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Residential energy consumption in Spain during the 1960s. Butane and the precariousness of developmentalism

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ABSTRACT
This article illustrates a key episode in the energy transition from traditional to fossil energies, a pattern often observed in developing nations. It examines the sharp rise in Liquefied Petroleum Gas (LPG) consumption for domestic use in Spain during the 1960s, with a focus on regional disparities. While the Franco regime actively promoted LPG use through the firm Butano SA, regional differences cannot be fully explained by variations in climate or industrial structures. To explore this, the study analyses LPG consumption alongside other substitute energy sources for calorific uses (firewood, coal, city gas) and complementary energy sources for lighting (electricity). The factors driving the adoption of these energy sources are then assessed. The findings highlight the complexity of Spain's household energy transition and confirm significant disparities in energy access between rural and urban areas. A novel argument is introduced: LPG became closely associated with large Spanish cities and their metropolitan areas, where precarious housing conditions played a pivotal role in driving its widespread adoption.

KEYWORDS: Energy transition, LPG, Spain, Developmentalism

JEL CODES: N34, N74, N94

1. Introduction

Liquefied Petroleum Gases (LPG) triumphed in the domestic sphere in Spain in the 1960s, constituting a dizzying episode in the energy transition between traditional energies, firewood and other biofuels, and fossil energies. This event is similar to those experienced before and now in other developing countries (Grubler 2012; Rubio and Muñoz 2019): in 2000, more than 52 percent of the world's population used LPG for residential use, so that total consumption amounted to 202 million metric tons (World Bank and World LP Gas Association 2002: p. 32). The extraordinary character of the Spanish case lies in the dynamism of this phenomenon: between 1960 and 1979, LPG use in Spain increased from a marginal 0.08 percent to a substantial 4.1 percent of the final energy consumption, at a

time when the latter had tripled (Muñoz y Rubio, 2024).[1] The purpose of this article is to determine the size and pace of the diffusion of butane gas as part of the energy transition to oil fuels experienced by Spanish households in this decade.

During this period, there was a notable shift in the sources of residential caloric services. Initially, firewood and then coal were the primary fuels, but there was a subsequent transition towards the use of gas, particularly LPG. Meanwhile, electricity was primarily used for supplementary purposes, such as lighting and mechanical applications through household appliances. These changes occurred during the so-called 'developmentalism' period, which was characterised by rapid economic growth, but also by significant regional and social disparities. During this stage, both traditional and modern forms of energy existed concurrently, with LPG, and specifically butane gas, occupying a prominent position. Between 1958 and 1975, LPG was adopted on a mass scale and at a rapid pace in Spanish households. The number of LPG users rose from 649,419 in 1961 to 7,850,766 in 1969. This transformation coincided with the implementation of certain public policies designed to stimulate supply and with the increase in per capita income among Spanish consumers. However, these factors do not fully account for either the pace or the magnitude of the transformation. This article examines these energy changes in detail after estimating total domestic energy consumption. In addition, it identifies other factors influencing residential energy demand that are not directly related to total household income, such as internal emigration and precarious housing, as drivers of the switch from traditional energies to LPG (and electricity). The significant differences between the various Spanish regions provide insights into the magnitude and origin of these changes.

2. Background

The butane cylinder - along with the SEAT 600 car and the television - was one of the symbols of Spanish developmentalism, the structural economic transformation that boosted household consumption and, in turn, bequeathed a high degree of social inequality and territorial imbalances during late Francoism (Carreras and Tafunell 2018, ch. 8). After the crisis of the 1970s, LPG consumption stabilised but maintained its importance in the residential sector. The latter was estimated at 324 kg oil equivalent (kep) per inhabitant in 2016, according to Eurostat (INE 2019: p. 38). Of this, 7.38 per 100 (23.92 kep) corresponded to net residential LPG consumption. Despite the progress made in expanding the natural gas network, which reached 85,108 km in that year, around 5 million Spanish households (more than 27 percent of the total) were still attached to LPG in 2016 (Sedigas 2016: p. 17), 33 percent according to the CNMC Household Panel (Comisión Nacional de los Mercados y la Competencia 2020).

[1] The case of Portugal, considered another success story in the diffusion of LPGs, illustrates the outstanding character of this process in Spain. LPG consumption in Portugal grew from 0.03 to 3.11 percent in the same period, while total energy consumption had barely multiplied by 1.95 (Henriques, 2009).

