The singularity of the energy transition in Latin America, 1900–1950: Schurr revisited*

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All studies dealing with the energy history of a country point to a typical phenomenon, present in all cases. Over time, stages can be identified in which an energy source (or type of energy source) clearly predominates, and then gradually begins to recede with the advance of a new energy source which eventually replaces it. This phenomenon has become known as *energy transition* and is defined as the gradual substitution of one energy source or type of energy source by another, through history. In 1960, Schurr was the first scholar to show the American energy transition between 1880 and 1950. In brief, the logic of this phenomenon is the replacement of traditional energies by other more modern sources, types or forms of energy. That is, energies which are "better" in terms of efficiency, yield, versatility, or any other attribute, which implies that the energy transition should be understood as a process of *energy modernisation.*[1] The processes of energy transitions, in particular the fossil energy transition, have been studied or at least described in most industrialised countries, but not in relatively less developed countries. In the case of Latin American and Caribbean countries, historiographic studies have not provided data or arguments to explain these. The aim of this paper is to analyse the phenomenon of the *energy transition* in fossil energies (the shift from coal to petroleum) and to discuss, in comparison with the classic model of energy transition, the singularity of Latin America. This is was not possible before now since the data was not available for these countries prior to 1950 when the transition was already complete.[2] For our

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[1] A. Grüble proposes a more complex definition of energy transitions "in terms of three interdependent characteristics: quantities (growth in amounts of energy harnessed and used), structure (which types of energy forms are harnessed, processed, and delivered to the final consumers as well as where these activities take place), and quality (the energetic and environmental characteristics of the various energy forms used). See Grüble (2004) "Transitions in Energy Use", *Encyclopedia of Energy*, vol. 6, p. 163

[2] Several studies provided punctual estimates in the first half of the 20th century, with data hardly ever comparable across countries. Punctual estimates for years 1928, 1929 and 1939, are found respectively in: U.S. Department of Commerce (by J.R.Bradley) (1931); Read (1933); Read (1945). Only three studies provide historical series of energy consumption in Latin America, namely UN-ECLA (1951), UN-United Nations. Economic Commission for Latin America (1951), ECLA (1957) United Nations. Economic Commission for Latin America (1957) and Darmstadter et al. (1971). Respectively, they provide data for 5, 7 and 11 countries of Latin America and the Caribbean starting in 1925 the earliest.

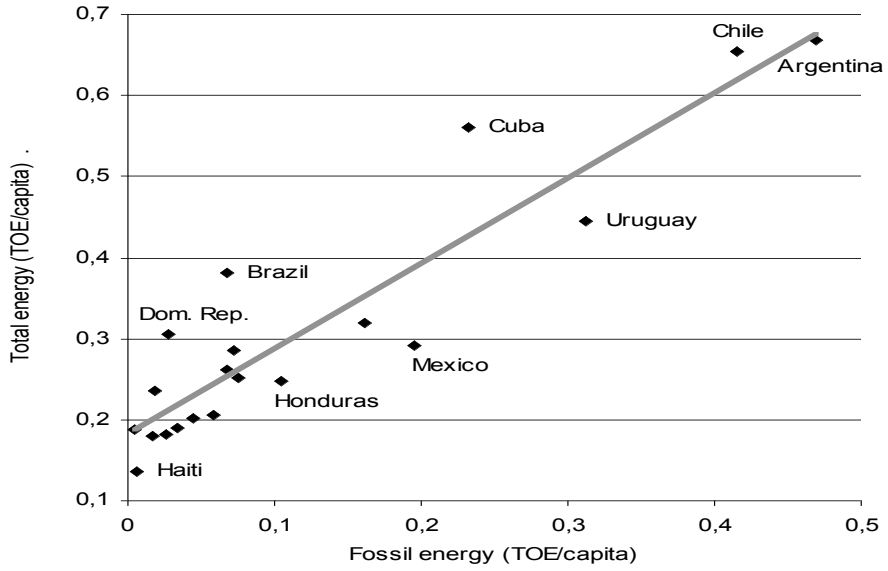
discussion we make use of a new reconstruction of data on energy consumption for Latin America and the Caribbean from 1890 to 1950.[3]

1. why concentrate on the fossil fuels transition?

There is not only one energy transition, but rather various energy transitions which can be consecutive, overlap in time or occur in parallel. One such transition is that from traditional energy sources to modern energies, that is, the abandonment of fuels of organic origin. Another transition is that of fossil fuels; from coal to petroleum. Another transition, which relates to energy forms, is the advance of electrical energy, regardless of its source.

The decision to concentrate on the energy transition of fossil fuels can be justified as follows: evidently, an exhaustive study of energy history should include the consumption of all types of fuel, including organic fuel (firewood, bagasse and vegetable coal) and also the use of other energy sources. Nevertheless, if we are interested in identifying changes in the pattern of energy consumption, then fossil fuel consumption between 1890 and the 1950s is a fundamental indicator.

Graph 1. Relation between total energy consumption per capita and fossil energy consumption per capita in Latin America in 1939.



Source: Elaboration by the authors using ECLAC data (1956), *La energia en América Latina.*

[3] Rubio et al. (forthcoming). On the fundaments and orientation of the data reconstruction see Carreras *et al.* (2003): "El desarollo económico de América Latina en épocas de globalización. Una agenda de Investigación", ECLAC. For an in-depth discussion of the methodological problems encountered with the reconstruction of historical statistics of energy consumption and the solutions adopted by the authors, see Folchi, Mauricio and Maria del Mar Rubio (2004), "El consumo aparente de energía fósil en los países latinoanericanos hacia 1925: una propuesta metodológica a partir de las estadísticas de comercio exterior", Second National Congress of Economic History, Mexican Association of Economic History, Mexico D.F.; also Rubio, M. d. M. and Mauricio Folchi (2005), "Energy as an Indicator of Modernisation in Latin America by 1925", Universidad Pompeu Fabra, *Economics & Business Papers,* no.868.

