Revision of European Standard EN 50160 on Voltage Quality: Reasons and Solutions

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***Abstract*— The paper describes the process of revision of European Standard EN 50160 on voltage characteristics of electricity supplied by public distribution networks, with a consequent evaluation of the Italian situation.**
The revision was initiated after the decision of the Council of European Energy Regulators (CEER) to participate to the standardization activities collaborating with the European Committee for Electrotechnical Standardization (CENELEC).
Several important issues are addressed and clarified in the new edition of the standard and possible improvements to be introduced in future revisions of the document are considered.
In Italy an extensive research work was started in 2004 within the Research Project on the Italian Electrical System and is still on-going in particular with a series of measurement campaigns and monitoring of MV and HV networks.

***Index Terms*— Energy regulation, European Standardization, Power quality, Supply voltage quality, Italian situation.**

I. Interest of European Regulators for Voltage Quality

In the evolution of electrical systems (at least in the European continent) the electrification phase can be considered as concluded. During this phase the main objective was to expand the networks at a fast rate and with reduced costs, without particular attention to service quality: the service itself was prevalently oriented to the satisfaction of not particularly demanding loads (civil users, "heavy industry" customers, etc.). Presently, a new phase is on-going in which it is necessary to have a better quality of supply, justified from a technical-economic point of view considering the wide diffusion of industrial processes (but also tertiary and of services) typical of advanced economies.

Indeed, observing this evolution in recent years, the European energy regulators (associated in the Council of European Energy Regulators, CEER[1]) are now dedicating specific attention and efforts to the issue of improving European standards relevant to voltage quality, presently considered in document EN 50160 (some more restrictive standards are present in a number of European countries).

It is well known that voltage quality is described by several parameters (slow and rapid voltage variations, harmonics, unbalance, voltage dips, overvoltages of various nature and others). Perhaps it is less known that these parameters can be suitably divided in "continuous voltage variations" and "voltage events", and that Standard EN 50160 defines specific limits for (almost all) the continuous voltage variations, while only supplies indicative values for the voltage events.

The first manifestation of interest of the European regulators for the issue of standards for voltage quality dates back to 2005, when – coinciding with the first, pioneering European experience of introducing standards for voltage quality by the Norwegian regulator [1] – CEER expressed some concern for the limits and indicative values of voltage quality given by the Standard EN 50160, which were considered "too vague and not sufficient for the protection of consumers" [2]. In particular dealing with "fast" disturbances, such as the so-called micro-interruptions and voltage dips, the existing Standard EN 50160 (first edition) was not judged by the European regulators as adequate to the competitive context in which European companies are operating. The standard is excessively prudent, being representative also of situations less advanced at continental level. Exactly as it was not acceptable to have indicative values for interruptions expressed as "up to several tens of interruptions per year", today it is not acceptable to have indicative values for voltage dips "up to thousands per year" (in Italy, the measurements, stimulated by the Italian Authority and carried out within the Research Project on the Italian Electrical System, confirmed that the situation is much better than these levels, even though it is still differentiated among the various Italian regions).

Bearing in mind these concerns, since 2006 the issue of the standards relevant to voltage quality was included permanently in the program of work of CEER, with the declared objective to cooperate with CENELEC for an agreed upon revision of Standard EN 50160. CEER initially started a wide activity of involvement of its European experts, ending with an international Seminar organized in September 2006 at Politecnico di Milano (the Italian Authority being one of the most active members within the initiative of CEER on voltage quality): the next step was the diffusion, in December 2006, of a consultation document of the European Regulators' Group for Electricity and Gas (ERGEG, a technical body recognized by the European Commission as its own advisor on matters of European relevance) [3].

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[1] All the documents published by CEER and by ERGEG are available on the website www.energy-regulators.eu.

The consultation collected more than 25 written contributions from different actors (operators and their associations, manufacturers and associations of consumers, professional experts and academia, etc.), which were published on the internet website of the European regulators [4]. At the light of the comments received and of the advancement of the work that in the meantime was started in CENELEC, the conclusion of the European regulators was stated in a document published in 2007 [5], which identified 7 principal recommendations (see the box below).

