Effect and Issues of Power Quality in India

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Abstract - *The International Copper Promotion Council India (ICPCI), the Indian Centre of ICA, has recognized the power quality (PQ) problem in India and wants to enhance the awareness of policy makers and regulators. In India, PQ problems in distribution system are not yet studied broadly by utilities. Power quality standards are not well-developed and imposed in the power distribution network.*

In India, there is wide gap between demand and supply. Regular power cuts, poor transmission and distribution system, frequent breakdowns and load shedding, theft of power, lack of service culture, low and high frequency regime in the power grid for about 60% of the time during the year, 220 kV system voltage goes to 165 kV and 400 V system goes below 300 V, harmonic levels touch 22% THD are responsible for loss, mal operation or damage to consumer equipment.

***Key Words*:** Power Quality, Distribution System, ICA, Issues, Power Distribution etc.

1. INTRODUCTION

The poor power quality may result into loss of production, damage of equipment or appliances, increased power losses, interference with communication lines etc. The decline quality of electric power is mainly because of current and voltage harmonics due to wide range application of static power electronics converters, zero and negative sequence component originated by the use of single phase and unbalanced load, reactive power, voltage sag, voltage swell, flicker, voltage interruption etc.

Therefore, it is very crucial to maintain a standard power quality. The series APF is coupled to the supply line through a series transformer. The series APF prevents the source side voltage disturbances from entering into the load side to make the load voltage at desired magnitude and frequency. Whereas the shunt APF connected in parallel across the load confines the current related problems to the load side to make the current from the source purely sinusoidal.

1.1 Definition of power quality:

A consistent amplitude and one constant frequency sinusoidal signal is considered as an ideal current or voltage signal. Quality of voltage taken from the utility or that delivered to the consumer is referred as voltage or current quality. The fluctuation of voltage, current or frequency from its best possible worth that may prompt mal-operation of the equipment can be considered as issue in the power quality. The term electromagnetic compatibility is also used in place of power quality, they are strongly related but not the exactly same.

As directed by the IEEE principles, Power quality can be characterized as the technique for grounding and supplying sensitive equipment with power so as to get a reasonable and good performance of the equipment .Overall power quality represents a blend of quality of the current and voltage. Voltage quality at the point of connection is governed by the network operator whereas the quality of current at the connection point is governed by the client's load. [1]

1.2 Power Quality Issues:

A. Voltage variation:

The voltage variation mainly results from the wind velocity and generator torque. The voltage variation is directly related to real and reactive power variations. The wind generating system equipped with an asynchronous generator consumes the reactive power and can cause additional negative problem for the grid. Switching the wind turbine generator ON and OFF also varies the voltages. The voltage variation is commonly classified as short duration and long duration voltage variation. [2] Various types of voltage variations are given as follows:

- Voltage sag
- Voltage flicker
- Short interruptions
- Voltage swells

B. Flicker:

Voltage flicker describes dynamic variations in the network voltages caused by wind turbine or by varying loads. Thus the power fluctuation from wind turbine occurs during continuous operation. The amplitude of voltage fluctuation depends on grid strength, network impedance, and phase-angle and power factor of the wind turbines. It is defined as a fluctuation of voltage in a frequency 10-35 Hz. The IEC 61400-4-15 specifies a flicker meter that can be used to measure flicker directly. [3]

C. Harmonics:

It results from the operation of power electronic converters. The harmonic voltage and current should be limited to the acceptable level at the point of wind turbine connection to the network. The emission of harmonic current during the continuous operation of wind turbine with power converter has to be stated. [4] The relative harmonic current limit is stated in the Table I.

Harmonic Number	5	7	11	13
Admissible Harmonic	5-6	3-4	1.5-3	1-2.5

2. Main Effects of Power Quality:

The effects of poor PQ on the electrical equipment differ from equipment to equipment. The equipment differs from another by the kind of susceptibility of electronic equipment; it differs in terms of magnitude and intensities of electrical stress that it can bear before failing. The critical factors that determine the tolerances of the equipment are as follows [7]:

- The nature, magnitude and duration of the PQ event
- The frequency of the event
- The sensitivity of the component to the event
- The location of the equipment within the customer's installations
- The age of the component

The loss of the power supply causes operational hassle to the consumer and monetary losses for the consumer and the utility. In the industrial production unit, the cost of unsupplied energy due to an outage is much higher than the cost of the supplied energy that is supplied when it is needed.

3. Consumer satisfaction:

The electricity consumers seek for the power supply of reasonable quality at reasonable price to serve their local needs. The consumer needs:

- Continuity of power supply
- Good quality of power
- Prior intimation of power cuts
- Correct billing
- Better collection system to reduce hassle and time spent in queues
- Power on demand
- Faster redressal of complaints

There is huge consumer dissatisfaction towards to power supply facilities especially during summer peak of the year. In some places like Delhi, Haryana, there was situation of the type of civil riots in 1998 when people confronted frequent bad supply. The World Economic Forum carried out power supply survey of various countries. As per their 'the Global Competitiveness Report 1996', the rating point of 1 to 6 for poor to excellent position of power supply to meet business needs of consumer was given as below:[5]

Country	Rating Point	Country	Rating Point
U.S.A.	5.66	Malaysia	4.13
France	5.56	Brazil	3.79
Singapore	5.45	Poland	3.71
South Africa	5.30	Maxico	3.69
U.K.	5.23	Indonesia	3.53
Germany	5.22	Philippines	3.51
Japan	5.00	Taiwan	3.18
Egypt	4.47	Russia	2.90
Korea	4.43	China	2.47
Thailand	4.18	India	1.85

From the above table, it is seen that India stands lowest in the power supply rating. However, Central Electricity Authority, under the Govt. of India prepared power development plans based on loss-of-load probability (LOLP) level of 2% and energy-not-served (ENS) less than0.15% [4].

