Paper accepted for presentation at 2009 IEEE Bucharest Power Tech Conference, June 28th - July 2nd, Bucharest, Romania

EVOLUTION OF THE MARGINAL BASED REMUNERATION OF THE PORTUGUESE TRANSMISSION COMPANY FROM 1998 TO 2004

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Abstract— **Back in 1999, the Power Systems Unit of INESC Porto concluded a consultancy study to estimate the remuneration that could be obtained by the Portuguese transmission provider using Short Term Marginal Prices. By that time the Regulatory Agency decided not to include a marginal based term on the Transmission Network Tariffs. However, that study was updated using information about the operation of the network in 2001 and recently it was concluded a new version of this study using information from 2004. This paper describes the models used in these studies, the assumptions that were adopted and the evolution of the marginal based remuneration that the Portuguese transmission provider could obtain if a marginal based tariff term existed. This evolution is important in order to get insight on the congestion level of the transmission network and on how neutral the transmission network is behaving in being able to physically implement the dispatches prepared by the Market Operator or related with bilateral contracts.**

Index Terms—**Short term marginal prices, Congestion rent, tariffs for the Use of Transmission, electricity markets.**

I. INTRODUCTION

The reregulation process of the electric industry had consequences both at organizational and regulatory levels. The first experiences in this area clearly pointed to the creation of competitive wholesale markets organized in terms of pool mechanisms as a way to organize the relations between generator entities and distributors or large consumers and to introduce competition in the sector. It was only afterwards that the possibility to choose the supplier was brought closer to the end consumers either by reducing the eligibility levels or by introducing the concept of retailer decoupled from the ownership of distribution assets. In any case, it was very clear since the beginning that the access conditions to the networks was a crucial aspect in order to develop market conditions. The need to turn these access conditions transparent and fair to all users lead, in the first place, to unbundle traditional vertically integrated companies in order to separate generation assets from transmission network activities and from the distribution sector. Transmission network activities started are now typically considered as a service that can be used by several agents and that should be paid accordingly. The need of transparency and technical accountability of decisions lead to the creation of Independent System Operators responsible for the technical operation of the system.

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This clear separation between transmission network activities from generation, distribution and eligible consumers was, in a second step, also applied in the distribution sector. In this case, distribution network activities were decoupled from retailing activities leading to the creation of purely commercialization companies not owning network assets nor responsible for the operation, maintenance or expansion of the networks. This means that, from this point of view, the situation is now very similar at the transmission and distribution levels. In both cases, there are network activities and services usually provided in a natural monopoly basis and in a national or regional geographical area. In both cases, there are a number of users in terms of generation companies, retailing entities and end consumers that in whatever way should pay tariffs for the use of network assets. This organizational evolution of the electricity sector clearly indicates the need to regulate transmission and distribution network companies since they are not subjected to competition. Regulation can be defined as an activity in which one aims at establishing rules and principles for a company or entity to act in a sector of society eventually leading to changes in the behavior of those agents. This can be accomplished by setting prices, remunerations, quality of service, investment levels, access conditions, … In a more closed sense, tariff regulation should be ensure the economic conditions of network companies while promoting economic and technical efficiency, the increase of quality of service levels and a more stable and less volatile environment. Tariffs for use of networks should be set in order to remunerate a number of costs namely in terms of operation, maintenance and expansion. These costs can be organized in terms of short or long term, fixed or variable according to the use of networks. They can also be explained or evaluated by several variables and they certainly are influenced by a number of factors as the voltage level, the type of networks, the density of consumers and of loads.

Regarding Regulatory Policies, the Portuguese transmission provider is regulated using a Cost of Service/Rate of Return – CoS/RoR – approach according to which the company submits to the Regulatory Agency its expected costs for year n by May in year n-1. The Regulatory Agency has the capacity to approve or not these costs as well as setting a remuneration rate over the transmission assets. The approved costs plus the remuneration on the assets led to the Regulated Transmission Remuneration that will be recovered by transmission network tariffs to be paid next year. This remuneration is then converted in tariffs using a postage stamp approach.

