THE STRUCTURE OF ELECTRIC ENERGY DISTRIBUTION TARIFFS IN BRAZIL

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ABSTRACT

This paper presents an overview of the costs allocation in tariffs of electric energy distribution. It analyzes, briefly, the marginal and average costs pricing, two-part tariffs and Ramsey rule that form the theoretical basis for natural monopolies pricing. From theory to practice, it presents the concept of allowed revenue for the distributor and its components as well as their allocation in the electric energy tariffs structure. In conclusion, this paper compares the tariffs with the regulation theory and also presents some considerations in discussions aimed at improving the electric energy distribution service pricing.

INTRODUCTION

The Brazil electric power sector is made up of four business segments: generation, transmission, distribution and trading. The electric power production system, except for a few areas, is linked by a transmission system also known as National Interconnected System (SIN). Only 3.4% of the production capacity of electric power in the country is outside of SIN, in small isolated systems located mainly in the Amazon region [1].

In the distribution segment, there are 64 companies which were responsible for supplying electric power to approximately 62 million consumers in 2008 [2]. The distributors supply electricity to their so-called "captive" market, while some consumers, usually those that use over 3MW, can choose their supplier among several energy traders and generators. In this case, the distributor keeps providing access to the distribution network, although it is not responsible for the sale of electric energy.

Preliminary figures released by the Energy Research Company (EPE) show that the electric energy consumption in 2008 registered a total of 393.9 TWh, 4% higher than in 2007, representing a growth comparable to the evolution of the gross domestic product (GDP) in the same period.

In the Brazilian energy sector model, production and trading sectors are considered competitive and don't require strong regulation, unlike the electric energy transmission and distribution, since they have characteristics of natural monopolies, and are regulated technically and economically by the National Electric Energy Agency (ANEEL).

PRINCIPLES OF ECONOMIC REGULATION

Since the monopolist company is exclusive in the market, it is not subject to competitive prices. The monopolist does not make use of the equality between supply and demand to determine price and quantity of equilibrium, such as in the competitive market. The profit maximization is obtained when the marginal cost is equal to the marginal revenue. At this point, the firm determines the quantity that it will lead to the market, which when placed on the demand curve, makes it possible to find the product price.

Comparing this situation with a perfect competition market, in which the break-even price is the intersection of the demand curve with the marginal cost curve, we find that the profit maximization state in the monopoly approach does not improve the condition of social welfare, because the price is higher than the marginal cost at the point where this is equivalent to marginal revenue.

In the case of the electricity distribution, which has natural monopoly characteristics, it is necessary that the regulatory agency (ANEEL) set the tariff in order to maximize social welfare at the same time it needs to ensure economic balance for the public utility.

Considering the economic theory, the price of the electric energy distribution service should be defined at the point where the marginal cost curve cuts the demand curve, known as the first best solution.

However, in a capital-intensive industry, the best price, as defined in terms of allocative efficiency (price equals marginal cost), can bring losses to the distributor, compromising production efficiency, because the marginal cost sits below the average cost.

Thus, in this case where the marginal cost does not cover all business costs, the alternative would be to equal the price to the average cost; which, however, results in welfare loss.

One solution to obtain the best allocation, while at the same time keeps the economic balance, would be to charge a price equal to the marginal cost and cover the distributor losses through a grant or other charges that do not depend on the amount sold.

There are several arguments against the allowance, such as there is no incentive to reduce costs, the coverage of costs by people who do not make use of the service, the total of consumers benefit may be less than the total costs [3].

Another challenge associated with the network industry is the fact that many products are produced using the same assets. To set the most appropriate price for each product may be complex because it is not easy to isolate the costs incurred in the production of a particular product.

In Brazil, as will be reported below, part of the electric energy distribution tariff is calculated in proportion to the marginal cost of each consumer category, considering the revenue necessary for the distribution utility to cover its efficiency costs and prudent investments for the maintenance of service quality. In the literature this method is known as equal percentage of marginal cost (EPMC) [4].