II. Collaboration CEER-CENELEC for the revision of Standard EN 50160

At European level, the collaboration between regulators and standardizers, i.e. between CEER e CENELEC, began exactly following the CEER third Benchmarking report. The Task Force CEER EQS ("Electricity Quality of Supply") was invited for the first time in May 2006 to participate to the meetings of CENELEC/TC 8X, responsible for the standardization aspects relevant to public energy systems. It should be reminded that CEI (the Italian Electrotechnical Committee, i.e. the National Standardization body), is holding the Secretariat of this Technical Committee of CENELEC and has always participated actively, with its experts, to the activities in progress. Since then a lot of work has been done and the results obtained up to now are the consequence of this common path.

Indeed, CENELEC started an intense revision work characterized by a wide collaboration with the European regulators. At the end of 2006 four "mini-task forces" were created within Working Group 1 of TC 8X, each composed of representatives of electrical Utilities, regulators, manufacturers, Universities and independent research institutes. In fourteen months (January 2007 – February 2008), more than fifteen meetings at the level of mini-task forces or Working Group were organized, which allowed to elaborate the draft text of the revised Standard EN 50160.

Each one of the mini-task forces (groups of 4 – 5 persons) was assigned a specific issue: TF1 dealt with the new definitions, together with the classification of supply voltage dips and swells, while TF2 worked on the extension of the standard scope to high voltages. TF3 was responsible for the slow voltage variations, while TF4 tackled the interruptions. The intervention of this last TF has been limited so far (few modifications to the text of the standard, relevant in particular to definitions), but the preparation of a Technical Report (TR) on the indicators of service continuity is under way.

The 7 proposals of CEER for the revision of Standard EN 50160

1	***Improve definitions and measurements rules****: It's important to avoid ambiguity as much as possible. Many parameters still need to be better defined, for instance rapid voltage changes and supply voltage dips and swells. Good and uniformly definitions are important as regards the free marked within EU and EEA. Measuring instruments from different countries should be able to measure the same parameter in the same way and give the same results, given the same accuracy class. CE marked equipment should be able to operate satisfactory across whole of Europe.*
2	***Limits for voltage variations – Avoid "95%-of-time" clause and avoid long time intervals for averaging measured values****: Important in order to protect customers. "95%-of-time" clause leave the customers responsible 5 % of the time also for voltage variations that damage electrical equipment, but which the network companies should manage to have under control. CEER should be clear on the differences between statistical purposes and the need for minimum requirements dealing with customer complaints. For 95 % of the time when the limits apply, they refers only to "normal operating conditions" and excludes a long list of events considered "out of control" of the distributors. Time intervals for averaging measured values are important in order to get as accurate results as possible. Long time intervals may "filter out" severe deviations (with short duration), and so reduce customer protection.*
3	***Enlarge the scope of EN 50160 to high and extra-high voltage systems****: EN 50160 is today applicable only up to 35 kV networks.*
4	***Avoid ambiguous indicative values for voltage events****: As a preliminary step introduce a classification of dip/swell severity. A classification is important in order to easier detect particular challenges and draw attention to where to put cost-effective measures. Supply voltage dips and swells can have very different effects according to both their duration and depth/height (a good experience in this field is available from South Africa).*
5	***Consider duties and rights for all parties involved****: Separate responsibilities between equipment and network. Power quality is given by the interaction between network and customer's equipment. Equipment immunity must be defined in strict relationship with network limits for voltage quality, and currently this is not the case.*
6	***Introduce limits for voltage events differentiated according to the network characteristics:*** *Nowadays, EN 50160 does not give limits for voltage events but only indicative values, generally through wide ranges (for instance: between a few tens and one thousand per year for dips, between a few tens and several hundreds per year for short interruptions). Actual levels are largely better than those stated in EN50160.*
7	***Power quality contracts****: Guidelines could be developed in order to help customers and network operators to apply this tool in practice to real situations.*

Source: [5]

A. Distinction between continuous phenomena and voltage events

A first modification was considered from a methodological point of view, introducing a suitable separation between continuous phenomena and voltage events [6]. In particular the distinction is between:

- *continuous phenomena*, i.e. limited deviations from the nominal value which occur continuously over time and that are essentially due to load pattern, changes of load or non linear loads, and
- *voltage events*, i.e. sudden and significant deviations of the wave form from normal or desired values; voltage events typically occur due to unpredictable events (e.g. faults) or to external causes (e.g. weather conditions, third party actions).

