# Electricity and the role of the state: New Zealand and Uruguay before state-led development (1870-1930)

● Reto Bertoni
Universidad de la República, Uruguay
https://orcid.org/0000-0002-1615-6574
reto.bertoni@cienciassociales.edu.uy

● Henry Willebald
Universidad de la República, Uruguay
http://orcid.org/0000-0002-0559-6013
henry.willebald@fcea.edu.uy

Abstract

The configuration of a "modern" production structure requires there to be sufficient energy supply at competitive costs. Since the last third of the nineteenth century, coal production and better natural conditions for generating electric energy at low cost explain – at least partially – the differences in favour of New Zealand with respect to Uruguay. However, institutional arrangements are another relevant factor of differentiation. Our argument is based on the concept of endogeneity of natural resources, and we use it to prove the different roles of states in electricity systems: state intervention aimed at improving welfare conditions in Uruguay without paying enough attention to aspects related to production conditions; while, in New Zealand, productive development was the focus of public action. As a result, a more extensive and denser electrical network was consolidated in New Zealand which, potentially, would have created better conditions in terms of diversification and rural production.

Keywords: settler economies, endogeneity of natural resources, role of state, electric system, electricity and development.

JEL Codes: N50, N70, Q41.

## 1. Introduction

The configuration of a "modern" production structure requires there to be sufficient energy supply, at competitive costs, to justify exploiting the available natural resources. New Zealand has had better economic performance

*Received: 29 December 2021 – Fecha de recepción: 29 de diciembre de 2021*
*Accepted: 23 August 2022 – Fecha de aceptación: 23 de agosto de 2022*

*Revista de Historia Industrial – Industrial History Review. Vol. XXXII, no. 87, March 2023. 11-46*
*ISSN: 1132-7200. DOI: https://doi.org/10.1344/rhiihr.37856*

than Uruguay since the last third of the 19th century (Álvarez and Bértola 2013, Willebald 2013), and the differences in terms of energy endowments would explain, at least partially, the divergent trajectories. Two factors had a direct impact on this differential in favour of New Zealand: the existence of coal mines (which came to cover 80% of the domestic demand), and the wide presence of waterfalls, which implied lower relative costs for hydroelectric generation (Bertoni and Willebald 2016).

New Zealand's advantage in energy endowments facilitated the development of a dairy sector, certain energy-intensive manufactures, and a more efficient use of railways that reinforced the differences between both economies. However, endowments are not the complete story, and the institutional arrangements are another relevant factor of differentiation. Our argument is based on the concept of endogeneity of natural resources, and we use it to prove the hugely different roles of states in the creation and management of electricity systems.

These differences were not related to the extent of state intervention – given that both states attempted to and in fact did intervene in the electricity markets – but rather the outcomes of this action. The result was the creation of different production conditions that explain the long-run divergent economic performance in terms of sector diversification, international competitiveness, and social conditions in favour of New Zealand.

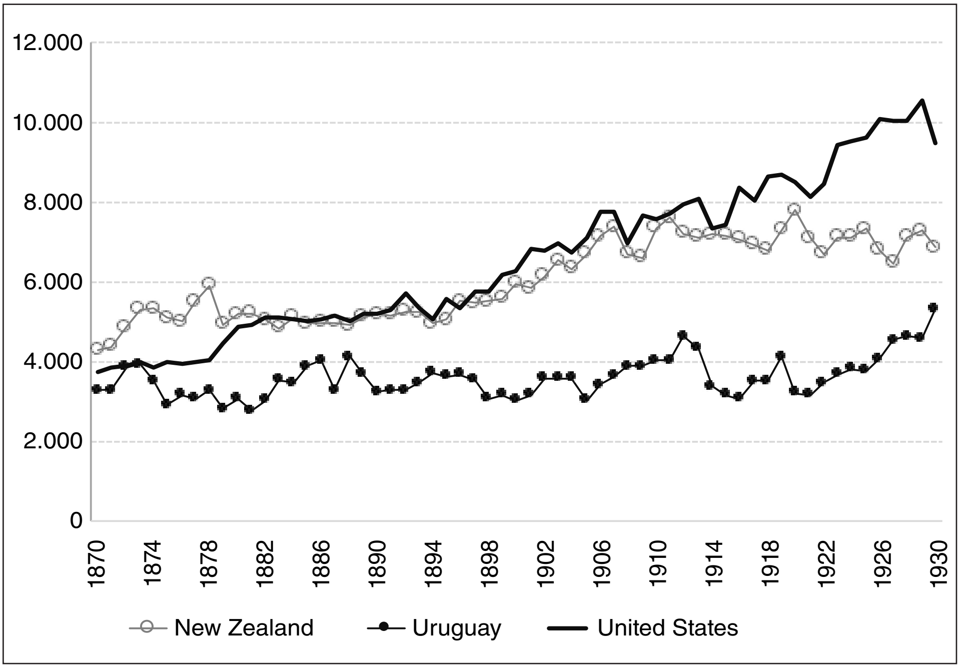
The article is ordered as follows. First, we present our conceptual framework based on the notion of the endogeneity of natural resources and a brief characterization of the economic conditions of both countries (Section 2). After that, in Section 3, we propose our hypothesis and an empirical strategy based on three analytical stages: (i) examination of arguments and concepts offered by the literature to understand the evolution of the electricity system in each country; (ii) review of laws, norms and qualified arguments that represented the tenor of public policy on the matter; and (iii) considering the electrical grid of each country as evidence of the different governmental actions. Initially, we present a review of those factors and conditions that we know about endowments, supply and demand of electricity (Section 4). Then, we consider a brief description of the creation and management of the electrical system (Section 5), we review the legal norms related to the implementation of the electricity system (Section 6), and show evidence of the extension and coverage of the electrical network in both countries (Section 7). In Section 8, we conclude.

## 2. Endogeneity of natural resources

The Industrial Revolution was at the root of the "golden age" of settler economies. This was a process based on intensive technological advances that changed social and economic relationships on a world scale. When these economies were exposed to the effects of the First Globalization, they took advantage of their abundant natural resource endowments and received the "blessing" of their natural capital. They grew quickly from the closing decades of the nineteenth century until the First World War, encouraged by dynamic international demand and inflows of production factors (labour and capital). Uruguay and New Zealand are typical new settlement economies in the sense defined by Lewis (1983, p. 209) and constituted, together with Argentina, Australia, Canada, Chile, South Africa and the US, the "temperate economies" that Foreman-Peck (1983, p. 195) identifies as "the group of non-European countries which in [the beginning of the] twentieth century can be classified as developed".

In the last third of nineteenth century, New Zealand and Uruguay showed income levels close to the "core" of the world economy – similar to the US and around 72 per cent of it, respectively – but the gap in favour of New Zealand was significant and endured over time (Figure 1).

**FIGURE 1** ▪ *Real GDP per capita in 2011US$, multiple benchmarks*




*Source:* Bolt et al. (2018).

As regards production structure, both economies had a high and decreasing share of agriculture value-added during the early decades of the twentieth century, with similar levels and dynamics. However, in terms of industry the differences were more notorious, with relatively important shares of mining and manufacturing in New Zealand (Figure 2).

**FIGURE 2 ▪** *Sectoral shares on GDP, in percentage (current prices)*

a) Agriculture

b) Industry

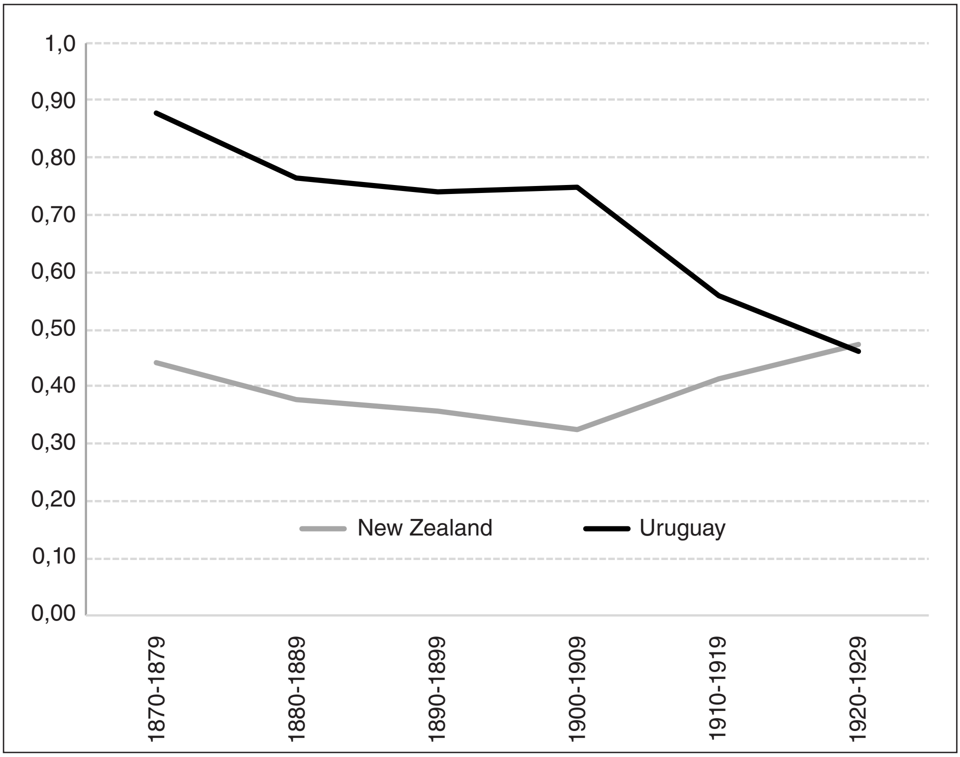

*Source:* NZ: Linehman (1968); Uru: Román and Willebald (2021).

