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A Review on Smart Grid Power Quality issues

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ABSTRACT: In this paper, a review of Power Quality Issues relating to Smart Grid are studied from its classic literature and presents. The term Power Quality is used for expressing a origin of electrical power, measurement and monitoring process on the wide range. Analysis of Power Quality can be takes place on various stages of Power System such as low, medium and high voltage. Non-linear loads and switching phenomena are causes for disturbance in power quality at lower level voltage. In Higher level voltage, disturbances are occurring due to the variations in the load which is connected to the grid and also due to power plants itself too. A good power quality ensures important collaborations between all the grids connected equipment. So, this is a critical concern for reliable and profitable working for not only present grids but also future grids. The present paper describes the Introduction, Importance of awareness about Power Quality, The Scope of Power Quality, Types of Power Quality Disturbances and newly identified Power Quality Problems which helps the research community to give possible solutions and suggestion for the further research in the field of Smart Grid Power Quality.

KEYWORDS: Power Quality, Smart Grids, Voltage Sag, Voltage Swell, Power Quality monitoring

I.INTRODUCTION

A. Introduction to Smart Grid Technology:

Electrical power grid is a progress of a system that was used firstly hundred years before. After the decade, many new needs arise in the Grid and which shows that the current grid system will become un-appropriate soon in upcoming days. Many Types of equipment used in power systems like Transformers, Transmission lines are costly and also peoples are deserved for communication facilities, Information technologies, and controlling Schemes to grow up their performance. In the last few years, many more technologies related to power systems are becomes less costly. So, for trial purpose demonstration of these technologies are affordable, but still, it will be more costly to implement in technologies of Smart Grid throughout all over the network system. From the literature, each particular section of the power system has its specific self-requirements. So, each section should have to produce its own quality of being smart as per the requirement. Here, in this paper, the Smart Grid is an ideal prototype mainly and taken some components from it and added them into the current real system as some native problem arises[5].

B. Goals behind Smart Grid Technology:

- Better Power Quality specially in the Voltage Controlling and Voltage Sag effect.
- Improved, flexible and adequate use of electricity network.
- Reductions in the price for the use of network.
- Additions of new customer demand choices consisting time-of-day tariffs.
- Self-healing ability for better system Reliability.

II. IMPORTANCE OF AWARENESS ABOUT POWER QUALITY

Due to presence of non-linear loads in the Power System network, Power Quality (PQ) phenomena achieves more attention in recent years. Break-down interruptions in the power system occurs from Non-linear load as well as due to occurrence of short circuit, Loading & Load shedding of system, Mechanical Faults may also spoil the power quality of system. Normally there are two basic causes of Power Quality Synthesis. Losses in electrical power system is one of the cause and another cause is variation in cost rising from the disturbance in power quality.

Controlling or management of electronic assembly, safety and increased life of these devices makes the attention towards the power quality.

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Power Quality issues can create savior effects which may consist following situations:

a) Critical Industrialized activities (Safety arrangements, Programmed Control Processes, Monitoring equipment.)
b) Essential Business Activities (Banking, Fund exchange, Controlling Processes)
c) Required Public Service Activities (Hospitals, College Laboratories, Air Traffic Control, Paramedics)

Power Quality disturbance may also be often indications of safety problems which may requires prompt corrective solutions[14].

III.THE SCOPE OF POWER QUALITY

The designing of electrical System should be such that it is adoptable by rest of electrical System. Professional or IEEE standards, Regulatory agency Codes and Utility Guidelines are helpful for performance inspection and finding out operational guidance for compatibleness of electrical equipment.

Manufacturer of Electronic equipment, many Controlling and Measurement instruments are prescribes an independent or isolated ground arrangement in order to supplies a Lower Earth Resistance for reference. Often such prescriptions are opposing to that of Electrical Codes and Standards and does not form any kind of operational meanings[15].

