# High-Tension Electricity Network Expansions in Argentina: Decision Mechanisms and Willigness-to-Pay Revelation

**Omar O. Chisari, Pedro Dal-Bó y Carlos A. Romero**

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**Abstract**

This paper describes the procedures established by the present regulation for high-tension network expansions, studies its optimality and points its main problems. According to the present regulatory scheme, the decision to expand the high-tension network system is on the hands of the private sector. A simple model of the Argentine electricity system and its regulation allowed the simulation of cases in which the present "Public Contest" method could result in the rejection of socially desirable projects and the acceptance of undesirable ones. Some of the reasons for the existence of wrong incentives to investment are found and changes to the mechanism are suggested.

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# High-Tension Electricity Network Expansions in Argentina: Decision Mechanisms and Willingness-to-Pay Revelation*

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## 1. Introduction

The Argentine electricity market has changed dramatically in the last decade from a highly centralized and government operated one towards a decentralized system with limited government participation. While this change has provided incentives to investments in generating and distributing electricity needed to satisfy the growing demand, and in fact, has reduced electricity prices, this has not been the case for the investments in high-tension transmission[1]. The reasons for this lack of investment in the Argentine high-tension network expansions will be the focus of this paper. The Argentine case, in fact, is not an isolated one and can provide useful lessons for understanding the electricity market and studying electricity regulation in other countries as well.

The fact that generators, distributors, and large users have open access to the Argentine high-tension grid, which makes new lines a public resource, raises the issue of preference revelation problems when deciding on investment projects. The present Argentine regulation tries to mitigate this problem by a voting mechanism called Public Contest, in which distributors, generators and large users participate. In this system votes are distributed among agents based on an estimation of their contingent future use of the line to be built. This is calculated using the so-called method of area of influence[2], a method that may have important effects on the results of the mechanism. In this scheme, if the project is approved, the agents pay a share equal to the share of votes they had. Projects need at least 30% of the votes to pass the Public Contest mechanism but can be vetoed with only 30% of the votes. In several cases this veto power has been used by some members of the market to halt investment projects that are otherwise consider welfare improving by the majority of

* This research was sponsored by the Electricity Regulatory Agency of Argentina in the context of the project "Análisis del concepto de beneficiario y de los incentivos a la inversión en el transporte eléctrico de alta tensión utilizando un modelo simplificado de simulacion", and was carried out under the auspicies of the UADE (Universidad Argentina de la Empresa). A first version of this paper was presented to the seminar on The Economics of Networks, held at the Institute of Industrial Economics, University of Toulouse, October 1998 (A Spanish version was published in "Desarrollo económico. Revista de Ciencias Sociales", IDES Buenos Aires, Argentina).

[1] See, for example, Chisari et al. (1995) and Torres (1995).

[2] This kind of methods are commonly known as MW-mile or Flow-mile Methods, see Shirmohammadi et al. (1991), Kovacs and Leverett (1994) and Marangon Lima et al.(1995).

the companies, analysts and regulatory authorities[3].

Thus the Public Contest mechanism, which is intended to mitigate the revelation problem, actually can produce a situation in which companies that do not profit from the investment project can stop it even when it is socially optimal. By approximating agents' future profits from the investment by a measure of their future use, the Public Contest mechanism may yield the wrong outcome. There are three main reasons for this. First, since consumers are not included in the mechanism, they have no way to reveal their willingness-to-pay for the investment. Second, the approximation of the future use of the line is done in such a way that it leaves important nodes underrepresented, thereby affecting the optimality of the mechanism. Third, the profit agents obtain from a line may not be related to their use, for example, for the generators profits depend also in generation costs.

In the following section we describe the electricity market structure, paying special attention to the main features of transmission regulations and the expansion procedures. In section 3 we exemplify the functioning, and shortcomings, of the Public Contest mechanism thorough the analysis of a simple case. In section 4 we use a model of the national electric system to estimate the effects of transmission investments on production, transmission, prices and profits, which will allow us to evaluate the possible results of the voting procedures and find flaws in the mechanism.

## 2. Market structure and high-tension transmission regulations

The Argentine electricity market has changed dramatically in the last decade from a highly centralized and government operated one towards a decentralized system with limited government participation. Understanding the generation, distribution and transmission stages in which these companies work is a key to analyzing the optimality of the grid's expansion mechanisms.

There exist a large number of generating units, which have allowed the creation of a competitive generation market. Competition at the generation stage combined with the grid's flow restrictions and the high cost of interrupted services has made necessary the creation of institutional coordination mechanisms. Currently, a mixed private-public company, called CAMMESA, is in charge of the dispatch –production decisions- and pricing in the Bulk Electrical Market. The amount of electricity generated by each company is decided based on the revealed marginal costs of generation, the grid's restrictions and the amount of energy demanded. The market price is determined by the price at the reference node or "swing bus", located near Buenos Aires, the main consumption node. The price there is calculated as being the highest marginal cost of generation adjusted by marginal transmission cost in the nodes integrated to the market. A node is integrated to the market if the capacity restrictions of the line connecting it to the market are not binding. If they are binding, the node is not integrated to the market and prices in that node are set regionally as the highest marginal cost in the non-integrated node. As we will see in section 3, it is important to note that the difference between the price paid for energy in the market and the price earned by the generators in a non-integrated node goes to a special account called SALEX to finance future grid expansions.

