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The Restructuring and Privatisation of the Peruvian Electricity Distribution Market

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Abstract

This paper attempts to assess the social welfare impact of the restructuring and privatisation of the electricity market in Peru. The target companies, Electrolima and Electro Sur Medio, account for 64 per cent of the total distribution market and 100 per cent of the privatised distribution companies respectively. Actual and counterfactual operating costs are examined. A separate analysis is performed for each company, due to the differences in terms of economies of scale and market structure. The benefits of being connected were also computed based on counterfactual scenarios. Companies that were not privatised (benchmark companies) were used for making appropriate comparisons and for determining our preferred counterfactual cost decline. Benchmark companies were also important for analysing the trend in quality issues. The results show that privatisation was worthwhile and that the social welfare of being connected has an important contribution on it. Government and producers benefited the most and consumers the least due to price increase.

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▪ 1. Introduction

The power reform drivers in developed and developing countries have been different, even though the mechanisms are relatively similar. Developed countries opted for restructuring the sector in order to improve the economic performance of a well-developed industry by competition, (Ghanadan and Williams, 2006). In developing countries by contrast, (1) the low performance of state-owned power companies, (2) the need to raise investments for satisfying demand, (3) the need to reduce or eliminate the fiscal stress from state involvement and (4) the desire to increase revenues through the sale of power companies, among others, were the main drivers for the reform, (Besant-Jones, 2006).

The reform in Peru began in 1992 with the promulgation of the Electric Concession Law - LCE. The starting conditions, similar to other developing countries, were unfavourable. The poor performance of companies, cross subsidy policies, political intervention in price regulation, among others; were the main drivers. In addition adverse macroeconomic conditions and terrorist threats made the picture worse (World Bank, 1990). Peru like many other countries, has applied a standard reform model which includes the creation of independent regulator, unbundling, privatisation and wholesale competition, (United Nations, 2007; Jamasb, 2006). Retail competition in distribution, has not been possible since the electricity regulatory framework does not allow the presence of retailers. The power reform also allowed the unbundling of the generation, transmission and distribution activities, being Electroperu and Electrolima the two state-owned companies that were subject to this de-merger. The application of this regulatory scheme has produced important achievements in the electricity distribution sector. The expansion of electricity coverage, the reduction of distribution losses and improvements in quality issues (duration and number of interruptions) are among the main indicators that support this fact. We expect that these improvements can be translated into benefits for the society.

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The aim of this paper is to measure the social welfare of the restructuring and privatisation of the distribution market. Electrolima and Electro Sur Medio are the companies on which we focus[1]. A cost benefit analysis will be performed, following the methodology discussed in Jones *et al.* (1990). As a result, the gains (or losses) from restructuring and privatisation will be calculated. Based on the social welfare of being connected determined by the World Bank it was possible to calculate the gains due to the increase of electricity coverage. A counterfactual scenario was used for this calculation. Total gains for restructuring and privatisation includes the social welfare of being connected. Quality issues such as distribution losses and number and duration of interruptions, will be also discussed with reference to both private and state-owned distribution companies.

This paper is a very instructive case study which will contribute to improve our understanding of the deregulation process in developing markets in the South American region. The study is organised in six sections. The next section describes the industry background. Section 3 sets out briefly the previous efforts for evaluating the impact of restructuring and privatisation and describes the cost benefit analysis methodology to be used. Section 4 presents the data collection. Section 5 shows the analysis of the results and includes the evaluation of additional benefits. Section 6 provides the conclusions.

- **2. Background**

Electrolima, the biggest distribution company was initially private. After several decades of private electricity ownership it was nationalized in 1972. In the same year, Electroperu, a state-owned company, was created and had exclusive rights on national generation expansion. The company was also responsible for managing the electricity sector nationwide, especially in areas not served by the main existing companies[2]. Sectors that were also involved in the nationalisation programme were agricultural, mining, petrol and others[3].

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[1] Electrolima and Electro Sur Medio were the first two distribution companies to be privatised in 1994 and 1997 respectively. In 2007 Electro Sur Medio and the three companies that were created due to the unbundling of Electrolima, accounted for 63.8 per cent of the total energy sold in the distribution electricity market with a total of 1.92 million customers. Electro Sur Medio and the unbundled companies from Electrolima account for 100 per cent of the privatised distribution electricity market. The biggest distribution companies unbundled from Electrolima, Luz del Sur and Edelnor, operate in northern and southern Lima respectively.

[2] Before 1972 a big number of private and public small electricity companies operated nationwide. In terms of installed power the distribution was as follows: (1) 267 MW for public sector, (2) 809 MW for private sector and (3) 854 MW for self producers companies such as mines, industrial companies, etc. The intention was to integrate those systems (private and public) in order to have a more efficient operation (CONEIMERA, 2006)

[3] The nationalization programme continued until the 80s. The number of state-owned companies increased from 29 in 1968 to 177 in 1990. However, the bad performance of these companies produced an aggregated net loss of US$ 531 million (World Bank, 1994)

In terms of prices, the Electric Tariff Commission (CTE) was the autonomous agency responsible for price regulation[4]. During the period 1985-1990, the tariff structure was based on accounting costs and marginal costs were greater than prices. In 1989 prices covered only 40 per cent of cost and the net operational losses represented 152 per cent of incomes by energy sold[5]. In addition, even though the autonomy for regulating the electricity tariffs was given to the CTE, the Ministry of Economy and Finance had a strong intervention in price regulation. At the beginning of 1990s there were around 27 types of tariffs for end users. The imposition of taxes in customers' bills was also a concern. In 1991 CTE put into practice a new tariff system based on marginal cost and as a result tariffs increased and the non related taxes were repealed from the customers' bill. The sale and purchase of electricity among companies was not derived from a price mechanism either. Instead, a Generation Compensation Fund – Fondo de Compensación de Generación, was used. This fund was created to compensate the cost differences in generation and transmission activities among electricity companies, produced as a result of having different sources of energy production, production scales and market structures[6]. The new tariff system allowed also the purchase of energy between electricity distribution companies and Electroperu.

Regarding the market structure, at the beginning of the 1990's Electroperu, the regional companies[7] and the isolated systems accounted for 70 per cent of the national electricity supply[8] (Bonifaz, 2001). Electrolima, the main electricity distribution company, was responsible for 57 per cent of the national electricity consumption and had its own generation installation for electricity production (Araoz, *et al.*, 2001). The nationwide transmission system was composed of three sub systems: (1) the Central Northern Grid - SICN, (2) the South Western Grid – SISO and (3) the South Eastern Grid – SISE and the isolated systems. The main sector authorities were the Ministry of Energy and Mining (MINEM) through the General Bureau of Electricity (DGE) along with the Electric Tariff Commission.

Due to the lack of progress on the sector, the Government began the most important sector reform through the launch of the Electricity Concession Law (LCE) in November 1992. The reforms involved: unbundling, privatisation and wholesale competition. This reform was based on the Chilean model. Both use a hybrid mechanism for regulating distribution prices; rate of return and model firm in Peru; yardstick and model firm in Chile (Bonifaz, 2001; Dammert *et al.,* 2008) The LCE focused on the following elements: (1) unbundling of state-owned companies, mainly Electroperu and Electrolima, in generation, transmission and distribution activities, (2) creation of a free market, which allowed customers with a capacity greater than 1 MW, to negotiate their supply contract freely, (3) the establishment of the Economic Operation Committee –

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[4] The CTE was created under the General Electricity Law (LGE) in 1982.
[5] CTE Annual Reports (1986-1990).
[6] Electrolima was the most affected which transferred important sum of money to the less profitable companies.
[7] Among the regional companies were: Electrolima and those companies that were created under the General Electricity Law in 1982. The companies are: Electro Sur, Electro Sur Medio, Electro Sur Este, Electrocentro, Seal, Electro Norte, Electro Norte Medio, Electro Noroeste and Electro Oriente
[8] The remaining was produced by private auto generation companies for their own consumption.

COES, a private entity that coordinates the operation system at the lowest possible cost, and (4) the creation of the Energy Tariff Commission, which later on became the Tariff Regulator Office – GART[9]. In December 1996 the Supervising Agency for Investment in Energy (OSINERG)[10], an independent regulatory agency, was created.

The launch of the LCE along with the Law for the Promotion of Private Investment in State Enterprises, prepared the scenario for the privatisation process in the electricity market. The last one authorised the creation of the Commission for managing and promoting the private investment – COPRI. Electrolima and Electroperu were unbundled into several new companies[11]. In most of the cases, the strategy was to transfer 60 per cent of the state-owned shares through public auctions to companies that accomplish technical and financial requirements imposed by the different Commissions. The sale of state-owned shares to workers was also a practice and represented a maximum of 10 per cent. The Government decided to retain the rest of shares for a subsequent sale through the scheme "Participacion Ciudadana" that involved selling shares in the stock market. This approach was used in the sale of generation and distribution companies. Other mechanisms were used as well such as the sale through capital investment and by Built Own Operate Transfer (BOOT), for generation and transmission companies, respectively. In addition to the above, a 30 year operating concession was established. As a result, a significant number of new companies were reformed and privatised during the period 1994-2004, including regional distribution companies[12]. At the end of 2007, generation, transmission and distribution markets were private to the share of 66.62 per cent, 98.95 per cent and 64.23 per cent respectively[13]. The total amount raised by the sale of the companies was US$ 3.3 billion from which generation, transmission and distribution accounted for 55.2 per cent, 17.4 per cent and 27.4 per cent, respectively. See Table 1.

In summary, the restructuring and privatisation of the electricity market is considered favourable, (COPRI, 2000; Ruiz, 2002; Torero, 2003; Alcazar *et al.,* 2007; Dammert *et al.,* 2008; Perez-Reyes and Tovar, 2009)*.* Among other Latin American countries with positive results are Argentina, Brazil, Chile and Colombia, (Chisari *et al.*, 1997; Mota, 2003; Pollitt, 2004; Larsen *et al.,* 2004;). In

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[9] The CTE and OSINERG, the energy regulator, merged in July 2000. GART is part of OSINERG.

[10] In January 2007 it became OSINERGMIN due to the extension of its duties in the mining regulatory arena.

[11] Electrolima was divided into four distribution companies: (1) Luz del Sur, (2) Edelnor, (3) Ede Chancay, (4) Ede Cañete; one generation (1) Edegel and one transmission company (1) Etecen. Electroperu was partially unbundled and four generation companies were created (1) Egenor, (2) Cahua, (3) Etevensa and (4) Eepsa. Electro Sur Medio, a regional company, remained bundled. In 1996 Ede Chancay was acquired by Edelnor.

[12] In 1998 four additional distribution companies were sold, Electro Norte, Electro Norte Medio, Electrocentro and Electro Nor Oeste. After nearly three years of operation, the four companies returned to the government because the buyer did not exercise its option to purchase the remaining 30 per cent of shares. These companies now operate under the name Distriluz and are outside of the common legal framework for public companies. The privatisation process has been suspended. Other regional companies that were included in the privatisation package were Electro Sur, Seal, Electro Sur Este, Electro Oriente and Electro Ucayali. However the government was forced to suspend the privatisation programme due to public protests and the opposition of the privatisation of the southern generation companies (Egasa, Egesur) in 2002. This fact had negative repercussions in privatisation plan of the pending regional companies.

[13] In terms of energy sale for generation and distribution companies and in terms of length of transmission line for transmission companies.

Peru, the electricity coverage increased significantly reaching 80 per cent in 2007 up from 53 per cent in 1990. Regarding total distribution losses, an important downturn was also observed, having moved from 22 per cent in 1993 to 8.2 per cent in 2007. The number of customers per employee[14] also increased. It jumped from 415 to 1,210 in 2007 (CTE, 1986-1999; OSINERGMIN, 2000-2007).

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[14] Regarding the electricity distribution companies.

