ECONOMÍA

SERIE DOCUMENTOS

BORRADORES DE INVESTIGACIÓN

No. 12 Mayo 2001

ISSN 0124 - 4396

Regulatory Reform in Colombia's Electric Utilities

Carlos Pombo

UNIVERSIDAD DEL ROSARIO

Regulatory Reform in Colombia's Electric Utilities

Carlos Pombo[1]
capombo@claustro.urosario.edu.co

Abstract
This paper analyses the process of regulatory reform in Colombia's electricity supply industry during the nineties. In order to provide a comprehensive view about the reform's motivations the first part of the essay describes the key features in the development of the power sector, the institutional structure and the economic performance since the seventies that end up in a general power shortage in 1992. Afterwards, it discuses based on the evolution of some technical indicators the causes of the 1992 power crisis. The second part emphasizes on the regulatory theory beneath the reform, the privatization process, the new regulatory institutions, and the evolution of the electricity spot market.

Resumen
Este documento analiza el proceso de reforma regulatoria que sobre la industria de oferta de energía eléctrica tuvo lugar en Colombia en la última década del siglo pasado. Para exponer las motivaciones de dicha reforma, la primera parte del documento describe los elementos claves del desarrollo del sector, su estructura institucional y comportamiento económico desde inicios de 1970 en adelante, hasta terminar en la crisis energética de 1992. Posteriormente,, con base en algunos indicadores técnicos se discuten las causas de dicha crisis. La segunda parte del ensayo hace énfasis en la teoría regulatoria subyacente a la reforma, el proceso de privatización, las nuevas instituciones regulatorias y la evolución del mercado de oferta eléctrica.

JEL Classification L51, D82

I. Introduction

By the beginning of the nineties, the Colombian government began an economic openness program, through the promotion of market competition and institutional deregulation. The economic openness package included major structural reforms in the i) foreign trade policy, ii) exchange rate regime, iii) capital flow controls, iv) central bank independence, v) privatization programs, vi) labor legislation, vii) foreign investment legislation, and vii) social security and pension regimes[2].

The industrial policy in turn, gradually abolished its direct promoting instruments, such as the assembly regime, direct funding, export subsidies, and non-trade barriers. The role of public investment

---

[1] Associate professor, Department of Economics, Universidad del Rosario, Bogota, Colombia. E-mail: capombo@claustro.urosario.edu.co.

I would like to thank Werner Baer and Manuel Ramirez for his comments on earlier drafts of this paper. Special thanks to Rodrigo Taborda for his research assistance, and the UPME for the copies of the SINSE and OLADE databases. Remaining errors are my sole responsibility.

[2]The general objectives and the scope of economic openness program are in the development plan 1990-1994 [DNP (1991a)]. The main institutional reforms are in the following laws and CONPES documents: i) foreign control regime (Law 9/1991), ii) foreign trade reform (Law 7/1991), iii) financial reform (Law 45/1990), iv) new statute of foreign investment (CONPES document - January 22/1991), v) labor reform (Law 50/1990), and vi) privatization of maritime ports (Law 1st /1991). These laws are collected in DNP (1991b).

switched toward those areas that can improve overall input efficiency. Thus, the plan emphasized in prioritizing investments in physical infrastructure, education, and social spending.

The *electricity supply industry* (ESI) undertook the most important institutional reform since 1967 when the national grid company - *Interconexion Electrica S.A (ISA)* - was established. The reform sought to introduce new competition within the sector and set up an independent and operative regulatory system. In that direction, the main purpose was to set the bases for the expansion and diversification of the generation sources that improved both the sector's efficiency and its reliability. The political willingness in support of this reform was most favorable by 1992, because the country was in the middle of a generalized blackout and rationing schedules. The generating system had to be less vulnerable of abnormal hydrological conditions (i.e. *el niño*) and should favor thermal generation based on either coal or natural gas. The country has the comparative advantage in the endowments of these fuels. For instance, the share of Colombia's reserves in thermal coal is 50% of Latin America's and 3% in natural gas; and the ratio consumption to reserves is 0.10% and 3% respectively. This shows that country's energetic potential is unconstrained relative to long run demand growth [table 1].

Table 1
Natural Gas and Mineral Coal Reserves

	Natural Gas Reserves (10^9mts3)							Mineral Coal Reserves (10^6 Tons)					
	Colombia		Latin America					Colombia		Brasil	Total		
Year	Continental Reserves	Domestic Demand	Continental	Open Coast	Total	(1)/(4) %	(2)/(1) %	Reserves	Domestic Demand		Latin America	(8)/(11) %	(8)/(9) %
	1	2	3	4	5	6	7	8	9	10	11	12	13
1980	169.9	3.4	4,443.1	72.7	4,515.8	3.8	2.0		4.09	1,849.0	1,849.0		
1981	177.2	3.7	4,387.9	376.8	4,764.7	3.7	2.1		4.20	1,883.0	4,419.0		
1982	130.3	4.0	4,668.7	418.7	5,087.4	2.6	3.0		4.29	2,047.0	4,583.0		
1983	121.8	4.4	4,712.7	432.9	5,145.6	2.4	3.6		4.49	3,722.0	6,258.0		
1984	109.0	4.4	4,798.1	458.7	5,256.8	2.1	4.0	3,892.0	4.55	4,097.0	10,816.9	36.0	0.12
1985	110.0	4.4	4,885.3	458.9	5,344.2	2.1	4.0	4,974.0	4.58	4,986.0	12,787.9	38.9	0.09
1986	110.0	4.4	5,635.8	556.9	6,192.7	1.8	4.0	5,339.0	4.55	5,289.0	13,585.6	39.3	0.09
1987	114.0	4.4	5,561.3	835.6	6,396.9	1.8	3.9	5,339.0	4.70	5,292.0	14,136.6	37.8	0.09
1988	123.0	4.5	5,776.2	833.3	6,609.5	1.9	3.6	5,339.0	4.62	5,337.0	13,909.2	38.4	0.09
1989	119.2	4.3	5,953.0	797.4	6,750.4	1.8	3.6	4,578.9	4.82	5,325.0	13,149.4	34.8	0.11
1990	114.4	4.5	6,188.5	782.9	6,971.4	1.6	3.9	6,442.6	4.78	5,314.0	14,786.2	43.6	0.07
1991	115.5	4.6	6,339.7	782.7	7,122.4	1.6	4.0	5,897.0	4.95	5,309.0	14,279.3	41.3	0.08
1992	167.0	4.5	6,300.5	790.7	7,091.2	2.4	2.7	6,540.0	5.56	5,314.0	15,100.3	43.3	0.09
1993	211.0	4.7	6,569.3	798.7	7,368.0	2.9	2.2	6,562.0	5.72	5,301.9	16,667.0	39.4	0.09
1994	215.2	4.6	6,568.8	838.1	7,406.9	2.9	2.1	6,584.0	5.48	5,301.9	16,699.2	39.4	0.08
1995	221.1	5.0	6,682.3	921.9	7,604.2	2.9	2.2	6,594.0	5.55	5,291.0	16,616.4	39.7	0.08
1996	217.3	5.3	6,840.9	1,027.9	7,868.8	2.8	2.5	6,749.0	4.81	5,285.0	16,346.2	41.3	0.07
1997	223.6		6,709.2	1,095.6	7,804.8	2.9		6,648.0		5,278.8	16,163.1	41.1	
1998	240.1		7,074.4	981.8	8,056.2	3.0		6,636.6		5,278.8	16,143.1	41.1	

Sources: OLADE, Domestic Demand: UPME-Energetic Balances
Notes: Proved reserves in all types of Mineral Coal (Thermal + Coke + Lignite + Antracit + Turba)

The reform's targets were therefore, to promote: i) competition in electricity generation, ii) private investment, iii) unrestricted access to the transmission and distribution grid, and iv) new regulatory schemes. The political economy beneath the ESI restructuring took into account the main features of the British and Chilean experiences where the reform sought to separate the natural monopoly structure between generation and transmission. However, the causes that led to this restructuring were different in each case. In Colombia besides the *el niño* phenomenon, bad sectoral planning, poor economic performance, and inadequate regulatory policy exacerbated the 1992 crisis. The first two ended up in a generalized financial insolvency of the regional electric companies, the sector's over-indebtedness, the lack of development of new thermal capacity generation along with the shutting down of existing thermal plants.

The purpose of this essay is to describe the process, causes and some results of the recent regulatory reform in Colombia's electricity supply industry, in order to highlight and put the experience within the international context. The regulatory reform in Colombia's electricity supply industry, has not been stressed enough in studies of Latin America's experience and lessons of the new regulatory framework during the nineties. One example is the study of Spiller & Guash (1998), which they mention tangentially the Colombian experience, and for the power sector they do not present the entire picture, motivations and instruments of this institutional reform.

The paper is organized in four additional sections. Section 2 describes the development, institutional structure, and sectoral public policies since the seventies until 1992. Section 3 links the analysis of the previous section with the study of several performance indicators that explain the sector's bottlenecks that ended up in the 1992 power shortage, and why this failure encouraged to a drastic ex-post regulatory reform. Section 4 describes the main features of the reform such as the economic principles behind the process, the new institutional structure, the privatization outcomes, and a brief analysis about the performance of the newly electricity spot market. Section 5 offers some concluding remarks.

II. Institutional Structure before the Reform

The regulatory system was *obsolete* as the government itself admitted during the 1992 power rationing[3]. The institutional structure responded to a centralized system, designed to undertake large infrastructure projects. In that sense, investment was channeled to boost power generation capacity, grid expansion, and geographical coverage. Funding came mainly from the World Bank and the Inter-American Development Bank[4], which favored a centralized sector planning from the *National Grid Company* (ISA). Thus, ISA had a predominant role in Colombia's ESI expansion and development since 1970. ISA is a mixed capital company, and was in charge of the planning, construction, property, and operation of the larger generation and transmission projects for the *national inter-connected system.*

The grid up to 1976 consisted of the connection of four regional power systems: Bogotá Power Company (EEB), Public Enterprises of Medellín (EPM), Autonomous Corporation of Cauca (CVC), and the Colombian Electric Power Institute (ICEL)[5]. This network covered most of the country's Andean region. The other important network, the Atlantic Coast Electric Corporation (CORELCA) covers the country's North region. This regional grid is a holding of regional electric companies from the Atlantic coast provinces, where the ESI rest on thermal generation, because this region has the country's largest reserves of coal and natural gas[6]. In August of 1976, the government, the World Bank, and ISA shareholders agreed that CORELCA would become a shareholder of ISA as well as its distribution network an integrated part of ISA's grid[7].

