Regulation, Tariff Schemes and Quality of Service - A Discussion

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Abstract

In this paper we start by describing and discuss the strategies available to regulate areas of the electricity sector that remain operated in a monopoly basis under a re-regulated structure. The regulatory policies adopted for the wiring sectors – that is for grid services, both in transport and distribution – are important in themselves since they are instruments available to ensure the economic operation of network companies. Their importance is beyond this issue since regulation should also be seen as an instrument to induce more efficient performances from the economic, technique and quality of service points of view. The methods adopted to allocate costs to users are analysed afterwards given the ability, inherent to some of them, to transmit economic signals to network users. The previous two topics will then be integrated when analysing the structure of tariffs due in several countries for the use of distribution networks. After presenting some results from long term planning simulations leading to the evaluation of long term nodal marginal prices, we will present several suggestions aiming at improving the regulatory policies and tariffs for use of distribution networks in force in Portugal.

1. Introduction

In the scope of the re-regulation of power systems, several new agents and companies are emerging contributing to change the traditional focus in global cost minimization to the maximization of the social welfare provided by the system. The implementation of market mechanisms started by the wholesale generation market integrating generation companies, eligible consumers and distributors. In a second step, market mechanisms moved closer to the end users both by lowering eligibility levels and by decoupling distribution wiring companies from retailing companies entitled of commercializing electricity. For economic reasons it is not feasible to duplicate networks. Therefore, in the re-regulated power systems, there are areas that remain operated in a monopoly basis corresponding to network providers both in transport and in distribution. This fact imposes the adoption of regulatory policies and tariff schemes to remunerate the use of networks. The adoption of these regulations can be seen from two points of view. In the first place, it is a way to ensure the economic performance of the companies giving them an adequate and predictable remuneration to pay both operational short term costs and the required long term investment costs. Secondly, it is a way to protect consumers from companies acting in a monopolistic basis both from the point of view of the tariffs and the quality of provided services. The above trend to decouple operation, maintenance and investment from retailing leads to tariff schemes in which the remuneration for the use of networks – both at the transport and distribution levels – is separated from the remunerations for power and energy supplied. This fact is recognized in a consultancy work developed by the authors for the Portuguese Regulatory Entity – ERSE.

The construction of tariff schemes should be included in a more general regulatory framework since it corresponds to an important tool in order to induce more efficient behaviors not only from the point of view of the companies themselves, but also in terms of the use of networks. Given the relevance of this topic, in Section 2 we discuss the usual regulatory policies – COS/ROR (Cost of Service/Rate of Return), Incentives (price caps, revenues caps and benchmarking) – justifying, in our opinion, the adoption of a revenue cap policy specially directed for distribution companies. This regulatory framework is specially interesting since it turns the global remuneration not entirely dependent on the number of sold units of the commodity. On the contrary, it allows the integration of parameters reflecting the Quality of Service provided to the clients, the characteristics of the network under analysis (urban, rural, aerial, cable, …) as well as other items as the remuneration for DSM programs. In any case, this scheme should be complemented by an approach designed to evaluate the costs in the initial year of each regulatory period as well as a well-designed mechanism to share profits along.

Once the remuneration is set, it must be converted in tariffs. In this scope, in Section 3 the paper discusses and evaluates the performance of some methods used to allocate costs referring their consistency to some general principles as their technical robustness, transparency, and the quality of the economic signals they transmit. Section 4 details the main principles governing the construction of tariff mechanisms – average costs/marginal prices, fixed costs/variable costs, short

term/long term costs, point tariffs, point-to-point tariffs and the general requirement of avoid cross subsidies. In fact, the adoption of a particular tariff policy – together with a regulatory framework – can have a direct short term impact on the shape of load diagram – eventually favouring a larger dispersion of consumptions along the day – as well as long term impacts leading, for instance, to postponements of reinforcement or expansion investments.

Apart from the previous discussion, in Section 4 we also analyse the structure of tariffs for use of distribution networks and for power and energy supplied – daily periods, tariff variables, etc - with the purpose of illustrating their influence on the behavior of consumers in some paradigmatic countries. This also leads to the discussion of the principle of tariff uniformity (meaning the adoption of a common tariff, at least for a given voltage level) versus assuming a geographic dispersion of the prices, interruptibility contracts or contracts reflecting different levels of ensured Quality of Service. The adoption of more flexible tariff schemes as the ones referred is important both for urban and rural areas since the main issue corresponds to develop tariffs more adapted to the requirements of the consumers. In order to illustrate the use of long term approaches, in Section 5 we present some numerical examples regarding the values of long term nodal marginal prices in distribution networks considering that loads have an elastic nature and are price sensitive.

