Review on Resolution of Issues In Reactive Power And Voltage STATCOM Based Distributed Generation

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Abstract- *Distributed generation (DG) is an emerging concept in the electricity sector, which represents good alternatives for electricity supply instead of the traditional centralized power generation concept. This Paper presents the basic principles of integrating distributed generation technologies in low voltage networks and particularly focuses on the economics of DG installations and the impact that DG may have on voltage control leading to improved power quality. Power system operation is very challenging from system security, reliability and efficiency points of view. The demand of electrical power is increasing continuously and existing power system networks are very complex, large scale, centralized and far from load centers to make energy supply to all customers must be continuously stable and reliable. Integrated distributed generation and existing power systems are capable of supporting energy security, such as during peak demand or power shortages.*

Keywords- DG,T&D,VC,FACTS,STATCOM

I. INTRODUCTION

For global climate change problem, renewable energy technologies are an important role in regard to and energy security for the future. The evolution of present conventional or centralized generation in the form of distributed generation and Smart and micro Power Grids has great potential to remove several issues linked with green energy, energy efficiency; energy security and the drawback of old power system infrastructures. These phenomena also become major options to fulfill the present high power demands and build flexible power system networks where both customer and power operator can mutually interact on a real time basis. The electricity marketplace is undergoing a tremendous transformation as it moves towards a more competitive environment. The 'growing pains' of this transformation – price instability, an ageing infrastructure, changing regulatory environments – are causing both energy users and electric utilities to take another look at the benefits of distributed generation(DG).[1].The combination of utility restructuring, technology evolutions, recent environmental policies provide the basis for DG to progress as an important energy option in the near future. Utility restructuring opens energy markets, allowing the customer to choose the energy provider, method of delivery, and attendant services. The market forces favour small, modular power technologies that can be installed quickly in response to market signals.

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.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 utilized to store any excess generation. 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 1**.

II. ISSUES

Distributed generation (DG) is currently being used by some customers to provide some or all of their electricity needs. There are many different potential applications for DG technologies. For example, some customers use DG to reduce demand charges imposed by their electric utility, while others use it to provide primary power or reduce environmental emissions. DG can also be used by electric utilities to enhance their distribution systems. Many other applications for DG solutions exist. The following is a list of those of potential interest to electric utilities and their customers.

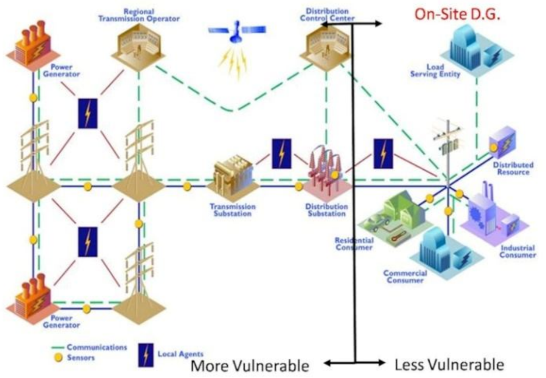

Figure 1. A Distributed Generation System

True Premium Power System - Clients who demand uninterrupted power, free of allpower quality problems such as frequency variations, voltage transients, dips, and surges, use this system. Power of this quality is not available directly from the grid – it requires both auxiliary power conditioning equipment and either emergency or standby power. Alternatively, a DG technology can be used as the primary power source and the grid can be used as a backup. This technology is used by mission critical systems like airlines, banks, insurance companies, communications stations, hospitals and nursing homes.

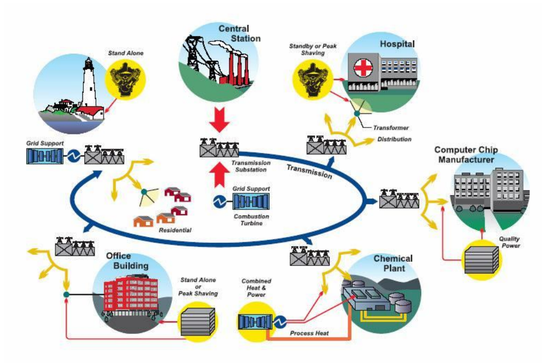

Figure 2. Summary of DG applications

Important DG characteristics for premium power (emergency and standby) include:

- Quick startup,
- Low installed cost
- Low fixed maintenance costs

A. *Issues of DG*

DG Electrical Interconnection

The interconnection with the network is a complicated procedure that involves the realiztion of a DG application. The DG operation is usually referred to as synchronised or parallel operation. In this configuration the DG is connected to the network the same time that it's producing power and in the case that the load is met any excess energy is also transmitted to that.The parallel DG operation is the most complicated in contrast with a stand-alone DG application. The complexity of DG operation generally depends on the level of interaction with the existing network.

