DEREGULATING THE ELECTRICITY SECTOR

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ABSTRACT

The purpose of this paper is to review several ways of restructuring the industrial electric sector providing examples of countries which have adopted the models that are submitted and that will be turning up in this work. The alternatives for a wholesale electricity market organisation are displayed taking into account that each particular solution to be adopted depends on the case of study features. In addition, advice is given on the transmission and distribution business regulation problem. Finally, we analyse the deregulation of the electricity sector in Uruguay in relation with the particular characteristics of the Uruguayan market.

KEYWORDS

Deregulation, wholesale electricity market, transmission, distribution, supply.

1. Introduction

For a hundred of years electricity and its delivery were thought to be inseparable. Since the late-1980s and early-1990s things began to change. Due to diverse reasons [1] both developed and developing countries began to abandon the idea of an electricity industry vertically integrated to adopt a new model that allows competition and choice in electricity. The idea of commercial separation of electricity as a product and its delivery as a service was put in practice firstly in the U.K. The success of this change was took by other countries as an example and since that moment introduction of competition in the Electricity Supply Industry (ESI) has being taking place in many countries around the world.

The change in the ESI involves two different aspects that are very related to each other.
One is *restructuring*; the other is *privatisation*.
Restructuring refers to changes in structure. It is about commercial arrangements for selling energy: separating or "unbundling" integrated industry structures and introducing competition and choice.
Privatisation is a change from government to private ownership, and is the end-point of a continuum of changes in ownership and management. It can be considered that there are four basic ways to structure an electric industry and three different possibilities of ownership and management. [2]

In the case of structure the models are defined by the degree of competition. Competition in the ESI may be implemented at the stages of generation and retail of electricity. Transmission and Distribution businesses are considered natural monopolies, so they must be regulated.
The following are the basic models when considering structure:

- Model 1: No competition at all.
- Model 2: Requires a single buyer or purchasing agency to choose from a number of different producers, to encourage competition in generation.
- Model 3: Allows distribution companies to choose their supplier, which brings competition into generation and wholesale supply.
- Model 4: Allows all customers to choose their supplier, which implies full retail competition.

In the case of ownership and management, three different levels can be considered:

- First level: The ESI is a government department, with no separate accounts, and often with responsibilities that are only remotely connected to electricity production.
- Second level: The ESI is a distinct government-owned company, or nationalised industry.
- Third level: The ESI is a privately owned industry.

When considering the two aspects (i.e. structure and ownership) at the same time different possibilities arise. A matrix of structure and ownership/management results as shown in Fig. 1.

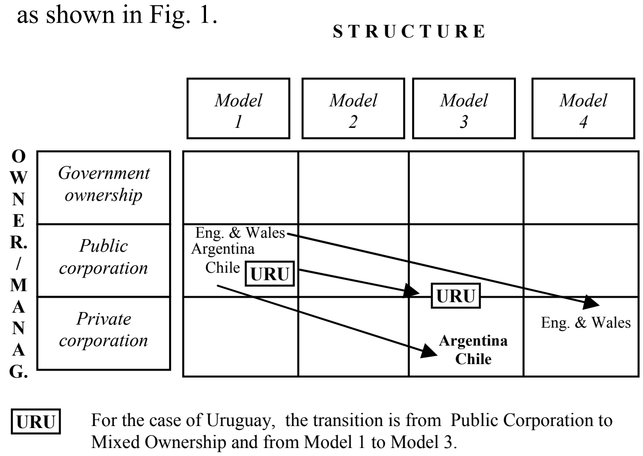

Fig. 1. Structure and ownership/management matrix.

The horizontal axis is competition and choice; the vertical axis is the degree of government control. Different levels of competition and choice, represented by the four models, are shown on the horizontal axis; on the left is full monopoly, on the right is full competition. On the vertical axis the dimension is the degree of government control. It starts at the top with a government department with full control, passing through a government-owned, but separate company, and ending with a privately owned company.

All over the world countries have got electric industries under this matrix. Many are moving from one place to another, but all the movement is from top to bottom, and from left to right: a reduction in government control, and an increase in competition and choice.

The cases of the United Kindom, Argentina, Chile and Uruguay are represented in Fig. 1.