Apart from punctual exceptions which are restricted in time, in the 19th century and occasionally in the 20th century (some railways, some lighting systems and some metallurgical and industrial activities), fuels of organic origin have not been used in modern activities, but rather in traditional ones such as domestic and some rural activities.[4] This explains how consumption per capita of this type of fuel tends to remain steady over time. If a country experiences a significant increase in total energy consumption per capita, it is highly probable that this will be reflected in the item of fossil fuel (see graph no. 1).[5]

One indisputable fact among studies of the history of energy is the positive relation between income level and energy consumption per capita. Irrespective of space and time, high income economies consume the most energy per capita and low income societies consume the least.[6] In the same way, we can say that there is a certain negative relation between the proportion of organic fuel consumed per person in an economy, and the level of production of the organic fuel. Activities which use traditional fuels are those which generate the least economic growth and as a result, it should not be surprising that the countries where the relative consumption of organic energy is the highest are those with the lowest income levels (see graph no. 2).[7]

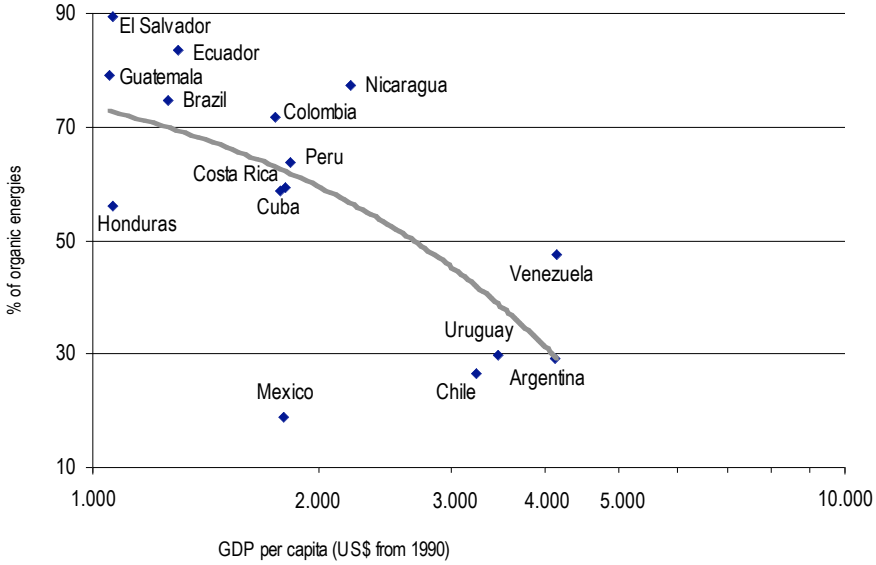
[4] The exceptions are interesting areas of study: the railways and steelworks in Brazil, copper and nitrate mining in Chile, the Cuban sugar industry, etc. FALTAN LAS CITAS FOLCHI (TESIS) REINALDO (CUBA) Y BRASIL

[5] Martin Melosi warns that "identifying wood as a pre-industrial or even primitive fuel would be erroneous, in the case of North America [...] wood was an indispensable element in the development of locomotives, steamships, and the growth of the iron industry require the use of coal". Effectively, in the mid 19th century, half of the iron was produced in the United States using charcoal. Melosi, Martin V. (1982): "Energy Transitions in the Nineteenth-Century Economy", 60. However, the importance of these cases is above all qualitative. In the case of U.S.A., 95,5% of the total firewood and charcoal consumed in 1879 was for domestic use. The remaining 4,5% was divided up among the railways (1,3%), the manufacturing industry (1,3%), iron foundry ((1,0%), steam ships (0,5%) and mining (0,4%). Williams, Michael (1982), "Clearing the United States forest: pivotal years", Journal of Historical Geography, vol. 8, no. 1, p. 21.

[6] This phenomenon has been recognized by economists since the beginning of the 20th century – see Hobson (1914) and Carver (1924) – and has been debated since the first studies of T. Read in the early thirties, in which he asserted that 'a general relationship between *work done* [energy consumption] per capita and economic well-being is observable; but a precise correlation is not yet possible' (Read (1933), 'The World's Output of Work', *American Economic Review,* 23, no.1, 55). In the same vein, Arnulf Grüble argued recently that "North-South disparities in the growth of energy-use roughly mirror disparities in income growth because growth in energy use is linked to growth in incomes" and that "the overall positive correlation between economic growth and energy growth remains one of the most important "stylized facts" we can draw from history, even if the extent of this correlation and its patterns over time are highly variable". Grüble (2004), "Transitions in Energy Use", *Encyclopedia of Energy,* vol. 6, p. 167.

[7] G. Leach argued in the same manner: "A major switch from the use of traditional biomass fuels to `modern´ fossil fuels and electricity appears to be a basic feature of economic growth with its associated urbanization and industrialization. In the poorest developing countries biomass fuels account for 60-95% of total energy use, in middle income countries for 25-60%, and in high-income industrialized countries - with minor exceptions - for less than 5%". Leach (1992), "The Energy Transition", *Energy Policy,* vol. 20, no. 2, p. 116.

Graph 2. Relation between relative consumption of organic energy and income level in Latin America in 1939.



Source: Elaboration by the authors using ECLAC data (1956), *La energia en América Latina* and Maddison (2003) *The World Economy: Historical Statistics.*

For these reasons, we insist that in order to identify quantitative and qualitative changes in energy consumption patterns, it is necessary to concentrate on fossil fuels.

However, apart from the study of the historical advance of fossil fuels, another significant area of study is the rivalry between different fossil fuels, that is, the energy transition from coal to petroleum. The significance of this is that this mutation has an enormous repercussion, not only on the energy model concerned, but also on all the technological, economic, social, cultural and environmental changes which accompany this transition. An energy change implies social, economic and environmental change. According to Melosi:

"The concept *energy transition* is useful as a historical tool. In a broad sense, the concept can illuminate the evolution of material human culture, the growth and the economic development [...]. As a mechanism of change, the energy transition influences and is influenced by technical, economic, political, environmental and social forces which also mark society".[8]

A separate issue is the generation of hydroelectric energy which, like fossil fuels, is a modern energy form and consequently is counted along with fossil fuels. The proportion of hydroelectricity in the total consumption of modern energies varies considerably across

[8] Melosi (1982). "Energy Transitions in the Nineteenth-Century Economy", *op cit*, p. 55.

countries.[9] Nevertheless, this item is not included in this study, which concentrates, for the aforementioned reasons, on fossil fuel consumption and on the energy transition within fossil fuels: the coal/petroleum ratio.

2. The fossil fuels transition: models and experiences

The *energy transition* in the USA is widely accepted as a paradigmatic case. Between 1890 and 1955 there were two energy transitions: from wood to coal in the 19th century, and from coal to petroleum in the early 20th century. The use of wood (and to a lesser extent wind and water power) prevailed in the USA until the mid 19th century, with wood consumption peaking in 1885. Coal became a leader in energy and fossil fuel markets from 1885 until the First World War. In 1910 coal comprised 76.8% of total energy and 89.2% of all fossil fuels. As of this moment, coal started to decline, while petroleum, or rather petroleum companies, started to steadily increase their market share, to the detriment of coal companies.[10] Towards 1950, the market share of petroleum in the energy market was already greater than that of coal and constituted over 50% of total energy consumed. In the early seventies, the share of coal in the energy market had decreased to 20%, while that of petroleum reached 75% of total energy and 95% of fossil energy (see graph number 16).

