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STRANDED COSTS IN THE ELECTRICITY SECTOR

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Stranded Costs in the Electricity Sector*

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Abstract

This paper discusses the stranded cost concept. Stranded costs have to do with the transition from a regulated to a more competitive market. The aim of the paper is threefold. First, the paper discusses the place of the stranded cost concept in the variety of costs concepts encountered in the economic literature. In order to come to a proper description of stranded costs, we first define a new concept, i.e. strandable costs. These are the fixed or sunk costs to be paid by the incumbents that have been imposed by the regulator. Strandable costs become stranded when they cannot be recovered through the market after the introduction of competition. Second, we argue on the basis of a simple graphical analysis that from the point of view of economic efficiency, there is no need to allow for stranded cost recovery. Third, this view is illustrated with some numerical simulations, based on the Belgian electricity sector. These simulations suggest that, according to the assumptions and to the definition of stranded costs in our model, there will be no stranded costs for the Belgian electricity producers. A fortiori , the conclusion is that there is no need to allow for stranded cost recovery. However, the simulations go one step further and assume that for one reason or another strandable cost recovery is allowed through a tax on electricity transmission.

Keywords: Stranded Costs, Economic Efficiency, Electricity

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1. INTRODUCTION

The stranded costs have to do with the transition from a regulated to a competitive electricity market. In the United States this reform started a few years earlier than in Europe, and as such the stranded costs problem has already been the subject of a discussion between the different actors and participants in the game. This discussion focused on several questions, such as what is the exact definition of stranded costs? Should the industry be able to recover them? If so, who should pay for them? And how should they be recovered? Obviously, the discussion in the European countries will concentrate on the same kind of questions and it is the purpose of this paper to provide the policymakers with some conceptual background. The next section presents a definition of the stranded cost concept. The third section discusses the recovery issue from the point of view of efficiency. Section four presents some simulation results for the Belgian electricity sector and, finally, section five concludes.

2. A DEFINITION OF STRANDED COSTS

Electricity generating firms make different expenditures that are considered sunk or fixed. It would be wrong to label all of them as stranded when the electricity market is opened up, because some of those costs would also have been made in a competitive market. However, some fixed or sunk costs are typical for a firm operating in a regulated market. Because they were imposed by the regulator, or because the firm chose to make these costs. Concerning the first category, the fixed or sunk costs imposed by the regulator, one could argue that it should be allowed to the firm to recoup these costs, whatever the market structure is. We will call them *strandable costs*. However, it is difficult to defend this position for the latter category of fixed costs.

This is summarised in Table 1. Two categories of fixed or sunk costs are distinguished, those imposed by the regulator and those resulting from decisions taken by the firm itself. In this paper, the costs in the first category are called *strandable,* those in the second category are *not strandable*. If stranded costs are present, then they should be in the strandable category, the non strandable costs cannot become stranded. But not all strandable costs are necessarily stranded, since some of these costs can be (partially) recovered via the market. Only those strandable costs that *cannot* be recovered via the market are stranded. In the table the shaded cells indicate the stranded costs. We will further elaborate on these concepts and their interconnection in the next section.

Summarising, strandable costs are defined as *those fixed and sunk costs that were imposed by the regulator in the regulated market.* Stranded costs are then defined as *strandable costs that cannot be recovered via the market if the market is opened up for competition.* Comparing this latter definition with other ones in the literature learns that it closely resembles the one given by Baumol, Joskow and Kahn[1]. However, our definition puts more emphasis on the role of the regulator or the supervising authority. We stress that the regulator should *impose* the expenditures, whereas Baumol *et. al.* include expenditures *approved* by the regulator. Clearly, the latter is a much broader definition of

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1 Taken from Doane and Williams (1995), p. 42.

stranded costs because it implicitly opens the door for *all* sunk costs made by the regulated firm to become stranded.