The related structure problem issues will be a matter of study in this paper. Particularly, ways of implementing competition at the wholesale market level will be focused. In particular, we will focus on the ways of implementing competition at the wholesale market level. This will be done in Section 2 of this paper.

In Sections 3 and 4, advice will be given on the problem of regulating the transmission and distribuition businesses.

Finally, in Section 5 we will apply the previous concepts to the case of the Electricity Market in Uruguay.

2. The design of a Wholesale Electricity Market

2.1 Generation dispatch and the Energy Spot Market

A particular characteristic of electricity compared to any other product that is traded in a market is that offer must balance demand instantaneously. This fact requires an Independent System Operator (ISO), which coordinates the whole system, dispatching generators in such a way that they meet the power requirements of demand at any exact moment of time.

In addition, generation dispatch should be the most economic one. In an electricity market, if only energy is traded, then (applying the economics theory) the optimal assignment of resources (in terms of Pareto) is reached when the energy price equals the marginal cost of generation. This leads to the idea of an Energy Spot Market (ESM) where generators and consumers trade energy. In this market, a price is set in every instant, at a different equilibrium point in which supply meets demand. Generally, Energy Spot Markets define hourly prices although they could define prices every 30 minutes or less.

Taking into account the former considerations, the design of a Wholesale Electricity Market should consider the intimate relation between generation dispatch and the ESM. As a result, three basic options arise [3]:

- Bundled operation of generation dispatch with the ESM.
- Unbundled operation of generation dispatch with the ESM
- A cost-regulated generation dispatch

2.1.1 Bundled operation of generation dispatch with the ESM

This solution has the following characteristics:

- Generators must bid in an energy pool, which is managed by an Independent System Operator (ISO).
- The ISO produces the economic dispatch (minimum cost dispatch) taking the generators' bids as the respectively generation costs. This operation provides the Energy Spot Price (ESP), defined as the price of the last generation unit dispatched (marginal cost of the most expensive unit).
- The process is repeated every hour or every period of time defined by the market rules.

It may be observed, that this mechanism provides an economic efficient solution if bids reflect the marginal costs of generation. This is true only under certain hypothesis [3] such as, deterministic characteristic of supply and demand, and enough number of players in the market.

Consequently, for markets with few players or with a great amount of electricity coming from sources that have stochastic nature (e.g. renewable energies), this alternative may not be a proper one.

An example of this solution could be found in the former (i.e. before NETA) Market of England and Wales [4, 5].

2.1.2 Unbundled operation of generation dispatch with the ESM

In this case, market mechanisms (e.g. price setting) are unbundled from system operation, which remains under the ISO.

There is one or more Scheduling Coordinators (SCs) which facilitate bilateral agreements between buyers and sellers in an anticipated market (e.g. a day-ahead market or an hour-ahead market). The SCs submit balanced portfolios to the ISO which may include bids and schedules for generation, load, import, export, and energy trades with other SCs. An iterative bid submittal scenario is used. Initial schedules submitted by the SCs are analysed by the ISO to determine congestion in the system. In the event of congestion, the ISO perform a detailed bus level analysis to determine the optimal adjustment to the schedules to relieve congestion. These adjustments in the form of advisory schedules are communicated to the market participants. The market participants then submit their revised schedules to the ISO to put them into operation.

This solution has advantages and disadvantages. The main advantage is that prices are set in the market exclusively by buyers and sellers without any interference of setting price mechanisms. Some disadvantages are, greater complexity and the high costs of coordination.

For markets with a great number of participants and countries where financial markets are very well developed, this solution could be suitable. An example of this alternative may be observed in the electricity market of California [6].

2.1.3 A cost-regulated generation dispatch

In some electricity markets, a cost-regulated generation dispatch is adopted.

In these cases, caps are established for the generation energy prices. These price caps try to reflect the generators' marginal cost and are determined by auditing.

For the case of markets with low number of participants or with high amount of renewable production (such as hydropower), where the former methods may fail, this solution could be the most suitable.

Examples of this operational method can be seen in Argentina, Brazil and Chile. [7, 8, 9, 10, 11, 12, 13, 14, 15]

2.2 The Contracts Market

Apart from the ESM, Electricity Markets often include a Contracts Market.

Contracts can be of different types; the most usual are forward contracts, future contracts or call options [3, 16].