Roughly the same process occurred in European countries, but with one important difference: coal had a much longer life. In Great Britain, for example, the phase of the predominance of coal started much earlier (at the end of 18th century) and ended much later. In the years subsequent to 1947 the United Kingdom was still very dependent on coal (90% of primary energy consumed) and "the energy policy of the country was basically still a coal policy". Coal consumption in Great Britain reached a historical peak in 1950,[11] and did not fall below 50% until 1970. In the early fifties, coal comprised approximately 70% of the total energy consumed in many European countries, whilst in the USA it represented approximately 30%. It was only in the sixties and seventies when there was a sharp decline in the percentage of coal of total energy consumed in European countries. For example, the percentage of coal in Germany fell from 90% in 1955 to 32% twenty years later. In France, the percentage of coal dropped from 70% to 18% during the same period. In Holland, where natural gas had been exploited since the sixties, the percentage of coal fell from 73% in 1955 to non-existent levels in the

[9] According to the United Nations report *World Energy Supplies in selected years, 1929-1950*, the eight countries where the hydroelectric sector was significant were: Costa Rica (36.0%), Ecuador (30.2%), Bolivia (18.4%), Colombia (15.1%), Peru (15.8%), Mexico (14.6%), El Salvador (12.0%) and Brazil (11.8%). It is noteworthy that these percentages are calculated from approximate estimates recorded in the aforementioned publication. There is no methodological explanation of these figures and thus they should be considered with the utmost reservation.

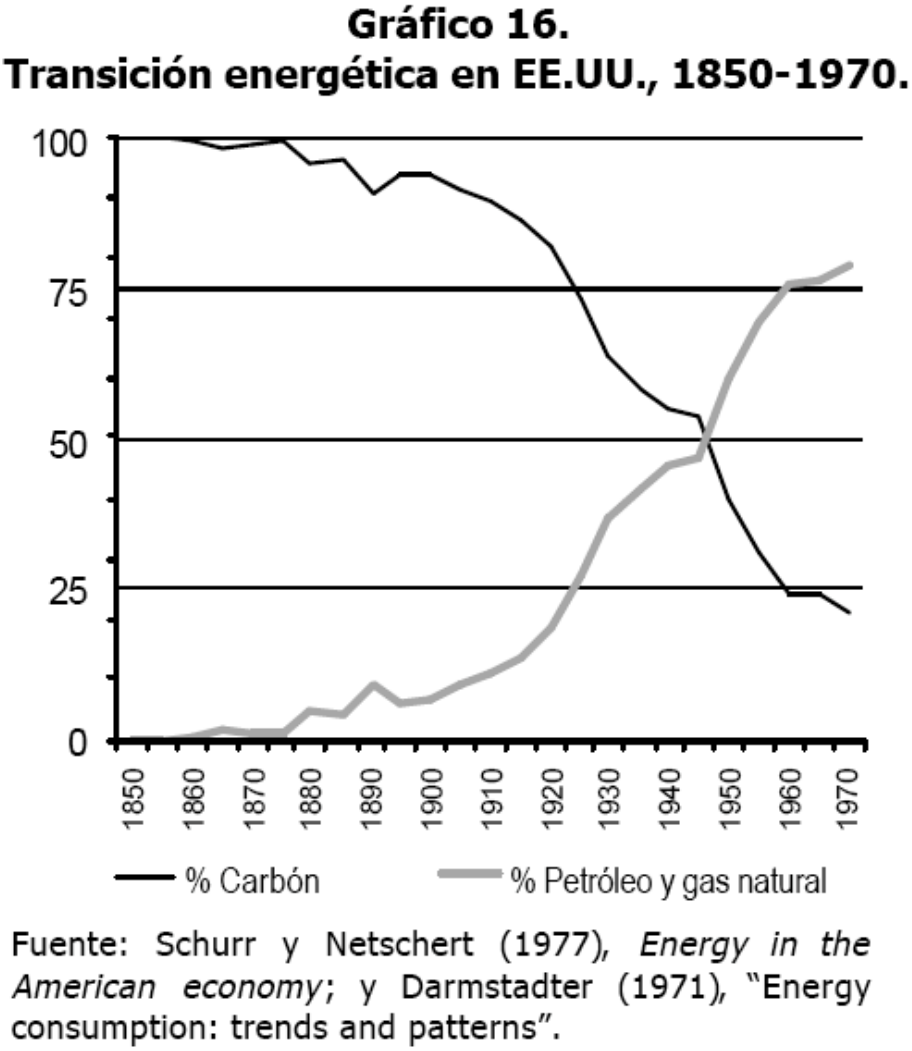
[10] An excellent description of the circumstances which prompted the advance of petroleum in the USA at the beginning of the 20th century, and of the strategies employed by petroleum companies to gain market share, can be found in Pratt (1981). It is noteworthy that during this advance, the use of petroleum also went through different stages before replacing coal as the main energy source. The period from 1869 until the nineties is known as the kerosene period, when kerosene was used for lighting; then came the fuel oil period; and at the turn of the century gasoline fuelled internal combustion engines. See also Melosi (1982), "Energy Transitions in the Nineteenth-Century Economy", p. 56

[11] Peake, S. (1994), *Transport in Transition: Lessons from the History of Energy,* p.

seventies.[12] In Spain, petroleum consumption became predominant only at the end of the sixties.[13]

Graph 16. Energy transition in the USA, 1850-1970.

Source: Schurr and Netschert (1977), *Energy in the American economy;* and Darmstadter (1971), "Energy consumption: trends and patterns".



