REGULATION OF QUALITY OF THE ELECTRICAL SERVICE IN ARGENTINA

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INTRODUCTION

Towards the end of 80's the Argentine Republic stuttered a very important crisis of deprivition of electric power fundamentally based in a scarce planning and lack of state investment. This caused important shortage in all the electric levels, beginning by the generation and finishing with the deprivition of energy , with programmed cuts for the population due to the impossibility of supporting the growing demand of electricity of the population.
The described problems forced to totally restate the focus of the energy policy of the country and it was decided to face the crisis opening the markets to the free competition and / or to regulated monopolies as in the case of the Distribution of the energy, those that would spread in the medium term to an open competition with less and less captive users.
In fact, since privatization began until now, there are more customers who can opt for the purchase of the energy directly from the generators. In order to achieve this, the premise is the hired power, and today these levels of power are 50Kw and it is hoped to arrive to the year 2000 with levels of 10 Kw.
Today the change of policy of is a the energy is a reality with a firm success in the competition of the markets of generation, achieving a reduction of the 50% in the price of the energy in this last decade. In the year 1994 the distribution of energy began with the privatization of the first company which supplied to de Federal Capital city of the Argentine Republic and continue whit the privatization of other provinces of Argentina, being Mendoza the last province to be privatized. From the first privatization until the last one there has been improvements of the regulating rules of the Electric Distribution enhancing the model in the aspects of quality of service and Quality of Electric product, forcing to the companies to carry out the necessary investments so that the users own more and more demanding levels of quality with competitive rates to international level.
Referring the progresses and improvement which have been obtained through these first six (6) years of regulation, we will focus this work, whose purpose is to expose the way in which the state has changed its role of executor for that of the controller, with concessions that prioritize the quality of the service and force them to carry out. These guidelines if the users are not satisfied, the sanctions will be superior to the investment that they companies have to do in order to achieve it.
Next we will develop the aspects of Quality of Electric Service and Quality of Electric Product and the improvements and adaptations that they have been achieving trough the years.

QUALITY OF ELECTRIC SERVICE

From beginning of the processes of privatization, electric companies did not have reliable indicators of quality of service. They not even did have indicators could measure the service that was given to the individual clients.
They began working in two fundamental aspects of the electric quality

1. The energy had to enjoy continuity they had to count the cuts of the service and sanction The Distributor when the acceptable limits were exceeded.
2. Once the continuity of the service, a satisfactory product had to be obtained. It was useless for the clients to have electric power, if this could not be used. Therefore the second aspect to control was that the levels of tension and the fluctuations were acceptable ones for the good use of the electric power.

At the beginning of the decade of the 90's, due to the lack of a computer system in the electric companies that linked the users with the mains of the distribution, they had to adopt indicators of quality which could reflect the degree of nuisances that a cut of the service caused, taking into account two aspects as the basis:

a) The numbers of cuts

b) The duration of the cuts.

This motivated the adoptions of global indicators of Quality of the Service that took into account in the power not supplied in each cut of the service.
In the first place the following indicators were adopted:
FMIK: Medium Frequency of interruptions for installed KVA.
TTIK: Total time of interruption for installed KVA.

$$FMIK = \frac{\sum_i kVAfsi}{kVAinst.}$$

$$TTIK = \frac{\sum_i kVAfsi * Tfsi}{kVAinst}$$

Where:

$\sum$= Sumatoria of all the interruptions of the service with a duration of more the 3 minutes.

KVAfsi= Quantity of nominal KVA out of order in each one of the "i" interruptions.
KVAinst= Quantity of nominal KVA installed.
An important aspect to keep in mind is that the cuts of the electric service are computed when they exceed the 3 minute- duration, whether this cut is produced in the power supply of the company of distribution or for the transports companies or the generators. The criterion is that the distributor always has the responsibility of the service in front of the customers.
Today this though has generated and continues generating important discussions between the different agents of The Argentinean Electric Markets. Nevertheless, it is known that when there is more than are responsible, the responsibilities are diluted and this is not healthy for the users of the service; therefore and considering this last point of view, it is the Distributor of Electric Power the one that in all the cases must respond before the customer.
In the environment of control of Quality of the Service the origin of the cuts is kept in mind, granting acceptable limits for the flaws in the mains characteristic of the Distributor or coming flaws from other agents of the electric market (Transporters or Generators). For this reason, in general the flaws are divided between the one of The Distributor and the flaws foreign from it, with different limits of tolerance in amount of cuts and amount of time of the cut.
We will start describing the system of quality of service in Mendoza which has introduced significant improvements that try to solve some difficulties seen in the other concessions.
As it is seen, the quality of service has admissible levels each timer more demanding giving clear signs of investments to The Distributor of the energy. This is even more magnified if it is taken into account that different forms to access the mensurations of the quality of service are demanded in each year of control.
In the first year of control and with the purpose of adapting the procedures of The Distributor, total mensuration of FMIK and TTIK are demanded between all the lines or power supplies of Medium Tension (13,2 KV). This methodology of mensuration produces little convenient compensations for the users of the electric service, since there are some areas of the concession with levels of Quality of the Service which are superior to the contractually demanded ones (areas of the urban downtown) and which will help to compensate other areas with a deficient Quality of Service.

