

Electricity Restructuring in Latin America Systems with Significant Hydro Generation

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Abstract – *This paper examines electricity industry restructuring in Latin America Systems with significant hydro generation. It focuses on governing the pool of a mainly hydro electric system in Chile, restructuring of the Brazilian electric market, electric sector reform in Peru, and the Colombian electricity market. Motivation supporting electricity industry deregulation, the main achievements, and the remaining challenges are discussed.*

First, the 1997 World Bank report that defines several conditions that a pool must fulfill to contribute to development of a competitive generation market is reviewed. Recent operation of the Chilean pool in face of a severe drought period in a mostly hydroelectric system that demonstrated that the pool does not fulfill these conditions and that changes must be implemented for the competitive market to develop is discussed. The main Chilean market, the concepts utilized in the design of the pool, the relevance of the hydroelectric dimension in the Chilean system, the problems faced in the pool over the last few years, and the solutions being implemented are then described. The paper then discusses the Brazilian restructuring process. The power sector requires US\$8 billion per year for new investments over the next 4 years whilst internal sector financing capability is approximately half of this value. Privatization of existing assets at both federal and state level is underway. Commercialization risks and possible mitigation mechanisms are then reviewed. The paper goes on to examine electric sector reform in Peru. Reform objectives, the new electric sector structure, electric business, and the electric market is discussed. The paper then describes briefly evolution of the Colombian electricity market: motivation supporting the Government's decision to de-regulate it, market operation and commercial bylaws, main achievements so far, and remaining challenges for strengthening the market.

Résumé – *Cet article aborde la restructuration de l'industrie électrique dans les pays Latino-américains ainsi que l'importance des systèmes de génération hydraulique. Il se concentre sur la gestion des réservoirs du système hydroélectrique principal du Chili, la restructuration du marché électrique du Brésil, la réforme du secteur électrique au Pérou, et le marché de l'électricité de la Colombie. La motivation de la dérégulation de l'industrie électrique, les principaux résultats, et les défis y sont discutés.*

Tout d'abord, le rapport de la Banque Mondiale, soumis en 1997, et qui définit les différentes conditions que les réservoirs doivent remplir pour contribuer au développement d'un marché de production compétitif est revue. L'opération ressentie sur les réservoirs chilien face aux périodes de sécheresse difficiles dans la plu part des systèmes hydroélectrique qui démontre que ces réservoirs ne sont pas conformes aux lois et que des changements doivent être effectués pour le développement d'un marché compétitif, est mis en relief. Le marché principal chilien, les méthodes de mise en œuvre d'un réservoir, l'intérêt de la dimension du système hydroélectrique du Chili, les problèmes rencontrés ces dernières années, et les solutions adoptées sont décrites. Ensuite, le processus de restructuration Brésilien est entamé. Le secteur de l'énergie nécessite 8 billion de Dollars US par an pour de nouveaux investissements au cours des quatre prochaines années alors que la capacité du secteur financier est équivalente à la moitié de cette valeur. La privatisation des structures fédérale et de l'état existantes est en voie de réalisation. Les risques commerciaux et les mécanismes de stagnation sont ensuite passés en revue. L'examen de la réforme du secteur électrique péruvien est aussi abordé. Les objectifs de réforme, la structure du nouveau secteur électrique, le commerce de l'électricité, et le marché de l'électricité sont présentés. Une brève discussion sur l'évolution du marché de l'électricité colombien est suivie, à savoir: la motivation de la décision du gouvernement de supprimer la réglementation, opération sur le marché et les arrêtés commerciaux, les principaux résultats obtenus, et les défis à relever pour le renforcement du marché.

Keywords: Electricity industry restructuring – Governing power systems with significant hydro generation
– Latin America electricity restructuring – Electricity deregulation – Electric sector reform.

1. INTRODUCTION

Ambitious national privatization programs have been committed in Latin America for more than 15 years. In the region there is an important contribution from hydro generation with major multi-annual reservoirs. These

characteristics have required particular arrangements in the deregulation process, on system dispatch, operational planning, pool pricing, and organization, etc.

This paper examines in a form not conveniently referenced in the technical literature heretofore competitive generation agreements and electricity industry restructuring of Latin America Systems with significant hydro generation. It focuses on governing the pool of a mainly hydro electric system in Chile, restructuring of the Brazilian electric market, electric sector reform in Peru, and the Colombian electricity market. Lessons to be learned from the deregulation process in these countries are addressed. The motivation supporting deregulation, main achievements so far, and remaining challenges are discussed. Market operation and commercial challenges, commercial bylaws, market participation and governance, settlements, and billing is reviewed. It is concluded that deregulation is successful in terms of its objectives although there is a long way to go.