The revision of the standard thus followed, from this methodological point of view, a quite different approach from the previous one, which led to structuring the document according to an index that favours the legibility and the usability.

According to the new standard, the continuous phenomena include:

- power frequency variations;
- supply voltage variations (slow variations);
- rapid voltage changes[2];
- supply voltage unbalance;
- harmonic voltages;
- interharmonic voltages;
- mains signalling voltages.

About these phenomena, it is possible to fix some limits since there is a consolidated knowledge, and it is acceptable to adopt a probabilistic approach. Thus, it is acceptable to define time percentages within which supply voltage values have to be maintained.

As far as the voltage events are concerned (sudden phenomena which give significant deviations with respect to the desired waveshape), the standard includes:

- interruptions;
- voltage dips;
- voltage swells;
- transient overvoltages.

On the contrary, for these events, given their very nature, it is possible at the moment to give only indicative values (see the following section dedicated to Annex B of the standard).

B. *Revision of the definitions, extension to HV networks*

In the new edition of the standard, great attention was dedicated to improving the definitions of the various phenomena; in general, a closer reference was made directly to standards that in the meantime were published concerning the measurement and detection of these events (especially Standard EN 61000-4-30 which is referenced in the forward of the document).

In particular, about the interruptions, a new lower voltage limit was specified (5% instead of the previous 1%) below which a voltage reduction is considered to be an interruption. A note on transitory interruptions was introduced, in order to clarify that the term Very Short Interruption (VSI) is typically used to indicate interruptions shorter than 1 or 5 seconds (depending on the country considered[3]). Therefore, attention was raised on the necessity to detect the values of interruptions in a homogeneous way (at least in the European continent), avoiding to compare numbers that objectively represent different phenomena in different systems. The criteria to aggregate the long and short interruptions are still to be clarified, since they are different in the various European countries.

The improvement of the definitions refers also to dips and swells (power frequency overvoltages): for example, for voltage dips (voltage reductions at a certain point of the electrical system below a defined limit), it was confirmed that the chosen threshold is that of 90% of the reference voltage. Also in this case, the choice of a univocal limit is finalized to the possibility of comparing data coming from different systems. The standard refers to voltage dips intended as electromagnetic disturbances having two dimensions (voltage and time), although recognizing that other parameters exist which characterize these phenomena (related to phase, etc.): in this respect, studies are proceeding in a joint WG CIGRE-CIRED[4].

About the extension to HV networks, a gradual approach was used considering the scarce availability of data (few measuring campaigns have been so far performed on HV systems). Consequently, the extension of the standard has not been complete: for example, dealing with slow variations, no general limits were introduced in the standard, considering the special nature of the users, connected to HV networks, that are normally subject to individual contracts. If we examine the Italian scenario, this observation is confirmed: the users connected to the distribution networks at 132 – 150 kV (and even more to the transmission network) have to respect conditions that in any case are contractually specified case by case.

A significant example relevant to the limits defined on phenomena that involve HV networks is that related to flicker. For this disturbance (which typically concerns loads that are related to productive processes of users connected at high voltage, such as arc furnace and which is defined in the standard by means of the parameter P_{lt} [5]) indirect limits have been used. Indeed, it has been established that the general limit of this parameter for HV networks is equal to 1[6]; in practice this limit is very conservative because the transfer coefficients between high and low voltages can be quite lower than 1: therefore, only in case of complaints, the limit to be respected on the HV network is the one that allows to satisfy

[2] For rapid voltage changes, the dichotomy between continuous phenomena and voltage events is really borderline: indeed, these are situations which, depending especially on their repeatability, can be assimilated to one category or to the other.