An alternative under study in the University, the Ramsey Rule, would be a good option - the prospect of efficiency - among those which guarantee the sustainability of the company in the situation where the marginal cost sits below the average cost [5].

This method allocates the difference between marginal and average cost inversely proportional to the price elasticity of demand for each product.

A second option would be to apply the non-linear price, or two-part tariffs, which consist of a value per unit and a fixed amount regardless of consumption. If this price per unit is equal to marginal cost, it is possible to have an efficient pricing in which a fixed value is set in order to recover the company costs. For example, the fixed value of the two-part tariffs could be calculated so that the sum of the amount paid by all consumers is equal to the losses identified by the difference between the marginal and average costs.

There are several ways to calculate the fixed value; one of them is simply to divide the losses by the number of consumers. However, as consumers vary considerably in terms of demand for the service, the fee may exceed the willingness to pay for a portion of consumers, excluding them from the market [3].

The ideal solution would be to determine different fixed values for different consumer classes, changing also the prices per unit in order to maintain the total amount paid by consumers at the limit of its disposition to pay for a certain amount of a product. This pricing scheme is called multi-tariffs.

ELECTRIC ENERGY DISTRIBUTION TARIFFS

In Brazil, the process of determining the distribution tariffs occurs in two stages. In the first phase it is estimated the total revenue the company is required to charge for a given year thus setting the tariff level.

In the second, the tariffs to be collected from different categories of users are determined to output the desired revenue, assuming that consumers actually purchase the estimated quantities of the product. The price setting is called pricing structure.

Tariff Level

The distributor revenue is composed of two large parts: i) costs exogenous to the distributor (called uncontrollable costs) or Parcel A and ii) controllable costs or Parcel B.

Parcel A costs include energy purchased for resale, energy transportation and sector charges. Parcel B covers operational costs, depreciation quota and investment remuneration.

Parcel A costs are totally passed through to the tariffs. Part B costs are readjusted annually by the IGP-M index, adjusted by an X factor which aims to divide with the consumer the distribution company's productivity earnings. On the other hand, in the periodic tariff review, which usually occurs every four years, ANEEL determines the new

distributor revenue. As the actual Parcel A variations are fully recognized in tariffs, the basic function of the tariff review is to define the new Parcel B value.

After ANEEL sets the distributor revenue, called tariff level, it is necessary to segregate it for each consumer category, designing various tariffs of electricity, or tariff structure.

Electric energy tariffs structure

It is possible to divide electric energy consumers by the purpose of the consumer unit, such as houses, commerce, industry, or by voltage level of supply, such as high, medium and low voltage.

Thus, the tariffs structure can be designed to encompass every category of consumer unit sorted by the level of voltage and by their purpose.

For most consumers, known in the sector as "captive", the distributor is responsible for supplying energy as a whole, including the transport and the product (electricity generated in plants). However, some consumers, known as "free", can choose the energy supplier regardless of the local distributor, who provides only the transportation service.

So the tariff of electric energy supply is segregated into two parts: the distribution system use tariff (TUSD) and the energy tariff (TE).

The TUSD is paid by both captive and free consumers to the distribution utility in which they are connected. On the other hand, the TE is charged only from captive consumers, because the free consumers buy directly from energy traders or generators.

It is important to note that a free consumer continues paying TUSD to a local distributor and will no longer pay the price of energy, TE, to this company since that consumer will buy energy from another supplier.

The TUSD includes network operation and maintenance costs, sector charges, investment remunerations and depreciation. The TE includes the costs of purchasing power and related sector charges.

Costs allocation

The costs allocation, essentially energy purchase and associated charges, in the energy tariff (TE) of the several consumer categories (high, medium and low voltage) is made proportional to the power consumption; e.g. the driver of cost to different tariffs is the energy consumed.

This kind of allocation is known in the energy sector as "stamp" because the mailing stamp has one price independently of the destination of the correspondence. In the case of electricity tariff, the term "stamp" means the same electric energy price that different categories of consumers pay.

