

A FIRST ANALYSIS OF PERCEIVED POWER QUALITY FOR DOMESTIC CUSTOMERS

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Abstract: The research shows as the deep lack of knowledge by low voltage and domestic customers is made the most by the producers/suppliers to impose their will disappointing the ISO 9000 certification. A new way to build the relationships between these actors is suggested with the declared aim to formulate new type of agreement based on the quality of electrical energy appropriately measured.

Keywords: Power Quality, Perceived Power Quality.

1. INTRODUCTION

The guiding thread of this article is the problem of the application to the electrical energy of the concept of “quality” usually used for other products and services.

“Quality” is at the moment identified as the research of customer’s satisfaction instead of research of the default because of the historic evolution of the concept that made predominant the positive meaning of “quality” in comparison of the negative one. This interpretation affects law too and it’s well known that some of the concepts of “total quality” are present in the most recent version of ISO 9000:2000 rules, which nowadays represents an essential requisite to apply “quality” in any enterprise like, for example:

- The “customer satisfaction”. It is necessary that the enterprise pursue its satisfaction as well as client’s one; this means that the enterprise must know the way to satisfy also the demand that the client doesn’t express (unexpressed demands);
- The “progressive increasing”. The management program has to constantly increase the quality of processes not only to keep their stability in time.

What permitted to define the concept of “quality” as “the capacity of the totality of the features of a product, system or process to comply to the demands of the customers”.

Besides being an attribute, in the common use, quality is also interpreted in accordance to “expected quality” and of “perceived quality” concepts. The first is the expression of the demand of the customer, expressed or unexpressed, detailed and affected by products (services in the market); the second one expresses the satisfaction of the customer with regard to a product or a service.

From the “total quality” point of view the customer satisfaction is very important. This term means the perception of the customers and their level of satisfaction.

It’s also important to underline the strong correlation between customer satisfaction and the economic success of an enterprise. To build up and to satisfy this concept of quality, the ISO norms order “to adopt a business management that includes the quality management, designed to continually improve the efficacy and the efficiency of performances of the organization, considering the own necessities of implicated subjects”.

A set of norms so complex and articulate can have an own inner coherence and applicability only if it’s founded on clear and defined strong theoretical assumptions. The current normative ISO 9000 indicates to pursue “conformity” of products, and are inspired to basic principles that assures the attainment of the total quality. These basic principles are relative to the following points:

- A policy of company steered to the customer: the organizations are subordinated to clients and so they should understand them current exigencies and to try to anticipate their future ones, they should satisfy the clients requirements and should aim to overcome their expectations;
- Leadership: the management states the company guidelines; it should create and maintain an inner environment that fully motivates personnel to pursue the organization target;
- Employees involvement: the personnel is the essence of the organization so their interest allow to put their capability to fully serve the organization;
- Processes analysis: a desired result is reached more easily when the joined activities and resources are managed as a process;
- Systemic analysis for the management: the specification, the understanding and the management of the processes each other correlated increases the efficacy and the efficiency of the organization to pursue the target;
- Upward continuous trend: the continuous improvement should be a permanent aim of the organization;
- To take decisions based on facts: efficacy decisions are based on data and information analysis;
- To improve the dialogue with the suppliers: a company and her suppliers are mutually dependent, so the information transfer can improve the ability to create added value for both.

Between these mentioned principles the most important is policy of company steered to the customer. The company

exists only if its products are bought by customers, so it is fundamental to have a clientele but it is also fundamental to preserve it and possibly increase it.

So, it is necessary:

- To identify the clientele and understanding its exigencies: this means to understand, with right methodologies, not only the exigencies directly declared, but also unexpressed ones; it is also important, following a “proactive approach”, trying to anticipate the evolution of the customers exigencies in the future;
- To define with the customers the requirements for goods or services;
- To motivate the personnel to the customer satisfaction;
- To establish lasting relations with customers: so it is important the evaluation of the claims, that can become a stimulus for improvement;
- To monitor the customer satisfaction level and acting to improve it [1,2].