		SUNK COSTS IMPOSED BY THE REGULATOR?	
		Yes ↓ ***Strandable***	***No*** ↓ ***Not strandable***
RECOVERABLE VIA THE MARKET?	***Full recovery***	Not stranded	Not stranded
	Partial recovery	Non-recoverable part is stranded	Not stranded
	No recovery	Stranded	Not stranded

Table 1 : The definition of strandable and stranded costs.

However, for the purpose of this paper, the exact definition of the stranded cost concept is not that important. The major purpose of the chapter is to illustrate – given the presence of strandable costs – how one should think about the subject from an economic efficiency point of view.

3. THE ECONOMICS OF STRANDED COSTS :A GRAPHICAL ANALYSIS

This section takes a look at the link between strandable costs, stranded costs and other cost concepts. Furthermore, it tackles questions such as when do stranded costs exist? If stranded costs exist, are there economic reasons to allow for stranded cost recoupment? Can, on a theoretical basis, anything be said about the size of the stranded costs? These question are answered by using graphical tools and the analysis is kept as simple as possible[2].

3.1. The regulated market

Assume that the total demand for electricity is perfectly inelastic and equals q_D. Initially, there is only one electricity-generating firm. This firm is called the incumbent and its cost structure is shown in Figure 1. It is assumed that the average cost of electricity *generation* (AC_I) decreases for some smaller levels of output, but in the range we are considering the average cost of electricity generation is increasing. The incumbent's marginal cost of electricity generation is assumed to increase linearly[3]. The average variable cost is labelled AVC_I. The vertical distance between AC_I and AVC_I is then a measure of the average

[2] More particularly, we focus on a market with one homogenous commodity. This can be electricity delivered at a constant flow over the year with a given level of quality. Using a multiproduct approach for electricity (peak, off peak, etc.) is more realistic but will obscure the stranded cost analysis in this section. The simulation model presented in the next section does however consider different consumer types and also extends the analysis in several other ways.

[3] The linearity of MC_I (and thus also AVC_I) is assumed for the sake of simplicity. Unless it is mentioned explicitly, this does not influence the main conclusion of the analysis.

fixed generation cost AFC_I (not in Figure 1). The present analysis only considers the cost of electricity generation.

We assume that it is compulsory in the regulated market to meet the market demand and that the regulator sets the price for electricity generation such that economic profit equals zero, i.e. $p^R = AC_I(q_D)$. The latter assumption is made for illustrative purposes, and has no effect on the conclusions of the analysis.

3.2. The liberalised market

Now assume that the market for electricity generation is opened up for competition and that the market demand for electricity remains equal to q_D[4]. Furthermore, assume that several potential entrants are competing for a market share and that each of these entrants has sufficient capacity to supply the market at a constant marginal cost (MC_E). This assumption may be a good approximation for what will happen on the Belgian electricity market. Belgium is a small open economy, with a relatively small production capacity compared to the available capacity in the surrounding countries.

Competition between entrants ensures that the entrant's price equals his marginal cost. Furthermore, we assume that if the incumbent increases his price above the entrant's marginal cost, then he would immediately be pushed out of the market.

In Figure 1, the market demand for electricity q_D is supplied by two generation firms, the incumbent (*I*) and the entrant (*E*). The vertical axis on the left-hand side is the incumbent's axis, the entrant's axis is at the right-hand side.

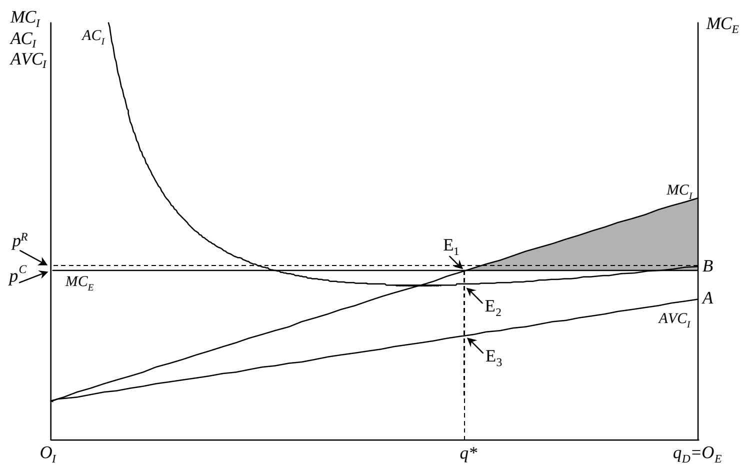

Figure 1 : The competitive market.

