NEW CHALLENGES IN THE DEVELOPMENT OF EDP DISTRIBUIÇÃO'S PQ MONITORING PLATFORM

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ABSTRACT

EDP Distribuição has implemented, over the past 14 years, as Distribution System Operation in Portugal, a Power Quality monitoring programme that meets, among others, the requirements of the Portuguese QoS regulation code. To support this programme, EDP Distribuição has been developing a consistent Power Quality monitoring platform, which has been successively improved. Although the platform consistency, new global and technical challenges are constantly emerging, either by external or internal factors to the platform. Some future trends will be focused, namely future perspectives related with the necessary and desirable standardization on Power Quality measurement methods, data regulatory report and data interchange format.

INTRODUCTION

EDP Distribuição (EDP D) is the main Distribution System Operator (DSO) in mainland Portugal and a member of the EDP Group Energias de Portugal. In Portugal, EDP D operates approximately 83500 km of High Voltage (HV) and Medium Voltage (MV) lines and cables, 411 HV/MV and MV/MV substations and 66000 MV/LV secondary substations, used to step down voltage to Low Voltage (LV) customers, with a total power capacity around 17000 MVA, being the size of the LV distribution grid around 141000 km. EDP D has about 6,1 million distribution network customers.

As a DSO, fully committed to provide a high level of Quality of Service (QoS), EDP D has been systematically monitoring the Power Quality (PQ) of its distribution network, especially in MV and LV levels, since the year 2001.

To ensure a continuous PQ improvement, EDP D has a PQ monitoring programme in accordance to the Portuguese QoS regulation code, which has a new edition since January 2014. In terms of voltage characteristics, this regulation code refers to the NP EN 50160 recommended standard, for LV, MV and HV networks.

To support this PQ programme, EDP D has been developing an ambitious PQ monitoring platform which aims the following main goals: fulfil the requirements of the Portuguese QoS regulation code; characterize the PQ at the distribution level, in order to implement actions that promote their continuous improvement; support the most sensitive customers to identify the right solutions and immunization strategies to improve their ride-through capability to low severity PQ disturbances, in order to achieve high reliability levels.

A description of the actual platform is carried out and, although its consistency, new global and technical challenges are constantly emerging, and will be detailed.

Some future trends will be focused, namely future perspectives related with the necessary and desirable standardization of PQ data.

PQ MONITORING REGULATION

The quality of service in the electricity sector in Portugal is regulated by the Portuguese QoS regulation code. The Portuguese national regulatory authority for energy services (ERSE) promoted a revision of the code, in implementation since the beginning of 2014 [1]. This revision introduced several changes in the PQ regulation frame.

The QoS code continues to establish that the operators must monitor the voltage characteristics, continuous phenomena and voltage events, in their network, including a selected set of network points.

According to the QoS code, the PQ monitoring plan must be done by permanent monitoring and periodic campaigns. In the first year (2014) the DSO plan comprised the monitoring of MV busbars at a minimum of 70 HV/MV substations, including a minimum of 40 by permanent monitoring. This number must increase, at least, 7 by year. The remaining HV/MV substations can be monitored by a periodic campaign during a minimum of one year. Simultaneously, the programme must include the monitoring of LV busbar at 2 different MV/LV substations by municipality, in every four years, by a periodic campaign during a minimum of three months.

In case of a customer PQ complaint, according to the QoS code, a specific procedure must be followed and, in some conditions, the operators must perform a PQ monitoring campaign in the customer's supply terminals

with a class A or S device according to the IEC 61000-4-30 standard.

About PQ reporting, the QoS code requires that the operators must publish an annual QoS report with the information about continuity of supply, power quality and commercial quality. This report must be available on the operators' website. In addition, the operators must send annually to the national regulatory authority a support report about the results of the PQ monitoring plan.
The operators also have to ensure the updated dissemination of the results of the measurements associated to their PQ monitoring plan on their website. EDP D already does this publication (Figure 1) with a trimestral update.

Figure 1. EDP D's PQ results website.

The DSO must supply to all DSO exclusively operating in LV the results of the measurements developed according to its PQ monitoring plan.
The QoS code also foresees the realization of an audit in every two years by an independent and external entity.

EDP DISTRIBUIÇÃO'S PQ MONITORING PLATFORM

EDP D has been developing a comprehensive PQ monitoring programme in order to meet the goals and challenges faced at each moment.

Overview

The PQ monitoring platform comprises the PQ monitoring recorders, communication infrastructures (collecting data), databases and analysis' software. The actual basic topology is shown in the Figure 2.

With this architecture, which has been constantly in evolution, it is possible to assure the requirements of the Portuguese QoS Regulation Code, including the most recent changes due to the new edition. Therefore, systematic monitoring campaigns in substations are performed, as well as permanent monitoring in HV/MV substations.