In Spain, LPG was first widely used as a source of domestic energy for cooking, providing hot water and heating. In 1969, there was already one butane gas contract for every four people, with an average of 9.8 annual charges per 12.5-13 kg cylinder, i.e. an average consumption of 154 kg per user (and 36 kg per inhabitant) in 1969 (1968 and 1969 data). These figures are pretty similar to those in Portugal (Henriques 2011) and in some emerging economies - Morocco and Jordan (40 kg); 50 kg in Mexico and the Dominican Republic; and slightly lower than in Brazil and Thailand (Matthews et al 2011: p. 6).

The concept of household energy transition is used to describe this shift from traditional biofuels (i.e., firewood and other plant residues) to electricity and piped gas in developing countries, with intermediate steps represented by coal, paraffin and bottled gas such as LPG. The significant upward relationship between household income and fuel consumption has helped to shape the concept of the energy ladder, with the rungs representing the successive substitution of fuels as they improve in quality and environmental benefits (Grubler 2008). However, this linear and somewhat rigid perspective ignores the existence of indivisibilities between different energy services - caloric, lighting or mechanical - and specific fuels in households (Fouquet 2008). Some case studies show that energies, including those for residential use, are not perfect substitutes for each other, so that new and traditional energies often coexist in households during transition periods, depending on the different services (Masera et al 2000; Kroon et al 2013; Toole 2015).

In recent decades, domestic energy transitions in developing countries have proven to be long, arduous and non-linear processes, as the substitution of biomass fuels, despite its environmental consequences, often meets with the discontent of potential customers. Sanctions on the use of traditional fuels have failed (UNEP 2010; Kojima 2011; Matthews et al 2011; Ekouevi 2012; Raslavičius et al 2014; Pope et al 2018; Teixeira et al 2018; Colomer et al 2020). Promoting the supply of LPG as a 'clean' alternative by supporting its suppliers and controlling its prices has not produced better results either (Hepbasli 2003). Incentivising consumers by reducing the inherent costs of fuel substitution would be a first step, but insufficient when transitions run aground, as in China (Yang et al 2014).

Paradoxically, the Spanish case seems to show the exact opposite, as the success of LPGs was abrupt, but with large regional disparities. The analysis of their introduction in Spain could shed light on some of the explanatory variables of these transitions. Therefore, this article examines the domestic energy transition in Spain since the introduction of LPG, reconstructing the evolution of its per capita consumption and that of other domestic energy sources at the regional level, and highlighting some of the factors that influenced its explosive trajectory. To this end, we first explain how the diffusion of LPG began in Spain and what were the supply-side constraints and incentives for its adoption. We then estimate the annual evolution of total residential energy consumption for caloric usages in the Spanish regions, as well as that of the different sources, traditional and modern. Finally, the main differentiating factors between the regions are examined. All the evidence suggests that the energy transition in this sector has been less linear than

previously thought and that LPG has not grown in line with the decline of its substitutes, but rather hand to hand with other complementary energy services such as electricity. The sources used are the detailed national and regional statistics of the *Sindicato Vertical* until 1969 and those of the regulatory authorities since then, though the latter include only aggregated data at national level. Although it would have been interesting to analyse at least up to the 1973 crisis, this objective was frustrated by the serious discontinuities in the series from 1970 onwards.[2]

3. The shape of the LPG market in Spain

According to Grubler (2012, p. 9), technical and institutional transformations in final services are the key drivers of long-term energy transitions. However, in the economic literature, the focus on the supply side - on its natural and/or technological availability - prevails (Smil 1994; Kander et al 2014; Wrigley 2016). In Spain, energy demand has been assumed to be eminently elastic and strictly limited by the scarce endowment of energy sources and their high prices, forced by dependence on international markets (Sudrià 1987; Coll and Sudrià 1987; Bartolomé 2007). The abandonment of firewood (Infante and Iriarte 2017) and the adoption of LPG for domestic use in the mid-20th century would, in this logic, constitute the domestic episode of this Spanish energy liberation, as international prices of oil derivatives became affordable (Sudrià 1987; Rubio 2005).

