Keynote – CAPACIT 2019

Title: Power Quality – Need for Regulation

I often feel, the PQ in an electrical network has innate similarities with the flow of water in the river. If we take flow of water in River Ganges as power flow through power system, then at Gangotri it is pure (well perceived), as it flows and everyone uses for differing purpose (Customer and their use), it keeps getting polluted. By the time it reaches the Bay of Bengal it is so polluted that not even worthy to bath forget drink. As every user en-route uses the water and yet overlooks his or her individual responsibility to keep rest of the river water clean for downstream use, there is no full stop to pollution.

At one end, we have an unfettered attitude to deteriorating the 'quality' of water from natural water bodies, just because its cheap, or even free at times. On the other end, we feel very secure in paying the price to make available clean, potable water, drawn from probably the very source we have polluted. It's intriguing how we tend to ignore the collective cost incurred for safe 'quality' of water as we try to improve every individual's 'quality of life' by ensuring clean water. As a solution, we have now started providing RO filtered water for the poor, of course at affordable prices, and for the rich there is always the bottled mineral water.

Similarly, PQ is perceived differently at different levels. What I think is bad PQ may not be so for another. 1 min interruption at Mumbai may be too bad but at rural village 1 hr may not be so.

In either case, it's beyond doubt that improving quality requires a culture change, not just a new diet. And particularly in the context of Power Quality, we can see many examples of how the steps to improve PQ are deeply correlated with advancements of the economy, well-being and quality of life for individuals. Any Quality aspiration must be backed up by strong standard and supported by equally robust regulation. More importantly, the efforts to improve standard and enforce the regulation too for PQ have to be at all the levels, from the Utility, Feeder to the end consumers.

We see the evidence for this in many countries that have successfully achieved good PQ.

- Since 1992, Norway has had a Voltage quality measurement program with mandatory reporting of interruptions implemented in 1995.
- The Japanese introduced a guideline, back in 2000, for Reduction of Harmonic Emission caused by electrical and electronic equipment for household use. Interestingly, the guidelines specify the limits for harmonic current emissions by equipment and "the measuring methods" for a range of household equipment including TVs, Luminaries, Washing Machines, Microwaves, and also the then popular video tape recorders and players.
- A more recent study on comparison of Standards and Technical Requirements of Grid Connected Wind Power Plants in China and the United States made some interesting observations. It found China's national standard, which requires wind turbines installed in a Wind Power Plants, are more stringent than those in the USA.

In addition to efforts to improve PQ at multiple levels, one more similarity strikes me the most from the above examples. All these countries, large and small, which are today

recognised to have significantly better quality of life for their citizens have taken cognisance of importance of improving the Power Quality early on. They seem to be preparing for it from the early 90's. Also, they tend to address the PQ aspects first, whenever the profile of the electrical network is set to undergo a rapid modification.

In contrast, a study of Power Quality Regulation in India and Abroad authored by Dr. G. Bhuvaneswari and Prof. Bhim Singh Department of Electrical Engineering IIT Delhi, INDIA - published by APQI in 2011 observed that in India, the power quality standards are yet to be evolved although there are general guide lines regarding supply code and standards of performance.

A paper on Critical Factors Facing Implementation of Power Quality Program (PQP) Framework published by International Journal of Scientific & Engineering Research quotes PQP implementation barriers in India as lack of PQ measurement; lack of PQ awareness and skills among employees. A second study in India found three significant categories of PQP barriers;

- lack of planning and designing the distribution network;
- lack of PQ monitoring and databases; and
- lack of PQ standards.

On observing closely, the countries with good PQ record have completed their journey to improve PQ over two decades or even more. The efforts involved driving greater awareness, preparing for implementation of PQ Improvement Programs and achieve high PQ through better monitoring and considering end-user satisfaction.

In India, we are racing against time to establish high level of PQ standards in a short time. As Power Systems in India face introduction of an unprecedented number of sensitive equipment, non-linear loads, renewable energy integration and a numerous other factors hampering the Power Quality, pulling off the feat to achieve high PQ is a stretch target for everyone involved.