These features in production structure developed parallel to export structure. In New Zealand the share of commodities other than pastoral and agriculture goods increased continuously to the First World War, giving as a result a more diversified composition of trade (Figure 3).[1] Uruguay remained dependent on primary products and the trend in manufactured goods began to increase just after the First World War, coinciding with the definitive installation of meat packing industries (several decades after New Zealand).

In sum, the two countries had a similar development pattern but New Zealand had a richer and more diversified economy. These differences, probably, opened diverse opportunities in terms of technological progress and state actions in the potential relation with the natural resources, the environment and the capacity to sustain economic growth. The conceptualization of these relationships deals with the role of natural capital in economic development, and the endogeneity of natural resources is part of the discussion.

1. We calculate a Herfindahl–Hirschman Index according to the following export shares by decade: mineral, pastoral, agricultural and manufactured (see Bertoni and Willebald 2016). This index represents a concentration ratio; then lower values are related to more diversify (less concentrated) productive structure.

**FIGURE 3 ▪** *Export diversification, Herfindahl–Hirschman Index*




*Source:* NZ: Bloomfield (1984); Uru: Bonino et al. (2015).

Abundance of natural resources is not a question of endowments but of the productive application of resources and, in this sense, abundance is an endogenous process. We emphasize that an abundance of natural resources is not a fixed situation but a process that reacts to changes in the structure of commodity prices and factor endowments (Williamson 2011), technical progress (Wright 2015) and suitable institutional arrangements (Acemoglu et al. 2001). Therefore, this abundance is not a given but is part of the evolution of the economic system. This idea is not new and it goes back a long way.

> Resources are highly dynamic concepts; they are not, they become, they evolve out of the triune interaction of nature, man, and culture… (quoted in Ding and Field 2004, p. 2, from Zimmerman 1933, p. 4).

> [Natural resources] should not be seen as merely a fortunate natural endowment, but rather as a form of collective learning, a return on large-scale investments in exploration, transportation, geological knowledge, and the technologies of mineral extraction refining, and utilization (Wright and Czelusta 2007, p. 186).

In economics, it is usual to consider natural resources as initial endowments that remain unchanging in time. However, endogeneity of natural capital is an obvious result of an historical analysis. History teaches us that “curses” and “blessings” are constructions – they are the result of the socioeconomic system – and the exploitation of natural resources means to address opportunities and challenges with profound consequences in the historical process of societies (Willebald et al. 2015).

Some successful experiences of economic development (such as Australia, Canada, Sweden) highlight the fact that institutions promoting the interaction between enablement and receiving sectors are fundamental to science-based and innovation-driven growth in resource-based economies. Therefore, it is crucial for institutional structures to evolve in ways that support knowledge capabilities and efficient uses of energy in the growth of natural resource-based industries.

In the field of energy economics, the exploitation and value of energy resources, transport and marketing, as well as satisfying the energy needs of production and households, are closely related to virtuous linkages between natural resources, technology and institutional arrangements. In the case of electric power, an additional factor can be considered. Given the existing technology in the first decades of the twentieth century, the electricity provided by a public utility generates a natural monopoly in generation and transmission. Particularly, long distance electricity transmission constituted a natural monopoly because a single firm could satisfy the entire market demand at lower cost than any other combination of firms.

> Historically, electric power systems have been publicly owned and operated because of their natural monopoly characteristics… Only the appearance of new generation technologies, particularly gas turbines, reversed the scale economies in the sector (Dubash 2004, p. 256).

As a result, state intervention has constituted a key feature both as a producing agent and as a regulatory entity, both of which are valuable for understanding the long-run performance of societies and economies. However, the type or modality of the state intervention could vary from place to place, whether regulated private ownership was viable, or whether municipal ownership was the default depending on a variety of factors. In the case of settler economies, the availability of the open frontier (“moving frontier” in the words of Di Tella 1982) pushed the balance of advantage more towards utilities and less towards municipality ownership (Newbery 2001). This happened because entrepreneurship and private finance both required private property rights and institutions of capitalism that, clearly, were absent – or in construction – in open frontier economies.

## 3. Hypothesis and empirical strategy

In the concept of endogeneity, the role of the state is a central matter and the modalities of action of the government regarding natural resources have fundamental differences between Uruguay and New Zealand. This idea is not new. Previously, other scholars have applied concepts similar to one of the main components of the abundance of natural resources of settler economies, namely land as the main natural wealth of these economies.

Indeed, though similar in many respects, Uruguay and New Zealand appear to have had substantial differences with respect to institutions governing both accesses to land and distribution of agricultural incomes. In New Zealand, the Crown adopted a policy that strongly facilitated access to land for white colonizers and European descendants. This in turn allowed an increasing number of landowners, which expanded along with immigration and population growth. Instead, in Uruguay land was heavily concentrated in the hands of a small group of landowners that benefited from massive transfers of public lands (Álvarez et al. 2011). Moreover, Uruguayan landowners obtained a larger share of agricultural output (in terms of land rents) than their New Zealander counterparts (Willebald 2015). We present a similar concern but instead of focusing on land we base our analysis on energy natural resources.

Our hypothesis is that the different results derived from state action in terms of natural energy resources and the electricity supply strategy explain, at least partially, an expanded and networked electrical system at an earlier date and with better articulation with the productive structure in New Zealand than in Uruguay.[2]

To test this hypothesis, we propose to proceed through three analytical stages. Initially, we examine the arguments and concepts that the literature offers to understand the long-run evolution in the creation and management of the electricity systems in each country. Second, we illustrate the differences with a review of laws, norms and qualified arguments that represent the *tenor* of the public policy in terms of creation of development conditions. Finally, one outcome of this process is the electrical reticulation of each country, shown as the extension and coverage of the systems in terms of public and residential lighting and motive-power purposes for farming, manufacturing, commerce and other productive activities.

2. Our methodological option has been dividing the subject of study in three stages; initially, we dealt with the role of the natural resources (Bertoni and Willebald 2016); in this article, we address state action and, in the next stage, we will combine both with demand factors.

## 4. What we know about endowments, supply and demand

### *4.1 Energy endowments, generation, distribution, costs and prices*

The coal and steam paradigm led modern economic growth in the nineteenth century (at least until the 1880s) but, in the last two decades of that century, it was bested by a more technically sophisticated paradigm based on electricity. Electric power and its application in heavy engineering imposed a new pervasive techno-economic paradigm, because electric power made it possible to separate the production of goods and services from the generation of energy (Freeman 1989, Perez 2009). Electric power is derived from primary sources and the technological options available to produce it at that time were thermal and hydropower. Therefore, countries with abundant coal and oil reserves or hydropower capacity had relative advantages when incorporating the new technical system.

In a supply approach, we compared natural endowments suitable for generating modern energy, which means evaluating to what extent a country was physically prepared to take advantage of an opening window of opportunity related to a new techno-economic paradigm (Perez and Soete 1988). In our case, we can consider two main issues: coal production and appropriate conditions to generate hydroelectric energy, because neither of the two countries produced oil or made extensive use of that fuel. In this comparison, the main findings were that New Zealand needed lower investments, had lower power generation costs and obtained lower final energy prices (Bertoni and Willebald 2016).

On the one hand, in terms of mineral fuel, the major difference regarding energy endowments was that New Zealand had coal but Uruguay did not. As a consequence, there was a very wide gap in coal consumption between both countries. From 1880 to 1930, Uruguay's coal consumption per capita was around 10-15 per cent of New Zealand's, and this could explain why the former had less energy available (Bertoni and Willebald 2016). All the coal consumed in Uruguay was imported and therefore availability depended on international prices and the market situation, which means there were supply constraints in times of war. If economic modernisation, including modern farming techniques, required a more intensive use of energy, then New Zealand had a clear advantage over Uruguay.

On the other hand, by 1930, hydroelectric power was more developed in New Zealand, which had already built several hydroelectric plants, while Uruguay had none. This disparity clearly gave the former country greater electric power potential. The amount of electricity that can be generated depends on two factors: the vertical distance that the water falls, and the flow rate. There are no historical statistics to estimate this potential, but we used topographical characteristics and the quantity and regularity of rainfall as indirect evidence.

Uruguay has a dense hydrographic network, however, as regards topography, it has broad grasslands and low hills, and as a consequence the caudal of the water flows is closely related to rainfall. Rainfall is abundant but it is irregularly distributed during the year. An absence of natural lakes and high lands allow an easy displacement of rainfall water and, consequently, water storage is difficult. The solution was to invest in dams to create these conditions artificially, but these were very costly and the energy sector has always relied on thermal stations to provide backup power. New Zealand had generous water reserves for generating energy, thanks to its more favourable topography and rainfall patterns. A large proportion of the country is mountainous, the country's rainfall (and hence its river flows) is relatively regular and there are numerous lakes, which constitute the best natural regulator of river flow.

In these conditions, New Zealand (Ogilvie Buchanan 1930) had twice as much hydroelectric potential as Uruguay (Oxman 1961).[3] This record represents nominal potential energy and does not take into account the effects of irregular rainfall that we considered above. Furthermore, Uruguay's topographical characteristics made it necessary to invest more in hydroelectric systems.

These contrasts led to entirely different conditions of supply. Electricity could be generated from a range of primary resources, and to reach the final consumer a network of transmission and distribution infrastructure was needed. This led to the need to consider at least three types of costs: investment costs, operation costs, and long-distance transmission. The capital per installed HP of a hydroelectric power station was 2.8 times higher in Uruguay than in New Zealand, and the same ratio for thermal power stations was 1.3. A third factor to be taken into account is the distance from the power station to consumers. In Uruguay, the average distance doubled that corresponding to New Zealand, and, consequentially, we find greater sunk costs in Uruguay for power transmission lines, which meant significantly higher investment.[4] These differences in terms of investment also had consequences in terms of operational costs and final prices.

