

EXPERIENCE IN SYSTEMS OF TECHNICAL MEASURE DISTRIBUTIONS

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INTRODUCTION

The characteristics of the Argentine market and its transformations since the year 1992 are here described, giving details of its components and its general rules. The main characteristics of the Edenor Technical Project, implemented on 09.01.96 in order to face the demands of the continuity service control at an individual customer level are summarized. Likewise, the results of the tension level measuring campaigns during a calendar year and disturbances (wave quality) since April 1997 to the present are exposed in detail.

ARGENTINE ELECTRICAL MARKET

Description

The Argentine electrical market has suffered a deep transformation these last six years, as a consequence of private capitals having got in charge of most of the electrical energy generation, transmission, distribution and commercialization. This tendency continues and the National State and the provinces are expected to retire completely from their function soon. The direct consequences are both an increase in the governmental regulations which control the quality of the services rendered by the electrical companies formerly belonging to the State, and a higher level of demand by the users as regards to the enterprise.

In short, it can be said that currently, and as of the Act 24065:

- The privatization of the electrical services (for national enterprises) is established.
- The thermal generators can be freely set once the permits are obtained and the environmental impact studies have been approved, and the contracts of supply can be celebrated directly with the distributors or main consumers. (The hydroelectric generators work, instead, under the regime of public concession, since they use a natural resource with which they get in contact through that juridical entity).
- The carriers (the enterprises operating with main high tension transmission power networks) must be holders of a transmission concession and they are responsible, from the point of view of the delivery of the generator, until the distributor or main consumer receives it.

- The distributor is the one who, within his area of concession, is responsible for providing the final users who cannot hire their supply independently.
- A main consumer is the one who hires independently the supply together with the generator and/or distributor for personal usage.
- Those who receive energy in block as payment or exemption are able to commercialize it as a generator.

This model leads to the creation of what has been called MEM (Wholesaler Electrical Market, in Spanish “*Mercado Eléctrico Mayorista*”) integrated by Generators, Carriers, Distributors and Main Users. The main institutions involved are:

- **ENERGY DEPARTMENT:** Depending on a Ministry (Economy and Public Works).
- **ENRE:** Electricity National Regulator Entity (in Spanish “*Ente Nacional Regulador de la Electricidad*”). They are independent. Their authorities are selected by assembly and passed by the Congress. Their main function is to control the fulfillment of the Concession Contracts.
- **CAMESA:** Wholesaler Electrical Market Administration Company (in Spanish “*Compañía Administradora del Mercado Eléctrico Mayorista*”). Is the one in charge of the technical dispatch of the system. It is formed by the Energy Department (with power to veto) and the following Associations:
 - AGEERA:** (in Spanish “*Asociación de Generadores de Energía Eléctrica de la República Argentina*”) Association of Electrical Energy Generators of the Republic of Argentina.
 - ATEERA:** (in Spanish “*Asociación de Transportistas de Energía Eléctrica de la República Argentina*”) Association of Electrical Energy Carriers of the Republic of Argentina.
 - ADEERA:** (in Spanish “*Asociación de Distribuidores de Energía Eléctrica de la República Argentina*”) Association of Electrical Energy Distributors of the Republic of Argentina.
 - AGUEERA:** (in Spanish “*Asociación de Grandes Usuarios de Energía Eléctrica de la República Argentina*”) Association of Electrical Energy Main Users of the Republic of Argentina.

