ENERGY DEREGULATION IN CHILE

By Octavio Santa Gadea

SARKEYS ENERGY CENTER

University of Oklahoma

2003

Index

Executive Summary

The Chilean energy deregulation processes started in the early 1980's when the Pinochet government decided to privatize the electricity sector. However the Chilean experience was not a smooth process. The government's rush to privatize the electric sector meant that many companies were sold even before the regulatory frameworks could be properly finished and this created inconsistencies with the deregulation objectives. For instance, after the privatization ended Chile had a big vertically integrated group, Enersis, that owned the main generation company Endesa, the high voltage transmission company Transelec and the largest distribution company Chilectra. The repercussions of the creation of such a group were several litigations that proved the weakness of the regulator in their role to foster competition. For instance, the abuse of market power on the transmission sector forced the generator company Colbun to build their own transmission lines in order to avoid using the lines of Transelec and pay expensive transmission tolls. The regulator also failed by creating a vague mechanism for transmission tolls based on a concept of areas of influence that created several disputes with many gas-fired generators located around urban areas. Finally the electricity crisis of 1999 showed the structural deficiencies of the Chilean electricity system due to its high dependency on hydroelectric power. It also showed the high level of inflexibility of the retail market where prices could only be adjusted every six months. All these conditions helped to increase the size of the failure during the crisis by not allowing an increase on the retail prices that would have definitely helped to reduce consumption and reduce the duration of the crisis.

1. Introduction

During the last two decades, several processes of privatization were initiated in the Latin American countries. These privatization processes lead to the transfer of many natural monopolies to the private sector, especially in telecommunications, natural gas, transportation, and electricity industry. At the same time, the governments tried to introduce competition in these markets by restructuring the industries through regulation. These efforts were mostly successful and increased competition by several degrees, depending on the particular conditions of each market. However competition in many of the markets still depended on access to the existing networks, especially in the electricity and telecommunication sectors. Therefore open access issues and access pricing were big concerns for the regulators, being the basic requirements for the effective competition in these industries.

Regulators must meet several requirements if they want to improve competition in their respective industries. First, they must create proper conditions for entry into the competitive sector while not inducing excessive entry. Second, they should not try to expropriate previous investment or discourage future investment in the monopolized parts of the industry. It is in this area where Chile has had a pioneering role. As the first country in Latin America to start the privatization process, their almost two-decades of experiences provide a valuable source of information of the effects of different regulatory arrangements on the areas of open access, access pricing, tariff setting, as well as mechanisms that a regulator could use to try to foster competition and at the same time try to avoid the effects of incomplete regulation. This paper is mainly focused in the open access and access pricing experience of the Chilean electric sector.

The regulatory reforms that tried to facilitate the transition to competition started more than two decades ago in Chile. The government engaged in an active policy of restructuring and transferring services of the previously publicly owned firms to the private sector through a privatization process where public owned firms were sold to private firms. This process was designed to eliminate the limitations on market entry and allow private sector participation in these markets. This process basically involved both privatization and liberalization, with the latter aimed specifically at promoting market entry.

Generally speaking, laws that tried to avoid competition for the state owned companies previously protected the sectors that were privatized. As a result, huge barriers to entry and an important degree of market power were common characteristics; moreover, many of these sectors also presented important economies of scale and scope. Therefore the Chilean government decided that the most efficient industrial organization was a regulated private monopoly.

The main objective of the Chilean government was to implement the necessary conditions to allow market competition in all the areas where monopoly power could not be used by the incumbents or imposed by technology. In the cases where monopoly power could be used, the government decided to use regulation in order to provide incentives to the incumbents to behave as in a competitive market. Consequently, a large effort to facilitate the introduction of competition in all the different segments of the markets occurred. Such was the case of the commercialization of the electricity sector.

Despite the government's best efforts, deregulation and privatization were not a smooth process. The privatization process in some cases was realized before the regulatory framework could be established. This is especially noticeable in the case of the electricity sector where the privatization process led to a degree of vertical integration. In the context of incomplete regulation in the area of transmission tolls this allowed the incumbents to create several barriers to entry by restricting competition in the retail markets and hence allowing the new comers to use their market power and obtain rents.

2. Regulatory Frameworks in Electricity

This sections main purpose is to provide some technical and economical background for those not familiar with the peculiarities of electricity supply and demand. Readers familiar with the electricity industry may skip this section.

2.1 Basic supply and demand attributes in the electricity sector

The supply of electricity is generally divided into three individual functions:

1. Generation: This is the process of generating electricity from several energy sources like falling water, steam turbines powered by steam generated by burning fossil fuels, wind turbines, internal combustion engines, steam turbines powered by steam generated in nuclear reactors, etc.

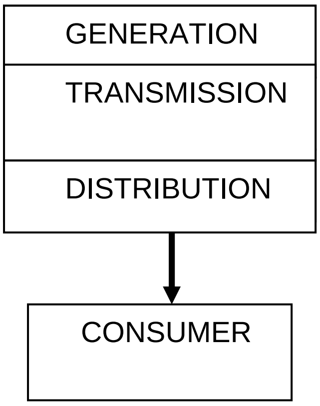
2. Distribution: This is the process of distributing the generated electricity to the residences and business by using low voltage wires and transformers along the streets. Distribution can also contain (and usually does) energy retailing. This includes supply contracts, metering, billing and various demand oriented services.

3. Transmission: This involves the transmission of electricity from the generating site to the distribution centers, the integration of dispersed generating centers and the scheduling and dispatching of generating facilities that are connected to the transmission network in order to balance demand and supply.

2.2 Market structure and deregulation

The electric power sector in Chile, and in most of the world, evolved largely with firms (private or state-owned) that were vertically integrated into generation, transmission and distribution[1]. These firms held a de-facto right to serve retail customers within a defined geographic area and were usually subject to a “rate of return” regulation[2]. Therefore every retail customer received a bundle product (generation, transmission and distribution) from their local monopoly with prices usually based on the total average cost.

Integrated Electric Market:



The decision to deregulate the electricity markets by privatizing (state-owned firms) and then “unbundling” the costs in many developing countries came from the conflict between the government's role as owner and operator of utilities which negatively affected the sector performance[3]. A need to increase power generation investment levels to satisfy increasing demand was also a big concern for many governments especially as several multilateral institutions like the World Bank required a deregulation process in order to

---

[1] Paul. L Joskow “Deregulation and Regulatory Reform in the U.S. Electric Power Sector” MIT press, 2002

[2] This means that the regulator guarantees a retail price that will give to the firm the specified amount of fix rate of return. The main assumption here is that the electricity sector has big economies of scale and therefore a large vertically integrated firm will be more efficient compared to smaller firms.

[3] Financial performance, as measured by indicators such as the rate of return on revalued assets, self-financing ratios, and the level of overdue accounts, declined.

approve new credits[4]. The World Bank also assisted with technical assistance and loans in order to create the regulatory frameworks. The are some exceptions to this process in Latin America like Mexico and Brazil that, probably because of their bigger economies, were not as constrained in financing new generation capacity and decided to deregulate by themselves at a slower pace[5]. On the other hand, Chile was the first country to deregulate its electricity market and the reasons to do so were more influenced by the internal politics than the World Bank support[6]. Due to the rush, in which the privatization process occurred, many issues were left unresolved and their consequences were felt later[7].

The theoretical framework for deregulating the electric market supported the idea that monopolies tend to be inefficient and their rent-seeking behavior was another reason commonly given. However the main dispute about the rate of return regulation is that by bundling the price, the firms that are particularly efficient in any sector (generation, transmission or distribution) are not rewarded since there is a lack of incentive in the system. This lack of efficiency is exacerbated by the fact that many vertically integrated firms in developing countries are state-owned[8]. Some technological advances in generation[9] made it also less clear whether this sector had big economies of scale, at least in generation.

---

[4] World Bank. “The World Bank's Role in the Electric Power Sector. Policies for Effective Institutional, Regulatory and Financial Reform” The World Bank, Washington D.C. 1993.

[5] World bank, “Energy Efficiency and Conservation in the Developing World: The World Bank's Role” The World Bank, Washington D.C. 1993.

[6] This was due to the fact that the dictatorial government of Pinochet during the 1980’s (that was transitioning the power to a civilian government) thought that the new civilian government would not carry on with the liberalization of the economy.

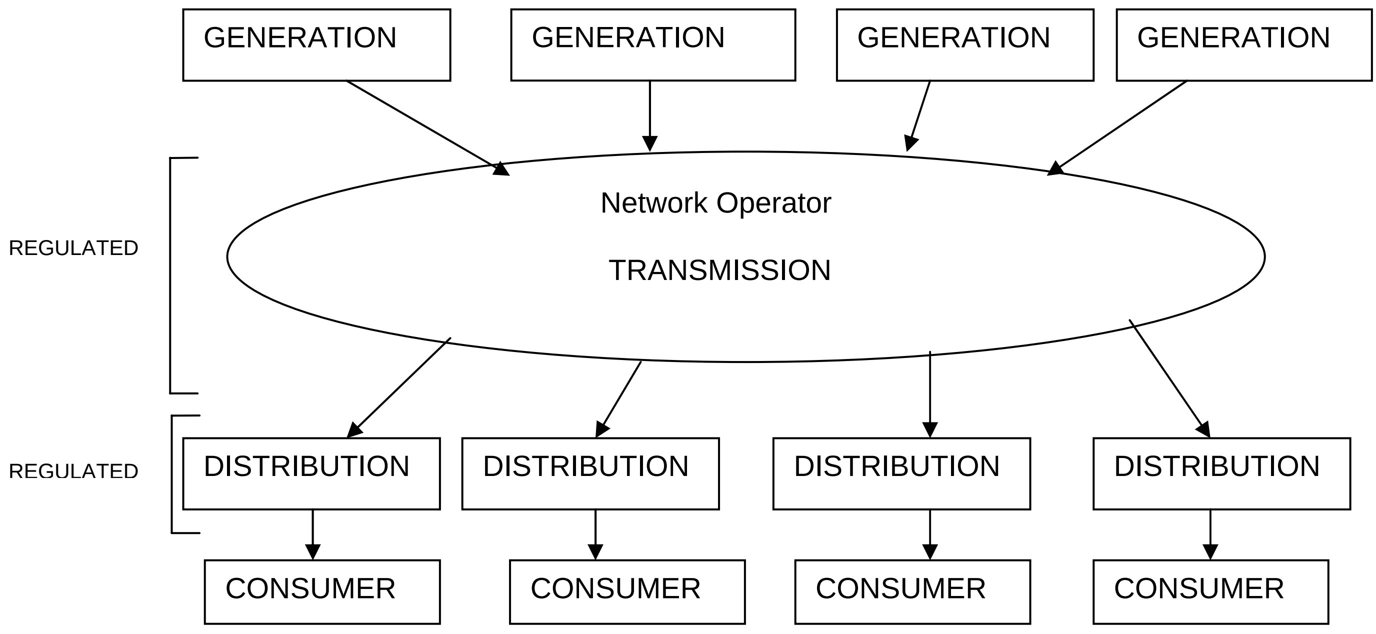
[7] Raimundo Soto. Telephone interview. 5 may, 2003.