4 It is assumed that one entrant enters the domestic market. The results would not change if more than one competitor would enter. The assumption of perfectly inelastic demand for electricity is acceptable in the short run and helps the exposition. We will relax this assumption in section 4.

The competitive outcome

Under the assumptions listed above, the competitive market outcome will always be such that $p = MC_I = MC_E$, which is generally accepted as optimal from an efficiency point of view. In Figure 1, the incumbent's output would reduce to $q*$, whereas the entrant's output would be $(q_D - q*)$. The implied price of electricity generation decreases ($p^C < p^R$), but this is not a general result. In fact the market price is determined by the marginal cost of the entrant.

Economic welfare

It can be shown that in this simple model social welfare increases as the market is liberalised. Furthermore, it can also be shown that the change in social welfare is equal to the efficiency gain that is made through improved production efficiency. The shaded area in Figure 1 is a measure of this 'benefit'.

3.3. The stranded costs

In order to show the stranded costs in a figure, we need to take a closer look at the fixed costs. From section 2, it is clear that only those fixed or sunk costs imposed by the regulator are candidates to become stranded, i.e. are *strandable.* In order to make this distinction, the fixed costs are divided in *strandable* and *non-strandable* fixed costs (F_S and F_{NS}). This results in the $AF_{NS}C_I$-curve in Figure 2, which represents the average non-strandable fixed costs. The next two subsections consider two cases.

3.3.1. The market price covers the average costs

In Figure 2, both the strandable and the non-strandable fixed costs are covered by the market price. The domestic firm produces $q*$ and makes an economic profit equal to the area $p^C E_1 E_2 D$. As was said before, from an efficiency point of view this market outcome is optimal. There is no reason why the government or any other regulator should intervene by allowing the recovery of strandable costs since the market automatically arrives in a Pareto-optimal situation. In fact, *there are no stranded costs in this case*.

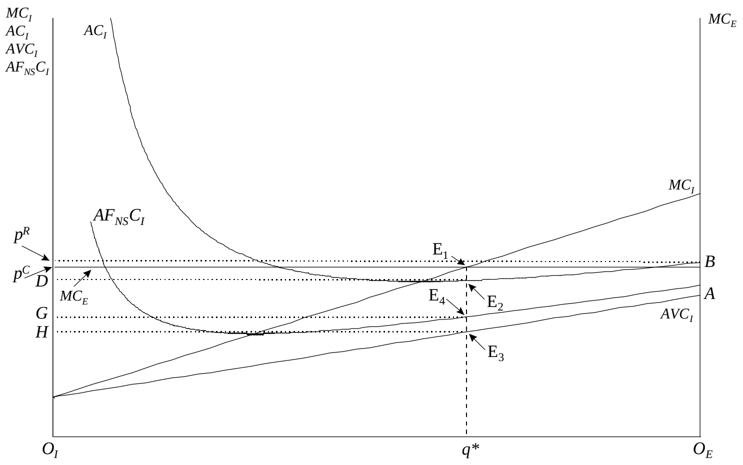

Figure 2 : The competitive price is higher than the average cost of the incumbent.