Defined the central role of the customers in the company activity, optimally pointed out by the norm, and established which way should be followed by the companies that work in accordance with the ideas of total quality, it is possible to ask which attitude the electric supplier and distributor companies adopt towards the domestic clientele that is the most widespread.

The actors of this scenery are two: the supplier/distributor of electrical energy and the generic domestic user.

On the one hand we can find the companies that produce and distribute the good electrical energy that are, for historic reasons, monopolistic or ex-monopolistic ones, that have giant economic dimension. For all the ‘900, they symbolized the engine of the economic development for all nations, supplying a good able to be converted into goods and services useful for the population. These companies improved in their own state in a protected system without a true competition which could threaten their existence.

The depicted picture made these societies privileged than the others and made them impervious to criticism, preserving them from any kind of significant legal or commercial action that could menace its existence, activity and structure. The only request that is normally effected to this company is to carry out the duty with continuity, forgiving possible local inefficiencies or attitudes not much inclined to the current market rules observed in all other commercial sectors.

Since few years, cause enormous epochal changes in the politic and economic European structure, but also thanks to a new, changed and more mature conscience of the consumer, the problem of the quality of the service became interesting also for these companies.

The second actor of this scenery is domestic customer, client of supplier/distributor of electric energy company and beneficiary of the good. The domestic customer presents various commercial disadvantages, first of all the trifling dimensions that reduce the bargaining power, but worst thing, he presents a deeply cultural gap toward the good electrical energy that detracts his capacity to understand this good. In fact, the man hasn’t biological sensors able to allow the quantification of the electrical energy moreover, to this

natural condition, it is possible to add that most of people hasn’t a specific technical/scientific culture so that the comprehension of the electrical energy is truly hazy.

The next three documented examples describe the attitude of a generic customer in three different situations with similar assumptions but that yield to unexpected results in the case that involves the electrical energy.

- On the base of technical specifications, a car industry orders a stock of bolts to a specialized factory. The order is dealt in three lots, but the third lot not satisfy the specifications. The car industry rejects the third lot and doesn’t pay the last invoice.
- The client of a railway service catches a high velocity train and, in Italy, if the train come with a late that overcomes half hour, can get back the excess fare.
- A lawyer office placed in the centre of Rome, with six computers, faxes, modems etc., undergoes a voltage fall of the line voltage at about 19:30, that, in some times, induces the PC switch off stopping the job activity between the 19:30 and the 20:00. For this manifest inefficiency clearly joined to the electrical outside network, the office doesn’t ask refunds and to adapt oneself to the circumstances planning a new final phase for the job activity fixing in the last half hour an apposite meeting to program the future activities.

In all three cases, there is a manifest inefficiency attributable to the supplier of good or service. In the first two cases are involved mechanical quantities, length and time, for which the man has biological sensors that allow him to quantify them and so, also their not supply is easy to quantify. In the last case the attitude to not ask refunds is joined to a lack of knowledge of the electrical energy quantity and of its correlated phenomena.

This lack of knowledge is the base of the electrical energy supplier power in the management of the clientele. So, in spite of ISO 9000 certification, the companies impose their will to domestic users not satisfying their true exigencies because of their inability to quantify the electrical energy. In this way the user doesn’t know what to ask to electrical energy good and he is also not able to form a own conscience in this subject so he is not even stimulated to try information on an argument anyway irksome both for mathematical and practical point of view.

The electrical energy supplier that shows off its ISO 9000 certification could help to overcome this situation, but it has no will to change the “status quo” because this lack of knowledge and the lack of will to knowledge is the base of present relations between it and the domestic users.

To back this thesis is sufficient to read the general conditions of the electrical energy supply agreement specifically in the articles related to “Interruption of the supply and supplier responsibility. Responsibility or not of the user”. If we read the 12th article of the “Bioraria” [3] offer made by ENEL Energy SpA, the most important Italian electrical energy producer, to the paragraphs 2, 3 and 4, we can find the following sentences:

- Paragraph 2: “...the interruptions or the limitations of the supply, due to accidental causes, for reasons beyond

one's control or anyway not attributable to the Supplier, will not produce indemnity or refund nor they can be reasons to the cancellation of the contract."