[8] Joskow, Paul L., "Regulatory Failure, Regulatory Reform and Structural Change In The Electric Power Industry," Brookings Papers on Economic Activity: Microeconomics. 1989.

[9] The new turbines of combined cycle together with cogeneration increased efficiency up to 60%

The main idea of unbundling the distribution, transmission and generation is that the last sector can accommodate more competition due to the lack of larger economies of scale. By separating generation we are leaving the market to provide better incentives for controlling capital and operating costs of new and existing generation capacity. Unbundling of the sector also sought to encourage innovation in power supply technologies and transmit all these benefits to the consumer. The new structure can be seen more clearly in the next graph:

Wholesale electric market:



The Idea of creating competitive wholesale markets was first tried in England but here it was also driven by the idea of reducing the consumption of some expensive fuels (coal) that were forced upon the state owned generating companies by powerful unions. The theory was that a combination of privatization and competition would drive the coal out of the market[10]. This process lead to the retirement of uneconomical energy plants due to the fact that they couldn't compete in the generation market.

In order to achieve a competitive wholesale market, like the one presented in the previous graph, we first need to dismantle the vertically integrated monopolies. Therefore generation, transmission and distribution should be separated. This, in the case of state-owned companies, can be done through a liberalization process, which is then privatized[11]. Of course in highly integrated companies the management of each sector should be divided prior to privatization. Also some part of the company debt should be reduced in order to attract the interest of the private sector. Converting some of the debt into public bonds could achieve this[12]. The more competing suppliers the better[13], however network congestion can limit geographic competition among the suppliers[14].

The simple separation into generation, transmission and distribution is not sufficient to guarantee competition, due to the special conditions in the electricity market that act as barriers to an efficient electricity market. A pool based market coordinated by a system can help reduce this barrier[15]: To present more clearly the functioning of an efficient wholesale electricity market we will divide the operation of the market between short run operations coordinated by the system operator and long run operations that include investments and contracts:

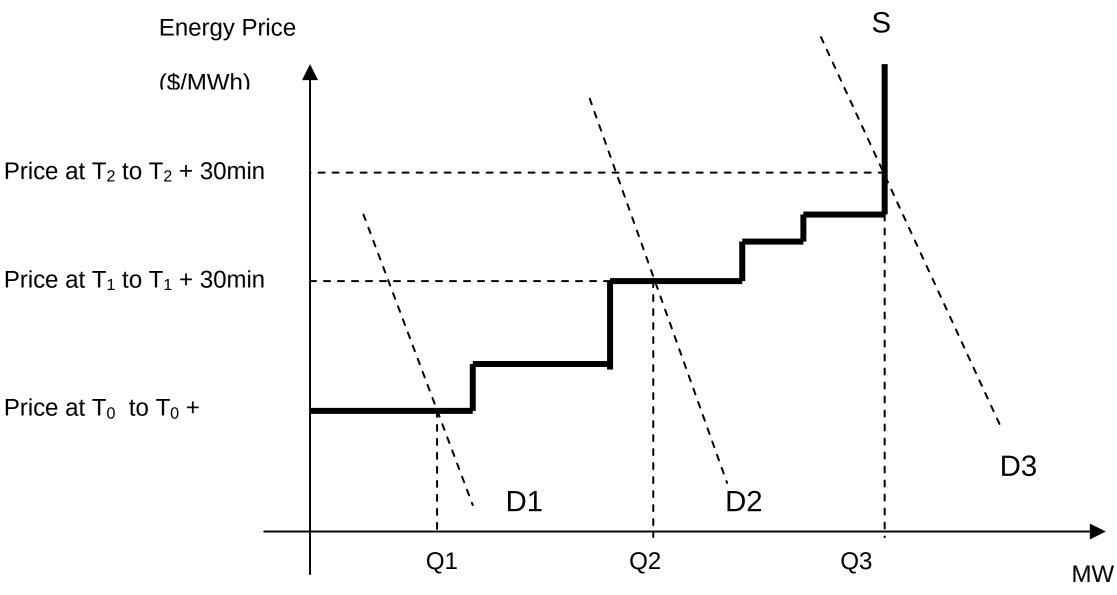
---

[10] Paul. L Joskow "Deregulation and Regulatory Reform in the U.S. Electric Power Sector" MIT press, 2002
[11] In Chile this two process were done at the same time.
[12] World Bank. "The World Bank's Role in the Electric Power Sector. "Policies for Effective Institutional, Regulatory and Financial Reform", The World Bank, Washington D.C. 1993.
[13] Usually by facilitating the entry of new suppliers into the market, by dismantling laws that created barriers to entry to protect the old public utilities.
[14] Paul. L Joskow, "Electricity Sector Liberalization Lessons Learned", MIT, 2002
[15] W. Hogan, "Competitive electricity market design: A Wholesale premier", John F. Kennedy School of government, 1998

2.2.1 Short run operations:

These short run operations are relatively simple and usually occur during a period of half an hour. In the short run investments are fixed, power plants, transmission grid and distribution lines are all in place. Customers and generators are connected. The only decision left is the actual delivery of the power, which in the short run truly behaves like a commodity market[16]. Every generator has a real marginal cost of generating power from each plant. Also every customer has a demand that depends on the price. The generators costs are used to assign a merit order; basically the generators with the lowest marginal cost have the highest merit order while the most expensive ones will have the last merit order. This merit order defines a short run marginal cost curve, in a similar way consumer's demands are sensitive to price: therefore a higher price will reduce the demand. This can bee seen more clearly in the graph below:

Short run marginal cost curve:



[16] W. Hogan, "Competitive electricity market design: A Wholesale premier", John F. Kennedy School of government, 1998

Generators and consumers provide information to the dispatcher that uses this information to decide which power plants will run at any given half an hour. The system operator tries to achieve the most efficient match of supply and demand. This efficient central dispatch is the main difference between the traditional power pool and the market solutions since the price that it is charged to the consumer in the traditional system will be equal to the average cost of the generation, while in the market system it will be equal to the marginal cost[17]. The marginal cost is the standard determinant of a competitive market.

2.2.2 Long-run operations:

Traditionally the idea of long-term contracts carries with it the assumption that the generator and the consumer can make an agreement to trade power at a certain price. The idea is that a specific generator will run to satisfy the demand of a specific customer. If the customer needs change, the customer may decide to sell the contract in a secondary market. An efficient operation of the secondary market will guarantee that the market converges to the true opportunity cost[18].

However this system of long-term contracts goes against the normal operations of the short run market. Since to achieve efficiency in the short run the dispatcher should be able to decide which plants are idle and which ones are running, independent of any long-term contract bindings. Also for the dispatcher it is impossible to know which generator is serving which customer. After all, the generation is providing power to the grid and all the

---

[17] W. Hogan, “Competitive electricity market design: A Wholesale premier”, John F. Kenedy School of government, 1998
[18] Paul. L Joskow, “Electricity Sector Liberalization Lessons Learned”, MIT, 2002

customers are taking power out of the grid. The short-term dispatch decisions by the system operator are done without any regard to any long-term contract[19].

All the previous conditions that were mentioned do not restrict the use of long-term contracts in the electricity sector, but they do change many of the contracts conditions. Rather than controlling the dispatch in the short run market, long-term contracts are used to hedge against the volatility of the price in the spot market. Take for example the following situation: a customer and a generator have a long-term contract for a fixed quantity of 100MW at an average price of 5 cents and in the half an hour where the customer is taking power of the grid the pool price is 6 cents for the 100MW. Here under the contract the generator owes the consumer 1 cent. It is easy to see the reverse of the case, lets say that the pool price is 3 cents and the consumer is taking power of the grid at this price. Under the contract the consumer now owes the generator 2 cents for every 100MW consumed during that half an hour[20]. This type of arrangement is called contract by difference.

2.3 Remarks on deregulation in developing countries:

In many developing countries transmission and distribution are assumed to be natural monopolies due to their economies of scale. In the case of transmission several facts should be taken into consideration: First a well-regulated energy market will require a much more robust transmission network infrastructure than a vertically integrated

---

[19] W. Hogan, "Competitive electricity market design: A Wholesale premier", John F. Kennedy School of government, 1998

[20] W. Hogan, "Competitive electricity market design: A Wholesale premier", John F. Kennedy School of government, 1998

company[21]. Second, in order to achieve competition in the electricity market investment in the transmission sector should be expanded. Third, to foster competition distribution companies should be completely independent and this can be achieved by prohibiting them participating in the power generation market. Regulatory rules forbidding this kind of ownership should be implemented[22]. Finally, all this is easier said than done and the following experience of Chile is a good example.

3. Structure of the Electricity Sector in Chile

In order to understand the particularities of the Chilean Electricity sector, we must consider the Chilean geography. Chile is an extremely long but narrow country (4400 km long with and average of 200 km width). The southern half of the country consists of a temperate climate where rain and snow accumulation is abundant. This makes hydroelectric generation an efficient and economic source of energy. Another important point to remark is that most of the Chilean population is concentrated in this part of the country where energy consumption is concentrated on industrial and residential uses. In contrast, the northern half on the country contains one of the driest desserts in the world, the Atacama dessert, which is largely uninhabited. Power generation relies heavily on thermoelectric facilities (gas and coal based) and energy consumption is concentrated on energy intensive mining activities (primarily copper mining).