The main idea behind contracts is to relocate risk. If all transactions were made in the ESM, both suppliers and consumers would be exposed to risk. Electricity prices could be very volatile in the ESM. In addition, consumers buying in the ESM could not be certain of having the amount of energy required at any time.

Contracts work as financial tools to spread risk. In addition, they may work as an insurance for the amount of power contracted for the cases when total power in the system is not enough for the whole demand (i.e. there is a risk of curtailments). For this occasions, contracts may assign the rights for the contracted power. As a result, demand with contracts would not be curtailed while demand without contracts would be.

Depending on the particular characteristics of the market, contracts may play with a different degree of importance. For example, in markets with volatile prices or with high curtailment risk, contracts may be quite important to manage risk creating stable prices and reducing lack of supply risk. This is the case in the Electricity Market of Chile which has a great amount of hydropower. In Chile, 100 % of demand is contracted.

In addition, contracts can be very useful for investors who plan to build a new generation plant. In this case, the contract reduces the investment risk because investors can arrange to sell the electricity to be generated by the new plant at a known price (i.e. the contract price). For this case, the greater the investment, the more useful the contract as a financial tool.

2.3 Capacity Payments

In most electricity markets, there is not only a price for the energy but also a price for the capacity. Payments to generators include, apart from those for the energy, capacity payments.

Capacity payments are intended to encourage generators to make capacity available.

A clear example, is the former market of England and Wales, where the Pool Purchase Price included a Capacity Element, calculated as follows: [5]

$$Capacity\ Element = LOLPx(VOLL - SMP)$$

where,

$LOLP$ is the loss of load probability

$VOLL$ is the value of lost load

In addition, unscheduled generators get $LOLPx(VOLL - Generator\ Bid)$.

From this expressions, it is clear that the greater the lack of supply risk (i.e. high LOLP value), the higher the Capacity Element. Consequently, for these cases there are incentives for generation to be built.

Although the theory of optimal capacity payments is very well developed [17], generally, empirical rules are applied in most markets such as in the previous example.

3. Regulation of the "Wires" businesses

The "Wires" businesses include both transmission and distribution business. Transmission refers to the transport of bulk power through the power system network at high voltages, from the generating plants to distribution systems and large consumers. Distribution consists in the delivery of electricity at medium or low voltages from the energy supply points (i.e. HV/MV stations, where transmission networks connects to distribution networks) to final consumers.

It is important to note that both networks link market participants. As a result, open access to those networks is a fundamental requirement in order to make the market work properly.

In addition, due to the economies of scale involved, the "Wires" businesses are natural monopolies. Therefore, they must be regulated. The Regulator acts as the network user's purchasing broker establishing both distribution and transmission service standards and by setting the maximum average price per unit transported (i.e. tariffs).

There are two main objectives of the Regulator when establishing tariffs:

- To produce incentives for the purpose that the regulated company may reduce costs.
- To capture all possible additional profits of the regulated company, taking care on keeping the company on business (i.e. profits cannot be negative).

The experience shows that this two objectives are very difficult to achieve together. For example, the well known cost plus regulation is good to achieve the second purpose, but it is not good enough to achieve the first one.

On the contrary, price cap regulation is good to meet the first objective, but not to achieve the second one. [18]

3.1 Cost plus regulation

The idea behind cost plus regulation is to fix a price in order that the regulated company may recover the average cost of supplying the service. The definition of costs include not only operational costs but also capital costs.

The most extended implementation of cost plus regulation is the widely known rate of return regulation. The Regulator calculates the total income (TI_t^e) that the company should get in the following tariff period (t):

$$TI_t^e = OC_t^e + s.NAV_{t-1}$$

where,

OC_t^e is an estimation of the company's operational costs for the following tariff period t, based on the past company's accountancy costs

NAV_{t-1} is the net value of the company's assets at the end of period *t-1*

s is a "fair" rate of return established by the Regulator

Finally, the Regulator calculates the price p_t for the following tariff period t so that,

$$p_t q_t^e = TI_t^e$$

where, q_t^e is an estimation of the quantity which will be sold.

It is important to note that in order to guarantee the rate of return, the tariff period should be short enough (e.g. one year).

This type of regulation was widely used in the USA in the past.

