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THE PERCEIVED POWER QUALITY OF ELECTRICAL ENERGY: AN ASSESSMENT IN ITALY

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Abstract: The Perceived Power Quality by costumers has been faced, starting from ISO 9000 Quality definition. An experimental investigation is presented on customers of Rome (Italy). By the results one demonstrates that fluxes of parameters defined on own manner by costumers, can be determined.

Keywords: Perceived Power Quality

1. INTRODUCTION

Energy is a strategic good for a Nation and it must be protected.

The connection between the production and the consumption of energy in a country and the importance that hold that land in the world context, is very strong.

To have big or giant societies, in this sector of economy, assures to each countries the defense of this primary good from "external" attaches and assured the own economic growth.

The electric societies satisfied the primary necessity to give energy to the Country, but, to make a use of this protected system, neglected some commercial rules already presented in others commercial fields; first of all the quality of the service and then the Quality of the Energy.

How said represents a historic picture of the recent past of Italian energy market in which the National Energy Society lived in a monopoly system without ever debate itself. In this situation only the Great Contractors have the economic possibility to discuss at the same level with the electrical society. Them have the economic capability to engage experts, the "energy managers", able to converse in technical language with energy producers obtaining attention to own problems that it translates in economical advantages, of great entity also. For the same reasons the Little and Medium Enterprise (LME), that represent the 90% of Italian economy capability, there wasn't the possibility to dialogue with the electrical society.

Although they are customers operating on the more different categories of the technology of commerce, they have, with respect to Electrical Energy, a psychological common attitude and the political impossibility to dialogue with the electrical society generated a situation of impotence that developed in lack of interest with respect to the operative problems and it turn on in misinformation and in cultural lost in Electrical Energy, along the time.

Actually the situation is evolving in way to have more producers more distributors of energy, creating a new way to understand the energy market. In this new situation the customer assume new importance because him can choice the own producer. Obviously, as happen in other commercial fields, the quality of the service is one of the choice elements.

All people are customers with respect to Electrical Energy, in modern society, and by the great social and economics differences, we have very different expectations, judging its Quality in a very unlike manner one to another.

It has no sense to talk about the Quality of Electrical Energy, not having established the implicit expectations of the customers. It is necessary to start from the analysis of customers.

By a series of definitions linked each others and furnished by ISO 9000, it allow to give a definition of Quality applied to Electrical Energy that considers the customer's expectations and sounds:

"Quality of the Electrical Energy is comprehensive of own intrinsic distinctive elements that satisfy the implicit expectations of customers".

This new way to set up the study of the Quality of Electrical Energy put at the same level of importance the producers, the distributors and the customers and traces the street to define a new concept that consider the quality from a sociological point of view.

It has been developed a new instrument, able to measure the electrical parameters of the net, to help us in the manage of the data. The instruments, or probes, are installed in the Rome territory in zones that represent the four cardinal points.

2. THE PERCEIVED POWER QUALITY

At the Roma Tre University, three years ago, it seems was the chance to set out a research on the definition of Perceived Power Quality by the customers of LME.

Starting from the "top", we settled the operative problem of how to carry out the research.

Sudden, two problems rise:

- How to converse with categories of the technology of commerce so different each others
- What will be the "language"
- A "Pertaining to the Technology of Commerce Filter" (PTCF) was the solution.

Every LME uses Electrical Operators (EO) either for the maintenance or for the project of electrical plants: their category will be which to use as an interface to collect information on Perceived Power Quality of Electrical Energy.

2.1 The Questionnaire

A "language" to communicate with this selected category must be developed.

This problem has been solved in two phases.

Using an heuristic procedure, a well-educated EO, able to dialogues with the "Accademia", to understand the demands and the needs of LME, and to compare the information to actual Technical Rules.

Has been requested to EO, to prepare a List of Questions (LoQ) to ask information on Perceived Power Quality of Electrical Energy (Q_1 in Fig. 1).

The LoQ has been given at a certain reduced number of EOs, far from "Accademia", still using the heuristic method (Q_2 in Fig. 1).

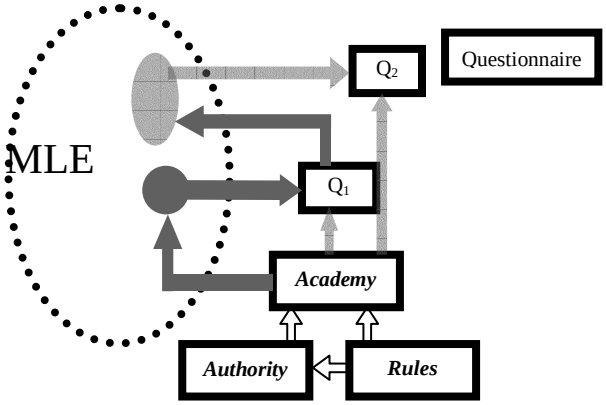

Fig. 1. Development of the questionnaire

The reduced number of the questionnaires obliged us to use the Student approach for the statistical analysis, but was possible to re-design the LoQ.