[3] The exact limit below which we can speak of VSI can vary according to the type of network automation systems, being such phenomena essentially due to reclosures of MV line circuit breakers.

[4] JWG CIGRE-CIRED 4.104, convenor Math Bollen.

[5] Among the future works of WG1 there will be the reconsideration of this choice, with a possible change to P_{st}, but also the eventual use of other indicators.

[6] Limit to be respected for 95% of the values of P_{lt} measured as average within ten minutes during one week.

the limits on the low voltage[7].

A similar approach was followed for the harmonic voltages, where indicative limits are given, besides a general rule to be used, in case of complaints, in order to choose the HV values in a suitable way.

C. Classification of voltage dips and swells according to severity

About the classification of these events, a new table was introduced following an approach already used in other normative documents, in particular in France and in South Africa (for voltage dips). It was decided to fix a limit between the events toward which the equipment must be immune, and the events that, in different ways, can be limited by the network managers, thus drawing a curve in the plane voltage-time (see Fig. 1). It was then chosen to describe the networks behaviour with the same parameters with which are tested the products that the customers use in the same networks, thus maintaining a strict correlation between networks standards and products standards: it is the concept of *responsibility sharing curve*, just a little bit wider [7], which the standard, for the time being, applies only to the classification table of dips and swells.

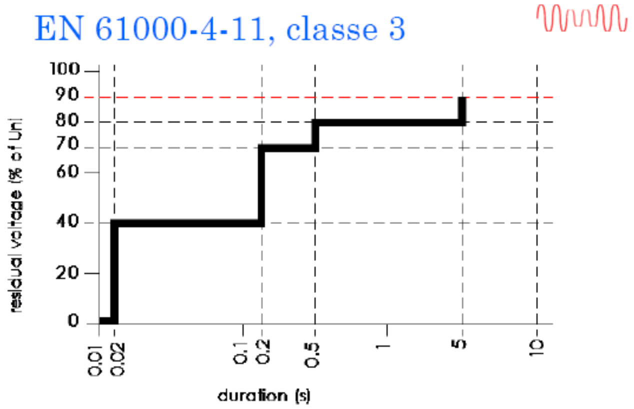

Fig. 1. - Responsibility sharing curve, class 3 (Standard EN 61000-4-11)

Among the various curves available, reference was made to the one defined for the test levels in EN 61000-4-11[8] (and, similarly, in EN 61000-4-34): these EMC generic standards establish different test levels for classes 1, 2 and 3[9], to which the product standards make then reference.

Starting from the test levels defined in the above-mentioned standards, a new classification table for voltage dips was created as shown in Fig. 2.

	Duration t [ms]			
Range of res. voltage Ur (in % of Un or Ud)	t <= 20	20 < t <= 200	200 < t <= 500	500 < t <= 5000
90 > Ur >= 80		A1	A2	A3+A4
80 > Ur >= 70		B1	B2	B3+B4
70 > Ur >= 40		C1	C2	C3+C4
40 > Ur >= 0		D1	D2	D3+D4

Fig. 2. - Classification table for voltage dips (Standard EN 50160)

Although the cells of the classification table are not exactly coincident with the test levels table, they can be easily brought back to them, and thus it can be expected that equipment tested according to the relative product standards can suitably match the voltage dips belonging to the corresponding cells.

The responsibility sharing curve allows to identify the primary responsibility: for the events classified in the cells above the curve, it is up to the equipment to maintain the operation, and therefore it is the responsibility of the customer to install equipment suitably immune; for the events classified in the cells below the curve (cells from pink to red to violet), on the contrary, it is not possible to expect the equipment to be immune[10] and, therefore, it is up to the network manager to reduce disturbances of this kind. Even though the standard does not fix (yet) the expected levels for each cell (or for each group of cells), the classification of severity is useful because it is possible that the national standardization bodies or the regulatory bodies attribute to these events expected values, either at a level of single network node, or at a system level.