Under these geographic conditions, there are two main independent electric systems, the Greater North Integrated System (SING) and the Central Integrated System (SIC)[23]. Each

---

[21] Since the traffic on the transmission grid will increase dramatically due to the arbitrage between competing generators.
[22] Paul. L Joskow, “Electricity Sector Liberalisation Lessons Learned”, MIT, 2002

[23] Matias Carvajal, Felipe Reyes, Hugh Rudnick “Interconexion del SIC y el SING” Pontificia Universidad Católica de Chile, 1999

of these independent systems[24] comprises their own generation plants, transmission lines, and distribution networks. There are several institutions that govern the electricity sector activities[25], which are listed below with a short explanation of their responsibilities (their abbreviations, in parentheses, will be used to refer to them from here on):

The national energy commission (CNE). This agency's main function is to advise the government on all matters related to energy (electricity, fuel, nuclear power, etc.). It also defines policies regarding development strategies, (studying, proposing technical, economical norms, tariffs and prices). The ministry of Economy has the right to approve and set the tariffs proposed by the CNE and also promotes the efficient development of the generation, transmission, and distribution.

The Superintendence of Electricity and Fuels (SEC) is an independent agency (related to the ministry of economy) in charge of monitoring the services of electricity, gas, fuels and their compliance with the regulation norms. It also controls the quality of services and safety of facilities, and prepares information to set tariffs rates.

The Economic Load Dispatching Center (CDEC) is a coordinating entity designed to optimize the operation of the transmission network by optimizing the energy dispatch. The CDEC acts as a clearance house in the energy market in the short term, but in the long term, its functions are also planning the combined generation and transmission system.

The peculiar geography of Chile creates a particular situation for the electrical industry and expands the importance of the open access issues. Since the country is narrow and

[24] The Chilean government plans their interconnection in a near future

extremely long, a unique high voltage transmission line is the only economically viable structure due to the existence of strong economies of scale in transmission. The regulation of the electricity sector, implemented after the privatization, was based on the assumption that transmission is a natural monopoly. The law explicitly considers the access problem in this context; however, the regulation is plagued by ambiguities and inconsistencies and therefore, making this area one of the major sources of conflict and legal dispute[26]. Another point of concern is the consumption patterns that in the case of SING correspond mainly to isolated mining operations. These mining operations usually negotiate contracts directly with the power generators. In contrast the electricity consumption in SIC is largely concentrated in Santiago where more than 45% percent of the population lives. This high level of concentration in one city makes the Santiago distribution company Chilectra a very large local Monopoly[27]. Therefore the regulator tried to implement strict regulations that cover tariffs, quality of service and access to free-clients within the concession area; however this area remains as one of the most controversial points for the industry.

Before the privatization process, the electricity sector was dominated by vertically and horizontally integrated state owned companies. The privatization process that started in the late 80's was carried under the assumption that generation was potentially a competitive market, while distribution and transmission were considered natural monopolies[28]. The government's privatization plan for the transmission and distribution sector included a scheme where private property and management were combined with

---

[25] The CNE, SEDEC were created after the privatisation. The SEC was in charge of the sector before the privatisation started.
[26] "Briefing on Chilean Electricity Law" Potificia Universidad Católica de Chile, 1999
[27] C. Diaz, R. Soto "Open acces Issues in the Chilean Telecommunications and Electricity sector", Universidad de los Andes, 1999

strict regulation. However the privatization process produced a structure that is inconsistent with the regulatory framework. First the high voltage transmission lines were sold bundled to the main generating firm, Endesa, therefore creating a vertically integrated firm. Although Endesa was forced to separate the transmission business from the generation business, it still retains 100% of the property of the transmitter Transelec. This was a huge mistake by the Chilean government and one that showed that the restrictions of ownership across segments of the industry were not clearly regulated. Finally this process resulted in a large conglomerate Enersis controlling the main distribution company (Chilectra), the main producer (Endesa) and having the monopoly in the high voltage transmission lines (Transelec). This vertically integrated group has been the main source of legal disputes and conflicts for the regulator. The first serious attempt to separate the integrated firm started in 1990 when the national economic prosecutor complained to the antitrust commission that the three companies owned by the Enersis group behaved in an anticompetitive way by discriminating against smaller producers. Sadly this accusation didn't prosper and was finally rejected, as was an appeal to the Supreme Court. The appeal lasted until June 1997 and was also rejected[29].

---

[28] Armstrong, M., S. Cowan, and J. Vickers. 1994."Regulatory Reform: Economic Analysis and British Experience" MIT Press, 1994

[29] MeloJ and P. Serra. "Competencia y regulación la experiencia chilena" Perspectivas 1997

4. Privatization Process in Chile

The electricity sector started its privatization process in the eighties. Before this the state had controlled 90% of the generation, 100% of transmission and 80% of the electricity distribution[30]. The privatization process helped to create private companies based on the old state-owned companies. Here we list the most important ones:

4.1 Endesa and Transelec

The main privatization process was the one of Endesa, which was the main state-owned electricity company. The company was vertically and horizontally integrated, therefore a privatization process couldn't be done directly. The company was first divided in six distribution companies and two-generation companies. This process will be explained in more detail later on. After the division of Endesa the composition of the electric sector in Chile became more complex as can be seen in the following table:

SYSTEMS	SEGMENTS		
	GENERATION	TRANSMISSION	DISTRIBUTIO
SING	EDELNOR ELECTROANDINA CELTA NORGENER GENER GASATACAMA	EDELNOR ELECTROANDIN NORGENER	EMELARI ELIQSA ELECDA
SIC	ARAUCO GENERACIÓN PETROPOWER GENER SAN ISIDRO ENDESA COLBÚN GUACOLDA E. VERDE S. E. SANTIAGO PANGUE PEHUENCHE PILMAIQUEN ACONCAGUA S. C. DEL MAIPO H. G. VIEJA Y M. E.E. CAPULLO GEN. S. ANDES	TRANSELEC STS TRANSNET TRANSQUILLOT	CHILECTRA CGE CHILQUINTA RIO MAIPO SAESA FRONTEL EMEC CONAFE EMELECTRIC EMELAT PUENTE COPELEC LITORAL LUZAGRO EMETAL COLINA LUZPAR
	CARBOMET		

[30] M. Aguilar, L. Lomuscio, H. Rudnick, "Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos", Pontificia Universidad Católica de Chile, 2001

Source: Superintendence of Electricity and Fuels (SEC)

The previous section explained that the process of privatization created a group of vertically integrated companies (Chilectra and Endesa) owned by the Enersis group. In order to explain this process thoroughly we will give a little historic summary: The National Power Company (Endesa) was created in 1943 by the Chilean government in order to realize its electrification plan for the country. Endesa was one of the main state companies for more than four decades and during this period of time the company became the base of the electricity development of the country. During the 1980's the company went through structural change prior to its privatization. This process included the separation of the areas of generation and distribution and also preparing the management areas in order to be able to incorporate the individual stockholders and the mutual funds that were going to be crucial for the privatization of the company. The privatization process started in 1987, but due to the size of the company and the complexity of dividing a previously horizontal and vertical integrated monopoly, it was forced to extend the privatization process until 1989. After the privatization process ended, the company became a multinational company by the year 1997, with the acquisition of electricity companies in Argentina (Central Costanera S.A. and Chocon S.A.), Perú (Edegel), Colombia (Hidroeléctrica de Betania and Emgesa), and Brazil (Centrais Electricas Cachoeira Dorada S.A.). This process attracted the attention of the Spanish group Enersis that is owned by Endesa España, a privatized electric company in Spain. Finally Enersis, which already owned 25.3% of Endesa Chile, acquired another 34.7% trough a bidding process in the stock markets in N.Y. and in Chile, finally giving it the control of the company[31]. The final ownership position of Endesa can be seen in the next table:

[31] M. Aguilar, L. Lomuscio, H. Rudnick, "Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos", Pontificia Universidad Católica de Chile, 2001

Stock owners	Participation (%)
Enersis S.A.	59,98
Citibank N.A (ADR)	9,55
A.F.P. Habitat S.A.	2,96
A.F.P Protección S.A.	2,29
A.F.P. Cuprum S.A.	2,2
A.F.P. Provida S.A.	1,88
A.F.P. Santa María S.A.	1,66
A.F.P. Summa Bansander S.A.	1,5
The Chilean Fund INC.	0,42
Cia. De Seguros de vida Cons. Nac. Seg. S.A.	0,41
Banchile Corredores de Bolsa S.A.	0,39
A.F.P. Magister S.A.	0,37

Source: Superintendence of Electricity and Fuels (SEC)

4.2 Chilectra

Chilectra is also one of the biggest electricity companies in Chile. It was created in 1921 by the merger of Chilean Electric Tramway and Light Co. and the Compañía Nacional de Fuerza Electrica. After the merger, the group also later acquired many other companies. By the year 1971 the Chilean government nationalized Chilectra by buying all the stocks and eliminating the private participation of the company. The company structure remained the same until 1981 when a structural change was required before the privatization of the company. Once again the distribution and the generation areas were divided so they could be sold separately creating a matrix company *Chilectra S.A*. with three branches: *Chilectra Metropolitana,* controlling the electric distribution in the capital of Chile Santiago, *Chilectra Quinta Region,* controlling the city of Valparaiso and the region of Valle del Aconcagua, and finally *Chilectra Generación* which kept the functions of generation and transmission. The process of privatization of *Chilectra Metropolitana* ended in 1987 by finally transferring 100% of stock to the private sector. The final owner composition of Chilectra can be seen in the following table:

Company Name	Participation (%)
Enersis S.A	72,56
Morgan Guaranty Trust Company (ADS)	7,26
A.F.P Habitat	1,36
The Chilean fund INC	1,07
A.F.P Provida	0,87
Banchile	0,66
Consorcio Nacional de Seguros	0,49
The Five Arrows Chile	0,48
Bolsa de Comercio de Santiago	0,41
Larrain Vial	0,35
Celfin,Gardewegs S.A	0,35
A.F.P. Summa Bansander S.A	0,32

Source: Superintendence of Electricity and Fuels (SEC)

4.3 Market Participation

After the privatization process ended, the market share structure in generation and distribution changed dramatically. From the tables below we can see that the group Enersis emerged as one of the most dominant players in the industry. This did not fare well with the intentions of promoting competition that the government had initially intended from this process. However it was assumed that strong regulation would be able to promote a competitive behavior even under these circumstances.