The Power quality protection provided by the uninterruptable Power supply (UPS) is not completely fulfilled. The technologies of all UPS are not similar. Power Quality protection provided by the different technologies UPS are also different. The poor quality or UPS systems of low cost does not give any improvement in Power Quality and also likely Power Quality Conditioning. They are simply the back-up power instruments. The required protection of power quality such as voltage regulation, protection from surges from the UPS, then firstly we have to confirm that such technology is implemented in that device[14].

IV.TYPES OF POWER QUALITY DISTURBANCES

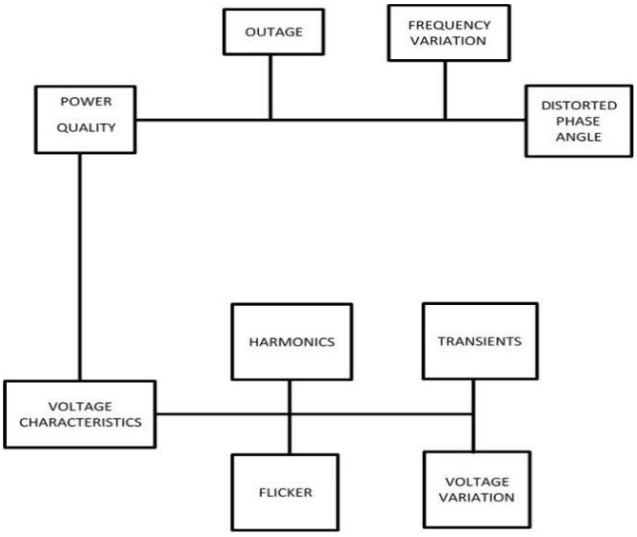

Fig.1 Block diagram of Power Quality Disturbances

A. Voltage Sag:

As per IEEE 1159, The Voltage sag means the decrease in the nominal system voltage level between 0.1 to 0.9 times of the normal rms system voltage.[2] Voltage sag is also known as voltage dip. This is due to faults happening on transmission and distribution network of parallel feeders. Connection of heavy or Non-linear loads in the system,

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Starting of Motoring loads and faults occurring during user's installation time are also subjected to Voltage Sag phenomena in a power system. This Voltage Sag phenomena results in mal-operation of information Technology based equipment, microprocessor-microcontroller based equipment such as computers, PLCs and this may results in to a stoppage of system. Voltage Sag/Dip issue also affecting on tripping of contactor due to which disconnection and loss of efficiency is happening in rotary machines[6].

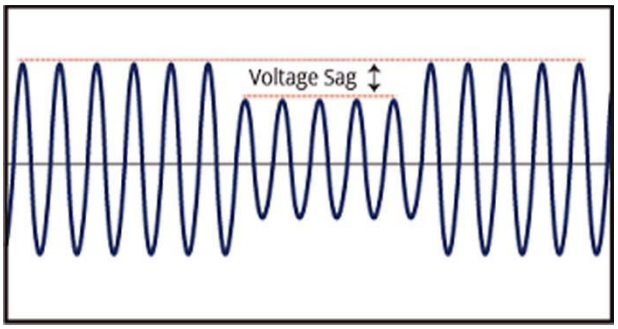

Fig. 2 Voltage Sag Phenomena

B. Voltage Swell:

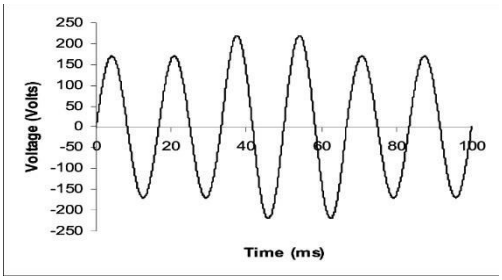

Fig. 3 Voltage Swelling Phenomena

IEEE Standard IEEE 1159 is defines a voltage swell as at a power frequency the increment in a voltage level (RMS) at 110% to 180% of a normal voltage level.[4] The Voltage Swell phenomena in power system is occurring due to switching off large inductive load or energizing of a large capacitor bank. However, voltage swell is not like as common as voltage sag, voltage swell is also subjected to faults in power system[3].