[3] See ENRE (1994) and (1997).

In terms of distribution, several regional monopolies have been created that are responsible for satisfying regional demands. These companies earn a constant remuneration per Kv and customer served and may face penalties if they fail to provide the electricity demanded.

In high-tension transmission a single company has been created, that can not buy or sell energy or deny access to any agent willing to pay the established non-discriminatory charges. This company is responsible only for the operation and maintenance of the lines and transmission facilities but not for expansion, and so earns a fixed remuneration subject to possible penalties.

Given that the transmission utility company is not obliged to invest to satisfy the growing demand, three mechanisms have been established to decide about expanding the grid. Two of these mechanisms are designed to provide the legal framework for minor and relative size expansions, and are not the subject of this paper. The third one, called Public Contest, is designed to provide large investments needed to satisfy growing demand and will be the subject of this study.

In the Public Contest method, expansions are decided and financed by the parties that the regulation considers to be the users of the grid: generation, distribution companies and large users. To decide on possible expansions, these users must vote. If more than 30% of the votes are cast in favor of the expansion, and there is not a corresponding 30% of the votes against it, the expansion is passed. If votes favor expansion, the regulatory agency calls for a public bidding for the construction, operation and maintenance of the new line. The company receives a fixed annual fee over a fifteen-year period for the construction of the line and earns transmission fees similar to the original high-tension transmission utility company.

These fees are paid by parties that the regulation considers to be users of the new line. Both the proportions of the fees that a company has to pay and the votes it is allocated are calculated using the area of influence mechanism. This mechanism first considers what agents will be users of the future line. Considered as users of the line are all generators (distributors and large users) for which an increase in production (demand) would result in an increase of the flow in the future line. These companies are said to belong to the area of influence of the expansion[4]. Roughly, votes and payments for the first two years are distributed proportionately among the users of the future line depending on the marginal effect that variation in their level of activity would have on the flow of the line in its first two years[5]. The payments for the following years are calculated from updated data.

## 3. Willingness-to-pay Revelation in the Public Contest Mechanism: a simple example

To better understand the main features of the Public Contests mechanism, we analyze its implications for a transmission investment in a simple system. We consider a system with two nodes

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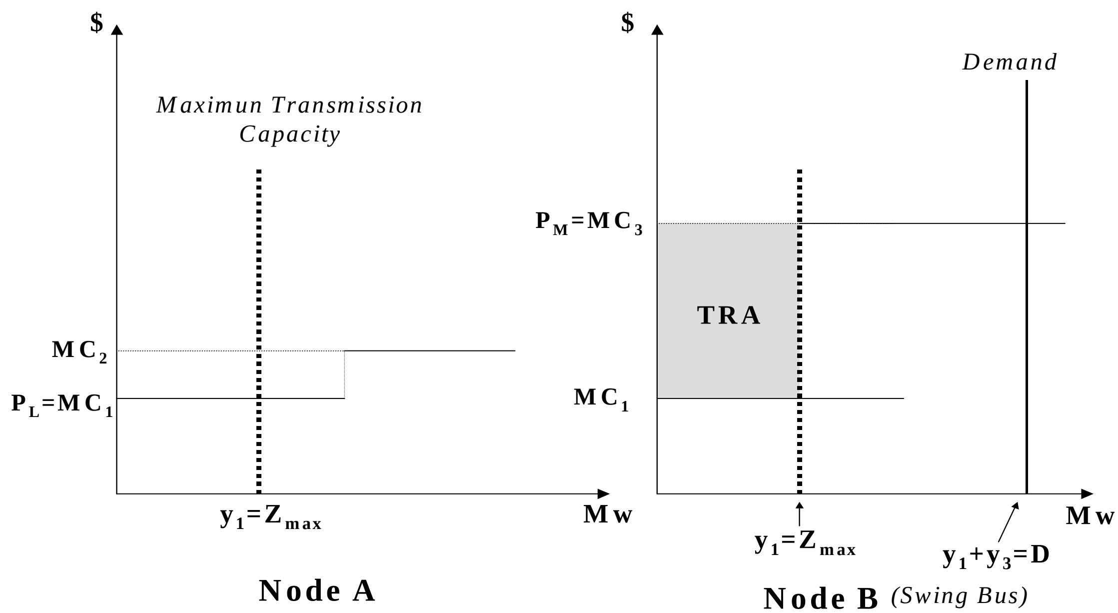
[4] It is important to notice that by Kirchoff's law, the levels of activity in all the activities, but one, are needed to know the level of flow in the lines. The node that is not being considered to calculate the flows is called "swing bus". The companies located in the swing bus have no apparent effect on the flow of the lines. Therefore, they can not be included in the area of influence of any expansion, what would save them of paying the fee but also would exclude them from the decision process. As we will see in the following sections, this has important effects on the results of the mechanism.

[5] For a precise definition of votes and payments see Chisari et al (1996) or ENRE (?).

(n=A,B) connected by one line, see figure 1. The line has a maximum capacity of $Z_{max}$. Two low cost generators are located in node A ($g_A$=1,2) while one high cost generator ($g_B$=3) and the whole demand are located in node B ($D=D_B$), which we will consider our "Swing Bus".

