Chile's national electricity company (ENDESA): a successful case of state-led national electrification, *c.* 1936-1981*

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Introduction

There is no doubt of the importance of electricity, a general purpose technology, for economic development: the world electric power system has been regarded as the most impressive construction project of the twentieth century, due to its social and industrial impact.[1] Yet, in around 1930, per capita electricity consumption in Latin America was far below that of developed countries, although electricity was adopted early in the region, including in Chile.[2] Santiago de Chile adopted a public electricity distribution system as early as 1883 (just two years after London and New York did so) for public lighting,[3] and there was an electric tramway in operation by 1899.[4] Mining and industrial firms were also quick to make electricity their main source of energy. Coal, copper and nitrate companies in particular were responsible for building most of the earliest electricity infrastructure in the country, and it

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1. Hughes (1993); Neufeld (2016). See also Rosenberg (1998); Smil (2005); Yáñez (2020); Bertoni (2010).
2. Tafunell (2011).
3. Artificial lighting spearheaded the worldwide development of the electric utility industry. Neufeld (2016).
4. In neighbouring countries such as Argentina and Uruguay (from 1887), public lighting and tramways were amongst the earliest utilities to depend on electricity. Lanciotti and Bartolomé (2013); Bartolomé and Lanciotti (2015); Bertoni (2010).

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was largely foreign companies that pioneered the introduction of technology to this sector.[5]

Yet, the per capita consumption of electricity for government, firms and households stagnated during the first decades of the twentieth century.[6] By the 1920s, the country had experienced several electricity crises, with electricity supply falling far behind demand.[7] There was a clear sense that the country needed to increase its electricity generation, which in 1930 was below 1000 million kWh, less than a tenth of the level eventually achieved in the late 1970s. A comprehensive national electrification plan was needed, which would considerably increase Chilean living standards and overall economic growth. It would also foster the industrial sector, which by the late 1930s was regarded as a key element of the very dominant import substitution industrialization strategy followed by most Latin American countries after the 1929 Great Depression.[8]

Despite this electricity shortage, within Latin America Chile did not do badly: only Cuba had a higher electricity per capita consumption than Chile in 1930, although it was still well behind that of leading northern European countries.[9] By the late 1930s, 63% of the electricity capacity installed in Chile was thermal (table 1), despite its rich vein of water-related resources and being less rich in fossil fuels (except for some coal deposits).[10]

Yet today Latin America is a world leader in hydroelectricity generation and consumption, the latter more than doubling every decade from the 1940s to the 1970s.[11] While a scholarly narrative has been constructed to account for this change in the region,[12] its significance for business history remains underexplored for some countries, in particular if compared to developed nations.[13]

5. Initially, these were thermal plants that relied on coal, which was increasingly replaced by oil (Garrido 2018). Chile's case confirms the important initial role played by foreign investment and multinationals in the electric power industry. Ferreira Da Silva and Bartolomé (2019); Hausman et al. (2008). Many of these copper and nitrate self-producers were US and British multinationals.

6. Tafunell (2011); Rubio and Tafunell (2014).

7. Only 20% of electricity produced nationally was destined for public service. Yáñez (2018). A report by CEPAL (1961) estimated that Chile suffered shortages of electricity before the 1950s.

8. Badia-Miró and Ducoing (2015); Muñoz (1968); Ducoing and Badia-Miró (2013); Nazer et al. (2009).

9. Tafunell (2011).

10. Uruguay's case was similar to that of Chile: it lacked oil and coal deposits. Bertoni (2010).

11. Rubio and Tafunell (2014); Varas et al. (2013).

12. Rubio and Tafunell (2014); Varas et al. (2013); Bértola and Ocampo (2012); Bulmer-Thomas (2014).

13. For example, the electric utility industry has been very well covered for the USA, UK, Germany and Spain. See in particular Hausman et al. (2008); Hughes (1983); Lagendijk (2009); Millward (2005); Bartolomé (2007); Bartolomé and Lanciotti (2015).

However, there are important works of business history relating to Argentina and Uruguay, as well as southern European countries.[14]

Hydroelectricity was first developed by a group of northern countries (together with Switzerland and Italy), and from there it expanded to other regions of the world. Yet many important questions have remained unanswered for underexplored cases such as that of Chile.[15] We know that hydropower plants require serious capital investment,[16] which Latin America has traditionally been unable to provide. How can this increase in hydropower generation be accounted for? This question is particularly relevant to Chile, as hydroelectricity started to gather momentum soon after WW2, when there was a notorious shortage of capital both at home and in the international markets. Even earlier, an engineer close to the existing private electricity companies in the mid-1930s recognised that the lack of capital was the main obstacle to be overcome for the expansion of the sector.[17] Other important questions to be answered are: which were the main companies that made this dramatic increase in hydropower generation possible? What was the role played by private companies (foreign and national) and by the public sector? What strategic decisions did they make? What was the involvement of foreign companies and foreign lenders? The existing historiography fails to provide comprehensive answers for the Chilean case, although it has been acknowledged that each Latin American republic went through different processes of electrification and had a different level of foreign involvements,[18] which makes the study of specific cases (such as Chile) even more important.

The aim of this article is to answer some of these questions and in so doing to show how Chile, a backward economy, increased its hydroelectricity generation and consumption from the 1930s to the early 1980s, reaching all sectors of the economy, including industry. The analysis ends in 1981, because that year there was a radical change in the industry (i.e., privatisation). Before then, hydroelectricity generation, which had started in the country during the late nineteenth century, was mainly confined to supplying some nitrate and copper mining operations.[19] By the end of our period of study, most sectors of the economy had made hydroelectricity their preferred energy source: over 55% of the installed capacity of the country was provided for by hydropower stations.[20] The country quadrupled its hydroelectric capacity in three decades

14. Bartolomé and Lanciotti (2015); Bertoni et al. (2009); Lanciotti (2008); Lanciotti and Saez 2014.
15. Madureira (2008); Hausman et al. (2008).
16. Neufeld (2016); Joskow and Schmalensee (1983).
17. Cox (1937).
18. Hausman et al. (2008).
19. Rubio and Tafunell (2014).
20. This gradual change of power mix is normal, not radical, for most countries. Hausman et al. (2008).

despite significant political instability, although this process was only completed because of the complete absence of security and environmental concerns and political opposition to this project in particular.[21] This is a peculiarity of the Chilean case, since the electricity industry has generated political and social controversies in most countries.[22] In contrast to the 1940s-1970s, in 2017, after many years of lawsuits, the largest ever hydroelectricity project in Chilean history, HydroAysén, had to be cancelled by ENDESA and Colbún due to popular opposition: it would have increased Chilean installed electricity capacity by around 20%. Yet, it might never materialise.[23]

Chile's improvements in electrification from the late 1930s to the early 1980s, beyond mining (where self-producers were more important),[24] were mainly due to the creation of a large state company: ENDESA, part and parcel of the successful implementation of a national electricity plan, drawn up and executed by the state, and largely based on hydropower generation.[25] This is not surprising, as after the Great Depression of 1929 there was a profound change in the electric power industry: it deglobalised, and national states became stronger (or had a monopoly) within their electricity systems.[26]

In Chile, a new electricity system was made entirely anew, in parallel with the previously existing infrastructures: centralised interconnection based on hydroelectricity. Comparable developments were also seen in other Latin American countries, such as Argentina and Uruguay,[27] as well as in southern European countries such as Portugal,[28] reflecting the fact that the electricity sector had been affected by public policies in most countries.[29]

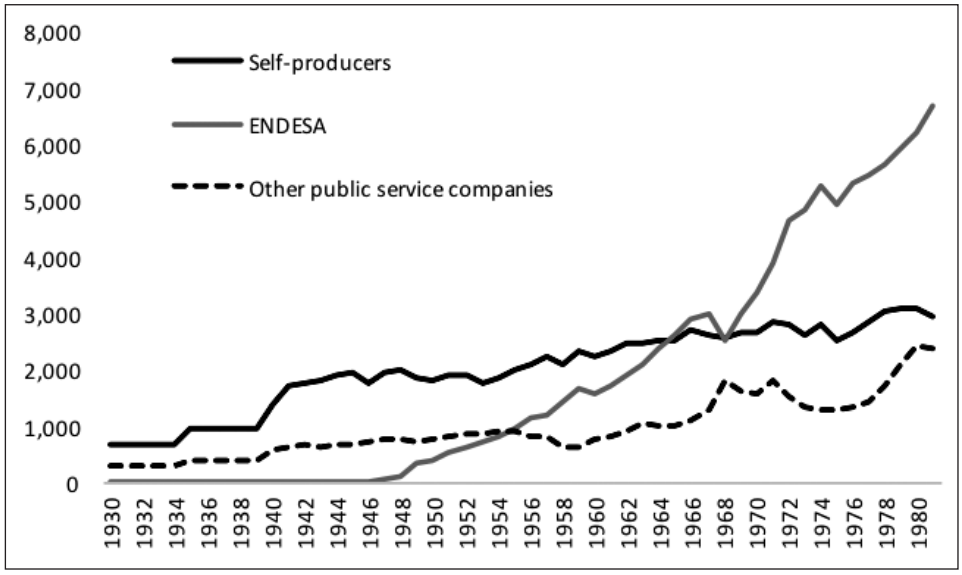
Yet in some countries where the power sector was in a poor state, as it was in the 1930s in Chile, and given the sizeable investment requirements this sector imposes on national budgets, some governments looked to rather small pri-

21. Nelson (2013); Varas et al. (2013).
22. Neufeld (2016).
23. https://www.nationalgeographic.com/news/energy/2014/06/140610-chile-hidroaysen-dam-patagonia-energy-environment/
24. Both in mining and manufacturing, it was fairly common that producers built their own power stations and power lines. Madureira (2008). In Chile's case, copper miners built thermal rather than hydro plants. CEPAL (1961); IBRD (1959).
25. The active presence of the state in the Chilean case is in line with the so-called Gerschenkron rule, which states that the less advantageous an economic situation, the more intense will be the state intervention to improve it. Madureira (2008).
26. Ferreira Da Silva and Bartolomé (2019).
27. In Argentina a National Electrification Plan was launched, which gave priority to the development of hydroelectric plants over thermo-electrical ones. Bartolomé and Lanciotti (2015); Lanciotti and Saes (2014). In Uruguay, the first hydroelectric plant started operations in 1945. Bertoni (2010).
28. Yet, Portugal adopted a joint venture model, financed by public and private capital. Madureira (2008).
29. Neufeld (2016).

vate companies to solve the power shortage.[30] That did not happen in Chile: from the presidency of Pedro Aguirre Cerda, marking the first of five continuous terms of office of the Radical Party, through to a conservative president, a Christian Democrat, a Socialist, and a right-wing dictator, ENDESA was universally accepted as the best solution to the electricity shortage in the country. Until 1981, when the company started an irreversible process of privatisation.