2. COMPETITIVE GENERATION ARRANGEMENTS IN CHILE: GOVERNING OF THE POOL OF A MAINLY HYDROELECTRIC SYSTEM

A 1997 World Bank report defines several conditions that a pool must fulfill to contribute to the development of competitive generation markets. Among them are: pool not controlled by one agent or class of agents, non discriminatory market, transparent decision making, reliable operation in agreement with quality standards, and pool structure and rules may be improved as needed.

The recent operation of the Chilean pool and the increasing problems in its governance, in face of a severe drought period in a mostly hydroelectric system, has demonstrated that the pool does not fulfill these conditions and that changes must be implemented for the competitive market to continue developing. This Section describes the main Chilean market, the concepts utilized in the design of the pool, the relevance of the hydroelectric dimension in the Chilean system, the problems faced in the pool over the last five years, and the solutions being implemented.

2.1. Plant ownership, market power and cross ownership

The Chilean power deregulation process was a pioneer one worldwide and had no other references to rely on for market design. One of the areas where this is clear was in the lack of restrictions on market control and plant concentration. Although the privatization process aimed at avoiding cross ownership, selling separately the distribution and generation businesses, there were no legal restrictions, and concentration of ownership was developed. In the Main Central System (SIC), there are three main groups controlling generation. The Endesa holding, a hydro-based holding, has 56% of the installed capacity (1997 figures) with its Endesa, Panguel and Pehuenche companies. Gener, a thermal-based holding, controls 27% with its Gener, Guacolda and Electrica Santiago companies. Colbun, hydro-based, owns 10% of the generation capacity. The future interconnection between the hydro-based central SIC system and the thermal-based northern SING system will not change this concentration of ownership. Cross ownership is present, with the Endesa holding owning most of the transmission system. Vertical integration is present with a larger holding, Enersis, controlling the Santiago distribution company Chilectra, being the largest shareholder in the Endesa holding.

2.2. Design of the pool

The Chilean market model, unlike the models recently implemented in California, assumes that a central dispatch is needed to clear the market, thus playing the Adam Smith role. According to the law, companies engaged in the generation of electricity in Chile must coordinate their operations through one autonomous entity integrated by the principal generating companies for each interconnected network, known as Economic Load Dispatch Center (CDEC). The CDEC, as an independent operator, plans and coordinates the operation of the plants to ensure secure and economic efficiency in the electricity system, irrespective of ownership. Demand is therefore met by dispatching the available plants according to their variable production costs, from lowest to highest, and thus always at the minimum attainable cost. The assumption behind this is that with perfect competition, prices would be optimal marginal costs.

Generation companies meet their contractual sales requirements with dispatched electricity, whether produced by them or purchased from other generators in the spot market.

2.3. Relevance of hydroelectricity

Regulatory design in electric markets with a high hydrological contribution provides challenges that are different to the markets where thermal generation dominates. This has made several countries rely on cost based spot prices pool schemes rather than bid based arrangements. Argentina, Chile, Bolivia and Peru implemented cost based schemes, with Brazil following the same path. Argentina relaxed the scheme, allowing bids around

marginal cost. Only Colombia chose an open bid-based scheme, but it soon faced difficulties with dominant hydro generators that had to be intervened.

The controlled use of water through the year is very relevant in the SIC, where energy restrictions are the norm rather than that of capacity. Demand increases at the time water reservoir inflows decrease. With yearly demand growth rates between 7 to 9%, main increases arise in March, when the country holiday period ends and the school year starts, and in July, when winter consumption increases. The contrary takes place with water inflows, with an important reduction between January and April. Historical inflows usually follow three seasons. The first season is a rainy season extending from April to September, with inflows increasing in April/May, with a maximum with winter rainy storms in June/July, to decay in August. A second season is between September and December, where the snow in the Andes melt, with water inflows growing rapidly towards November, starting to reduce in December. The third season, a dry season, starts in January, with a drastic reduction of inflows through February, March and the beginning of April. Inverse processes take place in March/April; demand increases with water inflow reductions.