It is easy to calculate the optimal generation levels by generator ($y_i$), line flow (z) and prices (Pn) for different line constraints. First, we study the configuration of the market if the line capacity is inferior to the demand existing in node B; and second, we analyze the effects an expansion of the line would have on production, prices and profits and how the different users would vote under the Public Contest mechanism.

*Figure 1:A two-node System with a restriction in transmission capacity*




If the total demand in node B is greater than the line capacity ($Z_{max} < D$), production at the cheap node will be set at maximum transport capacity ($Z_{max} = y_1$), and the rest of the demand will be covered by generation in the consumption node ($y_3 = D - y_1$)[6]. Because the line is being used at its maximum capacity, node A is an unrelated region and its price is set as a local price ($P_L$) equal to the maximum marginal cost of generation in that region ($P_L = MC_1$). The market price ($P_M$), that is the price at node B, is equal to the maximum cost of generation in that node ($P_M = MC_3$). Since prices in both nodes are equal to marginal costs and these are equal to average cost, by assumption, generators in both nodes will make zero profits. The amount of money that is being paid in node B for the energy imported from A, but not earned by generator 1 is remitted to the SALEX Account because of the existence of two unrelated regions. In this way consumers pay $P_M$ for the energy, while generators in the unrelated region receive only $P_L$, so part of what is paid by consumers does not get

[6] We assume thorough this section the absence of line losses.

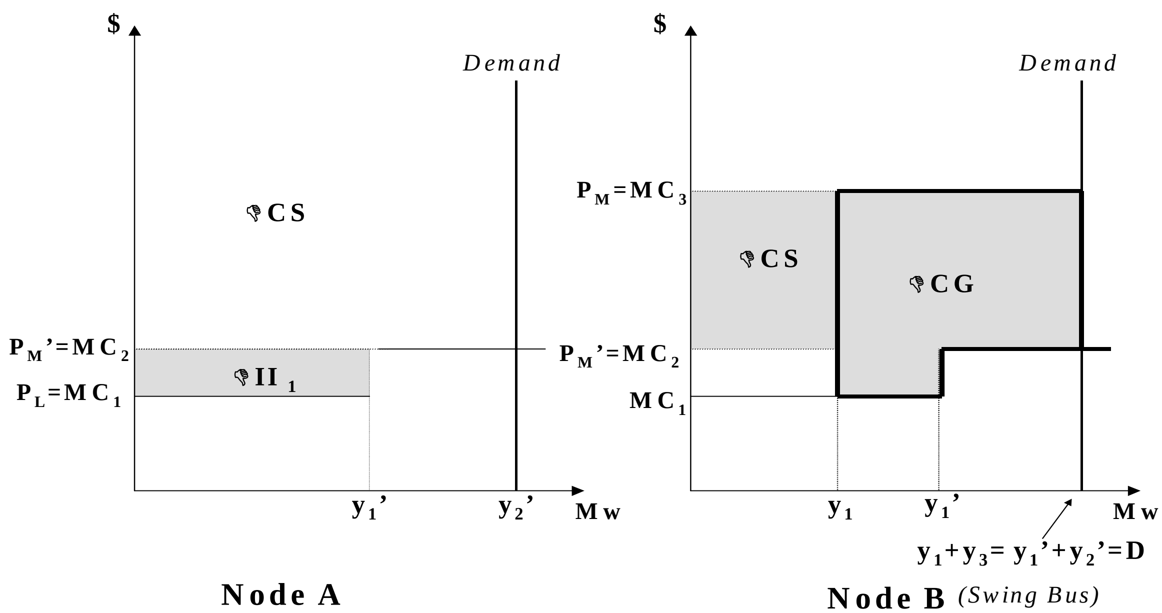
to the hands of producers. In this particular case $(P_M - P_L)\ y_1$ is what is destined to the SALEX Account.

If the line capacity were expanded a significant change would occur in the electrical dispatch and pricing. As it is shown in figure 3, generation would stop in node B, production would rise to maximum capacity in firm 1 ($y_1$') and the rest of the demand would be satisfied by firm 2 ($y_2$').

With a non-binding line restriction, the nodes would be related and the price in both nodes would be equal to the maximum marginal generation cost in the system ($P_M'=MC_2$). Given that generator 2 marginal cost is lower than generator 3 but greater that generator 1, the investment results in a reduction of prices at the demand node and an increase in prices at the production node.

Who would benefit from the extension? In the first place consumers would be paying less for their energy, leading to an increase in consumers surplus: $\Delta CS = (P_M - P_M')D$. Profits would rise for firm 1 because of the rise in prices and production at node A: $\Delta\Pi_1 = (P_M' - P_L)\ y_1'$. The other two firms remain indifferent towards either situation given the fact that in both cases they would obtain zero profits. It is worth noting that the contribution to the SALEX Account would drop to zero after the investment.

