An Overview of Power Quality Issues in Distributed Energy System

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Abstract : Distributed generation, also known as on-site generation or decentralized generation, refers to the generation of electricity for on-site use rather than the transmission of energy through the electrical grid from a large, centralized facility. Because economic development is outpacing the expansion of electricity supply in some parts of the world, and other areas are experiencing capacity constraints in supplying electricity where and when it is needed, it is critical to encourage local alternatives for electricity generation and transmission. Power generation from centralized sources such as nuclear, hydro, and thermal power plants necessitates long-distance transmission. Despite the advantages, it has drawbacks such as high costs for extra services, long wait times, and the risk of blackout in the event of a grid failure. Distributed generation eliminates most of these problems by the introduction of smaller power systems close where they are required. This paper focuses on power quality issues that arise in distributed energy system during integration with grid and utilization.

***Index Terms* - Distributed Energy Systems, Power Quality, Harmonics, Grid.**

I. INTRODUCTION

Electricity generation at low voltage from various distributed generation (DG) systems, such as renewable energy sources, is gaining popularity these days. There are many reasons for this, including environmental concerns and the rapid development of micro gird technology for small-scale power generation. Renewable energy sources such as wind and solar are primarily used to produce electricity. Solar energy has the advantage of being able to be used almost anywhere. The capacity of photovoltaic installations is increasing due to lower installation costs and government financial support.

The PV system's unstable active power generation raises concerns about increased PV system penetration. Power quality (PQ), voltage regulation, and stability are all affected as a result of this. As a result, meeting IEEE and IEC standards for PV grid installation is critical. With recent advancements in electronics, it is now possible to control a PV system to increase PQ at the common coupling point (PCC). Although the primary purpose of a PV system is to produce active power, it is also possible to provide voltage and reactive power support to the grid. When connecting a PV system to the grid, a multilevel inverter (MLI) topology is used, and the controller is engineered so that the MLI can be used for active power transfer, filtering, reactive power compensation, not only harmonics, but also unbalance mitigation, and voltage control at the PCC.

II. POWER QUALITY ISSUES

Electricity has become an essential part of our daily lives. The increased reliance on electrical and electronic devices necessitates the availability of electricity 24 hours a day, seven days a week. Short interruptions and voltage sag, on the other hand, are destructive to SMPS-based devices such as computers, mobile chargers, and even PLC in industry. Non linear systems include semiconductor devices and electronic components. Nonlinearity has an impact on the entire system's safety and reliability, efficiency, and lifespan. These nonlinear devices cause power system distortions and degrade power quality [1].

The term "power quality" refers to the supply's availability, frequency, and voltage magnitude, as well as the power supply's waveform characteristics. If the electrical supply is constant at appropriate, steady voltage and frequency, and has a smooth sinusoidal waveform, it is said to be of good quality. Voltage variation in the form of voltage dips or sags, voltage swells, flicker, spikes or surges, overvoltage, undervoltage, interruptions, outages, harmonics, frequency fluctuations, and supply interruption are all causes of poor power quality. Poor power quality causes productivity loss, IT equipment malfunction, loss of stability, overheating of wires and equipment, production loss, and equipment life reduction. As a result, the quality of the power should be tracked, and adequate mitigation techniques should be used as a corrective action [2].

Industrial processes are often subjected to a variety of electrical disturbances. Voltage imbalance, harmonics, voltage sags, voltage spikes, and so on are some of them. Inadequate electrical grounding or wiring, as well as relationships between loads inside the premises, are responsible for 80% of all power quality issues. Problem-specific approaches may be used to address power quality issues. Depending on the nature of the corrective action and load ratings, various techniques are available [3].

Microprocessors and microcomputers based drives are polluting power quality in manufacturing applications. The power electronic drive generates harmonics and is a nonlinear load. More losses in the system, a reduction in product quality, and power supply reliability are all influenced by a polluted power supply. Harmonics will be suppressed, voltage unbalanced will be controlled, and the power factor will be improved, among other things, if power conditioners are used. The use of power conditioners in the system is found to be cost-effective [4].

Injection of the distributed generators into electrical power grid can affect voltage profile thereby affecting voltage regulation, sustained interruptions, harmonics, sags and swells. Mitigation techniques for power quality issues arising at various situations are described [5] at basic level. Penetration of DR can be successfully integrated with the power system as long as the interconnection designs meet the basic requirements that consider not only power quality but also system efficiency and power reliability and safety.

III. Power Quality Standards

IEEE 1547 standards [6] for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces are in place that provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. It also includes general requirements, response to abnormal conditions, power quality, islanding, and test specifications and requirements for design, production, installation evaluation, commissioning, and periodic tests for distributed energy resources.