4. Technical Consequences:

The diverse PQ issues have varying effects on different kind of consumers. The power supply disturbance is often incorporated in the reliability analysis of the power system. Voltage sag is one of the most significant PQ issues as it has often a direct impact on the consumer's services and its finances. The Industries such as semiconductor industry, paper plants, glass and steel industries etc. suffer technically and financially on account of voltage sags. At times the entire plant operation gets interrupted and it takes time to resume its operation. So, the voltage sag is considered as a critical problem for continuous process operation. Sudden voltage sags can also cause inconveniences to the commercial consumers as they might damage the equipment and get low on business by down time, data loss etc [6].

For household customers, voltage sag might cause regular disturbances and hamper the tempo of completing the normal work. The Voltage sag is measured by the magnitude of voltage drop and its duration. Different devices have different sensitivity towards voltage sags and are described by their individual voltage tolerance curves. When voltage sag occurs, the voltage available at the equipment terminal is lower than the nominal voltage.

5. Financial Implications:

Electric power quality issues can have considerable financial implications for different types of facilities. The direct and indirect cost rises heavily due to poor power quality. It is very difficult to calculate the precise amount of loss when a PQ event or a voltage disturbance occurs. Field surveys, client's interaction and studies are done to calculate approximately the cost of poor PQ of the electric supply.

The three main factors which are often considered for accurate assessment of PQ cost are disturbance report at the bus bars involved, customer load susceptibility and the calculation of losses induced by damage or malfunction of equipment or process interruption. It may happen that a PQ problem that is initiated from a manufacturing plant may affect the operation of the nearby neighbouring industry. The actual financial losses are customer specific and that depend a lot on other factors including customer category, type and nature of the activities interrupted and the customer size. The various costs of poor PQ can be broadly categorized as follows:

Direct Costs: This cost is associated with production loss, product damage, equipment damage, loss of raw material, salary costs during non-productive hours, extra maintenance etc.

Indirect / Hidden Costs: Costs of lost sales, cost of premature equipment damage, costs of out-of specification products delivered or services rendered, costs associated with poor reputation for non delivery etc.

Non-material Inconveniences: Some inconveniences due to PQ disturbances cannot be expressed in terms of money (for example: loss of entertainment).

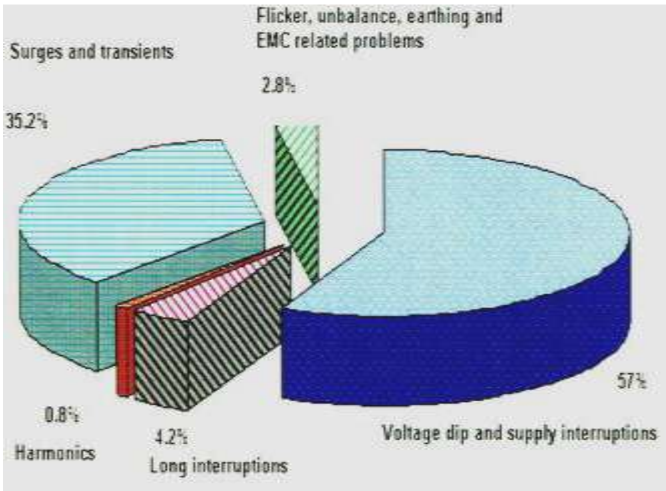

Figure1- Percentage cost of PQ aspect

6. Economic Aspects of PQ in INDIA:

The Electricity Supply Monitoring Initiative (ESMI), Prayas is an Indian non-governmental, non-profit public charitable trust actively working in the areas of health, energy, learning, and parenthood initiatives. The concept of ESMI is to execute basic monitoring system to know about the supply continuity and voltage levels at ordinary consumer locations, in order to get an understanding of actual picture in practice and to increase the accountability of electricity utilities. A data logger records the supply voltage at one minute intervals, as well as makes a note of the timing and duration of supply interruptions. The results might look startling for PQ experts who are used to IEEE standards. In the first monitoring week:

- The rated voltage was supplied only for 23% of the time
- The low voltage was supplied for the majority 69% of the time
- The voltage was very low 7% of the time
- There was no supply at all 1% of the time

7. Conclusion:

Good quality power supply is most requisite to-day than every before. The consumer satisfaction will be cutting edge in the competitive environment in the 21st century. The power cuts can be accepted for some categories of consumers but availability of power during agreed slot of time must be uninterrupted. The right priorities must be set up to solve the various quality problems. Professionalization of management of power sector, integration of grid operations, operations of SEBs on commercial basis, demand side management, kVAh electronic metering for consumer, privatization of urban distribution, limitation of harmonics, setting rural electric co-operatives and to give continuous supply to villages are urgent measures.

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