Table 1: Privatisation of the Electricity Market

1. Generation Companies	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)	Initial company participation	Commitments Investments (US$ million)	Installations (MW)	Sale of state-owned shares Stock market (US$ million)	%	date	Workers (US$ million)	date	%	Total (US$ million)	Energy production (GWh) - 2007 Hydro	Thermal	Total	%	Energy sold - 2007 [16] (US$ million)	%
Edegel [1]	Nov-95	Generandes	373	524.45	60%	42.00	100	139.22	30%	Apr-99 / Nov-99 / Jan-00	74.8	Jul-96	10%	780.47	4,443.42	3,344.44	7,787.86	28.38%	335.07	22.61%
Egecen - Energía del Sur [2]	Feb-04	Enersur	n.a.	62.05	100%	146.87	130	--	--	--	--	--	--	208.92	784.62	3,081.91	3,866.53	14.09%	259.25	17.49%
Egenor - Duke Energy	Aug-96	Inversiones Dominion	175	228.20	60%	42.00	100	60.00	30%	Oct-99	36.3	Nov-96	10%	366.50	2,060.51	125.20	2,185.71	7.97%	145.81	9.84%
Electroandes	Dec-01	Tractebel	n.a.	227.10	100%	17.50	n.a.	--	--	--	--	--	--	244.60	976.04	--	976.04	3.56%	55.41	3.74%
Eepsa [3]	Nov-96	Consorcio Cabo Blanco	n.a.	19.70	60%	40.00	80	--	--	--	--	--	--	59.70	--	601.00	601.00	2.19%	62.35	4.21%
Cahua [4]	May-95	Sipesa	21.12	41.81	60%	--	--	9.00	30%	Mar-00	6.67	Oct-96	10%	57.48	527.58	0.36	527.94	1.92%	25.75	1.74%
Etevensa [5]	Jan-96	Consorcio Generalima	65	120.10	60%	--	280	n.a.	n.a.	n.a.	3.44	Nov-96	1.78%	123.54						

2. Transmission Companies	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)										Tx. Lines	Transmission Line (Km) - 2006 220 KV	138KV	<75KV	Total	%	Income - 2007 [16] (US$ million)	%
Red de Energía del Perú (ETECEN, ETESUR) [6]	Sep-02	Interconexión Eléctrica Hydro Quebec	250.00	261.99										63	3,073.67	1,237.51	30.40	4,341.58	64.03%	65.30	49.64%
Consorcio Transmantaro [7]	Feb-98	International	300.00	179.18										4	603.03	--	--	603.03	8.89%	28.86	21.93%
Red Eléctrica del Sur [7], [8]	Mar-99	Red Eléctrica de España	92.50	74.48										4	427.75	--	--	427.75	6.31%	10.82	8.22%
Interconexión Eléctrica ISA Perú [9]	Apr-01	Interconexión Eléctrica	n.a.	65.40										5	261.72	130.52	--	392.24	5.78%	10.09	7.67%

3. Distribution Companies (includes those that returned to government)	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)	Initial company participation	Commitments Investments (US$ million)	Installations (MW)	Sale of state-owned shares Stock market (US$ million)	%	date	Workers (US$ million)	date	%	Total [15] (US$ million)	Present state ownership	Present owners	Number of customers - 2007 No	%	Energy sold - 2007 [16] (US$ million)	%
Luz del Sur [10]	Aug-94	Ontario - Quinta AVV	129.42	212.12	60%	--		172.56	30.0%	Dec-96/Feb-99	32.40	Jul-96	10.0%	417.08	0%	Endesa	777,289	17.8%	439.83	31.66%
Edelnor	Aug-94	Inversiones Distrilima	127.72	176.49	60%	--		94.24	36.3%	Mar-02	10.89	Jul-95	3.7%	281.62	0%	Ontario - Quinta AVV	986,365	22.6%	418.75	29.63%
Ede Chancay [11]	Dec-95	Inversiones Distrilima	10.35	10.36	60%	--		--	--	--	0.12	Apr-96	1.8%	10.48	0%	Endesa			--	--
Electro Sur Medio [12]	Mar-97	Consorcio HICA	35.00	25.64	100%	25.64		--	--	--	--	--	--	51.28	0%	late	130,701	3.0%	43.33	3.19%
Ede Cañete [13]	Jul-96	Luz del Sur	8.20	8.62	100%	--		--	--	--	--	--	--	8.62	0%	Ontario - Quinta AVV	27,210	0.6%	6.99	0.52%
Electro Norte Medio [14]	Dec-98	Jose Rodriguez Banda	36.08	67.88	30%	--		--	--	--	--	--	--	6.79	97.40%	Government	469,967	10.8%	103.43	7.04%
Electrocentro [14]	Dec-98	Jose Rodriguez Banda	26.28	32.69	30%	--		--	--	--	--	--	--	3.27	100%	Government	433,576	9.9%	67.52	4.27%
Electro Nor Oeste [14]	Dec-98	Jose Rodriguez Banda	12.96	22.89	30%	--		--	--	--	--	--	--	2.29	100%	Government	279,266	6.4%	60.12	4.27%
Electro Norte [14]	Dec-98	Jose Rodriguez Banda	11.35	22.12	30%	--		--	--	--	--	--	--	2.21	100%	Government	247,389	5.7%	48.55	3.33%

1/ US$ 273 million cash and US$ 100 millio. in debt title. The offer price includes both.

2/ Includes US$ 124.51 million (usufruct right) and US$ 22.36 million (social contribution)

3/ A capitalization investment modality and the transference of shares was used. The sale of 40% of state owned shares is still pending

4/ 20% cash and 80% in 8 years, interest rate= Libor (180 d) + 2%

5/ A capitalization investment modality was used. 60% of the state ownership's shares was sold for US$ 120 million (investment). It was absorved by EDEGEL in June 2006.

6/ Includes the base price for 30 years of concession (US$ 229.59 million) and spares stock, materials, assets (US$ 20.41 million).

7/ The company that proposed the lowest investment cost (based on a project implementation) was selected. Form of project financing: Build-Own-Operate-Transfer (BOOT)

8/ Transmission lines in concession: Socabaya-Moquegua, Moquegua - Puno, Moquegua-Tacna.

9/ Transmission lines in concession: Pachachaca-Oroya, La Oroya-Carhuamayo-Derivación Antamina, Aguaytía-Pucallpa

10/ The previous name was Edelsur

11/ Ede Chancay was sold to Edelnor at the end of 1996

12/ The government established the payment of 50% by cash and/or credit and the other 50% in investments. The company agreed: 20% cash and 80% in 8 years, interest rate= Libor (180 d) + 2%

13/ The first auction was declared void

14/ The government established the payment of 10% by cash and 90% by credit (12 years, including a 3 years pay off, interest rate=Libor (180d) + 2%). Due to the lack of payment the four companies returned to the government in 2001

15/ For the companies that were privatised temporarily only 10% of the offer price is considered as recaudation.

16/ Market share in terms of total market (privatised, private and public)

Source: CEPREL (1997), COPRI (2000),MINEM (2006), MINEM (2007), OSINERGMIN (2006), OSINERGMIN(2007), Proinversión, Libro Blanco from Regional Electricity Companies

- **3. Methodology**

Many empirical studies attempt to measure the impact of restructuring and privatisation of public utilities using different methodologies. One of the most popular and pioneering is the analysis of financial and physical indicators of performance. Among the literature that supports this is Hutchinson (1991), Megginson *et al*. (1994), Bishop and Green (1995), Boubakri and Cosset (1998), La Porta *et al*. (1999), Estache *et al*. (2001), Torero (2003). Selected indicators are compared pre and post privatisation in order to measure any improvement. The following category involves the use of labour and total factor productivity, Bishop and Thompson (1992), Parker and Martin (1995), O' Mahoney (1998). Other empirical studies are based on the use of frontier methodologies, such as Data Envelopment Analysis or Stochastic Frontier Analysis. Here productivity inefficiency is determined by the distance from the frontier. Examples of this grouping are Pollitt (1995), Bonifaz (2001), Kirkpatrick *et al*. (2004), Mota (2004), Giannakis *et al*. (2005), Margaretic and Romero (2007), Perez-Reyes and Tovar (2009). The last category, which is included in this empirical study, focuses on a social cost-benefit analysis. In comparison with the categories previously cited, this one also measures the broader welfare impact due to privatisation and also the individual effect among the different parties (customers, producers and government). It goes further than the comparison of performance indicators and the measurement of productivity. Among the empirical studies that support this approach are Galal *et al.* (1994), Newbery and Pollitt (1997), Domah and Pollitt (2001), Mota, R. (2003), Boardman *et al.* (2007), Wolf and Pollitt (2008). All these studies are based on the methodology described in Jones *et al.* (1990), which is also the one to be used in this study.

3.1 Social Cost-Benefit Methodology

The social cost-benefit analysis proposed by Jones *et al*. (1990) allows us to evaluate the impact of privatisation in terms of (1) efficiency gains from restructuring and privatisation and (2) distributional impact. The first concept measures the overall gains and the second one the gains (or losses) per actor (Government, Consumers and Producers). The methodology involves a counterfactual scenario and differs from others which are focused basically on financial and performance indicators, labour and total factor productivity and productivity. The counterfactual scenario, that simulates the continuation of government ownership, will be constructed in order to be compared with the scenario under privatisation.

$$\Delta W = Vsp - Vsg + (\lambda g - \lambda p) * Z \ldots\ldots\ldots\ldots..(1)$$

Where: Vsp : social value under private operation, Vsg : social value under government operation, λg : shadow multiplier on government revenue, λp : shadow multiplier on private funds, Z : actual price of the executed sale.

$$\Delta W = \lambda c * \Delta Con + \lambda g * \Delta Gov + \lambda p * \Delta Prod + (\lambda g - \lambda p) * Z \ldots\ldots\ldots\ldots..(2)$$

Where: ΔCon : Surplus of the consumer, ΔGov : Surplus of government, ΔProd : Surplus of producers, λc: Shadow multiplier on consumer surplus.

Following Newbery and Pollitt (1997) and Mota (2003), from a policy maker position, government revenue would be more appropriate as a numeraire for the measure of welfare. Under this approach, the idea is to determine the shadow multipliers based on the shadow multiplier on government revenue. The shadow multipliers represent the weight that different parties have in the social welfare function.

Following Jones *et al.* (1990), expression (1) is referred to the fundamental formula of divestiture, while the difference between social value under private and government operation is called the Difference Principle. When the variation in welfare is greater than zero (*ΔW* >0) it may be stated that privatisation was socially worthwhile. The social value is represented by the operating controllable costs (under private or public scenario) net of restructuring and privatisation costs[15].

Regarding expression (2), surplus of consumer is given by the difference between the private and counterfactual net average revenue[16]. The surplus of government is given by the difference between private and counterfactual taxes, which can be computed by projecting tax rates over operating profits. Tax rates are estimated using actual tax paid. The surplus of producers is obtained after subtracting the government and consumers' net gains from the total net benefits (ΔW).

In both scenarios, different values of shadow factors are assumed in order to analyse their impact in the social welfare. All values are aggregated on a present value basis.

3.2 Adjustments

Generation and transmission costs, purchase of energy and other issues, were excluded from the total operating costs in order to obtain the operating controllable costs[17]. Due to the lack of generation and transmission costs for the period 1986-1993, some approximations were made, see Appendix 1. Table 2 shows the detail of the actual consolidated accounts for the period 1986 – 2007 for the target companies. In order to measure the surplus of the consumers, it was also required to make some adjustments in terms of assets. Assets in the target companies were not disaggregated by activity. Generation and transmission assets were subtracted from Electrolima total assets and only

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[15] Net operating controllable costs = total operating costs – (generation costs + transmission costs + purchase of energy costs + depreciation + operating non-controllable costs)

[16] Counterfactual net average revenue = counterfactual operating profits + counterfactual operating controllable costs + operating non-controllable costs + depreciation. Counterfactual operating profit is computed using a rate of return on tangible fixed assets. Counterfactual operating controllable costs are calculated from unit counterfactual controllable costs taking into account a counterfactual cost decline.

[17] This study concentrates on the distribution business, other business such as generation and transmission were excluded.

generation assets were reduced from Electro Sur Medio. The last one did not report any transmission assets in the balance sheet.

3.3 The Counterfactual and Projected Scenarios

Electrolima and Electro Sur Medio were privatised in different years, 1994 and 1997. Both companies differed considerably in size[18], thus a separate counterfactual and projected scenario was performed. For the construction of counterfactual and projected figures some assumptions were made, see Section 3.4.