Although it was still in public hands, ENDESA managed to account for over 60% of the installed electricity capacity of the country, and over 55% of electricity generation, thus becoming the leading electricity company in the country (chart 1). Its dominance in hydropower generation was even more impressive: it controlled over 80% of the installed capacity for hydroelectricity (chart 2). There was a conscious decision to convert from thermal to hydroelectric, given the cheaper costs of hydropower, while nuclear energy was rejected as a feasible alternative.[31] Hydroelectricity was seen as the principal way of meeting the increasing electricity needs of the country. Thanks to

CHART 1 ▪ *Electricity generation in Chile per producers (million kWh), 1930-1980*

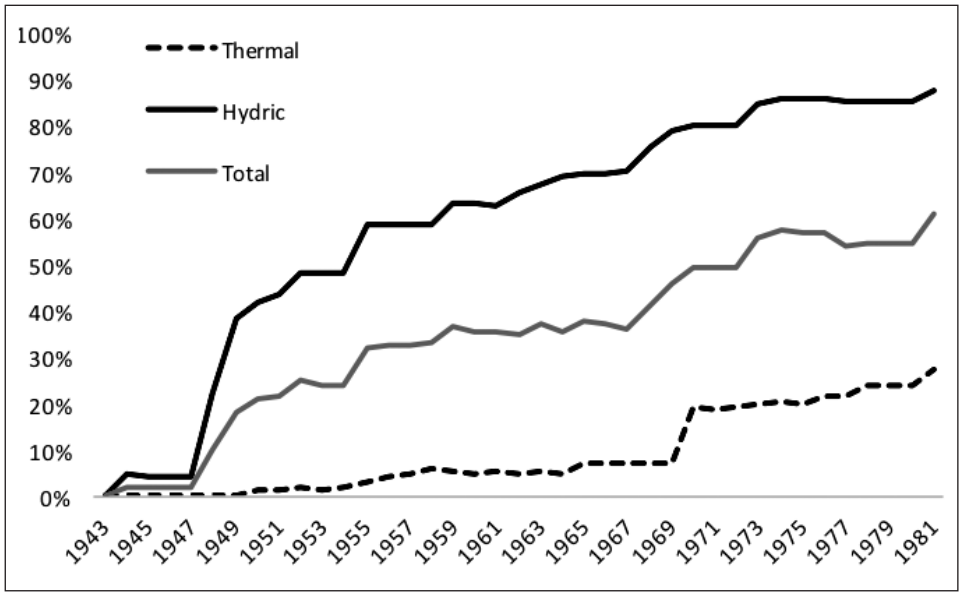


Source: ENDESA (1981).

30. Even in Europe and the USA, during the late nineteenth century and early twentieth century, electricity was characterised as a largely local affair, involving municipalities and small companies. Millward (2005); Madureira (2008); Neufeld (2016). That said, in several countries the electricity supply industry was eventually nationalised. Millward (2005).

31. Sullivan (1990).

CHART 2 ▪ *Share of ENDESA within Chile's total installed electricity capacity per electricity category (percentage), 1930-1980*



Source: ENDESA (1981).

these pioneers, by 1975, 85% of Chilean families had electricity in their homes, and many lives were changed for the better.[32]

Our main sources of information are all the Annual Financial Reports of ENDESA, from 1943 to the early 1980s, internal documents produced by the company, other contemporary reports (e.g. IBRD), and relevant secondary works. The article is divided into four more sections. We start by explaining how and when the first national electrification plan was launched. The next section deals with the creation of ENDESA, as well as with its structure and organization. We then turn our attention to ENDESA's implementation of the electrification plan. This is followed by an explanation of how the capital to fund this plan was raised, before concluding.

Birth of the state-led national electrification plan, 1936-1942

At the beginning of the 1930s, despite the insufficient market supply, the Chilean national electric system had reached an important stage of development, led by private companies. There were around 90 electricity companies

32. ENDESA (1977).

in Chile, which supplied over 100 locations in the country.[33] Yet, there was no state participation in this sector, except in regulation,[34] as was the rule elsewhere: electric utilities have barely ever operated within free competitive markets.[35] Most of the country's electric power had been developed by self-producers, and accounted for 61% of the installed electrical capacity of the country (table 1). These self-producers were mainly large mining and industrial companies,[36] which consumed sizeable quantities of energy, leaving only small surpluses to sell to public service companies.[37]

TABLE 1 ▪ *Installed electricity capacity in Chile, 1930-1939 (MW, annual averages per quinquennial)*

Year	Self-producers			Public Service Companies			Total		
	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total
1930-1934	126.5	34.3	160.8	55.2	86.0	141.2	181.7	120.3	302.0
1935-1939	174.9	49.4	224.3	56.8	86.8	143.6	231.7	136.2	367.9
Year	**Shares within each sort of company**								
1930-1934	79%	21%	100%	39%	61%	100%	60%	40%	100%
1935-1939	78%	22%	100%	40%	60%	100%	63%	37%	100%
Year	**Shares per sort of energy**								
1930-1934	70%	29%	53%	30%	71%	47%			
1935-1939	75%	36%	61%	25%	64%	39%			

Source: ENDESA (1960).

These latter companies had been in development from the late nineteenth century and first decades of the twentieth century, the most important of them being the *Compañía Chilena de Electricidad*. It was known as CHILECTRA, having been established in 1921,[38] and owned by the US South American Pow-

33. ENDESA (1993).
34. Yáñez (2018).
35. Neufeld (2016).
36. Lota's Coal Company was the first to build its own hydropower station. ENDESA (1993).
37. For most of the period covered by the study, mining was the principal consumer of electricity. ENDESA (1977); Garrido (2018).
38. For CHILECTRA's activities in the period before that covered by this article, see Hausman et al. (2008).

er Co. (Sapco), which had bought the company from the British Whitehall Securities Corp in 1928. Sapco, in turn, was a subsidiary of the better known American & Foreign Power Company (whose parent company was Electric Bond & Share, which in turn was controlled by General Electric), which had investments in Chile until 1965. American & Foreign Power was the leading force in the US expansion throughout Latin America, having been founded in 1923, with sizeable investments in other countries in the region such as Ecuador, Colombia, Mexico, Cuba, Venezuela, Costa Rica, Brazil and Argentina, to the extent that it was the largest US private equity investor in the entire region during the 1920s-1950s.[39] The US presence in so many Latin American countries confirms the dominance of global firms by the early 1930s in this sector.[40]

CHILECTRA's main business was to supply electricity to the largest cities at that time. Behind CHILECTRA, there were more than 30 small and medium companies. Amongst them, the most important ones were the Chilean *Compañía General de Electricidad Industrial* (CGE),[41] which supplied southern cities, and *Sociedad Austral de Electricidad* (SAESA), which supplied localities even further south. These secondary companies had built small thermal power plants or small hydraulic power stations.[42] They did not produce any surplus for localities far away from the power plants, and could not have done so had they wanted, given the lack of a national electricity transmission system.

The operations of these companies were regulated by the 1925 Electric Services General Law. It contained specific rules regarding concessions and the working of electricity companies, their relations with the state, and selling prices, which were to be fixed by the state, through its Electric Services General Directorate. This was also the norm elsewhere in the world: most electric utilities firms operated as local monopolies, which justified continuous government involvement in the market, in particular via price regulation.[43]

The 1925 law was subsequently modified in 1931, by new legislation that increased the regulating power of the state over these private companies, in relation to setting electricity prices (through a mechanism linked to the immobilized capital of the firms, which was to be revised every five years). The maximum profit rate allowed for the companies was kept at the same level (15%), but companies were entitled to request higher selling prices if profit

39. Lanciotti and Saes (2014); Lanciotti and Bartolomé (2013); Lanciotti (2008).
40. On this, see Ferreira Da Silva and Bartolomé (2019).
41. According to CEPAL (1961), CGE also belonged to American & Foreign Power, although this has been rejected by Nazer et al. (2005), for whom the company belonged to Chilean capitalists only.
42. Instituto de Ingenieros (1988); Castillo (1994); ENDESA (1993); Nazer et. al. (2005).
43. Neufeld (2016). For a theoretical discussion on the level of prices to be charged to consumers, see Joskow and Schmalensee (1983).

margins remained below 10% for three consecutive years.[44] In Uruguay, as in Chile, a law was passed in 1912 regulating the sector, which was dominated by the state between 1912 and 1977 (and became a state monopoly in 1947). The role of private companies was more important from the mid-1880s to 1912, and then from 1977.[45] In contrast, in neighbouring Argentina, before 1943, the state regulated prices only. There were no particular laws for the sector, nor government watchdogs. Yet, after Perón's reforms, special commissions were created to inspect the working of the sector; an Energy National Directorate was created in 1944, and a year later the State Electricity Plants National Directorate.[46]

During the 1930s the electricity companies in Chile were greatly affected by the Great Depression, a situation which was exacerbated by the inflexible state price-fixing policy. Worried about inflation, and trying to boost economic activity, the governments did not readjust electricity prices during this decade, leading to stagnation in the sector's investments. National governments were also aware of the fact that new technologies had been introduced internationally in the industry, which would lower production costs, making it less necessary to increase prices.[47]

The state clashed with CHILECTRA, accusing this private company of bypassing the state's exchange controls and unlawfully taking foreign currency out of the country, which led to the first calls for CHILECTRA's nationalisation.[48] After long negotiations, CHILECTRA and the state reached an agreement: not to punish CHILECTRA. In exchange, though, the state asked CHILECTRA to merge all of its subsidiary companies into a single company (CHILECTRA), of which the state would enjoy two-thirds of the profits (but would allocate 50% of these gains to consumers through lower electricity prices), to appoint a board dominated by Chilean directors, and to build a new plant with a capacity of 22,500 kW.[49] These were harsh conditions, and marked the beginning of nationalisation, eventually achieved during Allende's regime in 1970. The Chilean case was no exception: the structure of the electric utility industry in most countries has been more often than not determined by the legal and regulatory environment imposed by governments.[50]