*Figure 2: A two-node System without a restriction in transmission capacity*




Gross social benefits[7] could be represented by the increase in Consumers Surplus and in production profits minus the drop of payments made to the SALEX Account. By studying figure 3 we can see that the gross social benefits of the expansion are equal to the reduction in generation

[7] Gross meaning that the cost of the investment has not been discounted.

costs (GC):

$$\Delta GC = -(MC_3 - MC_1)(y_1' - y_1) - (MC_3 - MC_2)\, y_2' \qquad (6)$$

It would be in society's best interest to make the investment if the gross social benefits exceed the costs. If, to simplify calculations, we consider the case in which the expansion is useful only one period, it would be sufficient to compare the reduction in production cost reflected in figure 2 (ΔCG) with the cost of the investment.

We can now use the results of this simple exercise to study the optimality of the Public Contest method as a decision mechanism. Does this mechanism assure the approval of those and only those investments that result in reductions in generation costs greater than the cost of the investments?

Given the fact that node B is the swing bus, only firms in node A may belong to the extended line's area of influence and may be consider users of the extension by the regulation. Since level of activity of firms in the swing bus is not consider on the calculation of the line's flow, users at node B would not be able to express in the voting session the benefits they would receive from the expansion. Note that this means that the consumers in node B are not able to reveal theirs willingness-to-pay for the expansion.

Generators 1 and 2 would be involved in the voting and the financing of the project in proportions that hold relation with the expected participation of each firm in the total generation of energy at node A if the investment was made[8]. Since generator 2 would earn zero profits from selling electricity after the expansion but would have to pay the investment fee, it should vote against the expansion. If production of generator 2 represents at least 30% of that of the node after the extension, the firm could exercise its veto power and stop the project. The possibility of wanting and being able to stop the extension does not consider the social benefits that could be gained from the investment. Socially optimum projects could then be blocked at this stage by this mechanism.

The other participant in this decision would be generator 1. The way in which this firm votes depends on the expected earnings that would come from the extension and their relation with the fee this firm would face after the investment. If its benefits were greater than its fee, then the decision would depend on firm 2's veto power. If firm 2 does not represent at least 30% of the votes the investment would be carried out. If, on the other hand, the fee facing firm 1 were greater than the expected benefits, then firm 1 would accompany firm 2's decision to block the project.

This example shows that the present Public Contest voting mechanism does not guarantee the approval of socially optimal projects: It does not guarantee the realization of those and only those projects which generate a reduction of production costs greater than the cost of the investment. The main two reasons are that not all agents are represented in the voting session - for example, consumers' interests are not represented in this particular case- and that voting participation is based on a measure of the use of the line and not on economic benefits resulting from the investment.

This simple example can be extended to show the possibility of strategic reasoning in the vetoing of investments. Suppose that a new firm is planning an investment in generation at node A,

[8] In this simple case generator 1 would have $y_1'/(y_1'+y_2')$ of the votes while generator 2 would have $y_2'/(y_1'+y_2')$.

with a technology which requires large scale production - a capacity greater than the available is required- but that would yield a lower marginal cost of production than that of generator 1. Because of large-scale requirements the firm will only carry out its investment if transport capacity is extended. Generator 1, hence, has an incentive to veto the extension to keep the new firm out of node A.

It is important to point out that given the fact that the possible entrant investment has not been carried out yet, it is not considered a user and has no voting power and no way to transmit its willingness to pay for the extension of the line. This enables the incumbents to veto the extensions with the sole purpose of impeding the entrance to competitors.

## 4. Simulation of the voting mechanism

A model of the national electric system is used in this section to present some examples of the functioning of the Public Contest method in the determination of expansions of the grid[9]. This model facilitates a numerical approximation to the effects an investment on transmission would have on production, flow quantities, prices and the effects on the benefits perceived by agents. It will be possible to evaluate the results of the voting procedures and state some conclusions over the functioning of the established mechanisms.

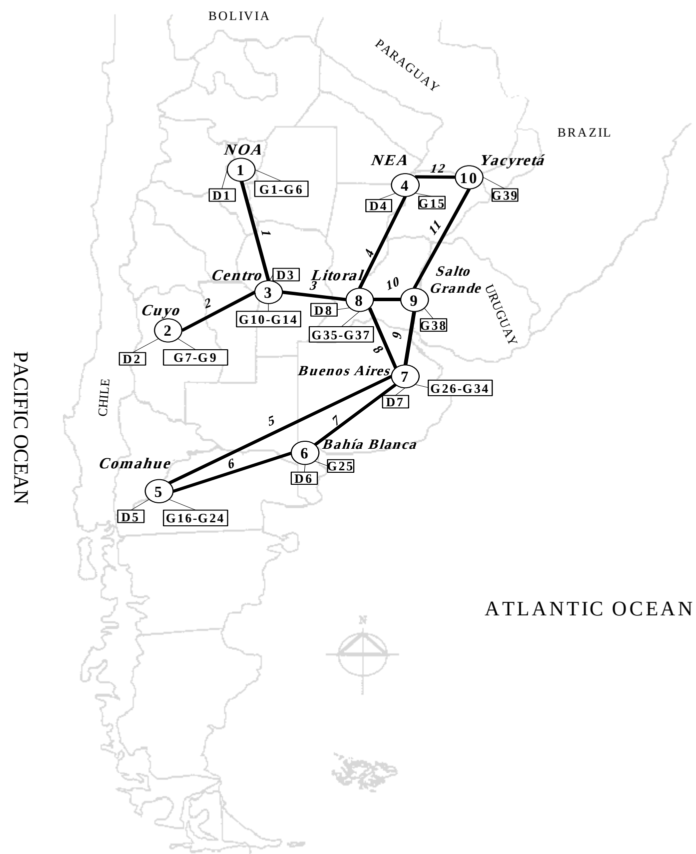
The model is a simplified representation of the national electric system, with ten nodes and twelve high-voltage lines. A two-year horizon is considered, each year having two seasons, and each season divided in tree states: Peak, Valley and Rest. Hence, a total of twelve states are considered. A total of 111 generating units -grouped in 39 firms- and 8 distributors is located at the corresponding nodes[10].