Isolated, stand alone source Figure 3 In this case the load is met by DG only with no network connection.

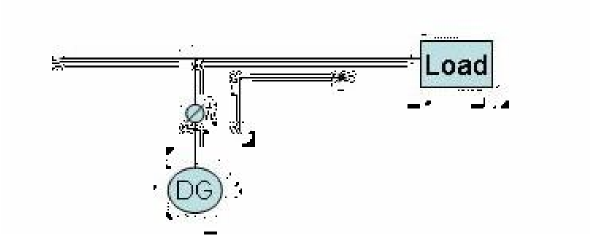

Figure 3. Isolated, stand alone source

Isolated system with automatic transfer **Figure 4.**DG provides power in Load 2. The network covers Load 1 and Load 2 when needed. DG does not work in parallel except for a few sec.

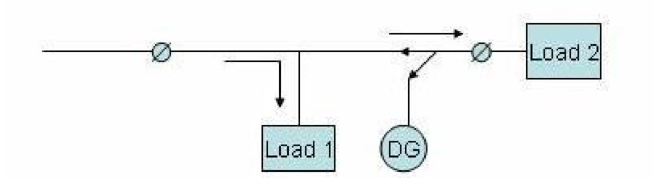

Figure 4. Isolated system with automatic transfer

DG connected to the network with no power export **Figure 5.**DG operates in parallel to the grid by transmitting power to one or more loads without sending any excess energy to the grid

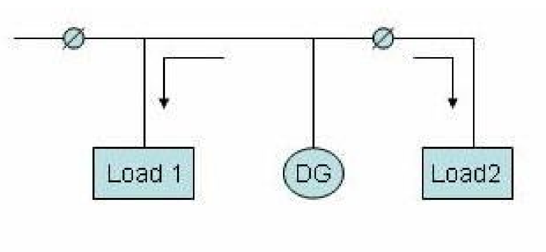

Figure 5.. DG Connected to the Network with no Power Export

B. *Technical issues*

The main technical issues for DG connection relate to reliability and quality of supply, protection, metering, and operating protocols for connection and disconnection, islanding and reactive power management. Voltage regulation, voltage flicker, harmonic voltages and DC injection are key quality of supply issues. Protection issues arise both for DG equipment and network equipment. The DG protection issues depend on the type of generator and the characteristics of the network. Network protection issues depend on the type and location of the DG installation and network characteristics. Thus protection design requires good communication between DG project developer and network service provider during the design process. It may be difficult to develop economically sound policies on how to pay for any required upgrades in the utility infrastructure to protect against those risks. Experts generally agree that the current risks to the distribution system from the parallel operation of small generators, representing only a small fraction of a local distribution network's capacity, are usually manageable. But the cumulative effects of many generators would be another matter. The utility network might require significantupgrades and additional protective devices to manage distributed generators that could use a large fraction of the local distribution network's capacity. [16]

C. Solutions to Voltage Control Problems

Line Re-conducting

Re-conducting a circuit with a lower resistance cable or overhead line improves the voltage regulation along that circuit. This improvement is a direct result of the lower network resistance, and therefore increases the amount of distributed generation which can be connected. Such a solution, however, clearly has associated costs.

Line re-conducting could be carried out at a time of scheduled asset replacement, where the marginal cost of using higher rated cables or lines may not be so great. Also, new networks have the option of using different design criteria, such as incorporating network designs with shorter cable lengths (but more, smaller transformers). Such an approach needs further study to quantify the costs and benefits and to optimize the design. The cost framework (i.e. regulatory incentives) would also need to be examined.

This solution can lead to a reduction in customer interruptions and connection interruptions, as a result of an increase of the availability of the connections and network capacity. Voltage profiles on the circuit can be improved, resulting improved power quality and lower losses. It is a “benchmark” solution and one of the key issues for implementing such a solution is the cost, and these are different for the different voltage levels.