This conflict and its resolution also epitomised the new role of the state in economic affairs, beyond the electricity sector: a "modern state", with a

44. Seguel (1941).
45. Bertoni (2010).
46. In addition, between 1943 and 1948 many foreign companies were expropriated, in particular from the US. Lanciotti (2008); Bartolomé and Lanciotti (2015).
47. Millward (2005).
48. Nazer et. al. (2005).
49. Castillo (1994).
50. Neufeld (2016).

clear inclination to foster industrial activity and economic nationalism; the beginning of a welfare state (promoting low electricity costs for the bulk of the population); and increasing state regulation through price and profit caps. There were higher expectations of national engineers and other professionals working for the state, who were seen as leaders of profound economic transformations.[51]

Increasing state interventionism in economic affairs gained further momentum due to the negative impact of the Great Depression on the Chilean economy. Chile suffered more than any other Latin American country, and this fact was taken by many as conclusive evidence of the failure of economic liberalism. There was a generalized belief that the market on its own would not solve the problems faced by the economy. The state had to play a more prominent role to solve this market failure. New calls emerged, from central government, professional associations and trade guilds for a national industrialisation process led by the state, either through the implementation of development policies or through the creation of state companies. One of the most ambitious projects was the national electrification plan.[52]

The first antecedent of this project is to be found in 1932, when the electrical engineer and professor of Electro-technology at the University of Chile, Reinaldo Harnecker, invited a selected group of engineers to study the so-called "national electricity problem". They acknowledged the important role played by the private sector in creating an electricity sector in Chile, but at the same time they were convinced that the private sector was unable to take the power sector to the next stage demanded by the country, mainly due to the lack of investment capital.[53] The first results of the diagnosis and recommendations of this group of Chilean engineers were published in a dossier titled *Chilean Electricity Policy*.[54]

Their main conclusions can be summarised as follows. First, electric power was regarded as fundamental to the economic development of Chile, to service an urgent public need, and which had to be taken as a means of development rather than as a commercial enterprise: electricity had to be supplied at the lowest possible price. Second, it was estimated that national electricity consumption was too low, and that the installed power capacity was both low and stagnant, so that electricity supply must precede electricity demand. Third, the country was rich in water and thermic recourses, which had

51. Ibáñez (1994).
52. Yánez (2018).
53. Harnecker (1937).
54. Instituto de Ingenieros (1936). By this stage the Chilean Institute of Engineers, created in 1888, was a highly respected professional body, influential in economic affairs. Ibáñez (1983).

to be put at the service of a general electrification plan, funded by public funds and to be developed by an autonomous state institution.[55]

Unsurprisingly, the Institute of Engineers gave its full support to the proposal and, in the same publication, strongly recommended that the state take forward these recommendations. The Institute argued that electricity ought to be regarded as a means to improve the welfare of the population rather than as an ordinary business seeking to increase capitalists' profits. Electricity was perceived as an immediate basic need, at the same level as drinking water or sewage systems. The Institute backed the idea of creating an autonomous state institution to take forward the plan, which had to be technical and centralized, but wanted to limit its actions to electricity generation, interconnection, transmission, and the distribution of primary electricity power,[56] leaving in private hands the distribution of this energy to final consumers. The state, though, was to regulate and fix consumer prices.[57] Further publications by the Institute provided additional support, such as that of Aldunate (1937). Finally, the influential Harnecker declared that private enterprises were incapable of solving the electricity shortage in the country.[58]

As was to be expected, some private electricity companies immediately reacted against these ideas. In January 1936, the president of the Electricity Companies Association, Agustín Huneeus, argued that the installed energy power stagnation was a transitory problem, and that it was unfair to blame it on the excessive profits of private companies. On the contrary, the main issue was the low electricity prices paid by final consumers, which made it impossible for private companies to finance new investment projects.[59] A few months later, Guillermo Cox Lira, director of Compañía General de Electricidad Industrial, CGEI, argued that it was unfair to talk about the notion of a "national electricity problem", advocating for state support rather than such a direct state intervention.[60] This seems plausible inasmuch as the international industry had introduced new technologies that cheapened production costs.[61]

This debate, though, was settled after the presidential election victory of the centre-left coalition Popular Front, in 1938. It paved the way for a direct and strong intervention of the state in economic affairs, not only due to ideological reasons, but also as a consequence of the damage produced by the 1939 Chillán earthquake, the deadliest in Chilean history, and to a lesser extent the beginning of WW2. The combination of these three elements provid-

55. Instituto de Ingenieros (1936); Yáñez (2018).
56. The benefits of interconnected supply systems, within countries, had become a key technological reason for government involvement in the electricity sector. Millward (2005).
57. Instituto de Ingenieros (1936).
58. Harnecker (1937).
59. Huneeus (1936).
60. Cox (1937).
61. Ferreira Da Silva and Bartolomé (2019); Hausman et al. (2008).

ed further stimulus for the emergence of an entrepreneurial state, the proliferation of policies aiming for industrialisation via import substitution, and strong state regulation of economic activities.[62]

A key institution within this process was the *Corporación de Fomento y Reconstrucción* (better known as CORFO), the Chilean development corporation[63] or development bank,[64] which was created the same year of the Chillán earthquake, and supported by all political sectors, being conceived as a powerful autonomous fiscal organization. It started to implement many policies to promote the development of the country, including "plans of immediate action".[65] One of these was the plan to promote electric power generation. It was produced by its recently created Department of Energy and Fuels, under the direction of the engineer Guillermo Moore, and its Technical Office (electricity section) was led by another electric engineer, the well-known Harnecker. Amongst the main collaborators were some young engineers, such as Raúl Sáez, Raúl Herrera, and Pablo Pérez Zañartu.[66]

The argument of the plan to promote new electric power generation was that national demand was higher than local supply, meaning that the Chilean economy was unable to reach its full potential. To improve this situation, a proposal was made to create several electricity companies, with funding provided mainly by CORFO, although private capital was also welcomed. These CORFO companies were to build nine hydroelectric plants in the centre and south of the country, with a combined capacity of 109,000 kW, thus increasing by 53% the national installed energy capacity.[67]

In line with the objectives of the plan, the first measures adopted by Pedro Aguirre Cerda's government were aimed at supplying electricity to northern zones, which were poorly supplied. CORFO provided support to existing local private electricity companies, by building small thermal power stations. In collaboration with the private sector, CORFO started to produce the first hydroelectric network of power plants. Yet these were short-term emergency actions only.

In a parallel effort led by Harnecker, CORFO's electricity engineers worked hard to come up with a "National Electrification Plan" (NEP), to be developed over the long term. It was eventually approved by CORFO's council in 1943, thus replacing CORFO's previous plan of 1939. It explicitly stated that CORFO was to take the necessary actions to ensure the study, construction, and exploitation of the installations needed to gener-

62. Nazer et. al. (2009).
63. Mamalakis (1969).
64. Sullivan (1990).
65. Mamalakis (1969).
66. CORFO (1939).
67. CORFO (1939).

ate and distribute the electricity needed by the country. It also stated that national private firms did not have enough capital to implement this plant, while it was highly inconvenient to leave it to foreign companies. The NEP had to be implemented by a technical state institution, which would be strong financially, and free from any undue influence of any interest group.[68] This institution became ENDESA, launched as a public joint stock company, created in 1943 (but operating de facto from 1939), designed to implement the NEP, and to avoid the bureaucratic constraints of a typical state institution, and it was to be fully controlled by CORFO.[69] Paradoxically, despite this declared conflict between economic nationalism and foreign capital, ENDESA's plan would rely heavily on foreign capital. Hausman et al. (2008) have correctly acknowledged that although multinationals ceased to operate in the electricity sector of many countries, foreign capital remained an important source of finance.

The NEP did not face major political opposition. There are many reasons for this. The NEP emerged from CORFO, and although CORFO was a public institution, it had the support of the private sector and of the interest-group associations (business guilds) that were so influential in the country: Sociedad Nacional de Agricultura (SNA), Sociedad de Fomento Fabril (SOFOFA), and Sociedad Nacional de Minería (SONAMI). Indeed, the presidents of these associations sat on CORFO's board.[70] Likewise, CGE, the most important private electricity company in the country, subscribed shares of ENDESA, also appointing a member to ENDESA's board, and subscribing mutual cooperation agreements.[71]

This is not surprising, since ENDESA was to play an important role in the working of many private companies, in particular in the industrial and mining sectors, which were increasingly making ENDESA's hydroelectricity their main source of energy, rather than that coming from their own oil's thermal plants. ENDESA played a key role in the process of industrialisation led by the state.[72] One of the principal financers of ENDESA was aware of this: a 1972 report by the IBRD stated that the first ever power loan extended by the IBRD was made to ENDESA because, "traditionally the Bank stressed the productive nature of such projects, related to the fact that a relatively large proportion of public utility electricity supply in developing regions generally goes to meet the needs of industry".[73] In 1939 the initial plan for the creation

68. ENDESA (1956).
69. ENDESA (1956).
70. Nazer (2016); Muñoz (2018).
71. Nazer and Camus (2005).
72. IBRD (1959, p. 5); Garrido (2018).
73. IBRD (1972, p. 3). Another report of the World Bank's (1976, pp. 16-17) made it clear that most of Chile's industry relied to a great extent on ENDESA's electricity supply.

of CORFO made it clear that one of the main obstacles to Chilean industrial development was the lack of electric power.[74]

The creation of ENDESA: structure and organization, 1943-1980

ENDESA was initially established as a joint stock company with a social capital of $500 million (Chilean pesos of 1943), divided in ordinary shares: series A and series B. The first group, accounting for $450 million, was subscribed to by CORFO. The second group, comprising the remaining $50 million, could be sold to private individuals, to CORFO itself, or to any other public institution. The Board was to be composed of seven directors. The directors related to CORFO were to be appointed by the government.[75]

The organizational structure of the company included general management, and deputy technical management, which oversaw four sections: studies, construction, exploitation, and planning. There was also a deputy administrative management, overseeing the divisions of accountancy, procurement, staff and control of materials; and a Legal Department. These positions were first filled by the original members of CORFO's Energy Department, who had formulated and started to execute the NEP. Guillermo Moore was appointed CEO; his main duty was to liaise with CORFO, and to obtain funding. Harnecker was made Technical Manager; his main responsibility was to execute the NEP. Other high profile managers were Carlos Claro (Deputy Administrative Manager); Raúl Obrecht (in charge of the Legal Department). In middle ranking positions were younger engineers who later on would be promoted to senior positions: Raúl Sáez, Pablo Pérez Zañartu, Raúl Herrera, and Renato Salazar.[76]

The continuity of this core team was remarkable considering the political instability of the country and the radical regime changes it experienced. The team lasted for nearly three decades, successfully completing the NEP. Moore, for example, remained as CEO for more than a decade, retiring in 1955, and was replaced by Harnecker, who in turn stepped down as CEO in 1961 (but was appointed Director of the Board). His disciple Raúl Sáez took over the presidential baton until 1965, when he was appointed President of the Board. Another of Harnecker's disciples, Renato Salazar, was left as CEO. The Legal Director, Obrecht, remained in his position for over three decades, between

74. Nazer et al. (2009).
75. ENDESA (1943); Concha (1978).
76. ENDESA (1993).

1943 and 1976,[77] epitomising the technical character of ENDESA: he was legal director during centre-left governments, Christian Democratic governments, the socialist Allende regime, and for a few years of the dictatorship. There are few public Chilean companies that could claim this level of staff stability and skills retention.