According to this logic of energy transitions, one would expect that, after the USA and the industrialised European countries, all countries in the process of economic modernisation would

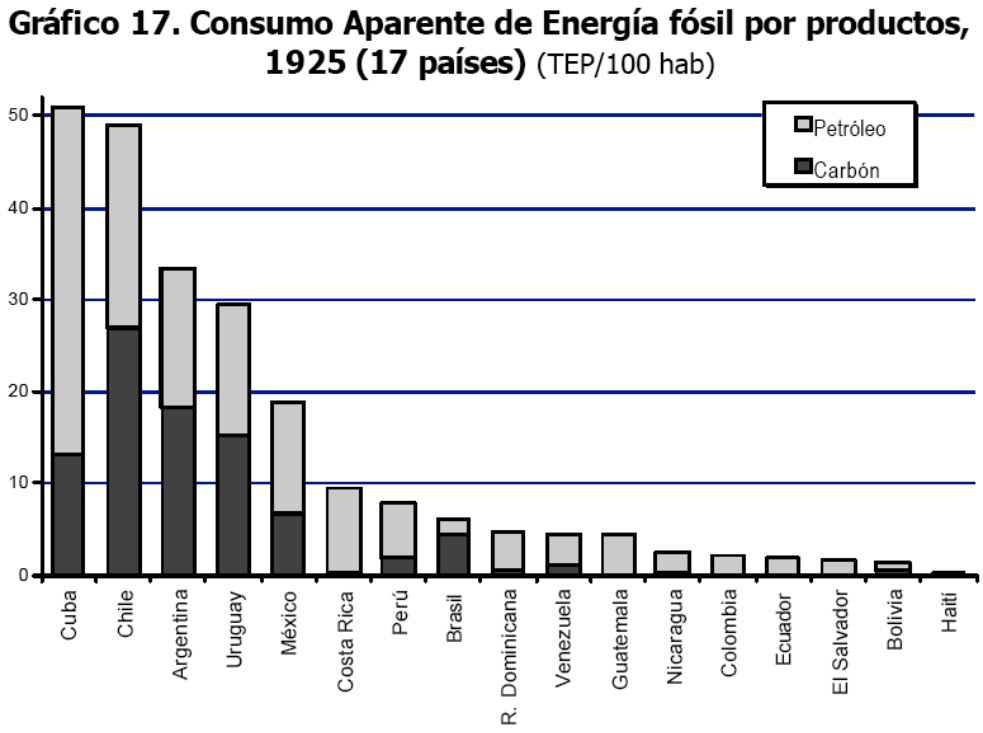
[12] Dunkerley, J. (1980): "Energy Use Trends in Industrial Countries: Implications for Conservation," *Energy Journal,* vol. 20, no. 2, p. 107
[13] Rubio ICE// Gales et al// Bartoletto Rubio // Rubio, M.d.M., "Series for the energy history of Spain: 1850-2001" Naples, (at the press).

have shown, with a certain time lag (according to the relative economic development gap of each country), the same pattern of energy succession in three phases: biomass, coal and petroleum. Likewise, one would expect a similar path in the transition from coal to petroleum. Nevertheless, in spite of the regularity of this phenomenon in the USA and Western Europe, we should not forget that energy transition is a complex phenomenon, governed by a variety of forces and circumstances. Thus, we can expect energy transition to occur in accordance with the North American or European model only in those countries where the set of forces and circumstances are similar.

7. The transition of fossil energies in Latin America

Accepting as true the hypothesis that all countries made their energy transition at different points in the 20th century, at a faster or slower pace, and using proportion of coal and petroleum consumed, we can do the exercise of estimating at what point of the transition each country was in 1925.

Graph 17. Apparent fossil energy consumption by products, 1925 (17 countries) (TOE/ 100 inhabitants)



The first striking fact is that for most of Central America coal accounts for an insignificant proportion, which suggests a relation with the geographic location of these countries. On the other hand, the Southern Cone countries show a clear tendency towards a greater use of coal.

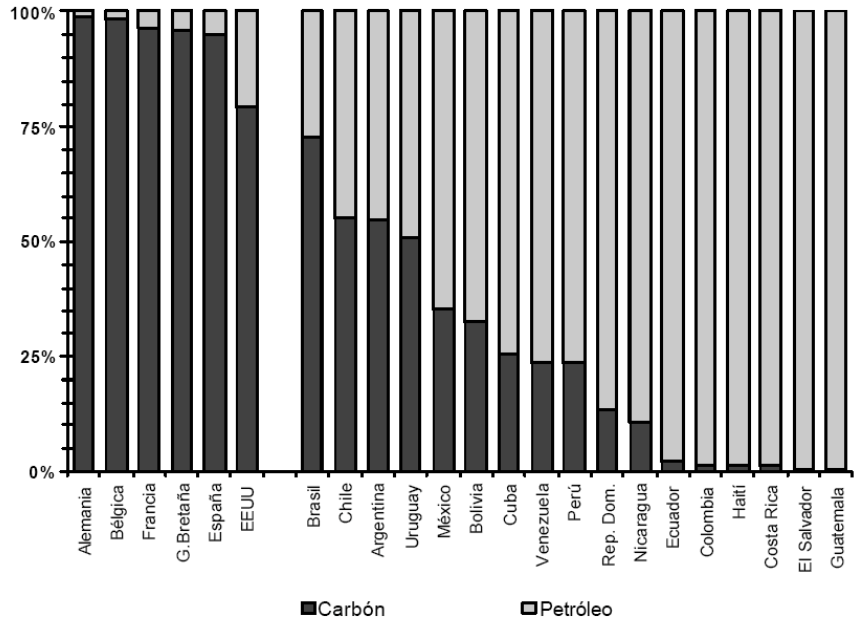
In fact, Argentina, Chile and Uruguay together account for 52% of apparent energy consumption in the region. The explanation for this can probably be found in the industrial and commercial history of these countries.

On comparing the levels of transition of Latin American countries in 1925 with some model countries the conclusion is clear: that the substitution of coal for petroleum occurred very early in Latin America (in time and in relation to GDP levels), compared to what occurred in industrialised countries. Arranged in order of proportion of coal out of all fossil fuels, the USA – the industrialised country which made the transition earliest, and therefore where petroleum features most – is to the left of Brazil, which is the Latin American country with the highest proportion of coal consumption out of all the fossil fuels. In other words, what these figures suggest is that in all Latin American countries, without exception, the energy transition occurred either prior to industrialised countries or more rapidly. Remarkable cases include the Dominican Republic, Nicaragua, Ecuador, Colombia, Haiti, Costa Rica, El Salvador and Guatemala where, it appears, the energy transition had already run its course in 1925.

Graph 18. Energy transition in 1925 (Latin America and Model countries)

Note: The data for the six model countries are taken from Darmstadter *et al.* (1973)

Gráfico 18. Transición Energética al año 1925 (América Latina y Países de referencia



Nota: Los datos de los seis países de referencia están tomados de Darmstadter *et al.* (1973)

In order to corroborate this initial interpretation, it is necessary to complement the information provided by this data sample with long series which we provide for eleven countries (see graphs 19 to 29). By regarding the transition in the long term, one can determine whether the data for 1925 represents a trend or, instead, is an exception. In addition, it is only by taking a long term perspective that we can determine whether the value for 1925, if this was indeed a normal year, is part of a short-term or long-term process.

The first thing that these data show is that, although in all cases the energy transition is confirmed, neither the American nor the European cases provide us with models with which to interpret Latin American cases. They differ in terms of the path of the transition, which oscillated much more in Latin American cases. They also diverge in terms of chronology, with Latin American transitions occurring much earlier. Also, the speed of the process varies a lot in Latin American cases. The group of Latin American countries offers not one, but five models of transition.