The cost per KWH in New Zealand was half that of a Uruguayan power station, which was transferred to the final price for consumers. The retail price of lighting was 50 per cent lower in New Zealand than in Uruguay, but the final price for power and heating was only a quarter of that paid in Uruguay.

3. Uruguay: 1,232 MW; New Zealand: 2,563 MV, although with huge differences between the north (475 MW) and the south (2,088 MW) islands.

4. The average distance from plant to consumer was 141 km on the North Island and 127 km on the South Island, while in Uruguay it was 270 km.

In other words, the expressions of those differences in terms of production were still more favourable than in terms of welfare.

### *4.2 Population and sectoral energy intensity*

From energy economics, it has been emphasized that the demand for energy – and in this case for electrical energy – is a derived demand, given that it does not satisfy a direct necessity of people, but makes possible the use of devices capable of providing an energy service (lighting, heating, food cooking, food preservation at homes, maintenance of the industrial cold chain, driving force, etc.). In this sense, the potential demand is mediated by the quantity and quality of the converters (Medlock 2004). This matter is beyond the scope of this paper, but the percentage of urban population and the spatial distribution of localities, as well as the energy intensity of productive activities, can be used as a proxy of demand.

The population density at the beginning of the twentieth century in Uruguay (1908) and New Zealand (1906) was similar (5.6 and 3.8 inhabitants/km2, respectively) but the dispersion of this indicator – taking the provinces as a reference – was much lower in the case of the former (the coefficient of variation are 0.23 and 1.8, respectively). That is, the population is much more evenly distributed throughout the territory in the case of New Zealand.

On the other hand, in New Zealand there were several medium-sized cities (Wellington: 71,553, Christchurch: 56,769, Auckland: 43,295, Dunedin: 38,857l), while in Uruguay, with the only exception of Montevideo (with 309,231 people), the rest were small cities (Paysandú: 20,953, Mercedes: 15,677, Minas: 13,345, Melo: 12,355).[5] These are indicators of a much more dispersed population distribution in the New Zealand case. The concentration of electricity demand in Montevideo conditioned to a certain extent the option for thermoelectricity and distributed generation,[6] while in New Zealand the dispersion and magnitude of the localities would have enabled the option for hydroelectric generation and reticulation, resulting in a higher potential demand.[7]

Complementarily, the study of the respective productive structures denoted a greater sectoral energy intensity in the case of New Zealand. As Bertoni and Willebald (2016) have pointed out, since the early nineteenth cen-

5. Around 1908 in Uruguay and 1906 in New Zealand. Census data.

6. In fact, during the first middle of twentieth century, engineers and politicians discussed the optimum mix of electric systems between hydroelectric and thermoelectric technology in Uruguay (Waiter 2020), but the thermal generation continued being dominant.

7. Bartolomé and Lanciotti (2015) find similar comparative results for Spain and Argentina (dispersed and concentrated, respectively) with alike commentaries in terms of localization of population and industrial structures.

tury the dairy industry in New Zealand has gone from farmers keeping a few domestic cows on bush blocks to being a world leader today (Stringleman and Scrimgeour 2012). However, that activity developed late in Uruguay, even though the natural resources in the two countries were apparently similar (Bertino and Tajam 2000), and it was not until the 1960s that we can identify a real dairy area where farming and manufacturing worked in a coordinated way. The differences were even greater in the manufacturing stage, where the cheese production of New Zealand was 10 times greater than Uruguay's and butter production 172 times greater (in the beginning of the twentieth century). In addition, the industrial sub-sectors typically characterized by high energy use such as metal products, engineering, and transport equipment accounted for 15 per cent of total value-added by manufacturing in New Zealand (1910-1915; Rankin, 1991). In contrast, in Uruguay even in the mid-1930s, these sub-sectors had not achieved that level (only 12 per cent in 1936).

## 5. Creation, management and political decisions of the electrical systems

### *5.1. New Zealand*

The history of electric power in New Zealand reflects the natural endowments of the country and the political environment (Martin 1998). It reflects the fact that development of its electricity supply occurred in step with the development of its initial administrative and economic infrastructure as a country of recent settlement (Culy et al. 1996). The fact that hydro was the cheapest source of power (Bertoni and Willebald 2016) made direct government involvement almost inevitable. Although there were pioneering private schemes to provide hydro power for gold mines, large-scale hydro development tended to come under government control.[8] Damming major river systems caused very significant effects on the environment (flora, fauna, changes in the rainfall pattern), land ownership rights, village settlements, conditions for river navigation, and deep changes in economic activities. In addition, because many hydro development opportunities happen at distant sites, substantial investment in transmission infrastructure was necessary. In a context in which the economic and administrative structure of the country was newly evolving, the role of the state was fundamental because of the difficulties

8. The first hydroelectric power station built by central government management was located on the Kaituna River (Okere Falls) to supply electricity at Rotorua, a touristic place, to power sewage pumps and lighting (http://www.ipenz.org.nz/heritage/itemdetail.cfm?itemid=2537, accessed 08/30/2017).

for private investors to negotiate with affected parties, defining secure property rights, and taking on potential liabilities (Culy et al. 1996).

In 1903, 1910 and 1918, three engineers from the Public Works Department reported on the hydro-electric potential of New Zealand. These reports formed the basis of the government's involvement in electricity, in particular, the planning and construction of hydro-electric stations at Lake Coleridge, Mangahao, Waikaremoana, and Arapuni (Duncan 2011). As a result of this strategy, in the third decade of the twentieth century, the consumption of electricity grew by 22% per annum and total generation in 1931 was more than 40 times greater than in 1911. This dynamic allowed for the majority of urban dwellers and farmers to connect to the network.[9]

New Zealand is a relatively small country, which made central control possible. The government played a dominant role in the economy in general and, in particular, in the management of natural resources (Álvarez 2014). This intervention was so important that historians have identified this process with modalities of "socialism" or "paternalism" (Milburn 1960). In fact, the need to develop the country and pragmatism in solving constraining factors had formed a "non- ideological" socialism where the participation of people was elicited. As was noted,

> […] while politicians restricted their planning to the solutions to immediate problems, by 1890 political thought and action had become dependent largely on two beliefs: that the state existed to aid its people; and that the people should participate in government by selection of their representatives (Milburn 1960, p. 62).

In New Zealand, democracy can be seen as a movement that used the instrument of expanded state action and intervention to bring about a more humane, democratic and egalitarian society.

> New Zealand shared the same fragment culture as Australia, even its Liberal reforms would reflect the same underlying egalitarian, communally-focused, working-class radical values and presuppositions as Australia's 'mateship' society (Paulson 1988, p. 276).

This socio-political context made natural resources one of the main issues in public policy, and politicians, theorists and common citizens identified these concerns early on. In this sense, a particular feature of the New Zealand experience was the concerted drive by the government, with support of the general public, toward development.

9. https://nzhistory.govt.nz/culture/the-1920s/overview.

This tendency toward state power production was reinforced, in our field of interest, by the

> […] belief that an integrated network, along with extensive reticulation, would be an engine of economic growth and social development, the benefits of which would be only partially captured by the power companies (Culy et al. 1996, p. 315).

Accordingly, by the end of the nineteenth century, the government passed a series of acts that: (i) granted power to the state to create lines of communication (telegraph, telephone); (ii) established the Crown agency control of streams, lakes and rivers; (iii) hampered private enterprise from constructing and maintaining electric lines for lighting purposes in public places, and (iv) prevented local authorities from granting anyone the right to generate or use electricity as a motive power without special permissions.

In the first decades of the twentieth century, the government became actively involved in the electric supply and constructed its own hydroelectric stations, alongside legislative actions that formalised the financial role of the government and established conditions for funding hydroelectricity. The Electric Power Board Acts of 1918 and 1925 constituted two of the main norms passed during the period in that they systematized and organized the regulations referring to the sector and represented the official vision on the management of energy natural resources. But principally, because they allowed a virtuous articulation between state action, natural resources and civil society.

The petition for any area to be constituted as an electric-power district was presented to the Governor General. Every such petition had to be signed by not less than one-fourth of the ratepayers within each proposed constituent power district and specify how to elect the members of the Board (whether the members of the Board were to be elected by the electors of the several constituent districts or by the ratepayers of the electric-power district). This process is indicative of the importance of civil society in the creation and management of electric systems.

Under both norms, local authorities were established to purchase a bulk supply of power from the state. The power board jurisdictions were defined so as to make urban communities subsidise the cost of reticulating to the local countryside. Because the system was not mandatory, several urban supply authorities refused to surrender their generating and distribution systems, allowing these municipalities to retain control of their electricity departments and of any profits.[10] These two types of electricity supply authorities – the

10. Certainly, a comparison with Norway would be pertinent. In this regard, the availability of hydropower was comparable, but municipality strength ended up leading the electri-

power boards and the municipal electricity departments – maintained their main characteristics until the 1980s when the profound changes experienced in the system extended to distribution and retailing stages.[11]

Electricity demand grew in the 1920s, slowed in the Depression, and then picked up before the Second World War. All of New Zealand's cities and many towns were connected to the grid and reticulated by 1930. Urban industrial and commercial users were attracted to the comparative cheapness, efficiency and cleanliness of electricity. From the 1920s suppliers intensively encouraged the domestic use of electricity. Showrooms displayed the latest appliances, cooking classes were held, and the cleanliness and convenience of electricity was highlighted. In the 1920s and 1930s, closely-settled and well-to-do farming areas, particularly those next to cities or large towns, were connected, but reticulation of remote hilly areas and the back country did not take place until after the Second World War (Cook 2010).