C. Voltage Unbalance:

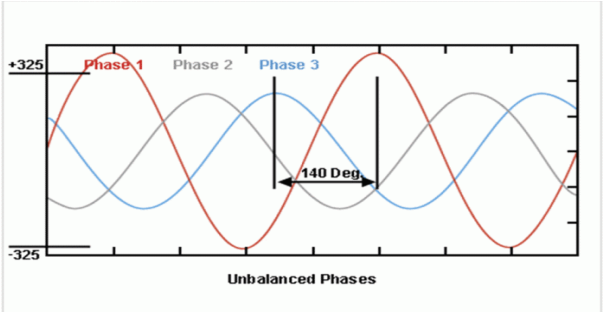

Fig. 4 Voltage Unbalancing

In three-phase systems, voltage unbalancing is occur when the magnitude of all three phases are not equal and unequal phase displacement. According to IEEE, Voltage Unbalance can be defined as the ratio of negative sequence component of voltage to the positive sequence component of voltage. Due to this voltage unbalance polyphase system are mainly affected[2], [4].

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$$\%VUF = \frac{Negative\ Sequence\ Volatge\ Component}{Positive\ Sequence\ Volatge\ Component} * 100$$

D. Flickering and Voltage Fluctuations:

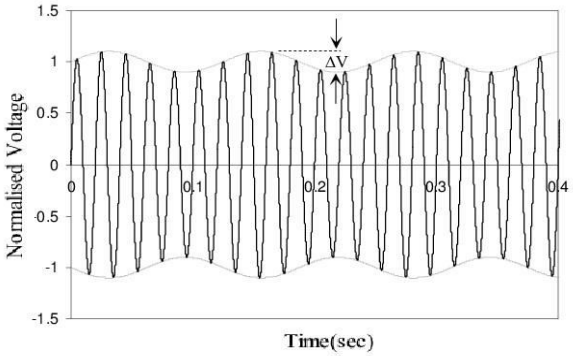

Fig. 5 Flickering

As per IEEE standard, Voltage Fluctuations can be defined as precise changing phenomena in the voltage wave, or a serial of change in voltage, in which the level of voltage magnitude drops down between the voltage limit that are specified by ANSI C84.1. This variation ranges from 1% to 70% of normal system voltage with frequency lesser than 25 Hz. Because of this power quality problem light output from various lighting sources continuously varies, commonly which is known as a Flicker. It is impacted from visual sensation instability comes by a light stimulus of fluctuating luminance with respect to time[2].

Generally, the voltage fluctuations are limited in between 0.1% to 7% of normal voltage level with below 25 Hz frequency. Due to this voltage fluctuation, light output from various lighting sources is varied, which is known as a Flicker. This is the representation of instability of the visual sensation which is carried out by a light stimulus, whose luminance is get fluctuated as per the time[1],[2],[3].

E. Transients:

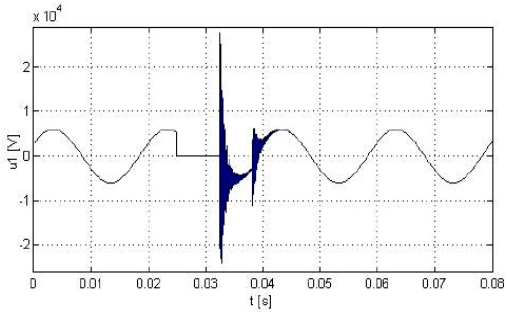

Fig. 6 Voltage Transients

From the rules of IEEE, when sudden changes occurs in voltages or currents in a system, some variations found in steady state condition of voltage and current in which frequency is differ than power frequency, this changes are known as transients. Transients are comes under short duration events. Due to which, detection of this transients is difficult. As the conventional meters are of limited frequency response or sampling rate they are unable to measure transients. These transients have 2 types:

a)Uni-directional Transients: When variation in voltage, current or in both is unidirectional then it is known as Unidirectional Transients. It consists either positive half or negative half.

b)Oscillatory Transients: When variation in voltage, current or in both are bidirectional then it is known as Oscillatory Transients. It consists of both positive and negative values[1].