978-1-4244-2235-7/09/$25.00

Back in 1999, when it was discussed the revision of the Portuguese Tariff Code, the Power Systems Unit of INESC Porto and the Portuguese Regulatory Agency ran a consultancy study aiming at, among other objectives, to study the interest and the possibility of implementing a term in the transmission network tariffs based on Short Term Marginal Prices [1].

Short Term Marginal Prices [2] for active power reflect operation and congestion costs and can be computed as a sub product of a DC based OPF problem. These prices are very attractive in an open market environment given the economic signals they transmit but they have some drawbacks related with:

- their volatility – dependency on load level, generation policy, reliability and topology of the network;
- the remuneration reconciliation problem due to the fact they do not reflect investment costs thus leading to recover a reduced amount of the approved remuneration;
- the increase of the marginal based remuneration if the degradation of the operation conditions of the network increase. This impact of this pervasive effect can be minimized by establishing minimum quality of service levels and investments plans;

By that time, the Regulatory Agency decided not to include such a term in the transmission tariffs, namely because it was concluded that the resulting Marginal Based Remuneration covered less than 10% of the Regulated Remuneration. This would always imply the existence of another large tariff term to recover the remaining 90%, in order to ensure revenue reconciliation. This recovery percentage is a good indicator of the congestion level of the network, and indirectly on the adequacy of the investment plan on expansion and reinforcements of transmission networks. Therefore, it was decided to update this study using data from 2001 and more recently using data from 2004. This paper addresses the models and the assumptions that were adopted in these studies and detail the results obtained for the Portuguese Transmission Network, namely to get information on how the percentage of recovery of the Regulated Remuneration by the Marginal Based Remuneration is evolving, reflecting the investments and the congestion level of the network.

II. Current Regulatory Scheme

The Portuguese electricity industry was till 1995 organized in a vertical and integrated way around EDP – Electricidade de Portugal S.A. By then new legislation was passed leading to the creation of an holding company and several child companies devoted to large thermal and hydro generation, to transmission, and four regional distributions companies as well as a number of others directed to some specialized areas of business and services. In terms of regulation, the industry was organized in a public driven sector and a market one. In the first one the referred large thermal and hydro company, two new companies operating combined cycle plants and the national distribution network operator were linked to the transmission company by long term contracts. The market driven sector would integrate eligible consumers, and generators and distributors not subjected to the referred long term contracts. The generation from renewables, or cogeneration was liberalized back in 1989 and there is specific legislation imposing that the public system should buy the energy from these entities and that the extra costs are allocated to all clients of the system both public and market driven. Meanwhile, the EDP holding started to be privatized so that, since mid 2000, the majority of the shares are private. In order not to reduce the transparency of the operation of the system, the transmission company was separated from EDP holding and constitutes today a public state owned company. In February 2006 it was passed a new Electricity Law organizing generation in normal regime and special regime. Normal regime generators present their bids to the market operator or establish bilateral contracts while special regime generators (namely renewables) are paid according to feed-in tariffs. This new law established that transmission and distribution network activities are run in terms of public concessions while generation and retailing are market driven. As a consequence of this law, distribution is now completely separated from retailing, there is full eligibility and it was established a common electricity market between Portugal and Spain.

Apart from this organizational reform, another major change is related to tariff regulation. In 1998 it was passed a new Tariff Regulatory Scheme leading to the creation of a Global Use of System Tariff and Tariffs for Use of Transmission and Distribution Networks. These tariffs enabled several agents to use the networks and to establish contracts away from the referred long term scheme. The regulatory scheme of the transmission company is based on a Cost of Service/Rate of Return basis and the remuneration is obtained from Postage Stamp based tariffs considering:

- a discrimination in terms of voltage level leading to Tariffs in Extra High Voltage and High Voltage Networks;
- prices for power (€/kW.month) and for reactive energy (€/kVAr.h) received or supplied. The price for power is to the contracted power and to the power in peak hours in each month. The price for supplied reactive energy is applied to the inductive energy that exceeds 40% of active energy in off valley hours. The price for received reactive energy is applied to all reactive energy received in valley hours.