IV. Impact of power quality on power system

The impact of integration of distributed energy resources in power system is reflected on power quality. The key power quality issues are discussed below [7 – 9].

4.1Harmonics

Sinusoidal components of a periodic wave or quantity with a frequency that is an integral multiple of the fundamental frequency are referred to as harmonics. PV plant inverters, which use switching devices, inject harmonics into distributed energy systems. Total harmonic distortion (THD) is a measure of the importance of injected harmonics. According to the IEEE standard 1547, THD shall be less than 5%.

4.2 Voltage fluctuation

Voltage fluctuations on the feeder buses are caused by the differing generation of distributed generation due to differences in natural parameters such as irradiance and wind speed. This is always the most limiting factor for the amount of Distributed Generation that can be accommodated on a distribution feeder without requiring modifications. At first glance, Distributed Generation appears to have the potential to increase voltage regulation on a feeder. Unlike traditional tap-changing transformers and switched capacitor banks, generator controls are much simpler and smoother. With enough Distributed Generation and careful engineering, this can be achieved.

4.3 Flicker

Mechanical power fluctuations in turbine-based energy generators are transferred to the electrical output as flicker. Flickers affect the system in the same manner that load fluctuations occur.

4.4 Voltage Sag

Voltage sags are the most prevalent power quality issue, but Distributed Generation's ability to help mitigate sags is highly dependent on the type of generation technology used and the interconnection location. When voltage sag occurs, Distributed Generation may act to counteract the sag. The voltage magnitudes and phase relationships can be supported by large rotating machinery. It is possible to control an inverter to counteract voltage excursions, but this is not a common feature. The service transformer's impedance, which adds some isolation from the source of the sag on the utility system, aids Distributed Generation's impact on sags at its own load bus.

4.5 Islanding

Though a distributed generator (DG) continues to power a location even when grid power is unavailable, this is known as islanding. Islanding can be hazardous for utility employees because they may not know a circuit is still on, and it may prevent devices from reconnecting automatically. Furthermore, without strict frequency control, the islanded circuit's load-generation balance can be disrupted, resulting in abnormal frequencies and voltages. As a result, distributed generators must detect islanding and disconnect from the circuit immediately; this is known as anti-islanding.

V. CONCLUSION

The distributed energy system is need of the hour despite of the power quality concerns raised in integration with grid. The power quality issues in distributed energy systems are discussed with its impact on power system. In the integration of renewable energy resources, a need is seen for a device which can improve the overall power quality. STATCOMs are proposed by researchers to cater power quality issues and developments are still going on to make it even better.

REFERENCES

[1] Ankita A. Yeotikar, Swapnil B. Mohod, " An Overview on Power Quality Issues in Power Systems", International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 11 | Nov -2016, pp. 581 – 584

[2] Daniel Ogheneovo Johnson & Kabiru Alani Hassan, "Issues of Power Quality in Electrical Systems", International Journal of Energy and Power Engineering, 2016; Vol. 5, issue 4, pp. 148-154

[3] Vidya.M, Dr.P.Pramila, "Power Quality Issues in Industries and Distribution systems", International Journal of Innovative and Emerging Research in Engineering Volume 3, Issue 6, 2016, pp. 75 - 78

[4] Rajashekar P. Mandi, Udyakumar R. Yaragatti, "Power Quality Issues in Electrical Distribution system and Industries", National Conference on Recent advances in control strategies for integration of Distributed Generation sources to grid and control of their power quality issues, at REVA University, Bangalore, July 2016, pp. 64 - 69.

[5] Umar Khan, "Distributed Generation and Power Quality", 7th EEEIC International Workshop on Environment and Electrical Engineering, 5-11, 2008. 17, 2008

[6] IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems, 2018

[7] E. Hossain, "Analysis and Mitigation of Power Quality Issues in Distributed Generation Systems Using Custom Power Devices", IEEE Access, Volume 6, April 2018, pp. 16816 - 16834

[8] S. Khalid and B. Dwivedi, ''Power quality issues, problems, standards & their effects in industry with corrective means,'' International Journal of Advanced Engineering Technology, vol. 1, no. 2, 2011, pp. 1–11,

[9] K. Ilango, A. Bhargav, A. Trivikram, P. S. Kavya, G. Mounika, and M. G. Nair, ''Power quality improvement using STATCOM with renewable energy sources,'' in Proc. IEEE 5th India Int. Conf. Power Electron. (IICPE), Dec. 2012, pp. 1–6.