ANALYZING VOLTAGE PROFILE AND TRANSMISSION LOSS OF IEEE 13 BUS TEST SYSTEM WITH TWO DIFFERENT DG's

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Abstract : Distribution generation includes a wide range of prime mover technologies, such as fuel cells, gas turbines, micro turbines, internal combustion(IC) engines, photovoltaic and wind power. The location and type of DG's have major impact on voltage profile and distribution transmission line losses of the distribution system, Hence in this work the transmission loss and voltage profile analysis of IEE 13 bus test system with two different DG's at different locations has been carried out. The modeling and simulation of Distribution system and Distributed Generators (DG) are performed using MATLAB/Simulink software package. Enhancement of the system Voltage profile with the insertion of Diesel Generator and Micro-turbine is observed and compared.

***IndexTerms* - IEE 13 BUS Test system, Diesel engine, Micro-turbine,MATLAB/Simulink.**

I. INTRODUCTION

A traditional electrical power system consists of power generation plants, such as thermal plants, hydro plants, and nuclear plants. Since these plants are located at far distances from the load centers, the energy must be transmitted from the power plants to the loads through the high voltage transmission lines and distribution systems. These plants, transmission lines, and distribution systems are already being used to their peak capacity, but the demand of load is increasing rapidly. This increase in load demand leads to the insertion of new power plants at the distribution system which are called as Distributed generators. The high cost and exhausting of fuel resources directed the research scholars to think about alternative energy resources.

Distributed generation includes a wide range of prime mover technologies, such as micro-turbines,internal combustion engines,fuel cells, gas turbines, solar cells and wind-power. The size, type and location of Distributed generators have its impact on the voltage profile and transmission lossof the distribution system. Hence it is very necessary to analyze the impacts of distributed generators on distribution system parameters. Many researches are carried in the area of the optimal location of distributed generators in distribution system by taking constraints voltage and losses and they have considered static model of DG's but practically the voltage profile and transmission loss depends upon type of DG's (ie: for different DG's the voltage profiles will be different) hence it is better to consider the dynamic model of DG's to understand the variation of voltage and losses with different DG's.

Diesel generators place an important role in power generating plants, industries and commercial installations to fulfillthe continuous and emergency standby power requirements for day to-day use. A good knowledge of basic operation principles, modeling equations, components and maintenance knowledge are very much required for the integration of diesel power plants in the distribution system.The micro-turbine technology as a distributed generator is becoming more potential and useful distributed energy source in the recentyears. This is due to its salient features such as high efficiency, less emission, low initial cost and portable. The micro-turbine generation system produces power in the range of 25 to 500 kW and can be operated in both autonomous and grid connected modes. Once micro-turbines are connected tothe distribution system, these generators will affect the dynamic behavior of the system. Hence dynamic models are very much necessary to understand the operation of micro-turbine.

In this work the dynamic models of diesel generator and micro-turbine are considered. Firstly IEEE 13bus test system simulation is carried out and then DG's are placed at voltage sensitive buses, voltage profile and losses at different locations and with different DG's are analyzed.

II. RELATED WORK

The key element of new distribution environment is to build and operate several DG units near load centers instead of expanding the central-station power plants located far away from customers to meet increasing load demand. Distributed generation technologies can enhance the efficiency, reliability, voltage profile, and operational benefits of the distribution system. DG can be powered by both conventional and renewable energy sources [1]. Several DG options are fast becoming economically viable [2-3]. Technologies that utilize conventional energy sources includes gas turbines, micro turbines and else engines. Currently, the ones that show promises for DG applications are wind electric conversion systems, geothermal systems, solar-thermal–electric systems, photovoltaic systems and fuel cells [4-5].

III. MODELING OF DIESEL ENGINE AND GOVERNING SYSTEM

Diesel generating set is made up of diesel prime mover, speed governor, generator and compound excitation transformer. It can be seen that this system has two closed-loop feedback control system they are speed feedback control system (figure 1) and excitation feedback control system (figure 2). Speed feedback system detecting generator speed quantity, and the compound excitation transformer of excitation feedback system detecting terminal voltage of generator and output current. For power system run reliably, the grid frequency constant is essential. Grid frequency constant can ensure the speed control of induction motor and synchronization generator. And grid frequency is decided by speed of in net diesel generator sets. Speed control system of diesel generator set also directly affect active power output of generator. For the control of generator excitation system, its control character also directly affecting the quality of power supply. Excitation system control will directly influence the voltage stability of grid and reactive power output of generator.