Generation Capacity	Participation (%)
Endesa	55.7
Gener S.A.	22.0
Colbún S.A.	16.0
Others	6.3

Source: The economic Load Dispatching Center (CDEC)

The market share in the distribution sector for the year 1999 can be seen below:

Generation Capacity	Participation (%)
Chilectra	50.15
CGE-EMEC-CONAFE	23.23
SAESA-Frontel-ChilQuinta	16.4
Emel	5.4
Others	4.81

Source: The economic Load Dispatching Center (CDEC)

The cause of these market conditions was the privatization process of Endesa, which produced a market structure inconsistent with the regulatory framework in two important areas. First, the high voltage transmission lines were sold as a part of the main generating firm, Endesa, thus creating a vertically integrated firm. Even though Endesa was required to separate transmission lines from generation plants, it retained 100% of the property of the transmission company Transelec[32]. Second, the government made several mistakes by not creating the necessary restrictions of ownership across segments of the industry[33]. As a result, the Spanish conglomerate Enersis was able to control the main distribution company (Chilectra), the main producer (Endesa) and the transmission company Transelec.

5. Open Access Issues in Transmission

Chile's particular geographical conditions and the scale economies of the Electricity transmission sector support the idea that high-voltage transmission is a natural monopoly.

[32] M. Aguilar, L. Lomuscio, H. Rudnick, “Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos”, Pontificia Universidad Católica de Chile, 2001

[33] The failure of the government was not clear at the end of the privatization process since Enersis increased their share on Endesa after the process ended from 25.3% to 59.98% through

Therefore, to ensure competition the open-access to the transmission network became critical. The Chilean Law guarantees access to the transmission lines in the form of an easement: as long as the lines have excess capacity, a transmission company cannot refuse to serve any producer interested in dispatching energy to a consumer or to sell in the spot market, even if the tariff has not been agreed in advance. However the regulation is incomplete in two main areas: transmission tolls and new investments required to expand the network when necessary. The Electric Law of 1982[34] did not establish clear procedures for setting transmission charges. In the decade of the 1980's this was not a problem for the state monopoly, Endesa, which at that time simply charged between 5 and 8 percent of energy cost[35]. However after the privatization process ended, the lack of definition became a problem.

The legal framework was changed in 1990 to create the price system for the transmission sector. Even though the law was passed and it covered the basic settlement mechanism along which prices are to be set, its corresponding statute[36] was not approved for several years -fostering conflicts- and when it was finally published it did not provide a clear mechanism to set tolls. The law defined that the tolls be determined as prorates between the users and that they should cover the facilities within the *area of influence* of a generating unit, which means, *the lines of the transmission network and the other installations necessarily affected by injections of power by a user*. The main problem with this law is in the definition of the area of influence, since it is highly ambiguous and since any action by a user must necessarily affect the entire system. It is easy to find several

---

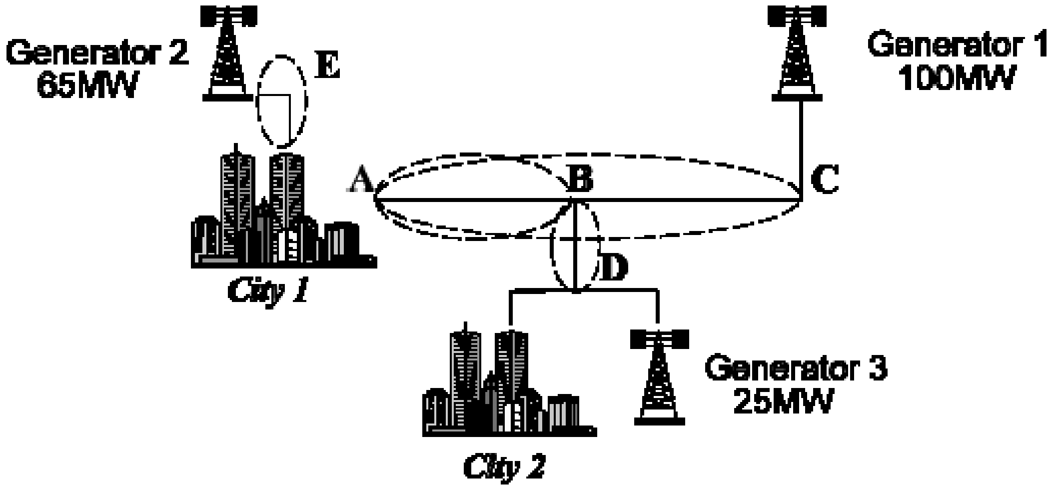
operations in the NYSE and the Chilean stock market. The regulator should have forbid these acquisitions in the stock market.

[34] The key Law is the DL No.1 that can be found at http://www.cne.cl

[35] C. Diaz,R. Soto "Open acces Issues in the Chilean Telecomunications and Electricity sector", Universidad de los Andes, 1999

[36] That gives the specifics of the Law

examples of the ambiguities and limitations of the concept of area of influence, which will become a source of conflicts. This can be explained more easily with the graph below:



Source: C. Diaz, R. Soto "Open Access Issues in the Chilean Telecommunications and Electricity Sector", Universidad de los Andes, 1999

First, consider the case of a generator 3 that is installed near a consumption center city 2. If demand in city 2 is less than what generator 3 produces (25MW), the difference of production is consumed by city 1. In such case, all the generators sell to city 1, but only generators 1 and 3 should pay for the use of the transmission line. Generator 1's area of influence is the segment AC, while generator 3's area is ABD. According to the regulation, they should pay at a prorate segment AB and face the full cost of segments BD (generator 3) and BC (generator 2). In this case, the current regulation provides a useful guide to pricing transmission. However, consider another case when generators 1 and 2 were originally serving both cities and generator 3 sells less than what city 2 consumes. In this arrangement generator 3 will displace the less efficient rival (generator 1 or generator 2). Assuming that Generator 2 is the less efficient and it is located within City 1. Therefore, installing Generator 3 implies a reduction of the demand for Generator 2 and thus vacates some capacity in the transmission line. However, generator 3 has "affected" installations and facilities in the two segments AB and BD and, thus, should pay tolls according to one interpretation of the current regulation[37].

It is interesting to note that a producer can be charged when it is not using a transmission line and it may be the case that a socially efficient outcome (displacing generator 2) is de-stimulated by compensating the transmitter for transmitting less energy. Furthermore, if we assume now that generator 2 is remote from City 1 but is still displaced by generator 3. In such a case, generator 3 will have to pay also for transmission line E although it does not use that line to reach any actual or potential client[38]. This problem of lack of definitions has been exacerbated by the substantial investment in gas-based thermoelectric generation that has been installed around the city of Santiago and uses imported gas from Argentina. It is not surprising that under the current regulation a large number of disputes and lawsuits have been initiated, but the authorities have not been able to advance any solution. This regulatory problem is aggravated by the vertical integration of the high-voltage transmission company (Transelec), even though the open-access law limits their monopoly power Transelec still retains important informational advantages with which can benefit its parent company. Being a subsidiary of Endesa, Transelec cannot guarantee fair treatment to other generators and, as a result fair competition is not achieved.

---

[37] C. Diaz,R. Soto “Open acces Issues in the Chilean Telecomunications and Electricity sector”, Universidad de los Andes, 1999

[38] C. Diaz, R. Soto “Open access Issues in the Chilean Telecommunications and Electricity sector”, Universidad de los Andes, 1999

5.1 Theory of Optimal Access Pricing

Before starting to analyze the case of Chilectra it is necessary to present a small synthesis of the current state of the economic theory of optimal access pricing. This theory has received a lot of attention in recent years and provides a useful framework for considering access-pricing problems. Almost all of the access-pricing theory is concerned with deriving the optimal access prices for a price regulated network monopolist. Therefore allocative efficiency is not a concern and the theory mainly focuses on the topics of efficient entry and long-term network investment decisions. The conclusions of this theory can be summarized in the famous Baumol-Willig[39] formula known as the "Efficient Component Pricing Rule" (ECPR):

Optimal Access Price = Marginal cost of access + Opportunity cost of access

This theory has been formalized by Armstrong, Dole and Vickers[40] by deriving the access pricing formula for a regulated network monopolist that provides access to a competitive fringe of price taking firms.

$$A=C_2 + \sigma (P-C_1) \qquad (1)$$

Where A = the access price, C_2 = the monopolist marginal cost of providing the access, C_1= the monopolist marginal cost of providing the retail service, and σ = the displacement ratio. When $\sigma = 1$ then equation (1) is equal to the ECPR, which basically states that the access pricing should be set to a level where entrance will not occur unless the entrant is more efficient than the monopolist. This happens only when the monopolist recovers its

---

[39] Armstrong, Mark and C. Doyle, "Access Pricing, entry and the Baumol-Willig Rule", mimeo, University of Cambridge, 1994

[40] Armstrong, Mark, C. Doyle and J. Vickers, "Access Pricing Problem: A Synthesis", Journal of Industrial Economics, 1996

marginal cost plus its opportunity cost. Therefore $(P-C_1)$ is the measure of opportunity cost.

The Armstrong, Dole and Vickers version of ECPR represented by (1) allows product differentiation, network bypass and technological substitution. Finally σ measures the rate at which the monopolist loses sales to the entrant as the charge varies. Decomposing σ into its three components provides:

$$\sigma = \sigma_d \times \sigma_b \times \sigma_t \qquad (2)$$

Where σ_d captures the effect of product differentiation, σ_b the effect of network bypass and σ_t the effect of technological substitution. If the price taking entrants and the monopolist provide the same homogeneous product then $\sigma_d = 1$ converting equation (1) into the ECPR. In the case where the entrant and the monopolist offer completely different products, an increase of one unit of access doesn't result in any loss of revenue to the monopolist. Therefore $\sigma_d = 0$ and $A=C_2$. Finally if the entrant is able to bypass the network of the incumbent then $\sigma_b = 0$ and $A=C_2$.

Laffont and Tirole argue that the regulator should also be concerned with the recovery of the incumbents' fixed costs through all the services provided, including access services. Therefore the regulator should add a markup to the access price in order to recover fixed costs added. Then the optimal access price can be expressed as:

$$A=C_2 + \sigma (P-C_1)+RMT \qquad (3)$$

Where RMT = the Ramsey markup term, which is an inverse function of entrants price elasticity of demand. Equation (3) is higher than the ECPR because it reflects the social benefit of selling access to entrants.