Finally, and apart from some conclusions, Section 6 presents some suggestions in order to improve the regulatory framework and tariffs for use of transport and distribution networks in force in Portugal. These suggestions aim at improving the quality of the economic signals transmitted to the users of networks, to reshape the profit share mechanism defined for the distribution sector and to more directly reflect on tariffs both global and local quality of service indices as a way to induce investments and more efficient behaviors.

2. Regulatory Aspects

2.1. General Principles

The restructuration of the electricity industry was particularly evident with the emergence of several agents in the two extremes of the sector, that is in generation and retailing. This supposes that, at a first moment, traditional utilities are deverticalized individualizing generation, transport, distribution and technical and economical coordination agents. At a second moment, typically when wholesale electricity markets are already consolidated, the market came closer to individual low voltage consumers, either by progressively diminishing the eligibility levels or by decoupling distribution companies in wiring and commercialization activities. This move changed the structure of the sector, decoupled the entities technically responsible for the flow of electricity from the ones really controlling the flow of money, contributing to financialize the industry.

Ultimately, this move allows us to identify four major activities: generation, network activities, transactions and coordination activities. On the Generation side, they are included electricity generation in normal competitive regime, generation for which special regulatory regimes exist in order to induce a more efficient and complete use of endogenous and renewable resources and the supply of ancillary services. The Network activities can be decoupled in transport and in distribution ones and they refer to network operation, maintenance, expansion planning and building of new facilities. Transactions corresponds to a purely competitive activity aiming at connecting generating entities with consumers and they can correspond to day-ahead spot markets, bilateral contracts, financial contracts and futures markets. Finally, Coordination led to the emergence of new entities as System Operators, Market Operators and Regulatory Entities.

The separation of network activities from retailing – with the creation of transport providers independent from the generation and the consumer sides, and with distribution wiring companies – had several important consequences:

- in the first place, this structure recognizes that it is not economically feasible to duplicate networks. This means there must exist transport and distribution wiring companies owning network assets and providing that service to other entities;
- the fact that these wiring companies operate in a monopoly regime clearly justifies the adoption of regulatory policies to protect the users and maintaining or improving the quality of service while ensuring their economic life;
- as a part of that regulatory framework it must be defined the Regulatory Policy to adopt to each sector – transport and distribution – as well as the tariffs to be paid for the service provided – use of networks;

The general Principles and Objectives (see Perez Arriaga, 1998) to be followed by Regulatory Policies correspond to Transparency, Efficiency both from the technical and economic points of view and not only in the short term but also in the long term, Fairness so that costs are allocated in a non-crossed way to the entities that responsible for them, Stability since a too frequent change in regulatory policies or parameters enlarges the uncertainties present in an environment already

dominated by risks and uncertainties. In this sense, Regulations should avoid the risk of over and too complex mechanisms and should contribute to create a reliable environment that does not introduce extra uncertainty sources.

In the following points we shall classify the costs to be remunerated by the tariffs set according the adopted Regulatory Policy both in transport and in distribution wiring companies and will briefly describe the main aspects related to the COS/ROR Regulation and to Incentives or Performance Regulation Schemes.

2.2. Identification of Costs

Once the networks included in the transport and the distribution companies are identified, the Regulatory process should go on by identifying the costs allocated to each activity. It must be referred that these costs can be organized in different ways such as fixed/variable, short term/long term and can be explained by different variables as peak power, active and reactive power, energy consumption, voltage level, number of consumers by voltage level and by area, type of network (aerial, cable, urban, rural, …).