### *5.2. Uruguay*

The origin of electrification in Uruguay is associated with the installation of electric lighting as a public service in urban areas.[12] From the late nineteenth century the state granted concessions to private firms to install this service, first in Montevideo – the main city of the country and the administrative and political centre – and later in major towns (Salto, Paysandú, Colonia, Canelones). In general, relatively small companies installed power plants to provide electricity for public lighting of the city and for domestic use. These power stations used coal (and oil afterwards) as primary energy.

Uruguay had an extensive hydrographic system and it was the protagonist of a pioneer experience of using water power for mining purposes in the

fication process. On the one hand, the Norwegian electricity market was characterised by a large number of small generators and retail distributors. Norway is unique in this sense because more than 99% of current generation is based on hydro (Myllyntaus 1994, Hjalmarsson 1996). On the other hand, the electrification of the Norwegian economy started around the 1880s and developed quickly since the beginning of twentieth century. Initially, the rights were often acquired by private – usually foreign owned – companies. However, it was soon decided that the exploitation of hydro power and supply of electricity was a task for public organizations. In 1917 special laws were enacted, which stated that all exploitation of watercourses must be subject to concession and, furthermore, that privately owned power plants should be handed over to the state after 50-60 years of operation (Bjerkholt et al. 1983). Municipalities also started to engage directly in hydro power projecting in the beginning of the century and maintained a significant role during decades.

11. In particular, in the 1990s, local electric power boards and municipal electricity departments became commercial companies in charge of distribution and retailing.

12. It is true that, previously, some firms used generators to carry out their economic activity, but they did not supply to other producers or consumers (at least in a considerable scale).

1880s,[13] but technological and financial restrictions delayed large-scale hydroelectric generation up to the mid-twentieth century (Bertoni and Willebald 2016, Waiter 2020).

Initially, the granting of concessions by the government to private entrepreneurs for the generation and sale of electricity was the institutional arrangement that allowed the diffusion of electricity (Bertoni 2011). In the first decade of the twentieth century, thirteen cities with electrical services offered by privately owned companies existed outside the capital (Montevideo).

From 1909 onwards, and with the exception of Montevideo, little installed power and the near absence of electricity grids around the cities made it very difficult to use electricity in production activities, particularly in manufacturing and agriculture (such as dairy production and shearing).

Between 1906 and 1912, the Uruguayan state became prominent in the configuration of the electrical system. In 1906, the Act of "Transformation of the Electric Power Plant Montevideo" put the public service of electricity in the capital of the country in the hands of the state and, in 1912, the Act of "Creation of the General Administration of Electric Power Plants of the State" established a state monopoly in generation, transmission and distribution of electricity across the country *"excluding any other company or person"*.[14]

From 1912 onwards, the Electric Power Plants of the State (UEE for the acronym in Spanish) absorbed or acquired thermal plants that had arisen in the context of public service concessions and created new power plants in cities and towns that still lacked electricity. The dominant scheme was so-called distributed generation,[15] creating or absorbing 35 thermoelectric plants between 1912 and 1932 (that is, proximity generation). This strategy allowed a major coverage of public electric services in urban areas but did not create electric grids. It wasn't until the 1930s that the first high voltage electrical networks were built to supply smaller villages and towns, with the capacity to connect farms and other rural establishments in the vicinity of the grid.

This brief description of facts reflects, in the energy sector, the policies promoted by the *Batllismo*, a political group created around the leading figure of José Batlle y Ordóñez, head of the Colorado Party that dominated the Uruguayan political scene in the early decades of the twentieth century.

The *Batllismo* promoted a set of transformations to build a "social republic" that faced the opposition of the conservative sectors of Uruguayan soci-

13. In 1882, the French company Minas de Oro del Uruguay inaugurated a hydroelectric dam in the Cuñapirú stream (in the north of the country, 400 kilometres from Montevideo), which provided light and power facilities that were built for the exploitation of gold mines.

14. Act No. 3121, September 27th, 1906; Act No 4273, October 21st, 1912.

15. Distributed generation is an approach that employs small-scale technologies to produce electricity close to the end users of power.

ety. The strong statist imprint of the policies implemented during the period induced the characterization of a government identified with a socialist ideology. But in 1915 the reforms were stopped and a "conservative republic" arose from those social and political groups threatened by the social policies (Caetano 1991, 1992). However, although the most radical plans were set aside – especially those about land taxation – a great sensitivity was maintained to bring well-being to the people. The "social republic" survived the decline of radicalism (Azar et al. 2009).

The energy policy of *Batllismo* should be analysed and interpreted in this context. The priority was social welfare. From this perspective, the electrical system would be developed with the primary objective of meeting the needs of citizens (mainly lighting); in other words, the main destination of electricity was final consumption. Distributed generation with locating plants in cities and/or towns was functional to that goal and thermal generation was an adequate technological option in this scheme (in contrast with the huge and costly investments that would mean the creation of a system based on hydroelectricity).

Certainly, the state's budget constraints and, in relation to them, the difficulties of financing the electrification plans, slowed the process and delayed infrastructural works, principally the construction of hydroelectric power stations and reticulation throughout the country.

In Montevideo, it was possible to relate the social function of electrical energy supply to the requirements of an incipient industrial sector and, thereby, a virtuous circle was established. But in the countryside, where the locations of productive activity were "out of the cities", this kind of synergy was not observed, at least until the 1930s, when the surrounding rural areas were integrated into the high voltage networks.

### *5.3. So similar, so different*[16]

New Zealand and Uruguay showed an extraordinary intervention and participation of the state in the configuration of the electricity system already in the first decades of the twentieth century. This represents true exceptionality on a global scale (Rozas and Bonifaz 2014). The state had a protagonist role in the electrical sector in the world from the Great Depression onwards, but not before, which represents a relevant institutional innovation in the cases of New Zealand and Uruguay.

Hausman et al. (2008) is a permanent reference about global electrification and it shows the importance of foreign-owned and -controlled firms

16. This title uses the same idea of Álvarez and Bértola (2013) referred, also, to New Zealand and Uruguay.

(multinational enterprise) in the early diffusion of electricity and how the role of multinational-enterprise activities reduced over time – a process that the authors name "domestication". However, this was not the case with Uruguay and New Zealand, because from early times the state was the protagonist of the process.[17]

The contrast with other settler societies in the southern cone of Latin-America is notable. According to Saes and Lanciotti (2012),

> […] the trajectories of the electricity sector in Argentina and Brazil up to 1930 were similar in terms of foreign participation in the structure and organization of electricity service companies… Supervision was the responsibility of the municipalities, and was based exclusively on concession contracts, without the intervention of central governments (p. 419; our translation).

Part of the explanation for this "precocious" state interventionism may lie in the presence of political regimes with a strong "socialist" imprint. Both governments, stimulated by mistrust that the private sector could guarantee the correct use of natural resources and the development of certain key sectors for the common good, played a central role in the management of energy resources. However, as it was shown in the previous sections, the institutional arrangements and technological solutions were different in both countries.

In New Zealand, the state promoted electrification in coordination with local agents, which were organized in power boards and investing in hydroelectric generation and transmission networks. In Uruguay, the state – through the public electricity company – led electrification and, given the high costs of hydroelectric generation, opted for thermoelectricity on a distributed basis, not developing transmission networks.

The articulation between civil society and the state in New Zealand promoted the electrification of rural areas adjacent to urban centers, which contributed to create better conditions of production (where the dairy industry particularly enjoyed this improvement). The existence of a "community life" in New Zealand encouraged "public-private" solutions for electrification, leading to dense transmission and distribution networks. None of these conditions were verified in Uruguay and the differences in terms of the consumption of electricity are eloquent.

We can see during this time period that New Zealand had an extraordinary expansion of electrification. This asymmetric behaviour in the two countries resulted in different paths. While around 1913 they had similar electric-

17. In the case of Uruguay, it should be noted that Hausman et al. (2008) falls into the error of identifying the tramway companies as "electric companies" when, in fact, they only produced electricity to supply their trams, without participating in the framework of electric utilities.

ity consumption per capita, in 1930 we observe that consumption in New Zealand was six times greater than in Uruguay (Table 1).[18]

**TABLE 1 ▪** *Electricity consumption per capita in kWh*

| | 1900 | 1913 | 1920 | 1930 |
|---|---|---|---|---|
| New Zealand | -- | 14 | 80 | 417 |
| Uruguay | 2 | 17 | 33 | 70 |

*Source:* Bertoni (2002, p. 41), Table NºIV.3.

In summary, two factors appear to be involved in the divergent trajectories of Uruguay and New Zealand. On the one hand, the endowment of natural resources affected the relative costs of hydro and thermoelectric generation and thus conditioned distributed generation in Uruguay. On the other hand, the absence of organized local actors in Uruguay conspired against the possibility of promoting distribution networks in rural areas, which contrasted significantly with New Zealand.

In the following sections these ideas are developed from the analysis of the regulations – allowing us to capture the *tenor* of public policy – as we inquire into the effects of divergent technological trajectories (especially focused on the electrical network) and explore how both states financially supported their corresponding projects of electrification.

## 6. Legal norms and qualified arguments. An overview

A legal norm is a mandatory rule of social behaviour established by the state and aims at developing certain social relations in the interests of the ruling class or the institutional arrangements resulting from a certain correlation of forces between social classes. The legal norm indicates the conditions of its own execution, the subjects of the regulation, the mutual rights of the parties, and the corresponding sanctions. The body of legal norms in a given society constitutes its law. Legal norms have been the preferred instrument used for creating, controlling and managing the electrical system.

