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Electricity Reform in Chile:

Lessons for Developing Countries

Michael G. Pollitt

Massachusetts Institute of Technology
Center for Energy and
Environmental Policy Research

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Michael Pollitt
University of Cambridge[1]

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Abstract

Chile was the first country in the world to implement a comprehensive reform of its electricity sector in the recent period. Among developing countries only Argentina has had a comparably comprehensive and successful reform. This paper traces the history of the Chilean reform, which began in 1982, and assesses its progress and its lessons. We conclude that the reform has been very successful. We suggest lessons for the generation, transmission and distribution sectors, as well as the economic regulation of electricity and the general institutional environment favourable to reform. We note that while the initial market structure and regulatory arrangements did give rise to certain problems, the overall experience argues strongly for the private ownership and operation of the electricity industry.

Keywords: Chile, electricity, restructuring, regulation, privatisation.

JEL classification: L33, L51, L98.

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Electricity Reform in Chile
Lessons for Developing Countries

1. Background

Chile is the world's longest running comprehensive electricity reform in the post-World War II period. Reforms were first conceived of in 1978 when the National Energy Commission (the CNE, now the closest institution to an electricity regulator) was established and the reform act – the 1982 Electricity Act – is still the most important law regulating the current organisation of the sector. This led to the vertical and horizontal break up (beginning in 1981), commercialisation and part privatisation of the existing state owned electricity system. Large scale privatisation began in 1986, four years before the reorganisation of the electricity sector in England and Wales, arguably the world's most comprehensive electricity reform. Chile's electricity reform has been hailed as a highly successful example of electricity reform in a developing country and a model for other privatisations in Latin and America and around the world.

Chile's electricity sector cannot be disassociated from the rest of the Chilean economy[2]. Chile was a democratic country from its inception until 11 September 1973 when the socialist government of Salvador Allende was deposed in a military coup headed by General Pinochet. Allende's government (1970-73) had undertaken a mass nationalisation of many large companies, including utilities and banks, and presided over a major economic slump which saw the government budget deficit reach 12.4% of GDP. In 1973 firms under state control constituted 39% of GDP and state owned enterprises made a loss of 7.8% of GDP. The military government brutally suppressed its political opponents but in contrast to the populist economic policies of military governments elsewhere in the region (most notably Argentina) pursued neo-liberal economic ideas inspired by Milton Friedman, Al Harberger and other Chicago economists. Within a few years many of the previously nationalised companies were being returned to their previous owners and large state owned companies, such as electricity companies, were being forced to trade on a commercial basis. State owned companies as a whole were breaking even by 1979 and into the 1980s electricity companies in particular were showing improving rates of return on capital.[3]

The macro economy and many of the main economic indicators began to show considerable improvement. Inflation fell and GDP began to grow strongly especially after 1985. This healthy economic situation further improved following the peaceful return to democracy in 1989 when growth accelerated to 6.2% p.a. during the 1990s. Towards the end of the military regime there was a major reform of the state pension fund system which operated through Pension Fund Management Companies (AFPs). A 1985 reform resulted in the AFPs being allowed to invest in private corporations such as privatised companies. This stimulated the domestic capital market and led to a growing demand for

[2] For summaries of the history of the Chilean privatisation programme see Paredes (2003) and Fisher, Gutierrez and Serra (2003).
[3] See Fisher, Gutierrez and Serra (2003, p.27).

stocks, supported initially by legal restrictions on overseas investment by private pension funds. This created highly favourable local conditions for the large scale privatisations of utilities, including electricity, which took place in the late 1980s. This resulted in a lower involvement in overseas investors in the initial privatisations relative to many other developing countries. Indeed the electricity industry remained largely domestically owned until the later half of the 1990s.

The Chilean constitution established under the military government provides for strong defence of property rights and commercial information. This is coupled with a legal system based very largely on tangible proof of illegal activity which makes it difficult to argue on the basis of reasonable cause. This has made it difficult for anti-trust cases to proceed.[4] The 1980 constitution ensures that the function of the judiciary is to protect property rights from legislative and administrative abuses[5]. The democratic system has ensured successive coalition governments where one party has not been able to simultaneously command a majority in both houses of parliament. This constitutional arrangement has had the effect of making it difficult to reform laws established under the military regime. Many of those laws specify in detail the methods of regulation to be used by government departments. This has two countervailing effects: first, it severely limits the scope of civil servants and ministers to interpret laws in the light of new developments and, second, it insures the stability of the regulatory regime. Both of these effects were intentional on part of those who developed the constitution and were aimed at preventing the economic radicalism of the Allende government being easily repeated.

Chile is an interesting case study of electricity reform because it shares many of the features of developing countries' electricity systems. The population is relatively small (15.6m in 2002) and hence the ability to exploit economies of scale, if they exist, is moderate. Although the GDP per head in Chile is relatively high at $4120 US in 2002, it was only $1770 (2002 US dollars) in 1982.[6] Electricity consumption per head is low by developed country standards but is increasing rapidly (6% per annum). The electricity generation system has a large installed hydro capacity base (38% for the country as a whole, but 58% in the central system)[7] but as demand increases fossil fuels have become more important (in this it is comparable to Columbia and the south west of Brazil). However Chile is perhaps unusual among developing countries because of the strength of protection for private property and the stability engendered by the long period of economically disciplined military rule.

2. Chile's Electricity Reform

In 1974 Chile's electricity utilities were in a mess.[8] Inflation, high fuel prices and price controls on final prices had led to large losses and a lack of investment under public

[4] See Basanes, Saavedra and Soto (1999, p.24).
[5] See Bitran and Serra (1998).
[6] Source: World Bank, 'Chile at a Glance', at www.worldbank.org/data/countrydata/aag/chl_aag.pdf
[7] Shares of capacity in 2003 (CDEC-SIC Annual Report 2003, p.7).
[8] Endesa, the largest utility, made a loss of 4.3% on equity in 1974, while Chilectra, the second largest utility made a loss of 3.2% on equity in 1974 (Fischer, Guiterrez and Serra, 2003, p.27).

ownership. This situation reflected the impact of nationalisation and the OPEC oil crisis. The government wanted to reorganise the sector in order to introduce economic discipline. Economists in the government, several of whom had studied at the University of Chicago, were charged with redesigning the regulatory and legal framework within which the companies operated. In the first years of the 1980s they designed the legal framework established in the 1982 Electricity Act[9], which is still the most important legislation governing the sector. However in January 2004 there were some subtantial amendments to the laws governing the sector following the passage of the Ley Corta, of which, more later. In what follows our analysis mainly refers to the arrangements before the passage of this new law as it is too new to give rise to much experience.

At the time there was not a lot of recent reform experience in electricity generation markets to draw on, however officials did visit the UK, France and Belgium. From these countries they came back with the idea of separate generation and distribution companies where power was paid for according to a formula based on the cost (as UK Area Boards then paid the Central Electricity Generating Board), a dispatch system based on marginal cost pricing (as perfected by the French company, EDF) and a system of trading power between generators to meet customer contracts (as existed in Belgium). These observations gave rise to the partial vertical disintegration[10] of the sector and the formation of a wholesale power trading mechanism. Vertical disintegration and power markets are central to modern ideas of electricity reform.

Following the break-up of the incumbent integrated companies a number of regional power markets based on the concept of an Independent System Operator (the CDEC) were established in 1986.[11] There are two main regional power markets: the SIC – covering the southern and central areas including Santiago – and the SING covering the northern part of the country. Within these markets generators were required to declare availability and plant marginal operating cost every hour. These declarations would be used to dispatch power plants and to set the basic marginal energy price or spot price. This price has to be used by the power generators to trade electricity among themselves to meet contracts. The spot price is heavily influenced by the opportunity cost of water in the SIC system and always equals this price. The price of water is calculated by a computer model (OMSIC) for the main Laja reservoir. Under normal conditions the opportunity cost is equal to the operating cost of the most expensive thermal plant dispatched. If there is a water shortage the spot price becomes the outage cost. The outage cost is equal to an amount based on consumer willingness to accept compensation for a planned outage of a particular magnitude. For a less than 10% demand restriction it is around 4-5 times the normal spot price.

[9] Mining Ministry of Chile (1982), *Law DFL No.1: General Law for Electric Services referring to Electric Energy*, available at www.cne.cl.

[10] The vertical disintegration was only partial because although the main integrated company, Endesa, was vertically and horizontally unbundled, it initially retained a large share of its generation and all of its former high voltage transmission grid.

[11] See Vignolo (2000) for details of the pricing mechanism in the CDEC-SIC.

Regulated prices for generated electricity are determined on the basis of the expected spot price of energy over the next 4 years and this price is fixed for six months in April and November. This is calculated using a computer program (GOL) which is a crude version of the OMSIC model. This node price is then converted into the regulated price of generated electricity at each of the basic substations of the system by an energy penalisation factor (to reflect system losses). This gives the node energy prices. To these are added the node peak capacity charges which reflect the annual marginal cost of increasing system capacity assuming a specified reserve margin. This is paid to available generators and reflects the capital and operating costs including a 10% return of the newest technology on the system. This is similarly adjusted by a capacity penalisation factor.

In the regulation of distribution charges there was little experience to draw on and only the general principles of incentive regulation – itself undeveloped as a discipline at the time.[12] The economists devised the idea of setting a tariff for distribution which was unrelated to the actual costs of the distribution company and hence gave it perfect incentives to cut costs. This would avoid the well known distortions of the rate of return regulation based system which existed in the US (and was heavily criticised by Chicago economists). The revenue for the distribution companies was to be set on the basis of the costs of a model company. Two independent consultants reports would be commissioned to model the network which a distribution company with given demands and sources of supply would require and to assess the cost of running that model network. These reports would be averaged (2/3 weight on the regulator's consultant report, 1/3 weight on the company's consultant report) to fix prices for distribution (the value added in distribution or VAD) relative to an inflation rate for the next four years. The inflation rate was to be a company specific weighted combination of the consumer price index, the price of copper, the wholesale prices and an earnings index. This model mirrors the later suggestions for RPI-X regulation (Littlechild, 1983) and yardstick competition based on average costs in other similar firms (Shleifer, 1985). The distribution charges are regulated by the National Energy Commission.