5.2 The Case of Transelec versus Colbun

The regulation law in Chile stipulates that when the capacity is limited or new transmission lines are required the transmission company and the interested firms must negotiate an agreement to undertake the expansion of the network. In this case the potential user has the choice of connecting with the network of the transmission company (therefore avoiding the investment) or invest money in order to build the lines to satisfy its own requirements. The law does not consider the possibility of asymmetric bargaining power, since the transmission is a monopoly and therefore the potential client has a bargaining power relative to the amount of electricity that it is going to transmit. In the case of the SING there is not an asymmetry in bargaining power since the customers are big mining operations that necessarily will require investment to extend the transmission lines, but in the case of the SIC the customers are small and spread out and building new transmission lines is not an option. These conditions increase the market power of the transmission company and allow it to obtain rents.

One of the clearest cases of this inefficient behavior in the transmission sector is the case of Colbun in 1995.[41] As explained earlier in the 1980's the electricity sector was owned mainly by the public sector, during this time Colbun sold most of its energy to Endesa and also distributed a part to its customers, for this Colbun relied on the transmission lines that at that time were owned by Endesa. Endesa charged a flat fee of 5 to 8 percent of the consumer price. The problem appeared in 1990 when this contract was finishing and therefore needed to be renewed. Endesa at that time was the sole owner of the transmission lines raised the charges of transmission substantially. Naturally both firms disagreed on the transmission tolls and connection fees. Neither firms could agree and finally they called an arbitration commission to settle the matters. In the meantime Colbun paid a tentative amount of $12 to $13 million, during the arbitration process. However the arbitrage commission couldn't determine the toll price, even though this process lasted for five years (from 1992 to 1997). Then in April 1994 Transelec demanded from Colbun payment of $21 million, even though prior to the dispute Transelect charged Colbun between $16 to $18 million a year. Finally Colbun rejected this decision, calling it a monopolistic and arbitrary decision. After this, Colbun, fearing that it could lose the arbitration and face large litigation expenses, decided to build its own transmission lines to Santiago. They concluded that their cost for building their own transmission lines was around $70 million, which represented $7.5 million a year in terms of Colbun's cost of capital. Yearly operation cost for a single 500Kv line would consume and additional $1 million, but for security reasons Colbun decided to go for a double 220kv transmission line, that raised the cost of yearly operation to $ 3 million a year. Finally, Colbun owning its own transmission lines would cost them only $11.5 million a year, or put in another way $4.5 million less than what Transelec wanted to charge them for the same service[42]. Therefore it shouldn't surprise anybody that Colbun went ahead and started to build its own transmission lines. Transelec fearing that it would lose its monopoly power followed a different strategy. First, it started to try to convince Colbun that the independent line was

---

[41] M. Aguilar, L. Lomuscio, H. Rudnick, "Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos", Pontificia Universidad Católica de Chile, 2001

[42] Soto, R. "Ambiguedades en la Tarifación de la Transmission Electrica en Chile" Universidad Alberto Hurtado, 1998

an inefficient solution due to the economies of scale of this sector[43]. Hence Transelec offered to Colbun a transmission fee of only $10.5 million a year. Also Transelec tried to stop the project by convincing the government that the second line was socially inefficient and that Enersis was willing to reduce the vertical integration between generation and transmission by retaining only 30% of the stock and selling the rest to the pension funds and other generating companies, but keeping the management of the company. Finally Transelec even proposed that Colbun only build a 500kv transmission line and use the lines of Transelec as backup. Colbun did not agree to any of this schemes and the government did nothing to intervene. It seems that Colbun thought that owning its own transmission lines would only cost them $1 million more than the offer from Transelec, and this cost could be easily shadowed by the legal cost of the trouble relationship with Transelec. Also it seems that the new offers didn't provide any assurance to Colbun that Transelec would not use its monopoly power in the future again[44].

This case can be examined using the theory of optimal access pricing previously explained. Using the formula for optimal access pricing, equation (1) of the formal model of a network monopolist (created by Armstrong, Doyle and Vickers that is also based on the ECPR): $A=C_2+\sigma\ (P-C_1)$ where $\sigma= \sigma_d \times \sigma_b \times \sigma_t$ and if we assume that Transelec behaved as a independent company that did not compete in the retail market with Colbun, then $\sigma_d=0$ since they provide completely different non-competing services. Therefore $A=C_2$ which basically means that the optimal access pricing should be equal to the marginal cost of the monopolist of providing access to the network.

---

[43] This is true if a whole new transmission line is build in a new region, however in a the case of a congested transmission line, like the case of Colbun, an expansion of the electrical network by constructing a new parallel line is not inefficient. Furthermore it is clear that an increase in the transmission capacity will foster competition on that region, under the assumption that there is open access to this infrastructure to the other players in the market.

This situation had an ironic twist later in 1997. Endesa decided to build a new hydroelectric power plant and Transelec requested permission from the government to expand the capacity of its transmission lines in order to accommodate the extra power. The government did not grant permission to expand the transmission lines under the concept that the new Colbun's transmission lines had the extra capacity required. The only trouble was that Colbun's new transmission lines were delayed in entering service until June of that year and Endesa initiated an arbitrage process in order to obtain compensation from Colbun's delays in the construction of its lines. This process was finally settled. From all these problems it became clear that the authorities had an important role to play letting Endesa and Transelec behave in an anti-competitive way. Therefore, allowing social losses, all this goes back to the 1982 Electric Law that failed to establish clear procedures for transmission tolls. The legal framework of 1990 that established the pricing system based on areas of influence didn't help much either since it failed to clarify several issues of the transmission sector regulation. The law also mandated that the CNE issue technical details for a transmission tariff within a year. However, it took the CNE almost eight years to issue the new rules and when they were finally released many companies disputed them in the Supreme Court[45].

All the previously mentioned issues are considered faults of the regulator, both technically and politically. One can start to understand the political failings when you see the two main energy holdings, Enersis and Gener, have interests in many countries in the region and therefore are able to have strong political lobbies in any matter concerning them.

---

[44] Soto, R. "Ambiguedades en la Tarifación de la Transmission Electrica en Chile" Universidad Alberto Hurtado, 1998

[45] The Chilean Supreme Court found that the new rules released by the CNE were inconsistent with the Electric Law of 1982 and issued some recommendations for its revision by the CNE.

Another point is the complexity of the statue, particularly regarding the network expansions.

6. Open Access Issues in the Distribution Segment

The distribution segment in the Chilean Electricity Sector is assumed to be a local monopoly. Therefore after the privatization many vertically integrated companies were forced to divide their distribution sector in order for it to be sold. In the case of a country as centralized as Chile, the main market for a distributor will be a major city, because of the large number of small consumers and not large consumers, since these, as we explain later, can buy their energy directly from the generating companies. Therefore in Chile the main market is it's capital, Santiago, where 45% of Chile's population lives. The distribution company of Santiago is Chilectra and is one of the main players in the market.

The sale of energy in the distribution sector is divided in to two markets; consumers with consumption above 2MW are allowed to negotiate their contracts directly with the generating companies, while those consuming below 2MW must pay for the distribution company's service at a regulated price.

The price or tariff is determined by two factors: the basic cost of energy and the cost of distribution. The regulator determines these costs every six months by the following methodology: first the regulator tries to calculate the nodal price of energy, which corresponds to the production cost at each point in the network[46]. These nodal prices are calculated considering a forecast of the short to medium run cost of energy production that is done considering the availability of water for the hydroelectric generation. Second,

---

[46] Including the energy losses due to transmission.

every four years the regulator revises the distribution cost according to an efficient model. Since such an efficient firm doesn't exist, a simulation model is used as a benchmark[47].

The flaw of the whole system is the assumption of symmetric information, under which the mechanism should provide an adequate incentive for firms to reduce their costs by competing with the simulated model. But since there is an asymmetric information environment, this mechanism is flawed since the regulator doesn't have enough information to assess the real cost structure of an efficient firm. Furthermore, since the market costs are influenced by the monopoly these distortions will tend to create a less competitive modeled firm.

6.1 Main access issues and the free clients

Another issue of concern in electric distribution is the main access, this relates to the ability of a generator to compete with distribution companies for those free clients located inside their concessions areas. In the SING this is hardly a problem since the main consumers are large mining operations that are most of the time located out of any concession area. However in the SIC this is not the case and a significant fraction of the clients are industrial and commercial and are located inside concession areas. The regulation of this proves to be incomplete leaving many loopholes. Specifically a problem exists in the area of electricity transformation from high voltage to industrial or commercial standards; this service is important and can be a significant part of the cost. In the case of large clients, generators usually provide their own transformers, but for medium sized consumers this is not economically feasible and the generator must ask the distributor to

[47] C. Diaz, R. Soto "Open access Issues in the Chilean Telecommunications and Electricity sector",

provide this service. Usually the distributor will try to extract rents for this service because it has the monopoly in the current concession.

7. The Electricity Crisis

During the period of 1998 until 1999 several events, but especially a drought that reduced the amount of energy generated by the hydroelectric generators, created one of the biggest energy crises in Latin America. Several factors increased the duration and severity of the crisis. Firstly many companies are blamed for their behavior during the crisis, but most of the guilt is attributed to the regulator that, according to the government, did not react fast enough to stop the blackouts allowing the accumulation of a 450GWh deficit. The main source of this crisis was a drought which showed the structural weaknesses of the energy generation and regulation in the SIC.