In Figure 3 the basic grid of the simplified model can be seen, with the corresponding localization of the generating firms (G1 through G39) and the distributors (D1 through D8).

[9] This model was constructed by the Instituto de Economia UADE (Universidad Argentina de la Empresa) for the ENRE in the context of the project “Análisis del concepto de beneficiario y de los incentivos a la inversión en el transporte eléctrico de alta tensión utilizando un modelo simplificado de simulación”. The results here presented do not reflect in a precise way reality, or the results of the original model, and constitute only examples. The opinions are the exclusive responsibility of the authors of this paper.

[10] The model has been programmed in GAMS.

*Figure 3: MEM's System*




The model finds the level of production per generator that minimizes the total generating costs of the system subject to the satisfaction of the nodes' demand, the Kirchhoff's laws[11], the generators' generation limit and the limits in line-flow capacity. Then, having obtained optimum production figures, prices and remuneration are calculated following the Argentine regulation guidelines, i.e. CAMMESA (1996).

The starting point of the analysis will be an approximation to the functioning of the system around the year 1997, to go on then to analyze transport capacity expansions and investments in new high tension lines. The model will allow the analysis of alternative methods of financing investments and voting mechanisms.

The information pertaining to each node's demand was obtained from the aggregation of data coming from simulations run by CAMMESA, assuming a 4% annual growth rate for the second year.

As a measure of the generation capacity of the one hundred and two thermal generators considered in the study, the effective power declared in the November 96-April 97 Seasonal

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[11] The laws that relate the flow in the lines with the level of activity in the nodes given the characteristics of the grid are known under this name. See Schweeppe *et al.* (1998).

Programming of the plants are considered. For the nine hydro-electric plants included, figures were obtained from Secretary of Energy and CAMMESA. Seasonal Programming figures of thermal generators are utilized to obtain marginal production costs of these plants, while for the majority of hydro-electric plants Weekly Programming data are used. Yacyretá and Salto Grande's[12] marginal costs are set sufficiently low to dispatch them first.

*4.1 Extension of the Comahue-Buenos Aires line*

The proposal to expand capacity of the lines connecting Comahue (a hydro node in northern Patagonia) and Buenos Aires (the main load node) is taken as an example to study the voting mechanisms established by the Argentine regulation. It is worth mentioning that before extensions, the use of these lines reached maximum capacity several times, provoking the separation of Comahue from the "related" market and forcing the existence of local prices. The extension of the line is about 1500 km.

Given the fact that financing and voting of the expansion is based on dispatch calculated after the investment, it was necessary to simulate the operation of the system with the extension already made. A characterization of the ex-post extended system was obtained, together with the fee corresponding to each agent and the votes they would represent in the voting session.

This would allow a comparison between the benefits perceived by agents before and after the expansion, an approximation to the economic incentives affecting the different voters and analyze the concept of economic benefits and the definition of "benefits" given by the regulation.

From the utilization of the model, the changes in generation levels and nodal prices resulting from the investment can be observed in table 1.

Table 1

Efects of an Extension in the Line Comahue-Buenos Aires[a]

| Node | Generation | | Price | |
|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 |
| NOA | -0.83% | 0.00% | -0.79% | -1.39% |
| Cuyo | -4.80% | -2.75% | -0.67% | -1.30% |
| Centro | 0.00% | -4.59% | -0.85% | -1.40% |
| NEA | 0.00% | 0.00% | -1.01% | -1.65% |
| Comahue | 10.40% | 14.73% | 1.94% | 2.31% |
| Bahía Blanca | 0.00% | 0.00% | -0.21% | -3.48% |
| Buenos Aires | -11.64% | -16.75% | -1.26% | -3.16% |
| Litoral | -6.08% | -2.54% | -0.98% | -1.62% |
| Salto Grande | 0.00% | 0.00% | -1.04% | -1.69% |
| Yaciretá | 0.00% | 0.00% | -1.02% | -1.66% |

[a] Variation with respect to dispatch without the Extension

For both periods, the investment results in an increase of generation activity in Comahue. This is

[12] The two bigger generators.

due to the fact that the expansion in transport capacity of the lines that link this node to the market allows a greater volume of energy exports to be made as a result of the lower generation costs of this site. As a result of the incorporation of Comahue to the market (previously an disconnected node), a rise in the price of power at that node can be observed as well as a reduction in the market price of electricity together with a fall in the other nodes' prices.

The price at Comahue rises due to the fact that generators can now charge the highest marginal cost of generation of the system –modified by the nodal factor-, and not just the highest nodal marginal cost as before[13].