- Paragraph 3: "**In particular, the Supplier is not responsible of the damages consequent on technical problems related to the delivery of the electrical energy as, for example, amplitude or frequency voltage variations, waveform variations, interruptions of electrical energy supply continuity, micro-interruptions, voltage dips and, in general, anomalies consequent on the management of the electrical energy plants of the User.**"
- Paragraph 4: "**The User is obliged to release the Supplier for each controversy or payment of burdens or damages that might arise to it during the execution of the services presents on the Contract and that derive by facts or behaviours due to the Client.**"

The interpretation of these paragraphs is simple: if the domestic user doesn't know the good electrical energy and all related world, how can he knows which are the accidental or the beyond one's control reasons that can interrupt the supply, how can he knows which are the voltage dips, the waveform or the frequency etc., how can he knows if these characteristics are changed, how can he knows what these changes can produce on electric and electronic domestic devices and, more important, how can he knows if these variations are produced by oneself or not? It's obvious that the **absence of electrical energy Measurements** makes everything absolutely aleatory.

Concluding, in this situation, the possibility to vindicate one's right is impossible in spite of the ISO 9000 Certification [4,5,6,7].

1.1. The Authority Role

To overcome this stalemate, it would be necessary the intervention of a "super partes" external qualified non-profit-making agency which was a direct expression of the state for this sector. The Electrical Energy and Gas Authority has been founded to carry out this function in Italy, so it should occupy to adequately protect the customers interests.

In fact, under an economic/legal point of view this agency performed a remarkable work simplifying and clarifying the writing of producer/user contract and electricity bill, so permitting an easy reading of these and of commercial offer coming from different producers. It fixed certain rules for quality commercial levels, establishing when and how of actions to adopt for the manage of reclaims and estimates or time for execution work etc...Under a technical point of view, for the low voltage (BT) customers, domestic or not, the Authority establishes precise rules only for the voltage dips, while for the other parameters trust to CEI EN 50160 [8] norms, it will put off to fix a own regulations in the future. Formally the Authority gives the possibility to stipulate a producer/customer contract based on the Quality, agreement that can be stipulate after an observation period of one year of the electrical energy. The Authority establishes that the instruments have to respect the CEI EN 61000-4-30 [9].

This doesn't solve the problems from a substantial point of view. In fact, after to have bought one's cost the instrumentations and to have effected one year of measurements, the low voltage user has a series of parameters that however it will not be able to fully interpret and so, it will have big difficulty to give an economic quantification to the eventual lack of quality.

1.2. The Aim

This research have the aim to help the domestic user to mature a new conscience in this field and to help to form a own will that can subsequently be put into in contractual ability based on the quality of the energy.

So, what does the domestic user could ask to a good which he knows so badly? And what does he would like from a product that he is not able to quantify? Instead to talk of true knowledge of the electrical energy, does it possible ask us what the man knows of the electrical energy?

We want to suggest the possibility to support the researches on the power quality that consider the studied object the electrical energy, those on the perceived power quality that put at the same study level the electrical energy and the Man with its knowledge and expectations.

This work presents a research on the perceived power quality from domestic users based on a questionnaire supplied to 3625 customers.

Our analysis raises from practical consideration and through a deductive process wants to present a possible way to put in communication two actors of the same scenery that for historic, economics and cultural reasons, at present, not dialogue each other.

2. THE QUESTIONNAIRE

To understand what domestic users mean for electrical energy and consequentially which are the expectations for this entity, helped by a psychologist, it has been developed a route based on questionnaires. Addressing our research to people with different degrees and different curricula, we developed two simple questionnaires, which could be understood by everybody and that could mirror the real expositive capabilities of people. Anyhow to not limit the expository capability of people, we leave the space for any observations on the margin of the questionnaire sheet.

The procedure is evolved for successive phases: first of all it is wanted to verify the electrical energy degree of knowledge in persons that should be "culturally educated", supplying, without notice, a simple questionnaire to 100 students that frequent the third year of the Electronic Engineering Faculty. These students had already frequented specific courses of physic and electrotechnics, so to answer to simple questions should take for granted. We will see that it is not so.