The LoQ characteristics was:

- Only six field of qualities
- A maximum of five questions for each section
- Heading of sections not congruent with the Rule EN 50130
- Answers to the question organized in such a way optimal statistical valuator of mean and standard deviation, cannot be used
- Questions developed essentially on failures

2.2. The Perceived Quality Fluxes

The confinement of customers with respect to the problems of Electrical Energy distribution and of the specific characteristics of this goods, make them unaware of their Quality of Electrical Energy can depend on the modality they
use to "draw off" energy from the network.

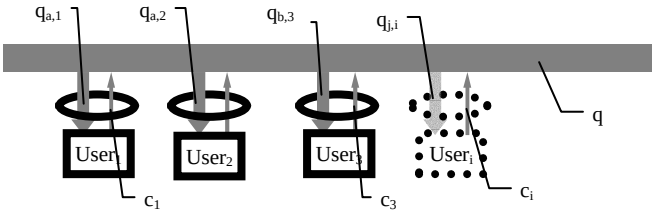

Fig. 2. Draw off by customers

The technical problem must be resolved is to establish the direction of the fluxes of the quality of the energy in the categories individuated both by customers and by Rule EN 50160.

Thirteen categories of Rule must be crossed with the six individuated by customers.

All this with the target to establish a communication between producer and customer with the possibility to
develop in the last a sensitivity to the problems of the Electrical Energy distribution.

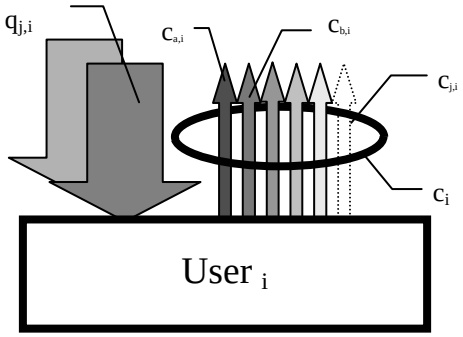

Fig. 3. Single customer draw off model

In the new deregulated situation of the market of the "electrical energy goods" the rules must be considered considering the customers' demands central in its logic, with the producer and the distributor.

The different demands, as function of category of the technology of commerce, misinformation and culture deficiency are customers' characteristics that have the right to pose own exigencies in terms of goods quality to be compared with producers and distributors well prepared in technical words that presume to be them to define the product quality.

The frame work of this relation customer-producer is actually defined, in Italy, by the "Autorità per l'Energia Elettrica ed il Gas (AEEG)"(Electrical Energy and Gas Authority) and, in a short time perspective, by the Judicial Power (JP) and by the "Sistema Nazionale di Taratura (SNT)"(National Calibration Service).

The AEEG declared in April, 2004, the Quality can be introduced in customer-producer agreement, with arranged parameters observed, at least, for one year.

But the observation of every parameter can be obtained only by measurements.

The observance of agreed quality parameters must be, also, by measurements.

If agreed parameters are not satisfied, JP judges the correctness of measurements by the SNT, as forecast by the Law.

3. AN APPLICATION TO ROME CUSTOMERS

The questionnaire has been give to 4000 customers of the EO category, on the territory of the Rome town, in Italy, and the results are represented grouped around the four physical probes, as indicated in last phrase of the Introduction, distributed on the territory, because the our ultimate goal will the comparison between ruled parameters fluxes with the Perceived Power Quality ones

The data treatment implied the use of non optimal statistical parameters.

3.1 The "Signature"

The first statement was the definition of the "signature" of all the territory in the sense of frequency of answer for each question, in each field defined by customers.

Obviously it seems that are an heavy situation on the territory, but it must remember the fact the EO, have developed the questionnaire in terms of failure.

The first graphic shows the global signature for the macro question on the field of "Interruption and/or absence of one or more phases" for all the answers in civic territory.