In addition, the fundamentals and the emphases in the discourse of those who made decisions or those who advised them, also offer clues re-

18. In this comparison, it is important to note that, at least partially, the difference in favour of New Zealand would respond to different levels of development: GDP pc of New Zealand exceeded Uruguay record by 1.5 (1929-1931) (Bolt et al., 2018). However, on the eve of the First World War, this ratio was 1.6. In other words, probably, levels of development were important to understand the differences but they are not the entire story.

garding the purposes of the design and instrumentation of the public policies adopted.

### *6.1. Norms, objectives and emphases*

In 1891, the New Zealand Electrical Syndicate (Limited) was authorised for the production of electricity and electrical energy, and for supplying the same for lighting purposes and as motive power. Power was to be given to enable the mentioned company to carry out the objectives for which it had been established in and over the area corresponding to the city of Auckland, and also the Parishes of Titirangi, Waitemata and Takapuna, as they are included within a five-mile radius of the centre of the Auckland City Market.

All the acts corresponding to the nineteenth century identified in this research[19] show the same feature. They indicate two aims – lighting and motive power – and a broad coverage in the territory covering suburbs and rural zones. We can see the *tenor* of public policy in these aspects of the norm that govern the creation and management of the electrical system in New Zealand.

A survey of the regulations applied to the public provision of electricity in Uruguay up to 1912 shows that, with the exception of Montevideo, the goal was only the lighting of the streets, public buildings and homes. This is the *tenor* of the norms that granted concessions to the cities of Salto, Paysandú, Minas, Mercedes, San José, Durazno and Florida (National Register of Acts and Decrees, www.impo.gub.uy). In Salto, even in 1906, when the concession was extended, the act gave the option to consumers of paying a conventional light bulb or pay price for their consumption at counters indicating devices. Clearly the homes' lighting in the cities was the focus of public service that the norms referred to.

### *6.2. When the state led the electrification*

In the second decade of the twentieth century, state intervention was intensified in both countries. But the modality of this intervention was different. State monopoly in generation, transmission and distribution was enacted in Uruguay in 1912. It established that a public company – *Usinas Eléctricas del Estado* – was the only entity authorized to execute the electrification of the country.

19. The Christchurch Electric Lighting Act, 1891; The Wellington Electric Lighting Act, 1891; The Gore Electric Lighting Act, 1893; The Hawera Gasworks and Electric Lighting Act, 1897; The Stratford Electric Lighting Act, 1898; The Olnnemuri County Electric Power and Lighting Act, 1899; The Queenstown Electric Lighting Act, 1900; The Hawera County Electric Lighting Act, 1902; The Wanganui Suburbs Lighting Act, 1903; The Waipori Falls Electrical Power Act, 1904.

The text of the act says (own translation):

> The General Administration of the Power Plants is created as dependent on the Executive Power… (Art. 1). The provision to third parties of electric energy for lighting, power, traction and other applications in the entire territory of the Republic shall be entrusted to the State Power Plants, excluding any other company or person (Art. 6).[20]

And, Article 7 of the norm adds:

> […] this service will be implemented with the authorization of the Executive Power in all population centres that do not enjoy such advantage and that, due to their importance, deserve it.[21]

The message of the Executive Power in favour of the state monopoly argues in the same direction; the emphasis of the institution was the necessity of guaranteeing "everywhere the service of public and private lighting". Batlle's message from the Executive Power to Parliament accompanying the Law for the Creation of the State Electric Power Plants, added,

> […] responds to major ends and purposes: to the collective diffusion and distribution of essential factors of well-being, comfort and hygiene, to provide to more numerous and less favoured classes of a sum of benefits that would otherwise be only accessible to the well-to-do… It is simply and, in a nutshell, to favour the public, improving, extending and making services cheaper, while avoiding the difficulties that arise from the concession regime (Medina Vidal 1952, p. 126).

There is no mention concerning the electrification of the rural areas surrounding cities and villages in the whole norm or in the fundamentals of Executive Power.

Once the state-owned company was created, the revision of the Annual Reports of the firm shows that the focus of attention remained on lighting services in urbanized areas.

On April 3rd, 1914, in a letter addressed to the Minister of Finance, the president of the company, engineer Santiago Calcagno, informed that the organization took over the existing power plant in Real de San Carlos, Colonia – until then, a private concession – "in order to use it for the electric lighting of the city of Colonia" (General Administration of Electric Power Plants of the State. Annual Report, 1912-1913). Note that only "electric lighting service" is mentioned as the purpose of the decision.

20. http://www.impo.com.uy/diariooficial/1912/10/29/2.
21. http://www.impo.com.uy/diariooficial/1912/10/29/2.

Finally, in the 1930s, after twenty years of implementing policies aimed at electrifying of the country, the company expressed concern about the low penetration in rural areas (Energía 1934a).

Meanwhile, in New Zealand, after 1918 the Electric Power Board Act allowed virtuous complementarities between the public sector and civil society to develop the electrification of the country. As the original document says, it was about,

> An Act to provide for the construction or purchase of works for the generation, transmission and supply of electric power… [on] any area… [starting from] a petition shall be signed by not less than one-fourth of the ratepayers within each proposed constituent district… [at Governor-General]… For every electric-power district there shall be an Electric-power Board constituted… [and] every Electric-power Board shall consist of one or more representatives of each of the constituent districts within the electric-power district.[22]

In this second decade of the twentieth century, the electrification process was inspired by the supply of electricity to rural areas. In a report by the chief electrical engineer, Evan Parry, dated at October 26th, 1918, to the Minister of Public Works, he said:

> The extension of the Lake Coleridge supply to the country districts in Waimairi, Eyre, Halswell, Paparua, and Springs has served to demonstrate its convenience, utility, and its effect in lessening the drudgery of farm life and in increasing production, especially so in dairying districts (Parry 1918, p. 3).

With this experience, the necessity to promote the laying of distribution networks in the areas surrounding urban centres arose through agreements between the state and the power boards:

> To assist local bodies in reticulating their supply area, and so help to build up the load on the power-supply system and make it the more quickly come to the profit-earning stage, it is suggested that a fund should be provided for issue on short-dated loans to local authorities, or alternately to bear the cost of the Department carrying out reticulation work which will be taken over by local authorities as soon as it has been put into operation (Parry 1918, p. 11).

The result was an accelerated process of building of generation plants and transmission and distribution lines to supply electricity in cities and their respective hinterlands.

22. http://www.nzlii.org/nz/legis/hist_act/eba19189gv1918n5285/.

In sum, the exceptionality of New Zealand is notable. Since 1918 the government made it a priority to extend the distribution of electricity to the farms. By 1930 many farming areas had access to electricity and 80% of them had electric power by 1936 (McKinnon 1997). New Zealand was, in this sense, a pioneer in a worldwide perspective. In Europe, it was only during the 1930s when rural electrification began to spread.

Based on the evidence presented in this section, we can affirm that the regulations and policies related to electric power diffusion in New Zealand contemplated and prioritized the arrival of electricity to rural areas, at least, 15 years before this was identified as a problem in Uruguay.

## 7. Electrical network

Hydro-electricity generation began on a small scale in New Zealand in the late nineteenth century. It was immediately identified as a clean, reliable and instant form of energy and with extensive production and consumption applications. It could provide heat and light for homes, and electricity was particularly useful on dairy farms, where it could be used to run milking machines, light milking sheds, and heat water for cleaning and sterilising. Small power companies in Taranaki built their own hydroelectric plants in the late nineteenth and early twentieth century, offering energy to local towns and farms. In the first decade of the twentieth century, small electricity-generating stations were mainly found in dairying regions like Taranaki, Waikato and Southland (Swarbrick 2016).

From 1918 onwards, the government gave priority to extending electricity lines to farms with a clear objective of helping to develop agriculture. Power boards were set up, and had to ensure that the grids reached the hinterlands of cities and villages.

In Figure 4, we present a map with both islands that represents the electricity network in New Zealand (classified by voltage), and it can be seen how it extends into farming areas. Canterbury, Otago and Southland, like Waikato, the Bay of Plenty, Taranaki, Rangitikei and Wairarapa, were electrified relatively early in the twentieth century.[23] The first farms had been connected to electricity in the early 1890s, while remote areas of the country (Northland, the East Cape and the West Coast) were not yet connected in 1930.

23. New Zealand parliamentary papers, 1930, AJHR 1930 D-1, following p. 146 (Appendix D: annual report of the chief electrical engineer, maps showing electrical supply areas, North Island (Te Ika a Maui) and South Island (Te Wai Pounamu)). Labelled on the maps as X43 and X44. https://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&d=AJHR1930-I.2.2.3.1&pg=201&e=-------50--1---bySH---0-JHR%5f1930%5fI%5fCZz-G-. Thanks to Prof. Malcolm Mc Kinnon for his generous advice in this matter.

**FIGURE 4 ▪** *New Zealand. Electrical network, 1930*


*Source:* own elaboration based on McKinnon (1997) and New Zealand parliamentary papers (1930).

In Uruguay, the scheme based on distributing electricity generated from direct current (DC) stations with low capacity per plant acted against the development of the electrical system (Figure 5). It implied low prospects for designing networks transmitting at high voltage to cover nearby rural areas or other cities or towns. A phenomenon of path dependency took place in the Uruguayan electrification process. Decisions in institutional and technological spheres prevented the construction of transmission or distribution networks of a certain density even in small areas.[24]

In times as advanced as September 1934, a publication of the public electricity company lamented the low penetration of electricity in "farming areas of outstanding production" (Energía 1934b, p. 25). This journal stated that the recent construction of the high voltage lines (Central and Centenario) opened the possibility of promoting the application of electrical energy in rural activities (especially dairy farms) and proposed the development of an educational campaign among rural producers "in order to properly teach […] with practical experience […] showing how electricity is used in rural work" (Energía 1934b, p. 15).