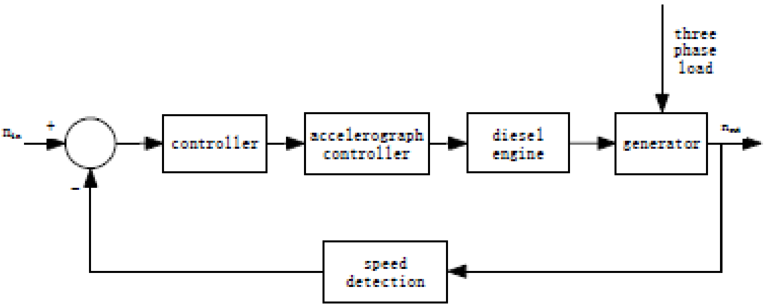

Figure 1: Diesel engine speed feedback control system

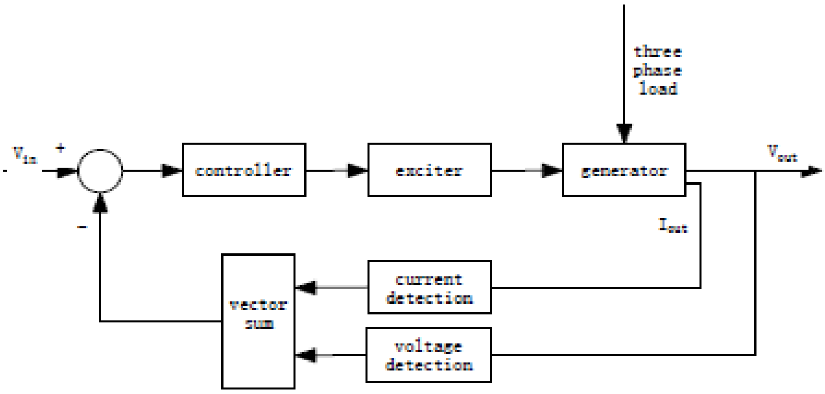

Figure 2: Generator excitation feedback control system

In diesel generator sets, diesel engine is the main purpose of providing impulsion. No automatic speed control of diesel engine oneself ability, thus it must furnish governor. The purpose is ensuring that the diesel engine can be specified speed to stable operation. In this paper, the combination of diesel engine and governor usedis second-order. The simulation model is shown as figure.3.

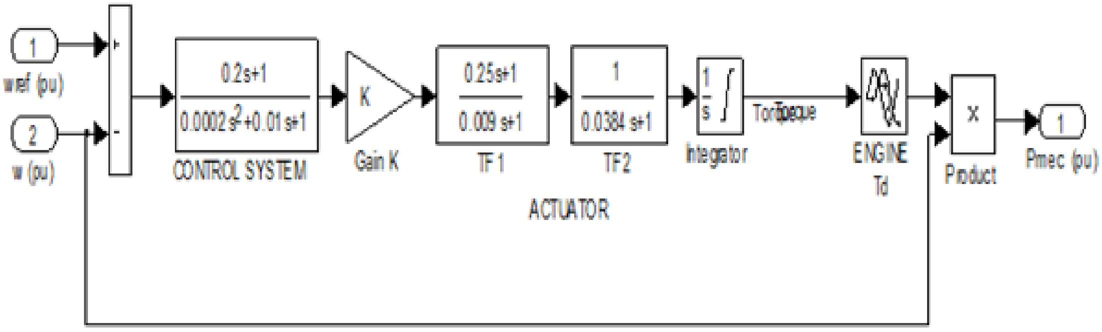

Figure 3: Simulink Model of Diesel Engine and Governor

IV. EXCITATION SYSTEM

It provides excitation for synchronous machine and regulates its terminal voltage in generating mode. The Excitation System block is a Simulink system implementing a DC exciter. The basic elements that form the Excitation System block are the voltage regulator and the exciter is shown in Figure 4.

