Integrated Power Quality Metering

by
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Introduction

It is now almost 10 years since Power Quality (PQ) measurement was introduced in South Africa.
The market has been dominated by the NRS048 requirements. Many municipalities have bought equipment that complies with the very minimum NRS048 requirements. There was, and still is, no long-term plan in place. A few municipalities, however, have seen this requirement from the NER (National Energy Regulator) as an opportunity to learn more about their networks and to provide a better service to their customers.

This paper will try to put PQ measurement in perspective and highlight the fundamental principles of integrated metering. If done correctly, the negative experience of the regulator forcing an unnecessary burden on the already overloaded technical personnel can be converted into a very positive preventative experience.

It is all about Compatibility

A prominent American consultant was once asked how he saw the future of Power Quality.
His reply was that within the following 5 years, the international market would have adopted the latest IEC requirements on how to measure Power Quality and all instruments would comply. The focus would then move away from instruments towards equipment. Manufacturers of different equipment would then differentiate themselves by the degree of compatibility with existing networks.
In about 5 years we will know exactly what level of performance we can expect from the transmission and distribution system and we will also know where good quality electricity will be available and where not. The client can then use this information together with a good electrical specification to buy equipment that will be 100% compatible with the network.

Good quality statistics and a good supply policy can be a valuable asset to attract large industry to certain areas. This in return will guarantee more units sold and the growth of the area.
If equipment end users put pressure on equipment suppliers to be fully compatible with the supply network, they can reduce their downtime considerably. It also leaves possibilities for the municipality to supply its key customers with a better than average quality electricity at an additional premium.
Both the customer and the utility will benefit from this policy, as there will be less customer induced problems.

Permanent PQ monitoring will still be required, because the network and environment changes constantly. Today the 5th harmonic may not be a problem, but it might grow at a constant rate to become a major problem within a few years. The trends of all PQ parameters are therefore very important.

Be customer orientated

If a customer complains about the quality of their electricity supply, the right thing to do is to check it out. Roaming PQ monitoring instruments with standard site assessment reports are needed for this. The technician installs an instrument at the point of common coupling and a week or two later removes it. A report on the findings is now automatically created for the customer, already classified according to NRS048 requirements. Both parties can now come to the table with facts and start negotiation on solutions. A very important aspect of this approach is that the instruments used must fully comply with the requirements set out by NRS048.

Any large customer (larger than 1.5MVA) should be permanently monitored for power quality.
The load impedance of this size of customer is normally significant in the contents of the network.
Any fault generated in such a plant might have a large impact on the network. If a significant event or a series of events caused large losses to the customer or disturbances to the network, you would need detailed diagnostic data to prove that the network has responded to the events as expected. If not, you have detailed information about how the network has responded that can be used by experts for analysis. Such events normally happen far apart in time and if you do not have the information, you will always have an unhappy customer.
An added advantage of permanent monitoring at key customers is that the customer will learn more about his plant and consumption profile. An informed customer is a better customer.
If an event like a dip happened high up on the transmission system, the municipality can call the customer within 5 minutes after the event has occurred informing him that the event was upstream. The customer can then go through a normal restart procedure to restart his plant.

Link PQ events with fault data

An American customer told me about a utility that entered a supply contract with his firm that excluded any lightning events. One night a bad storm hit town and the customer experienced severe damage as a result of dips. The next day the customer retrieved all lightning strike data from the Internet and matched the dips caused by lightning with the dips that he measured at his supply point. To his surprise only 10% of the dips matched. It was later found that the utility had tried to save costs by not cutting trees and that the wind had blown the trees onto the network causing numerous dips. The trees were cut and the amount of dips during storms was reduced by more than 90%.

The customer claimed damage from the utility and the utility paid for their duplicity.

This story just illustrates how important it is to know the origin of each event. If you do not investigate each event, you will not be able to identify patterns and simple solutions.

If you know what has caused dips, you can use the information as proof to justify capital expense, or you can advise sound solutions.

If you do not have the in-house experience to analyse PQ statistics, you can enter into partnership with instrument suppliers or consulting engineers to analyse the data monthly and to report back to management.

Planning

Network planners very seldom install large quantities of instruments on the network. The models they use are dominantly developed for 50Hz applications. Modern plants are changing from directly connected rotational plants to variable speed drives. This kind of load is normally highly distorted and the dynamic response differs considerably from directly connected rotational plants. Network stability and harmonics (and flicker) become ever more important.
If the municipality has profiled information available that includes phase response information, then planners can build much better models and prevent problems from happening.
One of the biggest problems that planners face is that the captured data they receive is sometimes not time synchronised, or is calculated using different accuracies. They then have to work with large tolerances to cater for the inaccuracies. If data can be properly time synchronised and flagged if a dip has occurred etc, then planning departments can design better cost effective networks.

Integrate the data in reports

Many different departments in an organisation can use power Quality data:

- Management needs performance indexes
- Reporting to the NER
- Network planners need field data
- Key customers need profile + event statistics
- Maintenance people need feedback
- Treasury need power consumption profiles and they need to monitor supply contracts
- GIS systems want to archive data for future use

Once the data is captured, it needs to be categorised and stored in a central database. From this database the different role players must collect the information that they require. If each department or user can define a daily, weekly or monthly report, then the system can automatically generate the report in a PDF or HTML format and mail it to a mailing list or to a web server. The user is then triggered when he receives the report in his Inbox. Reports generated can also include data obtained from other third-party information sources like GIS systems, billing databases, maintenance databases, lightning event databases etc.

This way the complete system can run autonomously and will only call for assistance when needed. The cost of ownership is dramatically reduced this way.

It sounds Expensive!

Power Quality monitoring, unlike revenue metering, is normally done on a statistical basis or it is implemented with key customers where the customer pays for the instrument. Each instrument normally requires remote communications links (modem, cell modem, etc) as well as installation hardware (weatherproof enclosure, CT's etc). This kind of instrumentation is intended to be operational for at least 10 years. The instruments must therefore be designed to work unattended for at least 5 years, but preferably for 10 years.

A typical large South African utility would require about 50 instruments. At a budget price of R 75,000.00 per installation (labour + hardware + SW included), this will cost the utility about R3,75M. If you pay back the investment over a period of 10 years at interest of 10% per annum, it would cost about **R 1,000.00 per instrument per month**.

Conclusion

Power Quality is a new name for old well known network parameters, but it put the focus on the right place namely: **Compatibility**. If you do not know the performance of your network or the character of the load drawn by the customer, you would not be able to implement the right solutions to constantly improve or maintain your network.

There is valuable information embedded in raw meter readings. It takes a lot of time and effort to collect it, make sure that it is cleaned up properly and stored in a well-organised way. Spend the time and money to automate as far as possible and to compile reports that can be used throughout the company. Knowledge is power.

Draw up a long term plan or start talking to your instrument supplier. You do not want instruments; you want reports that contain practical information. Suppliers do not just want to sell instruments; they want a long-term relationship with a happy customer.

Try to explain all system events and identify those that can be eliminated today. If you can identify and remove one small repetitive problem, the sustainability index for that year gets a considerable boost.

Start measuring today – you will need the information tomorrow!