3.3.2. The market price does not cover the average costs but does cover average variable costs

In this case, the market outcome could be as shown in Figure 3. Standard economic theory then suggests that in the short run the firm will stay in the market since stopping activity will only imply an even larger loss. The point E_1 indicates the short run price-output combination for the incumbent firm. This point implies a loss per unit of output equal to E_2E_1 and a total loss equal to the rectangle $DE_2E_1p^C$. The stranded costs in this case are equal to that part of the strandable costs that is not recovered via the market, which also equals $DE_2E_1p^C$.

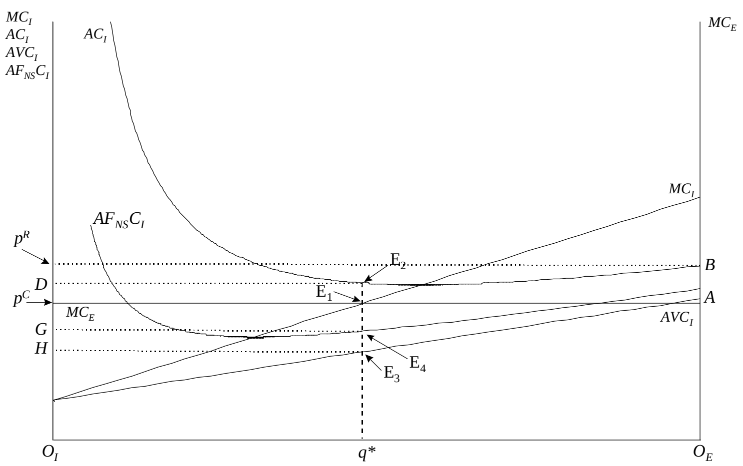

Figure 3 : The competitive price is lower than the average cost of the incumbent.

Again, *from the point of view of efficiency* there is no case for allowing stranded cost recovery[5]. The incumbent incurs a loss due to the presence of strandable costs, but this does not influence his output decision. The Pareto-efficient output will still be the outcome.

One could also turn around the question: is there a case for *not* allowing stranded cost recovery? No, there is neither. If the incumbent is allowed to recover stranded costs and if the recovery is organised in a competitively neutral way, then the firm will choose the same Pareto-efficient output. The difference between both cases is that the burden of stranded costs is (partially) shifted from the firm to the customers and/or the government.

Standard economic theory also suggests that a firm, not able to cover its fixed costs in the short run, will leave the market in the long run. This is true, but in the present model, the situation might be slightly different because *strandable costs are a short run phenomenon*. In the long run, the owners of the firm will absorb the strandable costs, and the firm will only reoptimise its *non*-strandable fixed costs. If it is possible for the firm to cover its long run average costs (now not containing any strandable costs anymore) with the market price, then it will stay in the market. If on the other hand, the firm is not able to cover its long run average costs through the market price, then it will leave the market. From an efficiency point of view, this would even be optimal.

This reasoning puts an upper limit on the financial support for stranded cost recovery. The support may *not be larger* than the amount of the *strandable costs*. If the regulator sets the compensation at a level that covers more than the strandable costs, then he is subsidising some of the non-strandable fixed costs of the incumbent, which may create the wrong incentives for the incumbent. The incumbent may decide to stay in the market, whereas we know that this is not optimal from the point of view of efficiency.

4. SOME SIMULATION RESULTS

This section presents some numerical simulations. The basic features of the graphical model remain present in the numerical model, but the latter also includes some realistic extensions and is calibrated on the Belgian electricity sector in 1996. Even then, the model is kept as simple as possible and focuses only on the most relevant aspects of the stranded cost discussion.

4.1. A Brief Description of the Model

The *demand* for electricity is modelled in a very simple and global way. It is assumed that the yearly demand for GWh depends on the price per GWh in a linear way. Two consumer types are distinguished: small (residential) consumers (including SME) and large (industrial) consumers. No other possible market segmentations are distinguished.