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The causes behind the production of this transient are –

- Atmospheric Phenomena such as lightning strokes, solar flares, geomagnetic disturbances.
- Switching of loads
- Switching of transmission lines
- Switching of Capacitor banks
- Interruption of Fault currents[3]

Because of transients malfunctioning of many devices occurs which are sensible to changes in frequency[2].

F. Harmonics:

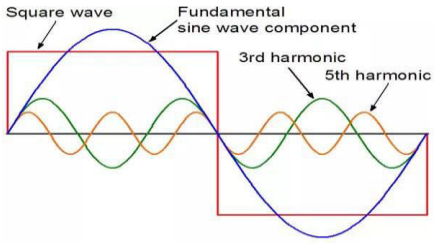

Fig. 7 Harmonics

Some other frequency components are occurs in fundamental wave whose frequencies are integral multiples of fundamental frequency. These components are known as Harmonics. These harmonic components are mingled with fundamental wave of current or voltage and generates harmonic distortion[2]. Percentage of Total Harmonic Distortion or THD can be used for computation of Harmonic distortion in a system.

These harmonics are occurred in a system because of -

a) Non-linear industrial load such as welding machines, variable-speed machine drives, large UPS systems, lighting systems.

b)Non-linear residential and commercial load such as Electronic office equipment, Computers, Printers, Xerox machine, electronic devices and lightings. Some loads are drawing uneven current between the positive and negative half of one cycle so, even harmonics are generated in a system. In addition with harmonics there is one more component is present which is known as inter-harmonics and as pre IEC-1000-2-1 it can be defined as the another frequency components observed in harmonics of power frequency which are not an integer multiple of fundamental frequency component and they can occurs as a discrete frequencies or as wide band spectrum[1]. Due to harmonics wave shape is changed and it becomes non-smoother. These harmonics are also causes to heating and blowing of fuse of capacitors which are implemented for power factor correction, Heating of transformers, Mal-operation and Tripping of over-current protection scheme, Heating of neutral conductors[2],[11].

G. Interruption:

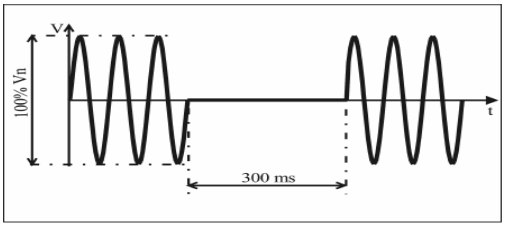

Fig. 8 Voltage Interruption phenomena

Reduction in system voltage or current to 10% of normal rms value and whose length is not beyond 60 sec is known as interruption. Sometime this interruption may be more than 60 sec then it is known as long duration interruption[1].

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The interruptions are occurs in a system due to faults occurring on a transmission line. Large inrush currents flowing through lines also causes for interruption in electrical system. In some cases, there are large installation faults which may also subjected to interruption. Due to this interruption, the current data is get disturbed or it may lost which may causes system to be corrupt. After Long interruption when system comes in normal state, it takes more time for system to be reboot. Interruption in a system may directed towards the large system failure as during interruption power system faults may occur, circuit breaker may become operate in malfunctioning operation. Thus, protection system of network fails.