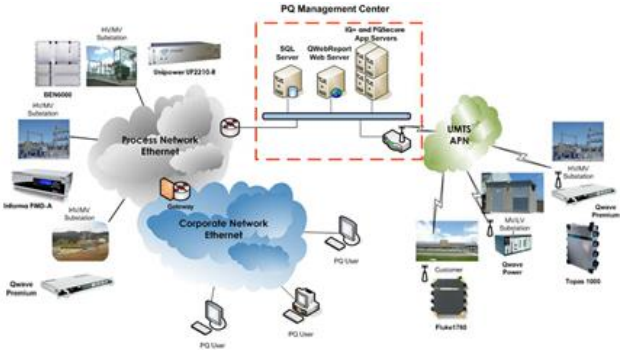

Figure 2. EDP D's PQ monitoring platform.

PQ Recording Devices
For systematic campaigns, performed in HV/MV substations and MV/LV secondary substations, portable recording devices are used. Voltage measurements are performed in MV busbars of HV/MV substations. For MV/LV secondary substations, beyond the voltage measurements of LV busbars, are also carried out current measurements.
Since 2010, fixed class A devices according to the IEC 61000-4-30 standard, have been installed in all new HV/MV substations and in those submitted to a major refurbishment, in order to perform permanent PQ monitoring. Voltage measurements are performed in MV busbars, as well as current measurements.
Whenever customers complain, they are supported by a dedicated PQ monitoring. Typically, a portable class A PQ recorder is installed for monitoring during at least one month.

Remote Communications
All PQ devices are provided with remote communications to a central server, regardless of their type and location of installation.
About 60% of fixed PQ devices installed in HV/MV substations are provided with Ethernet communications supported by a dedicated internal communications network. All the other PQ devices (the remaining 40% of fixed and all the portable) are equipped with a 3G modem, supported on a mobile communications UMTS network.
Thus, it is possible to download the data to a central server, perform scheduled upload of data, in a fast and reliable way.

PQ Management Centre
All the collected data is stored automatically in a bulk SQL database and is processed in order to create PQ reports according to the requirements of the Portuguese regulator and for other types of analysis. These non-standard reports are produced using a dedicated web based application, which reads data directly from the SQL database.

Development - Global Challenges

Regulatory Constraints
As stated above, the new edition of QoS code was issued in January of 2014. This edition requires the amendment of various aspects in the PQ system management, particularly in the methodology of the monitoring activities and also in terms of the reporting system. These changes have caused an increased and rigorous work, however, all were successfully carried out.

Answer to End-User Demands
Some sensitive customers are supported with PQ monitoring in the delivered point, in order to perform an accurate characterization of the PQ supplied and to help to identify improvement actions. Mostly, these clients report production disturbances facing to voltage dips. The sensitivity is variable, but an important number of them are sensitive to voltage dips of short magnitude and/or short duration. Continuous processes supported by sensitive devices to voltage dips can be experienced long downtime periods. There are typical difficulties to adopt immunization solutions and reengineering strategies to improve the process reliability at the customer level.

Distribution Network Optimization
All the recorded data, from HV/MV substations, MV/LV substations and from customers, are analysed in order to detect any non-compliance with standards or other situation that deserves analysis. In case of data from customers it is very important the correlation with reported disturbances. This kind of information is very useful for the improvement of QoS. These improvements can be achieved in various ways depending on their origin and characteristic. Some actions have been considered, like preventive and predictive maintenance strategies, adjustment of the insulation level to the specific local conditions of the network and implementation of innovative solutions. At the operation level, some actions have also been considered, like optimization of the protection systems, supply of sensitive customers by shorter circuits, from busbars with lower fault incidence or higher voltage levels, and increasing HV and MV network robustness.

Development - Technical Challenges

Amount of data
As stated above, due to the new Portuguese QoS regulation code, it is expected that the number of PQ monitoring devices will grow annually. As a result of PQ monitoring platform expansion, the requirements in terms of memory management for storage will proportionally grow.

Although these figures may vary according to the continuous phenomena and to the number of voltage events recorded, it is assumed that each monitoring device added to the PQ monitoring platform will require a memory increment of 1Giga Byte per busbar per year.

Considering the annual increase of 7 substations in permanent monitoring, required by the new regulations, and also that each monitoring device installed will monitor one or two MV busbars, the requirements in terms of data storage will have an additional annual increase between 7 (best case scenario) and 14 (worst case scenario) Giga Bytes per year.

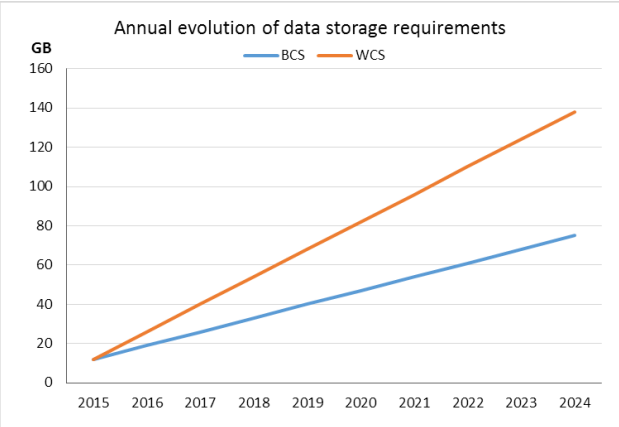

Figure 3. EDP D's PQ monitoring platform.