2.3.1. Extreme hydroelectric conditions test the pool model

Emergency conditions with severe droughts in Latin America are testing the regulatory models, particularly in countries by the Pacific Ocean. This has been dramatic in the Chilean case, where a critical supply condition arose in the SIC at end 1998 and beginning 1999. Water inflows remained constant and low throughout the hydrological year, with almost no rainy season and only minor increases between October and November, due to the melting of high mountain icecaps. A similar situation arose thirty years earlier in 1968-1969. However, at the time, the emergency was controlled with voluntary demand reduction and no shortages took place. Instead, the recent situation led to rotating blackouts in November 1998 and April 1999. In what is the most severe drought of the century, supply was endangered by the unreliable start-up of new combined cycle natural gas turbines (CCGT) that were due to be commissioned in early 1998.

The uncertainty of water inflows, high investment required for hydro plants and limited local energy resources in the country, combined with availability of low cost natural gas in neighboring Argentina, led private investors in Chile to build several gas pipelines across the Andes to feed new power plants and industrial consumers. A new combined cycle plant in Santiago started in 1997, with two more due to start in 1998. One of them, Nehuenco, was due to start by March 1998, which led the CDEC to plan water use accordingly. The plant commissioning was repeatedly postponed and finally, it only started at the end of 1998. To worsen things, both new combined cycle plants proved more unreliable than expected. The CDEC was faced with a condition where it had used most of its water reserves and there was no thermal backup to rely on.

The government had to intervene on two fronts; one in looking after society interests confronted with frequent blackouts, and the other in its legal responsibility to take decisions when CDEC participants did not agree unanimously. The pool model, the CDEC, had started operating in the SIC with a specific bylaw enacted in 1985. It operated well over the first ten years, with competition taking place on cost of supply (efficiencies were increased by generators, new technologies like CCGT were introduced) and on commercial actions (contract portfolios). However, as the extreme drought conditions damaged hydro businesses, and as competition increased and prices decreased with the arrival of natural gas, unanimous agreements became the exception. Reliability was endangered by disagreements and fines had to be imposed on participants following some unexpected blackouts in 1998.

2.4. Questioning of price regulations

One source of disagreement lies deeply in the price system defined by the law, both in calculation of spot prices and in regulated prices for small consumers. As indicated earlier, energy transactions between generating companies take place in the spot market. The price for those transactions is the instantaneous spot price, as determined by the CDEC. In a cost based scheme with hydro-generation usually dominant, hydro-thermal dispatch models are required to determine which is the spot price when a generator in a reservoir acts as the marginal unit. While the single bus multi-reservoir model called the OMSIC model has been in place for more than a decade, disagreements have arisen on new multi-nodal dispatch models being developed. However, matters aggravate when having to determine the spot price at the time of energy shortages. In a bid-based scheme, the bidders rise the price to what the market allows, depending on supply and demand.

2.5. Regulatory changes

Disagreements in the pool arose long before the extreme drought developed. The regulator, through the Minister of Economy, essentially directed actions of the pool, with no interest to do so. Therefore, a new bylaw was introduced in 1998 with changes to the decision process as well as to operation of the pool. An arbitration

expert committee assesses the differences before they are brought to the Minister, making recommendations to the CDEC governing board. This "learned" intermediate body will help solve most disagreements.

The bylaw also makes it compulsory for each CDEC to create an independent control center, managed by independent staff specially hired, in what could be defined as an independent system operator, although it will depend on the CDEC decisions. Previously, the system was loosely operated through agreements among CDEC participants.

3. COMPETITIVE GENERATION ARRANGEMENTS IN BRAZIL

The Section examines competitive generation arrangements in Brazil: system characteristics, the Brazilian restructuring process, and the mitigating mechanisms.

Brazil has a population of 160 million inhabitants, a land area slightly smaller than the United States, and economic output of nearly US\$ 800 billion, half of Latin America economic output. Industry output is responsible for 37% of the GDP, indicating its maturity level. Brazilian economy is integrated in a regional trade zone (Mercosul) with Argentina, Uruguay and Paraguay, the objective being to increase competitiveness of the regional economies.

Since 1990 Brazil has been committed to an ambitious national privatization program that was to be completed by the end of 1999. This program is part of the Brazilian effort to attract private and foreign investments in the infrastructure sector concentrating the state actions in areas as education and health. One of the measures to show opportunity for private investment in the infrastructure area is difference between financial requirement for the current year (more than US\$ 40 billion) and public sector expenditures in new infrastructure projects (US\$ 20 billion). For example, the power sector will require US\$ 8 billion per year for new investments over the following 4 years whilst the internal sector financing capability is approximately half of this value.