V.NEWLY IDENTIFIED POWER QUALITY PROBLEMS

A. Emission from new equipment:

As smart grids are placed in service, the most expected outcome is to get increment in generation amount of electricity at smaller voltage range from local power plants like distributed generation and also in another new ways of use of electrical energy such as charging station for electric vehicles, spreading high speed railway network etc. Out of its cases, some of will introduces the power quality issues like unbalancing, harmonics. From preliminary study, harmonics are generated because of distributed generation is limited to some extent. Most of end user devices (like computers, lamps, TVs,) presented in the system emits lower order odd harmonics (3,5,7,9,etc), but there are some indications that there is a emission of Broadband Spectrum from modern devices and also from certain types of distributed generators[15].

B. Interference between devices and Power-line Communication:

Smart Grid performance is mostly depends on communication ability between Power Customers, Distributed generators, devices and Grid operators. There are many choices of communication channels but Power Line Communication is preferred because of its merits such as easily available & reliably operated. But selection of Power Line Communication added some new disturbances which affects worsen the power quality. Modern devices used in a system are interfere with Power Line Communication, not only by generating a high-level disturbance stage at selected level of frequency but also by the formation a low-impedance path, which can short the signals of Power Line Communication [16].

C. Enhancement in Voltage Quality:

The main concern to implement Smart Grid is to make better the performance of power system profile by avoiding the more investment for power system components like Transmission lines, cables, Transformers, etc. In demand side or by the view of customer side, there can be improvement in Voltage Quality, Reliability and price. For secondary improvement customer expects another thing such as Transformer Loading, Cable Loadings, protection co-ordination, efficiency, security arrangements. The voltage quality improvement resulted from Smart Grid as per expectation in near future, gives decrement in variation of Voltage magnitude in Longer-term. As per theoretical knowledge, the mitigation of undervoltage and overvoltage can be achieved by balancing between generation and consumption. This balancing can also be used for harmonic voltage control [17],[18].

D. Immunity of devices:

Due to disturbance in voltage quality like voltage dip many of distributed generators are triplet simultaneously. The solution for this problem is not yet found. As smart grid is designed for making balance between generation and demand or consumption side, the sudden tripping on consumption side could have similar adversely affect[15].

E. Weakening of transmission grid:

The increment in the application of distributed generations and wind mill parks resulted in a decrement in conventional generation amount which are connected to the grid transmission system. The fault level due to conventional transmission become less but due to distributed generation power quality disturbances are spreads. The spreading of power quality disturbances will worsens the voltage dips, flickers, fast voltage fluctuation and harmonics[19].

VI.CONCLUSION

In this paper, Power Quality Issues occurring during the operation of Smart Grid are explained. The newly identified Smart Grid Power Quality issues which are depicted in various literatures in past couple of years are reviewed. One of the major contributions in Smart Grid is of Distributed Generation. Mostly Distributed generation is