The sectoral institutions and regulatory system were set up after 1967 to support the centralized decisions through ISA regarding individual investment projects in generation and transmission, and to undertake ESI's expansion plans. The ESI structure had minor changes during the 1967-1992 period, which is fairly described by figure 1. The electricity sector in Colombia before the regulatory reform consisted of three types of institutions according to their jurisdictional action: i) national, ii) regional, and iii) municipal. The national grid became an integrated system in 1983 when the 500 kV transmission line was completed[8]. Seven companies generated, transmitted and distributed all the electric power within the country. Three were municipal public enterprises: EEB, EPM, and EMCALI. The first two are power generators and local distributors. The latter is the largest distributor company in the city of Cali and its province[9].

Two regional holdings: ICEL provides and distributes electricity in all the Andean region excepting the geographical areas covered by the municipal enterprises, as well as the non-interconnected areas of the country, mainly located in the Eastern planes -*Orinoquia*- and Amazon provinces[10]. The generation in these

---

[3] See Ministry of Mining and Energy (1991-1992), *Report to the Congress*.

[4] Between 1970-1987, the loans from these institutions add up US 5000 million dollars. Total country's foreign debt balance in 1987 was US 13842 million dollars.

[5] These enterprises were the former shareholders of ISA.

[6] The second electrification plan (1962) conducted by the mission of *Electricité de France*, suggested that the ESI in the Atlantic Coast region would be based on two thermal plants located in Cartagena and Barranquilla, the larger cities in the region. For more details, see Sanclemente (1993).

[7] The deal was called the *Sochagota Agreement*.

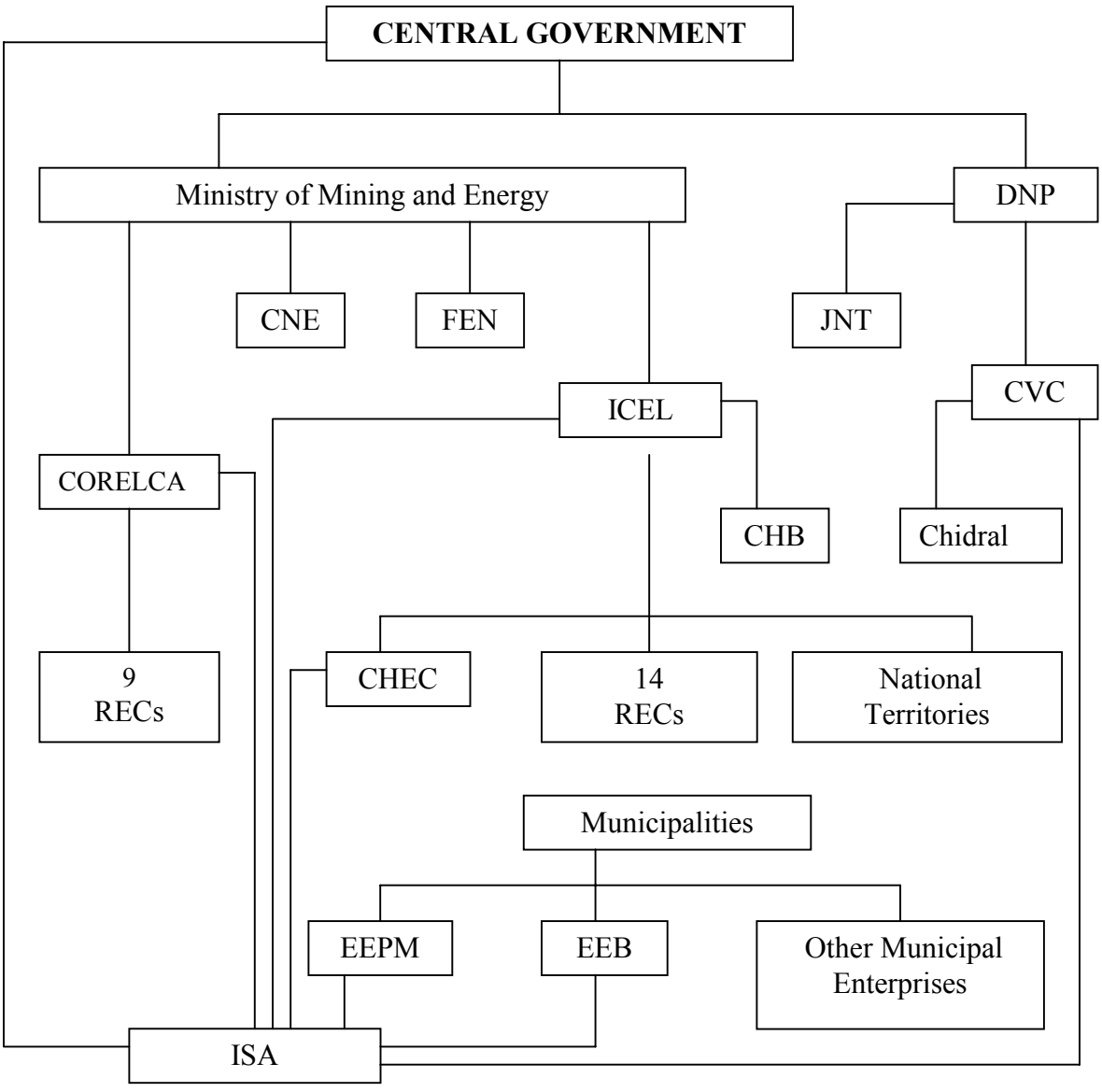
[8] The World Bank financed this project, in which the Central Government was the direct borrower. The loan was approved in 1978 for USD 50 million. This line connected the Andean central region with the North Atlantic coast. For details, see the World Bank (1991) and the grid map in appendix 2.

[9] Cali is the third largest city of Colombia and is located in the province of the Cauca Valley.

[10] The non-connected provinces and regions cover 600.000 Km^2, but they represent less than 1% of electricity demand.

areas is through either hydraulic, thermal, or diesel micro-stations. Fifteen regional electric companies (RECs) or *Electrificadoras* are the ICEL members within the inter-connected system. CORELCA by turn is a holding of nine subsidiaries that generate and distribute electric power for the Atlantic region. The other regional company is CVC, which is only generator for the *Cauca Valley*.

FIGURE 1
COLOMBIA- ELECTRIC SUPPLY INDUSTRY
INSTITUTIONAL STRUCTURE IN 1992



Source: Ministry of Mining and Energy (1992)
Notes: Appendix 1 describes the used acronyms

Before the reform, ISA, the grid company was one of the largest electricity generators and the transmission natural monopoly, as well as its main role has been to coordinate, and planning the buying and selling of bulk electricity. As coordinator, ISA manages the *Dispatch Center*. The Center works according to a merit order criteria: i) the marginal cost reported by the company, ii) the Hydro operational reserves, and iii) the transmission availability. The reserve criteria for each reservoir are set according to the rain season and

the installed generating capacity[11]. During the eighties, ISA invested in six major hydroelectric projects that counted for 40% of the total system increase in capacity generation between 1980-1986. Three of them were the largest after the *Guavio*[12] project [Table 2].

Four national institutions had an important role on ESI's policies until the nineties: i) The Ministry of Mining and Energy (MME), ii) The National Planning Department (DNP), iii) The National Tariff Board (JNT), and iv) The National Electric Financial Corporation (FEN). The first one is charge the general ESI policy directions. In that sense, the Ministry rules through ordinary Decrees, and Laws already approved for the Congress. The DNP revises ESI's public investment programs, and presents them to the *National Council of Social and Economic Policy* (CONPES) for approval[13].

Table 2
Colombia - Electricity Supply Industry
Power Generation Projects by companies 1980-1987

Project name	Company	Installed Mw	Project name	Company	Installed Mw
1980			**1984**		
Barranquilla Thermal Plant	Corelca	132	Tasajero Thermal	ICEL	150
Cartagena Thermal Plant	Corelca	66	Jaguas Hydro	ISA	170
1981			Salvajina Hydro	CVC	180
Zipaquira Thermal Plant IV	ISA-EEB	66	Calderas Hydro	ISA	15
1982			San Carlos II Hydro	ISA	620
Paipa Thermal Plant III	ICEL	66	Guajira Thermal Plant II	Corelca	150
Chivor Hydro II	ISA	500	Guadalupe IV Hydro	EPM	210
Chinu turbo-gas	ISA	130	**1986**		
Barranca turbo-gas	ICEL	50	Playas Hydro	EPM	200
Ayura Hydro	EPM	19	Betania Hydro	ICEL	500
1983			Guavio Hydro	EEB	1000
Guajira Thermal Plant I	Corelca	150			
San Carlos I Hydro	ISA	620			
Mesitas Hydro	EEB	600			
Zipaquira Thermal Plant V	ISA	66			
% ISA					***37.5%***

Source: Sanclemente (1993)

This includes for instance, the authorization of all new foreign indebtedness lines, domestic credits, firm's capitalization through bond or stock issues, project's construction installments, and REC's maintenance spending. The former *National Tariff Board* was an office assigned to DNP, and was in charge of setting the tariffs for all domiciliary public services. In this front, there were two important regulatory measures during the eighties that tried to correct for the lag in electricity tariffs and the distortion introduced by local government management of electric utilities, through the usage of tariffs as an anti-inflationary instrument.

The decree 2545 of 1984 established a uniform tariff structure according to type of demand and socio-economic cohort. The pricing rule allowed for the usage of two part tariffs and third degree price discrimination among final users. In particular, the access fee was allowed to vary across six socio-economic cohorts within the residential users that generated direct cross subsidies from industrial and commercial users to residential users. Afterwards, the JNT-086 resolution of 1986 permitted the *Tariff Board* to take over the control of the entire tariff system. First, this ruling eliminated the companies' discrecionality in setting tariffs structures, and followed the JNT criteria in setting tariffs to final users. In that direction, the Board tried to

[11] This level varies from 0.2 to 0.4 of the installed capacity.

[12] The *Guavio* hydroelectric is the largest substation in the country.

[13] The composition of the CONPES varies in accordance with the cabinet composition. In all cases, the DNP acts as the technical secretariat.

link nominal tariff increases to company's long run marginal costs (LRMC) through the introduction of varying subsidies to residential consumers according to their socio-economic cohort. Thus, the lower percentiles had up to 80% subsidy of the company's LRMC. The higher percentiles had up to 20% subsidy. On the other hand, they were not able to set a markup higher than 20% for the other users.