Chart 1

CAUSA	INDEXES	Year 1	Year 2	Year 3
INTERNAL	LimFMIK	3 per Sem.	**	**
INTERNAL	LimTTIK	3 Hs. Sem.	**	**
EXTERNAL	LimFMIK	3 per Sem.	3 per Sem.	2 per Sem.
EXTERNAL	LimTTIK	3 Hs. Sem.	2,5 Hs. Sem.	1,5 Hs. Sem.

Being:
Lim.= Acceptable limit
Sem= Semester of control
**= Chart 2

What is said in the previous paragraph is partially solved in the second year of control since the mensurations in the mains of The Distributor are made in each one of the feeder of 13,2 KV, Therefore the harmful average to which we made reference is limited to many smaller areas.
The damaged caused by the cuts of the electric service in densely populated areas and in rural areas essentially different, in general it can be assumed that in urban areas, there are users with a highly increased use of technology (banks, shopping centers, industries, etc) and who even consider the shortest cut of the electric service a big damage. For these cases The Distributor Companies must adapt the power supplies (net worked systems and automatic systems) to meet the customers demands.
This situation is different in the rural areas, where the cuts of the service generally have a longer duration due to the large territorial expanses covered by the mains of distribution, which are generally radial and with limited possibilities of installation. Also the level of technology of these users and their demands of quality of the service are significantly lesser than those of the urban customers. For this reason, it was created a subdivision for the admissible limits of flaws between these two types of areas and users.
In this stage of the control the feeders of 13,2 KW are classified in rural and urban according to the following definition.

- Urban Feeder is that whose installed power is equal or superior to 160 KVA for Km. from line of 13,2 KV.

- Rural Feeder is that whose installed is minor to 160 KVA for Km. from line of 13,2 KV.

Chart 2

TYPE	INDEXES	Year 2		Year 3	
		1° Sem.	2° Sem.	1° Sem.	2° Sem.
URBAN	LimFMIK	3	3	*	*
URBAN	LimTTIK	3 Hs.	2 Hs.	*	*
RURAL	LimFMIK	8	6	5	4
RURAL	LimTTIK	8 Hs.	6 Hs.	5 Hs.	3 Hs.

Being:
Lim= Acceptable limit
Sem= Semester of control
*= Mensuration per user

The limits of the total times of interruption and the average frequencies of the cuts of service described in Chart 2 are considered according to the place where the interruption of the service occurs and according to the users affected by it.
In the third year of control the rural flaws by the feeder of Medium Tension continue to be considered, but the totality of interruptions of service in Low Tension (380 –220V) are incorporated to the urban flaws and to their associated times in other words, the degree of control is incorporated to the user's detail.
In the fourth year of control all and each one of the deficiencies of the service of the customers of The Distribution Company of energy must be controlled in individual form, evaluating the cuts of service and the

times of interruption, if the flaws took place in the power supplies of Low Tension, Medium Tension or High Tension. In this stage, the acceptable limits are found in the Chart 3

SANCTIONS FOR THE QUALITY OF ELECTRIC SERVICE

Exceeded the acceptable limits as in the average frequency of interruptions of the service (FMIK) as in the total time of this interruptions (TTIK) an economic sanction is given to the Distributor which consists in a credited sum in the billing of the electric power of the affected users. These sanctions are calculated according to the following formulas.