Regarding transport costs they include fixed administrative costs, operation and maintenance, capital costs related to investments and expansion and depreciation costs. The costs incurred by distribution wiring companies can be organized in administrative and global fixed costs, costs of connection of new consumers, operation, maintenance and monitorization of the networks, capital costs due to investments and expansion, costs of depreciation, costs with billing and invoices related with the use of networks. These costs should be carefully identified in order to avoid cross-subsidies and to allocate them to the users of networks. In any case, it is important to refer several aspects that help understanding the differences between regulatory policies adopted for distribution and transport wiring activities:

- in the first place, the structure of regulated end user electricity prices clearly shows that transport wiring costs have a much smaller weight when compared to distribution ones. For instance, in Portugal the average price is broken down in about 53% for generation, 6% for transport, 31% for distribution network activities and about 10% for retailing;
- transport companies are traditionally more efficient when compared with distribution wiring ones. This is not only evident in terms of economic indices but also in terms of quality of supply indices clearly showing that for many years there was a sub-investment situation in the distribution wiring business. This explains the lower automation levels and the higher share in the regulated prices of investments costs going on nowadays in the distribution wiring sector;
- apart from that, it is possible to identify distribution wiring companies having different economic requirements since they depend, for instance, on the density of loads, the type of networks and of consumers and voltage level. This means that the situation of each company should be investigated by performing econometric studies aiming at identifying the most significative variables explaining similar situations as well as variables responsible for dissimilar performances.

2.3. COS/ROR Regulation

The Cost of Service/Rate of Return Regulation is the traditional framework used to define the macro-economic performance of regulated companies. It basically aims at setting the tariffs for the estimated number of units of services provided by the company so that the company can recover its approved regulated costs plus a Remuneration Rate over investments, considered reasonable for the economic activity in question. This can be mathematically translated into expression (1). In this expression, p_i is the unit price of service i, q_i is the number of units of service i estimated to be sold next year, $Cost_j$ is the regulated approved cost for item j, r is the approved remuneration rate and RB is the Rate Base corresponding to a measure of the investments of the company.

$$\sum_{i=1}^{n} p_i.q_i = \sum_{j=1}^{m} Cost_j + r.RB \qquad (1)$$

2.4. Incentives or Performance Regulation

The previous regulatory scheme has some deficiencies that are addressed by Inventive Regulatory Schemes. These can be organized in Price Cap schemes, Revenue Caps and Benchmark Regulation (see details in Gomez, 1999).

Under the Price Cap scheme the tariff levels are set for the initial year of a regulatory period – typically 4 or 5 years – considering economic and financial data submitted by the regulated entities and once performing several econometric studies. For the following years of the regulatory period, the Regulatory Board estimates that regulated companies will behave more efficiently so that they will be able to transfer part of that productivity gains to the consumers in terms of reductions in tariffs. This process can be characterized by expression (2). In this expression $T_{i,t}$ and $T_{i,t-1}$ represent the

tariffs for service i in year t and t-1, RPI is the Retail Price Index in %, X is the productivity factor in % and Z is a positive or negative adjustment factor to take into account externalities.

$$T_{i,t} = T_{i,t-1}\left(1+\frac{RPI - X}{100}\right) \pm Z \qquad (2)$$

The Revenue Cap policy works on a similar way by imposing limits on the revenues of the regulated company rather than on the prices of the services. This process requires the identification of variables emulating market conditions and affecting the behavior of the revenues. As an example, if one considers that the number of clients supplied by the company affects in a determinant way the revenues, expression (3) can be adopted as the Revenue Cap formula. In this expression, $R_{i,t}$ and $R_{i,t-1}$ represent the revenues of the company for years t and t-1 and AF_{client} is an adjustment factor leading to an increase of the allowed revenues once the number of supplied clients increases by ΔN_{client}.

$$R_{i,t} = \left(R_{i,t-1} + AF_{client}.\Delta N_{client}\right)\left(1+\frac{RPI - X}{100}\right) \pm Z \qquad (3)$$

As an example of the application of this scheme, expression (4) details the Revenue Cap in force in Norway for the distribution sector for the period 1997-2001.

$$IT_t = \left[\left(IT_{w/losses,t-1}.\left(\frac{KPI_t}{KPI_{t-1}}\right)\right) + \left(NT_{MWh}.P_t\right)\right].\left[1+\left(\frac{\Delta LE_{t,t-1}}{2}\right)\right].\left(1-EFK\right) \qquad (4)$$

In this expression:

- IT_t represents the allowed revenues for year t;
- $IT_{w/losses,t-1}$ is the allowed remuneration for the company in year t-1, not including the cost of losses;
- KPI_t / KPI_{t-1} represents the adjustment to take into account the annual inflation rate;
- $NT_{MWh}.P_t$ is the cost of losses in the distribution network. This cost is estimated by the product of the value of losses by the projected energy price in the spot market for year t;
- $\Delta LE_{t,t-1}$ is the estimated increased in energy cost in the spot market or via bilateral contracts from year t to t-1;
- EFK is the annual productivity factor in %;