It can be clearly perceived, from the mere enunciation of the members composing CAMMESA, that the ones involved are opposed interests which have to be harmonized to achieve the best technical and economic

results (Producers will always try to dispatch its production to the market, users will require the minimum price for the energy and, besides, distributors will desire to optimize the transportation security (for, as it will be seen below, they are responsible for all the interruptions it could be subjected to before the customer, regardless the level in which those interruptions take place). It is important to remark that, from the point of view of the distributor company, not all the customers from their area of concession are obliged to purchase the energy directly from them, but they can do it directly from the Wholesaler Electrical Market. Currently the following types are defined:

- GUMA (Large Main User, in Spanish “*Gran Usuario Mayor*”) His power supply must be equal or superior to 1 MW y and the Energy equal or superior to 4380 MWH per year. He must hire at least 50 % of his demand on term on the market (minimum 4380 MWH per year for a period longer than one year)
- GUME (Large Minor User, in Spanish “*Gran Usuario Menor*”) His power supply must be inferior to 2 MW and equal or superior to 100 kW. He hires the totality of his demand and energy.
- GUPA (Large Private User, in Spanish “*Gran Usuario Particular*”) His power supply must be inferior to 100 kW and equal or superior to 50 kW. He hires the totality of his demand and energy.

If this tendency of reducing the requirements to access to the MEM continues, it is possible that, in the future, the market gets completely released. The main difference for the Distribution companies is that the regular customer-fare is composed by the MEM price plus the acknowledged technical losses plus the distribution cost while, for the Main user, the MEM energy cost is not included, that is to say, only the service of distribution power network installation at the customer’s disposition is rendered.

Technical Control of the Distribution Companies

The Argentine model establishes an indirect control system over the technical performance of the distribution companies by means of a follow-up of the supply continuity indicators and tension level control campaigns.

Service quality (Continuity). In general, it can be said that this control (quantity and duration of interruptions), goes through a first stage in which the continuity indicators are established at a company global level up to the MT stage included. That is to say that only a few values are representative for the quality perceived by all the customers and, therefore, the incidental deviations and sanctions due to nonfulfilment are not personalized, under no obligation of a more detailed follow-up. The systems that both, Edenor and other companies, had to implement had a medium complexity, since it was only necessary to know the performance of the distribution mains in HT and

MT, up to the level of the MT/LT transformers centers and they are, therefore, practicable of implementing and keeping under control with no complex systems although, of course, the information provided for the measure is also limited. The qualitative and quantitative differences are produced with the obligation, on the second stage, of controlling the continuity of the supply of all the customers of the distribution company at an individual level, with which the LT level is included. In brief, it has to be possible to know the history of all the interruptions suffered by any customer of the company. For the companies of the Buenos Aires metropolitan area, among which is Edenor, this obligation began on 09.01.96 so, to the date, an experience of almost two years of dealing with the subject has been achieved.

EDENOR TECHNICAL PROJECT

General Description

To fulfill the contractual demands of the supply continuity follow-up at an individual customer level, Edenor’s decision was to implement an integrated system, which did not only attend the contractual demands of information, but also provided indispensable means for an efficient technical measure. In general, this system called Edenor Technical Project is based on the implementation of telecontrol in all the HT/MT substation of the company, plus 600 critical spots of the MT power network which, besides, implied the technological renewal of the installations involved. This decision is therefore closely connected to the informatization of the whole MT power supply as the only means to follow up its performance. The inclusion of the LT power supply in the model implied, as well, the solution to a problem much more complex to solve, the maintenance of Edenor’s customers’ (currently more than 2,100,000) connection to the power network and the creation of the interruption measure systems. As an integrated system (which included both the power supplies telecontrol aspect and the data base and applications generation, maintenance and exploitation) and after a selection in the market, the application of the supplier company REDESA, already used in the company ENHER from Barcelona (Spain) was chosen, of course, with the necessary modifications for Edenor’s internal needs and the external obligations imposed by the control entity.

Customers’ connection to the BT power network

Choice of the connection. The time to achieve the system implementation and the technical and commercial integration was short. The decision of separating the fields of the technical data from the commercial one was taken. Thus, a parallel work and the establishment of respective control processes was possible. The geographical element chosen as connection key was the

customer's domicile. This decision implied, first of all, the creation of a master base of streets at a corporative level, codifying each existing street from each Municipal District. A street code was assigned to each different group of street-district (for the streets with the same name within a Municipal District a code according to the locality it belonged to was assigned). It must be considered that an important part of Edenor's area of concession corresponds to suburban and rural sectors, and that, in many cases, there was no official catastral nomenclature. In these cases, the names of the streets, the addresses and all the information related to the domicile were agreed with the respective Municipal District. Whenever the consensus was not reached, the information was assigned in order to regularize the situation later on. Besides, and as a company policy, Edenor proceeded to place public identifying marks of the adopted nomenclature whenever necessary. The success of this procedure was evidenced by the fact that many Municipal Districts and public services, such as Fire Departments, solicited copies of Edenor's cartography and nomenclature to adopt them as proper and official from then on.