In order to calculate unit operating controllable costs regarding Electrolima, the cost trend for the period 1986-1993 was analysed. The actual figures show that for the years 1986-1989 there is not a clear trend in real terms. One explanation may be the high inflation rate in the late 1980's[19]. Thus an analysis for the last three years prior to the sale was performed. The unit operating cost was obtained calculating the average unit operating controllable costs for these years, due to these twofold reasons (1) if we only consider the period 1991-1992 we may be capturing any effect of the inflation rate and (2) if we only include the period 1992-1993 we can be absorbing additional costs incurred by the company before the sale. Therefore a way to smooth any impact under both scenarios is to compute the average for the whole period 1991-1993.

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[18] The average energy sold for the period 1986-1993 was 4.6TWh (Electrolima) and 0.21TWh (Electro Sur Medio).

[19] For instance, in 1990 Peru faced a hyperinflation annual rate of 7,560 per cent. BCRP.

Table 2: Accounts for Electro Sur Medio, Electrolima and the unbundled companies (Edelnor, Luz del Sur, Ede Chancay, Ede Cañete) at real values

2007 prices (US$ mio.)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2,007
Total operating revenue	308	343	239	148	289	303	356	425	547	612	693	746	697	757	821	822	838	846	850	926	949	944
Energy sold	306	342	238	147	288	295	348	405	523	575	658	698	657	718	785	786	805	816	819	912	910	894
Other incomes	2	1	1	1	1	9	8	19	24	37	34	48	40	39	37	36	33	30	31	14	39	50
(-) Generation expenses	21	28	18	20	15	23	46	44	1	4	1	1	1	1	1	1	1	1	1	0	1	1
(-)Transmission expenses	8	10	6	7	5	7	7	11	0	1	6	16	17	18	16	18	21	21	21	0	11	20
(-)Purchase of energy	52	53	53	29	65	90	106	160	329	385	423	439	391	427	478	479	500	517	526	580	567	504
Operating revenue	227	252	161	91	205	184	197	210	217	222	263	290	288	311	326	324	317	307	303	345	370	419
Operating cost	253	263	210	195	272	188	152	182	224	176	182	191	177	176	172	169	169	165	171	208	208	191
(-)Depreciation	49	35	48	35	33	30	23	38	30	31	35	41	45	53	61	62	66	69	73	80	77	69
(-)R&P	0	0	0	0	0	0	0	0	3	2	0	8	0	0	0	0	0	5	0	0	0	0
Net operating cost	204	229	162	160	239	158	129	140	192	145	138	150	132	124	111	106	98	96	98	128	131	122
(-) operating non controllable cost	104	100	73	57	158	63	36	4	6	2	2	8	7	9	9	9	9	9	11	12	12	11
Net operating controllable cost	100	129	89	103	81	94	92	136	186	143	136	142	125	115	102	97	88	87	86	116	120	111
Assets[1/]	411	449	1,196	701	1,091	417	317	437	596	777	875	973	1,063	1,128	1,182	1,253	1,265	1,262	1,318	1,357	1,313	1,293
Operating profits	-27	-11	-49	-104	-68	-4	45	28	-7	46	81	99	111	135	154	155	148	142	131	137	162	229
Taxes and workers participation	0	0	0	0	0	0	0	0	3	15	21	27	26	53	58	59	54	58	62	45	54	55
Workers participation	0	0	0	0	0	0	0	0	0	0	0	2	1	4	5	7	7	7	10	8	9	9
Taxes	0	0	0	0	0	0	0	0	3	15	21	25	25	48	53	52	47	51	53	38	45	46
Units distributed (TW.h)	4.73	5.21	5.30	4.90	4.74	5.26	4.52	5.32	5.90	6.15	6.14	6.66	7.09	7.21	7.54	7.57	8.02	8.10	8.53	9.14	9.84	10.38
Employees [2/]	4,256	4,514	4,360	4,917	4,705	4,111	3,223	3,153	1,978	2,035	1,721	1,740	1,640	1,643	1,448	1,461	1,573	1,544	1,522	1,558	1,534	1,485

1/ Generation and transmission assets have been subtracted from total assets.

2/ The number of employees from 1986 - 1993 only accounts for Electrolima employees. From 1994 it includes Electro Sur Medio employees and those from the unbundled company.

Exchange rate: 3.13 (Soles/ US$)

In relation to Electro Sur Medio, a similar procedure was followed by the calculation of the target unit operating controllable costs. This company was sold in 1997; therefore the analysis is focused on the period 1994-1996. Thus, the average of unit operating controllable costs was computed using the accountings for the period 1994-1996. It is important to remark that even though the period 1994-1996 was a more stable period (the inflation rate was much lower) in comparison with the period 1991-1993, the average unit operating controllable costs in this period differed only 2.6 per cent from the average unit operating controllable costs computed for the period 1994-1996[20]. As expected, the unit operating controllable costs calculated for Electrolima is around 18 per cent lower than that from Electro Sur Medio.

With the calculation of these unit operating costs the next step is to perform a sensitivity analysis using different annual cost fall rates, from 0 per cent to 4 per cent. That means for example that a 2 per cent p.a. fall in controllable costs under the counterfactual scenario implies that this cost will decrease 2 per cent p.a. In addition to the sensitivity analysis for the five cost fall rates, a central-case scenario related to the total efficiency gains and to the distributional gains is also discussed in this study. The unit operating cost is multiplied by the number of actual distributed units to obtain the total operating controllable costs for the period 1994-2007 (Electrolima) and period 1997-2007 (Electro Sur Medio). These costs are then compared with those from the actual scenario under private ownership. The efficiency cost savings are obtained from this difference, after aggregating on a present value basis with a specific discount rate.

In terms of projections, it was assumed that the efficiency gap under both approaches, public and private ownership will be closed in the medium term and that prices would be the same. Following Pollitt and Smith (2002), 15 years would be an appropriate time to make this possible[21]. Total efficiency cost savings are computed by the difference between (1) the counterfactual and the counterfactual projected costs and (2) the actual and projected costs; aggregated of a present value basis.

3.4 Assumptions

Some assumptions were made for the construction of the counterfactual scenario and projections for computing the efficiency gains:

1. The Wholesale Price Index (IPM[22]) is used for adjusting all the accountings. All figures are expressed in 2007 prices[23].

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[20] The average unit operating controllable cost for the period 1991-1993 is 2.64 per cent higher than those for the period 1994-1996, in real terms.

[21] In summary, the cost benefit analysis will be performed from 1994 to 2022. Regarding the simulation of public ownership, figures from 1994 to 2007 refers to the counterfactual values and from 2008 to 2022 to the counterfactual projections. Regarding private ownership, figures from 1994 to 2007 are actual values and from 2008 to 2022 are projected values.

[22] According to the National Accounting Regulatory Council, the IPM is the index used for the adjustment of companies' financial statements. Electricity companies submitted both, historical and adjusted financial statements to OSINERGMIN until 2004. After that the submission of the adjusted accountings was not compulsory due to the low inflation rate in the last years.

2. A total of 5 discount rates[24] were selected: 5 per cent, 6 per cent, 8 per cent, 10 per cent and 12 per cent. A discount rate of 7.3 per cent is used for the central-case which represents the annual average reference interest rate in the 1990's.
3. Projections of the demand growth rate are based on the Electricity Reference Plan (Plan Referencial de Electricidad) (MINEM, 2008).
4. Generation and transmission assets for the period 1986-1992 (Electrolima) and 1986-1994 and 1996 (Electro Sur Medio) remain the same in real values. Distribution assets are the same under public and private ownership. For projections, assets increase at the demand growth rate.
5. The counterfactual operating profits are based on the average rate of return of assets for the period 1991-1993 (Electrolima) and period 1994-1996 (Electro Sur Medio).
6. Depreciation and operating non-controllable costs are the same under public and private scenarios. For projections, the depreciation rate is equal to 3.3 per cent based on the lifetime of electricity connections[25]. Projected operating non-controllable costs per KWh, regarding Electro Sur Medio and the companies that were unbundled from Electrolima, follow the same trend of their respective unit operating non-controllable costs after privatisation.
7. The efficiency gap under public and private ownership will be closed in the following 15 years. For counterfactual projections, operating controllable costs will decrease to reach the same level of costs under the projected values (private ownership). These projected values were computed for each company based on the trend of unit operating controllable costs after privatisation.
8. Prices under public and private ownership will be the same in the following 15 years. Projected prices (private ownership) will decline to reach the same level of prices under the counterfactual projections. Projected prices were calculated for each company based on the trend of net revenues per KWh after privatisation.
9. Tax rate is equal to the ratio of tax to operating profits[26]. A rate of 0 per cent for the first three years after privatisation (1995-1997 for Electrolima, and 1997-1999 for Electro Sur Medio) and a rate of 30 per cent after these periods is assumed[27].

▪ 4. Data Collection

The companies' financial statements for the target companies, Electrolima and Electro Sur Medio, were obtained from Annual Reports of the Electric Tariff Commission (period 1986 – 1999) and OSINERGMIN (2000 – 2007). Among the

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[23] All calculations are made in Nuevo Soles, the Peruvian currency, and were adjusted using national accounts data. Then we use the 2007 exchange rate (US$/Soles) for presenting the results.
[24] Based on the reference interest rate established by the Peruvian Central Bank – BCRP.
[25] OSINERGMIN estimates a 30-year lifetime for calculating the connection costs.
[26] For the construction of the figures, taxes are composed of income tax and social contribution. Thus, tax rate refers to the combination of income taxes and social contribution over operating profits. In Peru the rate tax is equal to 30 per cent over operating profits.
[27] The tax trend payment in state-owned companies (Seal and Electro Norte Medio) was examined. These companies did not report tax payment after the first three years of being established the payment of taxes (in the financial sheets the item of "tax" appears from year 1994) Thus, we believe that the three-year interval is convenient.

data required were: revenues, total operating costs, operating controllable costs, taxes, compensation funds and transfers, purchase of energy, fuel expenses, depreciation, labour expenses, purchase of energy, taxes and social contribution, among others. In addition, the collection of physical data such as number of employees, distributed units and distribution losses were also obtained from these reports. Regarding the generation and transmission costs before privatisation, they were calculated using the Informational Memorandum and the Diagnostic Report both developed by the International Finance Corporation and Coppers & Lybrand respectively for CEPREL. These reports were found in the Libro Blanco[28] from CEPREL. These costs are important for analysing the cost trend before privatisation in order to approximate the unit operating controllable costs. The generation assets were obtained from Electrolima and Electro Sur Medio Libro Blanco as well. The transmission assets regarding Electrolima were obtained from the Ministerial Resolution No 164-93-EM-VEM[29].

The restructuring and privatisation costs were collected from the Libro Blanco and from the National Public Treasury Office (Ministry of Economy and Finance). The IPM index and its specific adjustment factors[30] were required for adjusting figures to 2007 prices, and for the calculation of generation and transmission costs before privatisation. This was obtained from the National Accounting Regulatory Council (Ministry of Economy and Finance). See Appendix 2 for details.

Figure 1 depicts the composition of revenue (actual values, 2007 prices) from the period 1986 – 2007, in terms of operating profits, net operating controllable costs, operating non-controllable costs, depreciation and restructuring and privatisation costs.

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[28] "Libro Blanco" is a large report that contains important documents before the privatisation of Electrolima.
[29] This resolution established the transmission assets that would be transferred from Electrolima to the company Empresa de Transmisión Eléctrica Centro Norte. This company was created to operate the transmission business of Electrolima and Electroperu.
[30] Due to the high inflation rate in the late 1980's, the adjustment factors were divided twofold: before 1990 (initial adjustment) and after 1990 (final adjustment). See Resolutions No. 02-90-EF/93.01 and No. 03-93-EF/93.01 from the National Accounting Authority (Consejo Normativo de Contabilidad) – Ministry of Economy and Finances.