III. Evaluation of the Marginal Based Remuneration, MBR

In the first place, it is important to refer that it is not the objective of this work to question the way the global yearly regulated remuneration of the transmission provider is determined. This the responsibility of the Portuguese Regulatory Agency since 1999 and with this work we simply aim at testing alternative ways of recovering that remuneration if possible more efficient from an economic point of view.

Using marginal nodal prices and accepting that each generation entity at node k is remunerated using the nodal price at node k and that a consumer at node k pays the energy at the nodal price at node k, then the Marginal Based Remuneration can be estimated using (1). In this expression NCS is the number of generation/load scenarios considered along the year, Nnodes is the number of nodes of the 400/220/150 kV network, ρ_{ik} is the marginal price of node k in the scenario i, P_{Lik} and

P_{Gik} are the load and generation in node k in the scenario i and d_i is the duration in hours of the scenario i.

$$MBR = \sum_{i=1}^{NSC} \sum_{k=1}^{NNodes} \rho_{ik}.(P_{Lik} - P_{Gik}).d_i \quad (1)$$

The optimization model used to compute the nodal marginal prices ρ_{ik} for each scenario corresponds to a DC based formulation aiming at minimizing the generation cost subjected to a global generation/load balance equation and to generation and branch flow limit constraints. This DC based model is formulated by (2) to (6).

$$\min f = \sum c_k.P_{Gk} + G.\sum PNS_k \quad (2)$$

$$\text{subj.} \quad \sum P_{Gk} + \sum PNS_k = \sum P_{Lk} \quad (3)$$

$$P_{Gk}^{min} \le P_{Gk} \le P_{Gk}^{max} \quad (4)$$

$$PNS_k \le P_{Lk} \quad (5)$$

$$P_b^{min} \le \sum a_{bk}.(P_{Gk} + PNS_k - P_{Lk}) \le P_b^{max} \quad (6)$$

In this model we are minimizing the generation cost given that Pg_k is the generation in node k, c_k is the corresponding cost and PNS_k is the output of a fictitious generator modelling the power not supplied in node k. Pg_k^{min}, Pg_k^{max}, P_b^{min} and P_b^{max} are the minimum and maximum generation and branch flow limits and a_{bk} is the DC sensibility coefficient of the flow in branch b regarding the injected power in node k.

This algorithm has to be enhanced namely to integrate an estimate of active losses because they are one of the causes leading to a geographic differentiation of nodal marginal prices. Therefore, if adopting a DC based algorithm it is crucial to integrate an estimate of these losses. Active losses in branch b from node i to node j are approximately calculated by (7) considering that voltage magnitudes are 1.0 pu. In this expression, θ_i, θ_j and g_{ij} are the phases in nodes i and j and the conductance in branch ij.

$$Loss_{ij} \approx 2.g_{ij}.(1 - \cos\theta_{ij}) \quad (7)$$

Apart from other more involving processes, one simple way of computing an estimate of branch losses consists of running a set of DC-OPF crisp studies in an iterative scheme. At the end of each DC-OPF run, the phase angles and branch losses are computed and half of the losses in each branch is added to the load in each extreme bus. This change on loads leads to a change in generation and thus in voltage phases. The process converges when, in two successive iterations, the differences between phases, in each node, are inferior than a specified level.

When this iterative procedure is completed and according to this model, the marginal short-term nodal price in node k for the scenario i is given by (8) [3, 4]. In this expression, the first term γ_i represents the dual variable of constraint (3) for scenario i while the second term measures how much the cost function varies due to a change in branch losses caused by an increased of 1 unit of the load in bus k

$$\rho_{ik} = \gamma_i + \gamma_i.\frac{\partial Loss}{\partial P_{Lik}} + \sum_b \eta_b.\frac{\partial P_{b,mn}}{\partial P_{Lik}} + \sigma_{ik} \quad (8)$$