Privatization of existing assets at both federal and state level is underway. From 1995 to 1998, several large distribution companies have been sold to local and foreign investors. As a consequence, 51% of the distribution market is now owned by private agents. Total revenue was US\$ 22 billion. The privatization program of the distribution companies was completed by 2000, at which time 81% of this market was comprised of private companies [1].

3.1. System characteristics

The Brazilian power system is composed of two large interconnected systems. The first corresponds to the South, Southeast and Middle-West Regions (SSE) and the second, to the Northeast and part of the North Region (NNE). Since December 1998, a 500 kV, 1,000 MW, 1,000 km line interconnects these two systems.

The system is hydro dominated (more than 90% of the installed capacity) and characterized by large reservoirs presenting multi-year regulation capability, arranged in complex cascades over several river basins, including the world's largest hydroplant, Itaipu, with 12,600 MW installed capacity and jointly owned by Paraguay. There are also isolated electric systems of varying sizes, mostly located in the North region. Some of those isolated systems are of significant size, as they supply state capitals.

Load growth rates in Brazil have been historically high, mostly due to the country's industrialization effort. In the 1970s, average growth rates were 9%. Even with the economic recession of the late 1980s and early 1990s, growth rates averaged 4%. In 1997, firm load increase was around 6%. Forecasts made by GCPS (Coordinating Group for System Planning) indicate an average growth around 5.1%, for the next ten years [2].

3.2. Brazilian restructuring process

The objectives in implementing a new institutional and regulatory framework in Brazil are the following:

- ◆ ensure a secure and reliable supply of electricity
- ◆ encourage economic efficiency in all segments of the sector, notably through maximization of competition (where feasible), design of appropriate regulatory arrangements, and continuity of relevant system integrative functions
- ◆ support further development of economic hydroelectric sites
- ◆ create conditions which support continuation of the privatization program and make new investments attractive to the private sector, in particular through appropriate allocation of risks.

In the new trading model for the Brazilian electricity sector there will be a Wholesale Energy Market (WEM), in which all buyers and sellers of electricity can trade and in which the spot price of energy will be determined. The WEM will be created by a multilateral agreement which is compulsory for all generators with

installed capacity greater than 50 MW and for all distribution and retail companies with consumption greater than 100 GWh per annum. Large consumers with demand above the threshold for the free market (currently 10MW) can choose to become WEM members.

The main objectives of the WEM are[3]:

- ◆ to set a price which reflects, in each time period, marginal cost of energy on the system. This price will support long term bilateral contracts
- ◆ to provide a marketplace in which generators and retailers can trade their un-contracted energy
- ◆ to create a multilateral environment to support development of competition under which a retailer may buy from any generator and a generator may sell to any retailer.

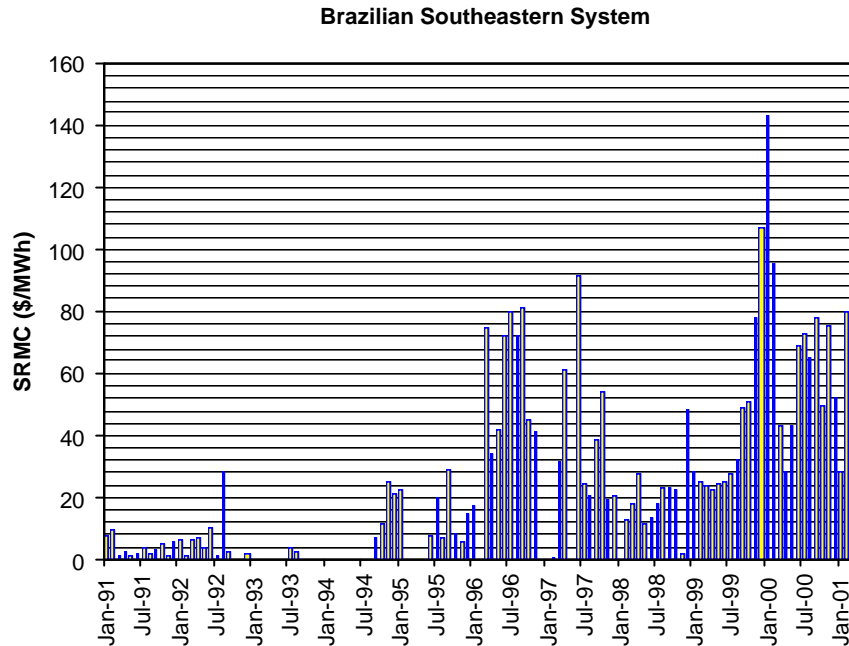


Fig. 1: Historical monthly short-run marginal costs for the Brazilian system

3.3. Mitigation mechanisms

In most restructured power industries, the clearing price for energy purchasing and sale is the short run marginal cost (SRMC). However, the application of SRMC in hydrothermal systems have some difficulties due the characteristics of those systems .