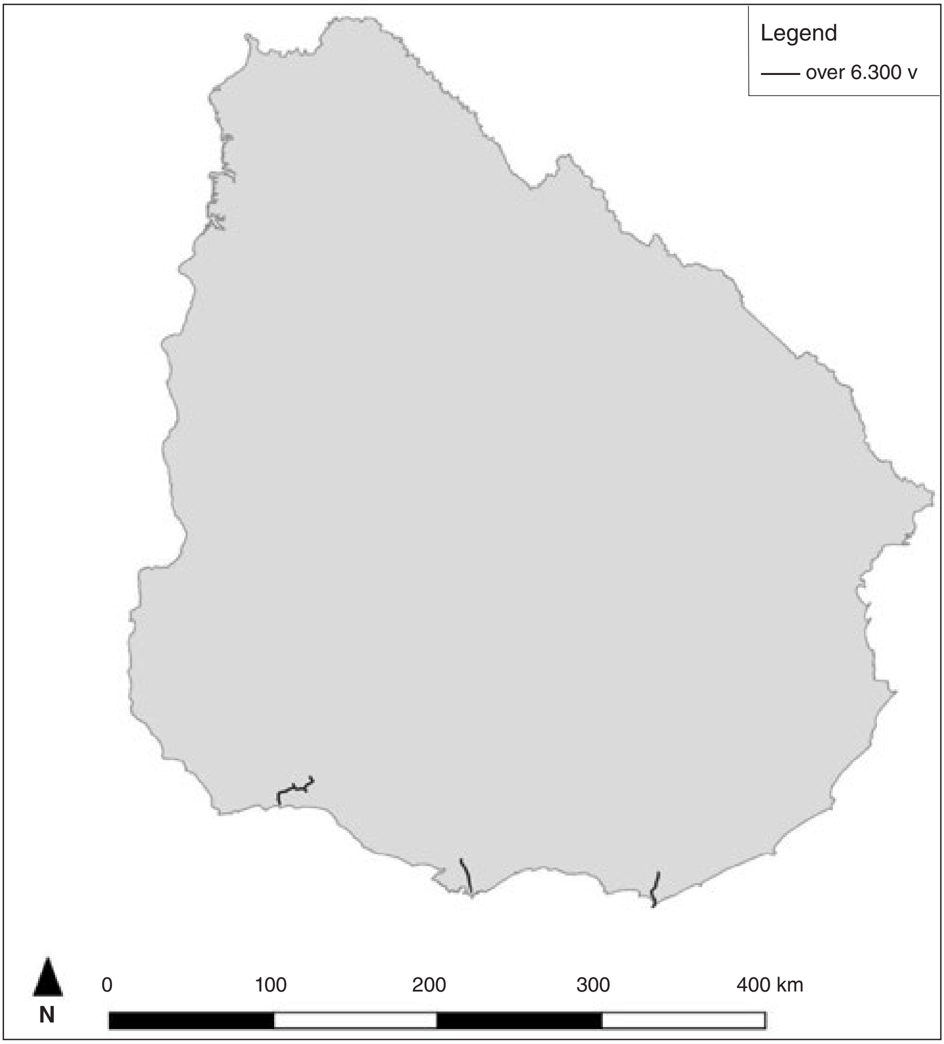
While New Zealand, by 1930, had hundreds of kilometres of transmission lines that resulted in a relatively dense grid in some regions (Figure 4), in Uruguay, at the same time, there were only a few tens of kilometres of high voltage lines. These networks allowed only modest supply to some localities in the vicinity of Rosario, Maldonado and Montevideo (in the south). In the rest of the territory, small power stations offered the public electricity service in 25 locations (Figure 5).

The construction of two high-voltage lines in the early 1930s was the first major change in the scale of the Uruguayan grid. As a result of these infrastructures, regions located up to 100 kilometres from Montevideo were interconnected, including provincial capitals such as San José, Florida and Canelones. Electricity was generated in a new thermal power plant inaugurated in Montevideo in 1932.

It should be noted that the area covered by this network was an area on which an incipient dairy farming industry was located. The arrival of electricity meant the possibility of major development in dairy in the 1940s. However, it was not until the 1950s that the Uruguayan electricity sector was configured as a mixed national utility grid (hydro and thermo) with an actual

24. A similar contrast between Argentina and Spain is presented in Bartolomé and Lanciotti (2015). The authors argue (own translation; we added the brackets): "The reasons for the divergence [in favour of Spain] in the results of these two electrifications are of a complex order, although the most reasonable thing is to think that the fundamental cause was the relative weight that in one place [Spain] and another [Argentina] had the water as primary source of electricity" (p. 102). In this paper, the network characteristics of hydro and thermo systems are discussed. Additionally, Betrán (2005) quantifies the differential impact of these two electrification models on economic growth of a sample of countries with different energy endowments.

**FIGURE 5** ▪ *Uruguay. Electrical network, 1930*




*Source:* own elaboration based on Energía (1934a).

capacity to offer electricity to the various economic activities in the territory. In Table 2 we present a summary of our evidence for around 1930 in both countries.

We consider the three main high-tension transmission lines of Uruguay – around the 90% of the generation – and the main power stations of New Zealand – around 60% – as well as the length of the lines and the corresponding coverage area. In the case of Uruguay, the city where the power station was located was not considered. In New Zealand, only lines over 11,000 volts were

**TABLE 2 ▪** *Reticulation indicators of New Zealand and Uruguay,* circa *1930*

| Power Station | Transmission lines | Length (km) (1) | Coverage area (km2) (2) | Consumers (no.) (3) | Consumption (kWh 000s) (4) | Consumption (kWh per c.) (4/3) |
|---|---|---|---|---|---|---|
| **URUGUAY** | | | | | | |
| Montevideo | Montevideo; La Paz; Las Piedras | 30 | 210 | 1,673 | 400 | 239 |
| Rosario | Rosario; Juan L. Lacaze; La Paz (Colonia Piamontesa); Col. Valdense; Nueva Helvecia | 42 | 200 | 777 | 149 | 192 |
| Maldonado | Maldonado; San Carlos; Punta del Este | 19 | 50 | 1,125 | 173 | 154 |
| | **Total** | **91** | **460** | **3,575** | **722** | **202** |
| **NEW ZEALAND** | | | | | | |
| Coleridge | Ashburton Power Board; Banks Peninsula Power Board; Christchurch City; Halswell County Council; Heatheote County Council; Kaiapoi Borough; Lyttelton Harbour Board; Lyttelton Borough; Malvern Power Board; North Canterbury Power Board; Rangiora Borough; Riccarton Borough; South Canterbury Power Board; Sumner Borough; Tai Tapu Dairy Co.; Timaru Borough; Waitaki Power Board; Waimairi County Council | 806 | 12,502 | 52,326 | 112,601 | 2,152 |
| Mangaho -Waikaremoana | Central Hawke's Bay; Dannevirke; Hawke's Bay; Horowhenua; Hutt Valley; Manawatu-Oroua; Poverty Bay; Tararua; Wairarapa; Wairoa; Wanganui-Rangitikei | 673 | 31,370 | 72,741 | 159,013 | 2,186 |
| Arapuni -Horahora | Cambridge Power Board; Central Power Board; Te Awamutu Power Board; Thames Valley Power Board; Waitorno Power Board; Franklin Power Board; Waitemata Power Board; Bay of Plenty Power Board; Hamilton Borough Council | 933 | 13,970 | 32,171 | 173,003 | 5,378 |
| | **Total** | **2,412** | **57,842** | **157,238** | **444,617** | **2,828** |

*Sources:* Electric Power Plants of the State. Annual Reports. Several years, for Uruguay. New Zealand parliamentary papers, 1930, AJHR 1930, for New Zealand.

considered and those over 6,300 volts in Uruguay. These decisions may be debatable but they are justified because the important issue, from the perspective of our analysis, is to show long distance transmission lines (which requires high-voltage connections).

The evidence is overwhelming to show the magnitude of the difference in the reticulation in both countries.

Although our data records only 60% of the generation in New Zealand, the extension is more than 27 times that of Uruguay and 126 times the area covered.

We propose an indicator of density of the network in the form of the ratio between the coverage area and the length of the lines. This is an index that represents how many square kilometres are served by each kilometre of line. The ratio for New Zealand (24) is almost five times that of the Uruguayan ratio (5). This is accompanied by huge differences in terms of consumers served and energy consumed. Whereas the average user in Uruguay consumed 202 kWh, in New Zealand this ratio reached 2,828 kWh; i.e., the consumption per user in New Zealand was 14 times higher than in Uruguay.

The huge contrast observed in Table 2 corresponds – beyond demand factors – to a technological component. While Uruguay bet, from the origins of electrification and until the 1930s, on thermoelectricity and distributed generation – even until the 1920s with a predominance of direct current generators – in New Zealand the authorities opted early for hydroelectricity and remote transmission, which enhanced the possibility of electricity distribution in urban and rural districts.

But these enormous differences between the electrical systems also manifested themselves in important differences in terms of investment and, consequently, in financial matter.

Around 1930, the capital outlay amounted to £13,765,542 in New Zealand, a substantial share of which was financed by public debt (60%).[25] In contrast, Uruguay had capital stock, at that same time, of £2,614,422 in electrification, of which only 35% was financed by public debt.[26] The economic incidence of both amounts was then different.

As the capital stock represented 25% of total government expenditures in Uruguay,[27] in New Zealand, the same measure amounted to 55%.[28] In terms of GDP, the difference in favour of New Zealand was lower; as the capital

25. The New Zealand Official Year-Book, 1930. (https://www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1930/NZOYB_1930.html).

26. Electric Power Plants of the State "1929 Annual Report". We used the exchange rate from Maubrigades (2003) to show the Uruguayan data in pounds.