In order to ensure the proper storage and the security of data concerning PQ monitoring, EDP D plans to transfer the current PQ monitoring platform to a Data Protection Centre, where, among other things, backups in a periodically way will be ensured for the different databases that constituent PQ monitoring platform. In addition, and once the new platform will be based on a virtualized structure, the management of space for data storage will be simpler since the memory can be easily expanded.

Fast and reliable communications
PQ data associated to continuous phenomena and voltage events are automatically collected in a daily base from each PQ monitoring device. Furthermore, as stated above, there will be 7 new devices every year, it is important to ensure that the communications' infrastructure is sufficiently fast and reliable to enable proper and timely data collection, in order to allow its use to produce the different kind of PQ information to those who need it.

Online analysis
The fact that there is a platform from which it is possible to directly access to different monitoring devices enables PQ analysts to perform faster analysis in case of potential network PQ problems, anticipating, in most cases, their resolution. However, given the increased number of monitoring devices, and the difficulties connected to a

human based analysis, it is important to provide the PQ monitoring platform of automatic warning systems that can inform PQ analysts in case of non-conformities or even, ideally, before they can occur.

Integration of different devices

EDP D faces some difficulties when purchasing new PQ monitoring devices, due to the natural evolution of market products as well as their features and functionality. Therefore, EDP D has identified devices' characteristics as a necessity to ensure the requirements and growth of EDP D's PQ monitoring platform and especially to not compromise its integrability. Thus, EDP D developed a specification [2] that established the characteristics and tests that must comply with the PQ permanent monitoring devices in order to address PQ monitoring platform evolution concerns as well as to meet regulatory needs.

This specification has the following main objectives:

• Define characteristics of the operation, design and construction, so that devices can be installed in the typical environment of HV/MV substations.

• Define functional characteristics, analog and digital inputs, requirements to remote communications and time synchronization.

• Define specific requirements in order to integrate devices into centralized management system, inclusively allowing the definition of scheduled upload of data and the management module to export data and in which format.

Particularly, all new recording devices bought after 2008, are in accordance with the requirements of IEC 61000-4-30, class A.

FUTURE TRENDS

Stability and standardization of PQ data regulatory report

In order to allow the creation of a PQ data history, properly comparable between each other as well as with data from other European and international counterparts, it is fundamental to ensure the standardization and stability of PQ regulatory report. Thus, a major concern of EDP D will be to ensure flexibility and the possibility of the evolution of a web based application used to create and deliver reports to the regulator.

In addition to the above mentioned and in order to ensure an easy international benchmarking, it is important to specify the methods that shall be used for measurement and aggregation, otherwise, despite the flexibility of the applications used, it will always be difficult to make valid comparisons.

Statement of a standard for PQ data interchange

As mentioned above, EDP D, and also other users of PQ monitoring devices, cannot depend on a single solution due to technical reasons associated with the natural evolution of the solutions presented by the market as well as for commercial reasons. Thus, it is expectable that the fleet that composes EDP D monitoring platform can use equipment from different manufacturers.

However, to ensure the usability of data and the comparability between them, regardless of the monitoring device that collects those, one of the main future concerns go through the statement of standards for PQ data interchange. It is therefore vital to ensure the evolution of existing standards, finding common ground between different players (users, equipment suppliers, regulators and scientific community), to guarantee the characterization of existing standards and the requirements for their classification.

CONCLUSIONS

Following the constant dynamic of the electric system, the PQ monitoring platform has been adapting to the various development requirements. These have been motivated by: (1) regulatory requirements, particularly the new edition of QoS code issued in January of 2014, (2) the EDP D strategy for the adoption of PQ permanent monitoring in HV/MV substations, (3) increasing focus on improving QoS and customer support, (4) competitive market issues related to the extension of the number of PQ recorders suppliers.

These changes, driven by internal and external factors to the platform, represent new global and technical challenges. In this context, should be highlighted, as technical challenges, the amount of data to be processed and their gradual increase; maintaining a fast and reliable communications system; integration of multi-vendor PQ devices dealing with its own proprietary software and limiting the comparison of data. However, these challenges are being taken very seriously and will therefore be overcome.

The dynamic continues and, for the future, some trends are already focused, namely those related to standardization: PQ data measurement methods and regulatory reports; PQ data interchange format.

The Power Quality has gained increasing importance in the context of improving the QoS, so, the challenges shall be seen as opportunities for improvement and growth.

Acknowledgments

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