Finally, a third Incentive Regulatory Policy, currently in use in the Chilean, Argentinean and Norwegian distribution sectors corresponds to the Benchmark Process. The basic idea under this process it the recognition that, namely in the distribution sector, distribution wiring companies are not subjected to competition since in each region they correspond to a monopoly. To induce more efficient performances, both from economic and technique point of view, competition can be simulated by comparing existing companies between themselves and with model companies. This requires a large amount of studies typically to divide the franchized area of a company into smaller areas having similar characteristics in terms of density and type of consumers, and type of networks. Each of these areas will then compete with similar areas of other companies in order to identify variables explaining similar behaviors. It is also important to compare very dissimilar performance areas to better understand and mathematically model such situations.

In Chile, this process is conducted for geographical areas in which the company is divided in order to determine the Distribution Value Added – *Valor Agregado de Distribucion, VAD*. This term according to the Chilean Law is based on model companies and considers fixed costs related to:

- administration, billing and consumer services;
- average energy losses in distribution networks;
- standard investment, maintenance and operation costs per unit of supplied power;

These costs will be calculated for each area of the distribution companies by the Regulatory Commission and by consulting services contracted by the regulated companies. The final values will correspond to a weighed average taking into account the weights defined for each area (considering comparisons between similar areas) and the results obtained by Regulatory Commission - two thirds – and the consulting services – one third. These values are added to the nodal marginal prices in the bulk power system to define the regulated tariffs. Once these tariffs are set, it is possible to estimate the total revenue of each company as well as the corresponding remuneration rate. The VAD values will be accepted if the

remuneration rate does not differ more than 4% regarding the rate considered in the Law. A more complete description of this process can be obtained in Charun and Morande, 1997, and in Rudnick and Ranieri, 1997.

2.5. Comments

The previous Regulatory Policies have different characteristics turning some of them more adapted to one sector when compared to others. These characteristics allow us to make the following comments:

- in the first place, COS/ROR Regulation is the traditional framework used in the transport sector. Transport providers typically have higher technical and economic performances allied to a small share of their costs and investment in the breakdown of the final regulated prices and in the global investments in the sector. This turns it less relevant to induce more efficient behaviors and eliminates the danger of over or under investment in the sector;
- differently from transport, on the distribution wiring sector it is most important to transmit signals to induce more efficient technical and economic behaviors. Since the level of required investments is typically larger and the share of the costs of these companies represents a larger percentage of the final regulated prices, it is in this sector that is possible to obtain larger efficiency gains. This turns incentive regulation the most interesting and widely used Regulatory Policy for distribution. Among the three described approaches, benchmarking can be adopted to set the remunerations of efficient companies in the initial year of each regulatory period. On the subsequent years, tariffs or revenues can be determined either by Price Caps or Revenue Caps. Between these two schemes, Revenue Cap is usually considered more complete and adequate to emulate market conditions in the distribution wiring sector since, in this area, there are usually fixed costs for instance dependent on the number of supplied customers. DSM program costs and costs from acquisitions of energy from renewables can also be more easily integrated in this framework;
- in several countries incentive regulations are combined with sharing profit mechanisms aiming at transferring to users extra profits obtained by the companies. This mechanism should be progressive in the sense that a first amount of the profits is shared between the company and the consumers; in subsequent amounts of profits, more difficult to be obtained, the share assigned to the company is increased;
- finally, in order to protect consumers, to induce investments and to avoid some perverse effects related, for instance, with marginal approaches it is a common practice to have Quality of Service Regulations dealing with Quality of the Wave, Continuity of Service and Commercial Quality issues. This Regulation should impose minimum values to several indices, in some cases, and maximum limits in orders as well as fines – related to the violation of global requirements - or compensations directly paid to consumers considering local indices.