Base information. Prior to the connection plan launching, the different operative areas of the company had began the cartographic replacement and the entry of the LT power network data with CAD tools, but without normalizing the symbology and the annexed data base. Therefore, in order to not waste all the replacement task already made, the following measures had to be taken:

- Modification and normalization of the CAD software, with a measure centralized by the Systems area.
- Conversion and fitting of the graphic representations to the new common design.
- Normalization of the annexed data base.
- Conversion of the graphic representation to alphanumeric files and loading in the named BDE (Data Base Exploitation, in Spanish "*Base de Datos de Explotación*"), which constitutes the corporative data base.

Then, the generation process went through the existing cartography, the generation of the corporative streets base, the replacement in field and the verification between the addresses of the service delivery points (in each delivery point there can be one or more customers) and the addresses of each and every customer.

Advantages: This philosophy opens future possibilities of data interchange outside Edenor since, for the electrical service is the most widely spread among the population, Edenor already has normalized addresses of service for each customer which are not repeated in the whole area of concession and that are independent from the electrical mains, or from the electrical supply characteristics (customer's name, fare, etc.). Internally this sole domicile (VCR or power network-customer connection, in Spanish

"*vinculación cliente-red*") is the entry code to all the corporative systems, such as:

- RYCA : Failure Control and Reception (in Spanish "*Recepción y Control de Averías*")
- CLARION: Minor Usage Commercial System, (in Spanish "*Sistema Comercial Pequeños Consumos*")
- GT3: Main Customers Commercial System
- SIRE: Energy Recovery Integrated System (in Spanish "*Sistema Integrado de Recuperación de Energía*").

Base information volumes. Currently, Edenor's technical field has the following approximated MT and LT power supplies data entered to their corporative data base:

| | |
|----------------------------|-----------|
| MT/LT Transformers Centers | 10,720 |
| Boards | 10,800 |
| Feeders | 28,900 |
| Delivered points | 1,550,000 |
| Sections | 3,022,900 |
| Derivation points | 1,115,000 |
| Isolated points | 59,400 |
| Maneuvering gadgets | 83.900 |
| Fuses | 137,400 |
| Underground joints | 90,100 |

Interruptions Technical Management

HT and MT level: It is centralized in the named CCE (Edenor's Control Center, in Spanish "*Centro de Control Edenor*"), which is in charge of the measure of all the MT level interruptions and maneuvering, using both the Telecontrol system in the HT/MT substations where it has been implemented and the manual work of the mobile units distributed within the area of concession. The HT level interruptions are, in principle, managed by another entity (called SACME), common to both Gran Buenos Aires Distribution Companies, since the transportation networks are interconnected. Nevertheless, the CCE is enabled to function as SACME's backup and to operate the AT power supplies as well. All the work involving MT power supplies must be previously coordinated and authorized by the CCE.

LT Level: Currently it is decentralized in each one of the four zones in which Edenor's area of concession is divided. Customers' claims for lack of power supply and other technical problems are attended through the RYCA system (Failure Reception and Control, in Spanish "*Recepción y Control de Averías*"), which was developed by Edenor and was already working before the PTE to which it had to be integrated was implemented.