Predominantly hydro systems are designed to ensure load supply under adverse hydrological conditions, which occur very infrequently. As a consequence, for most of the time, there are temporary energy surpluses, which imply very low system short-run marginal costs.

In turn, if a very dry period occurs, SRMCs may increase sharply, and even reach the system rationing cost. Due to reservoir storage capacity, these low-cost periods not only occur frequently but can last for several years, separated by higher-cost periods, caused by droughts.

This pattern is illustrated in Figure 1 [4], which shows the observed hydro marginal costs in the Brazilian south-southeast system from January 1989 until March 2001. It will be seen in Figure 1 that the system SRMC was close to zero in 46 out of 123 months, and the longest wet period lasted for 25 months.

This punctuated price evolution results in a very skewed price distribution in each stage. For example, Figure 2 shows the forecasted SRMC cumulative distribution for the Brazilian South Eastern System calculated for January, 2003 [5]. Out of 2000 simulated hydro scenarios, there are 45.3% with marginal costs less than \$3/MWh, and another 50.1% whose costs range from \$3/MWh to \$50/MWh. In contrast, there are a few scenarios where the SRMC exceeds \$200/MWh.

4. ELECTRIC SECTOR REFORM IN PERU

This Section reviews reform objectives, new electric sector structures, electric sector agents, prices and tariffs, coordination of electric system operation, and control of quality of electricity supply in the process of electric sector reform in Peru.

Results achieved by the Peruvian Electric Power Utilities in 1990 showed that the electricity service had failed to reach its objectives. The electrification coefficient was only 48% and due to lack of reserve capacity there was a high risk of rationing the electric service.

The objective of the reform of the Peruvian Electric Sector was to establish the basis for a strong Electric Sector; able to assure an opportune, reliable and adequate service to the society; and with prices compatible with the economic costs of operation and expansion of the service. With this objective, the Electric Concessions Law (November 1992) and its Regulation (February 1993) was enacted to provide the legal framework for the reform.

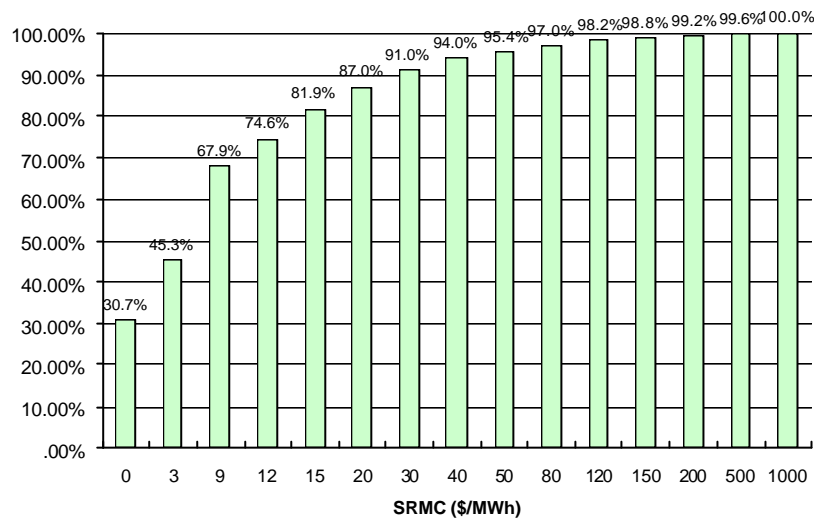


Fig. 2: Forecasted SRMC cumulative distribution - January 2003

4.1. Reform objective

With the objectives stated above, the Electric Concessions Law was enacted by Decree Law 25844 dated November 6, 1992 and its Regulation were approved by Supreme Decree 009-93-EM dated February 25, 1993. These provide the legal framework for promotion of all the activities related with generation, transmission, distribution and commercialization of electricity.