The liberalisation of the electricity market is assumed to have no effect on the demand in the residential market (since competition is not allowed in that market), but it does have an effect on the demand in the industrial market as it is faced by the domestic producer of

[5] Note that in the stranded cost debate, many other economic and non-economic arguments are raised both in favour of and against stranded cost recovery. See for example, Boyd (1998), Baumol and Sidak (1995) and Rose (1996).

electricity. Technically speaking, the residual demand on that market becomes more elastic.

Before the liberalisation, electricity *supply* is provided by one domestic firm. After the liberalisation, this monopoly situation remains present in the residential market, but competition is introduced in the industrial market. Competition comes from foreign producers, as described in section II. In the base case, the domestic firm has no market power, i.e. residual demand if perfectly elastic.

It is assumed that the domestic firm behaves in a profit maximising way. The entrant's output equals the difference between the *market* demand at that price and the quantity sold by the incumbent. The cost structure of the electricity-generating firm is as described in section II. The model also takes into account transmission and distribution losses.

The model is calibrated for the Belgian electricity market in 1996. The data are taken from the annual report of the CCEG (Controlecomité voor de Elektriciteit en het Gas (1998)).

4.2. The base case Simulations

Table 3 (see Appendix) presents the results of 3 simulation exercises. Simulation 1 describes the regulated electricity sector in 1996, simulation 2 simulates the liberalisation of the electricity market for industrial consumers without stranded cost recovery and, finally, simulation 3 simulates a scenario for stranded cost recovery via a fee on transmission. The discussion in this section concentrates on the changes in the surpluses of the consumers, producers, the government and overall welfare. The results are presented in Table 2.

Simulation 1: Before the liberalisation

The average consumer price in the residential sector equals 4,920 BEF per kWh. In the industrial sector the consumer price equals 1,706 BEF per kWh (see Table 3 in the appendix). Both (maximum)prices are imposed by the regulator[6]. At that price, the residential and the industrial sector consume 43.807,0 GWh and 25.180,0 GWh, respectively. The incumbent's net profit from generation and transmission activities equals 24.290,4 Mln BEF. The net profit from participation in intercommunalities equals 5.447,2 Mln BEF.

[6] This is a simplification. The regulator only fixes maximum prices.

Base Case (ef = $-\infty$ and mcf =1,500)		
Change in	**2**	**3**
Consumer surplus	256	-4.850
Res	*0*	*0*
Ind	*256*	*-4.850*
Producer surplus	-176	4.403
Government surplus	-67	-55
Total change	**13**	**-502**
ef = $-\infty$ and mcf =1,200		
Change in	**2**	**3**
Consumer surplus	9.712	4.100
Res	*0*	*0*
Ind	*9.712*	*4.100*
Producer surplus	-3.371	1.468
Government surplus	-1.285	-1.073
Total change	**5.056**	**4.494**
ef =-2,100 and mcf =1,500		
Change in	**2**	**3**
Consumer surplus	-4.131	-8.412
Res	*0*	*0*
Ind	*-4.131*	*-8.412*
Producer surplus	2.712	6.601
Government surplus	1.034	783
Total change	**-386**	**-1.029**

Table 2 : Changes relative to the regulated market outcome (in Mln BEF).

Simulation 2: The opening of the market for the industrial sector (no strandable cost recovery)

Table 2 shows that under the base case assumptions the market liberalisation results in a *small welfare gain* for the *industrial consumers* (256 Mln BEF). This result depends on two critical parameters: the price of foreign electricity (1,500 BEF per kWh) and the price elasticity of the residual demand for electricity ($-\infty$). Both parameters will be the subject of a sensitivity analysis.

The *domestic producer's profit decreases* with 176 Mln BEF but remains positive. Thus, under the assumptions used in this simulation, there are no stranded costs. There is also a small decrease in the *government surplus* of about 67 Mln BEF because of the decreased corporate profit tax receipts. Overall, social welfare increase with about 13 Mln BEF per year. In general, the effects are rather small. This is has to do with the base case assumptions as will become clear in the sensitivity analysis.