Where there was less continuity was in the structure of the company, due to the increasing staffing of the firm, an area where ENDESA showed considerable flexibility. By the early 1960s it employed almost 6,000 people, including 1,500 professionals and technicians (of which 240 were engineers), 1,500 permanent workers and 3,000 temporary workers.[78] In 1955, ten large departments were created: urban distribution, operations, HR, engineering, construction, finances, management, social action, legal, and auditing. For each of them a manager was appointed, who reported directly to the CEO. Six years later, these departments were organized around several divisions: construction, operations, finance and procurement, legal advice, and HR. An IBRD (1965, p. 7) report stated that, "this new organization at the top management level is a definite improvement over the former organization".[79] Initially, these divisions were located in around ten different buildings across the city of Santiago. Yet, in 1968 a corporate building was finished, an imposing seventeen-floor tower in the city centre, for all personnel.[80]

The work ethic of ENDESA must also be acknowledged. This was an organization where an idealistic generation of national engineers took forward their ideas of transforming the country, through a modern economic policy, which was nationalistic and led by the state. They were members of an elite, alternating their work at ENDESA with academic lives at the Faculty of Physics and Mathematics of the University of Chile. Most of the several hundred engineers recruited by ENDESA came from the University of Chile.[81]

Implementation of the NEP, 1943-1980

The implementation of the NEP was preceded by an extensive study of the country's geography, climate and hydraulic resources, to facilitate national electrification. Chile has many geographical peculiarities. From north to south the country extends over 4,000 km, but has an average width of around 250 km. This narrow band contains, to the left, the mighty Andes, from where

77. ENDESA (1993).
78. ENDESA (1960-1965).
79. In a report of 1959 (p. 5), the same IBRD stated that, "the management and organization of ENDESA are good".
80. ENDESA (1993).
81. Ibáñez (1983)

many rivers flow towards the Pacific Ocean, in an irregular fashion. The amount of rainfall varies significantly from region to region.[82]

Taking into account these variations, the NEP divided the country into seven electricity regions (unrelated to administrative divisions), according to the type of rivers and other water resources they contained, and therefore their potential for hydroelectricity. In the first stage, each region was intended to operate on its own, isolated from the rest, only supplying that region's localities.[83] In a second stage, the regions would be partially interconnected, with the aim of transferring any surplus from one region to another, although this plan faced some important technological challenges. Finally, in a third stage the second region would be directly connected to the fifth region (numbering from north to south), from La Serena to Puerto Montt, transferring large amounts of electricity. This system required huge installed capacities in the exporting region, as well as powerful transmission lines.[84]

Each of these stages would last six years. They all took into account the building of hydroelectricity plants and large distribution lines, which were designed to transfer electricity in large blocks to distribution companies, industries, and other large consumers. Although ENDESA's original design did not include participating in the distribution of electricity to final consumers, the company did enter this segment of the market from the mid-1950s.[85] In 1970, ENDESA acquired 75% of CHILECTRA, the latter becoming a subsidiary of ENDESA,[86] showing some similarities with the Argentine experience.[87] Between ENDESA and CHILECTRA, these two public companies controlled 98%[88] of the generation and production of public service electricity, with ENDESA serving the whole country while CHILECTRA focussed on Santiago and Valparaiso.[89]

But ENDESA also planned to transfer electricity to consumer cooperatives, and to the agricultural sector to promote irrigation. The NEP considered specifically a plan for mechanical irrigation (for small and medium plots) and another plan for rural electrification. A report by CEPAL (1962, pp. 71-72) praised ENDESA for its work on the construction "of a dam on the river Maule designed to help irrigate the area", as well as for building "an intake tunnel for the waters of Lake Laja on financially unfavourable terms, but with a view to the substantial contribution it would make thereby to the future irrigation

82. ENDESA (1952).
83. On the challenges faced by isolated electricity plants, see Neufeld (2016), and Lanciotti (2008).
84. CORFO (1942).
85. ENDESA (1993).
86. Castillo (1994).
87. Lanciotti and Bartolomé (2013).
88. The remaining 2% belonged to CGEI and CONAFE. ENDESA (1977).
89. ENDESA (1977).

of 200,000 hectares of agricultural land". The second of these plans included technical and financial assistance for the creation of small rural cooperatives, which would be in charge of distributing electricity to local rural communities lacking that service.[90] The experience was so successful that it was highlighted as good practice within Latin America by the same report in the early 1960s. Yet, as for many other countries, rural electrification was a far slower process.[91]

TABLE 2 ▪ *The NEP's electricity regions, their potential and population, 1940-1982*

Electricity region	Population in 1940	Share 1940 (%)	Population in 1982	Share 1982 (%)	Hydro-electricity potential c.1940 (Kw000)	Share	Climate zone
I	249,244	5.0	616,846	5.4	97	0.5%	Desert
II	329,921	6.6	603,363	5.3	225	1.1%	Steppe Desert
III	2,586,955	51.5	6,845,433	60.4	3,917	19.3%	Mediterranean
IV	1,273,678	25.4	2,217,120	19.6	2,555	12.6%	Rainy temperate
V	517,914	10.3	848,699	7.5	2,477	12.2%	Maritime rainy
VI	17,014	0.3	66,361	0.6	10,822	53.3%	Maritime rainy
VII	48,813	1.0	131,914	1.2	213	1.0%	Steppe polar
TOTAL	5,023,539	100	11,329,736	100	20,305	100%	

Source: ENDESA (1981).

Most energy distribution to final consumers was to remain under the control of the private sector (before the nationalisation of CHILECTRA), although ENDESA or CORFO could supply technical or financial assistance to these private companies. Only in those cases where there was no local private distributor would ENDESA have entered into the distribution business to final consumers.[92] The regional distribution of the NEP is shown in table 2, which also includes population and hydraulic potential. By this stage, the share of the industrial GDP within total GDP was around 15% circa 1940, which is a lower rate than that of those Latin American countries that industrialised to a greater extent, such as Argentina, Mexico and Brazil.[93]

90. Technical assistance was also provided by the National Rural Electric Cooperative Association of the USA (NRECA). Labarca (2015).
91. Neufeld (2016).
92. CORFO (1942).
93. This rate increased to 22-23% in the 1970s. Ducoing and Badia-Miró (2013); Badia-Miró and Ducoing (2020).

During the period 1945-1949, mining and industrial establishments accounted for 34% of Chile's total electricity consumption, gradually increasing to 45% in the 1970s and early 1980s. The industrial sector was among the most important beneficiaries of the NEP, since most industrial establishments used electricity as their main source of energy. But the mining sector was also indebted to it.

As a result of the high concentration of the population in the centre of the country, ENDESA decided to build most of the intended hydroelectricity plants between regions II and V, where more than 90% of the national population lived. Although region VI accounted for more than half of the national hydroelectricity potential, it was isolated and underpopulated. It also lacked the proper infrastructure which would make the exploitation of its hydroelectricity potential viable. The population of the extreme regions (I and VII), was small, and concentrated in the main trading ports, which made thermal plants the best solution to supply their electricity demands.

To implement the NEP, ENDESA needed an army of well-trained professionals and the leading technologies of the time. The Faculty of Physics and Mathematics at the University of Chile had a long tradition of training civil and electrical engineers, and was the main source of qualified labour for ENDESA. The company was also active in sending its engineers abroad to receive specialised training, in particular to the USA, where they were well received by the government and electricity companies, and shown how to operate newly purchased equipment.[94] From the 1960s, many of ENDESA's engineers and technical staff received training in leading European countries too.[95] They were also supported by foreign consultants. A report by the IBRD (1959, p. 25) concluded that, "the management of ENDESA is good. Its engineering staff, with the assistance of the consultants already retained, is well qualified to execute the projects".

Hydropower frontier technologies were initially supplied by US electrical companies, from the 1940s to the 1950s. From the 1960s, they started to arrive from Germany and Italy as well.[96] Inputs were also supplied by local industries, many of which emerged in response to the demand created by ENDESA. For example, the iconic MADECO was created in 1944, to produce copper cables (amongst other copper products) for the electricity sector. Likewise, FANALOZA, which already existed as a bathroom fixtures manufacturer, specialised in the production of electricity insulators.[97]

94. The importance of a new generation of national engineers was also relevant to Portugal and Italy during the 1940s and 1920s-1930s, respectively. Madureira (2008); Storaci and Tattara (1998).
95. ENDESA (1993).
96. ENDESA (1943-1980).
97. ENDESA (1993).

The core of the implementation of the NEP consisted in making the most of the water resources of the country, subject to both the population and the transmission technology available. From 1943 to 1981, ENDESA managed to build 13 hydropower plants, with a combined power capacity of 1.25 million kW, with (up to that year) another three under construction, which were finished later, adding an extra power capacity of 790,000 kW (table 3).