4.2. New electric sector structures

The structure of the electric sector established by the Electric Concessions Law and its Regulation are given below:

- ◆ Defines the Government role as Normative, Regulator and Controller.
- ◆ Redefines and reinforces the regulation institutions and those in charge of the Economic Operation of the system.
- ◆ Separates the generation, transmission and distribution activities in independent companies, establishing free competition in generation, open access to third parties in the transmission systems and recognition of efficient standard distribution.
- ◆ Establishes concession contracts as a requirement for the activities that use natural resources, property of the Government and/or require the imposition of rights of way, with service obligations.
- ◆ Establishes a price system that stimulates efficiency, penalizes lack of quality and the lack of security in the supply of service and also promotes investment in new installations.
- ◆ Establishes indemnities to customers by inefficiencies in the electric service.

- ◆ Establishes rules and procedures for developing generation, transmission and distribution activities, fixing prices and tariffs for electricity and establishing rights and duties of the electric concessionaires and customers.

4.3. Electric business

The types of electric business are:

- ◆ **As Generator.** (i) between generators, by transfer of power and energy at the short term marginal cost determined by the Committee for Economic Operation of the System (COES), as a result of economic dispatch; (ii) sell power and energy to the Regulated Market at Regulated Tariffs to Distribution Companies; (iii) sell power and energy to the Free Market at free prices to Generation or Distribution Companies and Free Clients.
- ◆ **As Transmitter.** (i) with Generators for transmission costs at regulated tariffs; (ii) with Distributors for transmission costs at regulated tariffs; (iii) with Free Clients for transmission costs at regulated tariffs .
- ◆ **As Distributor.** (i) sell power and energy to Final Regulated Clients at Regulated Tariffs; (ii) sell power and energy to Final Free Clients at Free Prices; (iii) with Generators for Transmission or Distribution costs at Regulated Prices.

4.4. Electricity business

Market Segments: In accordance with the Electric Concessions Law and its Regulation, the electric market is formed by the following segments:

- ◆ **Free Market**, constituted by those final clients whose contracted capacity is larger than 1,000 kW; they generally correspond to long term businesses at free prices and transactions are made with firm capacity and energy.
- ◆ **Public Service Market**, constituted by regulated clients whose contracted capacity is equal to or lower than 1000 kW; they correspond to long term businesses at regulated prices and transactions are made with firm capacity and energy.
- ◆ **Inter-generators Market**, constituted by the transference of capacity and energy between generators by economic dispatch that correspond to short term businesses at short term marginal costs.
- ◆ **Opportunity Market**, constituted by sales of capacity and energy, according to availability, correspond to short term businesses at free prices and transactions made with non-firm energy.

Relationship between Free Prices and Public Service Tariffs. The average tariff for public service clients cannot differ by more than 10% of the average free price for the same conditions of service.

4.5. Results

After five years of Peruvian Electric Sector Reform, the majority of the Share Capital of the Generation Companies EDEGEL, ETEVENSA, CAHUA, IEPISA and the most important distribution companies such as EDELNOR, Luz del Sur, EDE Cañete, EDE Chancay, Electro Sur Medio, Electronoroeste, Electronorte, Hidrandina and Electrocentro, are in Private hands.

New installed capacity between 1993 and 1998 was over 720 MW in the Central Northern Interconnected System, of which 520 MW was from Privatization Compromises and 200 MW was due to private initiative.

There is an Equipment Plan that assures satisfaction of the Demand. It has a Capacity Reserve of about 40% in the Interconnected Systems. In the medium term it is planned to interconnect the two main Systems to form the National Interconnected System.

Electric tariffs are set with different options that can be chosen by customers according to their load characteristics in both Medium and Low Voltage Supply, independent of the activities developed by them. Such tariffs reflect System Marginal Costs.

There are two Committees for Economic Operation of the System, for the Central Northern and the Southern Interconnected Systems, respectively.

At the end of 1998 the electrification coefficient had reached about 70%. The Peruvian Electric Sector consists of an installed capacity of 5,600 MW with an annual production of 17,500 GWh. The electricity Sector consists of two main interconnected systems, the Central Northern Interconnected System (SICN) and the Southern Interconnected System (SIS), plus several isolated regional systems and smaller systems.

The SICN has the largest installed capacity and supplies electricity to approximately 12.6 million inhabitants. The SIS supplies electricity to approximately 2.5 million inhabitants and the Isolated Systems supplies electricity to approximately 2.0 million inhabitants.