Simulation 3 : Strandable cost recovery through an access fee for all producers

Assume that one decides ex ante that a strandable cost recovery is allowed for a total amount of 15 billion BEF per year. From simulation 2 it is clear that this is not really needed as profits remain positive. A fee for access to the transmission grid is used as the instrument for recovery[7].

Social welfare decreases by 502 Mln BEF. The *main losers* are the *industrial consumers*. Two effects explain this result. First, the producers shift to the transmission fee to the customers, which increases the consumer price for electricity. Second, as a consequence of the increased consumer price, less electricity is consumed. Because of the price ceiling, the incumbent cannot use his market power in the residential market. As a result, in the residential market the full burden of the transmission fee is carried by the producer (the producer price decreases). The *producer's overall profit increases*, but with less than 15 Bln BEF.

4.3. Sensitivity Analysis

The full simulation results are available in the Appendix. We primarily concentrate on simulation 2, because it appears that the major impact of the parameter changes considered in this section is on the effect of the liberalisation.

Sensitivity analysis suggests that *the elasticity parameter* has a relatively small impact on the *overall* welfare (Table 4). However, it does have a significant effect on the *distribution of the benefits and losses* from the market liberalisation. The more elastic the residual demand the more the benefits go to the industrial consumers. The less elastic, the more the benefits are taken by the producer, because inelastic demand allows the producer to take advantage of his market power. Once the liberalisation has taken place, the effects of strandable cost recovery on the distribution of the welfare gains are comparable to the effects in the base case simulations.

Table 5 contains the results of a sensitivity analysis on the *entrant's marginal cost* of electricity generation. Compared to Table 3, the results in this table are based on a marginal cost of electricity generation for the entrant equal to 1,200 BEF per kWh. Intuitively, a lower price of foreign electricity leads to increased social benefits from liberalisation. At the same time, the domestic producer will lose some of his profits. The industrial consumers reap the benefits. With this assumption, there is a large shift in the market share in the industrial market.

5. SUMMARY AND CONCLUSIONS

This paper studies the stranded costs problem for the electricity sector. Stranded costs have to do with the transition from a regulated to a more competitive market. A distinction is made between strandable costs and stranded costs. Strandable costs are fixed or sunk costs imposed by the regulator. Strandable costs become stranded when they cannot be recovered via the market when the market is opened up for competition. When one is

[7] Many other instruments are available to organise the stranded cost recovery. See Baxter *et al.* (1997) for a survey and discussion.

concerned about economic efficiency, allowing for stranded costs recovery is not necessary. On the other hand, allowing for recovery would not hurt either, but if financial support for stranded cost recovery is given, then it should be organised in a competitively neutral way. Moreover, there is an upper limit to the size of the support, i.e. it may not be larger than the strandable costs. Of course, if there is no recovery of stranded costs, then the firm will make a loss on the home market but this does not result in inefficiencies.

A simple economic model was used to test what could be the welfare effects of a transmission fee to recover stranded costs. The effect on welfare of opening the electricity market for the big industrial consumers depends on the supply price of the foreign producers and on the ease with which the big consumers switch to another supplier. When the supply price of the foreign producer is only slightly lower than the marginal cost of the home producer, opening the market could give welfare gains and higher profits for the home firm. The welfare gains come from imports at lower costs than the indigenous production. Despite the loss of market share for the home producer, his gross profits are not affected much because of two reasons. First the protected market is responsible for the major share of the gross profits. Secondly, the home producer might be able to charge higher prices at home for the market share he keeps at home. In the sensitivity studies, the opening of the market does not lead to negative profits and therefore the strandable cost would never become stranded.

Although the probability of stranded costs is rather low, one could imagine several types of ex ante allowances to recover strandable costs. A transmission fee would generate a welfare loss compared to the non-recovery case. This means that increasing the profits of the home firm by making the small or large consumers pay more will generate a net loss for the society as a whole.