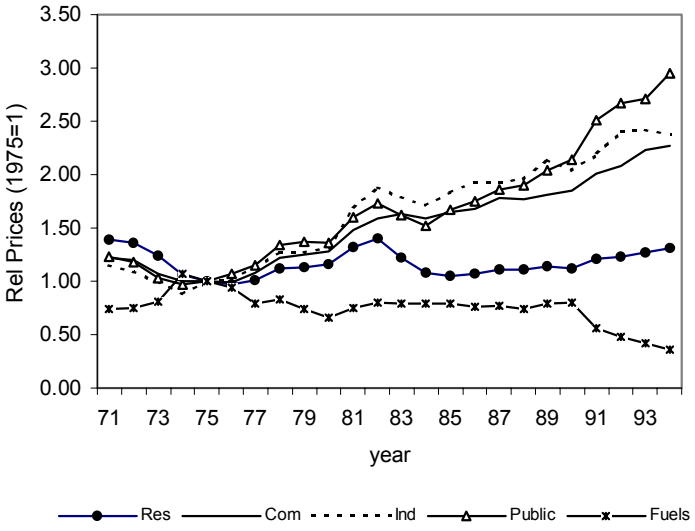
The application of this tariff structure generated substantial *cross-subsidies* among types of final users and according to data could not correct the tariff distortion. Table 3 displays the relative prices for electricity by users and power-company or holding. This distribution allows for tracking of price differences among the regional markets that form the interconnected system. Three facts are worth mentioning. First, there are substantial cross-subsidies to residential demand from industry, public, and commercial users as was mentioned. The tariff formulas were set on *income distribution* rather than marginal cost or *efficiency* basis. This distortion might cause important welfare losses because the system was not compensating the *load factor*. Industrial users have a higher load factor that implies utilities' lower transmission costs. Furthermore, this price scheme did not allow the implementation of *Ramsey* prices, since authorities by definition disregarded the demand elasticities as a source of tariff structure. Second, the major subsides were located in the largest markets like Bogotá. The EEB charged the highest industrial and commercial tariffs relative to residential consumers. However, EEB was the only company that could effectively reduce its price distortion after the 086-JNT resolution. Third, cross-subsidies have shown an increasing trend over time. Figure 2 displays how the gap between residential and the other final users tariffs have steadily increased since the seventies.

Table 3
Colombia - Electricity Supply Industry
Cross-Subsidies by Power Companies to Final Users (Averages)

	Ind/Res			Com/Res			Public/Res		
Company	70-79	80-89	90-94	70-79	80-89	90-94	70-79	80-89	90-94
Corelca	0.95	1.47	1.81	0.94	1.38	1.55	0.97	1.40	1.81
CVC	1.00	1.46	1.55	0.98	1.23	1.49	0.93	1.27	1.92
EPB	1.08	2.19	2.00	1.06	2.32	2.18	1.03	1.96	2.26
EPM	1.03	1.43	1.44	1.04	1.41	1.33	0.90	1.16	1.41
ICEL	0.91	1.50	1.80	0.99	1.32	1.70	1.06	1.51	2.24

Notes: original tariff series are in $/kWh
Source: Own estimations based on SINSE

Figure 2
Colombian Electricity Supply Industry
Electricity Real Price Indices by Type of Final Users



Note: Series deflated by the GDP implicit price index.
Source: SINSE

The *National Electric Financial Corporation* (FEN) is an investment bank whose objectives are to fund investment projects in electric generation, transmission and distribution[14]. FEN became an important financial institution in the local capital market after starting operations in 1983. Local public sector loans counted for 60% of FEN assets, and they reached a peak by 1990 where ESI loans had a share of 10% of the domestic portfolio holdings of Colombia's financial sector [table 4]. Power generation projects absorbed a major part of the available funding during this period, representing around 4/5 of ESI's foreign debt by 1990[15].

FEN foreign liabilities were on average 17% of ESI's foreign debt during the 1984-1992 period. This amount reflected the long run indebtedness strategy, were FEN underwrote much of these credits coming from either multilateral credit agencies or private banks. Thus, FEN had an active role as financial intermediary that contributed to span efforts and to channel domestic and foreign savings to finance ESI's expansion investments.

The *National Energy Board* (CNE) completes the institutional structure before the reform. This office was established in 1987 as one requisite of the special adjustment loan for the electric sector that the government underwrote that year with the World Bank. The DNP director, the Secretary of Energy, and the companies' representatives formed this Board. The Board had the following responsibilities: i) to approve sector's investment programs, ii) to regulate the usage of the energy resources and prices, iii) to set financial and operative targets for public utilities, and v) to regulate entry.

[14] Law 11 of 1982 created the *National Electric Financial Corporation*, with seed capital coming from the central government and the sector's companies. Afterwards Law 25 of 1990 restructured FEN as the *National Energetic Financial Corporation.* The restructuring implied an expansion FEN's banking operations to natural gas, oil and modern coal extraction.

[15] The composition of the foreign debt balance in 1989 was: USD 2733 million in power generation, USD 358 million in transmission, and USD 174 million in distribution projects. For details, see the study of *Contraloría General de la Nación* (1989).

Table 4
Colombia National Electric Financial Corporation (FEN)
Balance Sheet Accounts and Foreign Debt

year	Assets			Financial			Liabilities			Total		
	Domestic Credit		Total	Sector	(1)/(3)	(3)/(4)	Total	Foreign	ESI's	Public	(8)/(9)	(9)/(10)
	Public Sector	Private Sector	Assets FEN	Portfolio Holdings[1]	%	%	FEN	FEN	Foreign Debt[2]	Foreign Debt[3]	%	%
	1	2	3	4	5	6	7	8	9	10	11	12
1984	285.6	193.4	552.4	10,102.8	51.7	5.5	308.5	227.1	2,638.0	7,849	8.6	33.6
1985	444.3	208.7	715.6	9,133.4	62.1	7.8	509.7	418.8	3,372.0	9,595	12.4	35.1
1986	547.2	174.0	721.2	8,751.3	75.9	8.2	554.4	476.2	4,173.0	12,463	11.4	33.5
1987	620.9	173.1	771.4	9,274.9	80.5	8.3	616.9	530.5	4,838.0	13,842	11.0	35.0
1988	838.9	152.8	992.0	9,570.0	84.6	10.4	818.6	704.9	4,430.0	13,823	15.9	32.0
1989	1,070.3	2.1	1,206.5	11,645.7	88.7	10.4	1,030.3	852.9	4,367.0	13,835	19.5	31.6
1990	1,309.1	11.5	1,338.4	13,216.0	97.8	10.1	1,197.4	1,019.6	4,682.0	14,587	21.8	32.1
1991	1,640.7	145.6	2,072.4	12,941.0	79.2	16.0	1,931.3	1,111.4	4,693.0	14,464	23.7	32.4
1992	1,889.8	198.7	2,162.3	16,231.7	87.4	13.3	1,993.3	1,332.3	4,480.0	13,487	29.7	33.2
1993	1,811.3	86.9	2,001.0	20,587.1	90.5	9.7	1,792.6	1,345.2	4,529.0	13,257	29.7	34.2
1994	1,874.7	113.7	2,094.7	27,484.8	89.5	7.6	1,822.1	1,503.5	4,402.0	13,554	34.2	32.5
1995	2,088.7	127.8	2,251.6	34,194.0	92.8	6.6	1,914.1	1,637.4	4,179.0	13,952	39.2	30.0
1996	2,058.4	182.5	2,358.4	37,445.3	87.3	6.3	1,948.7	1,713.6	4,029.4	15,082	42.5	26.7
1997	1,915.7	317.5	2,281.0	43,469.8	84.0	5.2	1,818.7	1,628.9	3,321.0	15,519	49.0	21.4
1998	1,853.9	197.7	2,114.2	38,803.5	87.7	5.4	1,653.3	1,354.0	3,314.0	17,492	40.9	18.9

Source: Banco de la República
Notes: 1/ Includes: Commercial Banks + Investment Banks + Union Banks + Housing Corporations.
2/ Includes gas, and water; 3/ Refers to medium and long run debt balances.

III. The 1992 Blackout

In the midst of the economic openness program -*March 1992*-, the country experienced the longest blackout since the fifties. Abnormal hydrologic conditions accelerated the power generation crisis. However, the shortage reflected structural bottlenecks within the sector because of the institutional, operative, and financial crises. To provide a comprehensive analysis of the 90s crisis is beyond the scope of this section[16]. However, it is important to highlight two technical points that explain the causes beyond climatologic factors: i) bad operative grid criteria, and ii) the unavailability of the thermal park.

The first point concerns ISA's grid operation. The Government and the World Bank strategy in the 70s was to consolidate ISA as the grid natural monopoly and the major power generating company, allowing ISA the exclusivity in being the sole owner of all of the largest new projects in transmission and distribution. The Central Government, the regional holdings (ICEL and CORELCA), Public Enterprises of Medellín (EPM), and Bogotá Power Company (EEB) are shareholders of ISA since the 70s. The fast expansion of the electric infrastructure in the 70s caused a conflict of interests between the Government and companies' views about ESI future development. This fact put pressure on the signing of the *Cali Agreement* in 1979, which established that all new expansion projects have to be undertaken by ISA and its members. Afterwards, ISA was restrained to build up to 1/3 of all of the new capacity.

The new framework allowed regional electric utilities to access new markets, deregulate the bulk electricity sales, and increase intra-firm sales. However, this operative change coincided with the slowdown in electricity consumption, the increase of international interest rates, devaluation of the domestic currency generated by the macroeconomic adjustment program of 1986, and the Latin American debt crisis. These factors soared the utilities' foreign debt service. On the income side, the inadequate pricing rule kept a permanent cross subsidy to residential consumers. This tariff structure was partially the outcome of bad managing practices and regional political influence that local parties exercised on the electric utilities. The above elements caused a permanent financial imbalance that ended-up in a *sectoral adjustment plan* with the

[16] The 1992 report of the *Assessor Commission* summarizes the official view about the blackout causes. Also, see the work of Otero (1993), Sanclemente (1993), and Wiesner & Herrera (1996).

World Bank in 1987. The core elements of that plan were: i) utilities' debt reschedule, ii) firm's financial restructuring, and iii) improvement of operative efficiency[17].

Table 5 displays a summary of financial indicators for the regional holdings, EPM, and EEB for the 1983-1994 period. Three comments are worth mentioning. First, EPM and EEB - the largest municipal utilities- were the efficient ones showing the lower expenditures-operative income ratio, in part due to the associated scale economies from market size, lower power generation costs from hydroelectric sources, and better managing planning. These utilities are the profitable ones. Second, firm's debt service insolvency was not corrected, although during the 1991-1994 period some companies exhibited a slight improvement in debt-gross sales ratio[18]. Third, despite imbalances in the regional holdings, the grid company ISA could improve its operative profits and the profitability rate during the 1991-1994 period.