a) If FMIK measured in the mains of distribution is higher than the acceptable limit FMIK and the TTIK measured in the mains of distribution is lower that the acceptable limit TTIK, the energy no supplied by the interruptions (ENS) is calculated as:

$$ENS = (FMIK - Lím.FMIK) * \frac{TTIK}{FMIK} * \frac{ETF}{4380}$$

b) If FMIK measured in the mains of distribution is lower than the acceptable limit FMIK and the TTIK measured in the mains of distribution is higher than the acceptable limit TTIK, the energy not supplied by the interruption (ENS) is calculated as:

$$ENS = (TTIK - Lím.TTIK) * \frac{ETF}{4380}$$

c)If FMIK and the TTIK measured in the mains of distribution are higher than the acceptable limits FMIK and TTIK, the energy not given by the interruptions (ENS) is calculated as:

$$Si \ \frac{TTIK}{FMIK} \prec \frac{Lím.TTIK}{Lím.FMIK} \Rightarrow$$

$$\Rightarrow ENS = (FMIK - Lím.FMIK) * \frac{TTIK}{FMIK} * \frac{ETF}{4380}$$

$$Si \ \frac{TTIK}{FMIK} \geq \frac{LímTTIK}{Lím.FMIK} \Rightarrow$$

$$\Rightarrow ENS = (TTIK - Lím.TTIK) * \frac{ETF}{4380}$$

Where:
ENS: Energy not supplied in KWH by Internal or External Causes, in KWH.
ETF: Total Energy invoiced to the users for the controlled semester in KWH.
FMIK: Indicator of Average Frequency of interruptions per KVA.
TTIK: Indicator of Total Time of interruption per KVA.
LimFMIK: Acceptable Limit of The Indicator of Average Frequency of interruption per KVA.
LimTTIK: Acceptable Limit of The Indicator of Total time of the interruption per KVA.

When the admitted limits of frequency and/ or the times of interruptions are exceed the Energy not given (ENS) in the stage of control begins to be calculated the one that is valued to U$S 1,5 by KWH; this formula is calculated in the first three years of control, coinciding with the other privatized companies in the rest of the Argentina.
From the fourth year of control, it is considered a substantial difference in the calculation of the sanctions and important stimulus to the investment for the Distribution Companies of energy, since in the previously seen formulas the admitted limits are eliminated and therefore the ENS become the totality of the energy not supplied from the first interruption.
This concept is understood in the following way: the acceptable limits of Quality of Service go diminishing as we can see in Charts 1 and 2 and when some of these limits are surpassed in the period of control, The Distribution company is sanctioned calculating the ENS according to the difference between the measured value in excess and the limit value.
From the fourth year of control these limits act like triggers of the sanctions, **and when the limits are surpassed,** the calculation on the sanction is maid considering the total numbers of the flaws, including those which occurred before exceeding the acceptable limits that is to say, all the energy not supplied by the cuts of the service from the first flaws to the last one.
The decrease of the acceptable limits of frequency and time of interruptions is kept until the tenth year of control, when it will be studied according to technological advances and the user's requirements.
As we said before, in this new stage of control, the indicators of quality begin to be calculate in each one of the points of supply, so the acceptable limits of Quality of Service become:

FEU: Equivalent Frequency per User and its represents the amount of interruptions of the electric service in the point of mensuration of energy without taking into account whether the flaws happened in the power supplies of Low Tension, Medium Tension or High Tension.

TEU: Equivalent Time for User and it represents that total time that the individual user staged without the electric service in period of control.
This period of control is all cases of six (6) months.

Chart 3

USER	INDICATOR	VALUES (per Semester)					
		Years					
		4°	5º	6º	7º	8º	9º
SUPPLY	LimFEU	7	6	5	5	5	5
LOW TENSION (Urbans)	LimTEU	10	9	8	8	8	8
SUPPLY	LimFEU	9	8	7	7	7	7
LOW TENSION (Rurals)	LimTEU	11	10	9	9	9	9

Together with this decrease of indexes year by year, the value of the KWH of ENS is increased, arriving to the tenth year to U$S 2 for little demands and U$S 2,5 for big demands

Chart 4

RATE	COST OF THE ENS/kWh				
	6º Year	7º Year	8º Year	9º Year	10º Year
LITTLE DEMANDS	1,6	1,7	1,8	1,9	2
BIG DEMANDS IN LT	1,7	1,9	2,1	2,3	2,5
BIG DEMANDAS IN MT AND HT	1,7	1,9	2,1	2,3	2,5

Regarding to what was said before we can state that according to the sanction and variations with which the formula of calculation were affected, The Distributors, will see clear medium and long term signs which will give incentives to adequately improve the quality of the electric service.