In transmission the economists who designed the system envisaged a system where generators would have to pay for transmission to get electricity to their customers. Payment for existing transmission access was to be based on negotiated tariffs coupled with compulsory right of access if capacity was available.[13] New connections and lines were to be paid for by the generators, who were free to negotiate terms with transmission companies or build their own. This emphasis on what we now know as merchant transmission was revolutionary at the time when contrasted with the centralisation of transmission investment decisions in large integrated companies. There was to be no planning of transmission expansions. Incumbent transmission companies were to be unable to pass on costs of new transmission wires to existing customers with their negotiated consent. The lack of concern for the externalities inherent in transmission

[12] For a description of the system of regulation of distribution see Di Tella and Dyck (2002, pp.32-34). It is worth noting that one of the seminal papers on incentive regulation was not published until 1982 (Baron and Myerson, 1982).
[13] See Vignolo (2000, p.20).

networks, especially those caused by loop flows, is partly a function of linear nature of the electricity grid in Chile which is caused by the fact that Chile is a long thin country where the capital, Santiago, serves as the focal point for electricity supply in the SIC system. Although transmission charges were not regulated under this system, the rate of return in transmission was limited by the need for transmission companies to hold tender auctions for the building of new lines.

The concept of two types of customers – regulated and free – was established in the 1982 law.[14] Free customers were those with maximum demand above 2MW. These customers were free to contract directly with generators for the supply of power. Regulated customers were customers of the local distribution companies who could not contact directly with generators. These customers paid the regulated price of distribution plus a node price of energy which was based on the combination of the forecast short run marginal cost of energy, the capacity charge and the relevant transmission charge. Although not envisaged as being a radical new development at the time – no one even in Chile foresaw full supply competition – this distinction did create opportunity for some customers of the distribution companies to seek alternative suppliers.

The regulatory framework established in 1982 consists of a number of different institutions.[15] The National Energy Commission (CNE, established in 1978 to advise on long term strategy) has responsibility for advising the Minister of Economy on electricity policy, it is also responsible for the setting of regulated distribution charges. A Superintendent of Prices of Electricity and Fuels (SEC) has responsibility for data collection for the purposes of enforcement and regulation, handling of customer complaints and the implementation of service quality fines and customer compensations. In regulation the CNE uses data provided by the SEC on company costs. The law places limits on the number and background of civil servants working in the CNE. The Minister of Energy formally imposes the regulated tariffs and retains control over the issuing of rationing decrees during periods of drought when there is a shortage of hydro-electric generating capacity. The Minister also had responsibility for settling disputes in the CDEC board within 120 days, though this was altered in 1999. Currently disputes go to an Arbitration Panel (of three experts) which has 30 days to issue a judgement, if this is rejected by the CDEC board then the Minister has 60 days to issue a judgement. The Minister is himself part of a 5 member cabinet council which oversees the sector. Merger policy, abuse of dominance and collusion remain within the remit of the Office of the National Economic Prosecutor, Chile's Competition Regulator, which has a regulated utilities division. The Fiscalaria can present cases to the Antimonopoly Commission. This Commission has a Prevention Commission and a Resolution (or appeals) Commission. Companies have the right to appeal to the Supreme Court. This process has been somewhat refined by the 2004 Ley Corta in order to speed up the processing of disputes.

The initial restructuring of the electricity industry was extensive.[16] Endesa, a state-owned company created in 1944 with extensive generation, transmission and distribution assets

[14] See Fischer and Galetovic (2000, pp.7-9).
[15] See Basanes, Saavdra and Soto (1999) and Fischer and Galetovic (2000) for details.
[16] See Fischer, Gutierrez and Serra (2003).

across the country, was split into 14 companies. These included 6 generation companies (including Endesa and Colbun), 6 distribution companies and 2 small isolated companies in the south providing generation and distribution. Chilectra which had been privately owned until 1970 and controlled distribution in Santiago was split into 3 firms: a generation company (Gener) and two distribution companies (including Chilmetro, now part of Chilectra). The privatisations of electricity companies yielded $1200m (in year end 1995 prices) or 50% of privatisation proceeds between 1985 and 1989. Endesa, Gener and Chilmetro were sold off between 1985 and 1989. Initially this came through sales to workers but eventually through public offers. Subsequent mergers, however, severed to partially re-integrate the industry.

While the initial restructuring was radical, substantial market power remained. In particular, Endesa remained the dominant player. In terms of generation it was by far the largest company with a 58% market share in the SIC and control of most of the national water rights for many unexploited hydro resources as well as the main La Laja lake hydro plants which formed a substantial part of total generation in wet years. Colbun was created as the holding company for two hydro plants which were then under construction by Endesa. Initially this was wholly publicly owned. The existing high voltage transmission grid was left largely in the hands of Endesa. Further integration of Endesa in distribution followed within a few years.

Since the initial privatisations there has some change in the ownership structure. In generation the market share of Endesa has fallen substantially as a result of a share rise in the share of Colbun and the entry of some small new entrants. However Endesa has integrated into distribution and retailing when it became part of the Enersis Group in 1989 which also controls Chilectra. Colbun was part-privatised from 1993 but eventually fully privatised in 1997. Endesa fought a long running battle with the competition authorities over its ownership of the transmission network in the SIC. After initially overturning an unfavourable ruling from the Antimonopoly Commission in 1993 in the Supreme Court, in 2000 under continuing pressure from the authorities Endesa voluntarily sold its Transelec business to Hydro-Quebec. By the late 1990s foreign firms had gained majority ownership of the Chilean electricity system. Colbun is part of the Tractabel Group of Belgium (who controlled 50.6% of the company stock in 2002). Enersis is majority owned (65% in 2002) by Endesa of Spain. Gener is almost wholly owned by AES of the US (98.65% in 2002).

There have been some attempts to change the 1982 Electricity Act in order to adjust to developments in the sector over the last 20 years. The most important change (before the passage of the Ley Corta) came in 1999, enacted after the drought of 1998-99 which led to electricity rationing. This law forces distributors to compensate customers for energy losses during rationing and also establishes an obligation on generators to meet reasonable demands from distributors even in the absence of contracts. This law was enacted because for the regulated sector there were seen to be insufficient incentives – given that distributors can only pass through the node price – to sign long-term contracts to assure supply or compensation in cases of drought. This law importantly reformed the

governance of the CDEC, making decisions of the operations directorate legally binding while verdicts are pending following disagreements on the CDEC board.

In 2000 a substantial revision of the Electricity Act was debated but this proved to be too controversial and too complicated to be enacted. However in the summer of 2003 another new law, the so-called Ley Corta (or Short Law), was debated in parliament. This was passed in January 2004.[17] This law is seen as a way of addressing some of the most pressing shortcomings of the current system in a timely way.[18] In particular there was a concern to address what was perceived to be an unwillingness to invest in new generation and transmission facilities given the low node price and problems with the agreeing payments for new transmission lines.

The Short Law has introduced a number of significant changes to the operation of the market as discussed above.[19] We discuss those that are most relevant to points we make below. First, it provides for the reform of transmission charging such that Transelec is now able to recover 100% of the toll revenue required to pay for its existing lines. This will be based on a four yearly international study of the replacement value of its assets and a regulated rate of return. This is aimed at reducing the number of disputes over the level and allocation of payment for transmission rights. Second, the node price (paid by captive customers) is not allowed to vary by more than 5% from the free market price (rather than the current 10%). This should result in significantly less risk for generators in supplying the captive market. Third, the threshold level for free market customers able to choose their supplier is reduced from 2 MW to 0.5 MW. This will lift most non-residential customers out of the captive market and significantly increase the competition for customers directly connected to the distribution system. Fourth, there is to be greater regulation of the access charges charged by distributors to competitive suppliers of customers connected to the distribution network. As we discuss below the lack of regulation of third party access charges to the distribution network is a serious problem for the competitive supply market at the moment. Fifth, a market for ancilliary services is to be introduced. This will allow active trading of reactive power and voltage control services.

3. The Performance of the Chilean Electricity Sector since 1982

In this section we report some indicators of performance of the sector over the reform period. The areas which we look at are those which relate most directly to the social welfare effects of the reform and those indicators of most importance in a developing country context. Detailed data can be found in the information appendices.

[17] Actually the Law of Electrical Services of 22 January 2004.
[18] The term 'Short' refers to the original intention to enact a short, quick piece of legislation before eventually enacting a longer, more comprehensive law.
[19] See www.cne.cl for details of the provisions of the Short Law.

3.1 Investment

Between the beginning of 1982 and the early 2004 the installed capacity in the main SIC system expanded from 2713 MW to 6991 MW (4.1% p.a.), while installed capacity in the SING system expanded from 428 MW to 3634 MW (10.2% p.a.). The reserve margin at the peak in 2003 was 26% in the SIC and 59% in the SING (highest demand divided by available capacity). The mostly thermal SING system suffers from over capacity, while the hydro-dominated SIC system has been subject to rationing in dry years. The expansion of generation capacity was achieved largely under private ownership and while keeping prices in low. At the same time the number of units delivered has increased by 6.2% p.a. to around 42800 GWh in 2003. Endesa's domestic investment between 1991 and 2000 totalled $2.3bn.[20]

In transmission the route length of transmission lines in the main SIC system (at 500, 220, 154 and 110 kV) expanded from 4310 Km in 1982 to 8555 Km in 2002 (3.7% p.a.); for the SING system the figures are 363 Km and 5093 Km (14.9% p.a.)[21]. In distribution the total number of electricity customers was 4.177m (of which Chilectra had 1.274m) in 2001. The number of regulated electricity customers rose by 4.4% p.a. between 1999 and 2002. Between 1982 and 2002 the percentage of households with electricity supply increased 38% to 86% in rural areas and from 95% to 98% in urban areas.

While recent debates around the Ley Corta have been motivated at least partly by a perceived lack of incentive to invest in new capacity going forward, by any standards the investment which has occurred since 1982 is impressive.

3.2 Prices

Prices of electricity in Chile are low by international standards. In 2002 the average residential price was 8.25 US cents per kWh and the average industrial price was 5.51 US cents per kWh.[22] In 2000 prices were around the average for Latin America for residential prices but in the lowest quartile of prices for industrial consumers[23]. These prices reflect the presence of significantly higher percentages of hydro-electric generation in some of the countries with cheaper electricity prices, e.g. Venezuela, Parguay and Ecuador.

Between 1992 and 2002 average electricity prices have fallen by almost 30% in real terms demonstrating superior performance to prices for water, gas and telecoms. This fall reflects falls in the regulated value added in distribution and a significant fall in the regulated node price of energy (see Figure 1).[24] In the SIC system the node price (including energy and capacity charges) of power delivered to Santiago fell from 30.93 Chilean Pesos (CLP) per KWh in October 1982 to 23.97 CLP per KWh in October 2003

[20] Source: Fischer, Gutierrez and Serra (2003, p.41).
[21] Source: www.cne.cl
[22] Source: www.olade.org.ec.
[23] UN Statistics, December 2000.
[24] For details of node prices see www.cne.cl.