The second term can be obtained using (9) considering that, once losses are estimated, they are treated as loads. Therefore, the first derivative in (9) corresponds to γ_i and the second derivative is given by (10) where the derivative of the losses in a branch ij is given by (11). In expression (11) θ_i, θ_j and g_{ij} are the phases in nodes i and j and the conductance in branch ij, Z_{ik} and Z_{jk} represent the elements of line i/column k and of line j/column k of the inverse of the DC model admittance matrix

$$\frac{\partial f}{\partial P_{Lk}}(losses) = \frac{\partial f}{\partial Loss}.\frac{\partial Loss}{\partial P_{Lk}} \quad (9)$$

$$\frac{\partial Loss}{\partial P_{Lk}} = \sum_{\text{all branches}} \frac{\partial Loss_{ij}}{\partial P_{Lk}} \quad (10)$$

$$\frac{\partial Loss_{ij}}{\partial P_{Lk}} = 2.g_{ij}.\sin\theta_{ij}.(-Z_{ik} + Z_{jk}) \quad (11)$$

In third term in (8) $P_{b,mn}$ is the power flow in branch b having extreme nodes m and n and P_{Lik} is the load in node k for scenario i. This term measures the variation of the cost function if a branch flow constraint is active. In this case, the dual variable of constraint (6), η_b, is non-zero. It should be noted that, differently from constraints (3), an increase of 1 unit in the load in node k is not directly reflected on a change on the right term of branch flow constraints. In fact, the load in node k is multiplied by the symmetric of the sensitivity of the flow in branch mn regarding the load in node k. In (8) the derivative of $P_{b,mn}$ regarding P_{Lik} corresponds to the symmetric of this sensibility coefficient.

Finally, the fourth term corresponds to the dual variables of constraint (5). These dual variables will only be non-zero if a new load unit in node k directly increases PNS.

IV. Computation of the Congestion Rent for the Portuguese Transmission Grid

A. *General assumptions*

When computing the nodal prices, special concern was given to the generation profile due to the hydro thermal mix of the Portuguese system. In fact the computer program was not prepared to perform water management as it is done in real life operation. Since we had no indications regarding the value of using the water to include in the objective function (2) for hydro stations, we decided to include narrow generation ranges for hydro units in order to obtain results of the optimization DC OPF runs that are coherent with the data available in the generation/load scenarios used to discretize an year of operation. These scenarios include wet and dry values for several seasons along the year and values for peak, high load and valley hours and are publicly available in [7, 8, 9]. The values obtained for these scenarios were then weighted considering the duration of peak, full and valley periods and by the probabilities of wet and dry seasons.

The model described in Section III to compute the nodal marginal prices has a major drawback, as it requires selecting a reference node to invert the DC model admittance matrix. When considering the compensation of marginal losses, this node also becomes the slack node turning the computed prices dependent on the selected reference + slack node. In order to overcome this drawback, and for each scenario, we identified the marginal bus by increasing the load in several buses by 1 MW and checking the generator that supplies this increase. Once this generator is identified, the corresponding bus is selected for reference+slack.

B. Analysed scenarios

Each year, the transmission company publishes a document characterizing the operation conditions of the generation and transmission system in the previous year. For 1998, this document included 6 generation/load scenarios [5]. We prepared 9 other scenarios so that the resulting 15 analysed scenarios can be grouped as follows:

- Peak scenarios under Dry or Wet conditions in Winter, Spring/Autumn or Summer (PWW, PDW, PW(SpA), PD(SpA) and PDSu);
- Full hour scenarios under Dry or Wet conditions in Winter, Spring/Autumn or Summer (FWW, FDW, FW(SpA), FD(SpA) and FDSu);
- Valley hour scenarios under Dry or Wet conditions in Winter, Spring/Autumn or Summer (VWW, VDW, VW(SpA), VD(SpA) and VDSu).

For 2001, the document [6] details 8 scenarios for peak and valley Summer, Autumn, Winter and Spring conditions. In this case, we prepared 5 other scenarios basically related with wet conditions and full hours. As a result we analysed the following 13 scenarios:

- Peak Wet Winter and Peak Dry Winter, Peak Spring and Autumn Wet+Dry scenarios and Peak Dry Summer (PWW, PDW, P(WD)Sp, P(WD)A and PDSu);
- Full Wet Winter and Dry Winter scenarios and Full Dry Summer (FWW, FDW and FDSu);
- Valley Wet Winter, Peak Dry Winter, Peak Spring and Autumn Wet+Dry scenarios and Peak Dry Summer (VWW, VDW, V(WD)Sp, V(WD)A and VDSu).