QUALITY OF THE PRODUCT

As it is explained in the first part of this work, simultaneously with the Quality of the Electric Service (continuity of the supply) it has to make sure that the product is the appropriate so that the customers of the service could use it properly.
In order to achieve this permitted and non permitted bands of levels of tension have been defined which will be the reference to sanction The Distribution Company.
In the first three stages of the control the slow fluctuations of tension will be measured and for which there will be sanctions continuing the same methodology than in Quality of Service: The Distributor Company will be the one that carries out the mensurations, it will be calculate the sanctions and it will carry out the compensation to the users, being the Regulating Entity the entrusted of carrying out the corresponding controls in order to assure the correct execution of the methodologies.
In the fourth stage the quick fluctuations of tension, the flikers and the harmonicas are incorporated to the control, in this stage the incorporation of the holes of tension are being studied at the moment fundamentally due to the driving of devices of automatic reclosing.

The methodology for the control of the slow fluctuations of tension is based in statistical studies for which a representative sample of the universe of points of mensurations is obtained, (exit of Low Tension of center of transformation Medium Tension / Low Tension and according to the results of these mensurations, the separation of the acceptable values of tension is calculated.
We will introduce the charts with the acceptable levels of variations of tension:

a) For the first three years of control

Chart 5

HIGT TENSION	± 7,0 %
MEDIUM TENSION	± 10,0 %
LOW TENSION	± 10,0 %

b) From the fourth year of control

Chart 6

HIGT TENSION	± 7,0 %
MEDIUM TENSION	± 8,0 %
LOW TENSION	± 8,0 %

The equipment of mensurations will be placed for periods of time not inferior to seven (7) days. These equipment must have the possibility of carrying out “registrations” of mensuration of tension of 15 minutes, in a consecutive form, they must measure the supplied energy in each registration simultaneously; in this way and knowing the energy involved in a registration that exceeds the acceptable limits, the sanctions will be calculated with which the users of electric power in bad conditions will be compensated.
If the equipment of mensuration once placed and considered the registration of the least seven (7) days, it is determined that they were exceeded the acceptable limits of levels of tension for a superior time to the 3% of the period of mensuration, the Distributor will be sanctioned according to the approaches that will be seen later on.
Everything previously detailed will be carried out in the first three years of control of Quality of the Technical Product.
Starting from the fourth year of control the mensurations (the previously described ones plus of flikers, harmonics and holes of tension) will be carried out level of individual users of Low Tension.

GLOBAL INDICATORS

Besides the indicated mensurations, the ones in the centers of transformation Medium Tension / Low Tension, and those in the individual users Global Indicators of the Quality of the Technical Product were incorporated with the privatization of The Company of electric power of Mendoza. These Global Indicators allow us to show the

behavior of the diversion, of the levels of tension and to infer about the sample universe, facilitating the monitoring of the evolution through time. These indicators also enable us to study the not incorporated removal for each band of tension (in and out of the acceptable limits) in each geographical area of the Distributor and to compare the Distributor with other companies of the area concession and with other Distribution companies of the country and from abroad.

a) FEB_B: Equivalent Frequency per Band of Tension.

$$FEB_B = \frac{Nrg_B}{Nrg_{TOT}}$$

Where:
FEB_B : Equivalent Frequency associated to the "B" Band.
Nrg_B: Quantity of valid registers associated to the "B" Band.
Nrg_{TOT} : Total Quantity of valid registers.

For this indicator two characteristic factors are defined:

FEB_{PER}: Equivalent Frequency within of the permitted band (+/- 10% or +/- 8%).
FEB_{noPER}:Equivalent Frequency outside of the permitted band.

b) $FEBP_B$:Equivalent Frequency for penalized Band o Tension

$$FEBP_B = \frac{NrgP_B}{NrgP_{Tot}}$$

Where:
$FEBP_B$:Equivalent Frequency for penalized Band "B"
$NrgP_B$: Quantity of Penalized Register associated with the "B" Band.
$NrgP_{Tot}$: Quantity pf total Penalized Register.

c) $FEEC_B$: Equivalent Frequency Consumed Energy not incorporated for the band of tension

$$FEEC_B = \frac{\sum_{med=1}^{TotMed} Eng_B^{(med)}}{Eng_T}$$

Where:
$Eng_B^{(med)}$:Registered Energy in the associated mensuration with The Band of Tension "B".
Eng_T: Registered Total Energy made mensuration in the considered period.
TotMed: Total of made mensuration in the considered period

If at the end of the semester the relation between the FEBno per (not permitted Bands) and FEB once controlled is higher to the 3% **THE DISTRIBUTOR** will be sanctioned according to equivalent frequency and the associated energy in each band.