(prices in Jan 2004 Pesos), a fall of 22%. In the SING system the node price of power delivered to Antofaqasta fell from 105.3 CLP per kWh in October 1984 to 24.24 CLP per kWh in October 2003 (prices in Jan 2004 Pesos), a fall of 77%. The VAD for Chilectra fell by 18% in the rate setting process of 1992, 5% in 1996, 18% in 2000 and 8% in 2004.[25]

3.3 *Financial Performance of Companies*

The low price of electricity and high rates of investment in the sector have been accompanied by strong financial performance by the companies involved (see Figure 2). Financial performance was respectable before privatisation but improved markedly afterwards. Chilectra averaged a nominal historic cost return on equity of 32% p.a. during 1996-98, while Endesa's return on equity peaked at 15.7% in 1994.[26] The average real rate of return on capital at replacement cost in the distribution sector was a highly respectable 13.9% in 2002, this is at the high end of the range of rates of return permitted by law (5-15%). The high returns in distribution seem to reflect initially generous regulatory reviews of the VAD. In generation and transmission returns were initially high following privatisation but since the arrival of natural gas from Argentina in 1997, which sparked a lot of new building of gas fired plants, returns have been more modest. In 2003 historic cost rate of return on equity for Colbun was 14.8%, AES-Gener was 6.6% and Endesa was 5.0%[27]. These were respectable rates of return given the large sunk costs which both Endesa and Colbun have in hydro-electric investments and the generally poor performance of investments outside Chile.

3.4 Efficiency Improvements

The combination of falls in prices and high rates of return reflect superb efficiency improvements (see Figure 3). In Endesa's electricity generation business labour productivity improved from 6.3 GWh generated per worker in 1991 to 35.0 GWh per worker in 2003.[28] In Chilectra electricity distribution labour productivity improved from 1.4 GWh sales per worker in 1987 to 14.1 GWh sales per worker in 2003.[29] These figures are impressive even compared to the performance of UK privatised electricity companies.[30]

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[25] Source: Fischer, Gutierrez and Serra (2003, p.43) and 'Editorial: Chile Distribution tariffs to drop 8% from November', *Power in Latin America*, 19th November 2004.
[26] Source: Fischer, Gutierrez and Serra (2003, p.44).
[27] Net income divided by shareholders' equity. Source: Colbun, AES-Gener and Endesa Annual Reports 2003.
[28] Source: Fischer, Gutierrez and Serra (2003, p.41) and Endesa Annual Report 2003.
[29] Source: Fischer, Gutierrez and Serra (2003, p.42) and Chilectra Annual Report 2003.
[30] Newbery and Pollitt (1997) find that for the CEGB (responsible for generation and transmission of electricity in England and Wales labour productivity increased from 4.7 GWh generated per employee to 10.4 GWh generated per employee over the period 1985-86 to 1995-96. Domah and Pollitt (2001) found that in the distribution and supply businesses of the 12 regional electricity companies in England and Wales labour productivity increased from 2.5 GWh sales per employee in 1985-86 to 5.5 GWh sales per employee in 1997-98.

Interestingly there has been a particularly rapid improvement in labour productivity since the takeover of the formerly domestically controlled companies by foreign companies. Between 1999 and 2002 the total number of employees in the electricity sector fell from 8264 to 5706.

3.5 Rural Electrification

A notable success in Chile has been the increase in connections of rural customers to electricity networks. Although most people in Chile do live in urban areas and the degree of urbanisation is high, 62% of rural households (some 269,841 homes) were without electricity supply in 1982. By 2002 only 14% of rural households were without electricity. Most of the progress has been made in the last 10 years following the establishment of a national programme for rural electrification (REP) administered by the National Fund for Regional Development. Under this fund there is tripartite funding of the capital costs of rural connections whereby the users pay 10%, companies 20% and state funding 70% with users expected to pay for running costs.

3.6 Quality of Supply

Quality of supply has significantly improved in the Chilean electricity sector since 1982. Technical (due to resistance) and non-technical (due to theft) losses fell sharply. Across the country technical energy losses in the distribution system fell from 10.2% in 1982 to 6.2% in 2002. For Chilectra, the major distribution utility in Santiago, technical and non-technical energy losses fell from 19.8% in 1987 to 5.6% in 2003 (see Figure 4).[31] This reflects a significant improvement in the metering and bill collection in order to reduce non-technical losses (i.e. theft). It also reflects targeted investments by companies increasing the difficulty of putting up illegal connections to the electricity grid.

Power outages due to transmission system failures have fallen since privatisation. In the Transelec transmission system the number of minutes of supply interruption per year (TEI or equivalent minutes of interruption at the system's peak demand time) was 2.10 in 2003, down from 9.60 in 1997.[32]

3.7 Major problems

The Chilean electricity system has operated successfully for almost all of the 20 years since restructuring; however there was a serious problem in the summer of 1998-99 when there were repeated power outages caused by a lack of water to power the hydroelectric plants.[33] The year was extremely dry and hydrological conditions were the least favourable since the last major drought in 1968-69. Indeed it was the worst drought in the previous 40 years. The main dam La Laja - which at its maximum can store 6820 GWh of electric power and is able to store water from one year to the next - was emptied.

[31] Source: Fischer, Gutierrez and Serra (2003, p.42) and Chilectra Annual Report 2002.
[32] See Transelec Annual Report 2003, p.26.
[33] For an analysis see Fischer and Galetovic (2000).

The price setting mechanism (for the regulated node price) and planning systems failed to anticipate the seriousness of the water shortages. This led to the early release of water combined with a lack of fossil generation and random blackouts. Node prices fell throughout the period before and during the crisis: by 11% in April 1998, 8% in October 1998 and 5% in April 1999. Blackouts began in November 1998 and continued to April 1999 with eventually a total of 500 GWh of electricity not being supplied. While the hydrological conditions faced by the system were extreme the inability of the system to cope with predictably extreme conditions (statistically Chile should suffer an extreme drought once every 20 years) did expose a number of the issues that we will discuss later.

A further major problem has arisen recently caused by the aftermath of the 2002 collapse in the Argentine peso[34]. Chile relies on imports of gas from Argentina to fuel its gas fired power plants. These imports are the subject of a 1995 treaty between the two countries. This treaty guarantees that, in the event of a domestic fuel shortage, Argentina will only reduce supplies to Chile in proportion to the fuel shortage in Argentina. Following the collapse of the peso, domestic prices of Argentine gas and electricity were frozen in pesos in spite of high inflation and a fall in the value of the peso against the dollar of two thirds. The Argentine economy recovered sharply in 2003 as low prices fuelled export led growth. This has resulted in soaring energy demand in Argentina. In early 2004 there were power cuts. In March 2004 Argentina unilaterally announced that it would reduce exports of gas to Chile by 15%.

The cuts in gas exports have had serious implications for Chile.[35] First, coupled with a shortage of available hydroelectric capacity it has necessitated expensive substitution of fuel oil for gas. The cost of fuel substitition is estimated at $32m over 6 months. Second, it has raised the possible requirement for investment in expensive liquid natural gas (LNG) import facilities to import Indonesian gas by tanker (these could amount to $500m). In November 2004 Chile signed a preliminary agreement to import LNG from Indonesia from 2007 or 2008.[36] The shortage of Argentine gas has been significant in forcing the SIC system 6 monthly node price for wholesale electricity up by 7% in May 2004 and by 10% in November 2004.[37]

4. Detailed Lessons from the Reforms of the Chilean Electricity Sector

We discuss the reforms in detail looking at the issues under five headings: generation, transmission, distribution and retailing, practice of regulation and general institutional framework. In our view the picture that emerges is one a system which has worked well and delivered widespread benefits since its inception. In 1982, the design of the electricity market was well ahead of its time. By 2003, the design of the system was

[34] See Pollitt (2004).
[35] See 'What sort of neighour is this?', *The Economist*, 15th May 2004, p.34.
[36] See 'Indonesia agrees to supply up to 4.0 Mln T LNG to Chile Annually', *Latin America News Digest*, 24th November 2004.
[37] See 'Central grid node prices to rise 6.7%, fall 6.7% in north', *Business News Americas*, 20th April 2004, and 'Fitch: Node price increases 'consistent'', *Business News Americas*, 19th October 2004.

beginning to show signs of age and was ripe for reform in a number of areas.[38] As a general rule the system needs to reflect the institutional lessons that have been learned since 1982. To summarise these under each of our five headings:

A. Generation markets work best when characterised by a lack of integration with monopoly transmission and distribution networks, low degrees of concentration in the price setting segment of the market and when generators freely contract with customers.
B. Transmission systems need appropriate regulation of incumbents to ensure both fair prices and an adequate rate of return on investment. There needs to be some institution charged with proposing and overseeing system wide planning to ensure timely building of new transmission links.
C. Distribution companies need to be regulated to ensure that distribution charges both incentivise efficiency and are fair. Third party access charge regulation is essential to ensure efficient financial bypass of the distribution network by customers free to choose supplier. Supply competition is itself feasible for all industrial and commercial customers and has been successfully implemented for residential customers in some countries.
D. Economic regulation of the electricity sector is best practised by a single independent regulatory agency with minimal ministerial control. Statutory duties to ensure adequate planning of future demands in the sector can be effectively delegated to this body. Output based regulation using appropriate quasi-market mechanisms can deal with issues of quality of supply, network extension and consumer cross-subsidy which are the areas most subject to political interference.
E. The general institutional environment in which the electricity sector is placed must be stable and foster long-term investment based on protection from arbitrary changes in government policy. Legislation regarding the electricity sector should by credible and sustainable. However there should be the capacity for the regulation regarding the system to respond to new information. The ability of the regulator and the Independent System Operator (ISO) to do this requires clear and quick dispute resolution/review mechanisms especially in the case of disputes between companies and the regulatory agency. Given the technical nature of many of the issues this should involve specialist arbitration panels perhaps under the authority of the general Competition Agency.

4.1 The Generation Sector

The Chilean electricity system illustrates that it is possible to have effective competition and privatisation in a relatively small power market with significant hydro generation. Chile's power market has successfully delivered low prices and reasonable rates of return for investors in spite of both the SIC and the SING markets being initially small. This has been due to a combination of free entry into the generation sector and the price restraint posed by the marginal cost based bidding system in the power pool which has limited the short run exercising of market power by the three

[38] A good recent review of the Chilean electricity sector reform and its shortcomings see Fischer and Serra (2000) and Joskow (2000).

incumbent generators. The result of free entry has been that their market share of capacity has fallen from 79.7% in 1993 to 59.1% in 2003 with the share of the largest company, Endesa, falling from 47.7% to 27.6%.[39] This situation has come about in part due to the lack of restrictions on new building and the fact that the linear nature of the transmission system has made upgrading the transmission links reasonably straightforward. The Chilean system illustrates the success of private ownership of generation combined with free entry in the presence of cost based bidding.