Graphs 19 to 29 (at the end of the paper)
Energy transition in eleven Latin American countries, 1890-1950s

Graph 19. Argentina
Graph 20. Brazil
Graph 21. Costa Rica
Graph 22. Cuba
Graph 23. Chile
Graph 24. Uruguay
Graph 25. Haiti
Graph 26. Nicaragua
Graph 27. Dominican Republic
Graph 28. Honduras
Graph 29. El Salvador

In the first place, there are the cases of Brazil and Argentina, which most resemble the classic model: a relatively long and clear transition. Nevertheless, both cases are remarkable in terms of one important issue: chronology. In the USA and Europe, petroleum exceeds coal as from 1950, whereas in Brazil (the Latin American country where this happens latest) petroleum overtakes coal as from 1940. In the remainder of countries in the region, the primacy of petroleum occurs in the twenties, that is, thirty or forty years previously. In the case of Argentina, there is another striking difference, shared by most countries in the region. Within 28 years, coal fell from a quota of 93.7% to 10.8%. In the USA this same transformation took more than 70 years. Costa Rica is practically a model of its own. The transition in this country oscillated moderately, as in most cases, but it was surprisingly fast: the transition occurred in barely five years. In 1914 coal accounted for 96% of the consumption of fossil fuels, in 1919 it had decreased irreversibly to 5.5%. Cuba is a similar case to Costa Rica. In this country, the energy transition also took place abruptly, but in two phases: there was a marked change between 1919 and 1922 followed by a period of 16 years of relative stability, and then a second and definitive phase when coal fell as from 1939. We can identify a fourth model made up of a

group of countries where coal retreats and recovers in several cycles, with petroleum only predominating clearly many years after the start of the transition process. In the case of Chile, this lack of clarity about the process went on for as long as 56 years. It was not until 1961 that coal entered the final phase of descent, after three attempts at recovery. In the case of Uruguay what occurred was similar, although over a shorter time period: 32 years, between 1911 and 1943. In Haiti the same phenomenon occurred but the change was even sharper. Coal, which in ten years dropped from 82% to 14% (1904), managed to recover to 69% just before the Second World War, after which it fell definitively. A similar story is that of the transition in Nicaragua where the early and relatively short transition undergoes a cycle where coal recovers between 1896 and 1907. A fifth model, even further removed from the American paradigm, is represented by Honduras and the Dominican Republic where a reverse transition appears to have occurred. These countries enter the fossil fuel era at the end of the 19th century with petroleum consumption higher than coal, but after some years coal starts to strengthen and experiences a period of primacy starting in 1893 in the Dominican Republic and in 1899 in Honduras and lasting until the end of the First World War in both cases. El Salvador fits into this same model. This country, as in the former two appears to access modernity by means of petroleum and then suffers an abrupt and ephemeral rise of coal, but with marked oscillations which cause some doubts.

8. Reasons for the singularity of the energy transition in Latin America

The North American experience of the energy transition offers a very clear model: the power of coal allowed it to advance ahead of traditional energy forms until it dominated all energy systems: urban, industrial and transport. However, from the beginning of the 20th century a new energy source, petroleum, began to gain ground steadily until 60 years later, it had reduced the quota of coal to 25% or less.

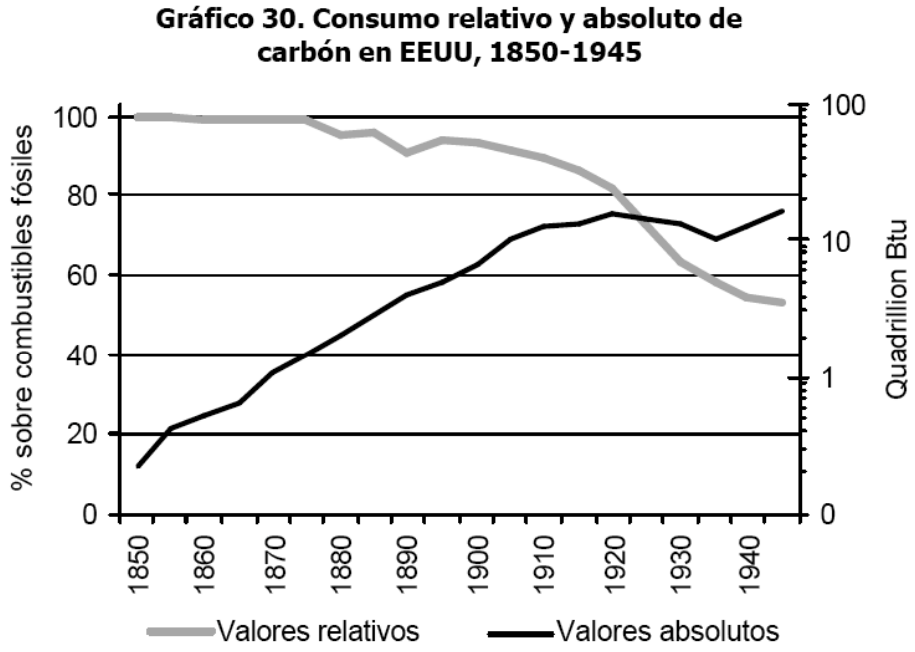
When considering Latin America the question arises as to why it did not follow a similar path of energy transition and why there were so many different courses.

Before exploring the answer to this, it is necessary to take into account that the model version of energy transition is always expressed in relative terms and not absolutes (see graph 30). Energy transition does not necessarily mean the generalised abandonment of coal and of coal technologies. In order for energy transition to occur, the pre-requisite is that coal and coal technologies, in absolute terms, remain relatively stable while petroleum and the associated technologies (the internal combustion engine, in the first place) grow steadily. In this sense, the advance of petroleum does need to dominate all industrial sectors. Some such sectors continue with coal. In order for the transition to happen, it is necessary that those economic activities

which from their beginnings use petroleum technologies, or those which convert to petroleum technologies, expand more than those which continue with coal.