3. Methods to Allocate Costs

The next momentum in terms of a global regulatory procedure corresponds to the adoption of a method, or methods, to allocate costs among the users of the network. The literature on this issue includes lots of papers and technical reports clearly emphasizing the advantages and disadvantages of several existing methods. The cost allocation methods can be aggregated in three groups:

- Embedded Methods either Rolled In approaches or requiring running a power flow study. In the first subgroup we can refer Postage Stamp, Contract Path and Mean Participation Factors. These methods are simpler to apply once one accepts the basic ideas behind them. Their problem is related with the lack of both technical and economic support since they are not based on the way power systems operate and they fail in transmitting economic signals to the users. In any case, Postage Stamp is widely used supposing that one accepts that all consumers/generators are treated in the same way, at least for the same voltage level, regardless of the geographic location of the users. Embedded Methods based on power flow studies – MW.mile, Modulus or Use, Zero Counter Flow, Dominant Flow and Generalized Distribution Factors – are more robust from a technical point of view, the application complexity is larger when compared with the previous ones but they transmit very dim economic signals to the users of networks. The interested reader can obtain a more complete description of these methods in Lima, 1995 and in Odériz, 1999;
- Incremental Methods are based on the comparison of a reference situation with another one in which a specified transaction is now included. The difference of costs between these two cases corresponds to the cost allocated to that transaction. This approach has a larger economic basis but it is difficult to apply when the number of transactions is large and it can become less transparent and more subjective since the order to consider the integration of transactions will affect the surplus costs. In any case, incremental approaches are in use in Chile and Argentina to identify the Areas of Influence of generators used to build transport network tariffs and allocate investment costs to the network users;
- finally, marginal methods are the most well sounded both at technical and economic levels but are also the ones requiring the larger computational effort. They aim at computing nodal marginal prices reflecting the extra cost of delivering a new unit of demand connected to each node (see references Calviou et al, 1993, Caramanis et al, 1982 and Schweppe et al, 1988). These methods can be divided in short and long term depending on the horizon that is considered. Short Run Marginal Prices are related to short term operation optimization problems and they reflect the

short term cost is generating a new unit of demand together with the cost of losses and of congestion. Therefore, they become very volatile since they depend on the current demand level and on its distribution along the network, the components in operation and on generation costs. These characteristics turn the short term marginal remuneration very volatile and generally only covering a small amount of the regulated remuneration. As examples, in Chile Rudnick et al, 1995, indicates that the short run marginal term of transport tariffs cover about 15% of the regulated remuneration while in Norway Glende and Borg, 1997, indicates that marginal terms covered about 30% in 1993. This leads to the well known "Revenue Reconciliation Problem" since the remaining remuneration should be provided by other tariffs terms or by changing marginal prices, for instance, according to the Ramsey Pricing Scheme. The short run deficiencies are addressed by long term marginal methods. In this case, one aims at identifying the most adequate long term expansion plan considering both investment and operation costs. The solution of this problem also allows us to compute nodal long term marginal prices that are, in general, able to provide a remuneration closer to the regulated one. In real case situations, there may still occur some Revenue Reconciliation to deal with, since normalization, economies of scale or purely reliability driven investments will not be completely remunerated. The long term approaches provide tariffs based on the future operation and investment costs and, apart from being the most complex from a computational point of view, are the most well suited considering both the technical side and the quality of the economic signals transmitted to the users.

4. Structure of Tariffs for Use of Distribution Networks in Some Countries

When analysing the approaches used in distribution system tariffs in several countries we are able to cluster them into a few methodologies. In this section we will point out those methodologies illustrated by some paradigmatic examples.

Point to point tariffs - These tariffs are transaction based between source and consumption. The procedure needs information about location of absorption and injection points. These tariffs require parameters related with distance, affected regions, voltage level, etc. This methodology doesn't reflect the direction of the flows and can potentially overestimate the remuneration. As an example, Italy considers a conventional path connecting source and load nodes in order to identify the voltage levels affected by a transaction.

Point tariffs - These are the most commonly used ones given their non-discriminatory nature and their flexibility of application in liberalized markets not based on transactions. They evaluate the impact of an agent being connected to a grid point and they are independent from the distance to the source regarding which a contract might have been established. For instance in several States in USA there are point tariff components in the tariffs evaluated trough marginal methods while in Spain the point tariff is evaluated by a Postage Stamp methodology.

Published/negotiated - In some regulated systems tariffs are settled and published while in others they are object of negotiation among different partners. Obviously transparency will be easily obtained if tariffs are pre-defined and publicised. In any case, the EU 96/92 Directive on the Electricity Market admits these two approaches.