TABLE 3 ▪ *ENDESA's hydropower plants, 1943-1980*

Hydropower station	Period	Power capacity kW	Electricity Zone
Pilmaiquén	1944-1959	35,040	V
Sauzal	1948	76,800	III
Abanico	1948-1959	136,000	IV
Los Molles	1952	16,000	II
Cipreses	1955	101,400	III
Antofagasta	1959	1,500	I
Sauzalito	1959	9,500	III
Puerto Aysén	1962	2,000	VI
Pullinque	1962	48,000	V
Isla	1962-1963	68,000	III
Chapiquiña	1967	10,200	I
Rapel	1968-1970	350,000	III
El Toro	1973-1974	400,000	IV
Total 1980		**1,254,440**	
Under construction			
Antuco	1981	300,000	IV
Colbún	1985	400,000	III
Machicura	1985	90,000	III
Total 1980		**790,000**	

Source: ENDESA (1981).

The first stage of the NEP was implemented between 1943 and 1955. It consisted of building hydropower stations in all regions, except for the seventh. The first plant was Pilmaiquén in Osorno (in the southern part of the country), which started operations in 1944. It distributed electricity between Valdivia and Puerto Montt, fully integrating the fifth electrical region. Next came Sauzal (near Rancagua, on the Cachapoal river), which started to generate electricity from 1948, and was finished in 1955. It supplied localities between Santiago and Curicó, integrating them into CHILECTRA's distribution system, making up the third electrical region. In order to prevent any

shortage of demand in the near future, the Abanico plant (in the Laja river, near Concepcion), also started operations from 1948. It was intended to supply Concepción and nearby localities of the fourth electrical region. Los Molles plant was finished in 1952, supplying Illapel, Ovalle, La Serena, Coquimbo and Andacollo, part of the second electrical region.[98]

The second stage of the NEP (1955-1968) encompassed the development of the Central Interconnected System (SIC, in Spanish), connecting the electrical systems of regions II, III, IV and V. The beginning of Cipreses' operations in 1955 signalled the start of the SIC: this power plant (on the eponymous river, near Linares) became linked to Santiago, connecting 765 km of the network in the third and fourth regions. To support this project, Abanico plant's capacity was enhanced, while Sauzalito was also built in 1959, near Rancagua. A year later, the SIC expanded northward, connecting with region two, and in 1963, following the inauguration of Pullinque plant (near Panguipulli), the fifth region was also integrated into the SIC. The same year, to further support the network, the Isla plant (near Curicó) begun operations. Thus, the objective to connect all regions from the second to the fifth was achieved, from Illapel to Puerto Montt, covering a distance of over 1,000 km, although with some limitations regarding transmission.[99] Despite these shortcomings, the end of stage 2 was a landmark. A report by CEPAL (1961, p. 85) highlighted Chile, together with Uruguay, as the leading "Latin American countries as regards the degree to which their electricity systems are integrated".

The third, and last, stage of the NEP (1968-1985), consisting of large new generation projects and a sounder transmission system, was designed to optimize the water resources of the country.[100] Rapel, not far from Santiago (built in 1968-1970), was the largest plant built at that time (160% larger than the previous contender), increasing the installed capacity of the country by nearly 70%. It linked Santiago with more powerful transmission cables (220 kV) than it had previously used. This is important because it has been noted that it was precisely the ability to transmit electricity over long distances that made the expanding use of electricity worldwide decisive.[101] Next came El Toro (built 1973-1974), near Los Angeles, the largest plant in the history of Chilean hydropower. Between these two mega plants, the installed capacity of ENDESA increased by 150%, with all the plants connected to the SIC with 220 kV cables. This development signalled an important stage in the modernisation of the transmission system in the country. The dream of the engineers

98. Instituto de Ingenieros (1988).
99. Instituto de Ingenieros (1988).
100. Larger plants have been associated with technical efficiency and, therefore, lower production costs. Millward (2005).
101. Millward (2005).

that drew the first electrification plan in 1936 was nearly fully achieved, and completely achieved by the mid-1980s.[102]

In order to bolster the SIC, many complementary projects were undertaken, in addition to the building of hydropower plants. Thermal stations were added to the system by ENDESA (table 4), in particular from the 1960s. Steel towers were built across the country to sustain the transmission lines. ENDESA's construction division was active and effective on many fronts. Like Uruguay,[103] the country enjoyed a successful mixed system, although in the Chilean case the specific weight of hydroelectricity was slightly more important.[104] Yet chart 3 (and chart 2) reminds us of an important point: we should not exaggerate the contribution of hydro power to Chile's total network. Thermal power remained an important source within the electricity sector.

TABLE 4 ▪ *Thermal electricity plants built by ENDESA before 1980*

Power Station	Period	Type of Plant	Power capacity kW	Electricity Zone
Guayacán 1	1952	Diesel	3,600	II
Huasco 1	1965	Coal	16,000	II
Bocamina	1970	Coal	125,000	IV
Guayacán 2	1976	Gas	23,750	II
Huasco 2	1977-1979	Gas	64,230	II
Total			232,580	

Source: ENDESA (1981).

In those zones beyond the SIC, in particular in the extreme regions of the country, ENDESA was forced to develop some additional projects and generation and transmission of electricity to new thermal plants. In some cases, the firm acquired existing medium and small electricity companies that provided poor services to local communities, with the aim of improving local supply.[105] Yet, in those localities where the private sector did not find the right incentives to enter operations, ENDESA built new small thermal plants, using diesel, coal or gas, for as much as 115,520 kW by 1980, having at the same time to be in control of centres of electricity distribution in these extreme or

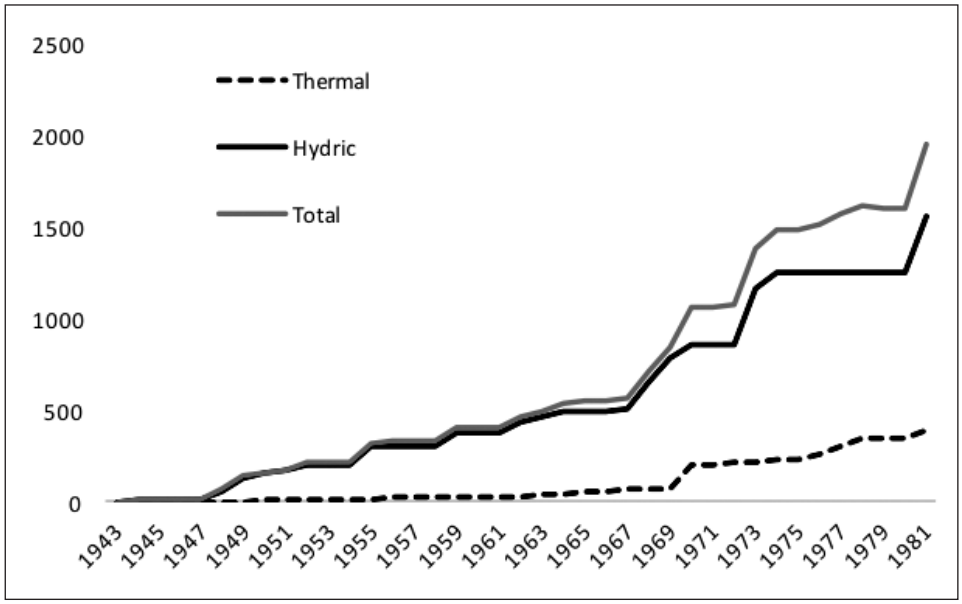
102. Instituto de Ingenieros (1988). The only major delay in the NEP was Rapel, which finished three years behind schedule "because of a severe earthquake, floods, landslides, poor rock conditions and prolonged strikes". World Bank (1976, p. 7).

103. Bertoni (2010).

104. Up until 1980, hydroelectric plants generated around 60% of Uruguay's electricity. Bertoni (2010). The comparable figure for Chile in the 1970s was 63%.

105. ENDESA smoothed over any conflicts between local communities and the central state, so common in other countries. Hausman et al. (2008); Lagendijk (2009).

CHART 3 ▪ *Installed electricity capacity of ENDESA (thousand kw)*



Source: ENDESA (1981).

rural regions which were barely populated. Thus, although hydropower remained the most important category for ENDESA, thermal plants also became increasingly significant (chart 3).

For rural electrification, ENDESA further promoted the creation of cooperatives. This strategy allowed it to group a scattered population in areas of low population density under a single electricity system, thus compensating for the high cost of laying down electricity lines to distant places or underpopulated areas. In exchange, ENDESA asked the cooperatives to manage the system and to keep the lines operating. The cooperatives were also granted funding to undertake new investment and to ensure the running of the business. The cooperative itself was to establish the price for final consumers, ensuring their revenues would cover the operational costs.[106] Between 1944 and 1970, 16 rural electrification cooperatives were created, gathering around 10,000 members by 1970.[107] The experience in Uruguay was similar, but delayed.[108]

To conclude this section, between 1940 and 1981 Chile's installed electricity capacity went from 486,700 kW to 3,209,400 kW, with ENDESA largely responsible for this impressive annual growth of nearly 5%. By 1981, ENDE-

106. Ibaceta (2009).
107. ENDESA (1970).
108. Bertoni (2010).

SA had consolidated 25% and 88% of the country's thermal and hydroelectric capacity, respectively (chart 2). Yet the role played by other companies cannot be ignored. Self-producers, mainly copper and nitrate mining companies, also made important investments, more than doubling their installed capacity between 1940 and 1981.[109] Likewise, from 1960 CHILECTRA made important investments in thermal plants, adding significant capacity to the system. The most important thermal projects were Renca (1962), Ventanas I (1968), and Ventanas II (1977). Thanks to these investments CHILECTRA managed to control around a fifth of the whole electricity capacity of the country,[110] before being acquired by the Chilean state.

Financing the National Electrification Plan

The funding of the NEP is particularly relevant given the international context: ENDESA was created in the middle of WW2, when the international capital markets were greatly disrupted. The immediate post-war period was no different: there was a global lack of capital.