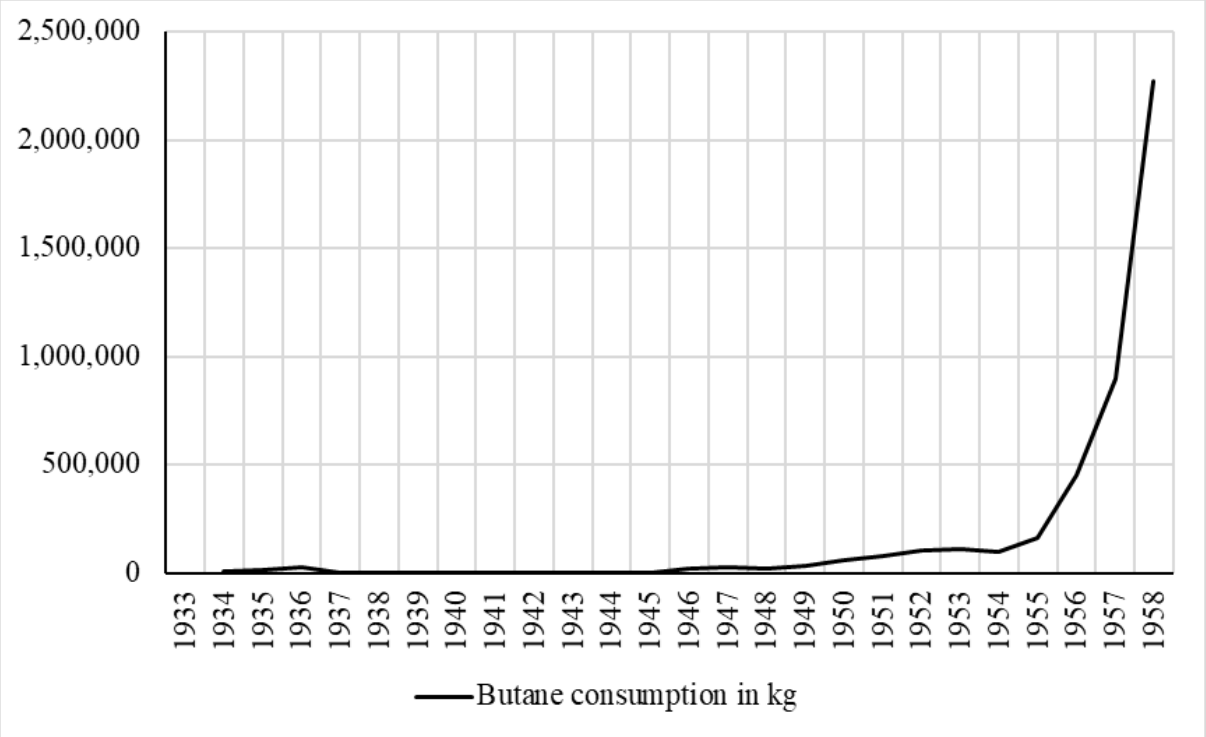
Indeed, the supply of LPG in Spain increased enormously since 1958 (Vela 1996). Previously, only some butane from France and the United States was consumed (Figure 1). LPG, which are naturally available in very limited quantities, are mainly produced in oil refineries as one of the lightest and most volatile derivatives of crude oil. Initially, they were considered a low-value residue of the refining process, used as fuel in the plants themselves. According to its protagonists, it was the increasing quantities of these oil cracking residues that led to the political decision that, in 1957, granted the monopoly in Spain for the distribution of LPG in cylinders larger than 3 kg to the company Butano SA and, in the Canary Islands, to DISA. Until then, DISA and the Compañía Arrendataria de Petróleos (CAMPSA), founded in 1927, had monopolised all petroleum derivatives in their respective territories since 1933 (García de la Fuente 2006: p. 280; Álvarez-Pelegry, 2022: p. 283). The process began with the amendment of the Petroleum Monopoly Law in April 1957, and in June CAMPSA was authorised to create an independent company to sell butane gas (Sudrià 2017).

The industrial structure of LPG usually takes the form of a natural monopoly, led by a large supplier that does not participate in the transport and distribution cycles, which are usually competitive. LPG is the surplus of a capital-intensive production process with high indivisibilities in the initial establishment investment (World Bank and World LP Gas Association 2002). The unusual feature of the Spanish case is that it did not start with the creation of a production monopoly, but rather with the creation of a distribution

[2] The main problems encountered are the aggregation of butane and propane at provincial level and the use of different units of measurement. See Appendix.

monopoly (bottling, distribution and supply), linked to CAMPSA, and giving a significant weight to Franco's public holding company, the National Institute of Industry (INI). The LPG business was of interest both to the Treasury, whose minister, Navarro Rubio, promoted the creation of the monopoly, and to the companies that joined it. The monopoly shares were equally divided between CAMPSA and REPESA (Refinería de Petróleos de Escombreras, S.A.). The latter was an INI company created in 1950 and partly owned by the Spanish company Compañía Española de Petróleos, SA (CEPSA) and the American company California Texas Oil Products Co.

FIGURE 1. Butane consumption in Spain, in kg (1933-1958)



Source: Sindicato (1959).