It is therefore evident the importance of the new table with respect to the voltage quality regulation in each single country, where the specificities of the situation can be suitably considered in a balance costs-benefits preliminary to the regulation itself.

D. New limits on slow voltage variations

The work of TF3 on the slow voltage variations has been particularly articulated: preliminarily the possibility was explored to restrict the temporal interval of voltage measurements (from the average of the rms values on 10 minutes to the average on 1 minute or on 3 seconds), or to reduce the amplitude permitted to the variations or to increase the percentile of the cases in which the variations must remain in the range of admissible variations.

The first assumption (restrict the integration interval) was not followed for the moment, both for practical reasons (higher costs of the measuring and monitoring systems) and also observing that cumulative times even lower than the present ones would not allow in any case to detect overvoltage phenomena dangerous for the equipment.[11].

[7] Considering possible mitigation actions on HV, MV and LV networks (reference is made to IEC TR 61000-3-7).

[8] In the Standard EN 61000-4-11 it is already stated that the *test levels* for the tests on the products are chosen on the basis of experience on the expected network behaviour (reference is made to IEC TR 61000-2-8).

[9] The classes are referred to different electromagnetic environments defined in Standard EN 61000-3-4.

[10] Unless to use special equipment, whose immunity level is agreed upon between manufacturer and user (class X), or to install suitable dedicated systems, such as UPSs.

[11] The critical points are tackled in the chapter dedicated to swells, and the new table of classification is the first step in this direction.

Maintaining therefore the duration of the cumulative time intervals, it was preferred the solution to review the minimal percentage of 10 minutes intervals in a week for which the limits of ±10% U_n must be verified, instead of modifying the variation value allowed to the voltage amplitude: this is due to the fact that the value of ±10% of the nominal voltage is largely accepted and used both in the international standardization (also at IEC level) and in the design of user equipment. Therefore, maintaining the range of ±10% of U_n, new limits were proposed for the time percentage, passing from 95% to 99% of the temporal intervals of 10 minutes[12].

In particular, in the new edition, two symmetrical limits are indicated:

- during any period of one week, 100% of the rms values of the supply voltage, averaged within 10 minutes, must be included in the interval of ± 15%;
- during any period of one week, 99% of the rms values of the supply voltage, averaged within 10 minutes, must be included in the interval of ± 10%.

Therefore, having on a weekly basis 1008 intervals of 10 minutes, 99% implies the exclusion of a ten of intervals of 10 minutes.

In cases of electricity supplies in networks not interconnected with the transmission systems, or for special remote network users, the admissible voltage variations are instead of +10/-15% of U_n (in the previous edition there were no specific limits for these customers).

Note 1 specifies that the actual power consumption of individual network users is not fully predictable, in terms of amount and of contemporaneity: it is thus clarified that electrical networks are generally planned and designed on the basis of a probabilistic criterion.

It is also stated that in case, following a complaint by a network user, the measurements undertaken according to what already explained should indicate that there is a departure from the limit of ±10% causing negative effects for the user, the network operator, should undertake remedial actions, in collaboration with the user, depending on a risk assessment evaluation.

A further point of interest is on note 2 (already existing in the previous edition, but which has now been expanded and better detailed), where it is specified that the user equipment manufactured according to the relevant product standards are designed so as to tolerate supply voltages of ±10% around the nominal voltage, thus covering the overwhelming majority of the supply conditions; it is also recognized that it would not make sense neither technically, nor economically, to give to all the equipment the capacity of functioning in case of voltage variations larger than ±10%.

Note 3 on the contrary is dedicated to the identification of the so-called “special remote network user”: this action can vary among the different countries for many reasons including the different characteristics of the national electrical systems, for example the presence or not of limitations of power on the supply terminal[13], or power factor limits.

E. New Annex B with references to the available Technical Reports

Finally, in the new edition of the standard it was decided to eliminate vague expressions relatively to indicative values for the voltage events. Previously, the indicative values were written in the text of the standard: these values were quite high, probably because they were obtained as envelope of the different conditions at regional level.