Interruptions Entry Systems

HT MT level: The interruption entry is centralized in the CCE, which has the system called MINISACMT, provided by REDESA. Through this system the operators register

the interruptions using graphic tools which act over the single-lined MT power supplies, which include the HT/MT substation and MT/LT Transformers Centers. The failures are thus automatically registered. The degrees of detail reach the MT/LT transformers from each one of the Transformers Centers. Currently the time and duration of the interruptions are entered manually basing on the Telecontrol data and/or the report of the mobile teams on location, but the implementation of the SAC (Conduction Backup System, in Spanish “*Sistema de Ayuda a la Conducción*”) is planned to be implemented in the near future, with which these times would enter automatically based on the signals coming from the Telecontrol and in real time. On the other hand, each interruption is classified according to its type, cause, origin and if they are a consequence of major force, operated maneuvering equipment, damaged materials etc. This information is used both with corporative purposes and to fulfill the information requirements of the control Entity (ENRE). The interruptions and their related information are available on line and they can be both consulted by the different users, and issued in parameter reports. The MINISACMT allows, as well, to enter the affected Transformer Centers alphanumerically through a screen selection which displays the information of the MT feeders and their related TC MT/LT. The customers connected to each TC interrupted are supplied every 24 hours in an off-line batch process. Otherwise, in the case of long-term interruptions caused by problems in the external power supply, where several HT/MT substation can become affected, it would be impossible to work on line collecting the information of thousands of LT customers (An average HT/MT substation supplies 40,000 customers). Nevertheless, if the information of a particular customer is desired to be obtained, there are ways of consulting which allow to determine whether he was affected or not by the recent interruption.

LT Level: In this level, the information is entered, in a decentralized way, into each one of the four zones in which Edenor’s area of concession is divided. By analogy with the MT level, the entrance tool is called MINISACBT, and has very similar functions. In this case, the task is carried out over a local data base which is updated every twenty-four hours with the central data base where finally the LT level interruptions are also recorded. In this case, and given that the interruptions don’t affect a large quantity of customers (the ones corresponding to a TC MT/LT to the most), the application works directly over the customers connected, and it allows to know in each interruption all the information of the customer (name, address, account number, meter number). Given that most of the LT interruptions are produced at an individual customer level (generally due to his internal installation), an interface between the telephone attending system for failure claims reception (RYCA) and the MINISACBT application which, basing on the information of the claims and their solution, generates

almost automatically the interruption, leaving to be made only a simple verification of the information coherence, made through software when reporting the finalization of the interruption.

Information consolidation and exploitation

It is performed at a centralized level, through an application called QUALITAS, which allows to analyze the interruptions of all the tension levels as a whole, and to detect inconsistent information (although they could come from a real situation: For example a LT interruption in a customer registered at 10:00 AM and solved at 11:00 AM, while simultaneously, between 10:20 AM and 10:30 AM a MT interruption affecting that customer among others, takes place. Both from the point of view of the penalizations for continuity as from the customer’s history of interruptions, the proper procedure is to exclude him from the MT interruptions since, otherwise, two supply cuts would be registered to his name at the same time). QUALITAS also allows the issue of different types of reports, entering only a few control parameters, for example time period, unexpected or programmed interruptions etc. Nevertheless, the experience shows that, apart from the consults registered in parameters, other kinds of studies forcing to develop specific applications, which constitute the additional reports library, are frequently required.

CONTROLLED INFORMATION

Apart from Edenor’s internal needs for an adequate technical measure, the complexity of the above-mentioned systems is originated in the rigid information requirements demanded by the control Entity. In effect, for a given interruption of the MT level, the following data has to be provided among other information:

- Type, cause, origin, possible major force, affected installation (MT supplier, MT/LT transformers centers, MT customers, LT customers quantity), the network electrical connection (including the codification of the maneuvering equipment used in each stage of the incidence measure), hours and claims made by customers affected by the interruption.
- Besides, when each semestral control period elapses, the history of interruptions of each one of the 2,140,000 Edenor’s customers must be reported (due to the required design, this data base can keep record of more than 12,000,000 entries).
- The information of all Edenor’s customers together with its electrical connection, that is to say, all the codification of these elements (MT feeder, MT/LT Transformers Center, MT/LT Transformer, LT Board, LT feeder) has to be rendered as well.