Figure 1: Revenue composition per KWh for Electrolima, Electro Sur Medio, Edelnor, Luz del Sur, Ede Chancay and Ede Cañete

(net of generation, transmission and purchase of energy payments)
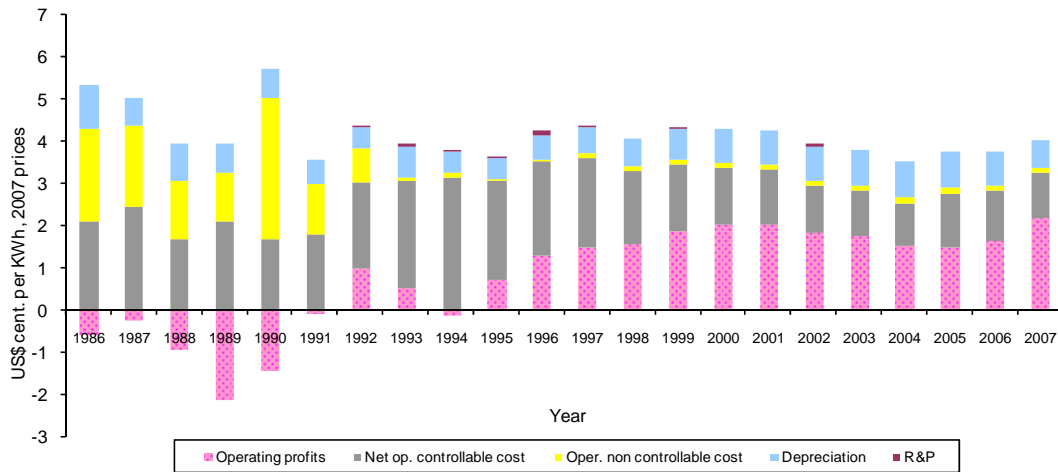
- ## 5. Results

5.1 Efficiency Gains

In this section the savings due to restructuring and privatisation of Electrolima and Electro Sur Medio are calculated. Both savings are then added in order to obtain the total gains. The net efficiency gains are calculated by subtracting restructuring and privatisation costs (R&P) from the gains explained by the controllable cost reduction. Table 3 shows the gains and losses under different scenarios for the whole period (including the future). Five discount rates were selected from 5 per cent to 12 per cent, based on the assumptions given in section 3.4[31]. Net efficiency gains vary from US$ 4 million to US$ 705 million. If we believe that there would have been no cost variation (or a little variation) under state ownership the use of counterfactual cost fall of 0 per cent and 1 per cent would be more reasonable. For instance, with a counterfactual cost fall of 0 per cent, gains would be US$ 627 million net of restructuring and privatisation costs at a discount rate of 6 per cent. On the other side, if we think that public sector would have been able to reduce costs significantly the use of a counterfactual cost fall of 3 per cent and 4 per cent would be more appropriate. With a counterfactual cost decline of 4 per cent, public sector ownership would be the best option at a discount rate of 12 per cent, with US$ 4 million in losses net of restructuring and privatisation costs. The use of a counterfactual cost decline of 2 per cent is a more impartial position in comparison with the four

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[31] For Electrolima's savings, we calculated the present value for the period 1995-2007. The year 1994 was excluded because the sale of companies (Edelnor and Luz del Sur) was completed in August 1994. In the case of Electro Sur Medio, the computed period for the present value is 1997-2007. We include the year 1997 because this sale was at the beginning of that year.

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previous counterfactual cost falls. Gains vary from US$ 153 million to US$ 349 million net of restructuring and privatisation costs.

Table 3: Efficiency Gains

Counterfactual cost fall 2007 prices (US$ million)	Discount rate				
	5%	6%	8%	10%	12%
Electrolima					
0%	687.3	611.8	489.0	395.1	322.3
1%	511.1	454.2	361.6	290.7	235.7
2%	349.8	309.8	244.7	194.8	156.0
3%	201.9	177.4	137.4	106.6	82.6
4%	66.4	56.0	38.9	25.5	15.0
Electro Sur Medio					
0%	33.4	30.0	24.5	20.2	17.0
1%	23.7	21.3	17.5	14.5	12.2
2%	14.7	13.3	10.9	9.2	7.8
3%	6.2	5.7	4.8	4.1	3.6
4%	-1.7	-1.4	-0.9	-0.6	-0.3
Efficiency gains					
0%	720.7	641.8	513.5	415.3	339.3
1%	534.9	475.6	379.1	305.2	248.0
2%	364.5	323.1	255.6	203.9	163.8
3%	208.1	183.1	142.2	110.7	86.2
4%	64.7	54.7	38.0	24.9	14.7
Efficiency gains (% cost)					
0%	25.4%	27.2%	29.0%	29.3%	28.7%
1%	18.9%	20.1%	21.4%	21.5%	21.0%
2%	12.9%	13.7%	14.4%	14.4%	13.9%
3%	7.3%	7.7%	8.0%	7.8%	7.3%
4%	2.3%	2.3%	2.1%	1.8%	1.2%
R&P	15.3	14.6	13.3	12.1	11.2

Table 4 shows the results from comparing net gains from restructuring and privatisation of the electricity distribution markets in England and Wales, Brazil and Peru. Gains are much higher in the first and second electricity markets in comparison with the third one[32]. This fact could be explained by the difference in size of the electricity market[33].

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[32] All figures were adjusted to 2007 prices and are expressed in US$.

[33] For instance, following Domah and Pollitt (2001) and Mota (2003); the average annual distributed units are 279 TWh and 187 TWh, regarding the electricity market in England and Wales (actual figures: from 1990 to 1997, projected figures from 1998 to 2005) and Brazil (actual figures: from 1995 to 2000, projected figures from 2001 to 2007) respectively. In the case of Peru the average annual distributed units are around 12.58 TWh (actual figures: from 1995 to 2007, projected figures: from 2008 to 2022).

Table 4: Net Gains from Restructuring and Privatisation of Electricity Distribution Markets
A comparative analysis

Cost fall rate = 2 per cent	Discount rate				
	5%	6%	8%	10%	12%
Domah, P. and Pollitt, M.G. (2001)					
Electricity Market: England and Wales					
Gains (US$ billion, 2007 prices)	26.08	19.70	12.76	8.88	6.10
Gains as % of costs	20.2%	18.3%	15.8%	13.7%	11.3%
Gains per KWh (US$ cents/ KWh, 2007 prices)	0.55	0.50	0.43	0.38	0.31
Mota, R. (2003)					
Electricity Market: Brazil					
Gains (US$ billion, 2007 prices)				13.39	11.86
Gains as % of costs				21.2%	26.2%
Gains per KWh (US$ cents/ KWh, 2007 prices)				0.94	1.00
This paper					
Electricity Market: Peru					
Gains (US$ billion, 2007 prices)	0.36	0.32	0.26	0.20	0.16
Gains as % of costs	12.9%	13.7%	14.4%	14.4%	13.9%
Gains per KWh (US$ cents/ KWh, 2007 prices)	0.31	0.33	0.35	0.35	0.33

In terms of gains as percentage of costs[34], Brazil has the highest percentage and England and Wales along with Peru have similar percentages (discount rates from 8 per cent to 12 per cent) One reason that could explain this fact is that in the Brazilian market net efficiency gains started accruing immediately (from 1995) in comparison with the English and Peruvian market, which began accruing after some years (from the base year, 1990 and 1995 respectively). Gains per KWh[35] are also in line with the previous results, being Brazil the market with the highest figures.

The next section explains in detail the selection of the counterfactual cost decline for the central-case scenario (up date and the future) and section 5.3 discusses the distributional gains.

5.2 Gains based on the central-case scenario

In order to select the counterfactual cost fall for the central-case scenario the trend of public companies was analysed. The target companies were those that operate in areas with high population density[36]. The companies selected were Electro Norte Medio (a company that was sold but then returned to public

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[34] The gains as percentage of costs indicate the average annual gains as a percentage of operating controllable costs. The procedure for computing this is as follows: the total gains are multiplied by the respective discount rate, and then this value is divided by the actual operating controllable costs (base year). The exercise is repeated for each set of discount rates.

[35] The procedure for computing this variable is very similar to the previous one. Net gains are multiplied by the discount rate and then divided by the number of distributed units related to the base year.

[36] Electrolima operated in Lima, where the population density is high. Electro Norte Medio and Seal operate in Trujillo and Arequipa respectively, two of the most important cities in Peru with important population density as well.

ownership) and Seal (a company that was always under public ownership) [37]. The results show that the annual average cost fall is approximately 2.4 per cent for Seal and 4.3 per cent for Electro Norte Medio[38]. Thus, a counterfactual cost fall of 2.4 per cent was taken for the central-case[39]. The counterfactual cost fall of 4.3 per cent was not taken into account because this rate may be capturing the effect of having been privatised for some years.

Table 5 shows the benefits regarding the central-case scenario at different discount rates for the period today (from privatisation to 2007) and the future (from privatisation to 2022). A 7.3 per cent discount rate is selected for the analysis. The selection of the period for computing this rate (1990's) is in line with our base year.

Table 5: Net efficiency gains for central-case scenario

Central case scenario (2.4%) 2007 prices (US$ million)	Discount rate											
	Up to 2007						Up to 2022					
	5%	6%	7.3%	8%	10%	12%	5%	6%	7.3%	8%	10%	12%
Electrolima	183.5	166.1	146.0	136.2	111.7	91.4	289.1	255.5	218.2	200.7	158.6	125.9
Electro Sur Medio	6.3	5.9	5.5	5.3	4.7	4.3	11.2	10.2	9.0	8.4	7.1	6.1
Efficiency gains	189.7	172.0	151.5	141.5	116.4	95.7	300.3	265.6	227.2	209.1	165.7	132.0
Efficiency gains (% cost)	6.7%	7.3%	7.8%	8.0%	8.2%	8.1%	10.6%	11.2%	11.7%	11.8%	11.7%	11.2%
Net efficiency gains	174.5	157.5	137.8	128.2	104.3	84.6	285.0	251.1	213.5	195.8	153.6	120.8

From Table 5 we observe that total net efficiency gains (including future gains) are equal to US$ 213.5 million in real terms and that gains amounts to US$ 137.8 if the period of analysis is limited to 2007. In both cases, the gains explained by the controllable cost reduction relative to Electrolima are much higher than those from Electro Sur Medio. Electrolima accounts for 96 per cent of the net gains (including future gains) and Electro Sur Medio for the remaining 4 per cent. These results are very dependant on the selected discount rate due to the skewness of the distribution cost and benefits. A 5 per cent discount rate produces an increase of 34 per cent in the net efficiency gains while a 12 per cent discount rate produces a decrease of 43 per cent.

It is important to remark that gains are also sensitive to the size of the market. Results from Domah and Pollitt (2001) for the UK electricity market and Mota (2003) for the Brazilian electricity market, show much higher efficiency gains than our results, under similar conditions[40]. Total delivered units previous to

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[37] An additional characteristic is that generation electricity is almost negligible in both cases (similar to Electro Sur Medio). This fact facilitated the calculation of the unit controllable operating costs
[38] The analysis was made for the period 1994-2007.
[39] This result is also in line with the counterfactual cost decline selected in different studies that involved developed and developing countries. Domah and Pollitt (2001), Mota (2003) selected a 2 per cent counterfactual cost decline for the central-case scenario. Thus, we believe that a selection of a counterfactual cost fall of 2.4 per cent is quite acceptable.
[40] In terms of discount rates and counterfactual cost falls.

privatisation were about 250 TWh and 135 TWh respectively, in comparison with 5.3 TWh regarding the Peruvian market.

5.3 The distribution of gains based on the central-case scenario

A distributional analysis will tell us about the winners and losers due to restructuring and privatisation. In this section and the next one the analysis will include future gains. Table 6 shows the net distributional gains for the central-case scenario when $\lambda g=\lambda c=\lambda p=1$.Government and producers benefit at the six discount rates of our analysis. Consumers suffer at any discount rates. This fact can be explained by the increase in tariffs after the following years of privatisation.

In addition, it is perceived that the distributional gains between the two companies are different. For the central-case scenario at 7.3 per cent discount rate regarding Electrolima, producers have the highest gains equal to US$ 329.3 million. In the case of Electro Sur, government accounts for the highest benefits equal to US$ 8.7 million.