Butano S.A. was founded on 27 September 1957 with the explicit intention of providing an outlet for the LPG from REPESA - by 1958 it had the capacity to refine 5.5 million tonnes of oil a year (Sudrià 2017). The orange cylinder quickly flooded the territory, to the point that REPESA's surpluses soon proved insufficient to meet demand, and by 1962 a third of consumption had to be imported (Sindicato 1962: p. 11). In 1969, REPESA's LPG production accounted for just over 35 percent of the LPG distributed in the country; that of CEPSA in Tenerife was 12.8 percent, but five other refineries (CEPSA in La Linea, ENCASO in Puertollano, Esso in Castellon, Gulf in Huelva and Petroliber in A Coruña) also contributed fractions of between 8 and 14 percent of total national production. During these years, LPG was imported from France, the United States, Holland, Belgium, Italy, England, Sweden, Venezuela, Denmark and even Russia (data for 1968 and 1969). This meant that the country was doubly dependent on the outside world, both for the raw material and for its transformation.

TABLE 1. LPG prices in Spain,1958, 1964, 1969

Purpose	Load (kg)	Distributor	Prices 1958	Prices 1964		Prices 1969	
				(1)	(2)	(1)	(2)
Industrial	35		346.50	315.00		297.50	255.00
Domestic	12.5	Butano	130.00	122.00	100.00 (13 kg)	122.00	100.00 (13 kg)
Popular/ Cheaper	3	Dragón-Gas	32.00	32.25		32.25	
	2.5	CGE	26.00	26.90	21.25	26.90	21.25
	2.25	Flaga	23.40	24.20	19.00	24.20	19.00
	2	Butsir	21.60	22.30	9.00 (1 kg)	22.30	9.00 (1 kg)
	0.5	CGE	5.90	6.15		6.15	
	0.25	Duplay	4.60	5.30		5.2	
	0.15	Duplay	3.35	3.90		3.9	
Autogas	15	(Auto-taxi)	156.00			150.00	

Notes: (1) LPG bottled by Butano SA for the continental market. (2) LPG bottled by DISA for the Canary Islands.

Source: Orden del Ministerio de Hacienda de 15 de julio de 1958 (BOE del 25 de julio) and Orden de 16 de enero de 1961 (BOE del 1 de febrero); Orden del Ministerio de Hacienda del 27 de octubre (BOE del 13 de noviembre). Sindicato (1960; 1964; 1969).

Butane gas consumption had taken off, albeit slightly, in the second half of the 1950s (Figure 1). The use of butane cylinders began with the rudimentary packaging of butane in 12.5 kg French cylinders, made by REPESA itself to dispose of surplus butane that was not burned in the flare at the Escombreras plant (Tortella et al 2003: p. 260). They were distributed by CAMPSA itself, using the REPSOL lubricating oil distribution network (Folgado et al 2007: p. 19). In Madrid, 3,500 users were registered as CAMPSA customers in 1957, with tariffs that the monopoly immediately increased with the creation of Butano SA. The charge rose from 76.5 to 130 pesetas (PTA) and the service fee increased tenfold from 50 to 500 PTA per cylinder (Table 1). In return, home delivery was guaranteed through local sales agencies operated by Petrolífera de Transportes SA (Folgado et al 2007: p. 28). The business opportunity was already proven and butane's public prices were double those of CAMPSA.

CAMPSA provided the distribution equipment and REPESA its small bottling plant in Escombreras. In August 1958, Butano SA's first proper packaging plant was inaugurated for Madrid, later joined by other distribution areas - Valencia, Alicante, Murcia, Vizcaya and Guipúzcoa (Sindicato 1959: p. 4). A strategic network of storage and packaging facilities was set up throughout the country, and in 1961 distribution was entrusted to private concessionary companies. This was followed by international cooperation as a technological partner with the Danish company Kosangas and the marketing of smaller containers for domestic use, the 'popular bottles' of Camping Gas SA, Butsir, Flaga and Drago, which Butano SA itself bottled until 1965 (Table 1) (Folgado et al 2007: p. 46).

The first use was for cooking, but the rest of the caloric energy systems were immediately imposed, such as stoves and water heaters, which led to intensive use in winter (The regulation of cookers, of 10 April 1963; and heating of 21 June 1968, BOE of 3 July). In 1967, the number of official distributors of Butane SA exceeded one thousand agencies, and in 1968 it began to be promoted in rural areas (Folgado et al 2007: 75). From 1970, propane for industrial use was promoted, accounting for 8percent of total LPG sales in that year. In 1971, Butano SA had 30 plants in operation, filling about 140,000 tonnes of LPG per year.