In the new edition, this information was grouped in a new Annex, Annex B, which contains indicative values for voltage events and rapid voltage changes (RVC): in this way, the standard becomes a “dynamic” document and in the future it will be possible to update Annex B with new values made available by the monitoring systems.

About long interruptions of the supply voltage, which are considered in item B.1, it is clarified that their number can vary significantly between different areas (e.g. urban areas and rural areas); it is reported the fact that in different countries, including Italy, there exist national statistics on interruptions that supply more precise indicative values. The Benchmarking report periodically published by CEER is recalled and also the standards specified for long interruptions by the regulatory authorities in several countries (including Italy[14]) are mentioned. It is necessary to consider with attention the principles used in order to aggregate the events when statistical values of long interruptions are compared. As an example, between Italy and France, just to mention two neighbouring countries having electrical systems with strong analogies, there exist differences in the way such aggregation of interruptions is performed which still make precise comparisons rather difficult.

The item B.2 is dedicated to the short interruptions of the supply voltage: it is specified that it is necessary to use properly the principles for aggregating events and to separate, where possible, very short or transitory interruptions from the short ones, when this type of statistics is made (the inclusion of transitory interruptions can introduce very significant differences in the statistics).

Finally, item B.3 shows that indicative values for dips are available. Typically a voltage dip has a duration of less than one second and has a residual voltage above 40%, but it is possible to have voltage dips with very high sustained voltage, 85 and 90% in case of weak networks. To give the reader an order of magnitude of the expected values, for the time being reference is made to Technical Report 61000-2-8 (statistics UNIPEDE not particularly updated), but, as already stated, in the future these values will be updated on the basis of new TRs with data available from the voltage quality monitoring systems[15].

[12] It must be reminded that the total measuring period is one week (i.e. 1008 intervals of 10 minutes).

[13] Limitations to which we are used in the Italian system, but which are not common to all the systems in Europe.

[14] The standards presently in force are defined by the Italian Authority Deliberation n. 348/07.

[15] In Italy, the system called QUEEN (developed by CESI Ricerca within the Research Project on the Italian Electrical System) contains, in this respect, a database, very important for quality and extension.

III. Present situation within CENELEC

The revision draft document of Standard EN 50160 has been subjected by CENELEC to the public enquiry in March 2008, with the purpose of collecting comments of the various European National Committees as to the opportunity to proceed with a formal vote on this text. The standard draft received a large attention: considering the 27 National Committees involved, 24 answered with very valuable technical comments. WG1 of CENELEC/TC 8X examined these comments and produced a final text which was submitted to the voting procedure in the first months of 2009. In CENELEC rules, the proposal is adopted if 71% or more of all weighted votes cast (abstentions not counted) are in favour.

The voting by the European National Committees obtained the required majority with a formal vote that took place in June 2009. However, during the CENELEC Technical Board meeting in November 2009, the ratification of the document was put on hold because the content of the section relevant to the power supply variations was to be more deeply examined with the interested product committees (in particular the requirement stating that “none of the 10 minutes mean rms values of the supply voltage shall be outside the limit of ±15% of U_n”).

In order to discuss only this item, a meeting with all the interested parties took place in Brussels in December 2009, resulting in an agreement according to which this requirement was substituted with the one existing in the previous edition text (“the supply voltage variations shall not exceed ±10% of U_n”). The formal ratification of the standard in these conditions took place in March 2010. Further investigation work was immediately started in order to find in the future a broader consensus also on this specific aspect.

The approval of the new edition of Standard EN 50160 certainly does not represent the arrival point: on the contrary, it should be considered as a new starting point.

As a matter of fact, WG1 has identified a series of new subjects on which to continue the work in view of further revisions of the Standard EN 50160. There are, among these issues to be discussed, a number of aspects relevant to service quality, such as in particular the minimum value of the short-circuit power (in Italy important preliminary analyses have been started in order to evaluate the influence of the network short-circuit power on the rapid phenomena [8]).

