MONITORING OF AND REGULATIONS ON QUALITY OF ELECTRICITY SUPPLY IN EUROPEAN COUNTRIES

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ABSTRACT

The Council of European Energy Regulators (CEER) publishes regularly benchmarking reports on the electricity quality of supply (EQS) in its member countries. This paper introduces the content of and describes some of the important highlights from the content given in the 4th CEER Benchmarking Report on Quality of Electricity Supply [1], which is based on detailed information gathered from 27 European countries.

INTRODUCTION

Electricity is expressed in terms of currents and voltages and has several characteristics which define its technical quality, i.e. its availability and usefulness. In a “perfect world”, electricity supply would always be available, voltage magnitude and frequency would be equal to their nominal values and the voltage waveform would be a non-distorted sine wave. In the real world, however, electricity supply is not always available, voltage magnitude and frequency deviate continuously from their ideal value and the voltage waveform is often distorted.

Electricity quality of supply (EQS) is of imperative importance to all parties connected to the electrical power system. The regulators will always seek for solutions benefiting the society as a whole taking into account all public and private interests. EQS can be separated into the availability of electricity (continuity of supply), its technical properties (voltage quality) and the speed and accuracy with which customer requests are handled (commercial quality).

There are basically four key instruments that might be employed in order to secure desirable levels of performance with regard to quality level [2]: publication of quality data, setting minimum quality requirements, introducing financial penalty and reward schemes and the promotion of premium quality contracts. Further, reliable monitoring systems are often a prerequisite prior to introducing the mentioned regulatory requirements.

CONTINUITY OF SUPPLY

Monitoring and indicators

Monitoring schemes for continuity of supply are in place in at least 20 European countries [1]. The presence of a monitoring scheme for continuity of supply, controlled by an independent entity like a regulator, is seen as an essential condition for a well functioning electricity market.

About half of the countries that replied to the questionnaire [1] monitor short interruptions. Only two countries collect separate statistics on transient interruptions; most countries include transient interruptions as part of short interruptions. The increased importance seen by customers of short interruptions makes it highly recommended to have some kind of monitoring scheme for short interruptions in place. A decision on the presence of such a scheme and on the required accuracy of the resulting statistics can only be made at the national level. Furthermore, a clear aggregation rule for short and long interruptions that occur at a short time distance from each other is needed. Large differences in aggregation rules exist between different countries.

Not all countries consider incidents at all voltage levels in the continuity of supply statistics [1]. Especially the absence of incidents at LV is seen as a serious limitation. Although incidents at MV give the main contribution to SAIFI (system average interruption frequency index) and SAIDI (system average interruption duration index), even for low voltage customers, incidents at LV cannot be neglected and the resulting interruption often last longer than interruptions due to incidents occurring at higher voltage levels. Data from Hungary and Italy shows that 22 % and 30 % of SAIDI in the two countries, respectively, are due to incidents in the LV network. All countries are encouraged to include incidents at LV in the continuity of supply statistics. Electronic energy meters (also known as “smart meters”) might be considered to obtain this information.

The use of different weighting methods for indices with the same term (SAIFI, SAIDI) makes comparison difficult and
is confusing. It is recommended to reserve the terms SAIFI and SAIDI for weighting based on number of customers. Other terms should be used when other weighting methods are used. Standard organisations, like CENELEC, IEEE and IEC, should take over the definitions used in the different countries and in this way help reducing the confusion.

The different rules and definitions used by different countries make it difficult to do a direct comparison of the continuity of supply in different countries.

**Monitoring results**

Statistics on continuity of supply have been obtained from a large number of countries [1]. The statistics are presented in a comparative way and discussed in detail in the report. An example of the presentation of the results is shown in Figure 1, containing minutes lost per year for each of the participating countries. The figure shows that a large number of countries participated in the survey and it shows the range of values between countries, as well as the trend for certain countries. The right-hand side of the figure indicates the voltage levels at which incidents are included in the statistics. Not including all voltage levels will underestimate the minutes lost, especially when incidents at MV are not included. The weighting method varies between some of the countries [1].

![Figure 1 – Unplanned interruptions including all events; minutes lost per year from 1999 till 2007 [1]. The voltage levels relate to where the incidents occur.](image)

A number of European countries have shown huge improvements in continuity of supply during the last 10 years. An inventory of the way in which this improvement has been obtained would be useful information for other countries. Implementing these improvements in other countries could result in a next round of improvement in the continuity of supply.

**Exceptional Events and Force Majeure**

The concept of exceptional events is commonly used in European countries [1] but it is applied with different designations and meanings, not allowing a clear conclusion on situations where the concept is applicable and on how to distinguish between “exceptional events” and “normal interruptions”. The exceptional event concept is used in most of the countries related to a rare occurrence, based on statistical methods. Statistical methods can be based on the level of exceptional influence of the weather conditions or it can be based on criteria like number of customers interrupted or interruption duration.