Line re-conducting is a solution that can be readily adopted in the short term, but the introduction of new network design philosophies could and should be considered in the longer term perspective. These philosophies include:

i) Increasing the extent of the higher voltage networks, combined with the use of more, smaller, transformation nodes.

ii) Extending the extent of voltage control within networks, possibly as far as the LV network.

D. Generator Reactive Power Control

Reactive power control is a technique commonly used in transmission networks to maintain voltage profiles along a line. Generally speaking, transmission lines tend to be longer than distribution lines and their X/R ratio higher. This means that reactive power control is not so effective within distribution networks, but nevertheless can provide some benefits. Presently, however, it is normal practice for DNOs to require distributed generators to operate at (or close to) unity power factor since this has a governing influence on the reactive power. Reactive power control for conventional generation can be at the distributed generator, or at the connection point of several distributed generators to the network. Switched capacitor & reactor banks or transformer tap changers can be used, giving a wide range of options. A practical example might be a wind farm with asynchronous generators. These would normally require power factor correction capacitors to be fitted to provide for generator starting. The capacitors would remain connected to allow the wind farm to operate close to unity power factor. However, if the capacitors were switched out after the wind farm had started, and then the wind farm would import reactive power, helping to maintain a flatter voltage profile on the network. However, this could also give rise to a poor power factor condition on the remainder of the network and hence voltage control problems. Obviously, system studies would be required in any particular case to assess the possibility, but it is a very cost-effective solution when it can be applied. Increased reactive power flow also influences the network loading and could reduce the network capacity available.

The solution is dependent on the generation technology. For synchronous machines the reactive power control is achieved by excitation control, for asynchronous generators the control is through capacitor switching and for doubly fed induction generators (DFIG) machines the power factor and voltage control is provided by the DFIG’s ac/dc & dc/ac converters and controller. The control is limited by the reactive power capacity for the generation technologies. The control is limited by the reactive power capacity for the generation technologies. The solution results in a reduction in generation constraint, though the reduction depends on the reactive power capacity and the generator size. The generator connection costs relative to the additional connected capacity achieved for small to medium generators can be reduced. For higher capacity generators, the effectiveness of the solution is limited.

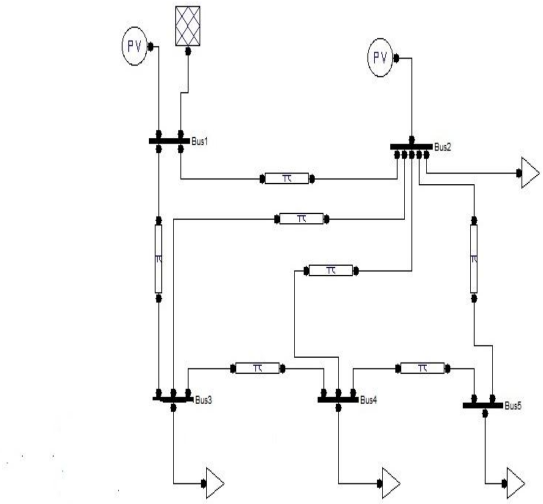

Fig.6 load flow diagram of IEEE-5 bus system

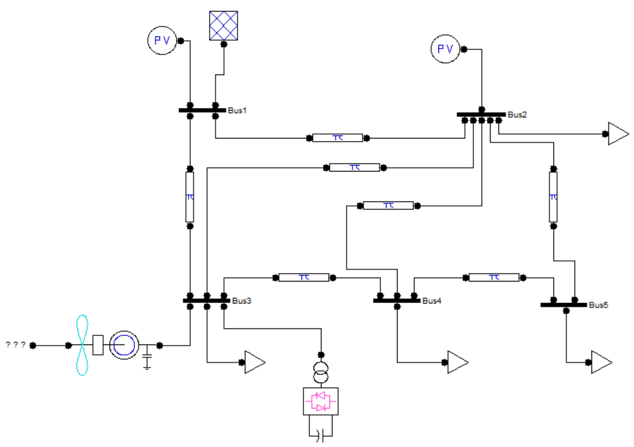

Fig.7 Simulation model of Load Flow diagram with DG and STATCOM IEEE – 5 Bus System

III. RESULTS

Here, in this work we have used the PSAT simulation software and the study has been done on an IEEE-5 bus network. From the graphs given below of a simple load flow and load flow with DG it can be seen that with the introduction of distributed generation into the network the voltage profile, active power profile as well as the reactive power profile of the existing network is disturbed. So in order to compensate for these disturbances, we are using the compensation method by FACTS devices like SVS and STATOM in our work we are using STATCOM as a fact device.