Graph 30. Relative and absolute coal consumption in the USA, 1850-1945

Source: Schurr and Netschert (1977) *Energy in the American Economy, 1850-1975.*



Fuente: Schurr y Netschert (1977) *Energy in the American Economy, 1850-1975.*

With respect to the forces that are behind the advance of petroleum, there is no doubt that the most important is the price per calorific unit. Interestingly, in its early years, petroleum was more expensive to produce than coal. Nevertheless, petroleum was much cheaper to transport by tanker or pipeline than coal was by railway.[14] The greater the distance that fuel needed to be transported, the greater the price competitiveness of petroleum.[15] As well as the relation between price/calorific unit at the point of consumption, petroleum had other technical attributes such as versatility, weight and volume which gave it an absolute advantage over coal in important sectors like motorised transport. We must add to this that the penetration of a product into markets is not simply a consequence of free market play, but rather a consequence of the greater or lesser efficiency of the strategies developed by the companies which trade in these products. In this sense, the petroleum companies – the first big companies and the first *trust* in history – left an indelible mark.[16]

[14] Richard Rodhes has argued that "Oil might have declined, because it was much more expensive per unit of energy than coal, but because it is a liquid it is also much cheaper to transport. Even as late as 1955, the cost per mile of transporting a ton of liquid fuel energy by tanker or pipeline was less than 15 percent of the cost of transporting an equal amount of coal energy by train". See Rodhes (2002), Energy Transitions: a history lesson".

[15] Grüble introduces an interesting nuance to this argument. He claims that "It is important to recognise that these two major historical shifts were not driven by resource scarcity or by direct economic signals such as prices, even if these exerts an influence at various times. Put simply, it was not the scarcity of coal that led to the introduction of more expensive oil. Instead, these major historical shifts were, first of all, technology shifts, particularly at the level of energy end use". Grüble (2004) "Transitions in Energy Use", *op cit,* p. 170

[16] On this, see Pratt, J. (1983), "El ascenso del petróleo...", *op cit.*

The experience of Latin America can be considered a discovery. The explanation of what occurred requires the setting up of a new research agenda which considers the multiple factors that intervene in the relative and absolute advance of petroleum, and in the relative retreat and stagnation or the absolute decline of coal, in the case of each country. Nevertheless, we are able to advance some hypotheses which can be deduced from an examination of the data.

The main difference which is evident in the different Latin American experiences is the difference in the rate at which coal is abandoned. At one extreme are Argentina and Uruguay where, although the process is rapid compared to that of the industrialised world, it is relatively slow in the Latin American context. At the other extreme are countries such as Costa Rica or El Salvador, where the process is extraordinarily rapid.

The first line of interpretation of this phenomenon is that the countries which begin the process of industrialisation early (Argentina, Chile, Uruguay and Brazil)[17] and therefore have a relative high level of coal consumption, tend to maintain longer the classic pattern of energy consumption (based on coal). This is a clear manifestation of *path dependence*.[18] On the contrary, in countries which industrialised more recently, where coal technologies are absent or scarce, it is easier to adopt high technologies which use liquid fuel. In the less industrialised countries fossil fuel consumption is much more reduced, present in fewer productive sectors and, probably, its adoption depends on the decision of a far smaller number of companies. In this scenario, which predominated in Central America and the Caribbean at the beginning of the century, it is highly probable that the influence of North American technology facilitated the shift of these countries towards the use of petroleum technologies.

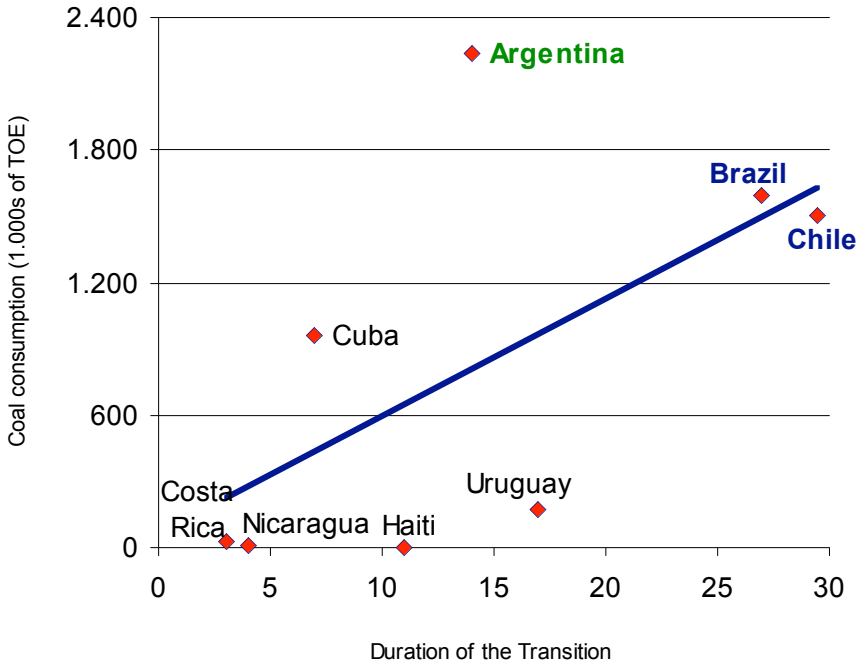
The second line of interpretation is related with trade networks. In the case of Argentina, it was probably because of its historical trade ties with Great Britain that it remained a great consumer of British fuel (coal) for so long. In the case of Latin American and Caribbean countries, there is no doubt that the geographical proximity, trade ties and the presence of North American companies which were big fuel consumers, like *United Fruit*, favoured the rapid adoption of petroleum.

Another element that merits consideration is factor endowment. The commercial inertia which tied Argentina to Great Britain was obviously broken when Argentina started to exploit its own oilfields. From that point onwards coal imports dropped irremissibly. In the case of Chile the

[17] We understand *industrialisation* in a broad sense, that is, not only as the development of the manufacturing sector, transportation and urban services, but also as the transformation or modernisation of the primary sector (agriculture, fishing, mining and forestry) with the introduction of machinery powered by modern energy forms.
[18] The idea of the *path dependence* of development, or historical inertia, refers to those technological configurations or institutions which developed historically and which end up eliminating alternatives (which initially were a possibility) and restricting the range of options when innovations are introduced.

initial situation is similar to that of Argentina, but the transition path is completely different because of Chile's own resource endowment (coal). The Chilean industrialisation starts off relatively early, fed firstly by imported coal and later national coal. The probable reason for the delayed abandonment of coal, as well as the strange cycles of recovery throughout the industrialisation process, can be found in successive policies of promotion of national industry which obliged a large proportion of consumers to favour national coal instead of petroleum (imported).

Graph 31. Level of coal consumption (thousands of TOE) at the beginning of the transition and duration (years) of the process in eight countries



Source: Elaboration by the authors

Another factor which conditions the energy transition in Latin America is the international situation. It is not coincidence that Costa Rica shifted from coal to petroleum between 1914 and 1919. Evidently, North American petroleum companies took advantage of the export restrictions on European coal-supplier countries during the First World War, supplying a fuel-hungry country. It is highly probable that the same happened in Cuba and the Dominican Republic, and to a certain degree in Argentina and Uruguay. In all these cases, the transition accelerated or occurred in the context of restriction of international trade (see graph number 31).