The questions are totally 13 divided in 4 categories:

- The first, constituted by two questions, wants to verify the voltage and current theoretic knowledge:
 - 1) *Define the Electric Voltage (5min);*
 - 2) *Define the Electric Current (5min);*

- The second is constituted by 5 questions and wants to investigate the general degree of knowledge of the electrical energy:
 - 3) *How does the electrical energy produced?* (5min);
 - 4) *How does the electrical energy conveyed?* (2min);
 - 5) *How does the electrical energy caught at home?* (1min);
 - 6) *Which are the aims of the electrical energy?* (2min);
 - 7) *Which does objects use the elctrical energy at home?* (1 min);
- The third category is constituted by 4 technical/scientific/practice questions to investigate the customer knowledge on the electrical energy supplied at home; among these questions, we inserted a tricky question, number 11, that has the aim to exactly probe the degree of knowledge of the electrical energy:
 - 8) *Which should the shape of the electrical voltage be?* (1min);
 - 9) *Which is the frequency of domestic voltage?* (1min);
 - 10) *Which is the phase of domestic voltage?* (1min);
 - 11) *Which is the amplitude of domestic voltage?* (1min);
- The fourth category is constituted by two questions that wants to investigate the knowledge of commercial elements of the domestic electrical energy supply contract and elements on electric safety:
 - 12) *Which is the maximum power foreseen by your electrical energy agreement?* (1min);
 - 13) *Do your domestic plant respected the laws in force?* (1min).

To each question is associated a defined time to answer, for a maximum time for the questionnaire equals to 27 minutes. The answers can be considered right, wrong, considering among them also the inadequate answers, with heavy deficiency or incomprehensible, or, as third option, is also considered the possibility to not answer.

The same questionnaire has been supplied to others 3525 persons with different degrees and different curricula, but anyway they can be considered domestic users. For everybody it has been recorded only their personal particulars, the educational qualification and their house typology.

The persons interviewed haven't been screened as representative sample so affirming the idea that everybody are domestic customers and so everybody can freely express own point of view on this argument.

The research is lasted two years and the audits have been qualified personnel adequately prepared by the University including some students and professors.

The first graph (fig.1) shows the answers supplied by the students and the picture isn't positive. The knowledge of the electrical energy shows serious gaps both theoretical and practical point of view. The firsts could be attributable to non-widening during the study of the specific university exams, but also to wrong examination mechanisms of their effective knowledge. From a practical point of view, the student life style hasn't allowed them to face practical problems.

The second graph (fig.2) shows the complete results for the 3625 persons, and the picture describes an unmistakable and discouraging situation: the sum of the answers that

describe a lack of knowledge or a wrong or imprecise knowledge is very elevated.

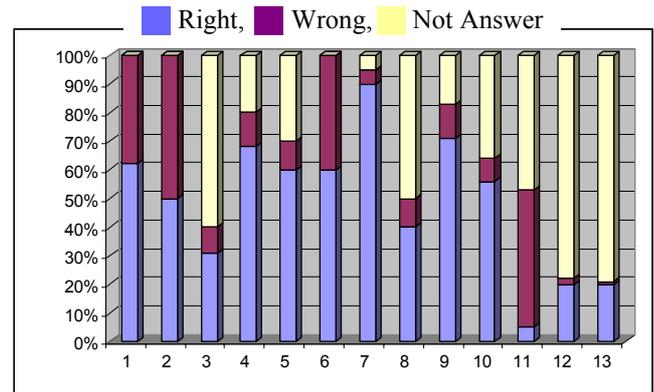


Fig. 1. Analysis of electrical energy knowledge by 100 students.

The only answers that can be considered suited to a sufficient comprehension of the electric energy are the 6th and the 7th, that are questions of general nature not very useful to allow a quantification of the electrical energy.