Table 5
Colombian Electric Supply Industry
Summary Financial Performance Indicators
Averages by four years period *(Percentages and Millions of USD)*

Company	Debt Service / Gross Sales			Operative Spending/Gross Sales			
	83-86	87-90	91-94	83-86	87-90	91-94	
	%	%	%	%	%	%	
CORELCA (1)	92.86	133.25	110.46	72.71	72.47	77.87	
CORELCA (2)	5.37	6.24	6.36	114.77	109.63	107.64	*
CVC	48.43	59.10	52.93	65.91	70.36	68.54	
EEB	38.82	64.36	88.24	63.87	63.26	72.29	
EPM	37.73	54.39	35.60	55.66	62.95	58.47	
ICEL	48.94	70.93	162.88	122.00	122.09	91.83	
ISA	68.17	105.95	127.96	52.12	46.27	50.30	
	Net Operative Surplus/Deficit			Net Operative Surplus / Networth			
	83-86	87-90	91-94	83-86	87-90	91-94	
	USD Mill.	USD Mill.	USD Mill.	%	%	%	
CORELCA (1)	23.02	-8.78	90.39	4.56	-1.93	11.69	
CORELCA (2)	-12.60	-28.10	-30.60	-10.87	-16.10	-13.43	*
CVC	19.21	-26.89	21.49	5.33	-10.87	4.19	
EEB	88.00	76.11	202.18	8.44	7.80	13.03	
EPM	50.10	38.47	178.38	9.33	8.00	14.98	
ICEL	-34.81	-41.61	-8.80	-5.44	-13.09	-2.25	
ISA	43.71	19.62	114.17	3.99	2.28	6.25	

Notes: Corelca (1): Refers to generation + sales of bulk electricity to regional subsidiary distributors
Corelca (2): Includes only regional subsidiary distributors: * = 1987-1991
Source: Own Estimations based on FEN's reports (1991,1994)

Regarding improvements in efficiency, the sectoral adjustment plan targeted an overall decrease in the power loss index. Two components explain this indicator, which reflects the difference between sales and net power generation. One is the technical loss that arises from power transmission and distribution activities. The other is the non-technical loss whose sources come from the losses in consumption and invoicing. That is, some consumers are either not registered or not charged. Figures 3a and 3b, display the evolution of the power loss index by the regional markets. One can observe that the regional holding ICEL is the inefficient one. It losses index reached a peak of almost 100% in 1994. The EEB in contrast was able to curve down its

[17] The World Bank underwrote a share capital loan along with the IADB, and the Japan Eximbank. The approved amount was USD 1160 million. For details, see CNE (1991), and Sanclemente (1993).

[18] The EEB show a drastic deterioration in this indicator up to 1994. The delays in the construction and operation startup of the *Guavio* hydroelectric represented to the company a financial over cost of US 228 million dollars. For details, see Jimenez (1996).

power losses after 1985. The most efficient one was EPM. Thus, the sectoral adjustment plan was not successful in improving sector's global efficiency.

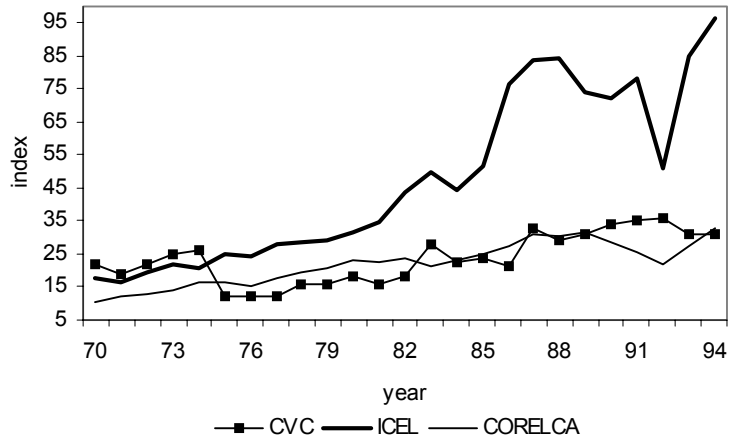
The sector's indebtedness, tariff lag, and the increase in power losses caused utilities to accelerate sales to increase their market share. Excepting CORELCA, the other generating systems are 95% hydraulic-based. Thus, the electric utilities as members of ISA put pressure to use in an intensive way the hydraulic resources, since this technology has the lowest marginal cost. Thus, ISA reduced the critical operative parameters, and the cost of rationed kWh. The first refers to the fact that ISA's forecasting model kept using the assumption of normal hydrology for 1991 and 1992 when the extended drought caused by *el niño* was already predicted by mid-1991.

The second point refers to the fact that ISA's *dispatch center* used a rationing cost of USD 0.045/kWh when the long run parameter set by the IADB in 1987 was USD 0.5/kWh after the delay in the startup of the *Guavio* project. The consequence was the over-exploitation of the hydraulic resources, and the reprogramming of the expansion plan regarding new hydroelectric projects.

The other important technical reason that explained the 1992 power rationing was the shutdown of several thermal plants, which could not serve as the *backup* for the interconnected system. There are five indicators that measure ESI operative reliability: i) the reserve margin, ii) the plant factor, iii) the load factor, iv) the available capacity to effective capacity ratio, and v) the hydro reserves as percentage of the maximum storable. Figure 4 describes the evolution of the first three of such indicators. The *reserve margin* defines the difference of effective capacity to maximum demand as percentage of the maximum demand. One can observe that the ESI in Colombia has steadily increased this indicator reaching international standards[19].

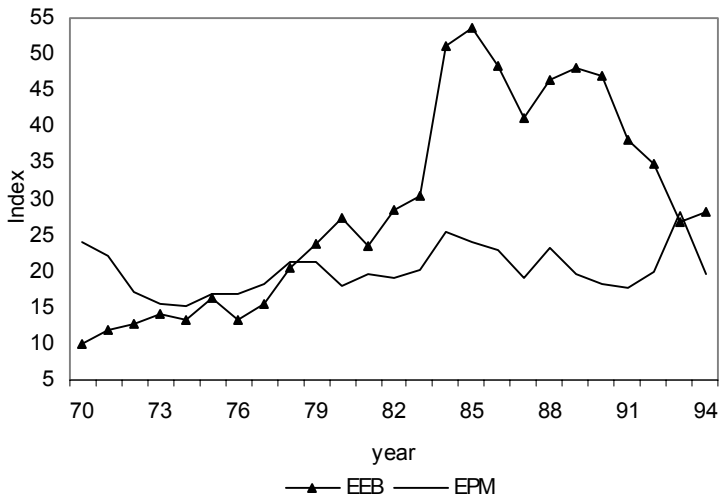
The *plant factor* defines the electricity demand to effective generating capacity ratio. This factor shows the cycles in the operative startups of new thermal plants and hydro reservoirs.

Figure 3a
Colombia- Electricity Supply Industry
Power loss indices by Company
(Regional Holdings -Percentages)



[19] For instance, the historical reserve margins for England, USA, Sweden are 25%, 22%, 50% respectively. For details, see Newbery (1996).

Figure 3b
Colombia- Electricity Supply Industry
Power loss indices by Company



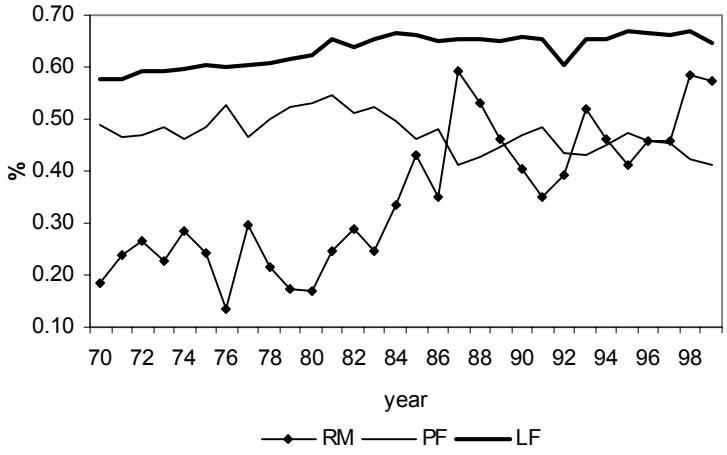
Source: Own estimations based on SINSE

Colombia experienced since 1970 three power-rationing episodes[20]. The peaks -*1976, 1983, and 1991*- show the beginning of rationing years and describe the length between rationing cycles.
Clearly, the last cycle begun in 1992 and there is no signal of deterioration in this indicator until 1999.

The *load factor* defines the average to maximum demand ratio. Higher load factors indicate lower power generating costs and gains in system efficiency. The variance falls between the peak and off-peak demands minimizing the transmission losses. The load factor has remained constant since 1983 fluctuating from 0.60 to 0.65 since 1980. The lowest observed value was in 1992. The evolution of these indicators shows that the expansion in ESI's generating capacity since the 70s caused a reserve excess of around 40% of the demand and the improvement of the overall system reliability.

Figure 4
Colombia- Electricity Supply Industry
Reserve Margin, Plant Factor, and Load Factor Indicators

[20] The rationing episodes of the seventies and early eighties were caused for the delays in construction in the following hydroelectric projects: *San Carlos I, Chivor I, and Chivor II*, and the delays in the setup of the high voltage transmission lines, and the interruption of new thermal capacity. For details, see Otero (1993).

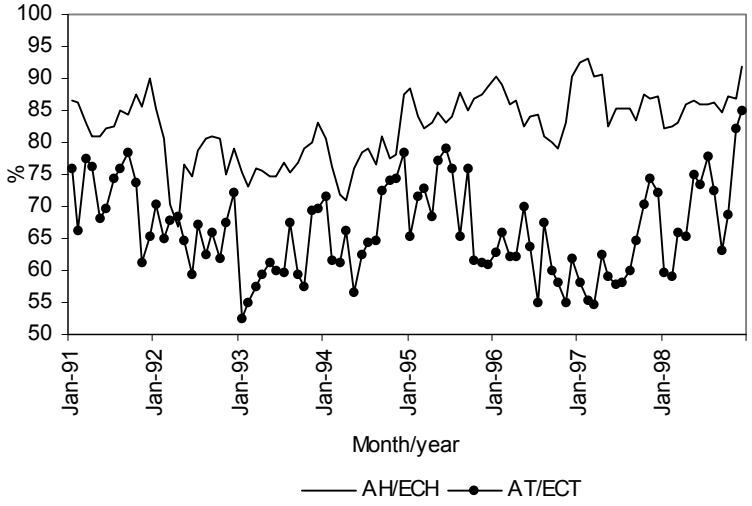


Source: Own estimation based on SINSE

Nonetheless, one must keep in mind that the effective capacity refers to the maximum plant's operating power. If the ESI is hydro based, the accurate variable is the *available average capacity*, that is, the amount that the system is able to generate in a particular point in time. Figure 5 displays the *available* to the *technical effective* capacity ratios by hydro and thermal generation for the 1991-1998 period. The figure shows that the lowest generating availability of hydro sources was in April of 1992, two months after the beginning of the electric rationing program. This date also coincides with the lowest point since 1984 in the hydro reserves to storable capacity ratio. According to ISA, the hydroelectric system had a potential storable capacity of 12.000 (GWh), mean while the usable reserves were only 2.000 (GWh) at that date.