Most of the analysed countries use the concept of “force majeure”, which is in many cases established in civil law and not restricted to the electricity sector. The concept is normally related to the network operator’s responsibilities. Being a factor that must be taking into account, however it does not mean that a force majeure event should be excluded from the quality of supply statistics or from regulation. Moreover, the force majeure event classification is usually related to the causes of the incidents not to its impact. The latter may still be influenced by the network operator by taking appropriate measures, like a sufficient level of redundancy.

It is recommended that any publication of continuity of supply data includes information about the interruptions that are excluded and included, together with information about those situations that are treated specifically. It is also recommended that each country use the definitions as set out in their own regulation. The use of expressions, like exceptional events, with an apparent intuitive meaning, but without a clear definition of the manner in which it is being used, can result in misinterpretation.

**Financial incentives**

There is not included any information about financial incentive based regulations for continuity of supply in [1]. Such information is however gathered for many European countries in [3].

**VOLTAGE QUALITY**

**National regulations different from EN 50160**

EN 50160 is probably one of the most important European norms on voltage quality, and it is applicable in all European countries. However, some regulators have in force voltage quality requirements different from those indicated in EN 50160 [1]. Hungary, Norway, Spain and Portugal have introduced national requirements as regards supply voltage variations. The Netherlands, Norway and Portugal have introduced national requirements for the flicker severity. The Netherlands and Norway have introduced national requirements for voltage unbalance. The Netherlands, Norway and Portugal have introduced national requirements for harmonic voltages. Only Norway has introduced national requirements for rapid voltage changes, voltage swells and voltage dips but only related to some specific causes. Further, in France, the voltage quality limits are set in the contracts between the customer and the distribution/transmission system operator; the regulator surveys the contracts but does not set the limits.

**Individual voltage quality verification**

In most European countries, customers who experience problems due to voltage disturbances can request individual voltage quality verification for their connection point, see Table 1 below. Generally, costs are paid for by the requesting customer. However, sometimes costs are paid by the customer if the voltage deviations comply with

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regulations and standards in operation, by the company if they don’t, and for some countries the costs are always paid by the company if the request is due to, or a result of, a voltage quality complaint.

<table>
<thead>
<tr>
<th>Regulatory framework for individual verification</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution system operators compelled to provide voltage quality individual measurements when requested by the customer or after complaints.</td>
<td>AT, BE, CY, CZ, DE, EE, FI, FR, HU, IT, LT, LV, NO, PL, PT, RO,</td>
</tr>
<tr>
<td>Proposal stage</td>
<td>SE</td>
</tr>
<tr>
<td>No legal obligation</td>
<td>EL, ES, LU, SL, UK</td>
</tr>
</tbody>
</table>

Table 1 – Individual verification of voltage quality [1]. Standard abbreviations for the countries are used.

Costs due to voltage disturbances

Another important aspect deepen by [1] regards results from surveys done on costs due to poor voltage quality. In [1] CEER agrees in principle that setting voltage quality standards requires a correct balance between the different perspectives assumed by customers, by system operators and by manufacturers of electrical appliances. Any cost/benefit analysis to be carried out must be with reference to today’s voltage quality level and cannot be with reference to existing limits in standards. When existing voltage quality levels are better than limits described in standards it will also imply costs if it is allowed to let today’s level worsen towards the limits described in standards. Evaluating benefits for new limits is probably the most difficult part of the proposed cost/benefit analysis. Nonetheless, some surveys have been attempted to evaluate the costs borne by customers due to poor voltage quality. Several European countries have estimated customers’ costs related to short and long interruptions over the past years and decades. A large consensus exists regarding the methodology for assessing customer costs for long interruptions and the available empirical work is rich in applications. On the contrary, the economics of voltage quality is not yet a consolidated subject. The countries where this matter has been developed through nation-wide surveys are:

- Norway: survey on customers’ costs due to interruptions and a few selected voltage disturbances (2002).
- Sweden: survey on customers’ costs due to short interruptions and voltage dips (2003).

Monitoring systems and data

At least eleven European countries have voltage quality monitoring systems in place [1]. The number of instruments, the voltage level, the voltage disturbances monitored, the entity taking the initiative for the monitoring, etc varies between countries. Six countries: France, Hungary, Italy, the Netherlands, Norway and Portugal have reported real measured voltage quality data [1]. All of them reported data on voltage dips, while some also reported other voltage disturbances, see example in Figure 2.