When it comes to ensuring good Power Quality, indigenous examples are rare to find. Even here, it's the US, German, Korean, Japanese industries setting their operations in India show the way. For instance, the first thing Toyota did after land and water assessment, when setting up its plant in Bengaluru, was a PQ assessment. This is when there is no regulation as such for PQ in Karnataka. Such examples highlight the need to reflect on whether we really value 'quality' as it should be or more often than not give it only the lip service rather than action that it deserves.

The poor power quality is estimated to cost the European economy up to €150 billion annually, according to the Leonardo Power Quality Initiative. The U.S. sees losses ranging from $119 billion to $188 billion, according to research by the Electric Power Research Institute (EPRI). In the recent past, the industrial sector in India has been witnessing weekly interruptions ranging from less than one hour to more than 40 hours. Assuming an average interruption of say 30 minutes per week to the Industrial load (connected load is approx. 170 GW) in India, the average cost escalation accounts to be around Rs.2.65 Lakh Cr. per year (assuming a very conservative cost escalation of Rs.10 per minute per kW of connected industrial load). Hence, it is required in India, that a

nation-wide survey is conducted to evaluate the various economic impacts of Poor Power Quality & bring awareness about the same. That may be too large a canvass but if utilities are serious about meeting the challenges of PQ then it is time that carry out an evaluation study on how poor PQ is affecting the distribution sector and push for stringent regulation based on rationale that is well explored.

On one hand we have the Indian consumers who now expect electricity to be a product where availability and quality is taken for granted and demanded as well. The PQ is vital to defining the competitive capability of infrastructure at every level - may it be modern transportation systems such as metro systems or a sim operated electrical pump motor working in a rural location for a farmer.

On the other hand, opening of electricity markets, including privatisation, are narrowing the operational safety margins required of Utilities to cope with larger PQ disturbances. Utilities, already burdened with financial and technical losses, lack of manpower and other challenges, will find it tough to meet the customer's expectations.

The Indian PQ landscape has a confusing topography with no particular authority to ensure rigorous enforcement of policies, lack of consensus on what's a good PQ among key stakeholders and absence of common standards for PQ. In a situation where a severe lack of awareness among users, further aggravated by the lack of appreciation and agreement for the urgent need and direction to improving PQ among stakeholders, regulation seems to be the only way to assert policy framework to achieve high PQ.

In the brief history of various attempts to get PQ to centre stage of power systems in India, so far, regulations attached with economic signals have been successful in two important areas.

- The first, and it needs no mention to this audience, is to offer incentives and lay penalties based on how the customers maintain Power Factor.
- Another important area is that of utilities maintaining the frequency variations owing to unbalance between generation and the demand. There were wide variations in system frequency prior to introduction of Availability Based Tariff (ABT) in India. Due to grid indiscipline by State entities in Indian transmission system, the frequency was not stable. CERC in exercising its power under the Act has taken number of steps to improve frequency profile in the grid over the time. And today wide frequency breach is matter of history for Indian Power Sector.

The existing Regulations for PQ, as observed in the recent report on PQ for Electricity Consumers in India released in 2018 and prepared by the sub-committee of Forum of Regulators, cover the power factor, frequency, and reliability of supply and voltage regulations as Power Quality parameters. Until recently, there was no comprehensive national Power Quality Standard issued by Bureau of Indian Standards. CERC gives Grid Code and CEA under the Act has specified Technical Standards for Grid Connectivity that is observed statutorily by Transmission sector. The Regulations such as Supply Code, State Grid Code or Standards of Performance etc. are notified by SERC at State level. The SERCs, at State Level specify limits for some Power Quality parameters as per International standards/guidelines.

Again, it is observed that the Regulatory Standards specified by the State Commissions are not uniform which indicates that the Standards exhibit different level of benchmarks.

- First, only few power quality parameters are specified in the Regulations notified by the State Commissions.
- Secondly, even the prescribed limits for the parameters which are specified are not harmonious across different States.
- For instance, voltage level of 11 kV, Tamil Nadu, Gujarat and Maharashtra specifies THDv as 5% with individual harmonics content not exceeding 3% whereas Karnataka specifies THDv as 3.5% with individual harmonics content not exceeding 2.5%. Andhra Pradesh and Madhya Pradesh specify the cumulative THDv as 8%.
- In case of Voltage unbalance too, the States of Tamil Nadu, Gujarat and Maharashtra had no standard specified, whereas the CEA mandates it to not exceed 3% at 33 kV and above. But even the CEA, does not specify any standards for voltage below 33 Kv.