9. Conclusion

We believe we have demonstrated that the energy transition model of the USA and Western Europe cannot be considered as the paradigm of fossil energy transition, but rather as one of the possible versions of fossil energy transition, and itself a particularly slow and relatively delayed transition.

It also appears clear that the succession of energy sources is not governed by a universal law of progress or of technical change. Instead, it is the result of a set of historical determinants among which the most remarkable include the structural conditions in each country (geographical location, resource endowment, economic structure, technological dependence, institutional framework, etc.) and the junctures and long term evolution of the international energy and fuel markets. According to the combination of all these factors, each country traces a particular path of energy transition.

Evidently, the explanation as to why Latin American and Caribbean countries made such a rapid and early transition is to found by considering each case separately. It must also be recognised that there will not be one single cause. This point opens up a wealth of fascinating research options.

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Appendix. Table 2.
Apparent fossil energy consumption for 1925, various alternative estimates

Old and new estimates of energy consumption of fossil fuels per capita for Latin America in 1925 (tones of oil equivalent per 1,000 habitants)

	ECLA[a]	ECLA[b]			Darmstadter et al			New estimates					
	Total fossil energy	Petroleum	Coal	Total fossil energy	Petroleum	Coal	Total fossil energy	Petroleum	Coal	Total fossil energy	Petroleum	Coal	Total fossil energy
								domestic sources			foreign sources		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Latin American Republics													
Argentina	**341.4**	93.8	180.9	**274.7**	166.0	191.0	**257.0**	151.2	181.8	**333.0**	145.1	182.0	**327.1**
Bolivia					10.0	5.0	**1.5**	9.7	4.7	**14.4**	3.0	0.2	**3.2**
Brazil	**65.0**				19.0	51.0	**70.0**	16.7	44.8	**61.4**	15.8	51.4	**67.1**
Chile	**515.0**	223.5	246.0	**469.5**	228.0	219.0	**447.0**	220.1	269.6	**489.7**	201.9	261.	**463.8**
Colombia					24.0	11.00	**35.0**	21.6	0.3	**21.9**	21.9	0.3	**22.2**
Costa Rica		95.6	0.17	**97.3**				92.8	1.2	**94.0**	79.5	0.1	**79.6**
Cuba					392.0	136.0	**528.0**	378.7	130.5	**509.2**	346.4	137.0	**484.0**
Dominican R.								40.0	6.2	**46.2**	35.3	6.10	**41.4**
Ecuador					19.0	--	**19.0**	20.2	0.50	**20.7**	16.9	0.40	**17.4**
El Salvador		16.9	0.10	**17.0**				17.3	0.08	**17.4**	9.1	0.10	**9.1**
Guatemala		30.4	-	**30.4**				45.2	0.12	**45.3**	33.8	1.50	**35.3**
Haiti		2.2	0.04	**2.2**				3.2	0.05	**3.2**	2.1	0.00	**2.1**
Honduras											122.3	1.5	**123.9**
Mexico	**192.0**	72.1	54.2	**126.3**	240.0	70.0	**310.0**	122.3	66.5	**188.8**	159.8	68.5	**227.9**
Nicaragua								22.2	2.7	**24.9**	17.1	2.5	**19.6**
Panama											1,731.7	466.0	**2,197.9**
Paraguay											0.03	0.20	**0.05**
Peru					54.0	18.0	**72.0**	60.2	18.5	**78.7**	59.7	17.4	**77.1**
Uruguay					136.0	153.0	**289.0**	144.0	150.4	**294.4**	107.6	179.0	**287.2**
Venezuela								10.5	10.9	**21.4**	13.9	10.8	**24.7**

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Gráficos 19 al 29
Transición energética en once países latinoamericanos, 1890-1950s

Gráfico 19. Argentina

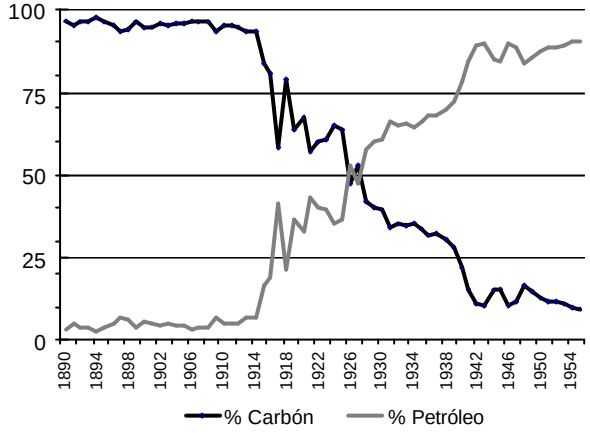


Gráfico 20. Brasil

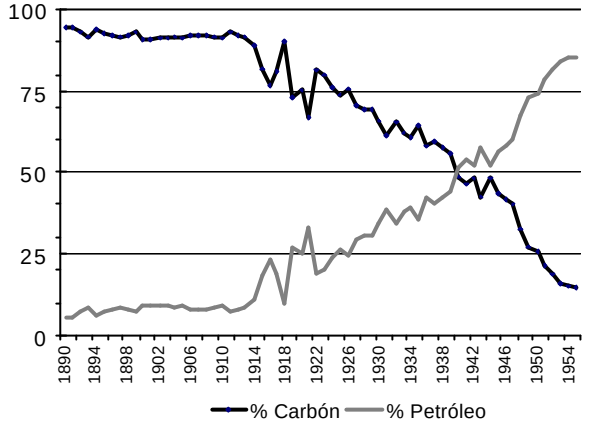
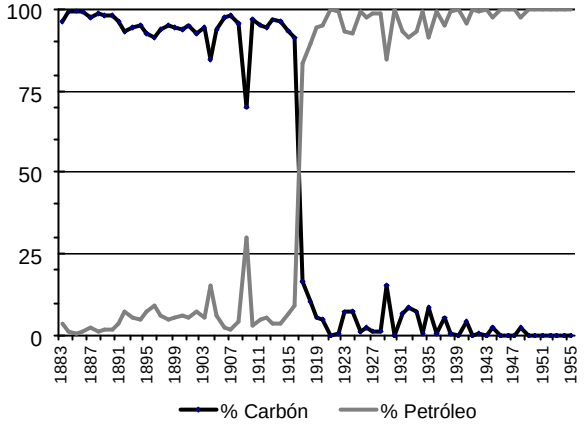