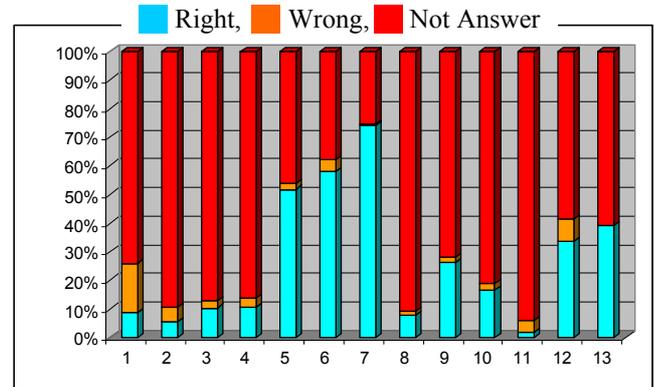


Fig. 2. Analysis of electrical energy knowledge by 3625 not selected persons.

The third graph (fig.3) shows the answers trend for persons with primary instruction, the number of interviewed (80) is small and it is possible to note that, to the theoretical questions, the most of them is not able to answer, while, to questions that reflect the real life, these persons are able to give right answers reaching sometimes satisfactory results as for 7, 12 and 13 questions.

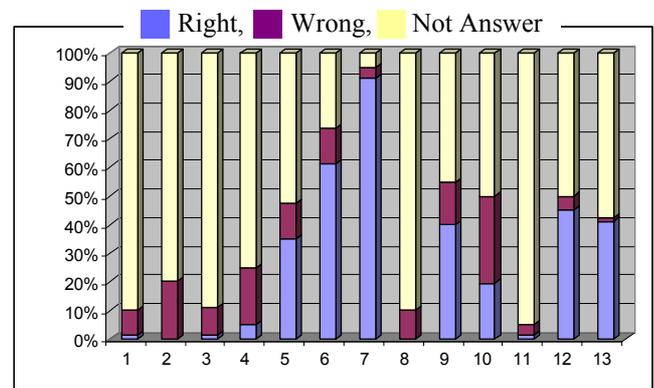


Fig. 3. Analysis of electrical energy knowledge by 80 not selected persons with primary instruction.

The reason is probably due to both the place where they live, almost exclusively rural, both to their rural activities that brought them to face alone all the problems joined to the purchase and to the ménage of the small problems of the domestic electric plants.

The fourth graph (fig.4) shows the answers for a sample of persons (461) with an Italian middle school degree. Also in this case it has been registered difficulty for theoretical questions while the practice nature questions are more congenial. With respect to the graph 2, it rises the number of persons that risk to give answers also without to have the capability: this is an index of an incorrect interpretation of the quantities and of the phenomena, but that seem familiar because however joined to the everyday life.

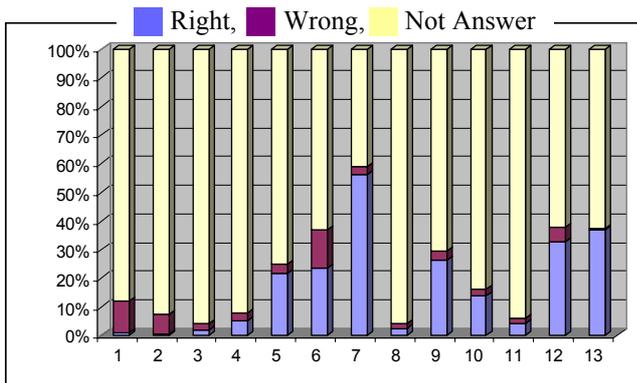


Fig. 4. Analysis of electrical energy knowledge by 461 not selected persons with Italian middle school degree.

The fifth graph (fig.5) shows the answers gave by the sample that has a secondary school degree and that is the most numerically representative (2407 persons). Between them there is a large group of persons that attended scientific or technical schools and so the number of persons able to give judicious answers to theoretical questions considerably rises than previous cases.