The reduction of market prices can be explained by the expulsion from the market of other generators that set prices at higher marginal costs prior to the increase in production at Comahue[14]. It could be said, then, that the studied expansion would result in lower market prices of electricity.

In this particular case, the reduction in market prices would represent savings of up to 30 million pesos for consumers, while it would only reduce generation costs in 6 million a year. The difference represents lost earnings for generators, without considering fees and contributions to the SALEX Account.

The model was utilized to calculate the fees corresponding to the users or "beneficiaries" of the extension, which added up to an annual total fee of 7.5 million pesos. Vote participation was also determined through this exercise. Table 2 shows the variation in benefits for the two-year period as well as vote participation of each agent in the system:

[13] Lower than that of the market given the fact that Comahue is an exporting node.

[14] Meaning the related generators of higher marginal cost that set the market price.

Table 2

Beneficiaries of the Extension and Voting Shares

| Node and Company | Benefits[a] | Votes | Node and Company | Benefits[a] | Votes |
|---|---|---|---|---|---|
| NOA | | | Bahía Blanca | | |
| G1 | 0.00 | - | G25 | -2.76 | 9.14% |
| G2 | -0.46 | - | D6 | -0.54 | 3.89% |
| G5 | -1.23 | - | | | |
| G6 | -0.35 | - | Buenos Aires | | |
| D1 | -0.10 | - | G26 | -1.25 | - |
| | | | G27 | -1.93 | - |
| Cuyo | | | G28 | -1.99 | - |
| G7 | -0.38 | - | G29 | -0.03 | - |
| G9 | -0.93 | - | G30 | -0.00 | - |
| D2 | 0.05 | - | G32 | -0.47 | - |
| | | | G33 | -3.50 | - |
| Centro | | | G34 | -1.90 | - |
| G10 | -0.16 | - | D7 | -3.90 | - |
| G12 | -0.21 | - | | | |
| G13 | -1.77 | - | Litoral | | |
| G14 | 0.03 | - | G36 | -2.09 | - |
| D3 | -0.15 | - | G37 | -0.50 | - |
| | | | D8 | -0.20 | - |
| Comahue | | | | | |
| G16 | 1.12 | 9.71% | Salto Grande | | |
| G17 | 1.18 | 10.16% | G38 | -3.73 | - |
| G18 | 0.25 | 2.17% | | | |
| G19 | 0.20 | 1.71% | Yaciretá | | |
| G20 | 0.39 | 3.36% | G39 | -3.07 | - |
| G21 | 2.36 | 19.57% | | | |
| G22 | 2.36 | 23.83% | NEA | | |
| G23 | -3.05 | 7.38% | D4 | -0.12 | - |
| G24 | 1.05 | 9.08% | | | |
| D5 | 0.27 | - | | | |

[a] in millions of pesos.

The column showing the variation in the discounted benefits of each agent (expressed in millions of pesos) would be a good representation of the economic incentives affecting the disposition of each agent towards the approval of the investment. If the results of the voting procedures were to be modeled, it would be necessary to compare, for each agent, the discounted benefits of making the investment today against those of making the investment any other year. The present value of the transaction with the investment realized should be compared with the value of waiting. If waiting has a minor effect over the fee facing the agent in the future, then the change in the benefits of the first two years could be a good approximation of his voting decision.

The “Votes” column represents voting power in terms of the area of influence measure of use of the line and shows who are the agents that could participate in the voting process, and in what proportions. In accordance to the legislation and the results offered by the model, all generating firms at Comahue and all distributors and generators at Bahía Blanca should be considered beneficiaries of the investment. If these agents were to vote following the variation of their benefits, expressed in table 2, it can be seen that almost 80% would vote in favor of the extension.

The votes against the investments would come from the generator and the distributor at Bahia Blanca and from a generator at Comahue, for whom the elevation in price and production does not cover the fee this firm would have to face following the investment.

Implied in this reasoning not only is the assumption that agents decide on the basis of the variation of their expected benefits for the first two years, but also the fact that generators, in the different nodes, are independently owned. If this latter fact were not true, the aggregated effects over benefits should be considered. For example, given that the extension would reduce the combined benefits of G22 and G33, if they belonged to the same economic group it should be expected that G22 joined the rest of the agents opposing the investment and veto the project using the above 30% representation they would achieve. Therefore, the estimated benefits for allocating votes could be misrepresenting the true willingness-to-pay when the overall profits of the parent companies were taken into account.

*4.2 Extension of the Comahue-Buenos Aires line, with higher investment fee*

An exercise similar to that of the previous section, but with higher fee, has been developed to study the effects that changes in the fee charged to beneficiaries could exert on voting results. The annual fee has been raised, in this exercise, from 7.5 to 13 million pesos.

This change does not affect optimum dispatch, observed prices or the participation of generators and distributors in the voting process. The only variation is observed on the benefits of those agents that finance the investment. Those considered beneficiaries by the regulation would see smaller gains due to the higher fees they would be facing.