Marginal Costs/Average Costs - The tariff settlement through marginal costs evaluation incentives efficient decisions among market operators although the evaluation procedure often leads to complex calculations. An analysis through the different methodologies in several countries points out examples where remuneration is evaluated by the use of short term marginal costs. Some of them are later converted into average values for geographical reasons. For instance in Chile a short term marginal cost approach is used to get one component of the use of transmission system. The tariff system also integrates other terms designed to get Revenue Reconciliation. In the distribution sector, regulated consumers pay a tariff integrating the generator marginal price affected by loss penalty coefficients together with a regulated term reflecting distributions costs. This term corresponds to the Distribution Aggregated Value – VAD – and reflects fixed costs, cost of losses and administrative ones. In order to induce competition in this monopoly based area, the VAD is set within a Benchmark Regulation process. In England and Wales, in the initial year of a regulatory period tariffs are evaluated from comparison studies between several companies and updated by an RPI-X formula.

5. Some Numerical Examples on Nodal Marginal Price Calculations

Marginal approaches (see Caramanis et all and Schweppe et al) are well established as the most efficient ones both on their transparency and on the adequacy of the economic signals sent to the users of networks. Unfortunately, short run marginal costs, although more easily computed by operation optimization problems are too volatile thus preventing a stable and predictable stream of money (5). Apart from that, they do not provide the full remuneration of the regulated companies thus leading to revenue reconciliation issues. In expression (5) ρ_k is the marginal price at node k and d_k and g_k are the

load and generation at that node. Marginal prices are influenced by a number of factors as the load level, the generation dispatch policy and component outages that explain large variations of prices in the same node along the time.

$$MR = \sum \rho_k . (d_k - g_k) \qquad (5)$$

Long run marginal costs internalizing investment costs on equipment and operation issues – as congestion and losses – are the most adequate approach to cope with these difficulties. Rudnick et al (1996) and Magaron Lima et al (1998) describe two long term planning approaches leading to the identification of economically adapted transmission systems and the most adequate expansion plan and tariff settings considering several criteria. In this section, long run marginal costs for distribution systems are calculated within a framework aiming at getting economic and technical efficiency from the network by considering operation, investment and reliability related costs as well as technical constraints namely related with congestion. This leads to a multiobjective mixed integer problem that is solved by a two step scheme. In the first one, we use a Simulated Annealing approach to generate a set of efficient solutions. This set will then be investigated in a more detailed way either by the regulatory agency and/or by the entity in charge of establishing a reference expansion plan for the network. As a result, the methodology provides a reference plan together with the set of nodal prices that lead to a certain level of remuneration collected via marginal concepts.

Figure 1 illustrates an aggregated distribution network. Marginal Costs were evaluated for two different scenarios with and without demand side actions in nodes 9 and 11. Some selected efficient expansion plans for the network are presented in Table II. In this Table, one indicates the values assumed by the objectives (investment costs, losses and reliability measured by the Energy Not Supplied, ENS) and by the correspondent average marginal costs for both scenarios. Table I details the nodal marginal costs obtained for the expansion plan A.

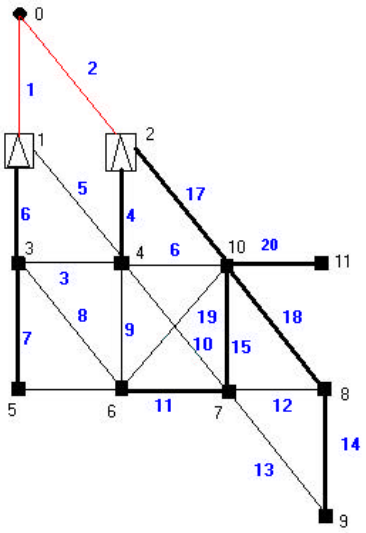

TABLE I – Marginal Costs for the two scenarios ($/MWh)

	with DSM	**without DSM**
Nó 1	1,166	1,166
Nó 2	1,880	2,099
Nó 3	3,505	3,505
Nó 4	2,202	2,638
Nó 5	3,870	3,870
Nó 6	3,906	4,466
Nó 7	3,662	4,066
Nó 8	3,709	4,240
Nó 9	3,987	4,379

TABLE II – Results for some non dominated expansion plans for the network presented in Figure 1.

plan	Investment	Losses	ENS	MC (with DSM)	MC (without DSM)
A	198,6	908,03	1,95	3,10	3,38
B	191,6	921,78	1,91	3,17	3,38
C	188,6	943,12	1,97	3,25	3,46
D	126,3	2859,62	1,94	10,27	11,30
E	121,3	2890,7	2.00	10,38	11,40
F	118,3	2912,03	2,06	10,46	10,46