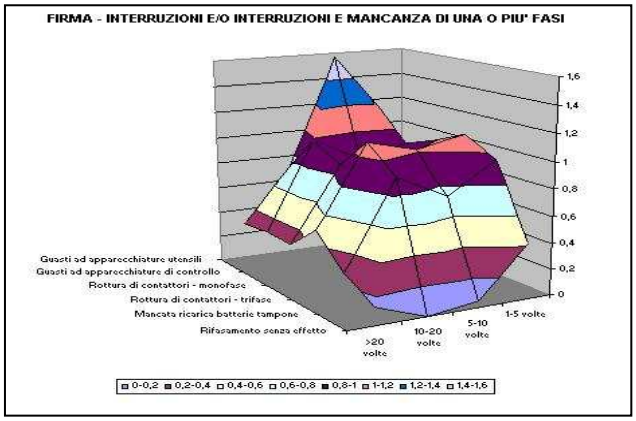

Fig. 4 Signature on the field of "Interruption and/or absence of one or more phases" (the headings of the figure are in Italian)

The answers for each category, point out both from kind of failure and times of happened, are normalized dividing them for the total number of answers for kind of failure.

How it was possible to wait, the peak of faults is centered around the failure on machines tools, problems that are happened with quite often.

Next graphics show the local signature for "Interruption and/or absence of one or more phases" for each probe present on the territory.

The answers have been grouped on the base of the distance between the customers and each probe. Each customers "belongs" to the nearest probe that became the "barycentres" for the probes. In these graphics is also presents the answer "Never", not present in the global signature. This answer is not useful for the representation of the failure, but is an index that help us to understand better the situation.

How it is possible to see in the graphics the peak indicates that the principal problems are due to breaking of one-phase electricity meter. There is nothing to be surprised if the problem most important in the local signatures is different from global because the local behavior can be different from a global interaction.

Signature – Interruptions and/or absence of one or more phases for Probe South

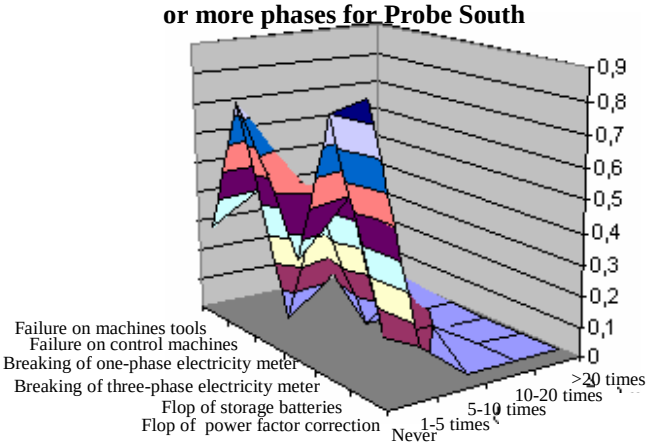

Fig. 5 Signature on the field of "Interruption and/or absence of one or more phases" for Probe South.

Signature – Interruptions and/or absence of one or more phases for Probe North

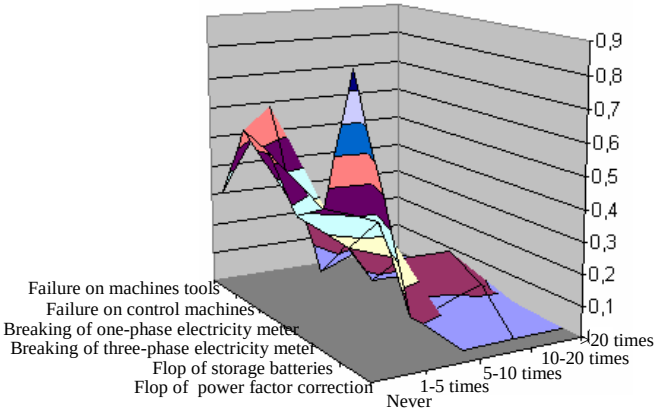

Fig. 6 Signature on the field of "Interruption and/or absence of one or more phases" for Probe North.

Signature – Interruptions and/or absence of one or more phases for Probe West

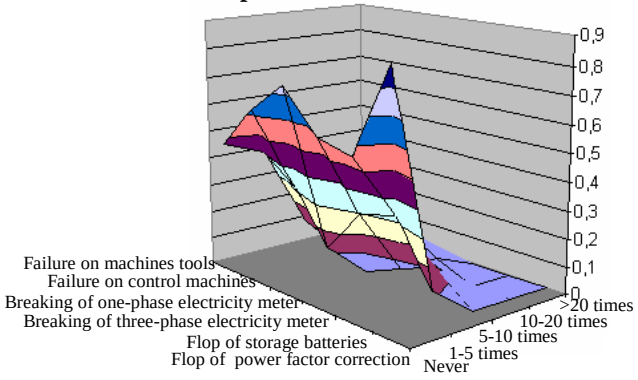

Fig. 7 Signature on the field of "Interruption and/or absence of one or more phases" for Probe West.