![Figure 2 – Residual voltage and duration of all dips recorded in 150 kV and 132 kV networks in Italy in 2007.](image-url)

There seems to be no harmonisation between existing monitoring systems in different European countries [1]. The lack of harmonisation includes devices, voltage levels, and voltage disturbances, number and localisation of instruments, classification of voltage dips and voltage swells and the reporting and publication of results. In the report [1], it is recommended, inter alia, that countries should consider monitoring voltage quality continuously and publishing results regularly, and further that a workshop between relevant stakeholders on this subject should be performed.

Revision of the EN 50160

There is an ongoing cooperation between CEER and CENELEC in the field of EQS, which started in 2006. The EN 50160 needs to be revised in order to be acceptable from a regulatory point of view. Other stakeholders involved in the process of revising EN 50160 are representatives of utilities, utility organisations, manufacturers and researchers. Thanks to the huge effort spent from all parties involved, the EN 50160 revision process by CENELEC is now facing the final approval stage; though more work needs to be done in the following years. More information is presented in [1], [3], [4] and [5].

COMMERCIAL QUALITY

Commercial quality relates to the nature and quality of customer services provided to electricity consumers and as such has a strong relation to overall customer protection duty of regulators. Commercial quality is directly associated with transactions between electricity companies (either distribution system operators (DSOs) or suppliers, or both) and customers, and covers not only the supply and sale of electricity, but also various forms of contacts established between electricity companies and customers.

One may think that in liberalised electricity markets there is no need for regulating such commercial aspects as competition is supposed to ‘take care’ of those. The reason for regulation lies at the fact that due to the competition
utilities strive for cutting expenses and a reduction of expenditures may result from the customers view in a declination of actual quality levels of network services.

Customers can request several services; e.g. new connections, starting and terminating supply, meter verification, and so on from the DSO or the supplier, and each of them is a transaction that involves some commercial quality aspects. The most frequent commercial quality aspect is timeliness of services requested by customers. The 4th CEER Benchmarking Report on Quality of Electricity Supply [1] presents the most used commercial quality indicators at European level.

Commercial quality involves so many aspects that it is hard finding out how many commercial quality indices, which exist. Further, attention must be drawn on many details in defining each commercial quality indicator. Hence, one has to be careful when comparing the commercial quality indices of different countries, because of the different interpretation of the same indicator definitions by the responding regulators. The report [1] classifies in three classes the regulatory tools used in a great number of countries for each commercial quality indicator:

- Guaranteed Standards (GSs) refer to service quality levels which are set by the regulator and which must be met in each individual case. If the company fails to provide the level of service required by a GS, it must compensate the customer affected, subject to certain exemptions.
- Overall Standards (OSs) refer to a given population of cases (for instance, all customer requests of a given region for a given transaction) and must be met with respect to the whole population. OSs in commercial quality are mainly expressed through a percentile: i.e., at least 90 % of cases for connecting a new customer, when the connection calls for complex works, must be carried out in less than 30 days. This kind of OS establishes the minimum percentage of transactions (90 %) that must be carried out within a certain time limit.
- “Other Available Requirements” (OARs), when requirements are set in regulations in order to achieve a certain quality level, that in most cases imply sanctions or financial penalties upon the company if they are not met, but without compensations to customers.

Based on the information in [1] it seems to be a general trend to move over from OSs to GSs for those countries using OSs and GSs. Further in [1]; CEER suggests National Regulatory Authorities (NRAs) to consider the usefulness of GSs tied to direct automatic compensations for quality parameters or other regulatory requirements, with the possibility for imposing sanctions in case of non compliance with such requirements.

In summary, based on [1], NRAs seems to devote great attention to commercial quality of the services provided for customers. At the same time it is clear that there are significant differences between European countries concerning the nature of regulatory tools applied, the levels and the number of the quality standards applied, the amount of compensations to customers in case of not fulfilling and the procedure for obtaining such compensations (automatically or upon customer’s request).

CONCLUSIONS

Electricity quality of supply (EQS) is of utmost importance to all parties connected to the electrical power system. Different regulatory instruments can be employed for different quality parameters. Monitoring quality parameters is often a prerequisite for many regulatory interventions (but not all). The regulators will always seek for solutions benefiting the society as a whole taking into account all public and private interests.

The 4th Benchmarking Report on Quality of Electricity Supply [1] issued by the Council of European Energy Regulators (CEER) includes a lot of valuable information about the EQS levels and policies in place in Europe (freely available through www.energy-regulators.eu). In the report, the European regulators state their conclusions and give recommendations to their members regarding several elements within continuity of supply, voltage quality and commercial quality, as well as lay down a basis for future harmonisation of regulations across Europe.

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REFERENCES