The obvious question that arises is whether the cost based bidding system in the pool should be replaced by a price based bidding system? In theory this would provide better signals for long-term investment as dispatch would be on the basis of the scarcity value of electricity rather than on the basis of current costs. It would also reduce the transactions costs of the current system where submitted costs need to be audited and where there is some scope for gaming in the declarations of costs (given that fuel costs are checked with reference world market prices rather than on actual costs and heat rates are assumed).[40] These distortions to optimal dispatch and efficient price signals seem small compared with the potential for the exercise of market power that exists in the current SIC system. This originates in the continuing large share of the three largest firms in the price setting region of the market and in the ability of the generators to strategically release water to drive up the price at times when generating capacity is tight. In particular Endesa's La Laja plants can provide 25% of annual demand in a wet year.

Simulations suggest that even if companies were to bid up their offer prices to those of next most expensive generation set on the system prices would rise by up to 27%[41], while if the companies were simply to maximise profits as within a non-collusive Cournot oligopoly prices might rise 60%[42]. Competitive dispatch of Endesa's hydro capacity and divestiture of its thermal generation plant would reduce the problem but prices might still rise by 16%.[43] In the light of these results it is not sensible to recommend a switch to price based bidding in the SIC system. The situation is rather different in the largely thermal SING system. Price based bidding is possible but the benefits remain small.[44] One problem is that there is current over-capacity which might lead in the short term to very low prices. Another issue is whether future interconnection of the two systems would be facilitated by them having different bidding and dispatch systems.

The integration of distribution and generators leads to an inability for non-integrated generators to compete for the customers of the distribution business. This is because of the inability of non-integrated generators to gain access to the distribution network. Although the Chilean system is divided into 'free' and 'regulated' customers this does not mean that there is a competitive market for the provision of

[39] Source: CDEC-SIC Annual Reports.
[40] Essentially generators face a tight price cap but can choose to bid any 'cost' between their actual cost and the ISO calculated cost. The scope for exercising market power by raising the cost declaration of marginal plant is small but does exist.
[41] See Watts, Atienzza and Rudnick (2003).
[42] Arellano (2003).
[43] Arellano (2003).
[44] See Watts, Atienzza and Rudnick (2003).

energy services to large users. What it means is that there are customers who receive supply from their incumbent supply company on the basis of an energy price which is set in the power pool ('free' customers) and regulated customers who pay the regulated node price for energy. Chilectra which is integrated with Endesa is the largest incumbent distribution and supply company in Chile. Between 1982 and 2003 it lost just 2 of its 2000 large customers to other companies. This indicates that there is relatively little competition between generators for customers embedded in the distribution network because the access charges / terms to the distribution network are not properly regulated to prevent discriminatory charging. In general generators should be allowed to merge with retailers but not with retailers and distribution wire businesses as this potentially creates the same access problems as arise when generation and transmission are merged. We discuss this further in the section on the distribution sector.

A market for ancillary services should be introduced. While it does seem to be premature to introduce a price based bidding system in the market for energy on the grounds that the incumbent firms still have too much potential for market power this is not the case in the market for ancillary services. Ancillary services (such as voltage control and black start capabilities) are currently remunerated with reference to the marginal energy costs of providing the services. However as almost all generators, transmission companies and large customers can provide some ancillary services there are enough potential competitors for this to be a free market in the SIC system. The Ley Corta does now provide for the establishment of such a market.

Governance of CDEC-SIC has been problematic and should be widened to include customer interests. The CDEC-SIC (and the CDEC-SING) is overseen by a governing board. The membership of the board is prescribed by law and consists of representatives of generators (with more than 9MW connected to the system) and transmission companies (with more than 100 km of high voltage lines). The law requires unanimity in voting for any rule changes and the dispute resolution proceed described above can take up to 4 months. This introduces a substantial delay into the dispute resolution process within a system where disputes are encouraged by the need for unanimity in decision marking. Relations within the CDEC have become increasingly adversarial over time as the interests of Endesa have diverged from the newer generators. The number of disputes referred to the Minister for Economy rose steadily through the 1990s.[45]

It is striking that in contrast to other countries only generators and transmission companies are represented on the board. In other countries there would be demand side representation – distribution companies and large users at a minimum. Representation of the demand side is important when decisions about operation of the market are taken to ensure that these do not collectively increase the profitability of suppliers. In particular it is important that there are those on the board who can represent potential entrants into the generation market. The absence of any customer representation on the CDEC board also means that discussions about the quality and availability rules of the do not include informed comment about customer preferences for such variables. Increasing

[45] See Basanes, Saavedra and Soto (1999). There was 1 dispute between 1984 and 1990, 2 per year from 1991 to 1994, and then a steady rise to 11 in 1998.

representation on the CDEC might lead to more disputes under the current unanimity and dispute resolution procedures but should be coupled with reform of those procedures.

The continuing high market share of 3 companies in the SIC is potentially problematic in the future. It is generally agreed that the generation market is currently operating in a way that yields near competitive outcomes. The spot price is close to the marginal cost of new gas fired plant. An important boost to competition came in 1997 when Argentine gas arrived in Chile and this facilitated an increase in gas fired generation and lowering of the marginal cost of energy. However the incumbent firms retain a large market share and Endesa has control of 75% of the water rights to undeveloped hydro-electric sites. In Aysen area Endesa has 30% of the water rights but no generation and recently refused to grant water rights for a new facility to supply a proposed aluminium power plant.[46] Increased tightening of environmental controls on the siting of new thermal plants and local objections to new hydro-electric schemes may mean that conditions for new entrants may not be so favourable in the future. A move to price based competition may be a desirable in the long run but is not feasible in the short run.

The UK market demonstrates that it is possible for three firms to tacitly collude in the power market very easily.[47] If there is continuing strong market demand growth and it becomes more difficult for new entrants to build new plants or get access to gas then there will be a problem with market power. It is also clear that genuine supply competition between generators is going to be limited by the lack of competitors. In our conversations with generators it seemed that some of them understood that it was not worth competing for free customers who were purchasing their electricity from other generators because of the threat of retaliation – this is classic circumstantial evidence for tacit collusion[48]. If the three incumbents do not continue to lose significant market share then there will be a need for a structural remedy ahead of any move towards price based bidding or full liberalisation of the supply market.

Fuel security is an important issue for a country like Chile and steps should be taken to optimise the risk of supply interruption. The recent shortage of Argentine gas due to the breaking of an international treaty raises serious economic questions about the way to manage fuel security. Clearly good international relations are the most cost effective way to minimise fuel costs. However the presence of significant fuel supply interruption risk means that careful assessment of the costs of alternative supplies need to be made. Chile needs to assess the relative costs and benefits of: improved relations with alternative pipeline gas suppliers, such as Bolivia; natural gas storage facilities; conversion to fuel oil; and the building of LNG import facilities. Especial care needs to be taken to avoid over investing in fuel security.

[46] See Barsanes, Saavendra and Soto (1999, p.19-20).
[47] See Green and Newbery (1992).
[48] See Monopolies and Mergers Commission (1986) report on British Salt for a similar admission of tacit collusion between the two main white salt producers in the UK.

4.2 The Transmission Sector

The Chilean regime for unregulated transmission access charges has worked reasonably well in terms of the development of the system to date, however that does not mean that system wide planning is not necessary in the future. The current system of transmission charging has worked well in the sense that there have been no major lines which have failed to have been built when the economic benefits were positive. This is a function of the fact that the system of negotiated third party access does tend to lead to an efficient solution in the absence of externalities and in the presence of low negotiation costs. This is the case in a linear transmission system where generators connect at various points along common network backbone. This is because it is easy to establish who should pay for new transmission and how much. However as the degree of meshing and loop flows increases in the system negotiated solutions become much more complex and gameable. In these circumstances system wide planning and determination of access terms is likely to become more valuable. That said it should be pointed out that transmission system planning must be market driven rather than subject to political interference. Littlechild and Skerk (2004) argue that Argentina provides an example of a country where in the past transmission projects have been driven by political pressures from remote regions rather than rational transmission system planning. Such pressures can lead to overbuilding of transmission lines, the costs of which are borne by the system as a whole rather than those proposing them.

The current system has involved disputes and significant transaction costs in negotiations.[49] Colbun had a long running dispute with Endesa/Translec about transmission tolls. During 1994 Transelec wanted $21m in tolls but the annual cost of building its own line was $11.5m. When Colbun threatened to build a new line Transelec dropped its price to $10.3m. However in 1997 Colbun decided to build its own line anyway. To the extent that the negotiation led to unnecessary duplication of assets this was an additional negotiation cost. Undoubtedly this situation was made worse by the vertical integration of Endesa and Transelec. An independent transmission company and a system of unregulated transmission access would have worked better but would still lead to higher transaction costs than under planned transmission system expansions. The Ley Corta has recognised this point and in future average transmission charges will be regulated.

Allowing unregulated connection by new generators to the transmission network is not efficient. While the negotiated transmission access charges have worked well for new generators, this has partly come at the expense of incumbent users. In order to facilitate access and reduce the ability of incumbent transmission companies from holding up new generators, new generators have a right to be connected in the absence of an agreement about charges. This means that new entrants can impose congestion costs on existing users of the transmission network and puts the transmission company in a weak negotiating position with the generators. Normally transmission companies with regulated monopolies can exercise market power over new generators by denying them access to the transmission network if they don't pay regulated tariffs and the tariffs are

[49] See Basanes, Saavedra and Soto (1999, pp.15-17).

regulated precisely because of the existence of market power. In Chile the situation is reversed in that generators can go ahead with connections and settle the prices via arbitration. This does not ensure that pricing signals will be efficient as the outcome depends on the sophistication of the arbitration process which is likely to be less than regulated access charges.[50]

Negotiated access has given rise to a further problem: the fact that some transmission lines may not be remunerated. This is because transmission charges are negotiated around the concept of an influence area. This is the area where the power is deemed to flow from generators to their customers. It is possible to show that certain sections of the linear backbone will not be remunerated on the basis of power flows even though they have backup capability to the system as a whole. The overall effect is therefore that transmission revenues are uncertain and that the cost of capital in transmission is unnecessarily high. A system of regulated transmission charges combined with a system of recovering congestion costs aimed at remunerating the cost of the whole network should solve both problems and reduce the riskiness of transmission investment in Chile. This is one of the aims of the Ley Corta and the law should be effective in addressing this point.

Both generators and customers should have to pay for transmission. Currently, transmission costs are being paid 100% by the generators who package energy costs and transmission delivery. This is inefficient because it does not give customers the choice to trade off energy and transmission costs in a way that would minimise their total costs. For example, it might be the case that a regulated distribution company could reduce the cost of its purchased power costs by paying for some extra transmission capacity which it would not be in the interests of the generators to pay for (because it increased effective competition in the market). The current node pricing system does not allow customers to pass through their own costs of transmission so the transmission network may not be optimally configured from the point of view of both generation and supply. Likewise distributors have no incentive to economise on the use of the transmission network if they can pass through to regulated customers all of the transmission costs from generators. What is required is sharing of transmission charges between distributors and generators combined with an incentive mechanism on the regulated distributors to minimise the sum of generation plus transmission costs (this happens in most other countries where supply companies must pay some proportion of transmission charges).

