INTRODUCTION

In small demand tariffs, the power requested by customer is not measured. Consequently, it is necessary to know as accurately as possible its consumption modality in order to design tariffs as well as designing networks to determine the fairest tariff minimizing business risk. This report presents EDEERSA’s experience as result of tariff revision.

TARIFF STRUCTURE IN THE ARGENTINE REGULATORY MODEL

The Argentine regulatory model sets tariff using price cap, which is set by the Regulator. Cost valuation and allocation is reviewed every 5 years based on a proposal presented by the Utility that harmonizes cost structures according to technological level at the time combined with the average service quality customers need and are ready to pay.

Final tariff for customers has the following structure:

\[ \text{Tariff} = DS + C - R + P \]

DS: Utility’s Distribution Service. Includes DAV, commercial and loss costs. There is an indirect control by the Regulator through the accepted remunerations in tariff reviews and service quality required.

C: Commercialization. This term only corresponds to customers requesting the Utility to purchase and sell energy and power (E&P). This value is directly passed through.

R: Rebate the Utility must apply to customers that did not receive the required service and product quality levels.

P: Penalties applied to customers when its demand impairs other customers. Such is the case of excess in harmonic current generation values, flicker level and/or power factor.

Business Risk

Knowledge and correct determination of the tariff structure rates set every 5 years are fundamental for business development.

Company’s income is contemplated in Utility’s Distribution Service, remunerated through the power of each tariff demand, an efficient investment and expenditure plan, which must maintain service quality levels below the allowed limits.

On the other hand, it must motivate a demand increase taking into account the system’s technical losses.

That is to say that decrease in profitability may occur due to the following:

- Over investment and/or expenditures in excess.
- Major technical losses than those acknowledged in the tariff.
- Low service and product quality.
- Penalties as result of low power factor in Utility purchase points.
- Decrease in customer’s demand.

Although the Utility has a natural monopoly of the distribution service, due to the necessary capital costs required, there is a virtual competition created by the Regulator through service quality required, capital costs and expenditures recognized in tariff reviews.

The actual knowledge of each of the factors that form the tariff chart provides the analytic bases to generate competitive tariffs for the sector the company deems necessary to promote.

Power and Distribution Added Value

Power is the main parameter to determine network cost. This close ratio must be maintained independently from the origin from which the customer purchases energy and power. The balance is determined by the Utility that is responsible for quality and safety. The Utility must assign responsibilities for the distribution costs corresponding to each tariff category considering no external impositions in the equilibrium that originate inadequate cost for some sectors or lack of investment in the short and long term in network development.

Final Tariff

Once costs and responsibilities for the use of electric service are determined for each tariff category, the mathematical model of the tariff will reflect company’s and customers’ point of view for a proactive incentive of electric use.

For example, in the case of residential tariffs, fixed costs have a greater relative influence in low consumptions, and variable charges in high energy consumptions. This scenario is reflected in socially differentiated sectors with different reaction capacities.

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1 Distribution Added Value (DAV) contemplates network capital amortization, plus a fair and reasonable remuneration, as well as operating and maintenance costs.

2 The low power factor decreases the active power transmission capacity. This implies over investments leading to greater capital costs included in tariff to all customers.

3 In order to compute capital cost, the New Reposition Value (NRV) model is generally used in Argentina.
TARGETS OF THE METER SURVEY

Target 1 (Customers with no power measurement)

The characteristic of tariffs with no power measurement is that: by only metering total amount of active energy consumed, costs that do not depend only on the value metered are allotted. A metering survey, using metering equipment that allow an analysis of the energy and power is made on a sample of the population of said customers, is made order to make the more precise tariff allotments.

Based on the results obtained, statistic estimates of typical consumption attitudes are made which are valid for allotment cost for the rest of the customers.

The Distribution Service (DS) plus the Commercialization (C) is formed by a value periodically metered and an \( f \) function with parameters obtained in the metering survey:

\[
DS+C = \{f(P_{\text{peak}}, F_c, Ke, Ka, \text{COIN}, \text{PLF}); \text{Measurement}(E)\}
\]

Where:
- \( E \): total energy.
- \( P_{\text{peak}} \): peak power.
- \( F_c \): load factor.
- \( Ke \): participation in the total energy measures in the different time ranges.
- \( Ka \): allotment or distribution factor.
- \( \text{COIN} \): coincidence of power peaks of the category with network peaks.
- \( \text{PLF} \): power loss factor and energy loss factor.