Table 6 summarizes the basic statistics of the reservoir system since 1991. *El niño* caused an extended drought season that did not allow for the recovery of the reservoirs' water reserves. 1991 and 1992 were two abnormal hydrologic years that, along with the excessive hydro generation, almost depleted the reservoirs. Hence, the inaccurate critical levels adopted by the dispatch center implied a non-optimal usage of the hydro stations and the bad hydrology, explains one side of the 1992 blackout.

Figure 5
Colombian Electric Supply Industry
Available / Effective Capacity by Type of Power Generation
(Percentages)



Notes: H=Hydro; T=Thermal
Source: Own estimations based on ISA

Table 6
Colombian Electric Supply Industry
Reservoirs Current Conditions (GWh and Percentages)

Description	1991	1992	1993	1994	1995	1996	1997	1998	1999
Water Filling (GWh)	24,780.0	20,818.0	33,468.9	37,281.4	32,309.3	41,218.5	29,872.0	36,315.3	44,189.0
Share to historic mean	74.8	62.8	87.3	94.8	80.3	102.4	74.5	89.6	109.0
Hydro Reserves (GWh)	5,759.8	6,523.0	10,910.2	11,474.4	10,824.9	11,071.7	7,988.8	10,576.0	11,573.0
Share to Maximun Storable	48.9	47.5	77.1	81.0	75.7	77.5	55.9	73.8	80.0

Note: After 1993 includes *Guavio* and *Riogrande.*
Source: ISA

Thermal generation failed in backing up the system in 1992. This is perhaps the main element that contributed to the 1992 shortage. By 1991, there was an effective installed capacity of 1835 MW, while the available capacity was 1200MW that is an idle capacity of 635MW. This number is very important. In 1992, the demand for electricity was on average rationed in 16%. This fraction is equivalent to 518 GWh per month since March. The shortage during the first quarter of 1993 was around 250 GWh per month. The unattended demand during the 13 months of the rationing program was 5.930 GWh. Assuming a 70% technical operative capacity for the thermal plants; the unavailable capacity would have generated 3.900 GWh in one year. In other words, having correctly set up the thermal park would have covered 65% of the power shortage.

The thermal park was not fully operating because were shutdown either for maintenance problems or because were no hooked to the grid. Three factors explained this operative failure. First, maintenance spending was an item under control of the National Planning Department [DNP], in the sense that this institution approves all public central government investment spending. This centralized process caused a time-inefficiency between the requested and the disbursement date, and unnecessary delays in a plant's repair activities.

Second, public utilities were autonomous in doing their maintenance spending from own sources. However, the utilities' financial crisis did not allow the companies to investment and cover the debt service simultaneously. This fact explains why some utilities did not consider it a priority to keep their thermal plants working. Third, there were cases of bad operative planning. Some thermal gas-based plants were built with out the adequate fuels sources, or there was no available pipe to provide the fuel[21]. Finally, it is important to point out that the delay of six years in the startup of the *Guavio* hydroelectric, with an initial capacity of 1000 MW in five units, influenced significantly the 1992 power shortage[22].

IV. Institutional Structure after the Reform

The 1992 blackout called for a regulatory reform along with a restructuring of Colombia's electricity supply industry. It took two legislative terms for the Congress to approve the regulatory reform and set the new rules. The government strategy was to implement power expansion plans that improved the thermal, hydro generating, and transmission capacity in order to recover the system operational reliability, and avoid future power shortages. At the same time, the government sought to increase the administrative, operative, and financial efficiency within the industry through different mechanisms. Thus, the reform targets were to promote: i) market competition in electricity generation, distribution, and commercialization; ii) private investment; and iii) unrestricted access to the transmission and distribution grid. In addition, the reform sought to set up the electricity spot market (*the pool*), and the designing of new regulatory schemes and institutions.

The *Electric Law* (Law 143) and the *Domiciliary Public Services Law* (Law 142) of July 1994 support the new regulatory framework. The former set the new rules regarding: i) the sector's planning and expansion

[21] For instance, this was the case of the *Chinu* thermal plant. The plant has a generating capacity of 100 MW. For details, see the 1992 *Assessor Commission* report.

[22] The first three 200 MW units of *Guavio* began operations in March 1993. *Guavio* has today a generating capacity of 1600 MW. For details, see Ministry of Mining and Energy (*1992-1993) Report to the Congress*.

plans, ii) the regulatory scheme, iii) power generation, iv) transmission and the grid operation, v) grid access fees, vi) the tariff regime for electricity sales, vii) concession contracts, vii) and environmental issues. The Law created the Regulatory Commission for Energy and Gas *(CREG)*[23], as well as determining its functions.

The Commission is in charge of setting the electricity tariff policy, the utilities' pricing rule, promoting market competition, establishing the operative rules regarding the planning and coordination of the National Interconnected System, and setting the technical criteria for regulated and non-regulated final users. The Commission rules through resolutions since November of 1994, and has focused in setting the specific rules regarding ESI's activities: generation, transmission, distribution, and commercialization. In addition, it has focused on the sector's technical, operative, commercial, and entrepreneurship businesses related issues.

The British experience inspired the regulatory reform in Colombia's ESI. The core elements of such reform were the separation between activities and markets, and the creation of an electricity spot market or *pool*. The former refers to the vertical integration of the industry among power generation, high voltage transmission, low voltage distribution, and electricity commercialization. The new regulation understands electricity distribution as the transportation of electricity through a set of power lines and substations that operate with voltages lower than 220 kV that do not belong to a regional grid. The usage of the infrastructure is within a municipal distribution system. Power commercialization consists in the buying of electricity to the spot market, and the selling to final users. Law 143 establishes incompatibilities and creates incentives for utilities to specialize in complementary activities. Like the British reform, the aim was to break the utilities' exercise of their monopoly power. The Law considers that transmission and distribution activities are natural monopoly technologies, while power generation and electricity commercialization are activities in which promoting market competition is feasible. To this end, Law 143 established the following differentiated rules:

a) Electric utilities founded after the issuance of the electric Law power can develop complementary activities such as: i) generation - distribution; ii) distribution - commercialization. The following activities are exclusive: i) generation - transmission; ii) generation - distribution; iii) transmission - distribution; and iv) transmission - commercialization.

b) The vertical integrated utilities founded before the Law might continue with two or more activities, excluding power transmission, but keeping separate the accounting for each one.

A complementary ruling that prevents market concentration, according to the Commission resolutions, is that no single utility can have more than 25% share in ESI's generating capacity. The same rule applies for distribution and commercialization. Furthermore, any power generating company is not allowed to hold more than 1/4 of a power distribution company stock. Regarding market separation, the new regulation identifies two types of final users: regulated and non-regulated. The first ones are currently residential users, and small commercial and industrial plants. The Commission regulates these tariffs according to the current tariff formula[24]. The second ones are large industrial and commercial clients with a minimum consumption of 0.5-MW/month[25]. The sale price for these users is free and established by bilateral contracts.

Figure 6 displays the new institutional framework resulting from the regulatory reform. One can see that the main institutional innovation is focused on the functions and activities of the Regulatory Commission. ISA is still the national grid company but all policy making regarding sectoral expansion programs and operative criteria are now transferred to the *Energy and Mining Planning Unit (UPME)* and the *National Operative Board (CNO)*.

The Commission sets the general ruling and the Operative Board coordinates along with the *Dispatch Center* the integrated operation of the generating and transmission resources of the interconnected system. Another change is the creation the *Exchange Commercial System* a specialized office, which depends of the Operative Board, in charge of invoicing, charging, and paying the contracts traded in the electricity spot market. The most important restructuring process generated by the reform was the breakup of ISA in two independent companies in 1995. One is ISA S.A, as the national grid company and the largest power

---

[23] *Comisión de Regulación de Energía y Gas*.

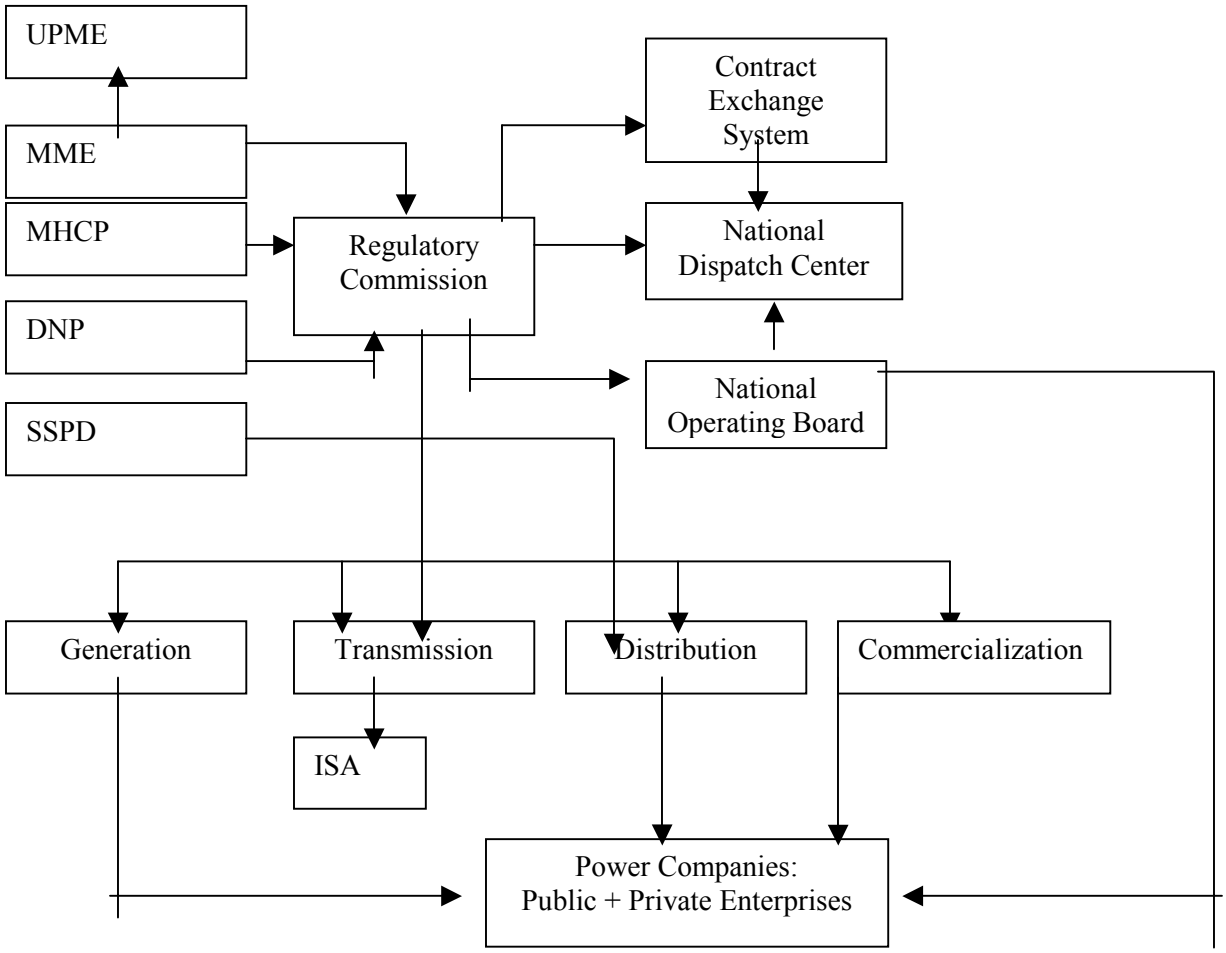
[24] The CREG's 031 and 079 resolutions of 1997 set the tariff formulas.