In 1958, LPG prices were harmonised throughout the peninsula and the remuneration (fixed per contract) and per cylinder were specified (Table 1). From then on, Butano SA enjoyed an excellent financial situation at the expense of the initial deposit, which was not returned at the end of the contract (Tortella et al 2003: 263). On the mainland, the Public Treasury benefited with 0.75 PTA/kg until 1966 and 2 PTA/kg since then (Ministerial Order of 29 July, BOE of 16 August). At a tax rate of 20.5 percent, a 12.5 kg cylinder of butane was taxed at 25 PTA.[3] In 1968, for example, 65,136,139 charges of the 12.5 kg cylinder were sold on the Spanish mainland and the revenue for the *Renta de Petróleos* for this item reached 1,628,403,475 PTA. Thus, in the first decade of its existence, Butano SA was an important source of revenue for the Treasury of the late Franco regime -though essentially regressive- and a growing business for its producers and distributors.

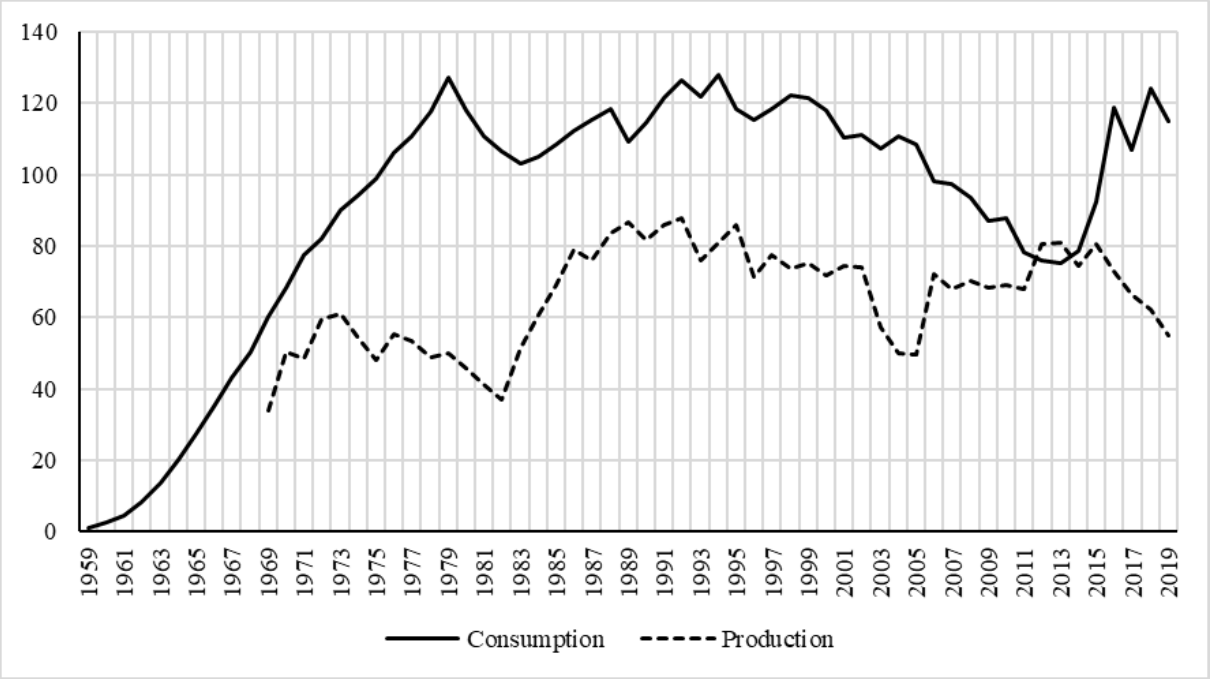
4. Regional diversity and the rampant growth of LPG consumption

In 1968, LPG consumption in Spain in the domestic sector was exclusively for cooking and heating and was fuelled by butane - 99.7 percent (Sindicato 1969); whereas propane was used for industrial applications.[4] Overall, LPG consumption grew strongly and steadily between 1959 and 1979 (see Figure 2). However, the increase was highly concentrated between 1961 and 1969, with a cumulative annual growth rate of over 40 percent. Subsequent annual growth rates were 7.71 (1971-1975) and 6.2 percent (1976-1979). From 1979 it stopped and began to decline, recovering from 1991 onwards. It was maintained during this decade, only to fall again until 2011, when it stagnated. Since 2014, it has increased again, with figures around the peaks of 1979 and 1994. In summary, the level of LPG consumption in Spain has remained above 100 million Gj per year between 1976 and 2019, except for the critical period between 2006 and 2015.

FIGURE 2. LPG production and consumption in Spain, in Petajoules (PJ)

[3] The difference between the price of a bottle of butane on the mainland and that of DISA in the Canary Islands was 22 PTA, as there it was taxed at a much lower rate, the IGTE (Impuesto General sobre Tráfico de Empresas). El propano, in Orden del Ministerio de Hacienda de 7 de agosto de 1968 (BOE del 29 de agosto).