3.2 Price cap regulation

Price cap regulation establishes a maximum price for the service provided by the regulated company. This price tries to reflect the future costs of an efficient company (i.e. model company) operating in the same conditions as the monopolist operates (e.g. same demand, etc.).

While considering price cap regulation, the tariff period (i.e. when fixed maximum prices remain valid) must be long enough so as to incentive the company to reduce costs. Opposite to the rate of return regulation case, for price cap regulation, 4 to 8 years tariff periods must be considered.

In addition, a variation to the former method consists in reducing caps during the tariff period by an efficient factor *X*, which is set by the Regulator. This factor tries to reflect the expected technological changes in the sector which may allow the regulated company to reduce costs.

An example of this regulation may be observed in the U.K. where it is known as *RPI-X* regulation, because prices are adjusted every year by the Retail Price Index (*RPI*) minus the efficiency factor *X*.

3.3 Network expansions

An important consideration when regulating the "Wires" businesses is to decide who is in charge of network expansions. There are two basic alternatives:

- "Active" regulated company: Expansions are decided and executed by the regulated company itself.
- "Passive" regulated company: Expansions are not decided by the regulated company.

One or the other of the options must be chosen taking into account both the business characteristics and the electricity market characteristics. For instance, for the distribution network, an "active" company model is usually preferred because the distribution business is characterised by the dynamism of network changes. Expansion decisions must be made in the short term, which makes the company itself the most appropriate to be in charge of them. On the other hand, for transmission networks both models could apply and perhaps the decision of which model could arise in terms of the particular electricity market characteristics.

In addition, it is important to note that if the "active" model is chosen, network tariffs should be set in accordance to an adapted or efficient network and not in accordance to the real network in order to create adequate incentives. Consequently, the "active" model goes very well with price cap regulation.

For instance, this model can be noticed in the Chilean distiribution business regulation.

4. The distribution business and the supply business

The new industry model drew distinction between energy retail ("supply") and the transportation of electricity to end customers ("distribution"). [19]

However, in many countries distribution companies (Distcos) do both activities at the same time (i.e. Model 3 in Fig. 1). In addition, it is frequent to observe that this is the model selected at the beginning of the deregulation process in most countries before moving further to retail competition. This fact is quite reasonable since final customers are, at the beginning, accustomed to buy electricity from their local Distco. It takes some time for them to understand the new market possibilities and to change their behaviour. Distcos have in these cases the monopoly of the retail business.

As a result, it arises the problem of regulating the maximum prices at which Distcos may sell electricity to final customers. [3]

In an electricity market, prices must be cost reflective. Therefore, prices to final customers must be the result of reflecting the costs involved in each of the stages of the electric industry (i.e. generation, transmission and distribution):

$$P_r = P_w + TuSC + DuSC$$

where,

P_r is the electricity retail price to final customers

P_w is the electricity wholesale price

$TuSC$ is the price of transporting electricity through the transmission network (i.e. transmission use of system charges)
$DuSC$ is the price of transporting electricity through the distribution network (i.e. distribution use of system charges)
From this expression, it may be observed that $TuSC$ and $DuSC$ are regulated prices resulting from some mechanism as those described in Section 3.
On the other hand, for the case of P_w, the Regulator has different options such as:

- To allow Distcos to automatically transfer the ESP to final customers (i.e. pass-through of the ESP)
- To regulate a fixed price at which Distcos may buy their electricity needs, generally a Seasonal Energy Price (which results from averaging the ESP over the seasonal period). This is the allowed price which may be transferred to final customers
- To apply yardstick competition which implies that Distcos may transfer an average energy price which results from averaging the electricity purchasing prices of the whole Distcos that operate in the market.
- To regulate a transparent purchasing procedure and allow Distcos to transfer the prices obtained from that purchases.

The first method has the disadvantage that final customers are exposed to price volatility, specially, as seen before, in markets with a high degree of penetration of renewable energies.
The second method is used, for example, in Argentina. It has the disadvantage that if the price is set too high, the Distcos could receive very high profits while if it is set too low, there could be a lack of supply risk. Distcos generally do not wish to be exposed to risk, so they prefer to buy electricity at the Seasonal Energy Price (which they may transfer to final customers) instead of making contracts.
With reference to the third method, it could be appropriate in very developed markets with enough number of Distcos.
Finally, the last method has the advantage of producing good incentives for Distcos in order to make contracts. In addition, this contracts are the result of a regulated procedure which guarantees transparency and competition. In some countries, such as Brazil and Chile it is mandatory for Distcos to purchase a considerable part of their electricity needs from contracts (e.g. 80 % in Brazil with two year anticipation and 100 % in Chile) [12, 15].