- The commercial information, that is to say, their fares, billed energies, dates of signing-up and resignation as a customer, etc.
- Eventually, when the Entity decision is sent forth by the end of each control semester, to make a credit note in the bill of each customer to whom a discount corresponds, and to detail his energy cuts history.

EFFECTS OVER THE INTERNAL ORGANIZATION

The complexity of the systems involved, the external control and the economic amounts at stake causes the direct or indirect involving of practically the whole internal organization of the distribution company with the subject. A clear idea of every member's function in the process and his orientation as an excluding condition to guarantee the quality of the information for which he is responsible must be achieved, for a bad measure in a certain point ends up affecting the whole system, given the tight relationship between the technical and commercial data from base. An example of the need for integration among the different areas of the company is the request for the exception of an interruption registration caused by major force. As it was formerly stated, the control mechanism relies the economical responsibility for all the energy cuts suffered by a customer on the distribution company, regardless whether it comes from the generation, transmission or distribution (that is to say, even those which are originated in the systems not belonging to them). With this responsibility, and the narrow control limits imposed, it is extremely important for the distribution company to be able to request the exception from all the energy cuts which could be the consequence of major force. To be able to present an application for this kind of exception, the steps to follow are:

- To send a Fax to the Control Entity 48 hours before the incident, requesting the exception.
- To gather documentary evidence, which could include witnesses statements, Public Notary Act, photographs, video recordings, etc., fulfilling certain legal requirements.
- To send the proofs to the Control Entity and to wait for their decision regarding the acceptance or denial.
- If the interruption has been denied and it is economically relevant, to gather additional proofs and to request them to be considered by the Entity.
- If it is finally accepted, to record it in the data base for it to be excluded.

As it can be seen, both technical and legal services take part in the internal organization, apart from people non-belonging to the organization, who must understand the mutual requirements and provide each other with the necessary information to lead the measure to a good term.

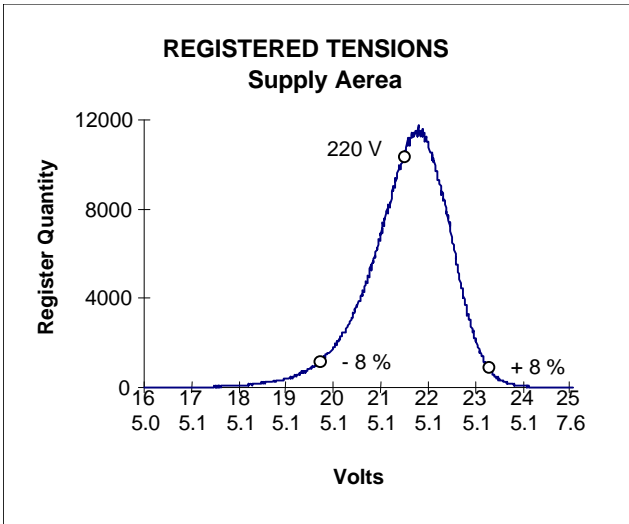
As a conclusion it is restated that only an organization equipped with the proper technology integrated to a culture aiming to achieve information quality, with a wide diffusion of the critical importance of the subject and the interaction among the different areas by which it is formed, can face successfully the demands of an external control system as the above-mentioned.