5. COLOMBIAN ELECTRICITY MARKET

This Section describes evolution of the Colombian Electricity Market, the motivation supporting the Government's decision to deregulate it, market operating and commercial bylaws, the main achievements obtained so far, and the remaining challenges for strengthening the market[6-8].

5.1. Background

Electricity services in Colombia were provided by government-owned utilities with small or negligible participation of the private sector and supported financially by multilateral banks such as the World Bank and Inter-American Development Bank. National, regional, municipal or special status utilities were born from regional endeavors. They grew up with neither unified vision nor centralized planning for overall system development and operation. Vertical integrated utilities provided electricity services.

Between 1987 and 1990, an Adjustment Program in the power sector was carried out. This showed that, for achieving a healthy financial status, structural changes to invigorate the electrical industry were required. In May of 1991, through the National Council of Social and Economic Policy (Consejo Nacional de Política Económica y Social -CONPES-), the National Government formulated the 'Strategy for re-structuring the power sector'. This was based on the following postulates: (a) energy diversification with increasing gas participation; (b) introduction of competition as a means to improve efficiency, introduction of a regulatory framework implemented and managed by the National Government, and policies to stimulate private investment; (c) pricing mechanisms of resources based on true economic costs; and (d) open access to transmission and distribution networks with regulated charges.

In 1991, a new Political Constitution was enacted. It assigned to the State the responsibility to achieve improved efficiency in the provision of public services. It established the competition mechanism, accepted private agent participation, and strengthened the role of the State as regulator.

In July of 1994, the Colombian Congress passed the Public Service Law (Law 142)[6] and the Electricity Law (Law 143)[7]. The Public Service Law established general principles and policies to rule provision of Public Services[7] in the country as well as the procedures and mechanisms for its regulation, surveillance and control.

The following issues reflect the purposes of both Laws to solve structural problems of the Colombian electricity industry:

- * Creation of a competitive market as a means to promote efficiency.
- * Promotion of private participation in order to strengthen competition and to incorporate other sources of capital.
- * Flexible operating and expansion planning by means of establishment of indicative planning to guide the decision making process.
- * Regulation of natural monopolies to prevent abuse against customers.
- * Rational rather than political procedures to set tariffs and an efficient subsidy allocation.
- * Re-structuring of utilities to introduce modern and sound management principles.
- * Granting budgetary, administrative and financial autonomy to state owned utilities so that they can operate in a competitive environment.
- * Surveillance and control of market participants to ensure efficiency, quality, and continuity in the electricity service provision.

On July 20 1995, new rules where competition is the key issue for improving efficiency changed the operation and the way of doing business in the Colombian power sector.

5.2. System description

The Colombian power system consists of a single interconnected network to supply almost 99% of the total demand. The remaining demand (just over 1 % of the total demand), is covered by local generation. In 1998, peak load was 7,506 MW. Energy demand accounted for 44,024 GWh. Consumption was split among the different sectors as follows: 44.0 % residential, 24.0 % industrial, 22.0 % includes commercial, government-owned entities, lighting and other consumption. 53.8% of the demand was located in the four largest cities (Santafé de Bogotá, Medellín, Santiago de Cali and Barranquilla). Energy losses represented 22.5% of total production.

5.3. Market participants and government

The Electricity Law defines the functions of policy-making, planning, regulation and operation as well as the

role of entities and agents involved in any electricity business activity (Generation, Transmission, Distribution and Trading) related to the electricity industry.

Generation: Consists of production of electricity from primary energy sources such as: hydro, coal, gas, diesel and fuel oil. It is a full competitive activity with the greatest and most dynamic private investor participation in recent years. Private and Government Generators in Colombia in 1995-99 is shown in Table 1.

Generators must submit offer prices to the System Operator for each of their generating resources (units or power plants) having an installed capacity greater than 20 MW. When the installed capacity is below 20 MW, Generators may, at their discretion, submit offer of prices for these generating resources.

Generators can trade by themselves their production in the Power Exchange and with Traders in the Long Term Energy Market. Generators are free to participate in any auction open by Traders to provide Bilateral Contracts for Regulated or Non-regulated Customers.