Finally, for 2004 the document [7] details 8 typical operation scenarios of the generation/transmission system. It is important to mention that 2004 was an extremely dry year which explains that all these scenarios reflect dry conditions. Apart from these 8 peak and valley hour scenarios we built 4 other intermediate scenarios associated to full hours. As a result, the 12 analysed scenarios for 2004 were as follows:

- Spring, Summer Autumn and Winter Peak Dry scenarios (PDSp, PDSu, PDA and PDW);
- Spring, Summer Autumn and Winter Full Dry scenarios (FDSp, FDSu, FDA and FDW);
- Spring, Summer Autumn and Winter Valley Dry scenarios (VDSp, VDSu, VDA and VDW);

For each of these scenarios the Portuguese Tariff Code specifies the number of peak, full and valley hours enabling the calculation of the duration d_i used in expression (1).

C. Short term nodal marginal prices

Once these scenarios were defined, we computed the nodal marginal prices in the nodes of the 400kV/220kV/150kV network system for each scenario. In Fig. 1 we display the simplified transmission network with the nodal prices obtained for some nodes in scenario PDS, Peak Dry Summer of 1998. One can notice that prices are higher in some nodes in the eastern central area mainly due to congestion problems. The southern area corresponds to a number of 150 kV lines poorly meshed. In terms of marginal prices, this leads to a steady increase of nodal prices as one gets away of generation areas and goes deeper into load areas.

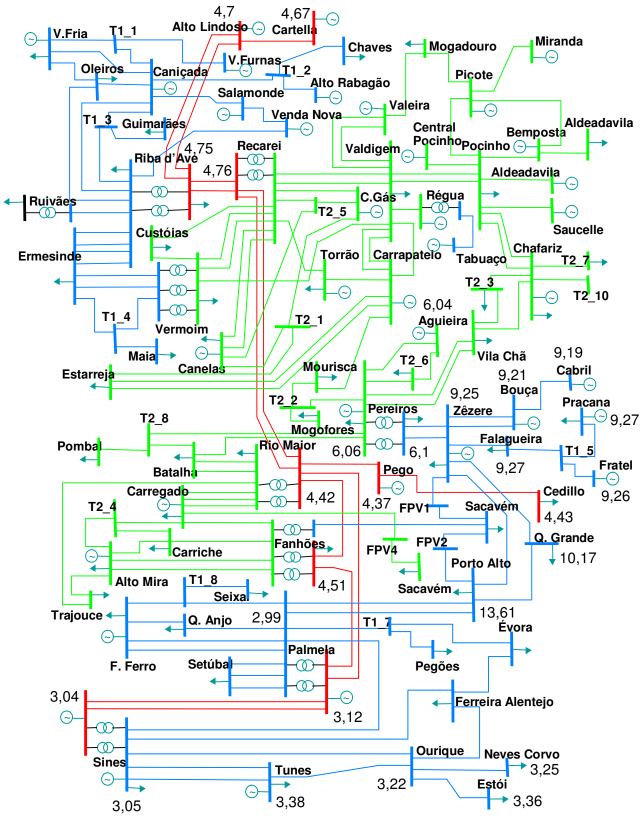

Fig. 1. Portuguese 400/220/150kV system with prices in some nodes for the PDS scenario of 1998 (in €/kWh).