TECHNICAL PRODUCT QUALITY

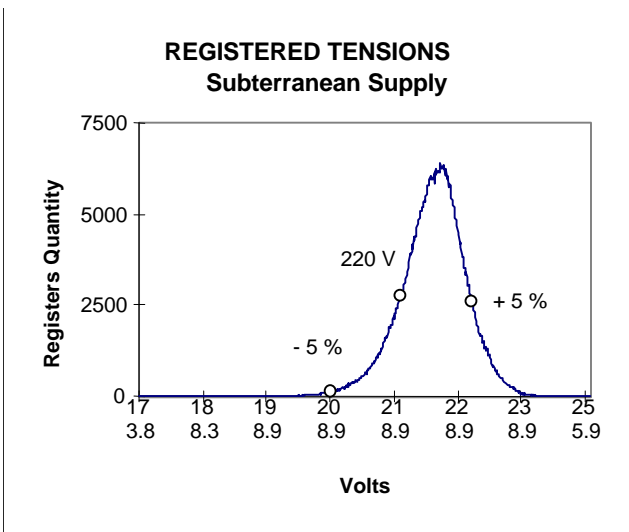
On September 1st, 1996, exactly four years after the beginning of the concession, the called Stage 2 of Control started. As regards to the surrendered Technical Product Quality control, it included two stages: Stage A which lasted for a period of two years beginning on the above-mentioned date and stage B which follows it immediately since September 1st, 1998. As respects to the control of the slight tension variations, the Stage 2 of Control led to an increase and concentration of the measures carried out at the level of the customer's supply point, since its main purpose is to follow-up and control the quality perceived by each one of the customers individually. Additionally, the control of the delivered tension wave was incorporated through the flicker register and the tension harmonics. Regarding the alterations, Stage A was considered to constitute an evaluation period to determine their level in the distribution power supplies and to intervene particularly in those cases in which a deviation from the Reference Levels established in the international ruling adopted (rules IEC series 1000 for harmonics and 868 for flicker) was registered.

Tension Measures

The slight tension variations are registered through average figures every 15 minutes, demanding a constant integration of between 30 seconds and one minute from the equipment used in order to avoid the reflection of the fast tension variations. A whole calendar year analysis (9/1/97 – 8/31/98) was carried out in registration periods of such characteristics, conducted in the measurement points selected by the Electricity Regulation National Entity for the said Tension Control Campaign. As a whole, 2,935,860 registrations corresponding to 4302 measurement done within the mentioned period were processed. The allowed deviations regarding the nominal tension depend on the kind of customer's power supply installation: 5% for the subterranean and 8% for the aerial ones, both superior to what, for example, the European ruling demand. For a quick visualization of the registered figures, the following curves of distributions respect to the supply nominal tension (220 Volts) and the lowest and highest limits allowed for each kind of supply installation, were drawn:



The registered average tension was 220.7 Volts with a standard deviation of 8.88 Volts. 95.4% of the figures were within the limits admitted ($\pm 8\%$) while 1.1% surpassed them by excess and 3.5% did it by defect.



The registered average tension was 224.9 Volts with a standard deviation of 5.24 Volts. 89.2% of the figures were within the limits admitted ($\pm 5\%$) while 10.2% surpassed them by excess and 0.6% did it by defect.

Disturbances Measures

Since April 1997, 12 monthly measures of harmonics and 6 of flicker started to be conducted in the points selected by the Electricity Regulator National Entity with the above-mentioned objective. Considering the precedent, the measures of the emission levels (harmonic total distortion in current) and of compatibility (total distortion in tension) present in the power supplies were carried out in the period going from Dec. 92/ Dec. 94, as the Distribution company's own initiative, in 155 MT customers and 175 BT customers, giving as a result regular figures. Apart from that, it was considered a priori, due to the results of the pilot campaign carried out by the II TREE-LAT from Universidad Nacional de la Plata before the beginning of these campaigns, that the alteration levels which are normally present in the power supplies would widely fulfill the Reference Levels (Electromagnetic Compatibility Guaranty with the different agents connected to it). The practical results show that, from April 1997 to the end of 1998, after having registered the alterations in 261 points for harmonics and 134 for flicker, only 5 cases of harmonics (1.9%) and an equal quantity of flicker (3.7%) presented figures outside the reference levels. In both kinds of alterations, cases were found in which the customer who caused the alteration was the only one affected by it, without affecting, by means of the conduction of the phenomenon through the distribution lines, to other customers. In most of the detected deviation cases, a redistribution of the charges allegedly altered or an improvement in the hired potency/ connection point short-circuit potency relation was enough as to take them to the electromagnetic compatibility state.