Similarly, some components of the distribution system use tariff (TUSD) are allocated as a "stamp" such as the transmission system costs and sector charges.

So basically the Parcel A (energy purchase cost, transmission system costs and sector charges) are collected in form of a "stamp" in the energy tariffs (TE) and the system use tariff (TUSD).

Moreover, the Parcel B of the distributor's revenue (approximately one third of the total) is charged from the different consumers proportionally to the capacity marginal costs which are calculated for each voltage level of supply. In theory, since in the natural monopoly the average costs outweigh the marginal costs, the regulatory agency cannot emulate the competitive market simply by setting the tariff based on marginal costs (first best), because the distributor cannot recover all its costs in this case.

Then the current methodology considers the capacity marginal costs of voltage level as a driver to allocate the Parcel B costs; this criterion is known as equal percentage of marginal cost (EPMC).

Capacity Marginal Cost

The capacity marginal cost is a composition of the cost of expanding the electrical system, the electric energy power flow and the consumer responsibility in the formation of peak loads on the distribution networks. As it is not possible to measure all consumers, statistically representative samples are used to identify the typical network and consumer curves in order to discover their responsibility.

The method seeks to identify the marginal cost to supply energy to a specific consumer, that is, measure the impact of providing another 1 kW. The consequence of this has two aspects considered in the methodology: the physical and time aspects.

First, the availability of 1kW in the system at a certain voltage level is also reflected in the electrical system upstream which depends on the power electrical flow and losses.

Second, the cost depends on the time of the peak load on a certain network that supplies to the consumer. That is why a demand increase for power when the network is not heavily loaded could be supplied without the need for system expansion. In contrast, to deliver energy when the network is under a heavier load would require investments in the electricity distribution system.

Thus, in this methodology, the costs of expansion are allocated in times of peak load on networks to which consumers are connected. Moreover, the cost is weighted by its load curve, that is, in proportion to the maximum demand in order to calculate the consumer's responsibility for every hour of the day. In short, the capacity marginal cost for a particular consumer is the core of customer responsibility in the formation of the peak of demand for the power distribution system that supplies them.

The capacity marginal costs are calculated for periods of peak and off-peak system and used for the definition of costs to be allocated in each voltage level.

Reference Tariffs

The passage from the capacity marginal costs to reference rates is performed in stages by the regulatory agency. First, ANEEL calculates a factor to adjust the "marginal" revenue, arising from the application of capacity marginal cost, to part of allowed revenue that is allocated by marginal costs After, the peak and off-peak signs, exogenous to the process and determined by the regulator, are applied to the capacity marginal costs, while maintaining the same revenue to be collected from each voltage level.

The last procedure is performed to adjust the capacity marginal costs in order to obtain allowed revenue for the billing market resulting in the so-called reference tariffs.

Tariff options for the consumer

Besides the vertical tariff structure, based on the capacity marginal costs by voltage level, it is possible to calculate different tariffs for consumers supplied by the same voltage level, the so-called horizontal structure.

The two-part tariff are not used in Brazil as an alternative to the allocation of the difference between the average and marginal costs, as advocated in theory, but to define the horizontal tariffs structure for captive consumers supplied with medium voltage.

These tariffs are built, at each hour period, from the chart that lists the capacity marginal cost of customers with their hours of use, as shown in the picture below.
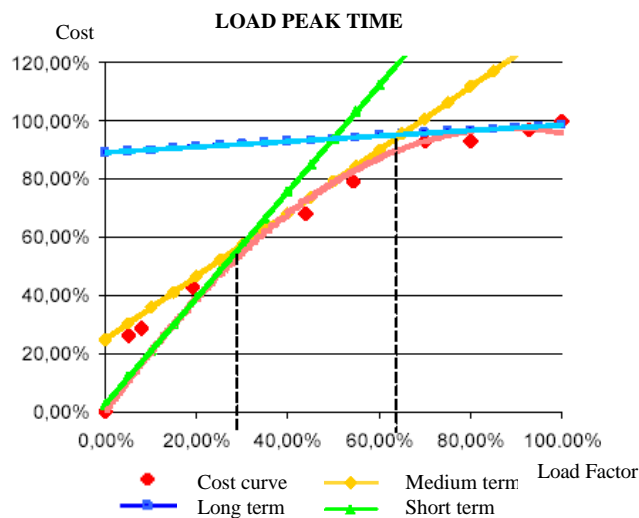