Table I
NODAL MARGINAL PRICES FOR SOME SCENARIOS IN SOME NODES OF THE TRANSMISSION SYSTEM (in c€/kWh)

	PDSp	PDSu	PDA	PDW
Alto Lindoso	2,46	3,63	2,64	3,69
Aguieira	2,54	3,77	2,77	3,78
Alqueva	2,54	3,67	2,68	3,58
Alto de Mira (400 kV)	2,58	3,76	2,74	3,71
Alto de Mira (220 kV)	2,63	3,82	2,80	3,75
Alto Rabagão	2,45	3,62	2,58	3,67
Batalha	2,61	3,81	2,80	3,77
Bemposta	2,36	3,64	2,53	3,66
Bouça	2,60	3,57	2,71	3,70
C. Gás	2,43	3,62	2,60	3,70
C. Pego	2,50	3,70	2,68	3,65
C. Pocinho	2,42	3,68	2,58	3,72
Cabril	2,60	3,54	2,69	3,68
Canelas	2,44	3,64	2,61	3,72
Caniçada	2,48	3,62	2,60	3,68
Carrapatelo	2,43	3,69	2,57	3,72
Carregado	2,60	3,78	2,77	3,72

Table I details the nodal marginal prices in c€/kWh obtained for the peak scenarios in 2004 for some nodes of the Portuguese transmission system.

D. *Marginal based remunerations*

Using the nodal short-term marginal prices computed for 1998, 2001 and 2004 for each of the scenarios just mentioned, we computed the Marginal Based Remuneration using expression (1). For each of these scenarios, Tables II, III and IV indicate the hourly remuneration (€/h), the duration of the scenario (h) and the marginal remuneration (€). These Tables also indicate the total remuneration resulting from the addition of the remuneration of each scenario, the regulated remuneration of the transmission activity set by the Portuguese Regulatory Board and the percentage of recovery of the regulated remuneration by the marginal one.

Table II
MARGINAL BASED REMUNERATION FOR 1998

	Results for the scenarios of 1998		
	Per hour remuneration (€/h)	Duration (h)	Remuneration (€)
PWW	2.776,41	162,95	452.415,6
PDW	1.903,74	162,95	310.215,0
PW(SpA)	989,85	260,71	258.063,4
PD(SpA)	1.205,32	260,71	314.241,4
PDSu	18.120,02	195,54	3.543.189,4
FWW	1.422,74	436,70	621.312,1
FDW	1.875,75	436,70	811.280,4
FW(SpA)	887,55	938,57	833.023,3
FD(SpA)	971,21	938,57	911.551,8
FDSu	1.564,02	1.003,75	1.569.887,1
VWW	795,18	495,36	393.901,3
VDW	949,79	495,36	470.492,2
VW(SpA)	440,13	990,71	436.045,8
VD(SpA)	586,53	990,71	581.079,6
VDSu	517,66	990,71	512.855,2
	total	8.760,00	**12.019.553,50**
		Regulated Remuneration (€)	**131.361.240, 00**
		% of recovery	**9,15**

Table III
MARGINAL BASED REMUNERATION FOR 2001

	Results for the scenarios of 2001		
	Per hour remuneration (€/h)	Duration (h)	Remuneration (€)
PWW	4.850,40	162,95	790.373,3
PDW	4.363,45	162,95	711.024,9
P(WD)Sp	3.223,98	762,59	2.458.579,9
P(WD)A	3.305,00	697,39	2.304.874,1
PDSu	3.383,49	195,54	661.608,1
FWW	3.230,79	436,70	1.410.890,1
FDW	3.683,29	436,70	1.608.494,9
FDSu	3.108,35	1.003,75	3.120.011,4
VWW	2.824,96	495,36	1.399.372,9
VDW	2.470,90	495,36	1.223.985,1
V(WD)Sp	1.562,75	1.427,41	2.230.690,5
V(WD)A	3.646,48	1.492,59	5.442.711,1
VDSu	2.331,72	990,71	2.310.063,0
	Total	8.760,00	**25.672.679,3**
		Regulated Remuneration (€)	**118.360.000,0**
		% of recovery	**21,70**