A Technical Report on the service continuity parameters has still to be developed, that can act as a basis of harmonization among the different European countries. This work was assigned to TF4, that has not completed its activities since it has to decide on the best modalities of recording of interruptions, so as to allow homogeneous comparisons and the possibility to regulate these phenomena (this regulation is already present in Italy).

IV. Perspectives in Italy

Since its creation in 1997, the Italian Authority has always dedicated great attention to the quality of the regulated services. In both sectors (electrical energy and gas), standards relevant to either commercial quality or service continuity and, for the gas sector, safety of the distribution, were fixed through complex consultations.

Already in the first years of activity of the Italian Authority, several industrial consumers of electrical energy manifested the need for a more stable voltage waveshape and of a reduction of the number of rapid disturbances – in the first place voltage dips and micro-interruptions – to which many industrial processes are exposed, and in increasing proportion with the development of automatic controls.

The Italian Authority initially tackled the issue of the electrical service quality starting from “long” interruptions, which involve all consumers of electricity. Regulation is a set of actions which includes both mechanisms of incentives and penalties, and individual standards with automatic compensations. So far distribution companies have reacted positively to this regulation, orienting their investments in such a way as to obtain results showing strong improvements of the service continuity (reduction of 70% in less than 8 years for the interruptions duration, reduction of 42% for the number of long interruptions without notice).

Since 2008, the mechanism of incentives and penalties has been modified, introducing also objectives relevant to reduction of the number of long and short interruptions. The new challenge in the reliability of MV and LV networks will hopefully lead to a reduction also of the “fast” events such as dips and transient interruptions, for which the Italian Authority, though having limited so far the regulation to service continuity, has started important initiatives in terms of measurements [9] and evaluation of the economic effects for the customers [10].

In any case since 2004, the Italian Authority has introduced with its own deliberations, the so called “quality contracts” which are the instrument used by industrial customers with high demands for service quality and by distribution companies to agree upon dedicated interventions for the service quality at the supply point. In this respect, the new classification of dips represent a very important novelty that can be suitably evaluated both for contracts and for regulation purposes.

V. Conclusions

The voltage quality can be imagined as the usability of electrical energy without interruptions. The subject of voltage quality is becoming more and more important in highly developed countries, because of the increasing use of applications very sensitive to disturbances of the voltage amplitude or of the voltage waveshape.

The issue of the voltage quality standards is since some time closely considered by energy regulators, electrical distribution and transmission systems operators, as well as equipment manufacturers and obviously the end users: not only users with industrial manufacturing processes, but also users of public and private services and even domestic clients (as examples it can be mentioned the issue of electronic equipment protection from overvoltages, or that of excessive voltage drops for “remote” clients).

This paper, besides giving updated information on the activities of revision of European Standard EN 50160, intends to highlight especially the collaboration path leading to a text representing a first, reasonable compromise between the different needs in the CENELEC standardization activities: several modifications introduced follow the indications given by CEER first in its consultation document (December 2006), then in the position paper (July 2007).

The experience accumulated in this occasion confirms how important and necessary is, on standardization subjects so delicate and complex such as voltage quality, the collaboration between regulators, utilities, manufacturers and users.

Moreover, it is important to underline that the collaboration between regulators and standardizers on voltage quality can be considered as the pacesetter for future developments in the collaborations on other important themes relevant to electrical systems. In this respect, and considering also the common work conducted on Standard EN 50160, a formal Memorandum of Understanding between CEER and CENELEC has recently been signed in Brussels (this MoU in some passages follows closely the agreement between the Italian Authority and CEI).

Unfortunately, as it has been pointed out in several occasions, the voice of the network users is still very feeble: to be able to bring to surface their opinion in a much stronger way is one of the most important challenges for the future.

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VII. Biography

Carlo Masetti was born in Ancona (Italy) on 20 August 1949. He graduated from University of Rome in 1974 and received a Master Degree from McGill University in Montreal in 1976.

His employment experience included Pirelli Cables Industries (1977-1979), Centro Elettrotecnico Sperimentale Italiano CESI (1980-1998) and Italian Electrotechnical Committee CEI (since 1999). His fields of interest include power system engineering and high voltage technology.

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