The regulation of Transelec interferes with efficient operation. The total costs of transmission in the Chilean system are small (around 3% of the total electricity bill) and this seems to have reduced the pressure to regulate the transmission monopoly in the SIC system, Transelec, in a way that clearly gives optimal incentives to efficient operation. Although Transelec's charges were unregulated until the passage of the Ley Corta, they will now become regulated. The new regulation will include a 10% regulated real rate of return on assets combined with competitive bidding for operation and maintenance, capital upgrades and system extensions. Such competitive bidding is already mandatory

[50] Even though the overall tariff revenue does need to be regulated, local tariff variations to reflect congestion effects can be implemented.

for Transelec. As such Transelec does not exploit economies of scale, scope or learning in transmission operation and building. While this scheme is highly innovative, it is clearly a model followed by any other advanced transmission system where such economies are assumed (in particular by Transelec's parent company, the vertically integrated, Hydro-Quebec).[51]

Such subcontracting is a function of the regulatory system which requires subcontracting for regulation but it is not necessarily the most efficient market outcome. The transaction costs of such a system are significant, in the short run these may be offset by bidding companies willing to take losses to gain a place in the market. However in the long run the number of active bidders is likely to fall and bidding costs will be fully reflected in their prices. The experience of enforced bidding for private sector finance contracts for public works in the UK seems to have followed this pattern.[52] Consistency of regulation would suggest that Transelec should be regulated in a way that is consistent with the way that the distribution companies are regulated: i.e. price controls set for a four year period based on a model company's costs.

4.3 The Distribution and Retail Sector

There is a need for a regulated third party access charge in order to correctly regulate the access to the monopoly distribution network by third party suppliers. The issue of financial bypass of a monopoly facility is one which has been addressed by the efficient component pricing rule. However in Chile there is no regulation of access charges to the distribution network, merely the final distribution value added which, combines the distribution and retailing charges. Generators who might wish to contract directly with large customers embedded in the distribution network find it difficult to negotiate fair access terms. In theory this should not happen inefficiently as if generators are genuinely cheaper at providing power and retailing they should be able to reach a bargaining solution which makes both parties better off. This would be true if there were no advantages of incumbent supply – such as in marketing or in positioning for further market opening.

Physical bypass of the incumbent distribution network is allowed and is sometimes feasible where large customers can be connected directly to the transmission network. This threat however may lead to wasteful duplication of assets and further reduces the incentive to efficient financial bypass. Incumbent distribution companies faced with the loss of any contribution to the fixed costs of their network from a large user may offer very low prices to large users which avoid the physical bypass but co-incidentally pre-empt the financial bypass. This inhibits entry into the generation market by denying new generators a contract market. What is needed is a regulated third party access charge to

[51] There may be an important distinction between contracting out of new building of large transmission projects and contracting out of operation and maintenance of the existing system. Large upgrades can be successfully tendered for in the international market and have a use value in that the construction cost arrived at in the tender can be used directly in calculating the required addition to the regulatory asset base. Such tendering does seem to have been successful in Argentina (see Littlechild and Skerk, 2004).
[52] See Pollitt (2002).

the distribution network which encourages efficient financial bypass and increases the amount of competition for embedded 'free' customers. This will be especially important when the threshold definition of a 'free' customer is lowered to 0.5 MW increasing the number of embedded customers in the competitive supply market. The Ley Corta has moved to address this point and recognised that third party access charges to the distribution network need to be regulated.

Assessment of efficient Distribution VAD is hampered by the legal specification of the methodology of assessment. The process of assessing distribution VAD is currently restricted by the enforced use of an engineering model of the distribution system with no account being taken of the actual cost of the network on the comparative cost of other distribution networks or of data trends. In practice data from the year of assessment is used to calibrate the model company. This appears to have led to gaming by the companies who report higher costs in the year of assessment and whose consultant reports consistently document higher costs than the regulator's consultant reports.[53] The calibration of the model company involves the assumption of a 10% real return on the new replacement value of the assets employed and involves the construction of an ideal company on the basis of actual demands and sources of supply. The overall price review can be reopened if the average return for the industry (electricity income only) is outside the range of 5 to 15% (it was 13.9% in 2002). However, the other income that the companies earn from leasing their lines to cable or telecom companies, does not count towards their regulated income thus leading to electricity customers paying for the full cost of the lines (this does not happen in the UK).

In theory the model company approach has appealing incentive properties in terms of making the revenue of the distribution company outside its control and giving it perfect incentives to reduce costs. However, the theoretical weakness of this system is that it relies heavily on the detailed structure of the benchmark model which may or may not bear any relationship to the reality of operating a distribution network in a particular environment. In practice additional distortion is introduced by the use of actual costs in the construction of the model company. The currently high rate of return on the distribution sector as a whole – much higher than in generation – suggests that the use of a model company is in this case excessively generous to the companies. If prices were reduced in order to bring the companies actual regulated rate of return down from its current 13.9% to 10% this might result in the value added in distribution falling by over 10%.[54]

In practice the calculation and checking of the costs of the model company is a time consuming task and involves truckloads of information being given to the regulator.[55] Higher level techniques (such as data envelopment analysis, corrected ordinary least

[53] Di Tella and Dyck (2002) find that stock prices of listed Chilean distribution companies rise on the announcement of higher costs during a year of assessment while falling on the same news in non-assessment years.
[54] Assuming that capital costs are equal to half the revenue of a distribution company and its capital costs must provide a return on assets and cover depreciation of 3% per year.
[55] See Di Tella and Dyck (2002) for a qualitative description of the process.

squares and stochastic frontier analysis) which involve analysing a few categories of overall cost in relation to a small number of outputs exist which substantially curtail the transaction cost and reduce the scope for gaming. These techniques have been successfully employed in regulation in Norway, Australia and the UK.[56] These models are more transparent and fair to the companies as they set regulated revenue with reference to the achieved costs in a comparator group of companies, they can also make good use of international data for the purposes of comparison.[57] There is also a question mark about whether the VAD model is capable of being implemented by consultants for the price that the CNE is allowed to pay. This was around $600,000 in 2000 which is less than one fifth of the figure for the UK distribution price control[58] which involved fewer companies (14 as opposed to 34) and a less complex methodology.

The node pricing system is unnecessary and inhibits long term contracts. Within the SIC system 70% of demand pays the regulated node price of energy. The idea of a node price is to reduce the exposure of residential customers to price spikes which might exist in a hydro system in years of extremely unfavourable hydrological conditions. This seems to be misconceived. In a completely free market customers who value price stability can buy stable prices direct from their suppliers who will then absorb or re-insure against the risks of high spot prices. In other words long term contracts (which allow recovery of a surplus in periods of low spot prices to compensate for losses in periods of high spot prices) can be entered into if valued by customers. The problem when there are regulated customers who have only one supplier is how to encourage the optimal amount of price smoothing.

The Chilean system imposes smoothing by only allowing distributors to pass through the smoothed price. However the smoothing mechanism itself is problematic. It represents a four year forward looking average of electricity prices and is reset every six months. As such it is poor at responding to short run price signals as happened during the 1998-99 drought, when the node price in November 1998 was predicting lower prices than six months earlier. Until the passage of the Ley Corta the node price was also restricted to be within + or – 10% of the free price. The problem with this was that at –10% generation companies may make significant losses thus it may be difficult for the generation and distribution companies to find a bargaining region where they can agree a meaningful long term contract with the optimal amount of insurance. The reduction of the banding of the node price around the free price to + or – 5% (following the Ley Corta) will reduce this problem but not eliminate it. The effect of the node price system has thus been to reduce the amount of long term contracting between generators and distributors to supply regulated customers. Some distributors have even preferred to purchase on the spot market to supply regulated customers. This would seem to be a perverse effect for a system aimed at promoting price stability and reducing exposure to spot market prices.

[56] See Jamasb and Pollitt (2001) for a survey.
[57] See Estache, Rossi and Ruzzier (2002) for an international comparison of electricity distribution company efficiency including Chile and Argentina.
[58] National Audit Office (2002) reports that the OFGEM's 2000 distribution price control review cost £2.5m.

An open auction for long-term contracts to supply regulated customers combined with some benchmarking of the long-term contract prices paid by the distributors on behalf of their regulated customers would ensure a large degree of smoothing. It would also ensure that high prices at times of shortage would be reflected (at least in expectation and in the price of un-contracted demands) in the regulated price. If there was still a need for smoothing the final price there could be a smoothing mechanism introduced on the final price to spread the payment for the high cost electricity by regulated customers. This could easily be achieved by a limit on the maximum dollar price rise in any six month period followed by a period of over recovery in prices to make up any revenue shortfall to cover the extra purchased power costs.

The current node price setting mechanism, is too forward looking and does not reflect all short term information about water availability (a major failing during the 1998-99 drought). It is also vulnerable to time specific misinformation about the availability of future demands (e.g. when Colbun's CCGT was going to begin operation).[59] If the node price is to be retained it needs to be made more responsive to all available information. For example, the current GOL model assumes all hydrologies are equally likely even during a prolonged drought. The consultant appointed to measure snow levels needs to be independent of the generator dominated CDEC-SIC. There needs to be penalties for companies whose predictions of availability are not subsequently met – otherwise there is room for strategically manipulating the node price. This appears to have happened in 1998-99 when Colbun's prediction of early introduction of their CCGT allowed the price of water to fall helping them to fulfil their supply contracts more cheaply. The proposal in the Short Law to reduce the range of variation of the node price from the free price to + or – 5% will reduce the likelihood of no bargaining region between the generators and distributors but it does not constitute a radical enough reform of the node pricing system.

The compensation and penalties regime has been difficult to enforce and should be strengthened. Regulated customer compensation payments are legally specified to be the difference between the outage cost and the node price. For a 10% restriction in supply this would be around twice the normal price of electricity. These compensations are paid by the generators for whom the outage cost effectively becomes the marginal price of energy. Supply failure penalties are determined according to the seriousness of the failure on the part of the generator, transmission company or distribution company. Penalty payments were until 1999 subject to a maximum of $26000, in 1999 the maximum was raised to $6m as it was widely recognised that they were too low. During the drought of 1998-99 no customer compensations or penalties were paid in spite of the value of compensations being legally specified. The reason why this occurred was because the generators (who would have been liable) claimed that the hydrological conditions were worse than the worst year in the 40 years which were used to calibrate the model of the node price (under Article 99 bis). The reason this occurred was because generation companies were able to claim force majeure due to the exceptionally dry conditions. This failure of the compensation system to operate is not optimal because it resulted in the absence of proper incentives to manage the electricity shortages and does not encourage

[59] See Fischer and Galetovic (2000) on the shortcomings of the node pricing system during the 1998-99 drought.

efficient rationing by distribution companies. The predictable result was that there were more blackouts than might otherwise have been the case and that the blackouts were random rather than managed.[60] The 1999 revisions to the law corrected this loophole and gave the authority to authorise compensations and damages payments to the SEC. The SEC imposed a penalty of $7.2m in 2003 on a number of generators and transmitters, however it is not clear what the economic basis of penalty payments system is.