The great hydrologic variability to which the SIC zone of the country is vulnerable can have a significant effect during a year period. For example in 1995 (a humid year) the total demand was covered by the hydroelectric power plant while in a dry year like 1999 this proportion falls to about 40%[48]. This characteristic implies that in the case of the SIC there should be a clear mechanism to increase the flexibility of the price of the electricity in order to be able to reduce consumption during the dry years. This, because it is uneconomical to have thermoelectric generators completely stopped in the humid years, just waiting to get into service in the dry years. Another point must be that the use of water should be managed more carefully in order to avoid the moral hazard that the generator

---

Universidad de los Andes, 1999

[48] C. Diaz, A. Galetovic, R. Soto "La Crisis Eléctrica de 1998-199 causas consecuencias y lecciones" Universidad de los Andes, 2000

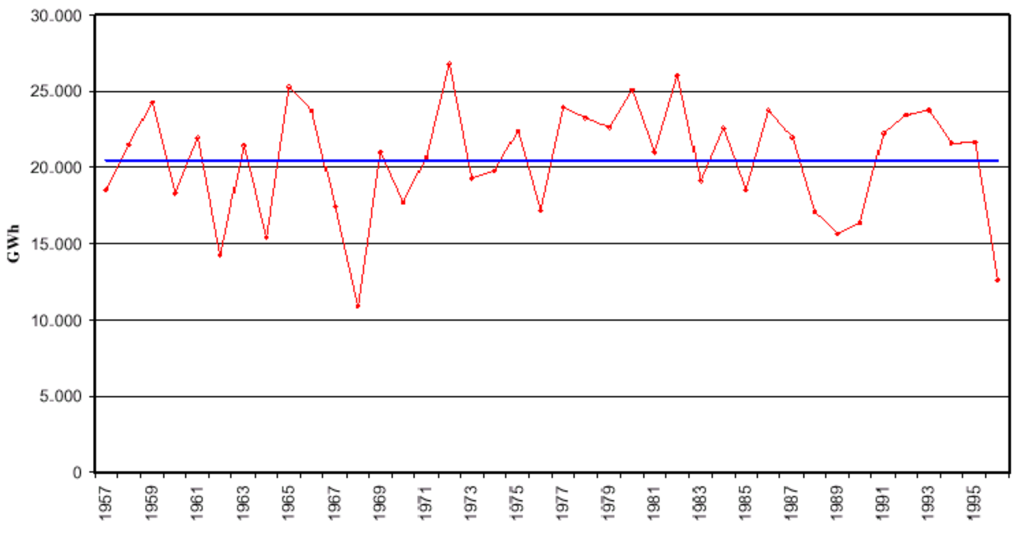
could have during the dry periods[49]. However the crisis provided many indications that the regulation is not flexible enough in order to accommodate the huge falls of energy supply by transmitting the real cost of opportunity to the users. The result is distorted price signals creating a market failure of electricity shortages.

7.1 The Hydrologic Variability in the SIC

The Chilean electricity system is extremely vulnerable to the hydrologic risk, because of their high dependence on hydroelectric power plants. Another aggravating fact is that the hydroelectric system does not have the capacity to collect water into their reservoirs inter-annually. This leaves the system vulnerable to the water precipitation of just one year. The only exception to this is the hydroelectric power plant in the lake Laja.

The following graph shows the variable amount of energy that could be generated in the SIC from 1957 to 1997

Hydroelectric Energy Generated by the SIC



Source: CNE

---

[49] Due to the fact that the long-term contracts hedge a price of a generator, in the case of a hydroelectric power generator failure or a drought the generator will be required to buy energy in the spot market to cover his contract. There could be a moral hazard if the generator decides to

The average energy generated in a normal year is approximately 21,000 GWh, which is equivalent to 80% of the energy demanded in the years of 1998 and 1999 (27,000 GWh). It is also clear that in a humid year like 1973 all of the energy consumed in the SIC can be generated by the hydroelectric power plants, but in the case of a dry year like 1969 or 1998 the energy generated approximately 10,000 GWh which is only able to cover 40% of the demand.

The consequences of this variability are that during extremely dry years like 1969 and 1998 the consumption will have to be reduced below the normal levels. This process will require strong price corrections since it is unrealistic to expect to increase supply by having an equivalent amount of thermoelectric capacity available. The amount of capital investment required to do this would take many years to recover and the dry periods do not last long enough to cover such investment.

Another point is that during a dry season the amount of energy that every company has to sell to its concession must be balanced by their dependence on hydroelectric power. For instance the main hydroelectric generators are Colbun and Endesa, therefore it is logical that in a dry season they will have deficits and will be forced to cover them with the supply of thermoelectric power, in this case the thermoelectric generator will have a surplus[50]. This didn't happen in Chile because the positions of the power generators were also dependant on their contractual structure this of course produced the bizarre situation

---

use water in a irresponsible way just to decrease the price of the spot price in order to minimize its loses.

[50] The main reason for this is the long-term contracts that hedge the price in the spot. In the case of a drought it is logical to assume that the hydroelectric generators will not be able to cover their contracts and be forced to buy the difference in the spot market that will probably be dominated by thermoelectric generators during the drought.

where the hydroelectric companies were having surpluses in the middle of a drought. This of course was the main cause of the abuse of the water reserves by these companies.

7.2 The price mechanism

The Chilean electric market in which generators, distributors and consumers exist is divided in three parts: The spot market where the generators trade energy at the spot price; the regulated market where distributors buy energy from the generators using contracts of medium or long term periods, the price for these contracts are set at each node and are fixed by the regulator (CNE) every 6 months; and finally the free market were the big customers (consumption above 2MW) can arrange contracts directly with the generators and/or distributors.

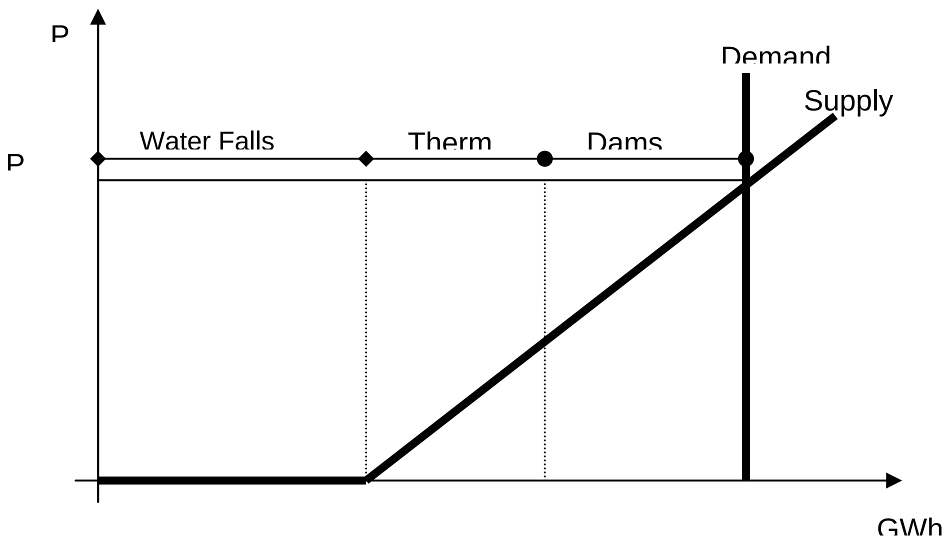
The spot market

The price in the spot market is set by the CDEC that has the obligation to force the electricity system to operate at the lowest marginal cost. Basically it forces the operators to fill their deficits by buying the energy with the lower marginal cost. In the Chilean case the first in line are the hydroelectric generators that are composed of two types, the waterfall generators (that have a zero marginal cost) and the dams. Second in line are the thermo electricity generators, but the thermo electricity generators are ranked by the cost of the fuel that they use and their efficiency in the conversion to energy. Therefore the thermo electricity generators that use natural gas are ranked first[51] followed by the oil and finally the diesel generators.

[51] The use of thermoelectric generators powered by Coal is not economic in many countries of South America, because of the lack of this natural resource.

The orders of the CDEC are mandatory for the energy companies, having priority over their own contractual arrangements[52]. The amount of energy generated by thermoelectric generators depends on the demand and also the level of water reserves. This quantity is calculated by the CDEC using a dynamic stochastic model called OMSIC[53].

This model tries to optimize the use of Lake Lajas water reserves. This therefore is the center of the price system used by the CDEC. The model tries to incorporate the economic benefit of not using fuels in order to generate electricity and in the case of a failure it also tries to reduce the amount of the failure. This can be seen more clearly in the following graphs:

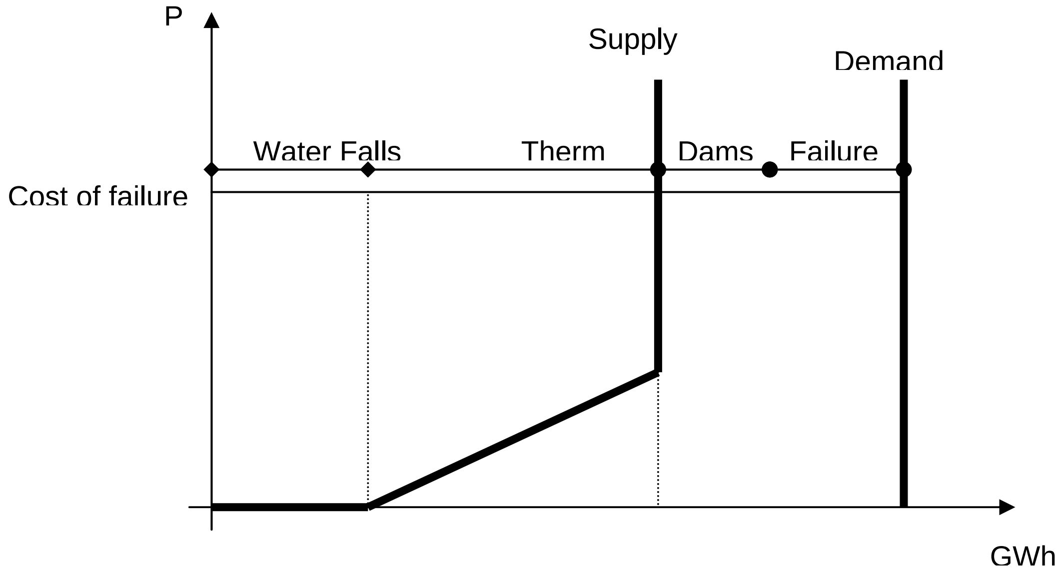


Under normal conditions it is not difficult to see that the price of the water will be the marginal cost of generating more energy using the most expensive thermo electric generation at that moment. Alternatively if there is an increase in the water precipitation the price of the water will diminish. There is also an opportunity cost, since the water that is used today won't be available tomorrow, the OMSIC model calculates how much water

---

[52] The short term dispatch decision by the system operator (CDEC) are done without any regard on any long term contracts.

is required in order to make that in the margin the benefit equals the cost. In the case of a failure the model can be used in order to reduce the amount of failure by controlling the amount of water used. In this case the cost of the water is higher and reserves will be treated more carefully.