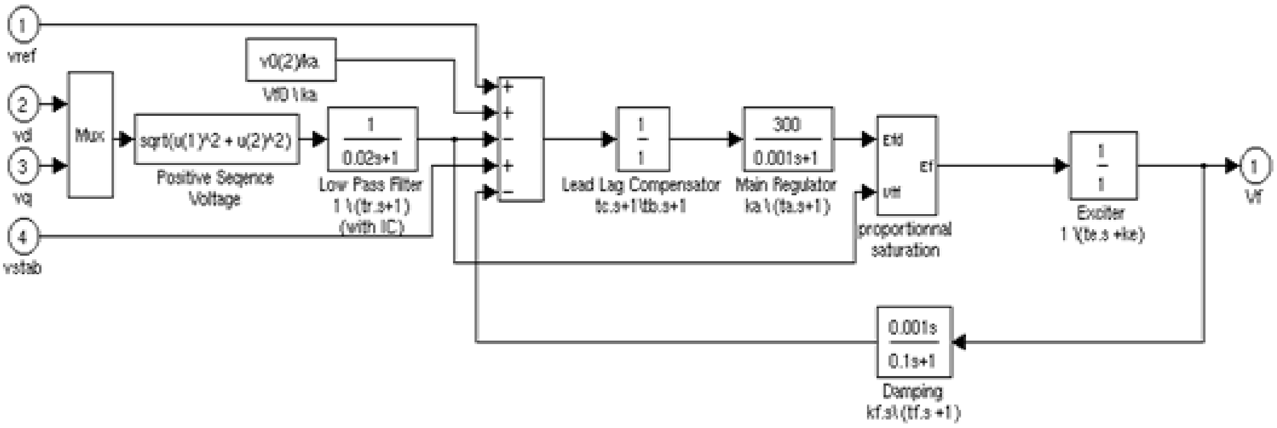

Figure 4: Excitation System block diagram

V. MODELING OF MICROTURBINE

In this section a model for dynamic analysis of a microturbine generation system is developed. The proposed model describes the dynamics of this devicewhen used as distributed generation source. The model is suitable for transient simulation and analysis and the finalmodel can be used in a distribution network to study theeffect of microturbine system on the distribution networkstability and the effect of network transients on themicroturbine stability.In order to model a microturbine system, four major partsare considered: high speed gas turbine, high speedpermanent magnet generator, power conditioning unitwhich itself consist of a rectifier and an inverter and thefinal part is load connected to microturbine terminal. Theproposed model is consisting of the dynamics of eachpart and their interconnections.

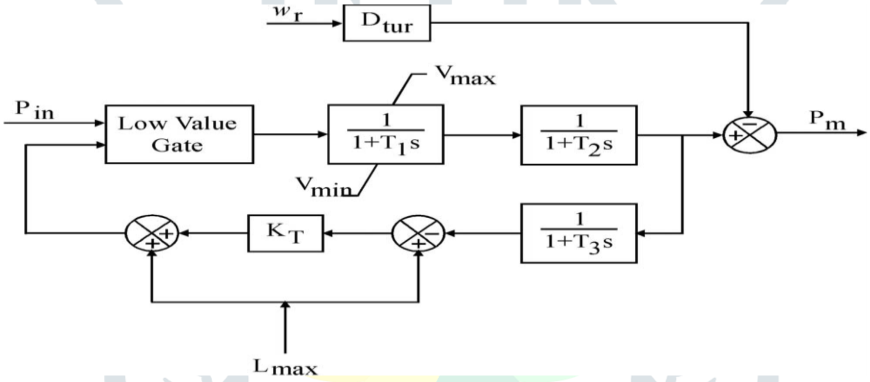

Figure 5: Turbine model.

Pm is the mechanical power, $D_{tur}$is the damping of turbine, $T_1$is the fuel system lag time constant 1, $T_2$is the fuel system lag time constant 2, $T_3$is the load limit time constant, $L_{max}$is the load limit, $V_{max}$is the maximum value position, $V_{min}$is the minimum value position, $K_T$is the temperature control loop gain. In the micro-turbines that are designed to operate in standalone conditions a battery is connected to the dc link to help providing fast response to load increases. The interface with the grid is also provided by an inverter.