[4] Catalana de Gas y Electricidad consumed some 10,000 tonnes of LPG per year in 1962, almost one seventh of national consumption in that year. This ended definitively in 1966, when the company was authorised to import natural gas from Libya and Algeria. (Tortella et al 2003: pp. 263 and 264).

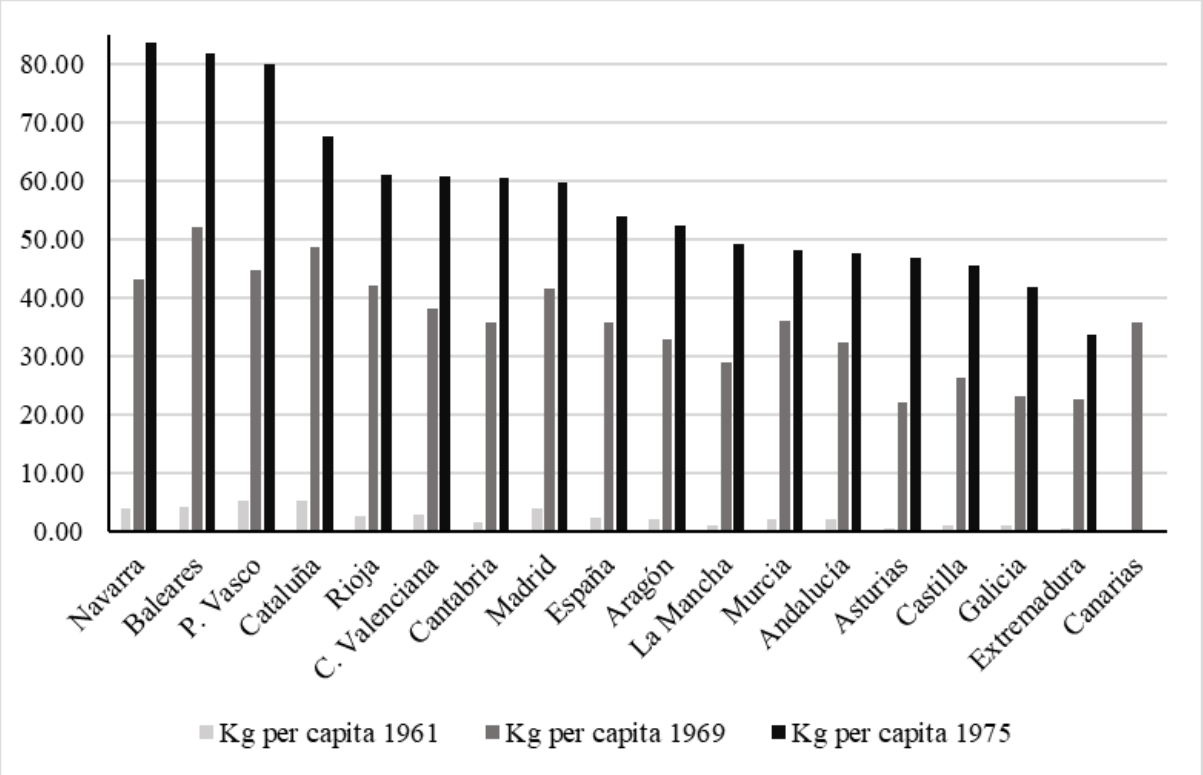


Source: Comisión Nacional de los Mercados y de la Competencia (1959-1979) and Cores (1980-2020).

Throughout the whole developmentalist period and until the exhaustion of the growth model (1961 -1975), the average annual per capita consumption of LPG in Spain increased slightly more than 22 times (Table 2). This growth in consumption was due more to the expansion of the number of users, which increased almost 15-fold in the crucial 1960s, than to the intensification of individual consumption - 130-140 kg between 1961 and 1969. However, this spectacular debut of LPG in Spain hid strong regional contrasts.

Though already defined in 1969, three groups of regions were clearly distinguishable in 1975 in terms of regional consumption (Figure 3). A very prominent group consisting of Navarre, the Balearic Islands and the Basque Country, followed by Catalonia. The following group above the Spanish average, with a consumption of around 60 kg per inhabitant per year in 1975, up from 35 kg in 1969, includes La Rioja, the Valencian Community, Cantabria and Madrid. Some regions present values below the Spanish average, whose consumption was less than half that of the most intensive consumers, but which grew strongly between 1970 and 1975. With the exception of Extremadura, which remained at the bottom of the group (we do not know the consumption of the Canary Islands in 1975).