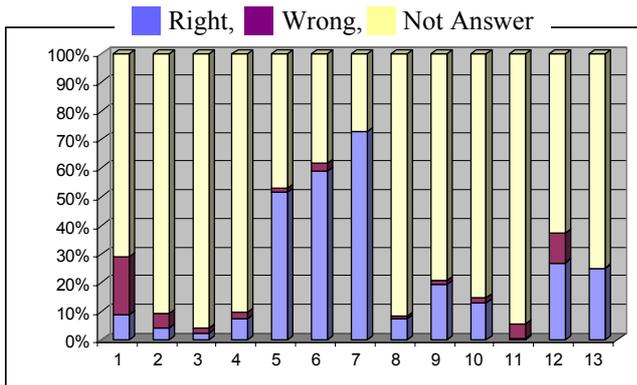


Fig. 5. Analysis of electrical energy knowledge by 2407 not selected persons with secondary school degree.

Moreover, they are member of small and very small economic activity like stores, or small commercial society, small industries, are inured to face practice problems and so are able to give right answers to practice/economic questions.

The sixth graph (fig.6) shows the answers gave by 677 persons with a university degree including all type of

graduated. On the base of the answers it is possible to note that rises the electric phenomena comprehension mainly from the theoretical point of view, while the practice side is surely better understood but proportionally less than theoretical one. The number of negative answers is falling: this proves more respect in the comprehension of this entity.

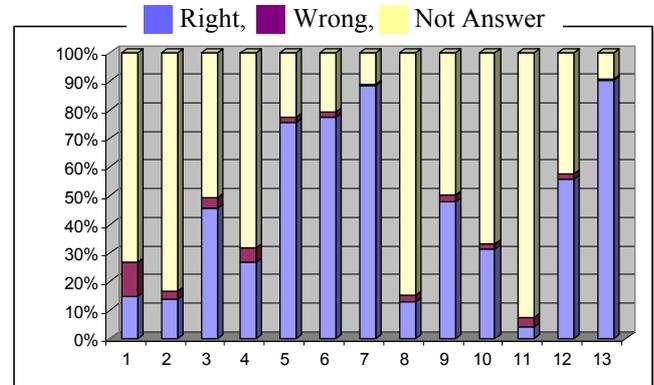


Fig. 6. Analysis of electrical energy knowledge by 677 not selected persons with university degree including all type of graduated.

The seventh graph (fig.7) shows the answers gave by 57 persons with a technical/scientific university degree like engineer, physic and math. The answers gave express a good knowledge of the electrical energy both from a theoretical side and practice one, but however they persist some doubts good expressed by the 11th, 13th and 14th questions. The unsatisfactory answers are mainly due to the female member of the sample, that evidently is less interested to domestic technical problems, historically prerogative of the men.

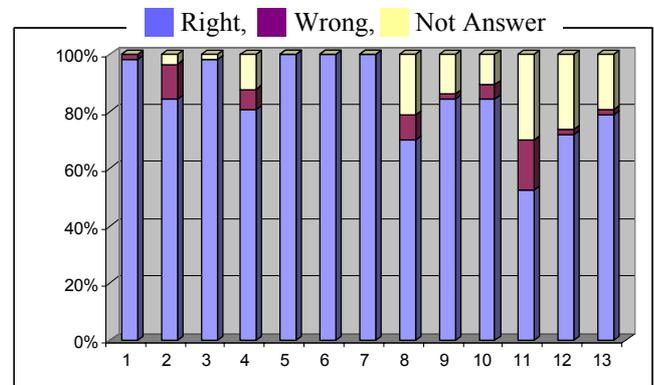


Fig. 7. Analysis of electrical energy knowledge by 57 selected persons with technical/scientific university degree.

In the last graph (fig.8) we show the results of the questionnaire proposed to the same students again, after a period of 15 days from the first test, asking they to study in depth the arguments dealt in the questionnaire. Obviously the results are decidedly better even if not yet perfects.

After having verified the flimsiness of the electrical energy concept for the domestic customers, we tried to understand which side of the electrical energy the users are more interested to, asking they what kind of inefficiency had their electric domestic plant and which are the inefficiencies more irritating. It has been set up a second questionnaire, for which it has reported only the summarizing tables of the whole interviewed sample, conceived analyzing the answers

and the hints gave by a successive students to the first questionnaire before and after the widening of the test arguments.

