in Table 1

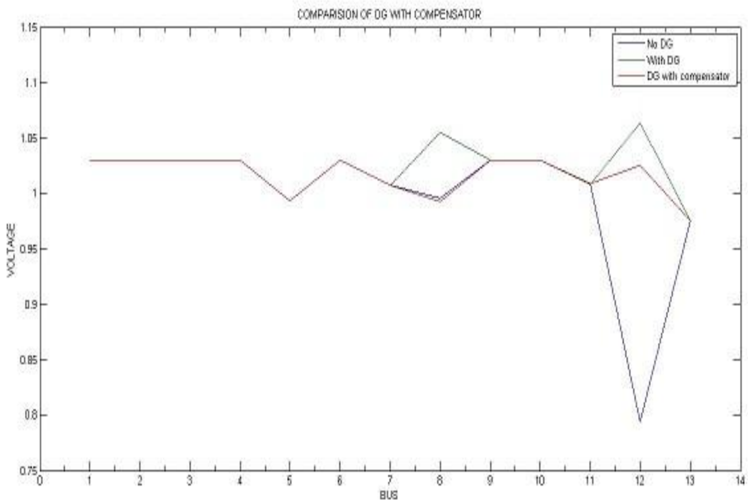

Fig 3. Voltage Profile For 13 Bus Industrial Distribution System

Bus	Without DG (PU)	With DG(PU)	Nominal Voltage (kV)
Bus 8	0.9459	0.9925	13.8
Bus 12	0.7941	1.0254	13.8

Table 1 Comparison Of Voltage Profil

V. Conclusion

In this paper a proper integration on distributed generation into a distribution network on voltage regulation constraints has been covered. As far as voltage limitation is concerned, it has been shown that distributed generation can undesirably affect the process of voltage control of the distribution network. However it depends on the location, magnitude, loading condition of the distributed generator and a DG may be used to support voltage control to regulate distribution network voltage within limit.

With concern to optimal location[8,9] of DG has been shown that distributed generation either increase or decrease system performance depending upon the maximum power injecting of the DG[10] compare to the voltage profile of load connected local to generation, the DG system effect of further complicated problems in the distribution network. However the VAR compensation device can be used to optimized the system problem while keeping the distribution network voltage profile within the specification limit.

Appendix

Specification of Test Systems:

Wind generator with following specification:
S=10MVA,P=2.2MW U=13.8KV,PF=0.86

From	To	R	X
Bus 1	Bus 2	0.00139	0.00296
Bus 3	Bus 5	0.00122	0.00243
Bus 3	Bus 6	0.00075	0.00063
Bus 3	Bus 9	0.00157	0.00131
Bus 3	Bus 10	0.00109	0.00091

Table 2 Per-Unit Line Data

Base Value =13.8 KV, 10,000 KVA

From	To	Voltage	% R	% X
Bus 2	Bus 3	69:13.8	0.4698	7.9862
Bus 4	Bus 5	13.8:0.48	0.9593	5.6694
Bus 6	Bus 7	13.8:0.48	0.7398	4.4388
Bus 6	Bus 8	13.8:4.16	0.7442	5.9537
Bus 9	Bus 13	13.8:0.48	0.8743	5.6831
Bus 10	Bus 11	13.8:0.48	0.8363	5.4360
BUS 10	**BUS 12**	**13.8:2.4**	**0.4568**	**5.4810**

Table 3 Transformer Data

Bus No	P_{Gen} KW	Q_{Gen} Kvar	P_{Load} KW	Q_{Load} Kvar
Bus 1	7450	540	-	-
Bus 3	-	-	2240	2000
Bus 4	2000	1910	-	-
Bus 5	-	-	600	530
Bus 7	-	-	1150	290
Bus 8	-	-	1310	1130
Bus 11	-	-	370	330
Bus 12	-	-	2800	2500
Bus 13	-	-	810	800

Table 4 Bus Data

References

[1]. H.M.Ayres and W.Freitas "Method for determining the maximum allowable penetration level of distributed generation without steady state voltage violation" Generation, Transmission & Distribution, Institution of Engineering and Technology (IET), Volume:4 , Issue: 4, April 2010
[2]. R. E. Brown and L. A. Freeman, "Analyzing the Reliability Impact of Distributed Generation", Proceedings of the IEEE Summer Meeting, pp. l013-l018, July 2001.
[3]. G.X. Luo and A. Semlye "Efficient Load Flow for Large Weakly Meshed Networks", IEEE Trans on Power Systems, Vol. 5, No. 4, November 1990.
[4]. Vovos P.N., Harrison G.P., Wallace A.R., Bialek j.w.: 'Optimal power flow as a tool for fault level-constrained network capacity analysis', IEEE Trans. Power Syst., 2005, 20,(2),pp. 734–741
[5]. Ent C.J., Ochoa L.F., Harrison G.P., bialek j.w.: 'Efficient secure AC OPF for distributed generation uptake maximization'. Proc. 2008 16th Power Systems Computation Conf. (PSCC'08)
[6]. Hiscock N., Hazel T.G., Hiscock J.: 'Voltage regulation at sites with distributed generation', IEEE Trans. Ind. Appl.,2008,44, (2), pp. 445–454
[7]. Senjyu T., Miyazato Y., Yona A., Urasaki N., Funabashi T.: 'Optimal distribution voltage control and coordination with distributed generation', IEEE Trans. Power Del., 2008,23, (2), pp. 1236–12424
[8]. Baran M.E., Wu F.F.: 'Optimal capacitor placement on radial distribution systems', IEEE Trans. Power Del., 1989,4, (1), pp. 725–73
[9]. Y. He, G. Anderson and R. N. Allan, "Determining Optimum Location and Number of Automatic Switching Devices in Distribution System", Proceedings of IEEE Power Tech'99 Conference, Budapest, Hungary, 1999.
[10]. LOPES J.A.P.: 'Integration of dispersed generation on distribution networks – impact studies'. Proc. IEEE Power Eng. Soc. Winter Meeting, New York, NY, USA, January2002