5. Electricity sector deregulation in Uruguay

5.1 Market characteristics

Maximum power demand in Uruguay was 1463 MW in 2000 and the total energy demanded was 7833 GWh in the same year. In addition, the annual demand growth is around 5 %. [20]

Uruguay has not oil reserves and is the only country in the region that has achieved almost 100 % use of the available hydroelectric resources. There are three hydroelectric plants over the “Río Negro” river owned by the public vertically integrated utility (UTE) and one installed over the “Río Uruguay” river which is also government owned. The hydroelectric capacity installed is 1534 MW (72,5 % of total capacity) with an average annual generation of 7000 GWh. [21] In addition, thermal generation plants have a total installed capacity of 581 MW. All these plants are owned by UTE.
It is important to say that the region MERCOSUR (The South Common Market integrated by Brazil, Argentina, Uruguay and Paraguay) is rich in energy sources, mainly hydroelectric but also oil, natural gas and uranium.

5.2 Legal Framework

Law N° 16832 of 1997 (Energy Act) [22] divides the ESI into three sectors: generation, transmission and distribution. The generation sector is organised on a competitive basis with independent generation companies selling their production in the wholesale electricity market (“MMEE”) or by private contracts with other market participants. Transmission is organised on a regulated basis. Transmission companies are required to provide third parties an open access to the transmission systems they own and are authorised to collect a toll for transmission services. At the moment, the whole transmission system is owned by UTE.
Distcos operate as geographic monopolies, providing service to almost all consumers within the specific region. Nowadays, the whole distribution business is in UTE’s hands.
The Energy Act also recognises a class of large users, consisting of industrial customers and other users with particular electricity supply needs (i.e. power demand greater than a minimum established value).
The electricity companies are subject to regulation on their prices and other aspects of its business in Uruguay under the Energy Act. The entity which has primary responsibility is the Electricity Regulator (“UREE”).
Although the Energy Act is from 1997, it has not been put in practice yet because the Regulator has been finally established in June 2001. At the moment, the “UREE” is working in the detailed market rules.
An other important aspect to mention is that the decision of makin public corporations private requires a law. In Uruguay, this aspect has produced large political debates, which have ended in the decision of no privatisation.

5.3 The New ESI in Uruguay

The situation of Uruguay in the structure/ownership matrix is shown in Fig. 1. Taking into account the previous analysis, a draft of the most important issues that the new market rules should consider are submitted in this Section.

- High participation of hydroelectricity in the total power offer: This leads to a wholesale electricity market design such as the one described in Section 2.1.3. In addition, this argument is reinforced because of the few number of initial participants in the market. In a near future, considering the market growth, both in demand and in number of participants, it is possible to think in a movement to model of Section 2.1.1. Moreover, another consequence of the high proportion of hydroelectricity offer is the importance of contracts and capacity payments. This was argued in Sections 2.2 and 2.3.

- Limitations in Uruguay energy reserves: Uruguay needs to be able to have access to MERCOSUR energy reserves. This not only implies a wholesale market design that takes into account regional energy exchange, but also the design of appropriate mechanisms for transmission network expansions. The possibility of participation of all market players in new investments in international inter-connections, in a competitive and transparent way, is of main consideration.
- Distribution and supply business: Although separate accounts must be applied to UTE's activities, the fact that it remains as a vertically integrated company leads to take carefully considerations in the regulation of the prices that the company may transfer to final customers. The model of regulating a transparent purchasing procedure, as described in Section 4 could be adequate, then.

6. Conclusions

The deregulation of electricity markets depend very much on the particular market characteristics. A general review on the different alternatives that the regulator has got when designing the rules for the wholesale electricity market and the transmission, distribution and supply business were submitted in this work.

For the case of Uruguay, a draft on the main issues that new market rules should consider was done, taking into account the analysis made in previous sections of this work.

In further publications, a deep study on the deregulation of the Uruguayan market considering for example the role that Distributed Generation could play, will be presented.

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