It is clear that the use of the water today depends on the forecast of the water precipitations that can replace the water used, if there precipitation then the price of water falls, but if the season is dry then the value of the water reserves increases significantly. The OMSIC model predicts the precipitation level by using a stochastic model based on the previous hydrologic data of the last 40 years.

7.3 The regulated market

This is main component of the energy sector in Chile compromising almost 60% of the energy produced in the SIC, the trouble with this sector is that the prices are fixed at each

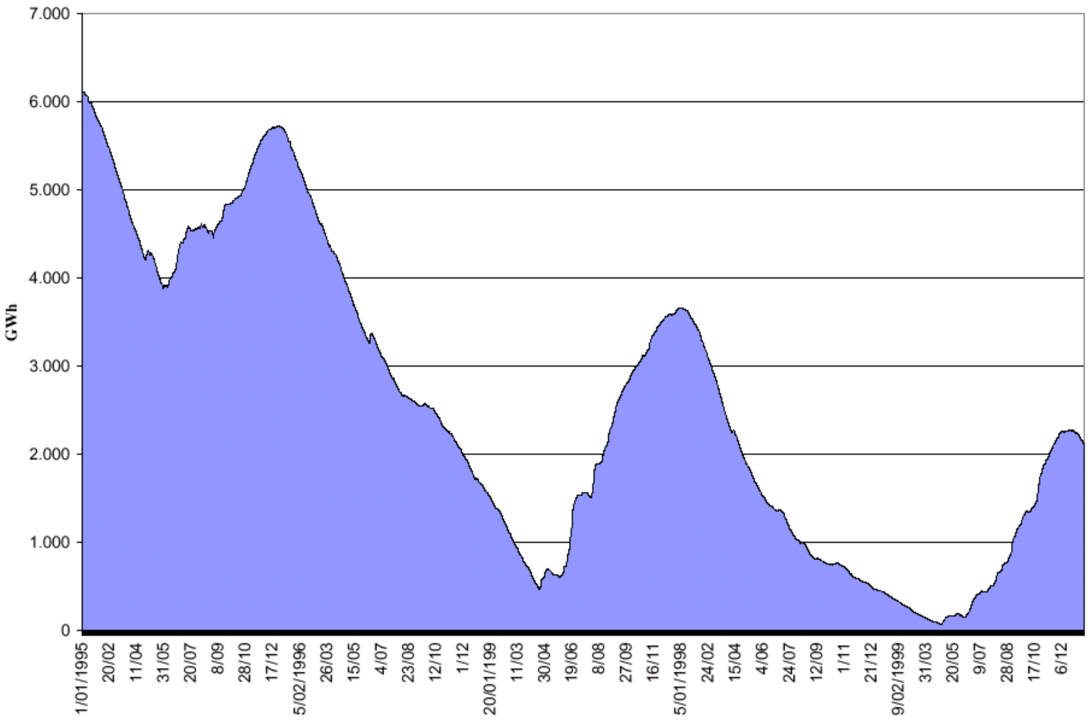
---

[53] C. Diaz, A. Galetovic, R. Soto "La Crisis Eléctrica de 1998-199 causas consecuencias y lecciones" Universidad de los Andes, 2000

node, and these prices are changed by the regulator every 6 months. The prices are the expected average of the spot price for the next 4 years, including the costs of failure if the model predicts some rationing. In order to do this the CNE uses another model called GOL that predicts the energy demand for the next 10 years. This model also tries to find the use of water that minimizes the expected cost. Like the OMSIC the GEOL model it incorporates the forty years of hydrologic water data[54].

The reserves of water are crucial to the price system and therefore one of the main causes of the crisis. As can be seen in the graph below, the water reserves in the dams were already low at the beginning of 1998 and they stayed like this until 1999.

Water reserves SIC 1995-1999

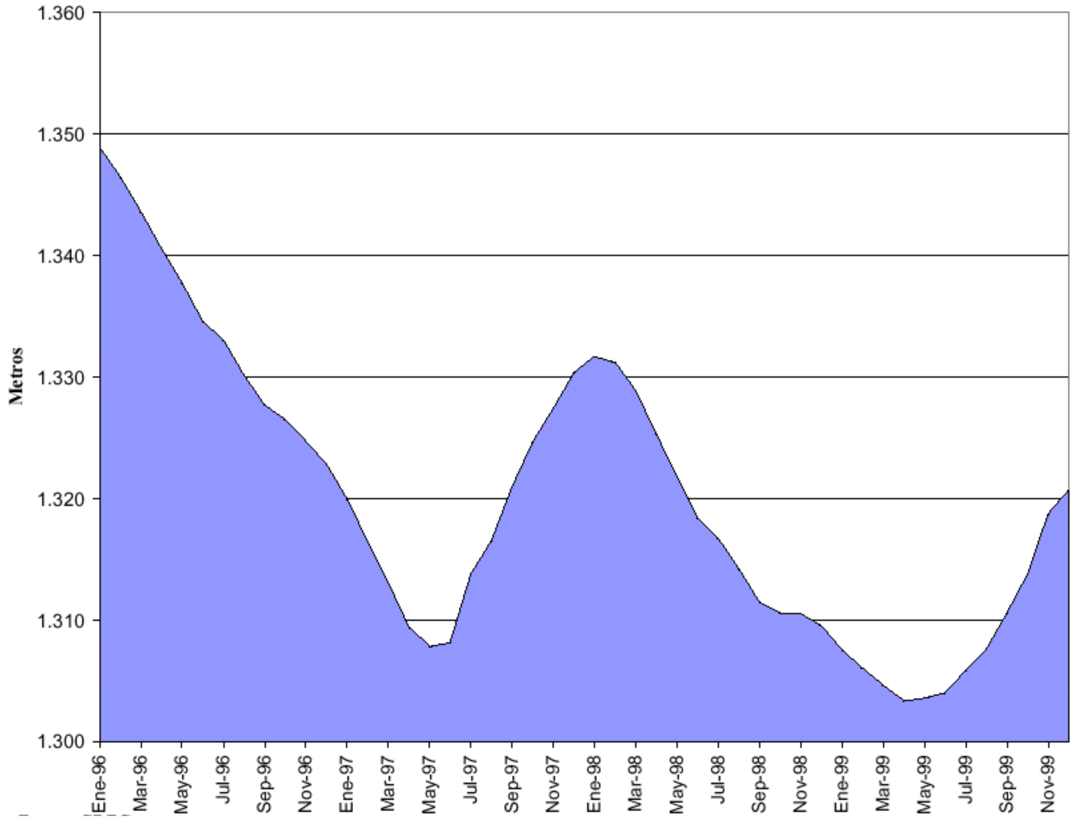


Source: CNE

[54] C. Diaz, A. Galetovic, R. Soto "La Crisis Eléctrica de 1998-199 causas consecuencias y

The main reservoir, as explained before, is the Laja Lake. The amount of water in this reservoir is measured by its height from the sea level. When Lake Laja is full this level is 1368 and when the altitude drops to 1,310 meters it is considered to be almost empty. As can be seen in the graph the Lake was almost depleted in 1997, later on there was some precipitation but this were not sufficient to fill the lake completely, therefore by the beginning of the crisis the lake had only one third of his capacity.

Water Reserves Lake Laja

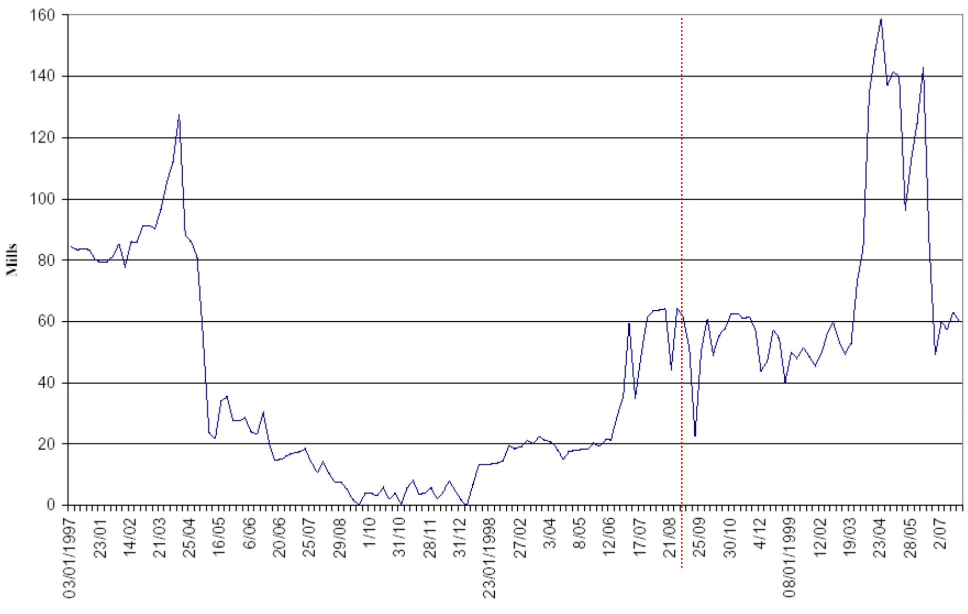


Source CNE

As can be seen in the next graph there was a very fast decline of the water reserves of the Lake Laja from January 1998 until May 1999, this is because the hydroelectric

lecciones" Universidad de los Andes, 2000 generators were used at their full capacity since February and as a government decision allowed a considerable increase in the water consumed by the farmers, equivalent to 315 GWh. The water reserves were completely exhausted by August[55]. This was clearly an irresponsible use of the water reserves so this will leave us to question what happened with the CNDEC and the OMSIC model that was supposed to at least try to make an efficient use of the water. In reality what happened is a struggle between the hydroelectric and the thermoelectric companies and specifically Colbun which was trying to avoid paying a high price differential between the spot market and the regulated one in order to cover their deficits. Therefore by generating more electricity by using hydroelectric generation the hydroelectric companies were able to depress the spot prices. It can be seen in the graph below that even though they knew that there was a drought the spot price was very low until the middle of June:

Spot prices January 1997 – July 1999



Source: CDEC, CNE

[55] C. Diaz, A. Galetovic, R. Soto "La Crisis Eléctrica de 1998-199 causas consecuencias y

Of course it is in the own interest of the hydroelectric generators to try to use the water as efficiently as possible in order to avoid a very step increase of price in the spot market. However, the case was that Colbun was counting in the timely deployment of their new thermoelectric power plant, Nehuenco. This power plant was a key to the crisis; with a capacity of 370MW it could supply 10% of the yearly consumption in the SIC. Nehuenco was scheduled to enter in to production in April 1998, but for technical reasons could not enter into production until December of 1998. Even then it was forced out of production in March 1999 due to a technical failure, which left the thermoelectric plant out of commission for the rest of the crisis. It is important to mention that if Nehuenco had entered in to production as was scheduled this could have had a big effect in diminishing the accumulated deficit, since Nehuenco has a capacity of 8 GWh this could have reduced the 81 days of the crisis to only 26[56]. Another important point is that if Nehuenco had entered into production, as planned, large amounts of water would have been saved. Therefore the crisis can't be attributed to a lack of investment by the generating companies.