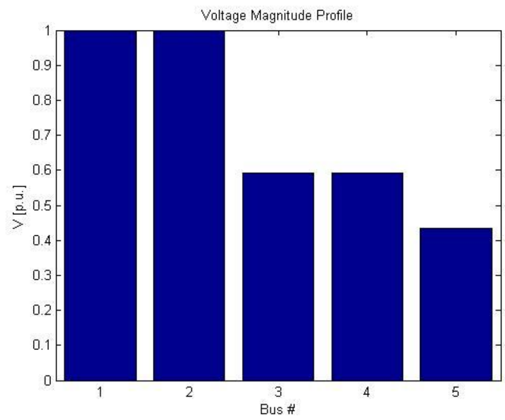

Fig.8. Voltage Profile

From the continuation power flow method, voltage profile will improved with the introduction of distributed generation into the network. The disturbances arisen will be eliminated through the STATCOM for increasing the stability, reliability and the performance of the power system.

The comparison between the simulation results obtained from simple power flow and power flow with DG and STATCOM connected can be seen respectively, with the integration of distributed generation the voltage of the network is improved.

The result of the simulation showed that the reactive and the active power losses were reduced with the DG connected to the power system and improvement was noticed in theactive and reactive power losses. The following given table will clearly shows the comparison of result.

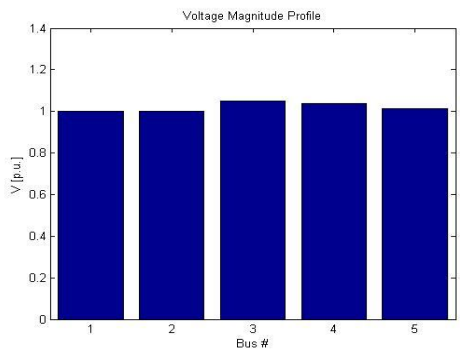

Fig.9.Voltage Profile

Result shows that the reactive power loss and active power loss are reduced with the above network configuration. It is therefore suggested that before connecting the distributed generation it is necessary that the system designer may think of the compensation devices as well as location of the distributed generation so that the losses are minimum. The optimal size of DG is also very important in reducing the losses. If a DGof any size is connected it will inject or absorbs the reactive power.

Table 1: Comparison

Power flow result without DG					
Total Generation		Total Load		Total Losses	
Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]
10.505	13.886	6.831	1.8844	3.6744	12.0024
Power flow result with DG					
Total Generation		Total Load		Total Losses	
Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]
10.18	11.97	7.129	1.966	3.051	10.0036
Power flow result with DG and STATCOM					
Total Generation		Total Load		Total Losses	
Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]	Real Power [P.U.]	Reactive Power [P.U.]
0.06247	-0.7924	0.051	-0.8242	0.01105	0.0318

IV. CONCLUSION

Distributed generation is expected to play a greater role in power generation over the coming decades, especially close to the end-use low voltage consumer side. There is a growing interest on the part of power consumers for installing their own generating capacity in order to take advantage of flexible DG technologies to produce power during favorable times, enhance power reliability and quality, or supply heating/cooling needs. The range of DG technologies and the variability in their size, performance, and suitable applications suggest that DG could provide power supply solutions in many different industrial, commercial, and residential settings. In this way, DG is contributing to improving the security of electricity supply. A main component in a DG installation unit can always be a cogeneration unit. CHP can convert over 80% of the fuel into usable energy. Depending on the ratio between fuel and electricity prices a cogeneration unit can always be operated in a flexible way in order to reduce the overall energy cost. In the case study the cogeneration unit has the ability to provide about 80% of the annual electrical demand and also satisfy the heat load of the installation. The low emissions of cogeneration to the environment establish it as the most favorable technology in order to meet the Kyoto Protocol targets. More than 20% of the whole energy production is to come by cogeneration.

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