Table 3 shows the changes in the first two years’ benefits, resulting from a higher fee being applied to those agents considered beneficiaries, remaining the rest of the agents as in table 2. We find that the rise of the fee changes the situation of a particular generator (G22), who went from obtaining a benefit increase to a reduction of those as a result of the extension. If this agent were to join the rest of the agents that already opposed the investment, we would see that they represent the necessary votes needed to veto the project, even though 55% of the agents involved are in favor of the extension.

Table 3

Beneficiaries of the Extension & Voting Share with a Higher Fee

| Node and Company | Benefits[a] | Votes |
|---|---|---|
| Comahue | | |
| G16 | 0.10 | 9.71% |
| G17 | 0.11 | 10.16% |
| G18 | 0.02 | 2.17% |
| G19 | 0.02 | 1.71% |
| G20 | 0.04 | 3.36% |
| G21 | 0.31 | 19.57% |
| G22 | -0.14 | 23.83% |
| G23 | -3.82 | 7.38% |
| G24 | 0.10 | 9.08% |
| D5 | 0.27 | - |
| Bahía Blanca | | |
| G25 | -3.72 | 9.14% |
| D6 | -0.95 | 3.89% |

[a] in millions of pesos.

*4.3 Optimality of the voting mechanism.*

This example could be utilized to study the optimality of the mechanisms established to approve extensions of the grid. Based on the simulations carried out in this section, a counter example is presented to refute the optimality of the Public Contest's extension mechanism. A rigorous study of the social benefits of an extension of the lines between Comahue and Buenos Aires is not the aim here; instead, the objective is to present some situations, not necessarily realistic for the Argentine case, in which the decisions arising from the voting process are not optimal solutions.

As it was presented earlier, we could calculate the gross social benefits of making the investment as the present value of the reductions in generation costs resulting from the extension. Let's suppose, in an unrealistic way, that the electric system maintained the structure, costs and levels of demand of the second year until the end of time. If we assume the extension will work properly for fifty years and the discount rate is of 5%, then the social benefits of the investments in the line Comahue-Buenos Aires would be close to 112 million pesos.

In this context it would be optimal to carry out the investment if the costs were below 112 million pesos and reject the project if its cost were above that figure. Given the fact that the fee agents face is not just based on the cost of the investment, but is also modified by the amount accumulated in the Surplus Account, two situations could occur through which the voting mechanism would result in sub-optimal decisions. For example, if the cost of the investment were below 112 million pesos, but the fee were sufficiently high as to impulse a veto of the project, as it were in section 4.2, a socially desirable investment would not be realized. On the other hand, if the cost of the investment were over 112 million pesos, but the fee was temptingly low, as in section 4.1, a socially undesirable project would be accepted in the voting procedure and carried out. Of course, situations exist in which the correct option would be taken, but the objective of this section is to show the possibility of this not happening.

*4.4 An alternative financing and voting mechanism under the Area of Influence scheme*

As it has been analyzed earlier, current regulation establishes that investments in the transmission grid should be financed by the agents which are considered to be related to the investment's area of influence, and in a proportion that holds relation with their use of the extension. Voting rights are also established on a usage basis, by the regulation.

Given the differences between the physical utilization of an extension and the economic benefits it creates agents may be willing to finance the investments in a proportion different from that which comes from physical usage. An alternative mechanism could be created then, based on the economic aspects of an extension.

This section will explore an alternative voting and financing mechanism and analyze its application to the exercises done in previous sections. This alternative mechanism consists of a new payment and voting structure under which those agents within the investment's area of influence vote and pay in relation with the variation of their benefits, gross of fees, if the variation is positive, and abstain from voting and paying if their benefits variation is negative. This mechanism has as an objective charging the costs of the investment to those who benefit the most from its realization.

Table 4 depicts the changes in the benefits, with the new fee, and the voting shares corresponding to the new mechanism for the Comahue-Buenos Aires line extension example. The figures from the lower fee version are used.

Table 4

Economic Benefits & Voting Shares with a Low Fee

| Node and Company | Benefits[a] | Votes |
|---|---|---|
| Comahue | | |
| G16 | 0.77 | 12.19% |
| G17 | 0.80 | 12.77% |
| G18 | 0.17 | 2.76% |
| G19 | 0.14 | 2.18% |
| G20 | 0.27 | 4.26% |
| G21 | 1.58 | 25.12% |
| G22 | 1.76 | 27.97% |
| G23 | -2.00 | - |
| G24 | 0.72 | 11.40% |
| Bahía Blanca | | |
| G25 | -1.57 | 0.81% |
| D6 | -0.07 | 0.54% |

[a] in millions of pesos.

From the data in table 4 we can see that if the new mechanism was utilized, where votes respond to the sign of the variations in benefits, 98% of the beneficiaries would be in favor of the extension.

The only opposing agents would be E25 and D6, for whom benefits rise if fees are not considered, but qualify as beneficiaries under this mechanism because of the sign a gross benefit variations. The fees these firms would face are greater than the increment in their benefits, so they would vote against the proposal.

The exercise carried out with the alternative mechanism generates a greater number of votes in favor of the extension. As we have seen, favorable votes shift from 80% of the electorate to practically 100%. However, this is not always the case, as we shall see when the exercise is repeated considering a higher annual fee.

Table 5 presents the variations in discounted benefits for the first two years of agents that participate in the system, considering fees under the new mechanism and the corresponding voting share.