Table IV
MARGINAL BASED REMUNERATION FOR 2004

	Results for the scenarios of 2004		
	Per hour remuneration (€/h)	Duration (h)	Remuneration (€)
PDSp	2.094,86	365,0	764.622,8
PDSu	2.993,68	365,0	1.092.694,2
PDA	2.895,40	365,0	1.056.821,0
PDW	6.726,39	365,0	2.455.134,1
FDSp	1.238,20	912,5	1.129.857,5
FDSu	1.829,70	912,5	1.669.601,3
FDA	1.463,90	912,5	1.335.808,8
FDW	1.417,065	912,5	1.293.012,5
VDSp	1.084,665	912,5	989.742,1
VDSu	1.151,20	912,5	1.050.470,0
VDA	722,90	912,5	659.650,0
VDW	634,89	912,5	579.381,7
	Total	8760,00	**14.076.796,0**
		Regulated Remuneration (€)	**137.700.000,0**
		% of recovery	**10,22**

E. *Comments*

The results obtained for 1998, 2001 and 2004 as well as their evolution, deserve the following comments:

- the regulated remuneration was set at 131,3 M€ for 1998, 118,3 M€ for 2001 and 137,7 M€ for 2004. This indicates a reduction of 10% between 1998 and 2001, meaning that the transmission company was induced to improve its economic efficiency or reduced its investment level and so its costs. From 2001 to 2004 the regulated remuneration increased by 16% namely due to the implementation of an expansion and reinforcement program leading to the increase of the investment costs;
- the marginal based remuneration was very reduced in 1998, only 9,15% of the regulated remuneration of that year. This means that in 1998 the nodal prices were very homogeneous in all scenarios, except in the PDS scenario – Peak Dry Summer, that was responsible for almost one third of that yearly amount. This also indicated that if a marginal based tariff existed, it would be necessary another tariff term to allow revenue reconciliation, in this case, to recover 90,85% of the regulated remuneration of the Portuguese transmission company. The reduced recovery percentage that would eventually be obtained using the marginal term is explained considering that these prices are short term ones, meaning that they do not reflect investment costs;
- this amount more than doubled when passing from 1998 to 2001. This means that the operation conditions of the transmission grid got degraded in terms of losses and congestion leading to nodal prices more different from node to node. This degradation may be due to a reduction of investments in this period while the demand increased;
- the result obtained for 2004 indicates that the percentage of recovery of the regulated remuneration by the marginal one reduced to about 10,2 %. This means that the operation conditions of the transmission

network improved, that is, the level of congestion and the level of losses got reduced. As a result, the nodal marginal prices are once again very homogeneous inside each scenario so that the hourly remunerations got reduced;

- this remark is in line with the fact that the regulated remuneration set by the Regulatory Board increased by 16% from 2001 to 2004 due to the development of an expansion and reinforcement plan than, apparently, succeeded in reducing or eliminating the bottlenecks that originated the degradation of the results obtained for 2001;
- finally, it is important to notice that 2004 was a very dry year. As a result, the share of hydro stations in the supply of electricity was very reduced which means that even in the winter the share of thermal stations was largely dominant. Due to these particular conditions, the largest hourly marginal remuneration was obtained for the Peak Dry Winter, PDW, scenario as indicated in Table IV. This result is very different from the one obtained for 1998 in which the Peak Dry Summer, PDS, scenario had the largest hourly contribution. As mentioned, the larger use of thermal stations even in the winter together with the peak power occurring in the winter, lead to a larger geographic discrimination of nodal prices in the PDW scenario in 2004. This originated a larger hourly remuneration in this scenario.

V. Conclusions

According to the model used and the assumptions that were briefly described above, the Marginal Based Remuneration was estimated to correspond to 9.15% of global yearly remuneration that would be obtained in 1998 with the application of the tariffs currently in force to remunerate the Use of Transmission Networks.

This percentage increased to above 20% in 2001 indicating a large congestion level of the transmission network and got reduced back to 10% in 2004. This evolution indicates that from 1998 to 2001 the operation conditions of the network got degraded namely due to a reduce investment level.

Meanwhile, in 2001 the transmission company submitted its first 5 year investment plan to the Regulatory Agency. This plan started to be implemented in 2002 and as a result the level of losses and the congestion level got reduced so that the referred percentage reduced rapidly. This percentage is therefore a good indicator of the quality of the transmission network and it is our objective to update this study regularly in to monitor the yearly operation conditions of the transmission network.

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