Effect of Distributed Generation on Design of Commercial Electrical System

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***Abstract*— As the energy demand increases every year, use of distributed generators (DGs) has increased overtime to meet these increasing demands. The customer who is connected to the network may face various technical and commercial issues. We are exploring these possible issues in this paper.**

***Keywords*- Distributed Generation, Short Circuit Level, Voltage Regulation, Power Failure, Harmonics.**

I. INTRODUCTION

Currently, the power systems are undergoing a rapid restructuring process all over the world. Indeed, with deregulation, technological advancements and concern about the environmental impacts, there is an increase in competition on the generation side which allows an increase in the interconnection of the generating units to the utility networks. These generating sources are called as distributed generators (DGs). Distributed generation is defined as a generation with a limited size (roughly 10MW or less), which is interconnected at the substation, distribution feeder or customer load levels. DG technologies include wind turbines (WT), photovoltaic (PV), gas turbines (GT), micro turbines (MT) and internal combustion (IC) engine, and so on. It is predicted that distributed generation may account for up to 25% of all new generation by the year 2010 [9], [10]. The interconnection of DG to the utility networks, creates difficulty in operation and controlof distribution systems and offers many technical challenges for successful introduction of DG systems.

Positive impacts of the distributed generation are listed as follows [4]:

- Reduction in losses.
- Increase in the reliability of the utility system.
- Transmission and distribution capacity release
- Much easier and faster installation process.
- Decrease in cost by avoiding long distance high voltage transmission.
- Positive environmental due the use of renewable energy resources.

Because of these positive effects utility implements DG in their network.

Negative impacts of the distributed generation [4]:

- Due to the connection of DG sets to grid via power converters, there is an introduction of harmonics in the system.
- Over-voltages, fluctuations and unbalance of the system voltage occur if proper coordination with the utility network is not obtained.
- Change in short circuit levels on account of connection of DG sets to the utility system.

Since these are supply side issues the industrial or commercial customer (Existing/new) is affected by these changes.

II. IMPACT ON CUSTOMER NETWORK

We think the customer will be impacted in following ways;

A. TECHNICAL

- It may lead to short circuit levels exceeding the capability of customer equipment.
- It may lead customer to change primary equipment, protective devices or settings.
- It may involve disruption to supplies during implementation.
- It may result in a reduction or increase in the duration or depth of voltage fluctuations.
- It may result in a reduction or increase in harmonics.

B. SAFETY

- It may lead to more or less fault damage resulting from a change of short circuit currents or changes in fault duration time.
- It may result in customer protection systems not grading or not operating.
- It may result in faster or slower operation of safety systems.

C. REGULATING POWER MARKET

Electricity market aims at the correction of deviations from schedule i.e. the addition of generation if frequency decreases and reduction of generation if frequency increases. However, with increasing penetration of DGs, demand for regulating power has increased[2].

D. RELIABILITY AND FINANCIAL IMPACT

It is always profitable for customers to install DG sources that affect the grid reliability to a very small extent. Increase in reliability increases electricity unit cost which make passive customers to avoid having electricity as the cost is higher than they are able to pay, that is the rationing cost.

In order to profit passive customers, execution of a bilateral contract between the electric utility and passive customers harmed by DG source connection is necessary. This contract enables such customers to receive a portion of the profit the utility gains due to the implementation of the incentives and compensation scheme.

Increased reliability of supply can reduce redundancies in customer network design reducing their costs[1].

III. RECOMMENDATION FOR DESIGN ENGINEERS

We will discuss various technical issues in following paragraphs:

A. SHORT CIRCUIT LEVEL

Presence of DG on the utility system increases the short circuit current levels. Fault current varies largely with the size and position of DG from fault site and the type of DG used. The fault current level is directly proportional to the number of DGs connected to the utility system, loss in the synchronism of the fuse-breaker mechanism is caused when the level increases. This hampers the reliability and safety of the distribution system. If the DG is positioned between the utility substation and the fault, a fall in the fault current from the utility substation may be observed. This fall needs to be investigated for minimum tripping or coordination problems. Contrarily, if the strength of the DG source (or sources) is more than the utility system then the fault current flowing from the utility system is affected. This may lead to failure of tripping, sequential tripping, or coordination problems. The synchronous generator adds a lot of fault current level, while others being self-excited and induction generators, contributing only during the few initial cycles[5].

We think of the use of a “Fault Current Limiter” to reduce the fault current to lower, acceptable level so that the existing protection system can still be used to protect the customer network for existing customers.

B. PROTECTION FAILURE

Protection system can fail in two ways; 1) mal-trip and 2) fail-to-trip. In mal-trip, one of the protection devices trips instead of the intended one. In fail-to-trip case, the fault current is principally formed by the current originated from the DG unit. Consequently, the fault current through the over current protection device can be below the setting (depending on number of DGs) for which it was designed and the protection remains passive, hence the fault isolation does not take place[8].

The over-current relays used in DG interconnected systems face protection co-ordination problems, in such scenarios distance relay, adaptive protection; differential relays prove to be feasible alternatives.

C. DISTANCE RELAY

When a line is protected against short circuits, the relation between the voltage at the relay´s location and the fault current flowing to the short circuit is defined by impedance. This impedance is proportional to the physical distance from the relay to the short circuit. Therefore, these relays attain selectivity on the basis of impedance rather than current[6].

D. ADAPTIVE PROTECTION

It is “an online activity that modifies the requirements in a timely manner by means of externally generated signals or control action". Data networks which are proficient of transferring data in a secured way and with sufficient latency are essential in this task. Data networks are required in real time to achieve high speed control and protection[7].

E. HARMONICS

Harmonics could enter the system via DG. Generally, the harmonics are developed by the synchronous generators in the DG units or by the inverters.The level of harmonics produced depends on the design the generator winding, earthling and non-linearity in its core [3].

Industrial/commercial customers will have to implement power quality conditioning systems in their network [3].

IV. CONCLUSION

In order to achieve various benefits from the DG sets we need to consider both positive and negative impacts of DG sets. A lot of research work has been done to study the negative impacts of DG sets on the electrical system parameters as summarized in this paper. The impact of connection of DG on technical and commercial aspects of Industrial/commercial customer is discussed.

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