Table 1: Private and government generators in Colombia in 1995-99

Generators	July 1995	Sep 1997	July 1998	Jan 1999
Private	1	5	13	15
Government	16	14	14	13
Total	17	19	27	28

Transmission: Consists of the transport of bulk power from production centers to customers or to Distribution Networks through transmission networks with voltage levels of 220 kV and above called the National Transmission System (STN). STN is a multi-owner network where Interconexión Eléctrica S.A. ESP (ISA) has the largest share. This participation increased up to 80.3% in 1998 with the acquisition of 65% of shares of TRANSELCA, a transmission company that serves the north region. This is the second largest company with the 7.67% of the property of STN. Almost the 2.76% of STN is owned by private investors, 88.87 % by mixed companies and the other 8.37% by government-owned companies.

Transmission ownership is indicated in Table 2.

Table 2: Transmission Ownership in Colombia 1995-99

Transmission Owners	July 1995	Sep. 1997	July 1998	Jan 1999
Private	0	3	3	3
Government	10	8	8	9
Total	10	11	11	12

Trading: Consists of purchasing energy in the wholesale energy market, short and long term, and selling it to end customers. This business activity did not exist before. Government participation decreased from 94.6% in 1995 to 70.9% in 1998, while private participation increased from 5.4% to 29.1% in the same period. The number of Private and Government Trading Companies 1995-1999 are given in Table 3.

Table 3: Private and Government Trading Companies in Colombia 1995-99

Trading companies	July 1995	Sep. 1997	July 1998	Jan 1999
Private	2	11	41	21
Government	32	35	35	35
Total	34	46	76	56

5.4. Challenges

Market mechanisms: Market mechanism expressed simply is the process of offers (supply) and bidding

(demand) for services and goods to maximize market participants' utility under a freedom framework to make decisions. Markets where all agents are price takers are the best mechanisms for price formation. Public Services and Electricity Bills introduced the need for free competition as a necessary condition for improving efficiency in the resource allocation process that will reflect in real terms a reduction in customer tariffs. Governance entities are conscious of this. However, introduction of market mechanisms for trading electricity has been timid.

Competition was introduced the first time in 1995 in the supply side by means of the Offer of Prices of Generators (but not availability that has to be declared) to trade energy in the Power Exchange. However, bidding on the demand side is still pending .

During operation, Load Following requires additional reserve that is called up on instructions of the System Operator. On the other hand, deviations of Real Generation from Final Generation is based on the penalty mechanism instead of using flexible market mechanisms. Generators claim for mechanisms to optimize use of their resources at very short notice and in real time operation.

In Bilateral Contracts for the Non-regulated Market, parties are free to agree prices and quantities, but there is not any simultaneous concurrency of Generators and Traders in the market. In the case of the Regulated Market, Traders are mandated by regulation to contract at least the percentage of regulated customers demand established for the corresponding year. Market participants would like to have new products including standardized physical and financial instruments administrated by a clearing house.

There has been substantial advance in Customer choices from 1997, but absence of flexible procedures and low costs technology for metering has limited the dynamics of these options.

Starting January 1 1999, competition to build new transmission assets resulted in a cost reduction in transmission and so in a reduction in use of transmission system charges. The challenge consists on setting and strengthening this mechanism in transmission and on introducing a similar mechanism in distribution.

Andean Power Exchange: Bolivia, Colombia, Ecuador, Peru and Venezuela are the Andean countries. They are already integrated in the trading of manufacturing products through the Andean Community of Nations (Comunidad Andina de Naciones-CAN). Also, during the last years local Investment groups have crossed borders and extended their business to those countries. During 1997 and 1998, the Electric Commission for Regional Integration (Comisión de Integración Eléctrica Regional-CIER) carried out a study in South-American countries to identify integration opportunities. In 1992 Colombia and Venezuela commissioned a 230 kV line with transfer capacity of 100 MW. With the installation of reactive power compensation on this line and a new line built later, this transfer capacity increased up to 240 MW. In 1998, Ecuador and Colombia commissioned also a line at 115/138kV with transfer capacity of 33 MW. Another and stronger interconnection between Ecuador and Colombia is under study.

This shows that for implementing the Andean Exchange, it is required first to develop physical routes to transport the energy and then to develop the rules and protocols to govern this market. A possible scheme to implement the Andean Exchange is to start first with market integration of Colombia and Venezuela, then to continue with integration of Ecuador, and so on.

5.5. General Conclusions

Deregulation of the electricity market in Colombia has been shown to be a successful process in terms of its initial objectives. Although there is a long and hard way to run, it is clear that nobody wants to go back. Achievements correspond to the past but challenges are for the future. Governance entities have a big challenge for the future, i.e., to strengthen and to develop market mechanisms to the benefit of customers and investors.

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