Table 6: Distribution of the net efficiency gains from restructuring and privatisation
Central-case scenario

Central-case scenario (2.4% cost fall) 2007 prices (US$ million)	Discount rate					
Net Distributional Gains	5%	6%	7.3%	8%	10%	12%
1. Electrolima						
ΔGov	320.9	291.9	259.7	244.5	207.9	179.1
ΔCon	-482.6	-435.4	-384.3	-360.6	-304.9	-262.6
$\Delta Prod$	435.6	384.6	329.3	303.7	243.6	198.3
ΔW	274.0	241.1	204.7	187.6	146.6	114.9
2. Electro Sur Medio						
ΔGov	10.7	9.8	8.7	8.2	6.9	5.9
ΔCon	-8.1	-6.7	-5.3	-4.6	-3.0	-1.8
$\Delta Prod$	8.4	7.0	5.4	4.7	3.1	1.9
ΔW	11.0	10.0	8.8	8.3	7.0	6.0
Total net distributional gains						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-490.7	-442.2	-389.5	-365.2	-307.9	-264.4
$\Delta Prod$	444.0	391.6	334.7	308.4	246.7	200.2
ΔW	285.0	251.1	213.5	195.8	153.6	120.8

Figure 2 depicts the annual trend of the distribution net efficiency gains regarding both companies after privatisation and for the central-case scenario. Government benefits from the beginning, fact that is explained by the collection of taxes. The fall observed between 1997 and 1998 is explained by the assumption that state-owned companies start to pay taxes since 1998. Producers benefit continuously since 1997. Based on the assumptions made (efficiency gap will be closed and prices will be the same under private and public ownership in 15 years time), for the period 2008-2022 government and producers' gains decrease continuously and customers' gains increases. Consumers are the most affected by assumption. The fall in the distribution of benefits to consumers is in agreement with the increase in price after privatisation. See next section for further details.

Figure 2: Distribution of net efficiency gains
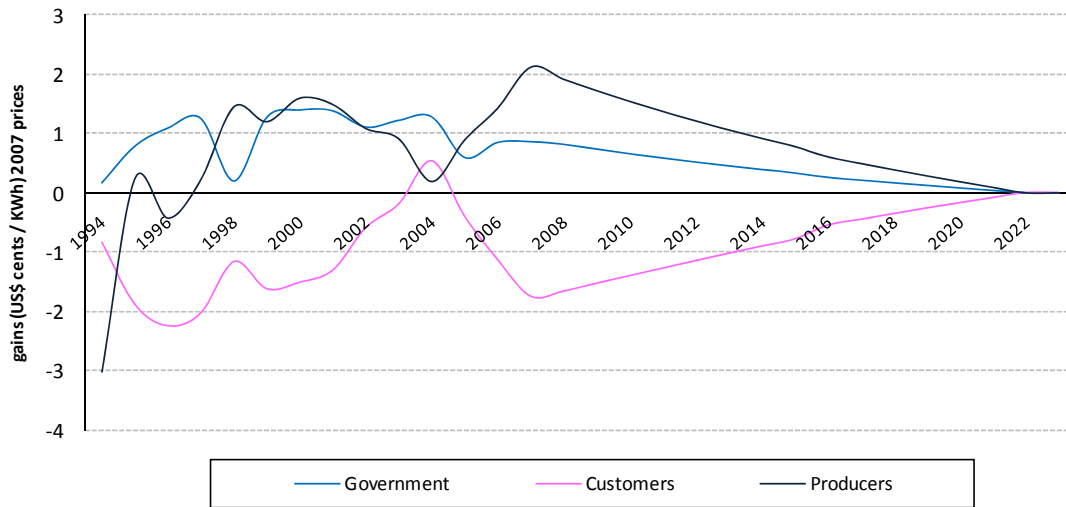
The use of different social weights increases significantly these gains. There is not a definitive agreement about the most appropriate value for *λg, λp and λc*. Galal *et al*. (1994) state that different weights may be required when an economy is highly distorted. Domah and Pollitt (2001) agree with that statement and assume *λg = λp = 1* in the case of a developed economy. Jones *et al*. (1990) find prudent to assume that *λg>λp from* the taxation perspective, otherwise it would imply that government would minimize the sale price. In addition, they agree that *λg > λc* in the case of developing economies. Mota (2003) assumes *λg> λp,* and sets two different values to *λp and λc* (0.8, 0.5) for analysing the social benefits in restructuring and privatising the Brasilian electricity distribution companies. Thus, the selection of the most appropriate value for each social weight involves a specific country analysis which is beyond the extent of this empirical study. Therefore, taking into consideration that Brazil and Peru are both developing economies, it is considered properly to assume that *λg=1, λp=0.5* and that *λc* can take two values, 0.8 or 0.5. The results of introducing different social weights are discussed in Section 5.5.

5.4 Impact on Prices

Based on the estimations made for the period 1994-2022, prices under private ownership would be in average 8.6 per cent higher than those under public ownership[41]. Figure 3 illustrates the trend of actual, counterfactual and projected prices for the central-case scenario. The gap between actual and counterfactual prices regarding the first years after privatisation is noticeable. This trend is also in line with the evolution of nationwide real residential prices, which increased around 20 per cent from 01/94 to 12/96[42]. For the period 2001 to 2003 the gap between both prices is much lower and in 2004 counterfactual prices are higher

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[41] Prices were obtained dividing net revenues by the total distributed units. Then, the price difference between the actual and counterfactual scenario per year was calculated. The difference was expressed in percentage. Finally, the average of this difference was computed for the period 1994-2022. This value is the average variation in prices equal to 8.6 per cent

[42] The trend of nationwide residential prices (tariff BT5) for the period 1994-2007 was analysed.

than actual prices. After 2004, a rise in actual prices is noticed and then a downturn is visualized. Based on our assumptions, in 2022 the gap between counterfactual and actual prices will be closed.

Figure 3: Actual, counterfactual and projected prices for central-case scenario (Net revenues per KWh)
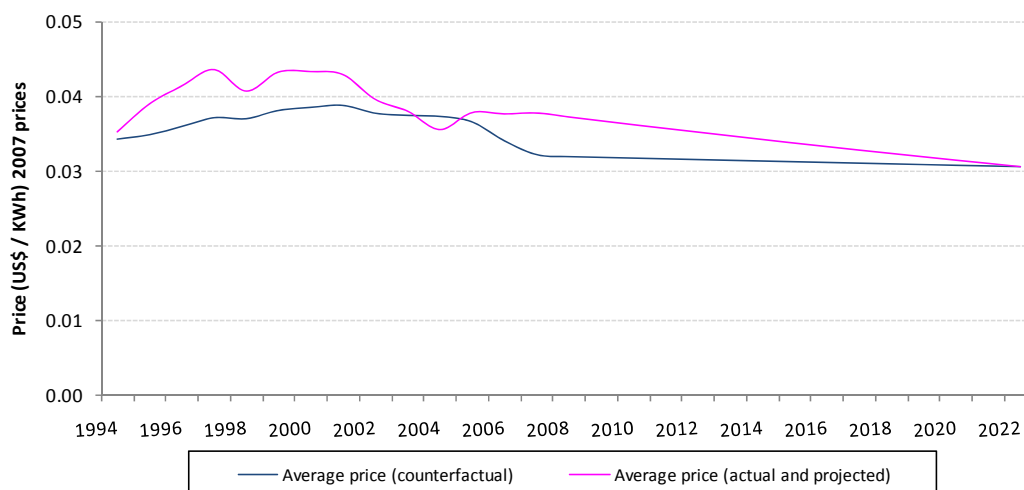
The trend changes in actual prices are also in agreement with the last three prices review regarding the distribution valued added (VAD). Prices were adjusted in 11/1997, 11/2001 and 11/2005, respectively[43]. It is important to note that even though the VAD represents an important component of the end user tariff[44] and is adjusted each four years; the end user price is also composed of "transmission prices" and "generation prices", with annual adjustments.

These results are in line with the trend in tariffs in some developing countries after the reform of the electricity sector. The true levels of price distortion are exposed during the first years of reform (Sen and Jamasb, 2010). In Latin American and Asian developing countries, electricity residential prices tended to increase when the regulatory agency was established, however, in developed countries the effect was inverse (Nagayama, 2007)[45]. Haselip *et al.* (2005) explain a different trend on prices after market liberalisation in Argentina. Price reductions are remarkable but the benefits have been disproportional; residential and industrial consumers with highest level of consumptions benefited the most (71 per cent and 44 per cent of reductions respectively). Prices for residential low-income remain nearly the same. In summary, increase in electricity prices could difficult the access to the service to low-income users, but at the same time cost-reflective tariffs (usually higher after deregulation in developing countries) could provide incentives to companies for expanding the service and for improving the quality of this. The subsidy schemes applied by

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[43] The most recent price control was in 11/2009. Taking into consideration that actual prices were computed for the period 1994-2007, the effect of the last price control was not captured in this figure.

[44] The distribution prices represent around 30 per cent of the end user bill (residential customers).

[45] An econometric model was built for analysing the effect that the establishment of independent regulator, unbundling, retail competition, among others; have in the trend of real residential prices. The establishment of independent regulator was statistically significant at 0.05 level. In terms of the trend of real industrial prices, the coefficient is also positive but not significant.

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some developing countries tend to increase the electricity access rate in low-income users from urban and rural areas. It is important to find a balance that allows passing companies' gains to customers. Lower prices could tend to an inefficient use of electricity and higher prices could inhibit users from the service and look for alternative sources that could harm the environment such as wood fuels (Goldemberg *et al.*, 2004).

In this section the actual and counterfactual prices trend has been examined. The price control formula put in place at privatisation contributed to the increase in prices, specifically after the first years of privatisation. However, are these trends, in line with those changes in operating controllable costs? When analyzing the trend of unit operating controllable costs, an important decrease is noticed for the period 1997-2001 and a smoothed decline for the period 2002-2007. However, from Figure 3 prices remain almost the same for the period 1997-2001, even though unit controllable costs decrease notably. For the period 2002-2004, the price reduction is in agreement with the decrease in unit operating controllable costs. Therefore, the gap between cost and prices tends to be much wider during the first years after privatisation. This fact is also expected. Taking into account the initial conditions under which the state-owned companies operated before privatisation, the application of cost reduction policies by the new administration (privatised company) tends to be more noticeable during the first years of operation. This is also supported by the fact that companies want to recover their investment in as short a time as possible after the acquisition.

5.5 Additional Benefits and the impact of different social weights

In 1993 the nationwide coverage was 57 per cent and at the end of 2007 around 80 per cent of the population had electricity. The companies derived from the state-owned company Electrolima; Edelnor and Luz del Sur, which accounted for 61.3 per cent of the total electricity sold in 2007, have achieved almost the 100 per cent of their respective concession areas. However, electrification achievements cannot be uniquely attribute to privatisation. The electricity sector reform, that includes the restructuring of the sector, the application of prices that reflect the real cost, the incentives that government provide to expand the electricity coverage in remote areas and to low-income users, among others; allowed to privatised companies to expand their services. Government through the Executive Office for Projects – DEP has played an important role. The DEP is managed by MINEM and it is in charge of planning, designing and implementing rural electricity projects. After their implementation the operation and maintenance is transferred to distribution companies, local governments or to ADINELSA[46]. Despite its effort[47], rural electricity coverage increased from 7.7 per cent in 1993 to 30 per cent in 2007[48]. The peculiar geography (in mountains and

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[46] ADINELSA is a state-owned company in charge of developing rural electrification projects in areas that are outside the concession area of distribution companies.
[47] The Peruvian Government has spent around US$ 50 million p.a. in the last 10 years for rural electrification. There is a commitment to increase this coverage from 30 per cent to 75 per cent by 2013. (World Bank, 2006)
[48] MINEM (2008)

jungle) and the high level of dispersion of rural villages makes the task more difficult.

Edelnor, along with Ede Cañete and Electro Sur Medio are the companies that have contributed more to the expansion of the electricity service to the poorest population into their concession areas. Edelnor operates in sectors 1, 2, 3 and 5, Ede Cañete in sectors 2 and 4, while Electro Sur Medio in sectors 2, 3, 4 and 5[49]. In addition, this statement is also in line with the fact that 83 per cent of Edelnor' customers belong to the poorer segments of Lima population. (Alcazar *et al.*, 2007). At the same time the strategy opted by the government in the sale of regional electricity companies (Electro Sur Medio); in which 50 per cent of the offer price would be used for future investments in isolated villages, resulting in the implementation of electrification projects that contributed to the expansion of the electricity frontier in remote areas.