FIGURE 3. Annual LPG consumption per capita in kg, regionalised (1961, 1969, 1975)



Source: Sindicato (1961; 1969), Cores (1975) and Nicolau (2005).

As with the aggregates, consumption per user does not show such marked variations either over the period (Table 2) or between regions (Figure 4). Even in regions with lower consumption, such as Asturias, the average consumption per user has been around 80 kg since 1961, and in most of them it was over 120 kg, with an expenditure of around 10 bottles of 12.5 kg per year already in 1961. In 1969, the Spanish average was around 140 kg, with Asturias and Extremadura at the bottom (113 kg) and Navarre and the Basque Country at the top with almost 190 kg (Sindicato, 1961; 1969). Comparing the average consumption per user and the total regional consumption, it can be concluded that the difference between the region with the highest consumption in 1969, Catalonia, and the region with the lowest consumption, Andalusia, was not so much due to the intensity of the users' use of gas, which was slightly different, but rather to its diffusion, i.e. the number of users, which was much higher in Catalonia and the Basque Country than in Andalusia, Asturias or Extremadura.

TABLE 2. LPG consumption in Spain (1961-1975)

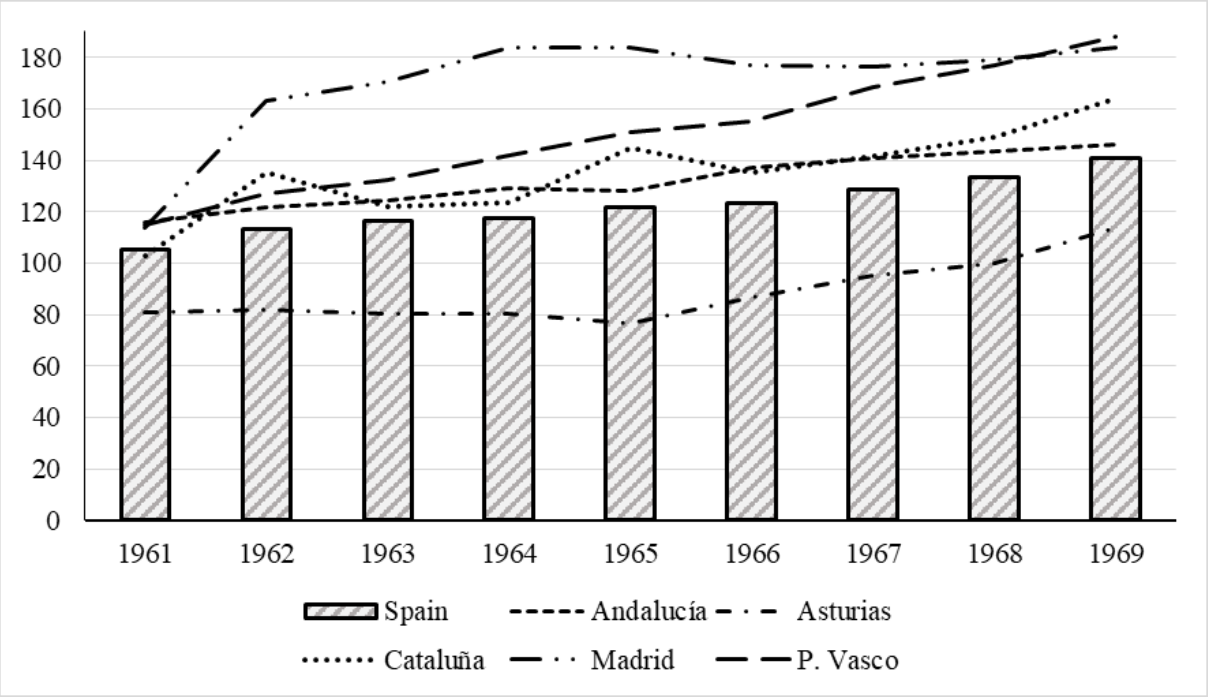
	Total consumption (Tm)	Average consumption per capita (kg)	LPG users (1)	Average consumption per user of 12.5/13 kg cylinder (kg)
1961	73,492	2.42	649,419	105.34
1962	146,831	-	1,098,946	133.61
1963	272,183	-	2,093,484	130.01
1964	398,646	-	2,995,079	133.10
1965	550,498	17.12	5,043,014	121.50
1966	702,817	-	5,101,777	137.76
1967	864,224	-	6,082,644	142.08
1968	1,015,208	-	6,937,952	146.33
1969	1,212,426	35.85	9,236,868	141.00
1970	1,327,996	-	n. a	n. a.
1971	1,511,675	-	n. a.	n. a.
1972	1,597,210	-	n. a.	n. a.
1973	1,758,142	-	n. a.	n. a.
1974	1,845,193	-	n. a.	n. a.
1975 (2)	1,933,824	53.98	n. a.	n. a.