The crucial point of the crisis was again the failure of Nehuenco, because it was included in the OMSIC model as available in the near future. This therefore allowed CDEC to use more water in order to keep the spot prices low. Some thermoelectric generators and especially Gener tried to negotiate with CDEC a mechanism to estimate the spot prices, because of the uncertainty of the date for its introduction in the system, however this mechanism was not accepted by the CDEC[57]. All these troubles were also exacerbated by the decision of the government to give water to the companies by their lobbies.

---

lecciones" Universidad de los Andes, 2000

[56] C. Diaz, A. Galetovic, R. Soto "La Crisis Eléctrica de 1998-199 causas consecuencias y lecciones" Universidad de los Andes, 2000

[57] "Camara de Diputados" Government of Chile, 1999

Endesa, being the biggest company in the sector, used all its influences to try to guarantee access to all the water possible. In this case the MOP sold water equivalent to 500 GWh to Endesa under the excuse of avoiding an interruption in the service[58].

7.4 Analysis of the crisis

It is clear to assume that the crisis could have been avoided if the CDEC didn't include Nehuenco in the OMSIC model, this would have allowed a more efficient use of the water and would also let the model raise the spot price more gradually, therefore expanding the amount of electricity generated by the Thermo electric companies.

The key point here is that there is a trouble of moral hazard for the hydroelectric companies. This was more clear in the case of Colbun, since it tried to avoid a rise in the price of the spot market and be forced to pay to the other thermoelectric generators a higher price in order to cover its own deficit. Colbun, however, was the owner of Nehuenco and therefore probably had better information about the date of introduction of the new central. From this we can conclude that Colbun played with the spot price creating a great deal of risk as was later proved by the delays in the introduction and finally the failure of Nehuenco. The fact that the spot price didn't react to all this risk in the market is a big flaw in the system. Since a higher price would probably have helped to internalize all this risk to the operators in the market, allowing an increase in the use of other thermoelectric generators much earlier and therefore saving more water.

[58] "Camara de Diputados" Government of Chile, 1999

8. Conclusion

The electricity sector in Chile shows many of the mistakes generated by Chile's privatization process despite the best efforts of the government, which privatized many companies before their respective regulative frames could be defined. This process, and specifically the privatization of Endesa, created a vertically integrated monopoly covering generation, transmission and distribution. It is paradoxical that a privatization process, which in theory intends to increase competition in a market, would have been allowed to generate such structure. It shouldn't surprise anybody that the resulting monopoly tried to exert its market power especially in the case of transmission. This uncompetitive behavior was allowed by the regulator, which can probably be explained by the strong lobbies that the Enersis group had with the government.

Another crucial point was the incomplete regulation for the transmission tolls in the law of 1982. This trouble was supposed to be solved by the law of 1990, but the new approved Toll mechanism was not clear and was susceptible to many distortions, one of the most amazing ones was the fact that a company in a certain area of influence would have to pay a toll even though is not using the transmission lines.

The fact that access to the transmission lines was used by Enersis as a barrier to the market is clear from the case of Colbun. Here, after many disputes with Transelec, Colbun finally decided to build their own transmission lines. It's also interesting how Transelec reacted in order to protect its market power by lobbing the regulator to try to stop Colbun. Finally it is clear that building a second transmission line helped to reduce the market power of the Enersis group. That's probably why the group decided to sell all its participation in Transelec in 2001.

The energy crisis of 1998 and 1999 also showed the structural flaws of the electricity system in Chile, because of the dominance of hydroelectric generation and the disappointing management of the water resources. The crisis proved that the mechanism for the management of the spot market under the CNEC was not flexible enough under the case of a failure, even though the drought was evident many months before the crisis started. Then again, the main cause of the crisis was the optimistic assumption that the Nehuenco plant would have entered production by April of 1998[59]. When the plant introduction was delayed until December 1998 and then finally a failure put it out of service in March 1999 the clear outcome was an energy crisis. The lack of a mechanism to transmit this risk to the spot market was a huge failure of CDEC, even though the thermoelectric generators offered several mechanisms. At the end the record of the regulators in the Chilean electric sector is disappointing.

The solutions to the regulatory framework in Chile will have to pass through the existing regulatory bodies starting by tackling the vertically integrated Enersis group. The regulator should consider forcing the group to sell generation (Endesa) in order to give more independence to their distribution company (Chilectra). It is clear that as long as the group participates in generation and distribution a competitive wholesale market will not be attainable. This contradicts with the main purpose of the deregulation process and should not be allowed to continue.

On the issue concerning the spot market failure during the crisis a possible solution should be to never allow any unfinished power plant to be included in the OMSIC model again. The regulator should create a set of clear and strict rules that dictate when a new

[59] This forced the CNEC to try to reach a low spot price, by using more water and therefore depleting the reserves faster

power plant is operative and only when all of them are met a new power plant should be included into the OMSIC model, therefore letting the CDEC set a higher marginal cost in the system.

The extreme inflexibility of the retail market is the biggest flaw of the system, since it only allows the retail price to change every six months. This inflexibility prevents the transfer of the real electricity cost to the consumer during dry years. The price mechanism for the retail market should be made more flexible, at least during droughts, by allowing the distribution companies to transfer the full price of the spot market to the consumers. The price increase will help to restrict demand during dry years and reduce the size of the failure.

9. References

- R. Selten, "The Chain Store Paradox", Theory and decision, 1978
- J. McGee, "Predatory Pricing Revisited", 23 Journal of Law and Economics, 1980
- F. Easterbrook, "Predatory Strategies and Counter Strategies", University of Chicago, 1981
- CNE. "Study on the Outage Cost in the Central Interconnected System", Santiago, CNE, 1986
- Schwarz, "In Competition", EC commission, 1987
- Staizer, "Changing Antitrust Standard", Conference Board, 1987
- World Bank. “The World Bank's Role in the Electric Power Sector. Policies for Effective Institutional, Regulatory and Financial Reform” The World Bank, Washington D.C. 1993.
- Armstrong, M., S. Cowan, and J. Vickers. ”Regulatory Reform: Economic Analysis and British Experience” MIT Press, 1994
- Armstrong, Mark and C. Doyle, "Access Pricing, entry and the Baumol-Willig Rule", mimeo, University of Cambridge, 1994
- Armstrong, M., S. Cowan, and J. Vickers. "Regulatory Reform: Economic Analysis and British Experience" MIT Press, 1994
- Armstrong, Mark, C. Doyle and J. Vickers, "Access Pricing Problem: A Synthesis", Journal of Industrial Economics, 1996
- Melo, J and P. Serra. “Competencia y regulación la experiencia chilena” Perspectivas 1997
- William Hogan, “The Visible Hand in Electricity: Using a Pool to expand customer choice or the ISO: "How not to get it wrong"", John F. Kennedy School of Government, 1997
- Soto, R. “Ambiguedades en la Tarifación de la Transmission Electrica en Chile” Universidad Alberto Hurtado, 1998
- Matias Carvajal, Felipe Reyes, Hugh Rudnick “Interconexion del SIC y el SING” Pontificia Universidad Católica de Chile, 1999
- “Briefing on Chilean Electricity Law” Potificia Universidad Católica de Chile, 1999
- C. Diaz, R. Soto “Open access Issues in the Chilean Telecommunications and Electricity sector”, Universidad de los Andes, 1999

- M. Aguilar, L. Lomuscio, H. Rudnick, “Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos”, Pontificia Universidad Católica de Chile, 2001

- C. Diaz, R. Soto “Open access Issues in the Chilean Telecommunications and Electricity sector”, Universidad de los Andes, 1999

- “Camara de Diputados” Government of Chile, 1999

- C. Federico Basañes, E. Saavedra, R. Soto “Post-Privatization Renegotiation and Disputes in Chile” Anti-American Bank of Development, 1999

- C. Diaz, A. Galetovic, R. Soto “La Crisis Eléctrica de 1998-199 causas consecuencias y lecciones” Universidad de los Andes, 2000

- Ahmed Kaloko, "Market Structure Overview Developments of Competitive markets", Pennsylvania Public Utility Commission, 2000

- Comisión Nacional de Energía, "Minuta Explicativa sobre la Ley General de Servicios Eléctricos", 2000

- Paul. L Joskow, J. Tiroley “Transmission Rights and Market Power on Electric Power Networks” Rand Journal of Economics, 2000

- Comisión Nacional de Energía, "Minuta Explicativa sobre la Ley General de Servicios Eléctricos", 2000

- Asia Pacific Energy Research Center, "Electricity sector deregulation in the APEC region", APEC, 2000

- M. Aguilar, L. Lomuscio, H. Rudnick, "Estructura de Propiedad del Sector Eléctrico chileno y su relación con la estructura de contratos", Pontificia Universidad Católica de Chile, 2001

- R. Fischer, A. Galetovic, “Regulatory Governance and Chile and Chile’s 1998-1999 Electricity Shortage” The World Bank, Washington D.C. 2001

- Paul. L Joskow, "Electricity Sector Liberalization Lessons Learned", MIT, 2002

- Paul. L Joskow, "Investing in new generation capacity", MIT, 2002

- P. Joskow and J. Tiroley, "Merchant Transmission Investment" MIT press, 2003