Gráfico 21. Costa Rica



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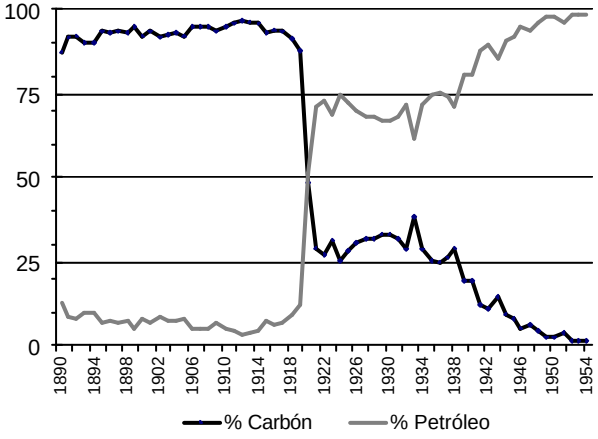

Gráfico 23. Chile

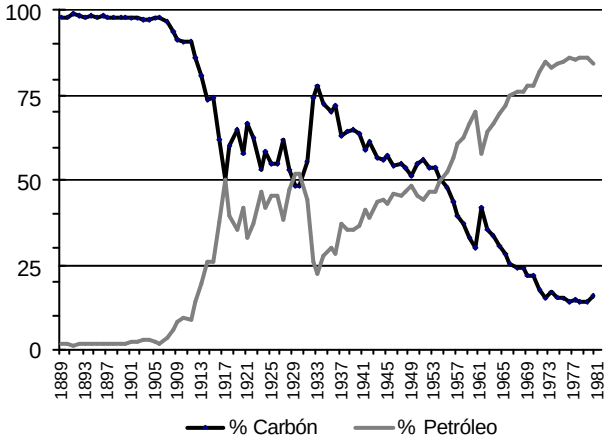

Gráfico 24. Uruguay

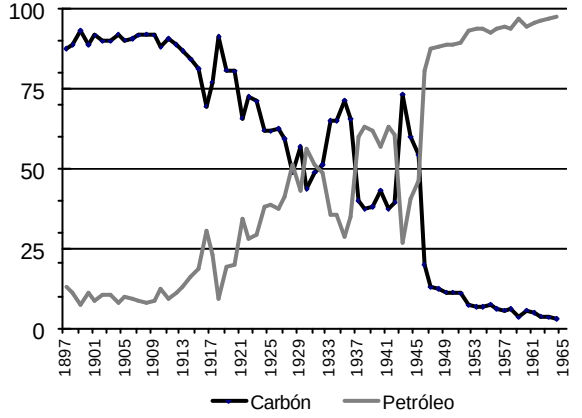

Gráfico 25. Haití

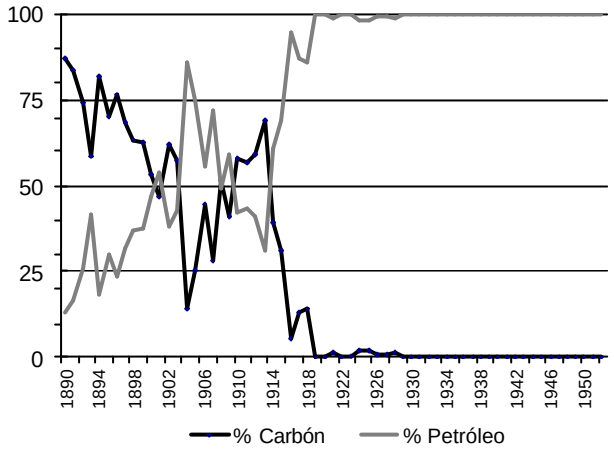

Gráfico 26. Nicaragua

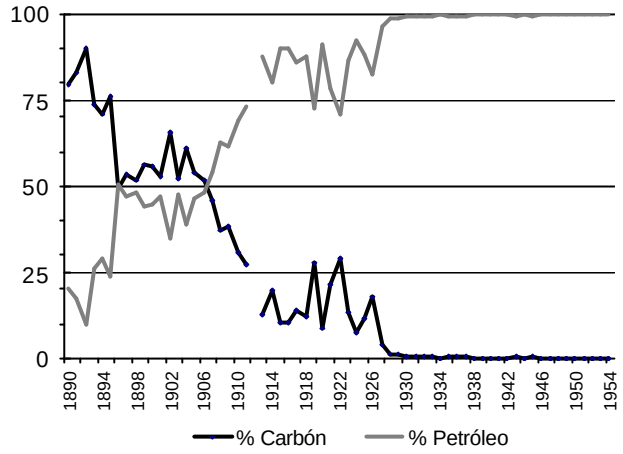

Gráfico 27. República Dominicana

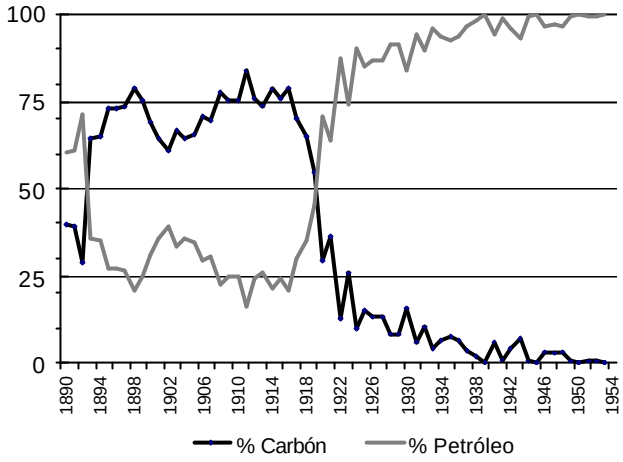

Gráfico 28. Honduras

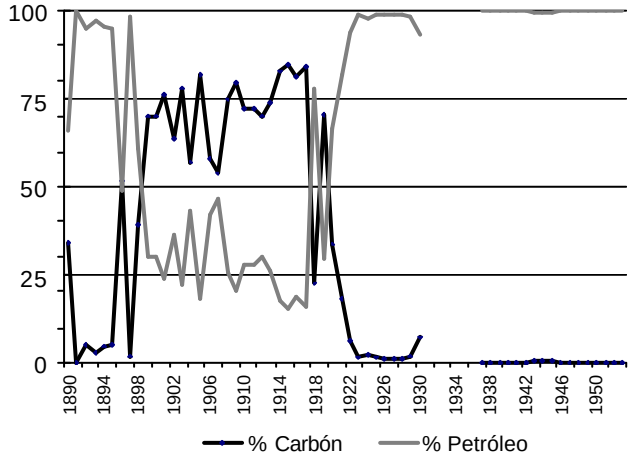

Gráfico 29. El Salvador