The electricity sector has many peculiarities. First, demand for electricity means that rates of growth are consistently high, usually higher than GDP growth, which entails that countries need permanent and sizeable investment in new projects to increase their electricity generation. Second, electricity power plants require huge capital investments; the sector is extremely capital intensive.[111] Third, new investment projects are usually long-term undertakings.[112] Fourth, and this was particularly relevant for the 1940s-1970s, electricity was difficult to store (or to resell) and to transmit within the region.[113] Fifth, the payback period of investment is around 20-30 years, far higher than for other sectors, and therefore long-term loans are needed. Sixth, electricity distribution, in contrast to electricity generation, tends to be a natural monopoly, given the high costs and inconveniences of duplicating distribution lines. Furthermore, from the early twentieth century there was widespread consensus that electric utilities had to operate as local monopolies.[114] Seventh, although electricity costs are low (3% of total costs) for most companies operating in other sectors, a shortage of electricity could have dramatic consequences.[115]

109. ENDESA (1944-1980). A report by CEPAL (1961) noted that copper miners alone had invested around US$100 million to increase their power capacity. See also IBRD (1959).
110. ENDESA (1944-1980); Nazer et al. (2005).
111. Neufeld (2016); Hausman et al. (2008); Joskow and Schmalensee (1983).
112. ENDESA (1977).
113. Millward (2005); Storaci and Tattara (1998); and Neufeld (2016).
114. Neufeld (2016).
115. Sullivan (1990); Instituto de Ingenieros (1988).

Nevertheless, the first 27 years of ENDESA were remarkably stable from a financial point of view, only disrupted by the accession of the socialist president, Salvador Allende, to power in 1970, followed by his convoluted presidential period and the bloody 1973 military coup.[116] Capital was available to fund all stages of the NEP for the whole period covered by the study.

The funding of the initial electrification plan, before the formal creation of ENDESA, was mainly provided by CORFO, with funds coming from the national budget.[117] CORFO, like the rest of the Chilean state, received a large influx of foreign loans, mainly from the USA, perhaps the only important exporter of capital after WW2.[118] This allowed CORFO, acting as a financial intermediary, to finance long-term investment not only of ENDESA but of many other public companies,[119] and at cheap interest rates. Mamalakis (1969) was right to classify CORFO as a *sui generis* investment bank, as it was run as a non-profit organization. CORFO converted hard US$ loans into domestic soft loans, subsiding Chilean state companies. Soon CORFO became the main contributor to Chile's foreign debt.[120]

From the mid-1940s, as in many other countries, Chile used the Cold War as leverage to secure international loans.[121] EXIMBANK and the Agency for International Development (AID), amongst other institutions, provided abundant external financing for Chile,[122] as they did for Brazil, Uruguay and Mexico.[123] CORFO established an office in New York, to deal, among other things, with borrowing and technical assistance. Chile's borrowing from Bretton Woods institutions during the 1960s further increased after the initiation of Kennedy's Alliance for Progress scheme. On per capita terms, Chile was the largest recipient of Alliance for Progress loans.[124]

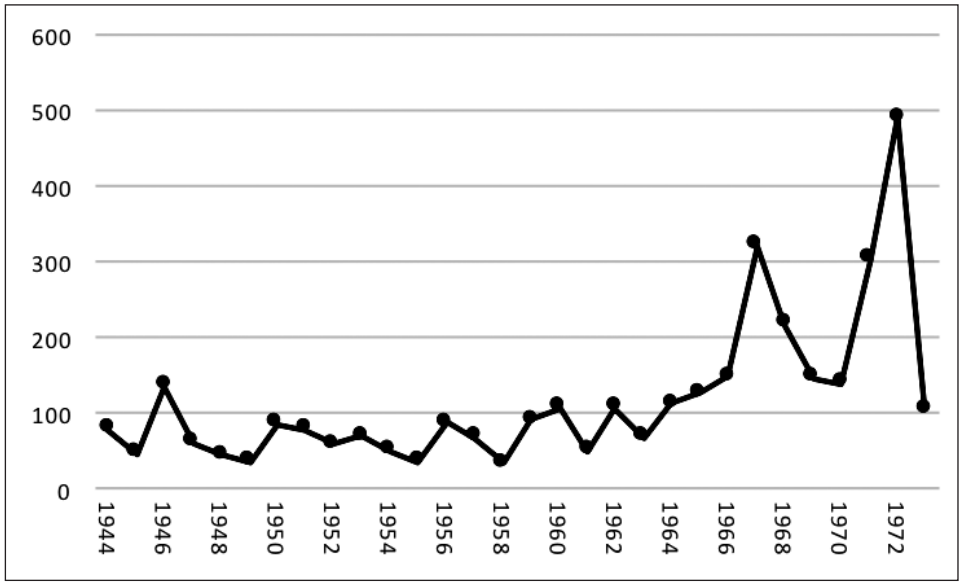
When ENDESA was created, CORFO's investments in the sector (around US$6.8 million) were taken as part of CORFO's capital contribution to ENDESA. During this early period CORFO obtained direct external fund-

116. Concha (1978); Meller (2007).
117. Mamalakis (1969).
118. Kofas (1999a).
119. The preferred sectors by CORFO were hydroelectric power, steel and oil. Mamalakis (1969).
120. Kofas (1999b).
121. Kofas (1997, 1999a).
122. Tokman (1969); Ffrench-Davis et al. (2000). By the early 1950s, due to generous loans, 15% of the country's dollar earnings went to service this debt, the highest rate in Latin America. Kofas (1999b).
123. Both the IBRD and the Eximbank invested more than US$450 million in the Latin American electricity sector. Lanciotti and Saes (2014). Uruguay, in turn, took its first loan from the Eximbank in 1942. Before that, electricity projects were funded by internal debt. Bertoni (2010).
124. Kofas (1999a); Tokman (1969).

ing from EXIMBANK[125] in 1940, worth US$ 11.1 million, to purchase machinery and equipment for the first hydropower plants, and for small thermal plans. This machinery and equipment had to be bought directly in the US, according to the loan's requirements.[126] Furthermore, technical assistance was provided through the use of the services of US, French and British consultants, which included recommendations beyond purely productive issues, even in the areas of budgeting and accounting controls.[127]

Once ENDESA was created we can distinguish three sources of funding. First, there were direct contributions from CORFO (and to a lesser extent from other shareholders). Second, there were external loans obtained from international development banks, foreign commercial banks, and foreign suppliers.[128] As CORFO did in 1939, ENDESA created an office in New York, to facilitate obtaining international loans and to inspect the machinery and

CHART 4 ▪ *CORFO's contributions to ENDESA (US$ millions of 2018)*



Source: ENDESA, all annual financial reports, 1944-1980.

125. Export-Import Bank of the United States or Ex-Im Bank, created in 1934. It lent not only to ENDESA, but also to Chile's central government. Kofas (1999a).

126. CORFO (1944).

127. In an IBRD report (1959, pp. 9 and 14), it is noted that ENDESA used the consultancy services of *International Business Consultants*, a British management consultancy, as well as those of the French firm *Coyne & Bellier*. In another IBRD report (1965), it is noted that ENDESA hired the services of another consulting British firm, *Kennedy & Donkin*.

128. There is a previous example of a country funding the expansion of its electricity sector with borrowing from the US, and these loans being backed by the state: Italy. Storaci and Tattara (1998).

equipment bought in the US.[129] Third, there was ENDESA's own capital, generated by its normal operations, although this was less important than the other two. A combination of these three sources allowed ENDESA to accomplish the planned stages of the NEP between 1943 and 1970, but access to foreign loans was crucial.

Chart 4 shows that from 1944 CORFO contributed to ENDESA every single year until the end of our period of study. In US$ of 2018, the annual average contribution between 1944 and 1966 was US$77.4 million, increasing dramatically to US$246 million per annum between 1967 and 1973. For the whole period included in chart 4, CORFO contributed US$3,504 million (US$ of 2018).

In 1946, CORFO and ENDESA agreed that CORFO's contributions would be capitalised as shares, through regular increases of capital from ENDESA. In 1952, as part of a loan negotiation with the IBRD, CORFO agreed to suspend getting dividends from ENDESA until the loan was fully paid, and soon after CORFO decided to capitalise dividends, although ENDESA continued paying dividends to its privately-owned shares. This was a clear state policy to provide ENDESA with a robust financial position, highly subsidized by the state. All state contributions, either through CORFO or the Treasury, were capitalised by the company.[130]

The second source of funding for ENDESA were external loans. Between 1944 and 1973 they amounted to US$1,265 million (US$ of 2018), equivalent to 36% of the contributions made by CORFO (table 5). After the EXIMBANK loan given to CORFO, described above, the next five external loans were provided by the International Bank for Reconstruction and Development (IBRD, the future World Bank). This was not unique to Chile. The IBRD, set up in 1944 as part of the Bretton Woods system, was quick to agree loans to public utility firms in developing countries, and in particular in the electricity sector, as happened in Mexico, Pakistan and Colombia.[131] The 1948 loan was the first ever given by the IBRD outside Europe, the first to any Latin American country, and also the first within the energy sector.[132] This was not down to good luck.

The truth is that it was easy for ENDESA to get these loans from the IBRD given that CORFO acted as solidary co-debtor and the Chilean state as guarantor of the loan, greatly diminishing the risk for the creditor. The rates charged by the IBRD to Chile were substantially lower than international market rates, from the first loan onwards (Basch, 1949). Like the previous

129. Concha (1978).
130. Concha (1978); Mamalakis (1969).
131. Davidsson (1986); Basch (1949); Hausman et al. (2008).
132. IBRD (1971); Kofas (1997).

TABLE 5 ▪ *External loans taken by ENDESA, 1944-1973*

Year loan	Lender	Amount of the loan, US$000 of 2018	Interest rate	Period of payment	Loan Guarantee
1948	IBRD (future World Bank)	140,661	4.5%	1948-1968	Chilean State
1956	IBRD (future World Bank)	138,478	5.0%	1957-1976	Chilean State
1959	IBRD (future World Bank)	280,446	6.0%	1963-1985	Chilean State
1965	IBRD (future World Bank)	35,075	5.5%	1968-1985	Chilean State
1966	IBRD (future World Bank)	465,000	6.0%	1974-1989	Chilean State
1966	Manufacturers Hanover Trust (USA)	7,750	7.0%	1967-1970	Chilean State
1967	G.I.E. (Italy)	116,532	7.0%	1967-1979	Chilean State
1968	Manufacturers Hanover Trust (USA)	7,220	8.5%	1969-1970	Chilean State
1968	MAN (Germany)	12,404	6.5%	1968-1976	Chilean State
1969	SIEMENS (Germany)	6,156	7.0%	1969-1976	Chilean State
1969	MAN (Germany)	14,966	6.5%	1969-1977	Chilean State
1969	NIO (Netherlands)	8,577	6.5%	1969-1989	CORFO
1971	SIEMENS (Germany)	6,653	7.0%	1972-1979	CORFO
1972	G.I.E. (Italy)	12,015	7.0%	1971-1989	Chilean State
1973	G.I.E. (Italy)	6,039	7.0%	1973-1980	Chilean State
1973	Banco Central Argentino	4,466	7.0%	1974-1982	None
1973	Banco Central Español	2,677	8.5%	1976-1983	None
Total		1,265,115			

Source: ENDESA, all annual financial reports, 1944-1974.

loan provided by EXIMBANK to CORFO, the IBRD loans were used to purchase machinery and equipment. The IBRD did not force ENDESA to acquire this machinery in the US only; Europe was also an option.[133] All loans were fully re-paid by ENDESA, with minor delays only.[134]

From the mid-1960s new players emerged: machinery and equipment manufacturers extended loans directly to ENDESA. These were Manufactur-

133. The IBRD only asked for international competitive bidding. IBRD (1959); World Bank (1976). For the period covered by this article, 40% of all loans extended by the World Bank to Chile were destined for ENDESA. CEPAL (1989).