VI. TEST SYSTEM

The 13 node IEEE test system is modeled using MATLAB/SIMULINK software package. A plant consisting of a resistive and inductive load is fed at 440 V from a distribution 11 kV network through an 11kV/440V Star-Delta transformer and from an diesel generator of rating 1100 kVA. The 11 kV network is modeled by a simple R-L equivalent source (short-circuit level 1000 MVA) and a 100W load. The plant has series R-L load of 900 KVA and resistive load of 500 KW.Initially, the 11kV distribution network supplies the load. At t = 11 s, overload condition occurs on the 11kV system, causing closing of the 11kV circuit breaker at t = 11.01s.Thus diesel generator starts to feed the load by maintaining the system frequency and voltage within the limits. Hence it maintains the continuous operation of the system. The figure shows the single diagram of IEEE 13 node test system.

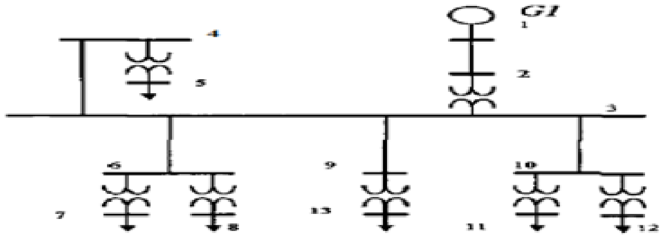

Figure 6: Single line diagram of 13 node test system.

VII. SIMULATION RESULTS

i) Location of DG

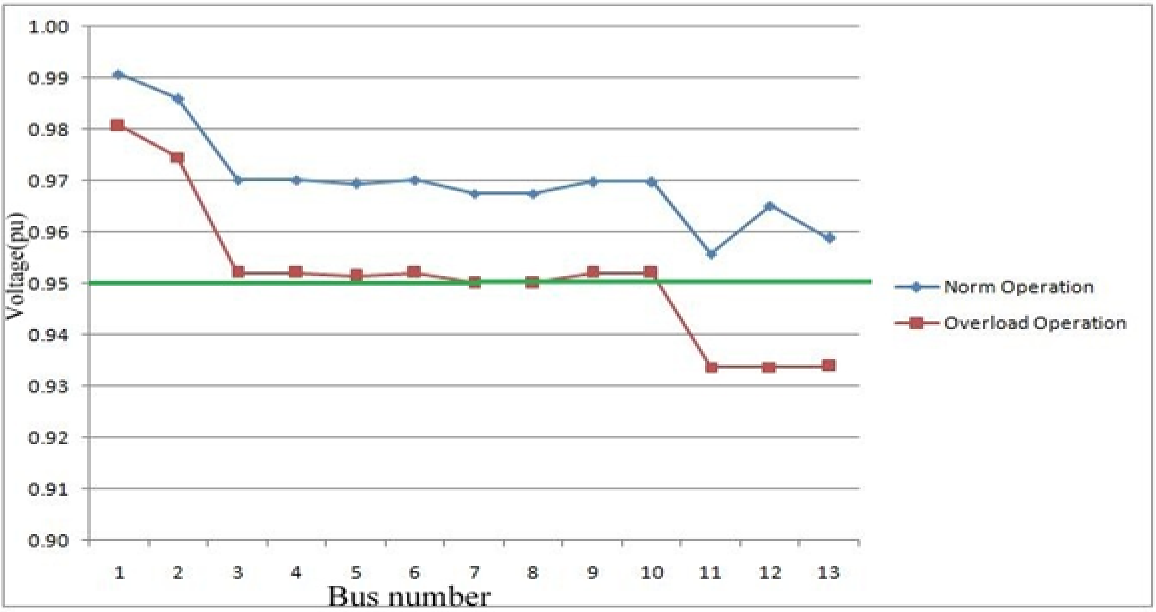

Figure 6: Voltage profile of IEEE 13 bus test system during normal and over loaded condition

From the Figure7 it can be observed that the voltage of all the buses during normal operation, lies above the acceptable range, but during the over loaded operation, the voltage at some buses, specifically at buses 11, 12 and 13 falls below the acceptable margin. These are the voltage sensitive buses where we have to place the DG's in order to increase the voltage margin. After the selection of sensitive buses, a DG of 0.5MVA capacity is placed at bus 11 and the voltage profile of the test system is recorded. Similarly, DG's of same capacity will be placed at bus 12 and 13 individually and the voltage profile of the test system is recorded. The recorded values of all bus voltages are shown in below figure.