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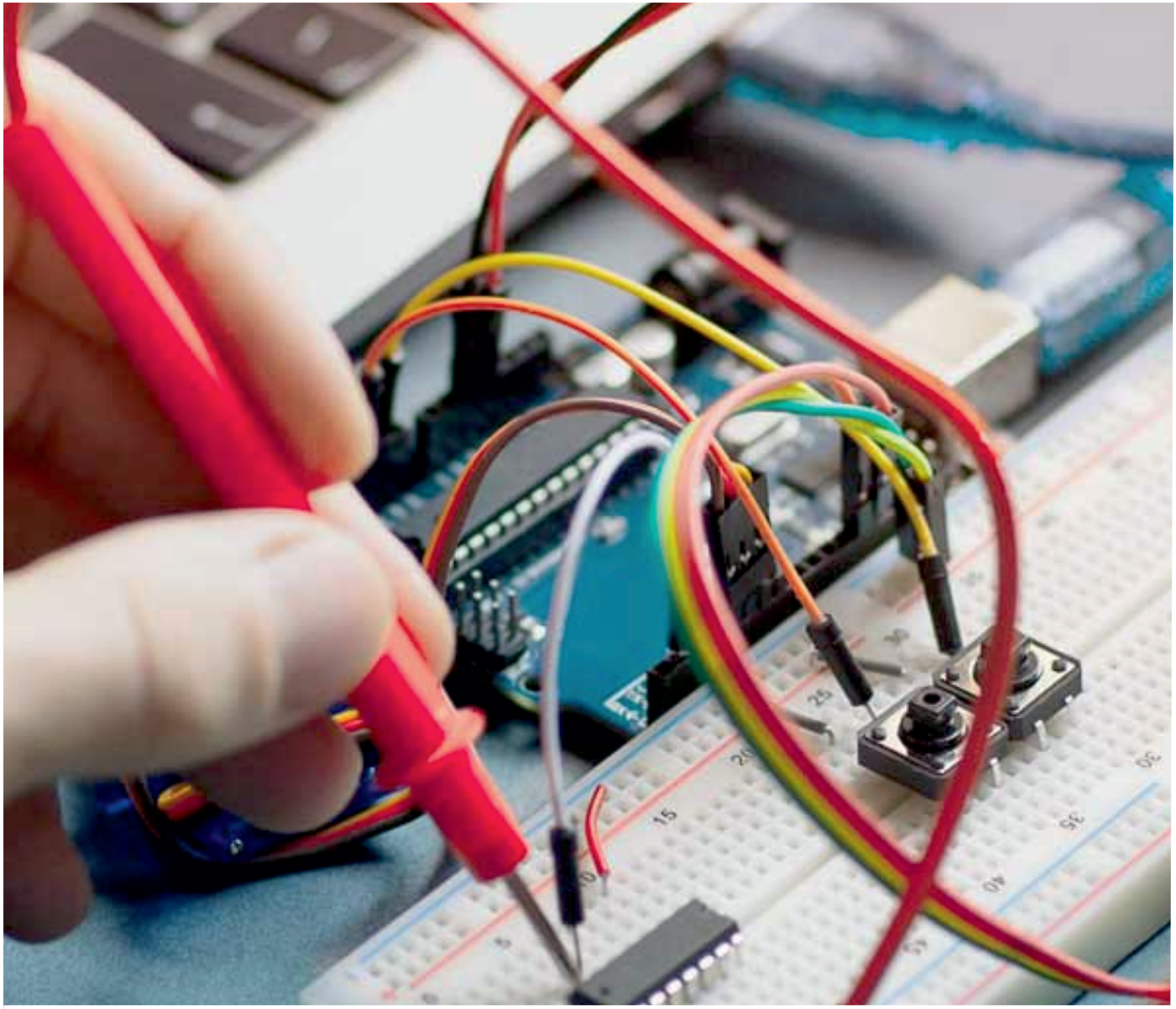
carried out with the help of various naturally available renewable energy resources. These renewable energy resources are varying in nature. Due to this variation, the generation achieved from them is also varied in nature. These variations subjected to the various power quality issues like sag in voltage, voltage swell, voltage unbalance, flickering and voltage fluctuations are discussed. Smart Grid System consists of various types of sensors for sensing and monitoring operation. Also, for controlling operation many power electronics circuitries are used. Due to use of various types of sensors and controlling circuitry, new problems regarding power quality are identified in Smart Grid. If poor quality supply is injected into the Grid, it may result in weakening of transmission grid and also may affects the health of various equipment containing in system. So, Power Quality Contributes a major role in overall system performance. For maintain reliability and continuity of supply, a fast working device are placed in the system which improves power quality. In upcoming future such systems can be essential and important for Smart Grid infrastructure.