134. World Bank (1976).

ers Hanover Trust from the US, MAN and SIEMENS from Germany, and GIE from Italy. GIE is an interesting case because this firm built the thermal station Bocamina, under the modality of a "turnkey project". Finally, the Netherlands Investment Bank for Developing Countries (NIO) provided an important loan for the studies to build Colbún.[135]

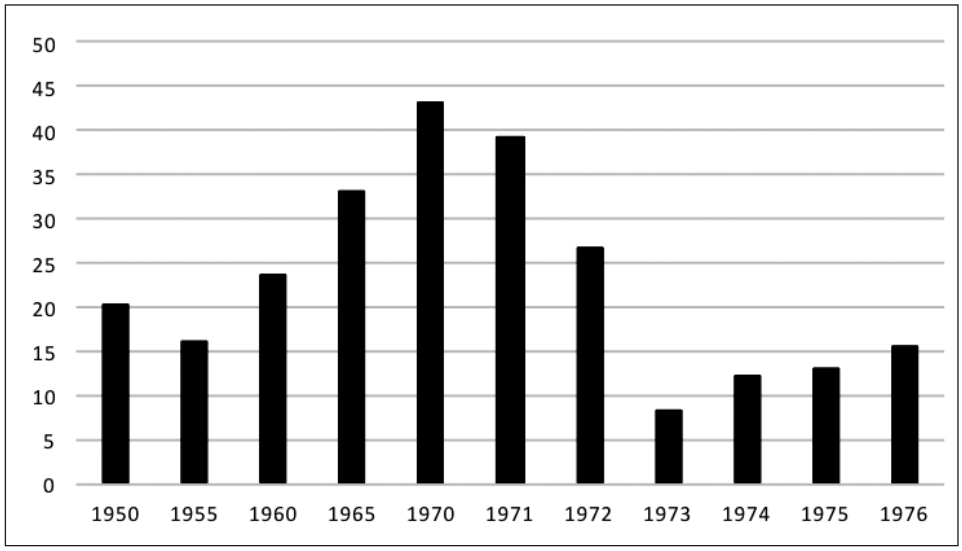
The last source of capital for ENDESA came from its own profits, either from generation or distribution operations, and was heavily influenced by the price set by the state itself, through its General Directorate of Electric Services. However, profits were slim, due to low prices, and also due to the high inflation affecting the country for most of our period of study (in particular during the 1950s). This was good for households and the industrial sector (the main consumers of electricity), but not for the company's profits. This situation led to ENDESA, and the rest of the companies in the sector, requesting increases in the selling price of electricity. Yet, these price adjustments were regulated by law (see above), and it was extremely difficult for the companies to prove that their profits were below the rates requested by the state to increase prices. The government stuck to the policy of providing cheap energy, which at times made it impossible for ENDESA to contribute with its own capital to the NEP (ENDESA, 1959 and 1993; Concha, 1978), increasing its reliance on foreign loans. This led the IBRD to threaten the Chilean government that it would stop loans if electricity prices were not readjusted. In reaction, some modifications were proposed by the legislator, and eventually accepted in 1959.[136] It enabled public utility companies to earn a 10% "net profit" on the replacement value of "operating assets".[137] A report by the IBRD (1965, p. 5) stated that, "ENDESA's financial situation has been weak in the past [before 1959] due to the inadequacy and tardiness of tariff adjustments which did not fully compensate for cost increases due to inflation". All these pressures triggered substantial real price increases between 1959 and 1970 (chart 5).

Thanks to 1959 reforms, during the 1960s ENDESA enjoyed a healthy financial situation, making sizeable profits, which were re-invested.[138] During this decade ENDESA's own resources provided between 40% and 50% of the capital invested by the company; external loans provided another 20%-30% while CORFO provided the remaining 30%-40%. Of these combined revenues, 80% went directly to new investment, and 20% to serve the external debt.[139]

This situation changed radically in 1970, following the presidential election of Allende (1970-1973). Electricity prices were frozen in nominal terms,

135. ENDESA (1944-1970).
136. CEPAL (1989); ENDESA (1993).
137. IBRD (1959).
138. This was even highlighted as a strength by CEPAL (1961).
139. Concha (1997); ENDESA (1960-1971).

CHART 5 ▪ *Prices of electricity in Chile, SIC, US$ per MWh, US$ of 1976*



Source: ENDESA (1977).

which, combined with high inflation, resulted in a dramatic fall in real prices, and the first annual losses of the company in 1970, 1971, 1972 and 1973.[140] Losses were also due to increased labour costs, since ENDESA's workers increased from 6,546 in 1969 to 8,539 in 1973. After the military coup of 1973, prices increased, but slowly, and never to the levels achieved in the late 1960s (chart 5),[141] while 50% of ENDESA's workers were fired. CORFO's contributions stopped, and ENDESA was forced to rely on external financing or loans from CORFO. The reduction in workers was due to the fact that during the dictatorship ENDESA decided to stop building plants by itself, and left this part of the business to private firms, while many other duties formerly performed by ENDESA's staff were externalised. This was a radical departure from the original structure of the company.

Between 1975 and 1978, ENDESA borrowed a total of US$231 million (in US$ of 2018) from CORFO, CODELCO and the Treasury to fund investment projects.[142] However, from the mid-1970s the main source of financing was external loans (table 6), in particular after 1975, when CORFO stopped its contributions to ENDESA. Between 1974 and 1980, ENDESA received external

140. ENDESA (1971-1974).
141. Internationally, electricity prices were increasing too, in part due to the increase in oil prices. Joskow and Schmalensee (1983).
142. Own calculation from ENDESA (1970-1980).

loans for US$2,443 million (US$ of 2018). In annual averages, this was over seven times more than the amount borrowed in the preceding 27 years.

As before, the loans received from the international development banks, such as the IBRD and the Inter-American Development Bank (IADB), were provided with CORFO and the Chilean state as guarantors, or co-borrowers.[143] They were used to modernise and expand ENDESA's transmission systems, as well as to buy machinery and equipment. It is widely acknowledged that transmission of hydropower over longer distances requires large capital investments with a deferred revenue, so that international funding became crucial.[144] Following the opening of the capital market in Chile, under the neoliberal reforms implemented by Pinochet's economic advisors, new international financial institutions dominated the financing of ENDESA, from late 1977. This development coincided with abundant credit in the international markets, or petrodollars. New lenders, such as Deustsche Sudamerikanische Bank, Citibank, Grindlay Brandts Ltd. and Banque Societe Financiere Europeenne, provided sizeable loans to ENDESA, without the backing of either CORFO or the Chilean state.[145]

During the first seven years of the military dictatorship, real prices of electricity increased seven-fold, providing an important additional source of revenue to ENDESA, but probably damaging the industrial sector through higher energy costs. Increasing revenues, combined with cost reduction (due to savings on staff), significantly improved the profitability of the whole business, especially in 1976, 1979 and 1980. ENDESA became one of the leading companies in the country, and one of the most important in the Latin American electricity sector.[146]

However, part of Pinochet's economic agenda was to reduce the size of the public sector, and to limit the actions of the state as a mere regulator and audit body, on the advice of "free market" economists, Chicago Boys.[147] In turn, during this period, the Reagan administration was also pushing hard for deregulation in the power industry.[148] ENDESA's period as a public company was approaching its end. In 1982, a new General Law of Electric Services was promulgated, which set out a blueprint for privatising ENDESA. All public electricity companies, either in generation, transport or distribution of energy were to be privatised.[149] As already stressed by Hausman et al. (2008), Chile was one of the first countries to substantially reorganize its electric utility sec-

143. See, for example, IBRD (1959), when ENDESA asked for a new loan to the IBRD with CORFO acting as co-borrower.
144. Storaci and Tattara (1998); IBRD (1965).
145. ENDESA (1975-1980).
146. Concha (1978).
147. Hausman et al. 2008.
148. Joskow and Schmalensee (1983).
149. Comisión Nacional de Energía (1996).