[25] The Commission has reduced this limit gradually since 1995. This limit began in 2.5 MW/month. The idea is to keep on reducing it in order includes large residential users (i.e. apartment buildings, condos) as non-regulated users.

transporter in the country. The other is ISAGEN, which gathers in one holding all former ISA's power generators.

Privatization
The regulatory reform is explicit in promoting private investment within the power sector as a mechanism to ensure market competition. In contrast to the British or the Chilean experiences, the regulatory reform in Colombia did not lead to a drastic selling of public utilities. Private investment has flown gradually into generating and distribution projects. In fact, today there is an active competition between private and public power generators, and distributors. The recent privatization experience in Colombia's electricity supply industry took place during the 1996-1998 period.

Figure 6
Colombian Electric Supply Industry
Post-Reform Institutional Structure



Source: Law 143 of 1994 (Electric Law)
Note: Appendix 1 describes the list of institutional acronyms

This process had two phases. The first one focused on thermal generating plants and hydroelectric plants. This transfer the government sought to leave in private sector's hands future generating expansion plans. Privatization implied an industrial restructuring that followed a mixed ownership scheme, and

companies' capitalization. The public sector would keep more than 50% share in utilities' net worth, ensuring service provision and social investment. To this end, the initial bid was offered to utilities' unions and the cooperative sector. At the second stage, there was an open-sealed bid. Table 7 summarizes the privatization outcome by utilities or generating plants during the 1996-1997 period, and calls for several comments.

First, Latin-American enterprises have had an active role in Colombia's ESI privatization. The Chilean companies had invested in the sector USD 3.300 million out of USD a total of 3900 millions. ENDESA the largest power generator in Chile has been the main foreign investor. Its investments in Colombia represent 25% of Chile's power generating capacity[26]. Second, EPSA -*Empresa del Pacifico S.A*- owns the generating capacity of the CVC regional market (982 MW), and is the power supplier for Public Enterprises of Cali. Private investors purchased 56% of the company stocks. The remainder is property of CVC and other regional institutions of the *Cauca Valley*. Regarding the distribution activity, this market includes the municipalities of this province, excepting the city of Cali, which covers 218.000 residential users. Four hydro-electrics and one thermal plant constitute the generation park for this market. Third, ESI's privatization represented 15% of country's global foreign investment during the 1997-1998 period, and 32% of country's power generating capacity.

Fourth, the most important transaction was the capitalization and the selling of 48% of EEB's net worth in 1997. Bogotá Power Company is the largest generator in the country, and has biggest regional distribution market that includes the metropolitan area of Bogotá and 98 municipalities in its province. The size of this market is 1.3 million residential users that represent 22% of the total interconnected system, 50% of the total industrial subscribers, and 30% of commercial users. EEB was a vertical integrated monopoly and a public enterprise whose owners were the City with 90% share, and the Nation with 9.2% share. The motive was company's financial over-cost generated by the *Guavio* project. By 1994, the debt service to sales ratio was 104 and it kept deteriorating until 1997. In order to proceed with the company's capitalization, it was broken in three independent enterprises: i) one power generating company (EMGESA), ii) one distributor and commercial firm (CODENSA), and iii) one power transportation firm (EEB). Thus, EEB kept the power transmission activities, serving as the regional grid. The total EEB's capitalization was USD 2177 million, representing 56% of the resources that came from the privatization program during these years[27].

[26] Chile's power generation capacity is around 5.000 (MW). The power generating capacity of the *Betania* hydroelectric plus the share of ENDESA in EEB's hydro-electrics (*Guavio, Canoas, Colegio, Guaca, Laguneta, Paraiso, Salto I, Salto II*) adds 1.200 MWs.

[27] See Cardona & Gutierrez (1998) for details on the privatization program of the EEB. The regional grid of EEB consist on 632 Km of 230 kW and 1150 Km of 115 kW transmission lines, along with 56 substations.

Table 7
Colombian Electric Supply Industry
Privatization of Electric Utilities 1996-1997

Company/Plant/ Hydroelectric	Generating Capacity MW	Generation Type	Transaction USD Mill.	Seller	Buyer	Networth Share %	Investor Origin
Betania	500	Hydro	497	ICEL	ENDESA	100	Chile
Chivor	1,000	Hydro	645	ISA	CHILGENER	100	Chile
Tasajero	150	Thermal-Coal	30	ICEL	Cooperative - Sector	58	Colombia
TermoCartagena	180	Thermal-Coal	15	Corelca	Electricidad-Caracas	15	Venezuela
					Cooperative - Sector	85	Colombia
EPSA-Generation	772	Hydro	535	CVC	Houston Industries/	56	United States
	210	Thermal-Gas					
EPSA-Distribution					Electricidad-Caracas		Venezuela
EEB-Generation	2,312	Hydro	810	EEB	Capital-Energia Holding[1]	48.5	Chile-Spain
	104	Thermal-Coal			(EMGESA)		
EEB-Distribution			1,085	EEB	Luz-Bogota Holding[2]	48.5	Chile-Spain
					(CODENSA)		
EEB-Transmission			141	EEB	Capital-Energia Holding[1]	5.5	Chile-Spain
			141	EEB	Luz-Bogota Holding[2]	5.5	Chile-Spain
					(EEB-Head Quaters)		
Private Sector (MW)	3,552						
Total (MW)	5,228		3,899				
Effective Capacity NIS 1996-1997 (MW)	10,800						
PS/EC (%)	32.9						

Notes:1/: Capital Energia = ENDESA (Chile) + ENDESA-Desarrollo (Spain); 2/: Luz Bogota = CHILECTRA (Chile) + ENERSIS (Chile) + ENDESA-Desarrollo (Spain).
NIS = National Interconnected System; PS=Private Sector; EC = effective capacity
Sources: MME (1996) and (1998) Reports to the Congress; ISA (1998), Cardona & Guttierez (1998), and Diaz-Orozco (1999).

The second phase of the privatization program consisted in the restructuring, capitalization, and the selling of CORELCA and its subsidiaries in 1998. This holding covers, as was mentioned, Colombia's Atlantic coast region. The privatization strategy was slightly different from the previous ones. The government decided to capitalize, restructure, and the refinance the holding internal debt with FEN (DNP 1997, 1998). The government approved a capitalization for USD 405 million in 1997, in order to reduce the unpaid short run liabilities, such as the debt service, unpaid electricity contracts traded in the spot market, unpaid transmission charges, and due payrolls. A second capitalization came in 1998 for US 187 million dollars. The financial resources came mainly from current profits from other public enterprises such as ISA, ISAGEN, and government debt bonds. These operations increased government's stock shares in CORELCA's subsidiaries.

The following step was utilities' operative restructuring once their financial recovery was in progress. Thus, the government looked to consolidate solid enterprises, with attractive markets to ensure service expansion, and fulfill the regulatory requirements. Based on these criteria the holding was divided in three enterprises. One generating company -*GENDELCA S.A*- formed by the power generation assets and liabilities of all the involved companies, plus the long run purchases of electricity in the spot market. One transmission company -*TRANSELCA S.A*- created with the assets, and transmission liabilities of CORELCA[28]. Three distribution utilities were founded: i) *ELECTRICARIBE S.A*; ii) *ELECTROCOSTA S.A;* and iii) *SAN ANDRES POWER & LIGHT*. The former two cover the service in the continental provinces, with a market size of 1 million of residential users. The third one provides the power service for 12000 residential users, in the Caribbean islands.

[28] This regional grid has 800 km of 220 and 230 kW transmission lines.

Later, the authorities invited strategic investors to participate in the capitalization of these restructured utilities. The result of such bid was i) ISA purchased 65% of TRANSELCA's shares for USD 180.5 millions; and ii) a holding formed by *Houston Industries*, and *Electricidad-Caracas* bought for USD 980 millions, the power distributor companies *ELECTRICARIBE* and *ELECTROCOSTA*. The transaction represented a 65% stock share. Finally, the sale of *GENDESA* was left open[29].

The Pool

The electricity spot market is perhaps the most important institutional innovation from the regulatory reform of Colombia's electricity supply industry. The setup of a wholesale market for bulk electricity followed the scheme adopted previously in the United Kingdom[30], as a mechanism to promote competition among electricity generators, and distributors. The last ones tend to behave more competitive as the non-regulated market increases. However, there are differences in the actual operating mechanisms and the type of transactions traded in the market still, the pool in Colombia is one of the most developed in South America[31]. This section describes the core features of the spot electricity market in Colombia, and presents some performance indicators.

The electricity spot market, known as the *Mercado de Energía Mayorista (MEM)*, began operations in 1995. The MEM works through the National Transmission System and trades a homogeneous good[32]. This market is located at ISA facilities along with the National Dispatch Center allowing for the coordination, supervision, and control of the Interconnected System, through the monitoring of 30 hydroelectric stations, and 60 thermal plants. The MEM has two dimensions: operative and commercial.