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APPENDIX

Full simulation results

Variable	*Sector*	*Unit*	*1*	*2*	*3*
Consumer price	res	*BEF/kWh*	4,920	4,920	4,920
Consumer price	ind	*BEF/kWh*	1,706	1,696	1,906
Producer price	res	*BEF/kWh*	4,066	4,066	3,892
Producer price	ind	*BEF/kWh*	1,706	1,696	1,696
Marginal cost of electricity generation		*BEF/kWh*	1,550	1,556	1,529
Marginal cost of electricity (generation → transmission)	ind	*BEF/kWh*	1,690	1,696	1,879
Transmission fee		*BEF/kWh*	0,000	0,000	0,210
Distribution fee		*BEF/kWh*	0,000	0,000	0,000
Demand with domestic producer	res	*GWh*	43.80	43.80	43.80
Demand with domestic producer	ind	*GWh*	25.18	25.55	23.68
Demand with entrant		*GWh*	0,0	302,5	0,0
Firm profit from distribution		*Mln BEF*	5.44	5.44	5.44
Net profit of generation and transmission activities		*Mln BEF*	24.29	24.09	29.18
Profit of the communalities from distribution		*Mln BEF*	17.55	17.55	17.55

Table 3 : Full simulation results (marginal cost of the foreign entrant = 1,500 and elasticity of residual demand = - infinity).

Variable	*Sector*	*Unit*	*1*	*2*	*3*
Consumer price	res	*BEF/kWh*	4,920	4,920	4,920
Consumer price	ind	*BEF/kWh*	1,706	2,027	2,196
Producer price	res	*BEF/kWh*	4,066	4,066	3,892
Producer price	ind	*BEF/kWh*	1,706	2,027	1,986
Marginal cost of electricity (generation → distribution)	res	*BEF/kWh*	1,550	1,403	1,390
Marginal cost of electricity (generation → transmission)	ind	*BEF/kWh*	1,690	1,543	1,740
Transmission fee		*BEF/kWh*	0,000	0,000	0,210
Distribution fee		*BEF/kWh*	0,000	0,000	0,000
Demand with domestic producer	res	*GWh*	43.807	43.807	43.807
Demand with domestic producer	ind	*GWh*	25.180	15.013	14.124
Demand with entrant		*GWh*	0,0	10.846	9.561
Firm profit from distribution		*Mln BEF*	5.447	5.447	5.447
Net profit of generation and transmission activities		*Mln BEF*	24.290	27.303	31.624
Profit of the communalities from distribution		*Mln BEF*	17.552	17.552	17.552

Table 4 : Full simulation results (marginal cost of the foreign entrant = 1,500 and elasticity of residual demand = - 2,100).

Variable	*Sector*	*Unit*	*1*	*2*	*3*
Consumer price	res	*BEF/kWh*	4,920	4,920	4,920
Consumer price	ind	*BEF/kWh*	1,706	1,385	1,586
Producer price	res	*BEF/kWh*	4,066	4,066	3,900
Producer price	ind	*BEF/kWh*	1,706	1,385	1,385
Marginal cost of electricity generation		*BEF/kWh*	1,550	1,245	1,245
Marginal cost of electricity (generation → transmission)	ind	*BEF/kWh*	1,690	1,385	1,586
Transmission fee		*BEF/kWh*	0,000	0,000	0,201
Distribution fee		*BEF/kWh*	0,000	0,000	0,000
Demand with domestic producer	res	*GWh*	43.807	43.807	43.807
Demand with domestic producer	ind	*GWh*	25.180	4.170	4.166
Demand with entrant		*GWh*	0,0	24.783	22.715
Firm profit from distribution		*Mln BEF*	5.447	5.447	5.447
Net profit of generation and transmission activities		*Mln BEF*	24.290	20.549	25.921
Profit of the communalities from distribution		*Mln BEF*	17.552	17.552	17.552

Table 5 : Full simulation results (marginal cost of the foreign entrant = 1,200 and elasticity of residual demand = - infinity).

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