In terms of benefits of being connected, Alcazar *et al.* (2007) explains that access to electricity in rural areas produces an improvement in household's welfare due to a substitution effect explained by a decline of hours spent in farm activities and an increase in hours spent on leisure. The World Bank (2008) calculated that rural electrification benefits are approximately US$ 30.5 per household per month in Peru[50]. Therefore, we find reasonable to add the benefits of being connected to the total gains regarding the restructuring and privatisation of Electrolima and Electro Sur Medio. For this purpose, a counterfactual scenario was also built for the period 1995-2022. This scenario was built in two stages: one for the period 1995-2001 and the other one for the period 2002-2022. For the first stage it was assumed that the annual growth rate is similar to that from Seal (5.4 per cent); the state-owned distribution company whose trend in annual average cost fall was taken into consideration for the construction of the central-case scenario in section 5.2. For the second period, it was assumed that the gap in household connections under the public and private ownership will be closed in 2022. In terms of actual household connections it was assumed that these grow at 3.12 per cent p.a. for the period 2008-2022, which is the average annual growth rate of households in the companies' concession areas for the period 1995-2007. Figure 4 illustrates the actual and counterfactual household connections. During the following 5 years after privatisation the actual household connections increased notably at 6 per cent p.a. (this explains the significant gap observed between 1995 and 2000). This value is twice the annual growth rate of households placed in the companies' concession areas. The value determined by the World Bank is taken as reference for estimating the benefits of being connected. The GDP index was used for adjusting this value[51] and it was

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[49] Distribution electricity companies can operate in more than one sector. At the moment there are six sectors, from sector 1 (high population density-urban) to sector 5 (low population density-rural), and sector 6 which refers to pre paid systems.

[50] From which U$ 16.16 accounts for benefits in lighting, US$ 8.5 for benefits in TV, US$ 5.5 for time saved for household chores/increasing leisure, US$ 0.02 for improving health, US$ 0.08 for reducing fertility and US$ 0.24 for reducing pollution. The Bank has estimated the valuation of the benefits of lighting and TV based on Willingness to Pay (WTP), which was calculated taking in consideration the cost of the existing source (kerosene lamp). Customer Price Index and GDP index were used for adjusting this value.

[51] Actual GDP per capita was obtained from World Bank database. Projected GDP per capita was obtained from International Monetary Fund database.

assumed that benefits are constant in real values for the whole period of the analysis.

Figure 4: Number of household connections (actual and counterfactual)
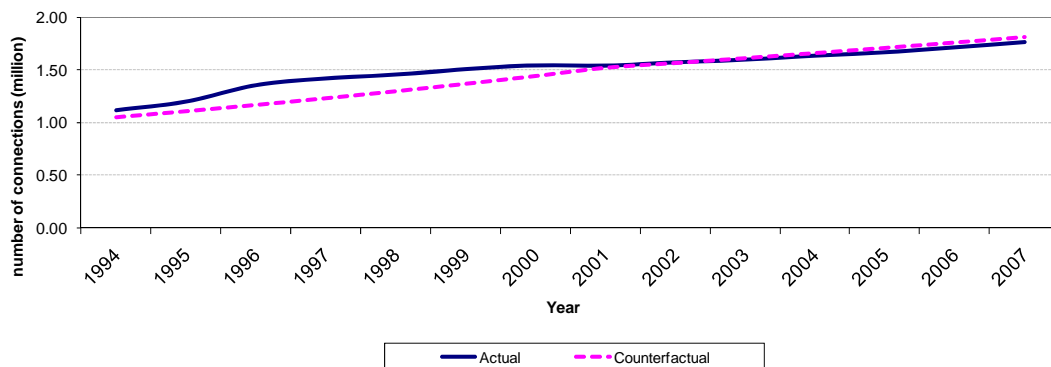
The difference between the actual and the counterfactual household connections is multiplied by the net benefit[52] of being connected per household. This product represents the total benefits per year. Then, all the values are aggregated on a present value basis using the same set of discount rates assumed in section 3.4. Table 7 summarizes the total social welfare for restructuring and privatisation Electrolima and Electro Sur Medio under three scenarios (1) $\lambda g=\lambda c=\lambda p$, (2) $\lambda g>\lambda c=\lambda p$ and (3) $\lambda g>\lambda c>\lambda p$.

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[52]Net benefits are equal to benefits net of connection cost. Following Horn (2007), the average cost of a new connection in rural areas amounts to US\$ 1,200 and it is assumed that it remains constant for the whole period. To compute the annual cost, this value was divided by the connection lifetime, equal to 30 years. The IPM was used for adjusting this value.

Table 7: Social welfare from restructuring and privatisation under different values of social weight – Consolidation of results

Central-case scenario (2.4% cost fall) 2007 prices (US$ million)	Discount rate					
	5%	6%	7.3%	8%	10%	12%
Base Scenario (λg = λc = λp = 1)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-490.7	-442.2	-389.5	-365.2	-307.9	-264.4
ΔProd	444.0	391.6	334.7	308.4	246.7	200.2
Social welfare	285.0	251.1	213.5	195.8	153.6	120.8
Including additional benefits						
ΔCon	-156.0	-109.7	-61.3	-39.8	8.1	40.7
Social welfare	**619.6**	**583.5**	**541.7**	**521.3**	**469.5**	**426.0**
Scenario 1 (λg = 1, λc = λp = 0.5)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-245.3	-221.1	-194.8	-182.6	-153.9	-132.2
ΔProd	222.0	195.8	167.3	154.2	123.3	100.1
Social welfare	820.6	788.6	753.1	736.5	696.4	665.2
Including additional benefits						
ΔCon	89.3	111.4	133.5	142.8	162.0	172.9
Social welfare	**1,155.2**	**1,121.1**	**1,081.4**	**1,061.9**	**1,012.3**	**970.3**
Scenario 2 (λg = 1, λc = 0.8, λp = 0.5)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-392.5	-353.7	-311.6	-292.1	-246.3	-211.5
ΔProd	222.0	195.8	167.3	154.2	123.3	100.1
Social welfare	673.4	655.9	636.3	626.9	604.0	585.8
Including additional benefits						
ΔCon	-57.9	-21.3	16.6	33.3	69.6	93.6
Social welfare	**1,008.0**	**988.4**	**964.5**	**952.3**	**920.0**	**891.0**
Social benefits from being connected	334.6	332.5	328.2	325.4	315.9	305.1

Social welfare includes the sales component (scenario 1 and 2)

Taking into account that it is the poor who are being connected, this assumption makes sense. Customer social welfare weight should be at least equal or greater than the producer one. Benefits to consumers of being connected have also been included in Table 7.

The large size of the price of the executed sale[53] in comparison with the non weighed efficiency gains, explains the increase in efficiency gains when using different social shadow multipliers. At a discount rate of 7.3 per cent, benefits accounted for the sale prices represent 68 per cent and 81 per cent of social welfare[54], when $λc=0.5$ and $λc=0.8$, respectively. When $λc=0.8$ social welfare increases by 198 per cent in comparison with the non weighted gains. The rise is more impressive when $λc=0.5$, social welfare jumps from US$ 213.5 to US$ 753.1 million. The individual analysis (per company) shows a similar trend in gains variation for both companies.

For the central-case and base scenario the social welfare moves from US$ 213.5 to US$ 541.7 million when the additional benefits are included. The application of different social weights increases the social welfare, in which the value of the sales still has an important participation. Social welfare ranges between US$ 541.7 and US$ 1,081.4 million when additional benefits are included. The

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[53] Sales amount to US$ 1.02 billion in 2007 prices.
[54] Without including benefits of being connected.

distributional gains are affected as well; due to the new distributional gains for customers (government and producers' gains remain the same). Even though the inclusion of additional benefits for customers, they still suffer. Under scenario 1 and 2, consumers' gains improves and amounts to US$ 133.5 million and US$ 16.5 million respectively; however this quantity only represents 12 per cent and 2 per cent of the total social welfare under scenario 1 and 2.

5.6 Quality Issues

It is expected that quality and performance improve after privatisation. In order to compute an integrated social benefit analysis, the inclusion of quality parameters would make the task more difficult due to the need to (1) measure and value quality and (2) identify a counterfactual that simulates the quality dimension. In this sense, the discussion is limited to analyse briefly the evolution of quality indicators such as number and duration of interruptions per customer (SAIFI and SAIDI respectively)[55] and distribution losses. For a better understanding of the evolution of these indicators, the trend of benchmark companies was examined[56]. SAIFI and SAIDI indicators dropped markedly during the first years after privatisation. A nationwide decrease of 64.4 per cent and 58.2 percent in SAIDI and SAIFI indicators respectively is observed for the period 1995-2001 (World Bank, 2005). The improvements are more noticeable in the biggest companies that operate in areas with high density, mainly in sector 1 and 2. For instance, SAIFI and SAIDI indicators from Edelnor have significantly decreased by 75.1 per cent and 77.2 per cent respectively for the period 1995-2001. However after several years of privatisation, period 2002-2007[57], there is no notable trend due to a possible stabilisation of the indicators in special for the biggest companies such as Luz del Sur and Edelnor. See Figure 5.

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[55] Interruptions that are equal or greater than three minutes.
[56] The companies were grouped as follows: (1) privatised companies – type 1, (2) companies that were privatised but returned to public hands – type 2, (3) companies that were included in the privatisation process but were not sold – type 3, and (4) companies that were not included in the privatisation process and are still under public ownership– type 4. An additional kind of companies is composed of private companies and those companies that are managed by local governments, however due to the relative small size in comparison with the privatised companies; these were excluded from the analysis.
[57] Data from this period refers to N and D (number and duration of interruption per customer) defined by the Quality Technical Normative for the provision of Electricity – NTCSE. Due to the absence of data from all the companies regarding SAIFI and SAIDI (before 2005) and the similarity of their calculation with N and D indicators, the last ones were used as reference.

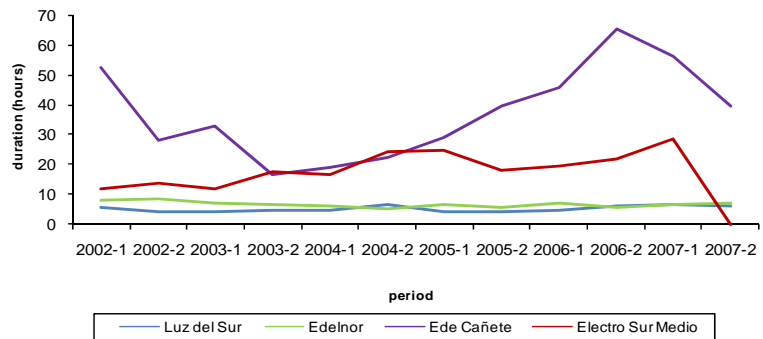# Figure 5: Evolution of the Number and Duration of Interruptions

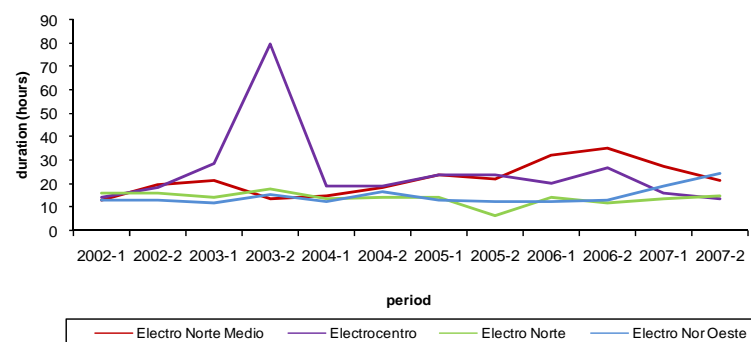**(a) Number of interruptions per customer/semester - Type 1**
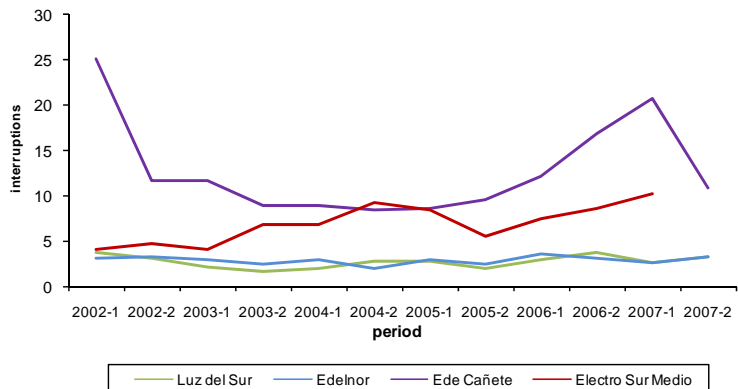
(b) Number of interruptions per customer/semester -Type 2
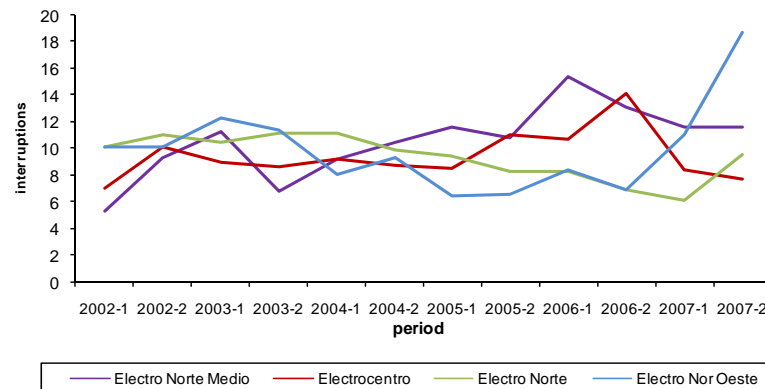
(c) Duration of interruption per customer/semester-Type 1

(d) Duration of interruption per customer/semester - Type 2

Source: Annual reports from CTE and OSINERGMIN

Smaller companies, such as Electro Sur Medio and Ede Cañete, do not show a downward tendency even after seven years of being privatised. Customers from these companies that live in lower sectors are the most affected in terms of quality issues and it seems to be that privatisation did not produce any significant change for them. The high level of dispersion and adverse geographical conditions in lower sectors could explain this. The time to repair any faults in the network would be much higher.