27. Calculation corresponds to Central Government (Azar et al. 2009).

28. Calculation corresponds to General Government (The New Zealand Official Year-Book, 1930, https://www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1930/NZOYB_1930.html).

stock represented 3% of GDP in Uruguay,[29] in New Zealand the ratio was 4%.[30] In other words, the gap in terms of fiscal priority of the energy investment was higher than in terms of the macroeconomic priority,[31] illustrative of the relevance of energy policy for the New Zealand state.

Although during the First World War and in the immediate post-war period the availability of financing sources was very restricted, in the 1920s the context could have been different and probably New Zealand enjoyed more favourable conditions due its specific relation with the British capital market.

## 8. Conclusions

Valorisation of natural resources results from a complex interaction between endowment, available technology and institutional arrangements that reflects power relations. From this perspective, the state appears as a key agent to understand the channels through which the endogeneity of natural resources is expressed.

New Zealand – in the last decades of the nineteenth century – and Uruguay – in the early twentieth century – showed the influence of political parties with a strong belief in the role that the state must adopt to achieve results in terms of economic development and social welfare. In this sense, when we analyse energy policies in both countries in the early twentieth century, the differences are not the extent of state intervention but the kind of this intervention.

In New Zealand, the government promoted state control of natural resources, viewing them as the basis of economic and social development. This strategy included considerations about strategic management of natural wealth, improvement in the productive capabilities of private agents and amendment of social conditions. As a result, the government of New Zealand set up administrative and institutional arrangements that were closer to the notion of a developmental state (Willebald 2011).

In Uruguay, the construction of a "social republic" did not have, in the energy sector, a clear expression of developmentalism. Unquestionably, the electricity policy improved the public welfare of consumers in Montevideo and in the largest cities of the country, but the extension and the coverage of the electrical grid was small. It was not until the 1930s–1940s that expansion was significant and linkages with production activities gained major relevance (coinciding with the industrialization process).

29. GDP comes from Román and Willebald (2021).
30. GDP comes from Brigss (2003).
31. Here, we are paraphrasing standard concepts of fiscal economics.

In a previous article (Bertoni and Willebald 2016), we dealt with the role of the abundance of natural energy resources in the capability of countries to offer electrical energy to consumers and producers. In the present article, we consider the role of the state in this process and, in particular, in the construction of an extensive electrical network. As further research, we propose study of energy demand to understand the economic possibilities opened up by electricity expansion. In particular, we will focus on the role of the distribution of population throughout the territory, because this process could have determined the convenience of different technological options to offer electrical energy to consumption and production. The constitution of multiple nodes of generation and distribution of electrical energy in New Zealand (see Figure 4) contrasts significantly with the case of Uruguay – only Montevideo – (Figure 5) and the relation with the concentration of people seems evident. It is possible that this was associated, in addition to the institutional factors studied in this article, to a lower cost in the technical standardization process in the case of New Zealand. This becomes part our research agenda.

**Acknowledgments**

We thank the comments of the participants of the workshop "Economic History, Energy and Natural Resources", 2017 Ridge Forum, May 2017, and the Annual Congress of the Asociación Uruguaya de Historia Económica (AUDHE), especially the suggestions of D. Baquero, V. Pinilla, E. Travieso and L. Bértola. We also thank Prof. Malcolm McKinnon for his generous advice for mapping the electric network of New Zealand. We thank very specially Martin Hahn, for his excellent work in the reproduction and design of the maps that represent the electricity networks of both countries. Finally, we also thank the anonymous reviewers and the editors of *RHI-IHR* for their helpful comments and insights.

**Author contribution statement**

Reto Bertoni: framework, methodology, formal analysis, investigation, data set, writing, visualization and supervision.

Henry Willebald: framework, methodology, formal analysis, investigation, data set, writing, visualization and supervision.

We have followed an alphabetic criterion for the authorship order.

## References

ACEMOGLU, Daron, Simon JOHNSON, and James A. ROBINSON. 2001. 'The colonial origins of comparative development: an empirical investigation', *American Economic Review*, 91 (5): 1369-1401.

ÁLVAREZ, Jorge. 2014. 'Instituciones, cambio tecnológico y productividad en los sistemas agrarios de Nueva Zelanda y Uruguay. Patrones y trayectorias de largo plazo'. PhD thesis, Montevideo: Programa de Historia Económica y Social, Facultad de Ciencias Sociales, Universidad de la República, Uruguay (PHES-FCE-UdelaR).

ÁLVAREZ, Jorge, and Luis BÉRTOLA. 2013. 'So Similar, So Different: New Zealand and Uruguay in the World Economy'. In *Settler Economies in World History*, edited by Christopher Lloyd, Jacob Metzer and Richard Sutch, 493-520. Netherlands: Brill.

ÁLVAREZ, Jorge, Ennio BILANCINI, Simone D'ALESSANDRO, and Gabriel PORCILE. 2011. 'Agricultural Institutions, Industrialization and Growth: The Case of New Zealand and Uruguay in 1870–1940', *Explorations in Economic History*, 48: 151-168.

AZAR, Paola, Ulises GARCIA REPETTO, Reto BERTONI, Claudia SANGUINETTI, and Mariana SIENRA. 2009. *De quiénes, para quiénes y para qué. Las finanzas públicas en el Uruguay del Siglo XX*. Montevideo: Fin de Siglo.

BARTOLOMÉ, Isabel, and Norma LANCIOTTI. 2015. 'La electrificación en países de industrialización tardía: Argentina y España, 1890-1950'. *Revista de Historia Industrial*, 59, 24 (2): 81-113.

BERTONI, Reto. 2002. 'Economía y cambio técnico: adopción y difusión de la energía eléctrica en Uruguay: 1880-1980'. Master's thesis, Montevideo: Programa de Historia Económica y Social, Facultad de Ciencias Sociales, Universidad de la República, Uruguay (PHES-FCE-UdelaR).

BERTONI, Reto. 2011. *Energía y Desarrollo. La restricción energética en Uruguay como problema*. Montevideo: CSIC / Universidad de la República.

BERTONI, Reto, and Henry WILLEBALD. 2016. 'Do Natural Energy Endowments Matter? New Zealand and Uruguay in a Comparative Perspective, 1870-1940'. *Australian Economic History Review*, 56 (1): 70-99.

BETRÁN, Concepción. 2005. 'Natural resources, electrification and economic growth from the end of the nineteenth century until World War II'. *Revista de Historia Económica – Journal of Iberian and Latin American Economic History*, 23 (1): 47-82.

BJERKHOLT, Olav, Svein LONGVA, Øynstein OLSEN, and Steinar STROM, eds. 1983. *Analysis of Supply and Demand of Electricity in the Norwegian Economy*. Oslo: Statistisk Sentralbyrå.

BLOOMFIELD, Gerald T. 1984. *New Zealand: A handbook of historical statistics*. Boston Massachusetts: GK Hall & Co.

BOLT, Jutta, Robert INKLAAR, Herman DE JONG, and Jan LUITEN VAN ZANDEN. 2018. 'Rebasing "Maddison": new income comparisons and the shape of long-run economic development'. Maddison Project Working Paper 10, Groningen: Groningen Growth and Development Centre.

Bonino, Nicolás, Antonio Tena-Junguito, and Henry Willebald. 2015. 'Uruguay and the First Globalization. On the accuracy of export performance, 1870-1913'. *Revista de Historia Económica - Journal of Iberian and Latin American Economic History*, 33 (2): 287-320.

Briggs, Phil. 2003. 'Looking at the numbers: a view of New Zealand's economic history'. *Research monograph* (New Zealand Institute of Economic Research) 69, Wellington: NZ Institute of Economic Research.

Caetano, Gerardo. 1991/1992. *La República Conservadora (1916-1929).* 2 volumes, Montevideo: Editorial Fin de Siglo.

Cook, Megan. 2016. 'Energy Supply and Use – Electricity, Late 19th to Mid-20th Century'. *Te Ara - the Encyclopedia of New Zealand*. http://www.TeAra.govt.nz/en/interactive/21443/expanding-network-1930 [accessed 13 September 2021].

Culy, John, Grant Read, and Brain Wright. 1996. 'The Evolution of New Zealand's Electricity Supply Structure'. In *International Comparisons of Electricity Regulation*, edited by Richard J. Gilbert and Edward Kahn, 312-365. Cambridge, UK: Cambridge University Press.

Di Tella, Guido. 1982. 'The Economics of the Frontier'. In *Economic in the Long View*, edited by Charles Kindleberger and Guido Di Tella, 210-227. London: Macmillan.

Ding, Ning, and Barry Field. 2004. 'Natural Resource Abundance and Economic Growth'. Working Paper No. 2004-7. Massachusetts: University of Massachusetts Amherst, Department of Resource Economics. http://www.umass.edu/resec/workingpapers.

Dubash, Navroz. 2004. 'Electric Power Reform: Social and Environmental Issues'. In *Encyclopedia of Energy*, edited by Cutler Cleveland, 255. Elsevier Science, Vol. 2.

Duncan, Bill. 2011. 'An Overview of New Zealand's Electricity System, 1908–1999'. IPENZ, http://www.ipenz.org.nz/heritage/itemdetail.cfm?itemid=2407 [Accessed 08/26/2017].

Energía. 1934a. 'El desenvolvimiento de los servicios de la UTE en los 20 años que lleva de existencia', *Revista de la UTE*, 1 (2): 1-72.

Energía. 1934b. 'La electricidad aplicada a las industrias rurales', *Revista de la UTE*, 1 (3).

Foreman-Peck, James. 1983. *A History of the World Economy. International Economic Relations since 1850*. Brighton, UK: Harvester Press.