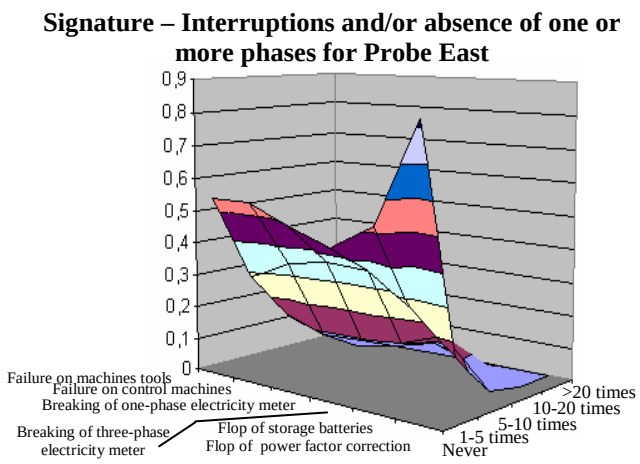

Fig. 8 Signature on the field of "Interruption and/or absence of one or more phases" for Probe East.

3.2 "Gradient"

From the four previous graphics, it is possible to determine the "gradient" for the analyzed parameter. This gradient can be considered an index that allow us to synthesize the information of flux for this parameter.

To obtain the gradient first of all we must characterize the directions among the probes: for four probes, there are obviously six directions. Then it is necessary to subtract each answer for each probe to the same of another probe indicated by the directions and to divide for the them distance. Normalizing these results by means of non optimal statistical valuators, we obtain the next table where

Table 1. 6 Absolute values of Gradients along the probe directions for the field of "Interruption and/or absence of one or more phases".

	SOUTH	WEST	NORTH	EAST
SOUTH	0	0.169	0.238	0.138
WEST	0.169	0	0.456	0.247
NORTH	0.238	0.456	0	0.260
EAST	0.138	0.247	0.260	0

It is interesting to see how the gradients are develop on the map of Rome. To obtain this, first of all it is necessary to find the absolute maximum of the gradient in the table: in this case the gradient between north and west probes. After this it is necessary to search the highest value in the table not present in the row where it is present the previous gradient: in our case the value among south and east probes. Repeating the procedure another time we obtain the direction for the gradients. Anyway the number of iterations depend by the number of the probes[7]. Considering the versus too (it needs to verify the sign of the difference among the probes) it is possible to draw the route of the gradient on the map of the city, as it is shown in figure 8.

The results of the research on Perceived Power Quality are shown in this figure, obtained by the results of a questionnaire given to EO operating on the territory.

It is evident the citizens of Rome perceive as very bad the Power Quality indicate by the parameter "interruption and/or absence of one or more phases" in the north a zone poor both of commercial activities and houses in which the supplier would provide to make better the service.

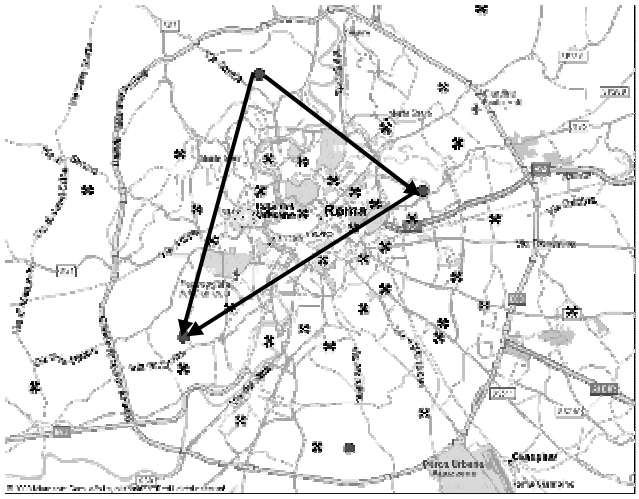

Fig. 8 Flux of Perceived Power Quality for the parameter "interruption and/or absence of one or more phases" own defined by customers (the headings of the figure are in Italian).

4. CONCLUSIONS

The Perceived Power Quality as been defined directly by the customers.

The fluxes of parameters defined Perceived Power Quality can be also defined allowing, in prospective, to identify the responsible of Electrical Energy Quality falling down.

The successive step will be the identification of Quality flux of parameters foreseen by the EN 50160, by probes distributed on the territory to cross the Perceived Power Quality parameters with the one forecast by the Rule.

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