These long term marginal tariffs provide a remuneration immune to volatility issues and its value can also be used by the decision maker in order to anticipate how expansion investments and demand side actions would impact on the revenue reconciliation problem. Since we are not dealing with short term load variations (for instance, from daily peak to valley hours) this remuneration would certainly not cover the entire costs of the distribution provider. In any case, from the point of view of the tariff debate it would certainly be preferred an expansion plan that would allow the distribution provider to

obtain a remuneration covered as largely as possible by these stable marginal prices. The identified solutions also allow distribution companies to evaluate trade offs between DSM actions against investment costs.

6. Suggestions of Changes in the Portuguese Tariffs

In Portugal, distribution and retailing activities are regulated by a Revenue Cap Policy aiming at inducing the efficiency increase of the regulated companies. This Regulatory Scheme should be accompanied by mechanisms to monitor and control, among other issues, the Quality of Service in those activities. The concern with this control comes from the fact that those activities are located in the electricity chain immediately before the end users and they are typically poorer in terms of reliability indices than other sectors. It is also important to guarantee that efficiency improvements are obtained via a degradation of the Quality of Service. In Portugal, this justifies the urgent approval and publication of the Quality of Service Regulation. This urgency comes from the fact that the above referred control mechanisms to be established must be based on the limit values included in that Regulation regarding several indices.

Apart from the above concern, in this Section we will refer several suggestions aiming at improving the regulatory schemes already adopted as well as to reflect in tariffs, either in a direct or in a indirect way, Quality of Service Regulations.

Quality of Service Indicators can be grouped in system or global ones, for one side, and individual ones, for the other. The first ones translate average values computed for a period of operation of the system (typically 1 year) quantifying the global Quality of Service provided by the system. The second ones are related to local behaviors of several indication functions evaluated for each end consumer. These indicators can also be organized in a zonal way trying to translate particular characteristics of local networks (aerial, cable, urban, rural, …). Finally, it should also be said that the evaluation of Quality of Service typically includes three topics – Continuity of Service, Power Quality and Commercial Quality.

Since it is our belief that the Quality of Service Regulation will include dispositions regarding these three topics, we consider that tariffs should include the following issues:

- Continuity of Service and Power Quality:
  - Global quality control:
    - in this evaluation there should be used system indices, eventually zonal values if available. In case the values violate the specified limits or admissible ranges, the distributor should be obliged to prepare and present to the Electricity General Directorate – DGE – an annual investment plan to improve the service in its network. The limit on revenues should be altered and the tariffs for use of networks changed, if eventually those investments were subsidized by any other entity;
    - if the quality of service indicators display values beyond the minimum required ones, it should be activated a mechanism leading to an increase in the regulated revenues not directly linked with increases in tariffs. The referred increase in retained revenues could be achieved by changing the limits inherent to the profit sharing mechanism;
  - Quality control at the end user level:
    - the violation of individual indicator limits or admissible ranges (zonal indices if available) would directly lead to compensations paid to the affected clients. The consequence for this would be a decrease of the revenues retained by the company since the tariffs remained constant. The retailers would be responsible for the payment of those compensations and would, subsequently, settled these costs with distribution, transport or generator companies according to their responsibilities;
- Commercial Quality:
  - Quality control at the system level:
    - In the event that system indicators were not according limits or ranges specified in the regulations, the Regulatory Entity should prepare recommendations or warnings or even determine the application of fines to the retailers;
  - Quality control at the end user level:
    - In the event that individual indicators did not comply with specified or agreed limits or ranges, there should be paid compensations directly to the affected clients;
  - The referred fines and compensations would have the effect of diminishing the revenues obtained by the retailers without increasing the tariffs for energy and power. The values of those fines and compensations could then be passed to distribution wiring, transport or generation companies according to their responsibilities;

Besides the referred aspects aiming at inducing companies to guarantee minimum Quality of Service levels, the regulations should be flexible enough to admit Quality of Service contracts between retailers, distributors, transport and

generation companies and end consumers in order guarantee on an individual basis improved Quality of Service levels. In this case, the compensations and penalties should be object of direct commercial agreement between those entities. For LV end consumers it seems adequate to have standardized contracts in order to facilitate these procedures eventually considering regulated tariffs for these products.