There have been a wave of mergers in the distribution sector and the welfare consequences of this have not been evaluated. Most systems of regulation of distribution charges rely on comparison of costs among distribution companies. Such comparisons are more meaningful and can be made more accurate if there are a significant number of distribution companies under the regulators supervision. Chile currently has 34 distribution companies which is enough for statistically interesting comparisons of costs to be made. However the sector has seen a significant number of distribution mergers which reduce the number of potential comparators in regulation. While this is not necessarily a problem within the current system of regulation of distribution charges it may be if the system is reformed. Mergers of distribution companies are also effectively mergers of supply companies as well, hence they reduce the number of potential competitors for free customers when the market is liberalised. As a precaution it would seem sensible to insist on continuity of regulatory accounting for the existing component distribution companies to maintain the option value of cost based regulation. Some more in depth analysis of the long-term implications of these mergers would be desirable.

4.4 The Practice of Regulation

The restrictions on the mix of professional skills in the CNE and the SEC limit the effectiveness of their regulation. A notable feature of the Chilean regulatory system is the reliance on engineering models and the lack of input from economic analysis. This has the effect of a bias towards a ideal model driven solution (e.g. in the setting of the node price and the regulation of electricity distribution). This is instead of a solution which reflects the principles of economic regulation where incentives should reflect the fact that private agents have superior information and should be allowed to form efficient expectations about the future. It has also lead to a system which pays insufficient attention to the need to incentivise innovation and allow beneficial technical progress and learning (e.g. in the specification of the threshold limits on market opening or the required rate of return in the model company). This bias in approach partly reflects the legal restrictions on both the size and the professional backgrounds of staff within the CNE. These restrictions may have made sense in the context of a rigid regulatory regime created to prevent necessary regulatory creep but does not make sense in a modern regulator where engineering, law, economics, accounting and finance specialisms are required for economically optimal regulation. Only a subset of these skills are now present in the agency and this clearly undermines its effectiveness. Similarly there is a lack of economic analysis associated with the penalty regime set by the SEC. Penalties are important economic incentives and hence should be set with reference to the

[60] See Fischer and Galetovic (2000).

economic damage inflicted (as with the US triple damages rule in competition cases which reflects both the probability of being caught and the actual damages).

Regulatory oversight of crisis management at times of water shortage is essential in a hydro based system. It is predictable in the Chilean system that one year in 20 there will be a severe shortage of water for electricity generation leading to the need for much higher prices / blackouts. How the system responds in such a situation is vital for the stability of investment incentives and for political and popular support for the privatised industry. The response to the 1998-99 crisis was technically and politically very poor: political interference in the use of water worsened the crisis and the industry unnecessarily engaged in random (rather than planned) blackouts. The crisis management has improved: a plan now exists and fines have been raised to enforce better management. However there is clearly a need for a willingness to raise prices and or allow a more flexible response (e.g. customer bidding to be interrupted). Following the 1999 law changes all customer demands must be proportionally reduced in a shortage situation. This does not exploit the differences in price elasticity of demand between customers and the willingness to accept interruption. It was put to us that a 20% rise in the residential price during a shortage would be enough to avoid the most severe blackouts. This may well be politically acceptable given the internationally low level of residential electricity prices in Chile and the fact that it would lead to lower prices in the 19 non-shortage years (due to the saving of peak capacity).

The transparency of the regulation and oversight of the industry needs to be improved. Transparency and openness in regulation of monopolies is important primarily because it reduces the likelihood of regulatory capture and the regulatory risk to companies who benefit from the stability that openness encourages. This comes about because regulatory decisions must be justified and consistent to informed external observers and because transparency allows replication of regulatory analysis and informed innovation of regulatory techniques by external parties. For a successful system that has a long history of regulation it is striking that there is a lack of published information about the practice of regulation on the websites of the CNE and SEC. The CNE does not publish the reports on which its assessment of VAD is based and the SEC does not even produce an annual report.[61] By comparison with the openness of the US, UK, Australian, Norwegian and Dutch regulators which have similarly advanced systems of regulation Chilean openness is poor and surprising. This is partly a function of the criminalisation of the publication by others of commercially sensitive information. This has made regulators reluctant to publish information which companies are unwilling to agree to publish. Recent moves towards more openness and e-government are to be welcomed and should be advanced as they would provide support to a more flexible system of regulation.

There is a lack of representation of small customers within the regulatory process and in the governance of the market. One of the main justifications for continuing

[61] See www.cne.cl and www.sec.cl

ministerial intervention in the electricity sector is because the democratic process should represent the interests of small regulated customers. This has some validity but it is clearly not the most efficient way to represent such customers within the system and may in fact be counter productive because it tends to lead to badly informed intervention based on short term political gain (as during a drought where a minister might think that customers prefer to put off rationing or price rises in the hope it might rain). A better alternative would seem to be the introduction of a formal role for small consumers in the governance of the industry as happens in many countries. In the UK Energywatch is the formal consumer association funded by an industry levy charged with handling complaints and representing consumers on industry governance boards. Such a body is capable of better representing customer preferences than the Minister of Energy because it is in direct touch with customers (through complaints and surveys) and is also well informed about the workings of the industry. Such a small consumer representative body can more carefully represent customer preferences about quality of supply and about willingness to accept lower prices in wet years and higher prices in dry years. Such representation also helps to formally police regulatory agencies and insure them against regulatory capture.

Rural electrification in Chile has been a notable success however it is not clear that there is proper incentive regulation of the costs of rural connection. Chile has an impressive record on extending rural electrification in the 1990s, this is due to the focus that it has put on such electrification and the subsidy (up to 70%) to the costs of connection that exist. The connection subsidies are generous and this in large part explains the success of the rural electrification programme (now up to $2000 per customer connection). The question arises as to whether the scheme adequately incentivises least cost connection including isolated generation. Most extensions are carried out by local distribution companies on the basis of audited costs rather than on the basis of an open bidding competition for blocks of system extensions (one could imagine regional contracts). Given the emphasis of open competition in transmission extensions and the potential for competitive bidding to substantially lower costs it seems anomalous that competitive bidding is not used.

4.5 The General Institutional Framework

Continuing public ownership in the electricity sector after initial privatisation led to problems. Chile now has a fully privatised electricity system. However a lesson for other developing countries is that continuing public ownership can lead to the sort a prolonging of the bad decision making that public ownership can give rise to. In the case of Chile this legacy of public ownership led to serious problem. The privatisation of Colbun (the third largest generator) was not completed until 1997. During this time the decision was taken to procure a new CCGT design for its latest thermal power plant (Nehuenco) which was untested anywhere in the world. Such decisions are common in the public sector where engineering excellence is frequently valued more highly than commercial value. This decision proved a mistake because the failure to make the design work in time lead directly to a shortage of capacity during the 1998-99 drought and the prediction that the plant would work led to the node price being reduced when with hindsight it should have

gone up. This illustrates the propensity of publicly owned companies to take market risks which would not have been undertaken in the private sector, the company now only invests in tried and tested plant designs.

The division of roles between the CNE and SEC creates the impression that there are two regulatory bodies – their roles should be reallocated so that there is one energy regulator. There is a confusing and unclear demarcation of regulatory responsibilities.[62] This is likely to lead to inefficiency in the co-ordination of data collection and enforcement and transparency between CNE and SEC. Data collection (now the role of the SEC) plainly needs to be overseen by regulator (now the CNE) otherwise there is an inefficient process of intermediation. This separation of responsibilities was originally motivated by concerns that the SEC would be open to regulatory capture as it had the responsibility for the promotion of the sector and additional investment and that this might cause it to not take its role in increasing efficiency seriously. Clearly regulatory agencies which are output oriented must take both efficiency and the need for investment into account and there are substantial co-ordination benefits from making these decisions jointly. Appropriate governance of the regulator rather than the creation of another regulatory agency would seem to be a more effective way of preventing regulatory capture, as it is generally thought that larger higher profile regulators (which would result from combining functions) are less susceptible to capture than smaller ones. It is interesting to note that the SEC-CNE separation is not a feature of the Telecoms sector in Chile where policy setting and efficiency goals are combined in one office. If there is to be a continuing role for the SEC it is surely as the consumer representative body handling customer complaints and representing the customer on industry governance boards such as the CDEC.

The CNE should be freed from operational ministerial control and be constituted as an independent energy regulator rather than as advisor to the Minister of Economy. The current advisory role of the CNE lays it open to challenge and does not clearly align the agency incentives to behave in the public interest, in particular it gives it a tendency to lobby within government to have its advice (albeit watered down) accepted. The CNE should be subject to only limited political oversight by the Ministry for Economy. The current situation requires the Minister to hear appeals, declare rationing decrees and involves conflict caused by different coalition parties receiving different Presidential appointments (both the Minister and the head of the CNE are presidential appointments). In 1997 the Minister reduced the reserve capacity level assumed in the peak capacity payment calculation from 15% to 6.7%, this is not a variable that should be under ministerial control (as it may be in the interests of generators to reduce this at times of shortage of capacity to keep their power purchase costs down).[63]

The involvement of the Ministry in dispute resolution is extremely inefficient in that it has lengthened the time during which decisions are in doubt and invited lobbying. During the 1998-99 crisis the generators in the CDEC-SIC could not agree what price should rule in the spot market – the outage cost or the cost of the most expensive thermal

[62] This has been recognised in Chile (see Jadresic, Blantot and San Martin, 2001).
[63] See Watts and Ariztia (2002).

plant.[64] This was referred to the Minister for a decision, which he referred to the CNE for advice. The CNE advised in five days that the outage cost should stand. However the Minister then took almost 4 months to confirm this recommendation. This worsened the crisis as generators were left with a weaker price signal than should have been the case to invest in emergency generation. There is a need for a genuinely independent regulator agency with the head of the agency appointed for a fixed term by the relevant Minister and only capable of being removed in exceptional circumstances. The only reasonable explanation for the delay was the lobbying of the Minister by generators, short of capacity to fulfil contracts, who would have to pay a higher price to make up their contractual shortfalls if the spot price was the outage cost rather than the cost of marginal plant. The final decision was weakened by referring the determination of when the crisis started to the CNE which then led to a further dispute. The net result was that were was no clear spot price for the whole of the crisis period.