Target 2 (Customers with power measurement)

For customers with power measurement, the simultaneity (SIM) of their peak demands must be determined. If the peak power demanded by each customer is added, the value obtained is higher than the value effectively purchased by the Utility. This is so because peak demands are not simultaneous for all customers.

The tariff is formed by two values periodically measured and an \( f \) function with parameters obtained during the metering survey:

\[
DS+C = \{f(\text{SIM}, \text{COIN}, \text{PLF}); \text{Measurement}(E, P)\}
\]

E, P: total energy and peak power measured in time ranges.
SIM: simultaneity in customers’ demand.

Target 3 (Curves)

Each tariff category has different responsibilities in the peak power that each network must undergo due to the magnitude of its demand, as well as the modality in the use of the electric service.

The allotments consider the coincidences (COIN) for the demand curves of the tariff categories and the networks.

PLANNING

Stages

In general terms, the process involves the following stages:

- Determination of the population of customers and the metering points of the networks.
- Methodology and determination of the samples of customers and network elements.
- Selection and purchase of metering equipment.
- Data gathering and storage.
- Data statistical processing.
- Sampling auditing, Relocations.
- Determination of the parameters for the tariff categories with no power measurement.
- Determination of the parameters for the allotment of distribution service cost and power purchase.

Customers’ Sampling

A group named sampling population with “normal” consumptions is obtained from the customer database. These are those meeting the following conditions:

- Uninterrupted consumption during a year.
- Active at the moment of starting the survey.
- Supply with no illegal connections.
- Remained in one year in only one tariff category.

Categories

Customers are grouped in tariff categories representing different consumption modalities and use of network. This allows a more fair allotment of responsibilities for the use of the networks and E&P purchase in the Wholesale Electric Market (WEM).

Sample

The size of a sample is inversely proportional to the error obtained. Furthermore, it has direct relation to the standard deviation of the values of the sample population and the level of confidence in the result.

The determination of the number of samples is given by the following equation:

\[
n = \left(\frac{z \cdot \sigma}{e \cdot \bar{y}}\right)^2
\]

Where:
- \( z \): is the confidence level. 90% is used.
- \( e \): is the relative error admitted. Values under 10% are used for residential and under 15% for the rest of the tariffs.
- \( \bar{y} \): average population.
- \( \sigma \): standard deviation.

Stratified Random Sample

The statistical analysis variable is power. In case there is no previous study of power demands, the energy is used as correlated variable for the determination of samples.
The creation of layers for each category is necessary due to the wide range of values of the variable to be analyzed, increasing thus the precision of the estimate.

For example, a category formed by no power measurement customers, may be obtained with 10 layers (subpopulations) with the same total energy consumed for all the customers of each layer. Once the amount corresponding to each layer is determined, customers are selected at random.

**DEVELOPMENT**

**Audit**

As the results of the samples are obtained, the representativeness of each must be analyzed considering the interest’s variable. The findings may be that in certain layers the variable analyzed shows results with more errors than those appraised through the correlated variable. Changes in the location of metering equipment may be done in order to diminish the target error variable.

Those samples with remarkable tendencies compared to the rest of the samples in the same category should be detected and eliminated.

**Determination of Layers**

Groups of layers with homogeneous behavior are obtained from the results obtained in the category layers. For example, if two adjoining layers have a similar load curve they need to be treated as a unity.

The following graph shows load curves as result of considering two pronounced significant layers in a tariff category.

![Average Hour Power Curves](image)

The similarity in consumption modalities is analyzed through “form estimators” given by:

- Day and night load factor.
- Energy percentage consumption in peak and rest hours.
- Night form factor.

**RESULTS**

**Customer Curves and Networks**

Once the tariff categories are defined, the average demand curve of each customer every 15 minutes is determined and stages of the network surveyed in the metering survey. For the analysis of the cost associated to the power (network costs and power purchase costs in the market) the relevant curve is the one corresponding to working days.

Responsibility factors in distribution costs are computed with the curve of each stage of the network corresponding to the month of peak demand of the complete system, as the stages are technically computed to support the peak request and each category participates with its due responsibility.

These curves allow the determination of the coincidence degree of the peaks of the tariff categories and the peaks of the demand curves in the near facilities, as well as the coincidence between the peaks of the stages of the successive networks.

**Coincidence Factor (COIN)**

Peak demands in networks are due to tariff category demands connected directly and through linked networks.