Table 5

Economic Benefits & Voting Shares with a High Fee

| Node and Company | Benefits[a] | Votes |
|---|---|---|
| Comahue | | |
| G16 | -0.51 | 12.19% |
| G17 | -0.54 | 12.77% |
| G18 | -0.12 | 2.76% |
| G19 | -0.09 | 2.18% |
| G20 | -0.18 | 4.26% |
| G21 | -1.06 | 25.12% |
| G22 | -1.17 | 27.97% |
| G23 | -2.00 | - |
| G24 | -0.48 | 11.40% |
| Bahía Blanca | | |
| G25 | -1.66 | 0.81% |
| D6 | -0.13 | 0.54% |

[a] in millions of pesos.

In this new exercise, we find that no participant would be willing to vote in favor of the extension under the new mechanism, while under the existent mechanism we saw that over 55% of the votes would be in favor of the project. The reduction of the approval rating of the extension, which would considerably reduce the price of electricity for consumers, is due to the fact that under the alternative mechanism annual fees are distributed between fewer agents, fact that could change the way agents vote.

The possibility exists that an election with a favorable result under current regulation could turn into the rejection of the project under the alternative mechanism. This would occur in the exercise we are considering, if annual fees were set at levels between those already utilized.

So, the distribution of the voting power and payment responsibilities among the “economic” beneficiaries inside an area of influence, does not bring a solution to the problem of designing an optimum voting mechanism.

### *4.5 General results of the simulations*

In the previous sections the results from a simulation model designed to study the financing and voting mechanisms of expansions to the high-tension grid, through the Public Contest regime, have been presented.

In the case of an expansion of transport capacity of the lines that link Comahue and Buenos Aires, assuming a sufficiently low annual fee, the outcome of the voting procedure, as we saw in this model, would be the approval of the investment. However, an increase of annual fees could turn the result in the vetoing of a socially desirable project, that would have reduced electric fares charged to consumers. Several examples have been found where the established voting mechanism leads to sub-optimal decisions: the rejection of some socially desirable projects and the approval of some undesirable investments.

The preceding exercises highlighted the importance of firm ownership analysis when it comes to studying the possible outcome of a voting procedure.

Beyond the strategic considerations, several factors were found to explain the sub-optimal results arising from the established voting mechanism. In the first place, the Area of Influence mechanism excludes from the voting table agents that could benefit from the extensions and that would be willing to finance part of the investment. Moreover, agents that do participate in the process do so in a proportion that hold relation with future use of the lines, and thus, are not allowed to express their true willingness to participate in the financing of the project, as this willingness really depends on the economic benefits they could derive from the investment. Finally, the existence of a SALEX account separates the cost of the investment, the relevant figure in welfare evaluation, from the costs perceived by the voters through the annual fees.

An alternative mechanism was studied in which the financial burden of the investment is spread between the agents belonging to the Area of Influence, in a proportion relative to the variation in benefits perceived as a result of the extension. It was found that this mechanism does not necessarily provide the correct incentives in relation to network expansions.

If the voting mechanism was to be modified to include all “users” as considered by law, this would not guarantee optimality either, given the fact that those who would benefit the most from the reduction in prices, that is the consumers, are not considered users by current legislation and that distribution companies are not interested in revealing their willingness to pay given that they pass to them all electricity costs.

## 5. Conclusions

While the transformation of the Argentine electricity market in the last decade has positively affected generation and distribution performance, most agree that current regulation has failed to spur needed investments in high-tension transmission. The lack or delay of such investments arises from problems in the willingness-to-pay revelation under the Public Contest mechanism.

The method is flawed on several scores. First, only generation or distribution companies and large users may vote and finance high-tension expansions, leaving the consumers out of the mechanism from the outset. The consumers' absence from the decision is even more striking if we remember that distribution companies have no incentives to reveal consumers' willingness to pay for an expansion, given that all the electricity cost is passed to consumers.

Not only are consumers excluded from the decision but also all agents in the swing bus since the area of influence method does not take account of that node's level of activity when calculating line flow. In the Argentine case, this means that users in Buenos Aires have no say in the investment decisions on lines that would reduce the prices of electricity in that city.

A third distortion of the willingness-to-pay revelation arises because votes and fees are assigned based on a measure of future use of the line by each company and not on the profits they would gain from it. This means that companies that do not profit from the expansion may have a large enough bloc of votes to veto an expansion that is socially desirable. This could also work in the opposite direction, resulting in the construction of lines that are not socially desirable.

Besides the problems that arise because of the way in which votes are assigned, the strategic veto of expansions is possible given the open access feature of the grid. Since future entrants could use an expansion financed by incumbents without paying extra fees, the former may be interested in delaying the investment to make future entry less attractive or to force late entrants to share investment costs.

Contrary to the effects of these distortions, the existence of the SALEX gives incentives to expansions since reduces the cost of the expansion paid by the users. Unfortunately this effect does not necessarily counterbalance the ones mentioned above, meaning that, under the Public Contest mechanism, desirable expansions may not be constructed while undesirables ones may.

While this paper presents the main reasons for the failure of the present regulation to provide the correct incentive for high-tension transmission investments, the design of a socially optimal mechanism that deals with the asymmetry of information in this market is pending.

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