SANCTIONS FOR THE QUALITY TECHNICAL PRODUCT

As it was previously said the equipments of mensuration must register the energy supplied to the users in bad conditions.
If from the values obtained in the registrations of the period of mensuration come off that The Distributor must be sanctioned, these sanctions will be calculated carrying out a valuation of the wrong supplied energy, the more is the separation of the acceptable limits of Tension, the greater must be the sanction. For example, it is snowed two charts of values.
1. Valuation of the energy in Low Tension for the first three years of control

BAND OF TENSION (%)	VALUATION OF ENERGY - $CE_{(B)}$ (U$S/kWh)
10 ≤ ΔU < 11	0,050
11 ≤ ΔU < 12	0,087
12 ≤ ΔU < 13	0,123
13 ≤ ΔU <14	0,160
14 ≤ ΔU < 15	0,428
15 ≤ ΔU <16	0,696
16 ≤ ΔU < 17	0,964
17 ≤ ΔU < 18	1,232
18 ≤ ΔU	1,500

2. Valuation of the energy in Low Tension starting from the fourth year.

BAND OF TENSION (%)	VALUATION OF ENERGY - $CE_{(B)}$ (U$S/kWh)
8 ≤ ΔU < 9	0,050
9 ≤ ΔU < 10	0,140
10 ≤ ΔU < 11	0,230
11 ≤ ΔU < 12	0,320
12 ≤ ΔU < 13	0,410
13 ≤ ΔU <14	0,500
14 ≤ ΔU < 15	0,800
15 ≤ ΔU <16	1,100
16 ≤ ΔU < 17	1,400
17 ≤ ΔU < 18	1,700
18 ≤ ΔU	2,000

Where:
AU=Vabs (Us-Un)/Un
Vabs (Us-Un). Is equal to the absolute value of the difference between half tension of the supply(Us) and the nominal tension of the supply (Un).

Once the KWH given the users are known in bad condition, in each one of the penalized bands of tension, the sanction (Spm) will be calculated in the following way:

$$Spm = \sum_i (CE_{(B)} * ESMC_{(B)})_i$$

Where:
Spm: Sanction of the period of mesuration.
CE_B : Cost of the measure energy in each punishable band of tension.
$ESMC_B$: Supplied energy in bad condition in the Band (B)

This sanction will be extended after the period of mensuration until a new mensuration of at least seven (7) days of duration is authentically shows that the problem has been solved. Therefore the final formula for the calculation of sanction is:

$$Sanción = (Dpm + Dnm) * \frac{Spm}{Dpm}$$

Where:
Spm: Sanction of the period of mensuration
Dpm: Duration of the period of mensuration in days.
Dnm: Duration of the period in days until the carrying out of the new mensuration taking into account from the ende of the period of mensuration.

In the case of non compliance of the Global Indicators about the Campaign of Mensuration, the sanction will be following:

$$Sanción = ETF * \left(\sum_{B=BP} FEEC_B * CE_B * FEBP_B \right)$$

Where

Σ: Sumatoria about the Penalized Bands according its correspondences with the Charts 5 or 6.
ETF: Total Energy Invoced by THE DISTRIBUTOR in the controlled period in KWH.
$FEBP_B$:Equivalent Frequency for Penalize Band of Tension.
$FEEC_B$:Equivalent Frequency for Consumed Energy no incorporated for the Band of Tension.
CE_B:Coeficient of penalization related to the level of tension.

The Determination and calculation of the sanction of the quality of the products including the described global indexes, and the quality of the service represent important stimuli to investment for the distribution company of the electric energy which are directly reflected in an improved quality of life for the customers and determining factor for the decisions of investment of private capital in the province of Mendoza.

OTHER SANCTIONS

It will be mentioned that other important sanctions for non compliance in the Quality of the Commercial Service exist, when the Distributor Company doesn't fulfill the times limits fixed for the attentions of reclamations connections, complaints for billing, suspension and renewal of the electric service for lacking payment, etc.
They are also strictly punishable the lack of security in works that the Distributor carries out in the public road or when regulations of contamination and environmental impact are not fulfilled.

COROLLARY

Summing up we will detail the fundamental improvements which were included in The Contract if the Concession of the Distribution of Electric Energy in the province of Mendoza:

- Putting at regular intervals the mensuration of the Quality of Service in : global , for feeder of Medium Tension and for individual users.
- Adoption of different indexes for areas: urbans and rurals.
- Increase of the demands of Quality sustained decrease of the acceptable limits.
- Gradual and sustained increase of the cost of KWH of not supplied energy.
- From the fourth year of control: calculation of the sanctions considering the total of de ENS, from the fisrt to the last interruption.
- Mensuration of the Quality of the Product with the Global Indicators.