The first one refers to the interaction among producers, distributors, and final users. It involves an operative scheme by which one day in advance all participating generators submit, by mid-morning their bids ($/MW) to the dispatch center and declare their power availability sets for each hour. Afterwards, the dispatch center sorts the bids by merit order and programs the next day's dispatches. If the system lies within the critical parameters, the ordering is saved to be run by the scheduling generation program. By noon, the bids are posted in order to inform the *supply marginal prices* (SMP) to MEM's participants. The reference price is the last price-auction needed to meet the market demand within a particular hour. In the afternoon, the dispatch center sends next-day schedules to generators. Because of Colombia's ESI hydro-based system, the critical parameters tend to be more volatile. Therefore, an authorized price intervention replaces the SMP if and only if the system operates below the minimum operative upper bound. The pool then transfers the electricity sets, and charges the *capacity charges* to power distributors and larger clients.

The *selling pool price* (SPP) is a two-part tariff by which the capacity charge works like an access fee but varies on a monthly basis. This is an important difference with the British spot market. The *capacity charge* is the mechanism to pay power generators their long run marginal cost, and to guarantee capacity investment. The usage of this instrument is not new. Under a vertically integrated public enterprise scheme, the *capacity charge* is an internal component of utility's long run incremental marginal costs corresponding to the system's optimal expansion. This fee is a regulated price within a market competition scheme. It seeks to compensate the agent that provides the required generating capacity under the *system's critical conditions*. The effect is to smooth the payments over time and not through a constrained high pool price.

Despite the fact that capacity charges exist in several electric systems worldwide, its implementation varies in several aspects. The designing of such fee depends on the expected power failures, and ESI's technology base. Colombia's power generating system is a mixed hydro-thermal system, where hydro capacity represents 75% of the system's effective capacity. Hydro generation constitutes the *base-capacity*, while thermal generation plays as the *back up capacity.* The main effect of the capacity charge is that provides the necessary funds to the marginal producers. If electricity failure is due to an *energy-shortage,* it reflects a deficiency in the base-capacity. Thus, the system would pay the plants able to produce in the base. In contrast, if there is a load failure, as consequence of an excess peak demand, the system will compensate the plants

---

[29] For details about CORELCA's privatization program, see ISA (1998), and Diaz-Orozco (1999).

[30] For details of the UK's pool market see Amstrong *et al* (1994), Newbery (1996) and (2000).

[31] For details on the regulatory reform in Chile and Argentina, see Spiller & Martorell (1996), Spiller & Guash (1998), Estanche & Rodriguez (1998), and most recently the work of Newbery (2000).

[32] The national grid company ISA has been since its creation the monopoly of the 500 kV high-voltage transmission lines and substations. Today ISA owns 66% of the 220 kV network.

with capacity able to produce at the system's edge. The second case is what has been observed after the pool startup. Consequently, this fact gives a clear signal to private investors to undertake investment in edging capacity.

The current formula used to estimate the capacity charge is given by

$$PEC = (TPC * CCV) / ED^{p} \quad (1)$$

where: PEC = Capacity Charge *Power Equivalent Cost* ($/kWh); TPC = *Theoretical Payable Capacity* (kW); CCV = *Capacity Charge Value* ($/kW-month). This value was set in USD 5.25/kW-month. This payment reflects the monthly fixed-cost of the most efficient power generating technology with the lower sunk cost of capital. The baseline technology is the open cycle turbine gas; ED^{p} = the projected demand for electricity for the current month[33].

Thus, the following formula gives the selling pool price

$$SPP = SMP + PEC + Uplift. \quad (2)$$

The last component as in the UK, includes the costs of the reserve provisions to stabilize the system, and prevent bottlenecks in transmission system.

The pool also foresees a re-dispatch mechanism if there are sudden events that change the system critical values, such as plant's shutdown, changes in the water levels, changes in peak demand, and a mandatory increase in the declared availability requested to generators by the dispatch center in order to improve system's reliability.

The other financial transactions within the MEM are the long run *purchase power agreements* (PPA). These are contracts for the buying and selling of electricity between power generators and wholesale retailers or power distributors. The contract specifies the price, quantity requested, distributor's demand, and some specific clauses that hedge the parts from pool price volatility, and firm's financial performance. The transactions trough contracts have to register in the Exchange Commercial System -*Sistema de Intercambio Comercial (SIC)*- . Each contracting party subscribes a managing contract with the SIC administrator for the invoicing, payments, and collections for the electricity transactions done within the pool. In addition, the parties in the contract have to agree on the collateral, warranties, and other requirements demanded by the Regulatory Commission. In order to hedge the regulated users from pool price volatility, a distributor has to subscribe PPAs with one or several generators such that covers 60% of its demand.

The electricity market, as Newbery (2000) points out, can be thought of two interdependent markets. One is the physical market for electricity or pool, and the other is a *risk-sharing* market. The second market is less developed in Colombia. In the UK there are two types of contracts. One is the *contract for differences* under which the contracting parties commit ex-ante to pay the difference between the spot price and the benchmark price. If the contract for differences is a one- way contract then this is equivalent to an option market. The second type is the *electricity forward agreements*, which allows hedging for price uncertainty components, such as the capacity charge, peak schedules, and the spot price. In Colombia, there are several types of PPAs traded in the market. Contracts vary according several factors. One is *to pay the contracted amount*. Under this scheme, the buyer commits to pay at contract's price all power sets previously established. Any deficit coming from an excess demand is charged at pool prices. In contrast, any deficit is sold to the pool. A second scheme is to pay what is *effectively demanded*. It can include an upper demand limit or leaving the demand unbounded. The second alternative is equivalent to the commercial demand. Another modality is *to pay what is generated*. The delivered quantity reported by the dispatch center determines the contracted power sets. Once the quantities are defined then the contract works as *pay what is contracted*[34].

The three publicly owned larger generators and the two former regional holdings formed the electricity spot market when began operations in July 1995. By 1998 after three years of public divestures and new regulation, the pool had 25 active large power generators registered with an effective installed capacity of 12000 MW. The Pool's power generator structure shows a balanced distribution among public, mixed and private competitors with market shares of 42%, 29%, and 29% respectively [Table 8]. This contrast with the

---

[33] CREG's resolution 116 of 1996 regulates the formula to estimate the capacity charges. The charge since 1997 is included in the generator's bids. The CCV payment reflects the monthly fixed-cost of the most efficient power generating technology with the lower sunk cost of capital. The baseline technology is the open cycle turbine gas. The Dispatch Center estimates the electricity demand every month. .

[34] There are other variations of the electricity contract market. For a complete description of each one, see ISA (1998).

case of the UK where generation stands in a duopoly market structure, and in Chile where three power generators dominate the central interconnected system[35].

On the commercialization side, there were 82 registered companies in 1998. Most of these companies are electricity distributors that are either vertically integrated with power generating companies or independent firms. Nevertheless, there are electricity wholesale retailers that are not distributors and their business objective is the buying and selling of bulk electricity. This feature makes the electricity market in Colombia different compared to the UK were commercialization is made through the 13 Regional Electric Companies (RECs)[36].

The evolution of the spot market prices and contracts, as well as the traded amount of electricity provides a partial evaluation of pool's performance. Figure 7 describes the behavior of the spot market prices as well as the contract prices, since 1995. One can observe that spot prices are volatile to external shocks. The peak from July 1997 to July 1998 was the response to expectations on the *el niño* cycle. Capacity charges are included in pool prices since 1997. This explains why the off peak prices are slightly higher since July 1998 in contrast to the observed levels of 1995 and 1996. There was no power shortage at that time, because of the good backing up of thermal generation. Nonetheless, purchase contracts were very effective to hedge buyers to price volatility. It is clear that distributors gained, because they did not pay generators' extra-price. The spot market transactions have increased while contracts have stayed relatively constant [Figure 8]. This is the result of having more agents participating in the market. Contracts have had a 70% market share since 1995.

Table 8
Colombia Effective Power Generating Capacity
by Plant Ownership Structure 1998

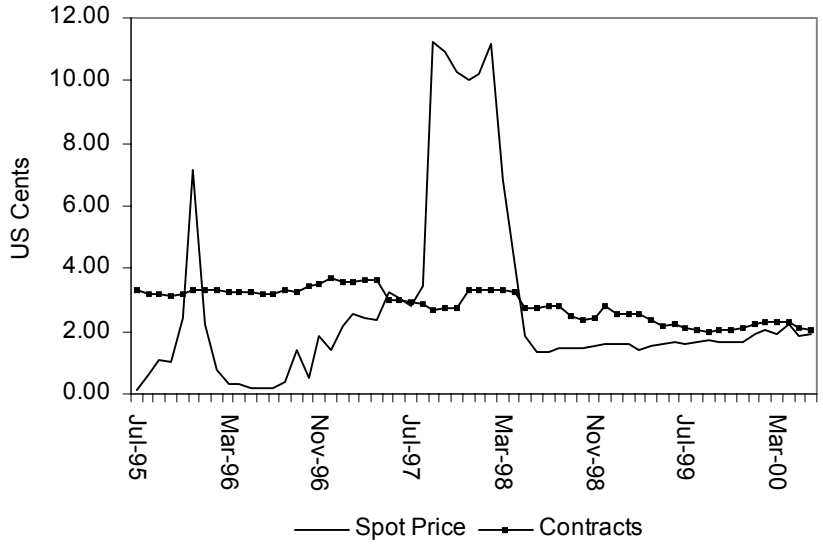
Power-Plant Name	Ownership	Capacity Hydro MW	Thermal MW	Total MW	Share %
EMGESA	Mixed	2,274.8	220.0	2,494.8	20.7
EPM	Public	1,708.0	300.0	2,008.0	16.6
ISAGEN	Public	1,410.0	193.0	1,603.0	13.3
CHIVOR S.A.	Private	1,000.0		1,000.0	8.3
EPSA	Mixed	772.0	210.0	982.0	8.1
TEBSA	Private		877.0	877.0	7.3
CORELCA	Public		626.0	626.0	5.2
CHB	Private	540.0		540.0	4.5
Others 1/		431.8	1,513.0	1,944.8	16.1
Total Private		1,614.0	1,851.0	3,465.0	28.7
Total Public		3,475.8	1,658.0	5,133.8	42.5
Total Mixed		3,046.8	430.0	3,476.8	28.8
Total		8,136.6	3,939.0	12,075.6	100.0

Notes: 1/ Includes 17 additional power plant generators: 6 private, 1 mixed, and 11 public utilities.
Source ISA (1998)

[35] ENDESA, CHILGENER, and COLBUN are the largest power generators in Chile. Their joint share is 85% within the Interconnected Central System. For details, see Spiller & Martollel (1996).