Due to the lack of coincidence during the peaks, the contribution to the network peak demand will be the sum of a proportion of peak demand of the categories and networks linked.

The following graph shows the values to compute the coincidence factor of the power $k$ tariff category ($P_{\text{coin},k,j}$) with the $j$ network’s peak power ($P_{\text{peak},j}$):

\[ \text{COIN}_{k,j} = \frac{P_{\text{coin},k,j}}{P_{\text{peak},k}} \]

Supposing that the network’s peak medium voltage occurs at 08.30PM, if the peak representative power curve of medium voltage customers does not occur at 08.30PM, the degree of coincidence (COIN) is less than one. This means that when computing the participation of these customers in the DAV and the power purchase, peak power recorded must be decreased according to the participation level on the power peak of the associated network.

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5 Also known as the “external coincidence factor”.
Power requirement in high voltage to supply the power demanded by a customer connected in low voltage, is given by the following equation:

\[ P_{\text{peak}} = \prod_{j=1}^{HV} C_{\text{IN},j} \times \prod_{j=1}^{HV} PLF_j \]

Where:
- PLF: is the power loss factor of each stage of the network.

**Participation in Energy Consumption (Ke)**

For each stage of the categories with no energy metering according to time strip, the participation in the total consumption in each of the time strips must be determined.

This allows the determination of the proportions of consumptions in the different time strips ruled by the WEM differentiated by generation cost.

**Power Graph**

In order to compute peak power (Ppeak) of each of the layers of the no power measurement tariff categories, the starting point is the graph that relates peak power average curves in 15 minute periods compared to the monthly energy registered for every customer.

With this value the load factor (Fc) resulting for all the customer of each layer is computed.

\[ \text{FC} = f_1 (PP, DAV, COIN, PF) \times P_{\text{peak}} \times K_a + CC \]

where:
- P: reference price for power during the peak
- CC: commercial cost.

Fixed charge is obtained from the graph starting from the intersection of the straight line with the axis of the ordinate; therefore, considering the previous equation, the Ka factor is determined. A sensitivity analysis demonstrates that this factor has low variability with the WEM price variance.

**Simultaneity Factor (SIM)**

In categories with power measurement (WPM), as peak individual demand of each customer will not coincide with the peak demand of the average representative curve of each category, a simultaneity factor between individual customers is determined as follows:

\[ \text{SIM} = \sum \frac{P_{\text{peak, cat}}}{P_{\text{peak}, U_i}} \]

It may be proven that the pair of average values \([x,y]\) of a data group is on the simple linear regression representing them, consequently, a virtual customer is adopted as “typical customer” with values that determine total costs, and those are the average values forming total costs of the sample.

The previous graph shows costs associated to the typical customer. DAV and power purchase (PP) are allotted in the fixed charge (FC) and variable charge (VC), through the “Allotment or Distribution Factor” (Ka):

\[ \text{FC} = f_1 (PP, DAV, COIN, PF) \times P_{\text{peak}} \times K_a + CC \]

\[ \text{VC} = f_2 (PP, DAV, COIN, PF) \times P_{\text{peak}} \times (1-K_a) + EP \]

The following equation may present for the typical customer:

\[ \text{FC} = [(SP \times COIN \times PF) + (DAV \times COIN)] \times P_{\text{peak}} \times K_a + CC \]

Where:
- SP: reference price for power during the peak
- CC: commercial cost.

Simultaneity Factor (SIM)\(^6\)

\[ \text{SIM} = \sum \frac{P_{\text{peak, cat}}}{P_{\text{peak, U_i}}} \]
In this way, the sum
\[
\sum (P_{\text{peak}_i} \times \text{SIM}_i)
\]
coincides with category’s peak demand.

**CONCLUSIONS**

The results of the metering survey allow the identification of the market’s characteristics, processing the information obtained in a way it ensures statistically based results.

Each tariff category must face the costs arisen from its demand to the network, based on that principle is that the concept of fair allotment of costs must be interpreted.

The results obtained reduce the business risks because the tariff model is built based on fair allotments on the requirements of the categories and a more precise knowledge is obtained of the demands on networks thus allowing a better technical and economical development.

Based on the above, for Regulators and customers, the elimination of assumptions in mathematical computing models determines a fairer tariff and the metering survey, together with its processing statistic fundamentals, constitute a significant base in the preparation of tariff charts.

**BIBLIOGRAPHY**