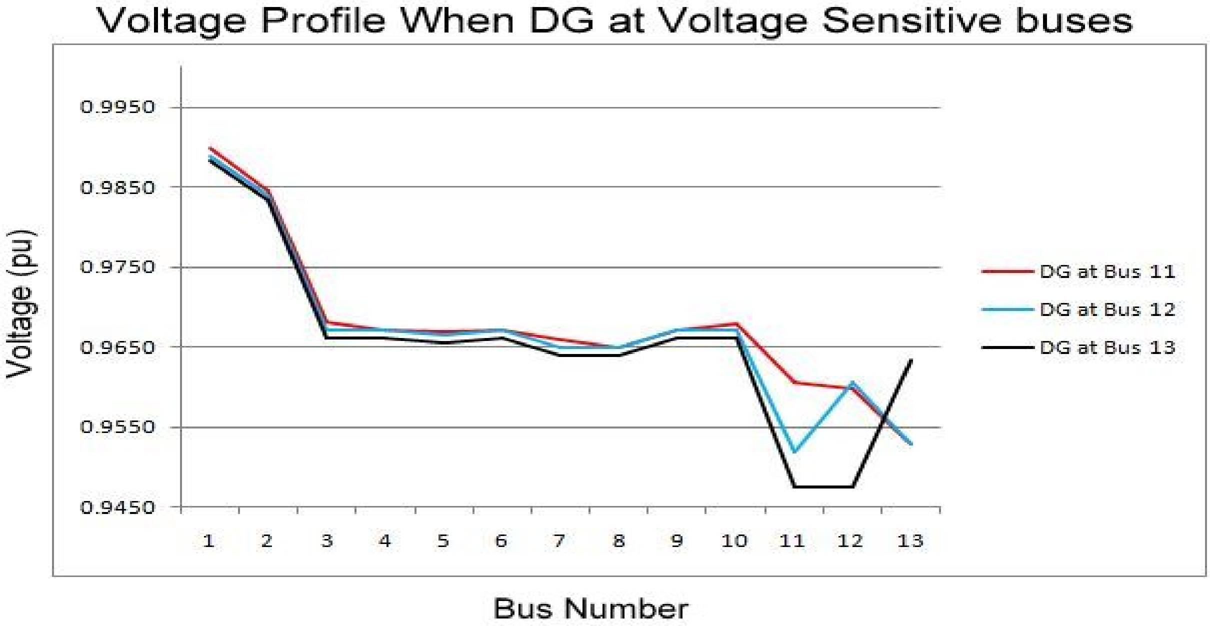

Figure 7: Comparison of voltage profile when DG placed at bus 11, 12 and 13.

The recorded voltages of all the buses when DG placed at bus 11, 12 and 13 individually are compared in Figure 8.Based on the comparison made, we can conclude that bus 11 is the best location for DG placement.

ii) Load Shared by utility and DG's

The variation of the load sharing between the distribution network and the distributed generator at different loading conditions has its impact on the stability of the distributed generator. The integration of DG at the distribution side involves change in power flow. The change in sharing of load is shown in the Figure 9.