The key PQ parameters as identified by the Forum of Regulators to be monitored for compliance include Frequency deviations, Harmonics, Voltage variations and Flicker, Voltage unbalance, Voltage dips and swells, Voltage Transient, Supply voltage interruptions, Power Factor. You will notice that it is first major attempt to go beyond just the PF and look at a broader range of parameters that justify the true expanse of PQ. But even with this, the PQ regulation in India can be said to address only the tip of the iceberg.

The POWERGRID's Swachh Power report estimates the total investment required in initial phase for Power Quality improvement for the industrial, domestic and commercial loads to be about Rs. 24,840 Cr. This considers both installation of Power Conditioning devices and PQ monitoring devices at the LT level. But the Utilities also face the inevitable – lack of finances added with inability of their engineers and technicians, who lack the skills and experience to solve these problems. The dominant rhetoric is always "when there is no availability what is the point of worrying about reliability". The government-controlled utilities are in many ways detached from the situation with regard to PQ issues.

On the consumer end, the OEM s are looking at Regulation to bring in business for them. Any customer won't put money to mitigate PQ if you ask them but they will feel worried and therefore act to solve if there is tariff signal associated. Given the low awareness about PQ among customers, mis-selling and overselling of solutions for PQ issues are not uncommon. Such practices, while lucrative in the short run, they are bound to create a serious question on the credibility of the solution itself in the long run. Just as we were used to conveniently categorise everything that is from China to be of poor quality and lower price, until a year or two ago.

In India, we still seem to be rather far away from making small sacrifices and converge to achieve common goal in the interest of larger context. Take for instance, the fact that the Indian UPS market is almost equal to the Chinese market size in spite of demand in India being 1/3rd as compared to that in China. Imagine the inefficiencies we are adding in our system due to all these converters, in places where things were not so mission critical.

But may it be UPS, or Harmonic Filters, the question we really need to ask is what kind of power quality are we seeking? The one where we want to ensure ‘power quality’ by making the consumers to pay for their protection against risks? And it sounds almost like corruption!... Or are we aiming to permanently eliminate the risks, uncertainties and free the consumers from additional costs of poor PQ?

That’s the culture of change. That’s the change in mind set we require at every stage to keep the river of power clean for everyone. The formation of the standards and regulations for better Power Quality is not a one-way exercise, but an example of collaboration of the highest order among policy makers, designers, utilities, academia, equipment manufacturers, testing laboratories as well as recognised experts in the domain. The buy-in of all the major stakeholders is undoubtedly the foundation to success. How we achieve this, given the diversity and disparity in India, holds the key to future of 'quality of life' driven by ‘Quality Power’ for every consumer.

Clearly, regulations alone will not take away the risks of PQ issues. But the responsible participation from all the stakeholders aligned towards the singular goal of improving PQ can do the magic.

Taking a leaf again from the pollution in rivers, the global experience too shows that river clean-up is always a lengthy and costly initiative. On the Rhine, the river emanating in the Swiss Alps, wastewater treatment plants alone took investments of more than 40 billion Euros between 1970 and 1990. In China, the government pledged more than $14 billion in 2007 to clean Lake Tai, the country’s third largest freshwater lake.

The Govt. of India had set aside INR 20,000 Cr. to clean-up the Ganga. After almost five years and spending around 20% of the budget in May 2018, 1000 MLD of 12,000 MLD sewage that goes into the Ganga was being actually treated. All this, when the CPCB already has strict regulations for discharge of waste in water. To my mind, unless we change our culture, regulate ourselves, and adhere to CPCB norms strictly “Ganga will remain Maily”.

The Ganga, after all, is a tangible resource that directly affects life. We can imagine the efforts of cleaning-up the pollutants in the intangible resource that is power. The current and future of PQ regulations has a tough task to satisfy the end-users, while creating an ecosystem of supporting stakeholders, aligned to its goals. We have just taken the first step by establishing the standards and prescribing the model regulations. It’s a long journey as we expand the regulatory framework in our quest to improve PQ. And now that we have already entered this tunnel, we must continue to move forward till we find the light…we are seeking!

Thank you!