REFERENCES

[1] Alexander Kusko, Marc T. Thompson, "Power Quality in Electrical System" Tata McGraw Hill Publication
[2] Antonio Moreno-Muñoz (Ed.), "Power Quality Mitigation Technologies in a Distributed Environment", Springer.
[3] C. Sankaran "Power Quality", CRC Press
[4] B. Puluhen, A. Pelletier, L. Joseph-Auguste, and T. Pelinski, "Concept grid: A new test platform for smart grid systems general presentation &experiments," in Proc. 2015 23rd International Conference on ElectricityDistribution. Paper 0737.
[5] O.P. Mahela, and A.G. Shaik, "Topological aspects of power quality improvement techniques: A comprehensive overview," Renewable and Sustainable Energy Reviews, Vol. 58, pp. 1129-1142, 2016.
[6] www.powerqualityworld.com
[7] Power Quality in Future Low Voltage Electricity Network, Technical Note 12 May 2013.
[8] Baggini, A, (ed) Handbook of Power Quality, Willey, p.36, 2008
[9] IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Standard 1159, New York.
[10] S.P. Jolhe, M. D. Karalkar, G. A. Dhomane, "Smart Grid and Power Quality Issues", in 2016 Online International Conference on Green Engineering and Technology (IC-GET), pp-1.3
[11] D. Amaripadath, R. Roche, L. Joseph-Auguste, D. Istrate, D.Fortune, J.P. Braun, F. Gao "Power Quality Disturbances on Smart Grids: Overview and Grid Measurement Configurations"
[12] Murat H. SAZLI, Ilhan KOSALAY and Galbadrakh ERDENESAIKHAN, "A Brief Review of Power Quality Issues in Smart Grid and a Simple User-Friendly Software"
[13] Oana CEAKI, George SERITAN, Ramona VATU, Monica MANCASIB, "Analysis of Power Quality Improvemet in Smart Grids", The 10th International Symposium on Advanced Topics in Electrical Engineering, March 23-25,2017, Bucharest, Romania.
[14] E. Pratibha, A. Manjunath, "An Overview of Power Quality Issues in Smart Grid", International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN:2349-2163, Volume 1 Issue 10
[15] Math H. J. Bollen, Jin Zhong, Francisc Zavoda, Jan Meyer, Alex McEachern and Felipr Corcoloes Lopez "Power Quality Aspects in Smart Grid", International Conference on Renewable Energies and Power Quality,(ICREPQ'10) Granada.
[16] S.K. Ronnberg, M. Wahlberg, E. O. A. Larson, M.H.J. Bollen, C.M. Lundmark, Interaction between equipments and Power Line Communication: 9-95 KHz, Bucharest Power tech, July 2009
[17] T. Senjyu, Y. Miyazato, A. Yona, N. Urasaki and T.Funabashi. Optimal distribution voltage control and co-ordination with distributed generation. IEEE Transactions on Power Delievery, 23(2):1236-1242, April 2008.
[18] I. Wasiak, M.C. Thoma, C.E.T. Foote, R. Mienski, R. Pawelek. A Power-quality management algorithm for low-voltage grids with distriburted resources. IEEE transaction on power Delivery, 23(2):1055-1062, April 2008
[19] M.H.J. Bollen, M. Speychal, K. Linden, Impact of increasing amounts of wind power on the dip frequency in transmission systems, Nordic Wind Power Conference, Helsinki, Finland.
[20] J. M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galván, R. C.P. Guisado, M. Á. M. Prats, J. I. León, and N. M. Alfonso, "Power electronic systems for the grid integration of renewable energy sources: A survey," IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1016, Aug. 2006.
[21] F. Blaabjerg, R.Teodorescu, M. Liserre, and A. V. Timbus, "Overview of control and grid synchronization for distributed power generation systems", IEEE Trans. Ind. Electron., vol. 53, no. 5, pp. 1398–1409, Oct. 2006.
[22] K. R. Padiyar, "Facts Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
[23] B. Renders, K. De Gusseme, W. R. Ryckaert, K. Stockman, L. Vandevelde, and M. H. J. Bollen, "Distributed generation for mitigating voltage dips in low-voltage distribution grids," IEEE Trans. Power Del., vol. 23, no.3, pp. 1581–1588, Jul. 2008



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