Figure 1 – Tariff options [5]

It is shown in the figure that a single average tariff results in payments lower to the costs for some customers and higher for other, which would not be an appropriate way to share costs, considering that the objective is to bring the tariffs closer to actual costs for each consumer cluster. In terms of pricing, it is interesting that the tariffs are linear functions of the parameters of services provided (consumption and maximum demand of customers).

Thus, it is possible to set straight tangents at various points of the curve, creating tariffs that intend to join short, medium and long term use consumers with their respective costs.

In Brazil, the hour-seasonal pricing arrangements (THS) "Blue" and "Green", created in the mid-1980s, match the long and short use tariffs, respectively. This tariffs structure was maintained until the present day, although its construction, since 2003, has caused some distortions.

CONCLUSIONS

The company's operating costs are determined on the basis of a virtual enterprise designed by ANEEL which incorporates the following basic functions: i) Administration and Finance, ii) Distribution Service (Operation and Maintenance) and iii) Commercial. In this virtual enterprise there is a reference to central structure, responsible for administration, which is a fixed cost not related directly to the electric energy distribution service.

Currently, all these costs, regardless of their classification as direct or indirect costs, are allocated to various tariffs in proportion to the marginal cost of expanding the electrical system.

On the other hand, it could be possible to adjust the price of each product in proportion to the consumers demand or through an absolute adjustment or fixed adjustment for each consumer.

The methodology applied by ANEEL is under debate. For example, some agents question the allocation criterion by marginal costs especially for indirect costs. They understand that the driver of commercial activities could be, for example, by number of consumers.

Of course, the choice of allocation driver will greatly change the relationship between high, medium and low voltage tariffs. Therefore, the allocation of indirect costs should be studied consistently with the theoretical basis.

In this case, it is necessary to analyze the nature of costs that make the virtual enterprise and propose a driver as relevant as possible for proper allocation of its costs by voltage level. The criteria choice could, where possible, make use of the existing factors in the virtual enterprise with degree of detail compatible for balance between the attributes of precision and simplicity of calculation process.

One critical issue is the relationship between peak and off-peak tariffs. These factors were calculated in the 1980s and do not reflect the new institutional environment in which companies are no longer responsible for the entire chain of the electric power industry.

In terms of time allocation of costs, another improvement could take into account energy loss arising from the different kinds of network curves and not just their peak load periods. This is because the energy loss factor is significant for the expansion and appropriate dimensioning of the network.

From the capacity marginal costs to reference rates, the final adjustment made by ANEEL (billing market) changes the proportion of revenue that would be collected per level. The logic of that procedure, however, is to keep the design of tariffs set by the peak and off-peak signs. However, the relativity between initial revenues, per voltage level, obtained from the capacity marginal costs is changed.

Finally, ANEEL does not make use of the capacity marginal costs of customers and their hours of usage to set long and short term use tariffs. The Blue THS is weighted by the average of capacity marginal costs while for the Green THS, the regulator turns the cost of power on demand (R$/kW) in costs for energy (R$/MWh) at peak time, applying again an exogenous load factor in the calculation process.

All these considerations are widely known by the regulator. So, recognizing the need for improvements in the tariffs calculation and profound methodological changes, ANEEL has recently proposed the implementation of cooperative research projects between the Brazilian distributors.

After ANEEL has defined the methodology of tariff level (allocation of energy and transport costs, return on capital investments and covering operating costs) now it is time to discuss a new tariff structure that includes the new institutional model.

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