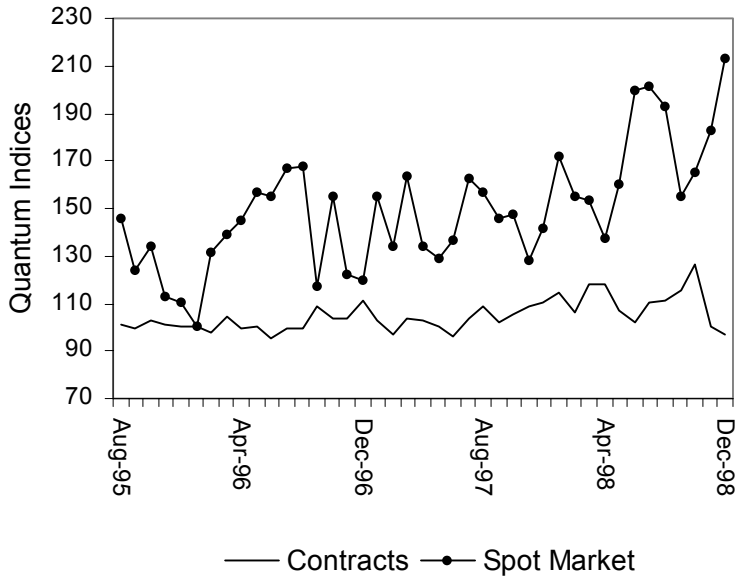
[36] However, large customers can purchase their electricity directly from the grid.

Figure 7
Spot Market Prices for Bulk Electricity and Contract Prices (US Cents/kWh)



Source: ISA (1998)

Figure 8
Colombia Electricity Market
Spot Market and Contracts - Quantum Indices (January 1996 = 100)



Source: ISA (1998)

V. Conclusions

The evaluation of the ESI's regulatory reform has to answer the question of whether the reform implied a gain in economic efficiency, better quality and a reliable service. An accurate answer of such a question needs further research beyond the scope of this paper. Technical efficiency has to be evaluated taking direct measures of translog indices of technical change, or more accurately through efficiency frontiers at plant

level. Competition after the reform has been tight in power generation and commercialization. Bulk electricity prices have remained constant in US prices after the reform, despite price volatility caused by *el niño*. Pool prices were on average 3 US/Cents/kWh in 1995 while in 1999 they were 2.07 US/Cents/kWh.

The system's reliability has improved sharply after the 1992 power shortage according to the evolution of the reserve margin and the plant factor indicators up to 1999[37]. Another open question is to analyze, by electric utility the evolution of the financial, managerial and quality service indicators. This would tell how the restructuring processes and the new business strategies among the utilities have proceeded. According to ISA (1998), there has been a decrease between 9% and 30% in the electricity tariffs for the non-regulated consumers since 1997.

The evidence suggests that the regulatory reform in Colombia's electric power sector has been radical, deep, and one of the most interesting reforms within the international context. One point that makes this experience appealing is that the reform led to a balanced competition between the newly privatized electric utilities and the most efficient public enterprises. In fact, *Public Enterprises of Medellin* (EPM) is stills as the most efficient electric utility nationwide. The National Grid company -*ISA*- is very dynamic enterprise. ISA has reported positive dividends for its shareholders since 1967, where transmission charges have been highly regulated before and after the reform. The company is currently biding for the purchase of Peru's northern grid. In the event of a positive outcome, this will make ISA as one of the largest electricity transporters in South America. In addition, ISA is issuing USD 150 millions worth new stock to be sold at the local stock markets by December of 2000. The sale represents a 30% company's net worth share. This will capitalize the firm and consolidate it as a mixed capital enterprise. Presently there is a debate about the convenience of privatizing ISA, and ISAGEN. The government has unsuccessfully tried to sell ISAGEN since 1998. Nonetheless, EPM seems the most favorite candidate to buy ISAGEN, which will consolidate it as the largest power generator nationwide[38].

One point that has not solved is the debt that some former ICEL subsidiaries ought to the pool. These power distributors need for further financial capitalization and restructuring in order to ensure the sector's expansion and modernization as well as the consolidation of the new regulatory institutions.

References

Armstrong, M., Cowan, S., Vickers, J., (1994) *Regulatory reform: Economic analysis and British experience*. Regulation of Economic Activity series, vol. 20; MIT Press, Cambridge, MA

Cardona C., & Gutierrez N., (1998) *Privatizaciones en el Sector Eléctrico Colombiano*, Tesis, Magister en Administración, Universidad de los Andes

Contraloría General de la República (1990), *La deuda pública externa en cifras*, Imprenta y Publicaciones Contraloría, Bogotá.

Departamento Nacional de Planeación [DNP] (1991a) *La Revolución Pacífica: Plan Nacional de Desarrollo 1990-1994*, DNP, Bogotá.

_____ **(1991b)** *Modernización y Apertura de la Economía*, Vol. I, DNP, Bogotá

Diaz-Orozco M., (1999), *Restrospectiva y Alcances de la Privatización del Sector Eléctrico Colombiano: la experiencia de CORELCA*, Tesis, Facultad de Economía, Universidad de los Andes

[37] The reform in Colombia has faced external shocks that other nation's reforms have not experienced. The power sector has not been isolated from internal conflict. Five hundred high voltage transmission towers have been blown up since 1999. Twelve thousand transmission towers form the nation's grid.

[38] EPM won a lawsuit stopping the sale of ISAGEN, from which the Government had previously excluded EPM from participating in the bid. The sale is currently pending.

Estanche A., & Rodriguez M., (1998) Light and lightning at the end of the public tunnel: The reform of the electricity sector in the Southern Cone, Mimeo, World Bank - Universidad Argentina de la Empresa.

Financiera Energética Nacional (1991), *Resultados Financieros Empresas Sector Eléctrico Colombiano 1983-1991*, Mimeo, Vicepresidencia de Crédito, Bogotá

_____**(1994),** *Resultados Financieros Empresas Sector Eléctrico Colombiano 1983-1994*, Mimeo, Vicepresidencia de Crédito, Bogotá

Gilbert R., & Kahn E., **(1996),** (eds.), *International comparisons of electricity regulation*, Cambridge University Press, Cambridge

Jiménez G., (1996), *Colombia se apaga: el caos del sector eléctrico*, Editorial Planeta, Bogotá

Ministerio de Minas y Energía (MME), (1990 - 1999), *Memorias al Congreso Nacional*, several issues, Bogotá

Newbery D., & Green R., (1996) "Regulation, Public Ownership and Privatization of the English Electricity Industry" in **Gilbert R, & Kahn E**,(eds) *International comparisons of electricity regulation*, Cambridge University Press, Cambridge

Newbery D., (2000), *Privatization, Restructuring, and Regulation of Network Utilities*, MIT-Press, Cambridge, MA

Otero D., (1993), "Algunas consideraciones técnicas para entender la situación del sector eléctrico colombiano" *Mimeo*, Bogota, Universidad de los Andes.

Sanclemente, C., (1993), *Desarrollo y Crisis del sector Electrico Colombiano (1880 - 1993),* Empresa Editorial, Universidad Nacional, Bogotá

Spiller, P., & Guash J., (1998) *Managing the Regulatory Process: Design, Concepts, Issues and the Latin American and the Caribbean story,* Mimeo, The World Bank

Spiller, P., & Martorell L., (1996) How should it be done? "Electricity regulation in Argentina, Brazil, Uruguay and Chile" in **Gilbert R, & Kahn E**,(eds) *International comparisons of electricity regulation*, Cambridge University Press, Cambridge

Wiesner L., & Herrera E., (1996), *El Apagón del Sector Eléctrico*, Ediciones UniAndes, Bogotá

World Bank (1991), *Colombia: The Power Sector and the World Bank 1970-1987,* in CNE Evaluación del Sector Eléctrico Colombiano, Bogotá

Web Pages and Databases

Comisión de Regulación de Energía y Gas (CREG), http://www.creg.gov.co

Interconexión Eléctrica SA (ISA), (1998), *Informes 1998***,** in CD, Medellín

Organización LatioAmericana de Energía (OLADE), (1999) *Sistema de Información Económica Energética (SIEE)*, DOS format, June Version, Quito.

Unidad de Información Minero Energética (UIME), (1994), *Sistema de Información Nacional del Sector Eléctrico (SINSE)*, Ministerio Minas y Energía, Bogotá

Unidad de Información Minero Energética (UIME), (1997), *Balances Energéticos Consolidados de Colombia 1975-1996*, Ministerio Minas y Energía, Bogotá.

Appendix 1 - List of Acronyms

CHB	Central Hidroeléctrica de Betania
CHEC	Central Hidroeléctrica de Caldas
CNE	Comisión Nacional de Energía
CORELCA	Corporación Eléctrica de la Costa Atlántica
CREG	Comisión de Regulación de Energía y Gas
CVC	Corporación Autónoma del Cauca
EEPM or EPM	Empresas Públicas de Medellín
EEB	Empresa de Energía de Bogotá
DNP	Departamento Nacional de Planeación
FEN	Financiera Eléctrica Nacional
ICEL	Instituto Colombiano de Energía Eléctrica
ISA	Interconexión Eléctrica SA
JNT	Junta Nacional de Tarifas
MHCP	Ministerio de Hacienda y Crédito Público
MME	Ministerio de Minas y Energía
SSPD	Superintendencia de Servicios Públicos Domiciliarios
UPME	Unidad de Planeación Minero Energética

FACULTAD DE ECONOMIA
SERIE BORRADORES DE INVESTIGACION

No.	Fecha	Autor	Título
1	Nov/99	Cortés, Darwin. Gamboa, Luis Fernando	Una discusión en torno al concepto de bienestar
2	Ene/00	Guataquí, Juan C.	Estimaciones de la Tasa Natural de Desempleo en Colombia: Una Revisión
3	Mar/00	Argüello, Ricardo.	Economic Integration. An Overview of Basic Economic Theory and other Related Issues
4	May/00	Gallego, Juan Miguel	Aspectos Teóricos sobre la salud como determinante del Crecimiento Económico.
5	May/00	Argüello, Ricardo.	A Survey on Colombian Agricultural Policy during the 1990's.
6	May/00	Argüello, Ricardo.	A Survey on Colombian Agriculture during the 1990's.
7	Jun/00	Casas, Andrés. Riaga, Carlos.	La Importancia de la Información en el Mercado de Trabajo.
8	Jun/00	Baquero, Jairo. Guataquí, Juan C. Sarmiento, Lina.	Un Marco Analítico de la Discriminación Laboral
9	Dic/00	Posada, Carlos E. Arango, Luis, E.	¿Podremos sostener la Deuda Pública?
10	Dic/00	Otero, Jesús Milas, Costas.	Modelling Official and Parallel Exchange Rates in Colombia under Alternative Regimes: A Non-linear Approach.
11	Abr/01	Gamboa, Luis F.	Una aproximación más a la relación existente entre crecimiento y equidad.
12	May/01	Pombo, Carlos	Regulatory Reform in Colombia's Electric Utilities