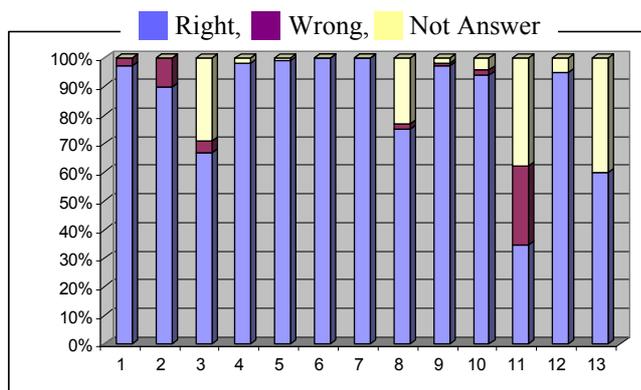


Fig. 8. Analysis of electrical energy knowledge by 100 students after a study period.

These lasts have been studied in depth with a small number of electricians that know under a practical point of view the problems that the domestic customers submitted them.

The questionnaire so conceived has been supplied to an electric engineer, consultant of Rome court for the electric problems, which has further suggested integrations and changes.

This second questionnaire is composed by two parts: the first, table 1, ask to specify the irritation level (expressed by 0 to 10 numbers) joined to the duration of eventual black out, the second instead ask more specifically, on the base of own experiences, to count the number of inefficiencies, in a antecedent period the test of two years, associating them the irritation level (table 2).

Table 1. Mean value of irritation level for black outs.

Length of Black Out	Mean value of irritation level expressed from 0 to 10
black out <1 min (don't tell in advance)	0.016
black out >1 but <5 min (don't tell in advance)	1.78
black out >5 but <15 min (don't tell in advance)	3.86
black out >15 but <30 min (don't tell in advance)	7.65
black out >15 but <30 min (tell in advance)	4.56
black out > 30 min (don't tell in advance)	9.63
black out >30 min (tell in advance)	5.62

As it was possible to foreseen the irritation level rise with the increasing of black out length and with the absence of notice.

From the second table it is possible to see the breaking of computers or black household appliance are the events more felt as irritating, this because they are interactive objects that have a big relevance for human activities. Interesting that the inefficiencies most dangerous, the 11th question, is also the event that is never verified.

The answers of this second questionnaire are clearly dominated by problems which particularly interest domestic customers and so, fall on failures and malfunctions.

These have anyway to be putted on the normative rules that define the quality of the electrical energy, quality that have however to be measured by the normative rules.

Table 2. Mean value of occurrences for some possible domestic and Low Voltage inefficiencies with correlated irritation level.

Type of Inefficiency	Mean value of occurrences happened to each person in the last two years	Mean value of irritation level expressed from 0 to 10
1) Fluttering of lamps	100	3.13
2) Anomalous replacement of lamps	3.4	6.27
3) Incorrect activation of antitheft device or burglar alarm	2.2	7.12
4) Breaking of personal computers	0.037	9.78
5) Breaking of white household appliance	0.012	8.32
6) Breaking of black household appliance	0.027	9.12
7) Anomalous behaviour of cash registers	0.033	3.01
8) Substitution of differential switches	0.006	7.16
9) Superheat or stopping of electric motors	0.005	5.25
10) Failures of conditioning plants	0.02	6.21
11) No well-timed intervention of differential switch	0	10
12) Phenomenon of corrosion of the electric plant	0.001	9.65

3. CONCLUSION

A research on the knowledge of electrical energy by low voltage and domestic customers has been presented.

This article clearly shows as the knowledge of electrical energy by domestic or low voltage customers is very poor and contemporarily it shows as the producer/distributor companies imposing their will and disappointing the ISO 9000 guidelines.

In spite of the sense of annoying produced by electric inefficiencies can be very high, the lack of knowledge of the electrical energy, testified by a questionnaire conducted on a sample of 3625 domestic customers, prevents any type of possible dialogue between the producers and the customers.

Starting from these considerations, this job wants to suggest a new way to build the relations between producers and customers based on the evaluation of the true customers exigencies so to establish new type of agreement based on the quality of the electrical energy. This new type of relationship should be encouraged by an independent non-profit-making organization.

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