The Ministry also has too great a role in declaring the need for rationing. This should be an economic decision as politicisation makes it highly likely that there will be a sub-optimal delay in rationing and increases scope for lobbying by companies. It is also unclear why a council of ministers is required to oversee the sector if the role of the agency is clearly and widely defined. The Council recently played a role in mediating a dispute between the former head of the CNE and the Minister of the Economy but if the roles of the Minister and CNE are clearer and the appoint process less confrontational then this role for the Council would not be necessary in the future.

Regulatory discretion should be increased according to the general principle that specific numbers, market designs and 'free' customer size threshold levels relating to a private electricity sector should not be specified in legislation. The concern to prevent too much discretion in regulation has been excessive with no major changes to the regulatory regime since 1982 and a failed attempt at comprehensive reform in 2000. While we appreciate that these inflexibilities successfully guaranteed the success of the investment in privatisation the rigidity prevents appropriate updating of the regulatory regime as new information comes in regarding the current working of the system. With hindsight such restrictions on regulatory discretion in electricity went too far given the general legal protection and political respect for property rights in Chile.

The Chilean law relating to the electricity sector has been rendered inflexible by the detailed specifications of the regulation governing the sector. This gives rise to two major problems: first it is very different to change market design and rules in the light of market evolution without changing the legislation; second detailed specification, based on expert opinion, is very difficult for the legislature to appreciate and gives rise to the likelihood of gaps and inconsistencies appearing the legislation which cannot be easily remedied (e.g. there is no clear definition of an influence area in transmission in the legislation, hence some of the problems of under-recovery on certain transmission lines). The Chilean law relating to electricity currently specifies the threshold limit on competition (0.5MW), the number of people in the regulatory agency (45 in the CNE), regulated rates of return (10%), the weightings to be given to consulting reports of the company and

[64] See Fischer and Galetovic (2000).

regulator (1/3 vs 2/3), the share of transmission costs to be paid by the generators (100%) as well as technical details of the legislation such as the way that ancillary services should be remunerated. All of the aforementioned could be decided by the regulator in conjunction with the relevant industry governance bodies such as the CDEC as the market evolves. The specification of such rules limits the scope for handling unforeseen technical progress (in 1982, no-one foresaw that below 2MW customers could exist in a competitive market). However, it is the case that such details have a value in situations where investors have genuine concerns about the financial impact of loss of market share following market opening.

The rules governing the sector are based on the requirements of the central SIC system not the northern SING system. The law treats the CDEC-SIC and the CDEC-SING system as equivalent with identical rules. This is problematic. The proposed short law sets out to correct some of the problems of the existing law as it relates to the SIC with the side effect that there may be negative consequences for the SING. The SING does not have the non-payment problem in transmission that relates to the SIC. However the effect of the proposed law will be to substantially socialise the payments in a way that many of the players will be left worse off with no obvious benefits to the incentives to optimise the use and expansion of the lines. The SING system is also a candidate for the introduction of a price based bidding system while the SIC system is not. Legislation should be amended to reflect the differing circumstances of the two systems or devolve more of the detailed rule making to appropriately constituted CDEC governance boards.

6. Concluding Comments

The Chilean experience of electricity reform is the longest amongst both developed and developing countries and deserves to be studied for this reason. However it should stressed that the particular institutional designs adopted in Chile reflect very clearly the legacy of the economic policies of the military dictatorship. That painful experience, in this instance, has had a lasting positive economic legacy: an institutional bias towards a status quo which protects the property rights of initial owners of capital in the electricity sector.[65]

Many of the problems of the Chilean electricity sector are hence problems of loosening the restrictions which the initial legislation placed around changing the regulatory regime in ways that might disturb those initial rights. While such restrictions were a deliberate attempt to tie the hands of future governments it is not clear that they were necessary given the strength of the general institution of property rights in Chile. For most developing countries the opposite bias prevails: a tendency to renege on regulatory contracts with initial private property holders leading to high costs of capital and failed reforms.

[65] See Murillo (2001) for a discussion of the impact of politics on privatization in Argentina, Chile and Mexico and see Heller and McCubbins (1996) for a discussion of the impact of politics on regulation in Argentina and Chile.

Chile's electricity reforms very clearly reveal how the protection of property rights within a regulatory system which limits the ability of incumbents to exploit market power can capture most of the gains from reform.. We have made many suggestions for reform of the sector in Chile on the basis of its long experience, some of which have now been included in the 2004 revision of the law. However it is clear that these are second order changes aimed at helping a manifestly successful system continue to be successful in the face of new learning.

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Table 1: System Operating Characteristics

SYSTEM	Year	Installed Capacity MW	Maximum Demand MW	Gross Generation GWh	Sales GWh
SING	1998	1,475.5	1,020.9	7,357.5	6,616.4
	1999	2,501.5	1,093.6	9,001.0	8,119.6
	2000	3,317.0	1,153.5	9,327.4	8,398.0
	2001	3,440.9	1,221.0	9,851.0	8,991.1
	2002	3,633.9	1,420.0	10,399.6	9,481.9
	2003	3,633.9	1,466.6	11,424.2	10,480.3
SIC	1998	6,274.5	3,991.4	25,658.2	24,245.5
	1999	6,681.9	4,185.5	26,920.2	25,530.3
	2000	6,646.3	4,516.0	29,576.8	27,916.3
	2001	6,572.7	4,694.0	30,765.0	29,143.3
	2002	6,732.9	4,878.0	31,971.3	30,330.4
	2003	6,991.9	5,162.2	33,708.1	32,091.7
AYSEN	1998	17.11	12.9	66.0	62.8
	1999	17.11	13.4	71.1	67.4
	2000	17.11	13.8	74.7	71.4
	2001	20.70	13.9	77.6	74.7
	2002	23.41	15.2	85.9	83.0
	2003	33.91	n/d	n/d	n/d
MAGALLANES	1998	64.38	32.0	151.7	146.5
	1999	64.38	31.8	154.8	149.5
	2000	64.42	33.7	163.1	159.1
	2001	64.50	34.0	170.4	165.0
	2002	64.46	35.1	176.5	170.1
	2003	78.40	n/d	n/d	n/d

Source: www.cne.cl

Table 2A: Total Installed Capacity by type and company
SING System (December 2003):

Operating Company	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
AES GENER	642.8	17.69%
CELTA	181.75	5.00%
EDELNOR	719.78	19.81%
ELECTROANDINA	1028.9	28.31%
GASATACAMA	783.30	21.56%
NORGENER	277.34	7.63%
Total Gross Installed Capacity	**3633.87**	**100.00%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Coal	1205.74	33.18%
Diesel	130.44	3.59%
Fuel Oil No. 6	172.65	4.75%
Gas Natural	2111.65	58.11%
Hydro	13.39	0.37%
Total Gross Installed Capacity	**3633.87**	**100.00%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Thermal	3620.48	99.63%
Hydro	13.39	0.37%
Total Gross Installed Capacity	**3633.87**	**100.00%**

Source: www.cne.cl

Table 2B:Total Installed Capacity by type and company
SIC System (April 2004):

Operating Company	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
ARAUCO GENERACION S.A.	132.0	1.84%
GENER S.A.	781.4	10.87%
COLBUN S.A.	1,550.0	21.57%
ENDESA	2,100.3	29.22%
GUACOLDA S.A.	304.0	4.23%
PANGUE S.A.	467.0	6.50%
PEHUENCHE S.A.	623.0	8.67%
S.E. SANTIAGO S.A.	379.0	5.27%
SAN ISIDRO S.A.	370.0	5.15%
IBENER S.A.	124.0	1.73%
ACONCAGUA S.A.	97.9	1.36%
PETROPOWER S.A.	48.6	0.68%
PILMAIQUEN S.A.	39.0	0.54%
PULLINQUE S.A.	48.6	0.68%
H.G. VIEJA Y M. VALPO.	39.3	0.55%
OTRAS	82.8	1.15%
Total Installed Capacity	**7,186.9**	**100.00%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Black liquor steam	53.0	0.74%
Steam Coal	937.7	13.05%
gas-diesel	91.3	1.27%
gas-IFO 180	64.2	0.89%
Single cycle natural gas	727.9	10.13%
Wood	96.4	1.34%
Combined cycle natural gas	1,119.0	15.57%
Petroleum Derivatives	48.6	0.68%
Run of River Hydro	1,295.4	18.02%
Reservoir Hydro	2,753.4	38.31%
Total Installed Capacity	**7,186.9**	**100.00%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Thermal	3,138.1	43.66%
Hydro	4,048.8	56.34%
Total Installed Capacity	**7,186.9**	**100.00%**

Source: www.cne.cl

Table 2C: Total Installed Capacity by type and company
Aysen System (December 2003):

Operating Company	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
EDELAYSEN S.A.	33.91	100.0%
Total Installed Capacity	**33.91**	**100.0%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Hydro	17.0	50.1%
Diesel	11.0	32.3%
IFO	4.0	11.8%
Wind	2.0	5.8%
Total Installed Capacity	**33.9**	**100.0%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Thermal	15.0	44.1%
Renewables	2.0	5.8%
Hydro	17.0	50.1%
Total Installed Capacity	**33.9**	**100.0%**

Source: www.cne.cl

Table 2D:Total Installed Capacity by type and company
Magellanes System:

Operating Company	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
EDELMAG S.A.	78.4	100.0%
Total Installed Capacity	**78.4**	**100.0%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Natural Gas	67.7	86.4%
Diesel	10.7	13.6%
Total Installed Capacity	**78.4**	**100.0%**

Type of Plant	Gross Installed Capacity [MW]	Gross Installed Capacity [%]
Thermal	78.4	100.0%
Hydro	0.0	0.0%
Total Installed Capacity	**78.4**	**100.0%**