For instance, in the second semester of 2007 the average number of interruptions per customer/semester[58] for sector 1 and sector 5 was 2.82 and 20.53 in the same order and the average duration of interruption per customer was 5.32 and 48.51 respectively. Thus, there is an important difference in quality indicators among sectors and these indicators depend strongly on the area in which companies operate. The application of penalties for breaching the maximum values allowed, helped to reduce these indicators[59] even though the level of improvements have not been the same among companies.

The reduction of distribution losses[60] after privatisation is significant. For Type 1 companies, losses reduced in average from 17 per cent in 1994 to 7.5 per cent in 2007. The most important reduction was during the three years after the sale of the companies: Electrolima (1995 – 1998) and Electro Sur Medio (1998 – 2001); distribution losses decreased by 7.5 and 6.0 percentage points respectively. Type 2 companies followed the same direction with the difference that the decrease started two years before the sale of this group of companies and are on average higher by two percentage points than those from type 1 companies. One of the factors influencing this behaviour is the process of restructuring that companies experienced prior to their sale. The fact that these companies returned to the government at the end of 2001, did not affect negatively the trend in distribution losses which was approximately 9.4 per cent at the end of 2007. For type 3 companies, the average distribution loss (10.3 per cent) did not differ significant from type 2 companies. The higher level of dispersion in which type 3 companies operate would explain this difference. The last category, type 4 companies has the highest distribution losses, 15.8 per cent at the end of 2007. One reason is that these companies are state-owned companies that never were included in the privatisation pack and therefore were never restructured for a future sale. See Figure 6.

One of the main explanations of these important reductions among companies is supported by the incentives that government provided to them (private and state-owned companies) though the recognition of supplementary distribution losses from 1993 to 2005[61]. These losses were added to those already recognized in the efficiency company model for computing their respective tariffs. The trend

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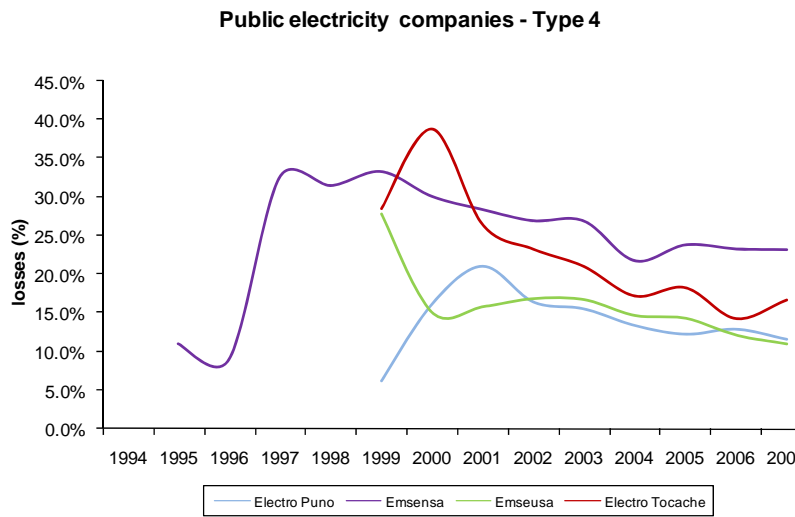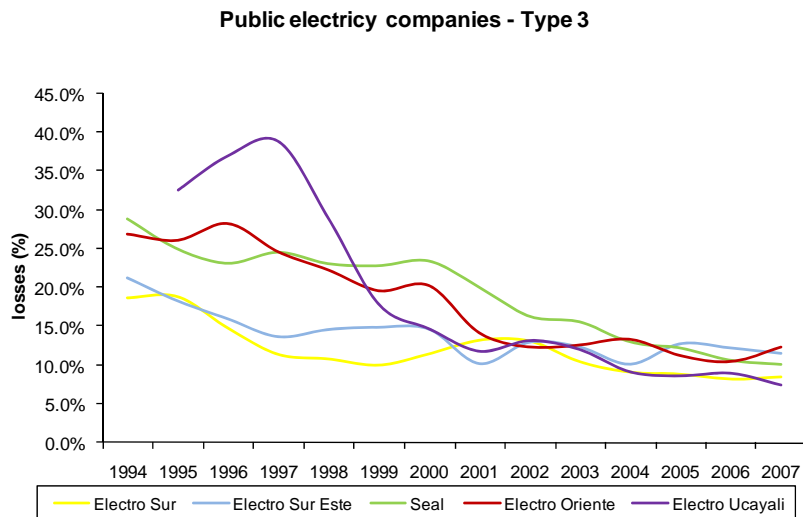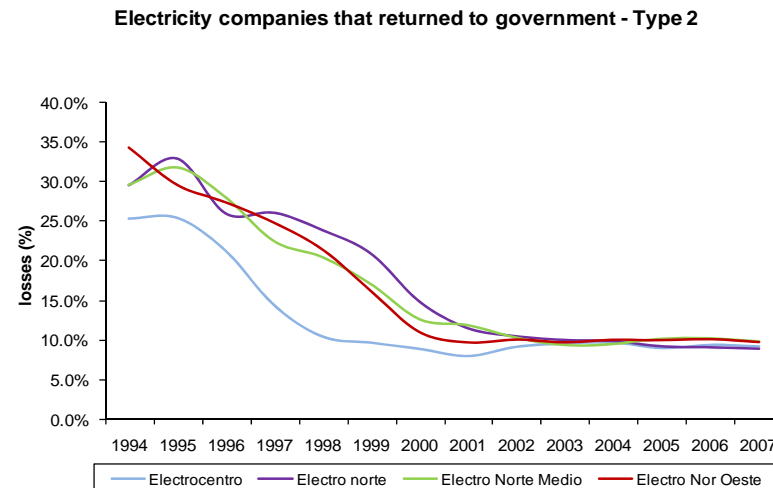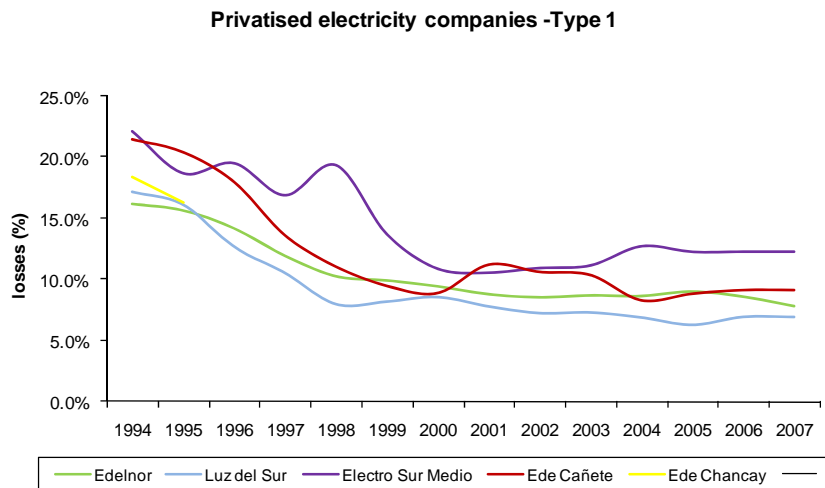[58] Includes all the public and private distribution electricity companies.

[59] For fine purposes, these indicators are multiplied by specific factors depending on the type of interruption. These factors vary from 0.25 to 1. Penalties are applied when these new values exceed the maximum allowed.

[60] The losses include technical and non-technical losses. A disaggregation was not possible due to the non-availability of this information.

[61] These supplementary losses decreased gradually during this period. In average, they moved from 9 per cent in 1993 to 0.8 per cent in 2005. From 2006 onwards these losses were not recognized in the tariff.

of these reductions is also in line with that from other South American countries such as Argentina (Pollit, 2008; Haselip *et al.*, 2005), Colombia (Larsen *et al.*, 2004; Arango *et al.*, 2006), Chile (Fisher *et al.*, 2003; Pollitt, 2004). A different approach is that from Sen and Tooraj (2010) who determine that transmission and distribution losses increased after deregulation of the electricity sector in India. They argue that inefficiencies tend to be exposed after deregulation. Political and institutional endowments in developing countries have a strong influence in the deregulation outcome (Newbery, 2001).

Figure 6: Evolution of electricity distribution losses

Privatised electricity companies -Type 1

Legend: Edelnor, Luz del Sur, Electro Sur Medio, Ede Cañete, Ede Chancay

Electricity companies that returned to government - Type 2

Legend: Electrocentro, Electro norte, Electro Norte Medio, Electro Nor Oeste

Public electricy companies - Type 3

Legend: Electro Sur, Electro Sur Este, Seal, Electro Oriente, Electro Ucayali

Public electricity companies - Type 4

Legend: Electro Puno, Emsensa, Emseusa, Electro Tocache

Source: Annual reports from CTE and OSINERGMIN

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Unlike electricity coverage and quality issues (such as SAIFI and SAIDI), a reduction in distribution losses implies greater benefits for the electricity companies than for customers. As a consequence revenues would increase, due to this reduction. Revenues (net revenues[62]) for type 1 companies were analysed for the years following their privatisations and it was observed the average annual growth rate was higher for those years. Edelnor, Luz del Sur and Ede Cañete presented an average rate of 5.7 per cent for the period 1995-1998 and 3.2 per cent for the period 1999 – 2007. The average rate for Electro Sur Medio was approximately 13 per cent for the period 1998 - 2001 and 3 per cent for the period 2002-2007.

From the perspective of distribution losses and irrespective of who were the main beneficiaries due to this reduction, it is clear that losses are much lower after the sector reform. From the analysis we observe that independently of the form of ownership companies have reported important achievements. Previous studies conclude that privatisation is not the major determinant from improving efficiency (Pollitt, 1997). Privatisation alone without the restructuring of the sector and a proper regulatory framework would not have produced these improvements. Incentive regulation has a positive impact on operative efficiency. This is also in line with Newbery, 2002, who states that efficiency depends more on the form of regulation that on the form of ownership. Jamasb (2006) points out that distribution companies in developing countries have strong potential to transfer gains to customers when incentive regulation is applied. Zheng *et al.* (2006) who analyse the impact of the electricity reform in developing countries conclude that in the absence of competition, the benefits from privatisation in terms of performance improvements are captured with the implementation of effective regulation.