TABLE 6 ▪ *External loans taken by ENDESA after the military coup, 1974-1980*

Year	Lender	Amount of the loan US$000 of 2018	Interest rate	Period of payment
1974	IBRD	32,647	7,3%	1975-1997
1974	Central Bank of Mexico	45,785	10,0%	1975-1983
1974	MARUBENI	62,582	8,5%	1976-1989
1974	MARUBENI	112,224	LB+1,67%	1975-1989
1974	Inter-American Development Bank	383,277	8,00%	1982-1987
1977	IBRD	144,900	8,70%	1981-1995
1977	Deustsche Sudamerikanische Bank	71,009	LB+1,125%	1980-1983
1977	Libra Bank Ltd	62,100	LB+1,125%	1980-1981
1977	Bawag	61,454	7,75%	1979-1989
1978	Citibank	346,500	LB+ 1,5%	1979-1987
1978	Morgan Guaranty Trust	2,707	LB+ 2%	1980-1981
1978	Industrial Development Corp.	27,535	7,00%	1980-1983
1978	Banque de París et des Paays-Bas	66,035	7,50%	1978-1988
1979	Citibank	280,161	LB+ 3/4%	1979-1990
1980	Citibank	128,100	LB+ 1%	1979-1990
1980	Grindlay Brandts Ltd.	250,100	LB+ 3/4%	1979-1992
1980	Banque Societe Financiere Europeenne	366,000	LB+5/8%	1985-1990
	Total	**2,443,116**		

Source: ENDESA (1974-1980).

tor, becoming a "model" for other developing countries. Uruguay, also under a dictatorship, privatised its electricity sector in 1977.[150]

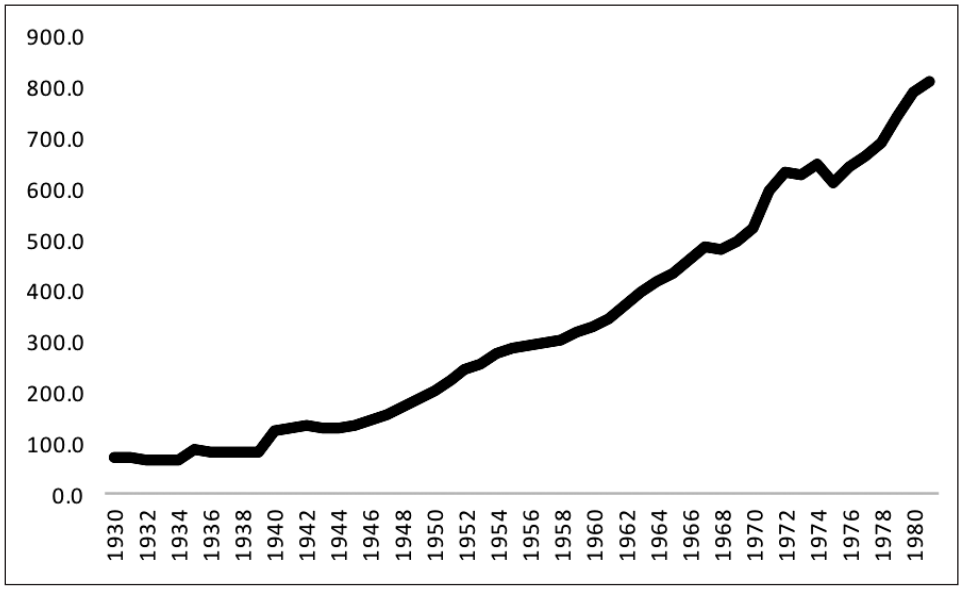
In ENDESA's case, the company was divided into eight regional distribution firms, plus FRONTEL (a subsidiary of ENDESA created in 1958), and SAESA (both privatised in 1981). Some of the largest generation plants were converted to single generation companies. The transmission system was also separated from the business. ENDESA was reduced to an electricity generation company, retaining a handful of the generation plants it previously controlled. The whole privatisation process started in 1981 (and completed in 1989), signalled the beginning of the end of the most successful electricity company in Chilean history. The industry was subject to complete price liberalisation.[151]

150. Bertoni (2010).
151. ENDESA (1993).

Conclusions

In the early 1940s, before the creation of ENDESA, Chile's per capita consumption of electricity was poor by international standards, at least when compared to developed nations: less than 130 kWh per inhabitant (chart 6), and dominated by thermal power plants mainly built by self-producers in the mining sector (many of which were foreign companies), with little involvement from the public sector. By 1981 this ratio had increased to over 800 kWh per person, mainly based on hydropower stations, and transmission and distribution lines owned and managed by the state, although thermal power retained some importance within the sector.

CHART 6 ▪ *Chile's per capita consumption of electricity (kWh), 1930-1980*



Source: ENDESA (1981).

Chile became one of the world leaders in per capita hydroelectricity generation, thus transforming its energy matrix. This was mainly attributable to the design and implementation of an ambitious national electrification plan, created during the 1930s by a group of Chilean engineers and implemented largely during the 1940s to the 1970s, which relied heavily on capital investments and foreign consultancy. It profoundly changed the nation's economy, while it was in line with the deglobalisation process experienced by the elec-

tric power industry.[152] That said, the plan was mainly funded with foreign loans: there was a contradiction between economic nationalism and this reliance on foreign capital.

The plan was carefully executed, sticking to the original design envisaged during the 1930s. This national accomplishment was not down to private enterprise; it was directly orchestrated and executed by a public sector company, ENDESA, although with support from the private sector and all political parties. It also received important consultancy services from abroad. In turn, the state also belatedly acquired CHILECTRA, the second largest electricity distributor in the country, and the largest within the private sector. By the early 1970s, the Chilean state controlled most of the distribution of electricity through public service companies.

A combination of factors explains the history of this successful state-owned enterprise. Chile is a country rich in water resources, although one which lacked any respect for the environment before the mid-1980s, so that major hydropower projects were easier to execute during the 1940s-1970s than thereafter. ENDESA operated, for the whole period covered by this article, without any concern whatsoever for the environment. In contrast, nowadays large hydropower stations face new cultural, social, and political conditions.[153] Second, despite being a developing country, the number of electrical engineers, civil constructors, bureaucrats and technicians was remarkable for a Latin American country, and ensured that the country was one of the pioneers in hydroelectricity generation in the region, together with Brazil, Uruguay and Argentina. They usually received good training at the University of Chile, which was complemented with specially tailored courses in the United States and some European countries. Chilean engineers and bureaucrats were more than capable of designing and executing an ambitious national electrification project, although guided by foreign consultancy firms whenever needed. The stability of the core team was also outstanding, despite changes of government and periods of major political instability. A report by the IBRD was very positive about ENDESA's overall performance.[154] Thus, Chile completed most of its current hydroelectricity capacity by the mid-1980s, when many other Latin American countries had just started their hydropower projects.[155]

Third, cheap international funding was coincidentally available for most of the period, and when it was not, the Chilean state was quick to act as a guarantor of international loans extended to ENDESA, at whatever interest

152. On this deglobalisation process, see Ferreira Da Silva and Bartolomé (2019).
153. Nelson (2013); Varas et al (2013).
154. IBRD (1965, p. 9).
155. Varas et al (2013).

rate it was offered. Lenders to ENDESA knew that their loans were to be repaid: the risk involved was small. All international loans taken by ENDESA, or by CORFO to re-loan to ENDESA, had the Chilean state as a trustworthy guarantor. Without this firm policy, ENDESA could never have received so many loans to accomplish the aims of the NEP.

Fourth, ENDESA was a great beneficiary of the establishment of the Bretton Woods System and the Cold War itself, including the Alliance for Progress programme. Amid fears of a rising leftist government in Latin America, especially in Chile, the US and all Bretton Woods' financial institutions were happy to lend extensively to Chile. Significant loans were provided directly to the Chilean governments (which funded CORFO operations, from the nation's budget), or to CORFO directly, and from CORFO or the Treasury transferred to ENDESA, or directly provided to ENDESA itself to fund the building of sizeable hydroelectric plants, as well as the machinery and equipment needed to furnish them. Few developing countries received as many loans from Washington as Chile did during the 1940s-1960s, while the company honoured all loans. In 1976, ENDESA was valued at US$4,440 million (in dollars of 2018), while CHILECTRA at US$547 million.[156] By 1977, ENDESA was the second largest company in Chile, second only to CODELCO – the state copper company.[157] Fifth, the negative impact of the Great Depression on the Chilean economy legitimised the creation of a state-owned company to accomplish the aims of the NEP. There was a wider political consensus, which no longer existed in the early 1980s, when both ENDESA and CHILECTRA were eventually privatised. Nowadays, in most Latin American countries current hydroelectricity projects are mixed enterprises split between public and private companies, while only in Chile is the sector fully controlled by the private sector.[158]

Finally, thanks to the implementation of the NEP (together with international technological advances in the sector), most of the population could enjoy electricity in their homes, and at affordable prices. Until the mid-1970s, the legal framework in place ensured that prices paid by final consumers were heavily subsidized, either for households or for companies. The industrial sector was also among the most important beneficiaries, since most industrial establishments used electricity as their main source of energy. All this was consistent with the ultimate aim of the NEP: to promote economic growth and to improve the overall living standards of the population. Where and when it was not economically profitable to lay an electricity line, ENDESA was there to promote cooperatives, or to invest in small, heavily subsidized

156. ENDESA (1977).
157. Concha (1978).
158. Varas et al (2013).

projects to ensure that electricity was available to all, even if that entailed expanding thermal capacity, rather than hydroelectric power.

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■

Chile's National Electricity Company (ENDESA): a successful case of state-led national electrification, c.1936-1981

Abstract

This article provides a detailed account of the electrification of a backward economy; how Chile developed from consuming less than 130 kWh per inhabitant, with an electricity matrix dominated by thermal power plants, and little involvement from the public sector, to consuming over 800 kWh per person, largely because of hydropower stations, which greatly improved the living standards of the population. This change was mainly attributable to the design and implementation of an ambitious National Electrification Plan, implemented by the state from the 1940s to the 1970s, which relied heavily on capital investments. This national accomplishment was not down to private enterprise; it was directly orchestrated and executed by a public sector company, ENDESA, although relying heavily on foreign loans. The article explains what made this success possible: qualified workers, generous financing by external institutions, the availability of rich water resources, and a lack of environmental concerns.

Keywords: hydroelectricity, Chile, hydropower, state-owned companies.

JEL codes: N76, L94, L98 H76, Q41.

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Empresa Nacional de Electricidad de Chile: un caso de éxito en un proceso nacional de electrificación liderado por el estado, c.1936-1981

Resumen

Este artículo proporciona un detallado análisis del proceso de electrificación de una economía atrasada. El caso analizado es Chile como evolucionó desde menos de 130kWh per habitante, con una base eléctrica dominada por centrales térmicas y un reducido desarrollo del sector público, a consumir por encima de 800 kWh, principalmente por centrales hidroeléctricas, que contribuyeron decisivamente los niveles de vida de la población. Este cambio fue principalmente atribuible al diseño e implementación de un ambicioso plan de electrificación, implementado por el estado entre los 1940 y los 1970, el cual dependía de forma importante de inversiones de capital. Este éxito no es atribuible a la empresa privada; fue directamente orquestado y ejecutado por una empresa del sector público, ENDESA, aunque dependiendo en gran medida de préstamos extranjeros. El artículo analiza qué hizo posible este éxito; trabajadores cualificados, generosa financiación por instituciones por instituciones externas, la disponibilidad de agua y la ausencia de preocupaciones medioambientales.

Palabras clave: Hidroelectricidad, Chile, energía eléctrica, compañías estatales.

Códigos JEL: N76, L94, L98 H76, Q41.