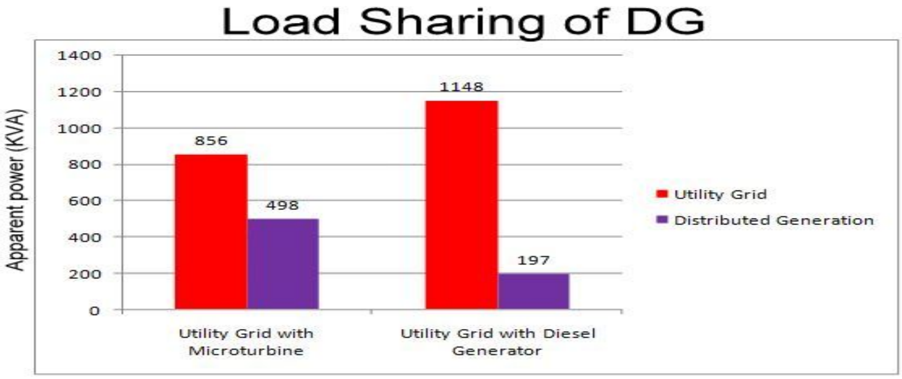

Figure 8: Comparison of power sharing by utility grid and DG's

From the Figure 9 we can conclude that the integration of the micro-turbine at the distribution side will result in sharing a significant load demand, when compared to diesel generator.

iii)Transmission Loss reduction by insertion of DG

In this section we concentrate on the loss reduction made by inserting the DG's at the best suited location. The insertion of DG at a bus will lead to the reverse power flow at the same bus which will result in peak load sharing and reduction in the transmission losses, but placing the DG at the location according to the section 7 will result in significant reduction in the transmission losses. The reduction in the transmission losses on insertion of Diesel generator and Microturbine is shown in the Fig 10.

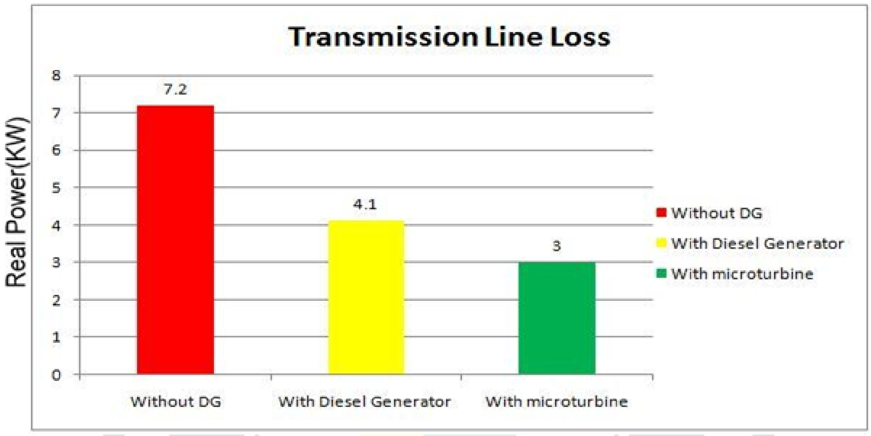

Figure 9: Loss reduction by inserting Diesel generator and Micro-turbine at bus 11

VIII. CONCLUSION

In this work, the dynamic modelling of IEEE 13 bus test system, diesel generator and micro-turbine has been carried out using MATLAB/SIMULINK software package. The modeled DG's are placed in the IEEE 13 bus system. Based on the voltage profile obtained from the results, optimal location for the placement of DG is decided. The insertion of Diesel generator on the distribution system improves the voltage margin of all the buses significantly when compared to the insertion of micro-turbine of same capacity. Thus we can conclude that the Diesel generator is best suited for the voltage profile enhancement at the distribution side

REFERENCES

[1] R.Ramakumar, P.Chiradeja; "Distributed generation and renewable energy systems", 37th Intersociety Energy Conversion Engineering Conference (IECEC), pp.716-724, 2002.

[2] P. Chiradeja , R. Ramakumar; "A review of distributed generation and storage", 31th Annual Frontiers of Power Conf., Stillwater, UK, pp. 1–11, 1998.

[3] S. Rahman; "Fuel cell as a distributed generation technology", IEEE Power Engineering Society Summer Meeting, July 2001, Vol. 1, pp. 551–552.

[4] T. Hoff , D. S. Shugar; "The value of grid support photovoltaic in reducing distribution system losses"; IEEE Transactions on Energy Conversion, 1995, Vol. 10, pp. 569–576.

[5] W. El-Khattam, M.M.A.Salama; "Distributed generation technologies, definitions and benefits", Electric Power Systems Research, 2004, Vol.71, pp119-128.