Freeman, Christopher. 1989. 'The Third Kondratieff Wave: Age of Steel, Electrification and Imperialism'. In *Festschrift in Honour of Lars Herlitz*, edited by Kihlstrom et al. Göteborg: Ed. Daidalos.

General Administration of Electric Power Plants of the State. Annual Reports. Several years.

General Administration of Power Plants and State Telephones (UTE) (July 1936). *Journal of the UTE*, 2.

Hausman, William, Peter Hertner, and Mirra Wilkins. 2008. *Global Electrification. Multinational Enterprise and International Finance in the History of Light and Power, 1878-2007*. Cambridge, NY: University Press.

HJALMARSSON, Lennart. 1996. 'From club-regulation to market competition in the Scandinavian electricity supply industry'. In *International Comparisons of Electricity Regulation*, edited by Richard J. Gilbert and Edward Kahn, 129-178. Cambridge, UK: Cambridge University Press.

LEWIS, William. 1983. *Crecimiento y Fluctuaciones*. Mexico: Fundación de Cultura Económica.

LINEHAM, Brent T. 1968. 'New Zealand's Gross Domestic Product, 1918/38', *New Zealand Economic Papers*, 2: 15-26.

MARTIN, John. 1998. *People, Politics and Power Stations. Electric Power Generation in New Zealand 1880-1998*. Wellington: Electricity Corporation of New Zealand.

MAUBRIGADES, Silvana. 2003. 'Mercado de Cambios 1929-1975', Serie Auxiliares de Investigación. Programa de Historia Económica y Social, Facultad de Ciencias Sociales, Universidad de la República, Uruguay.

MCKINNON, Malcolm, ed. 1997. *Bateman New Zealand historical atlas: ko papatuanuku e takoto nei*. Auckland: David Bateman, plate 88.

MEDINA VIDAL, Marcos. 1952. *Reseña Histórica de la UTE*. Montevideo. Ed. Medina.

MEDLOCK, Kenneth. 2004. 'Economics of Energy Demand'. In *Encyclopedia of Energy*, edited by Cutler Cleveland, 65-78. Elsevier Science.

MILBURN, Josephine. 1960. 'Socialism and Social Reform in Nineteenth-Century New Zealand', *Political Science* 12 (1): 62-70.

MINISTRY FOR CULTURE AND HERITAGE. *New Zealand History*, Research and Publishing Group of New Zealand (https://nzhistory.govt.nz).

MYLLYNTAUS, Timo. 1994. 'Electricity supply systems in the nordic countries'. In *Electricity generation and supply: regulation, market and competition. International comparison*, edited by Alain Beltran and Henri Morsel, 73-84, Eleventh International Economic History Congress. Milan: Universitá Bocconi.

OFFICIAL INFORMATION CENTER. NATIONAL REGISTER OF ACTS AND DECREES (several years). www.impo.gub.uy.

OGILVIE BUCHANAN, Robert. 1930. 'Hydro-Electric Power Development in New Zealand', *The Geographical Journal*, 75 (5): 444-457.

OXMAN, Ramón. 1961. *Energía, Consumo, Producción y Política Energética*. Montevideo: Universidad de la República.

NEWBERY, David. 2001. *Privatization, Restructuring and regulation of network industries*. Cambridge MA: MIT Press.

PARRY, Evan. 1918. *Hydro-electric development*. Report by the Chief Electrical Engineer to the Honorable Sir W. Eraser, Minister of Public Works. Laid on the Table of the House of Representatives by Leave. https://teara.govt.nz/en/biographies/3p11/parry-evan.

PAULSON, Ross. 1988. 'Review: The Antipodeans Connection: New Zealand Liberalism and American Progressivism', *Review in American History*, 16 (2): 272-277.

PEREZ, Carlota. 2009. 'Technological revolutions and techno-economic paradigms'. Working Paper No. 20, Tallin: Norway and Tallinn University of Technology.

PEREZ, Carlota, and Luc SOETE, L. 1988. 'Catching up in technology: Entry barriers and windows of opportunity'. In *Technical Change and Economic Theory*, edited by Giovanni Dosi, Christopher Freeman, Richard Nelson, Gerard Silverberg and Luc Soete, 458-79. London / New York: Pinter

ROMÁN, Carolina, and Henry WILLEBALD. 2021. 'Structural change in a small natural resource intensive economy: Switching between diversification and re-primarization, Uruguay, 1870-2017', *Economic History of Developing Regions*, 36 (1): 57-81.

ROZAS, Patricio, and José Luis BONIFAZ. 2014. 'Notas sobre la teoría de la empresa pública de servicios de infraestructura y su regulación'. *Serie Recursos Naturales e Infraestructura,* No. 165. Santiago de Chile: CEPAL.

SAES, Alexander, and Norma LANCIOTTI. 2012. 'La regulación de los servicios de electricidad en Argentina y Brasil (1890-1962)', *Economia e Sociedade*, 21 (2): 409-447.

STRINGLEMAN, Hugh, and Frank SCRIMGEOUR. 2012. 'Dairying and dairy products - Beginnings of New Zealand's dairy industry', *Te Ara - the Encyclopedia of New Zealand*. http://www.TeAra.govt.nz/en/dairying-and-dairy-products/page-1.

SWARBRICK, Nancy. 2016. 'Rural services – Electricity'. *Te Ara - the Encyclopedia of New Zealand*. http://www.TeAra.govt.nz/en/rural-services/page-4.

WAITER, Andrea. 2020. 'Capacidades de la ingeniería nacional y tomadores de decisiones: la construcción de la represa hidroeléctrica en Rincón del Bonete, Uruguay 1904-1945', *REDES*, 26 (51).

WILLEBALD, Henry. 2011. 'Natural resources, settler economies and economic development during the First Globalization: land frontier expansion and institutional arrangements'. PhD dissertation in Economic History, Universidad Carlos III de Madrid, Departamento de Historia Económica e Instituciones, Getafe, http://hdl.handle.net/10016/12281.

WILLEBALD, Henry. 2015. 'Distributive Patterns in Settler Economies: Agrarian Income Inequality during the First Globalization (1870-1913)', *Historia Agraria. Revista de agricultura e historia rural*, 66, 75-104.

WILLEBALD, Henry, Marc BADÍA-MIRÓ, and Vicente PINILLA. 2015. 'Introduction: Natural Resources and Economic Development. What Can We Learn from History?'. In *Natural Resources and Economic Growth: Learning from History*, edited by Marc Badía-Miró, Vicente Pinilla and Henry Willebald, 21-45. London / New York: Routledge.

WILLIAMSON, Jeffrey. 2011. *Trade and Poverty: When the Third World Fell Behind*. Cambridge, MA: MIT Press.

WRIGHT, Gavin. 2015. 'The USA as a case study in resource- based development'. In *Natural Resources and Economic Growth: Learning from History*, edited by Marc Badía-Miró, Vicente Pinilla and Henry Willebald, 119-139. London / New York: Routledge Explorations in Economic History, Taylor & Francis Group.

WRIGHT, Gavin, and Jesse CZELUSTA. 2007. 'Resource-based Growth, Past and Present'. In *Natural Resources: Neither Curse nor Destiny*, edited by Daniel Lederman and William Maloney, 183-211. Stanford, CA: Stanford University Press.

■

## *L'electricitat i el paper de l'estat: Nova Zelanda i Uruguai abans del desenvolupament dirigit per l'estat (1870-1930)*

RESUM

La configuració d'una estructura productiva moderna requereix un subministrament d'energia suficient a costos competitius. Des del darrer terç del segle XIX, la producció de carbó i les millors condicions naturals per generar energia hidroelèctrica a baix cost expliquen, almenys parcialment, les diferències a favor de Nova Zelanda. Tanmateix, els arranjaments institucionals són un altre factor rellevant de diferenciació. L'argument que planteja aquest article es basa en el concepte d'endogeneïtat dels recursos naturals i s'aplica per demostrar el paper dels diferents estats en els sistemes elèctrics. La intervenció estatal va procurar millorar les condicions de benestar a l'Uruguai sense parar prou atenció als aspectes productius; en canvi, a Nova Zelanda el desenvolupament de la producció va ser el focus de l'acció pública. Com a resultat, es va consolidar una xarxa elèctrica més extensa i densa a Nova Zelanda que, potencialment, hauria creat millors condicions de diversificació i producció rural.

PARAULES CLAU: economies d'assentament recent, endogeneïtat dels recursos naturals, paper de l'estat, sistema elèctric, electricitat i desenvolupament.

CODIS JEL: N50, N70, Q41

■

## *Electricidad y el papel del Estado: Nueva Zelanda y Uruguay antes del desarrollo dirigido por el Estado (1870-1930)*

RESUMEN

La configuración de una estructura productiva «moderna» requiere un suministro de energía suficiente a costos competitivos. Desde el último tercio del siglo XIX, la producción de carbón y las mejores condiciones naturales para generar energía hidroeléctrica a bajo costo explican, al menos en parte, las diferencias en favor de Nueva Zelanda. Sin embargo, los arreglos institucionales son otro factor relevante de diferenciación. El argumento planteado se basa en el concepto de endogeneidad de los recursos naturales, y se aplica para probar los distintos roles de los Estados en los sistemas eléctricos. La intervención estatal procuró mejorar las condiciones de bienestar en Uruguay sin prestar suficiente atención a los aspectos productivos; en cambio, en Nueva Zelanda, el desarrollo de la producción fue el foco de la acción pública. Como resultado, se consolidó una red eléctrica más extensa y densa en Nueva Zelanda que, potencialmente, habría creado mejores condiciones de diversificación y producción rural.

PALABRAS CLAVE: economías de reciente asentamiento; endogeneidad de los recursos naturales, rol del Estado; sistema eléctrico, electricidad y desarrollo.

CÓDIGOS JEL: N50, N70, Q41