Having a framework with these characteristics in force, investment decisions would be more determined by a trade-off analysis in which the merit of investment plans would be assessed by evaluating their impact in Quality of Service indicators and in eventually diminishing the fines and compensations referred above.

As indicated in Section 2.5, Incentives Regulations are usually combined with profit/loss sharing mechanisms. In Portugal, there are profit share mechanism in force in distribution wiring and commercialization activities. These mechanisms impose increasing percentages to the surplus of the profits to be passed to clients. In the distribution wiring activity this means that till extra profits not exceeding 65% of the revenues are completed retained by the company, while extra profits between 65% and 68% are retained in 80%, extra profits between 68% and 72% are retained in 50% and above 72% are retained in 20%. This mechanism can have a perverse effect since the company may go on monitoring the extra profit percentage along each year in order to avoid activating the profit share mechanism. This could prevent the company from achieving the main goal of improving as much as possible its performance. This could be avoided by reverting the profit share mechanism in a way that a percentage of the first amounts of extra profit were passed to the end users. That percentage should be decreasing as the extra profit was increasing. This means that the amount of retained extra profit was enlarged as a price for the effort of the company in turning itself more and more efficient. As an example of such mechanism, in California the major utilities are regulated considering a profit sharing mechanism considering three ranges:

- a first limit of 50 points around the regulated revenues. In this case, the company completely retains all extra profits;
- a second limit from 50 to 300 points in which the percentage of retained extra profits increases till 100%;
- a third band from 300 to 600 points in which the company retains all extra profits;
- a fourth limit of 600 above which a new Regulatory process is initiated to revise parameters and settings defined previuosly.

A final word regarding the uniformity tariff principle. This is in force in Portugal as a consequence of the legislation passed in 1995 and is implemented for all regulated tariffs in the same voltage level. The adoption of postage stamp procedures to tariff the use of transport and distribution networks and the uniform end user energy and power tariffs all over the country are not only a consequence of trying to adopt simple tariff mechanisms in the first regulatory period but also a consequence of that principle. The adoption of that principle should be discussed since the tariffs resulting from its application can not easily transmit economic signals to the users of networks namely to influence the location of new loads. Apart from that, when speaking about zonal Quality of Service indicators and reflecting them in tariffs, the uniformity principle would be in question. The elimination of this principle and the eventual integration of marginal tariff terms require a careful analysis:

- to check what are the regional effects namely in more depressed inland rural and in very densely populated ones. In both of them short term marginal prices could be increased either because loads were located at the end of long radial systems, or because there was shortage of local generation leading to more severe congestion;
- to evaluate the amount of revenues an hypothetical marginal term could provide. Not even speaking about long term prices, short term marginal prices are more complex to evaluate so that a very small marginal revenue could not compensate the quality of transmitted the economic signal;
- in long radial distribution systems the effect of marginal price increase could be counteracted by reflecting on tariffs Quality of Service indices that are usually lower in those areas.

7. Conclusions

In this paper we discussed the regulatory schemes that are usually used in areas of the electricity sector that are not subjected to competition, that is network activities. The analysis of those approaches and the situation in several countries allow us to conclude that Incentive Regulation, and among them, the Revenue Caps, are the most common and more adequate for the distribution network activities. This scheme should be completed with a well designed profit sharing mechanism that should not be perversely understood as a barrier to increase the performance of the companies. On the contrary it should actively induce more efficient behaviors. Apart from that, investments on the distribution network activities should be carefully analysed in order to avoid sub-investment situations. This could be counteracted by explicitly including terms on the remunerations directly related with investment costs and/or by imposing system and consumer Quality of Service indices. If those indices are violated, this would directly activate mandatory investment plans or, if corresponding to local situations, would lead to compensations paid to the affected consumers. Finally, short term marginal based tariff terms are in use in several countries as a way to partially get a remuneration of the network companies. The integration of such terms should be discussed considering two issues. In the first place, the Tariff Uniformity principle

should be questioned although we recognize that it corresponds to a political issue. Secondly, it should be analysed whether marginal approaches would lead to a significant percentage of the regulated remuneration or if a major amount would have to be obtained by any other embedded based approach. If the economic signals provided by the network are weak and loosely distributed from a geographic point of view such short term marginal tariffs have no justification. In that case, the postage stamp appears as an interesting method given its transparency and ease of calculation.

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