Even though there is empirical evidence that revenues increased during the years following their privatisations, reduction in losses could be just one of the factors that contributed to this phenomenon. Other factors may include tariff increase, electricity coverage expansion, tax benefits and improvements in the collection of commercial debts. Regarding to the first, as we have discussed before, the price control formula put in place at privatisation allowed price sincerity, as a consequence tariffs increased notably. In terms of electricity coverage, companies had enough incentives to expand their networks. The transfer of rural projects from government to distribution companies for their operation and maintenance, the implementation of social tariff scheme[63] and the permission that electricity companies had to ask for a reimbursed funding to the population that would be served through the expansion of the electricity service; are among these incentives[64]. In relation to the taxes, companies were subject to

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[62] Net revenues exclude purchase of energy and generation and transmission costs.

[63] In 2001 was established the Social Electricity Compensation Fund (FOSE) by Law 27510. This fund allowed fixed and gradually discounts to customers with monthly consumptions lower than 100kWh. FOSE is funding by regulated customers with consumptions higher than 100kWh. The main beneficiaries are low-income population from urban and rural areas, including those connected with isolated systems.

[64] During the first years of privatisation 590 projects that amounted to US$ 105 million were implemented by this method. Congreso (2002).

tax benefits from 1994 to 1998[65]. Tax benefits allowed companies to revalue their fixed assets in favour of these. As a result, companies reported lower operating profits before taxes and by default net revenues increased. Regarding the last concept, the trend of the biggest and smallest companies was analysed. For this purpose, an indicator was constructed which allows us to measure the annual average commercial' debts in months[66]. An impressive improvement is observed during the first years after privatisation related to Edelnor and Luz del Sur. Customers debts decreased by 26.8 per cent, which means the annual average debts moved from 2.7 to 1.9 months for the period 1996-2000. After this period, the indicator does not report important changes. In terms of the smallest companies, Ede Cañete and Electro Sur Medio, an apposite trend is observed. During the first years of privatisation the variation is small and the annual average indicator is 2.8 months. From 2003 to 2007 an important decline is perceived; the indicator decreased at 3 per cent p.a. and was around 1.8 months in 2007, similar to the biggest ones. Thus, debt indicators have improved in the biggest and the smallest private companies. This improvement, specifically to the biggest companies, could contribute in some extent to the remarkable increase in revenues after the first years of privatisation. The better collection of bills is also an expected output after reform. An important fact that contributed with this trend was the formality of illegal connections and metering. In Colombia, during the first years after deregulation, the collection of bills improved by nearly 60 per cent, it moved from 2.72 months (1996) to 1.1 months (1999), (Larsen *et al.*, 2004). Other reforms with positive outcomes in bill collection are Argentina and Chile, (Pollitt, 2008; Pollitt, 2004).

▪ 6. Conclusions

The partial privatisation and restructuring of the electricity distribution market was worthwhile and amounts to US$ 542 million in 2007 prices, relative to the central-case scenario at 7.3 per cent discount rate. The benefits of improving quality issues, namely the expansion of the electricity coverage contribute to these gains and represent around 61 per cent of the net gains. The highest benefits of being connected are obtained during the first five years after privatisation. During the period 1995-1999 the number of household connections increased at 6 per cent p.a., which is twice the annual growth rate of households placed in the companies' concession areas. The incentives that companies received for expanding their networks in the lower-income population areas could explain this expansion.

Results from the distributional gains show that government and producers benefit the most and consumers benefit the least. It is only with the introduction of the benefits of being connected that consumers start to gain. Customers suffer due to price increase. This fact was expected after the application of the improved price calculation methodology which allowed "price sincerity". Actual

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[65] Approved by Law No 26283, 10/01/1994 and its directive by Supreme Decree No 120-94-EF, 19/09/1994.
[66] The procedure is as follows: (1) the annual net commercial' debts are divided by the total energy billed, (2) this value is multiply by 12 in order to obtain the average consumer's debt. The net commercial' debts are found in the companies' balance sheet. Commercial debt refers to the customers' debts.

average price p.a. is higher than the preferred counterfactual in 8.6 per cent, for the period 1994-2022. The application of cost reflective prices provided enough incentives to companies for improving the quality of services and for expanding the electricity coverage. The application of social tariffs (FOSE) has helped in some extent to alleviate the impact of price increases on low-income customers.

The increase of net revenues relate to the privatised companies during the first years after being privatised, is noticeable. The price increase, tax benefits, service expansion and the better collection of revenues (bills) are among the main issues that could contribute with this. Operating controllable costs follow an opposite trend. Bearing in mind the initial conditions under which the state-owned companies operated before privatisation, privatised companies tended to apply effective cost reduction measurements which results were more noticeable during the first years of operation.

Incentive regulation has contributed notably to the positive trend in quality issues. Improvements in quality indicators such as number and time of interruptions are more evident in companies (privatised and state-owned) that operate in areas with higher population density. Smaller privatised companies do not show a downward tendency even after seven years of being privatised. The sectors in which the electricity companies operate have a strong influence on these indicators, independently of whether the companies are under private or public-ownership. In terms of distribution losses, Edelnor and Luz del Sur have the lowest distribution losses and smaller privatised companies, such as Ede Cañete and Electro Sur Medio, show a less impressive but significant reduction of distribution losses after their sale. Important improvements were also observed in state-owned companies.

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- **Appendix 1: Adjustments**

a. Generation and Transmission Costs

Because of the lack of historical data related to both costs, for the period 1986-1993, some approximations were made. Regarding Electrolima, the calculations for generation costs were based following the diagnostic performed by International Finance Corporation (IFC) and the Andean Bank for CEPREL. They calculated the generation costs for the years 1991 and 1992. These costs did not include depreciation and taxes (fixed costs) but included fuel costs (variable costs). In order to approximate the generation costs for the pending years, an additional study elaborated by Coopers & Lybrand for CEPREL as well, was also examined. In this study a cost disaggregation per activity (generation, transmission, distribution, commercialization and administration) was performed for the year 1992. Taking into consideration the proportional cost allocation per item (such as depreciation, taxes, labour expenses, others), a cost disaggregation for the period 1986 – 1990 was constructed. In order to analyse the robustness of this approximation, a comparison in fixed generation costs (excluding depreciation and taxes) was made with those calculated by IFC and the Andean Bank for 1992 and 1991 in real values. As a result, an average difference of 3.7 per cent was found. We use this difference in order to adjust the rest of the calculations (from 1986 to 1990) related to the fixed generation costs. Thus to obtain the total generation costs per year (equal to fixed cost plus variable costs) the fuel cost were added. The transmission costs were obtained using the respective proportional cost allocated to the transmission activity by Coopers & Lybrand. Both, the approximations for generation and transmission costs were net of depreciation and taxes.

Regarding Electro Sur Medio, the generation of electricity was not too significant in comparison with the purchase of energy, it just accounted for 5 per cent of the total electricity to be distributed in 1986 and for less than 0.2 per cent at the end of 2007. Due to the lack of information regarding generation costs for the period 1986-1993[67], the average generation costs for the period 1994 – 1996 was taken as a reference for calculating the generation costs for the pending years. It was assumed that these costs would remain the same in real values. Electro Sur Medio did not report any incurred expenses in transmission[68].

b. Generation and Transmission Assets

In the case of Electrolima, generation assets are equal to those assets that were transferred to Edegel (the generation company created after the unbundling of Electrolima) in 1993. In the same way, transmission assets are equal to those assets that were transferred to the transmission company Empresa de Transmisión Eléctrica Centro Norte (a transmission company that was created in order to assume the transmission activities of Electrolima and Electroperu) in

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[67] The submission of the cost breakdown per generation, transmission and distribution activities has been compulsory since 1994. For the period 1994- 2007, the company reported cero expenses in transmission.
[68] For the period 1994- 2007, the company reported cero expenses in transmission.

1993. It was assumed that both values would remain the same (fixed values) in real terms for the period 1986-1992. For Electro Sur Medio, generation assets were obtained from Electro Sur Medio Libro Blanco[69]. This information is available only for 1995, thus it was also assumed that generation assets will remain the same in real terms for the period 1986-1996. The exclusion of generation and transmission assets was necessary in order to calculate the rate of return on assets regarding only the distribution activity. The average rate of return for the periods 1991-1993 (Electrolima) and 1994-1996 (Electro Sur Medio) was used for computing the operating profits under the counterfactual scenario for both companies, respectively

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[69] The Libro Blanco contains a document that was prepared by the company Agua y Energía Ingenieros Consultores. The company made an inventory of fixed assets for the year 1995. The generation assets were represented by the thermal and hydroelectric power plants assets.

▪ Appendix 2: Data construction and sources

Data	Sources and explanation
Operating revenue	Data obtained from the financial statements that companies reported to the authority (CTE and OSINERGMIN). The revenues are composed of: (1) sales to final customers, (2) others (incomes deduced from other activities related to distribution) and (3) compensations. The last category was excluded and was a component of the FCG and/or FOTAR.
Operating costs	Figures taken from the financial statements that companies reported to the authority. These are composed of: supplies, fuel, labour expenses, taxes, third-party services, management expenses, provisions and other operating costs. This item is net of purchase of electricity, generation and transmission payments.
Purchase of energy	This data was also obtained from the financial statements that companies sent to the regulatory authority. Before privatisation, the FCG (expenses) were allocated in this category. Two types of FCG were distinguished: type 1 (expenses incurred for the purchase of electricity), type 2 (composed of different kinds of compensations). This last was composed of compensation for: (1) source of energy, (2) economies scale and (3) market structure. Therefore for our calculations type 1 was taken as "purchase of energy" and type 2 was computed as non-controllable costs.
Generation & Transmission costs	For the years before 1994 they were calculated using two reports from CEPREL (Libro Blanco): (1) The International Finance Corporation and Interandean Bank Informational Memorandum, and (2) Coopers and Lybrand Diagnostic. For the period 1994-2007 this item was found in the annual reports from the regulatory authority.
Operating controllable costs	These are operating cost excluding depreciation and restructuring and privatisation costs.
Operating non-controllable costs	Before privatisation they are composed of: taxes (includes taxes on revenue), FCG, FOTAR and Fund for electric development. For 1994 they include only taxes.
Restructuring and privatisation costs	Those costs that Government incurred before and after the sale of Electrolima and Electro Sur Medio. These were obtained, from CEPREL (Libro Blanco), from the Ministry of Economy and Finance – MEF (National Public Treasury Office) and from the Agency for the Promotion of Private Investment – Proinversión (concluded process). These costs include: (1) expenses for national and international consultants, (2) travels, (3) administration, (4) third-party services, (5) equipments, (6) commissions for the sale of remaining shares in the stock market, (7) others.
Taxes and social contribution	This data is available since 1994 and was collected from the CTE and OSINERGMIN annual reports as well.
Assets	Assets were taken from CTE and OSINERGMIN annual reports for the period 1994-2007. For the previous period, generation assets were obtained from Electrolima and Electro Sur Medio's Libro Blanco respectively. In the case of Electrolima, transmission assets were obtained from the Ministerial Resolution No 164-93-EM-VME, 22/07/1993 in which the transmission assets that would be transferred to "Empresa de Transmisión Eléctrica Centro Norte" were defined.
Index and reference interest rate.	IPM was taken from the National Accounting Regulatory Council (Ministry of Economy and Finance) and the IPC from the Central Reserve Bank of Peru – BCRP. The reference interest rate was taken from the BCRP as well.
National accounts	GPD per capita for the period 1994-2007 was taken from the World Bank Database (World Development Indicators). For the period 2008-2015 we use the projections given by the International Monetary Fund (IMF World Economic Outlook)
Number of employees	Collected from the annual reports from CTE and OSINERGMIN. Data is available since 1990 (Electrolima) and since 1994 (Electro Sur Medio).
Units distributed	These are the net unit distributed to end customers. This data was taken from the authority's annual reports.
Electricity distribution companies' concession area	Obtained from the companies' website and also from the following Ministerial Resolutions: Luz del Sur (107-96-EM), Edelnor (011-95-EM, 080-96-EM, 040-2006-EM), Ede Cañete (095-95-EM) and Electro Sur Medio (066-94-EM, 091-96-EM, 032-2000-EM, 022-2002-EM)
Population, number of households and households with electricity	Data collected from the nationwide census of 1993 and 2005 provided by the National Institute of Statistics and Information (INEI). Data from these two years were used for approximating the annual population, number of households and households with electricity for the period 1994-2007.