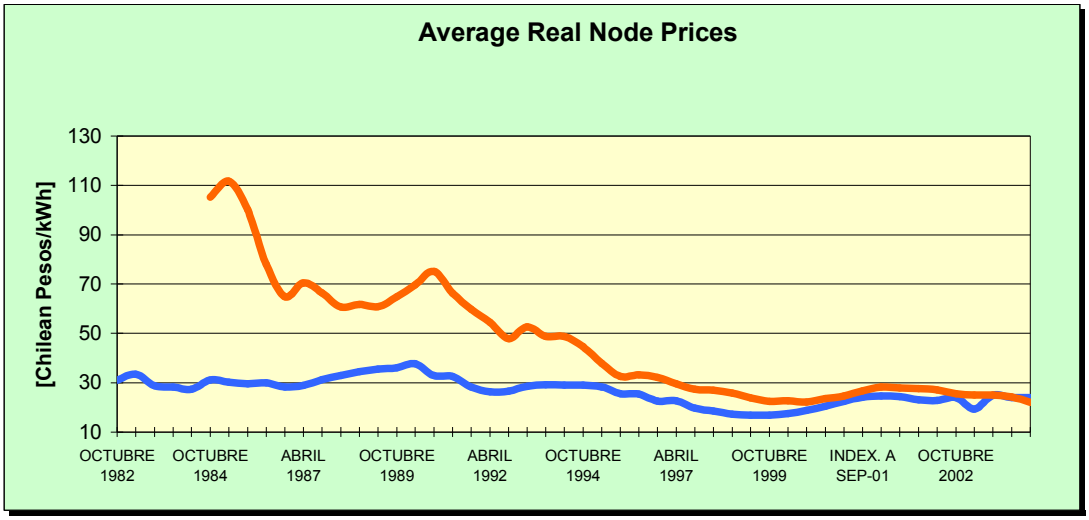
Source: www.cne.cl

Table 3: Distribution System Characteristics at 31st December 2001

Company		Region of Distribution	Regulated Customers	Purchases	Sales
	Name		at 31.12.01	KWH	KWH
01	EMELARI	I	53,812	190,802,694	183,300,239
02	ELIQSA	I	60,446	311,429,843	290,504,072
03	ELECDA	II	117,725	537,441,480	493,794,948
04	EMELAT	III	70,785	421,558,731	369,199,738
05	EMEC	IV y V	199,917	687,945,793	666,792,419
06	CHILQUINTA	V	405,573	1,720,973,928	1,599,174,955
07	CONAFE	V y VII	138,818	683,176,000	641,390,791
08	EMELCA	V	4,205	10,391,361	9,158,952
09	LITORAL	V	35,213	57,256,249	50,057,377
10	CHILECTRA	RM	1,274,410	9,832,331,843	9,255,646,782
11	RÍO MAIPO	RM	294,156	1,329,868,807	1,238,489,849
12	COLINA	RM	14,151	37,628,340	34,592,995
13	TIL-TIL	RM	2,616	7,368,432	6,693,939
14	EEPA	RM	34,600	156,416,303	151,838,598
15	LUZ ANDES	RM	1,489	5,185,908	5,660,852
16	SEP	RM	3,386	24,649,467	22,691,367
17	EMELECTRIC	RM, VI y VII	178,976	715,056,432	619,727,670
18	CGE	RM, VI, VII, VIII y IX	629,930	3,182,524,417	2,923,723,267
19	EMELPAR	I	s/i	s/i	s/i
21	COOPELAN	VIII	8,426	39,649,505	33,002,112
22	FRONTEL	VIII y IX	219,328	512,989,094	443,310,347
23	SAESA	IX y X	238,715	1,225,442,141	1,112,950,326
24	EDELAYSEN	XI	20,188	74,724,950	67,966,877
25	EDELMAG	XII	45,801	164,993,873	156,012,613
26	CODINER	VIII y IX	7,890	35,413,384	30,724,725
27	ELECOOP	IV	8,790	33,693,932	28,075,859
28	EDECSA	V	2,489	25,735,552	23,129,440
29	CEC	VII	6,057	55,316,934	49,724,206
30	EMETAL	VII	14,692	52,742,358	44,447,255
31	LUZLINARES	VII	15,854	54,138,449	49,776,783
32	LUZPARRAL	VII	12,276	31,693,047	27,566,971
33	COPELEC	VIII	28,252	82,291,492	71,783,826
34	COELCHA	VIII	7,891	20,523,753	17,306,967
35	SOCOEPA	X	3,818	20,027,734	16,946,184
36	COOPREL	X	4,542	19,444,752	15,521,740
39	CREO	X	12,549	95,283,841	85,870,905
TOTAL			**4,177,766**	**22,456,110,819**	**20,836,555,946**

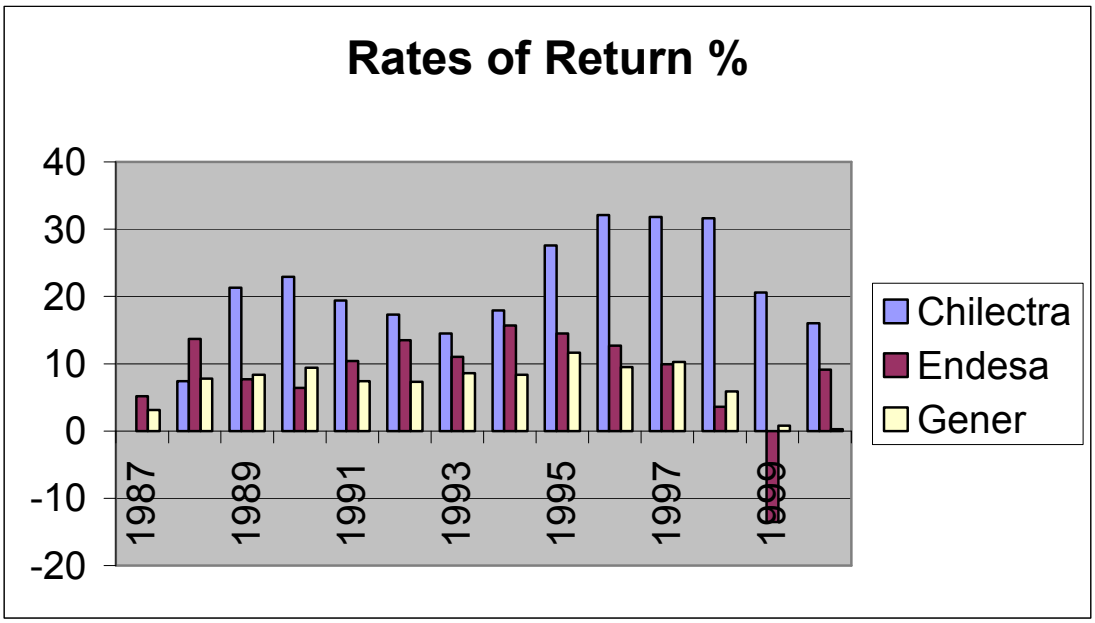
Source: www.cne.cl

Figure 1: Average Node Prices in the SIC (blue line) and SING (brown line) systems January 2004 Prices



Source: www.cne.cl

Figure 2: Financial Performance of leading companies (historic cost rate of return on equity) (not available for Chilectra in 1987)



Source: Fischer, Gutierrez and Serra (2003, p.44).

Figure 3: Labour Productivity since Privatisation in leading companies

Source: Fischer, Gutierrez and Serra (2003, p.42-43) and Annual Reports.

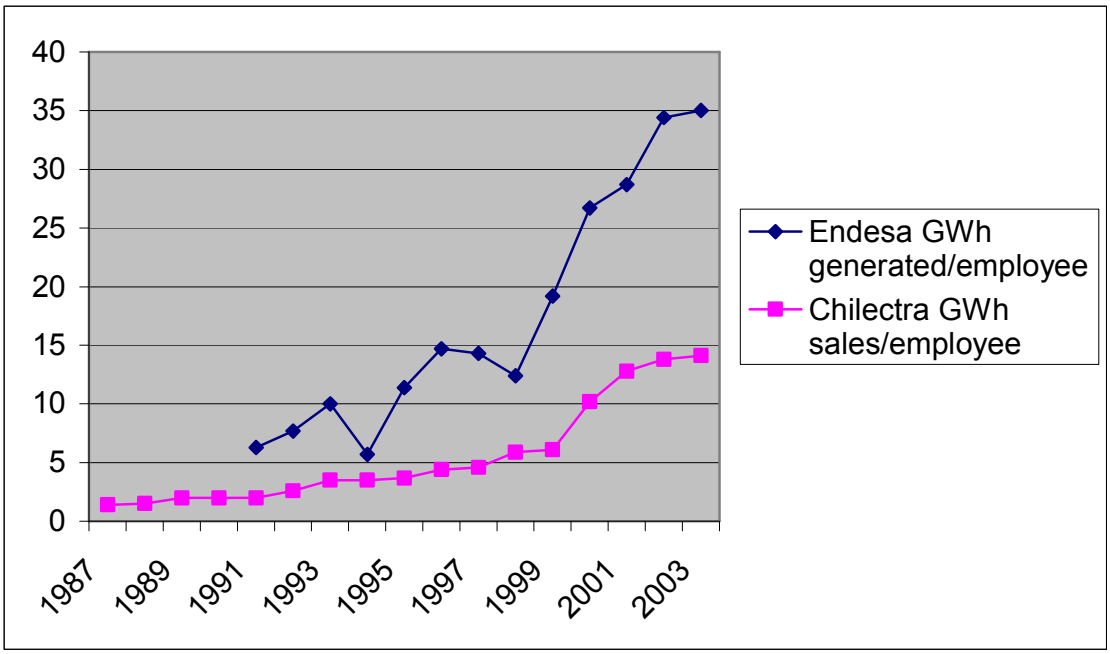
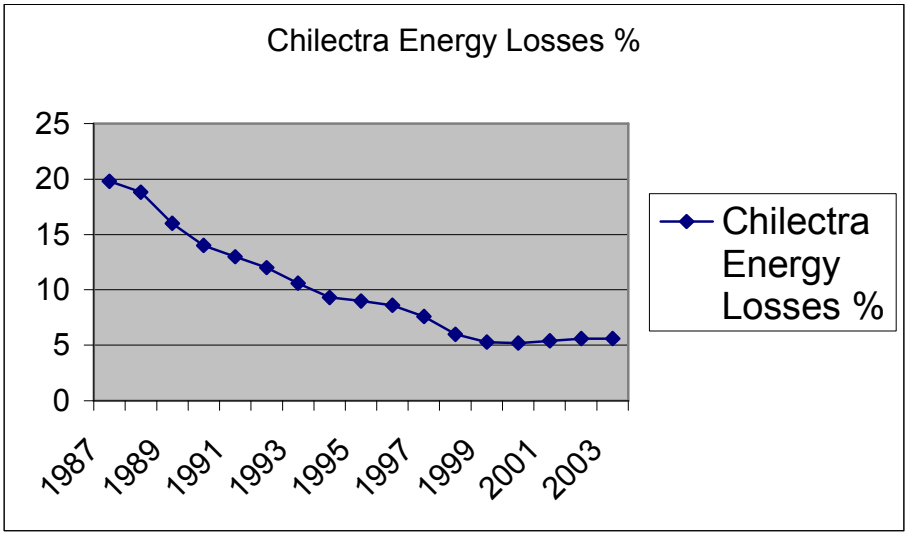


Figure 4: Quality of Supply: Energy Losses (Technical and Non-Technical)



Source: Fischer, Gutierrez and Serra (2003, p.42) and Chilectra Annual Reports.