Notes: (1) Includes all users; (2) Canary Islands excluded.

Source: Sindicato (1961-1969) and Cores (1970-1975).

Geographical differences in fuel use are often attributed to climatic diversity and industrial specialisation (Kander et al 2014; Garrido-Lepe, 2024). With regard to the former, the monthly breakdown of LPG use, available for the period 1969-1975, shows that the use of LPG for heating during the cold months was more pronounced in those years. In December 1975, total LPG consumption was almost 250,000 mt of LPG, while in July it was around 120,000 mt and in August only 106,000 mt. Despite this evidence, many of the regions with the highest consumption, such as the Balearic Islands, Catalonia and the Valencian Community, enjoy a Mediterranean climate with very mild winters. With regard to industrial specialisation, no provincial statistics that differentiate between uses are available. We know that from 1971 onwards the use of propane increased and that in 1973 it accounted for 16percent of total LPG consumption (10percent strictly industrial); however, in the 1960s, "non-domestic" uses accounted for around 10percent (8-9.4percent, between 1967-1969) of total LPG consumption. Of this, industrial uses accounted for about 2-3 percent, with commercial and artisanal uses accounting for the bulk. Consequently, neither climatology nor industrial specialisation alone would explain the regional divergence in LPG consumption during these years. LPG as a fuel had only made limited inroads into the industrial sector, and heating was not yet its main use in the residential sector.

FIGURE 4. LPG consumption per user, in kg



Source: Sindicato (1961-1969).

5. The role of LPG in domestic energy consumption in Spain during the 1960s

In order to study the role played by LPG in the energy basket of domestic consumers in the different Spanish regions during the crucial decade of 1960, we have estimated the consumption of the main energies used in households in Gigajoules (GJ) per inhabitant (and as a percentage). On the one hand, the substitute energies, mainly used for caloric services of energy, which are firewood, LPG (butane), town gas (coal gas) and coal; on the other hand, the complementary energy, electricity, which was used specifically for lighting and light mechanical uses. As can be seen in Tables A.1 and A.2, the estimates are for two dates, the beginning and the end of the decade.

Firstly, as can be seen in Tables A1 and A2, it is noteworthy that total energy consumption in most Spanish households fell in the 1960s, from 10.02 to 8.38 GJ per inhabitant per year. This circumstance is not surprising, but it is consistent with what we know about the thermal efficiency of traditional energy consumption and what happened in the Spanish economy as a whole, since the new converters (including coal or economic cooking) contributed to a more efficient use, even of firewood and charcoal (Rubio 2005, Henriques 2011, Kander et al 2014). This was true to the extent that the main traditional energy source, biofuels, decreased significantly from 7.96 GJ to 4.78 GJ per capita and year on average. Fuelwood accounted for almost four fifths of the average energy consumed per inhabitant per year around 1960, and less than three fifths by the end of the decade. Of course, biofuels still remained the fuel of choice for the whole country, but the changes over the decade were dramatic. Coal also fell sharply, from almost 15 percent

to less than 10 percent; manufactured gas also doubled its share, but never reached more than 5 percent because it was confined to urban markets with installed pipelines, such as Madrid, Barcelona and the Balearic Islands. However, electricity and LPG experimented the biggest advantage. The use of electricity was almost equal to that of coal, but did not exceed 10 percent in 1970, while LPG accounted for almost a fifth of domestic caloric services by that date, compared with just over 1 percent in 1960.

Thus, in the 1960s, domestic energy consumption in Spain showed a profile in transition (Table A.2), with a predominance of traditional energies, biofuels, which in 1970 still accounted for 43percent of the total annual energy consumed per inhabitant for domestic use. Only a few regions had reached a predominance of fossil fuels, such as Asturias, the Balearic Islands, the Canary Islands, Cantabria, Catalonia, Madrid, Navarre and the Basque Country. In these regions, fossil fuels or electricity already accounted for more than half of household energy consumption by the end of the decade. LPG was undoubtedly the fastest to take off, amounted at least a quarter of household energy consumption. What was the nature of this rapid take-up?

6. The traditional hypothesis: butane, clean and affordable

The preference for a supply-side approach in the study of energy has handed down a compartmentalised approach to explore the path of development of each new energy included in the energy basket, with little distinction between uses (industrial or residential) and between the services demanded - caloric, mechanical or lighting. The most widespread hypotheses were those that disentangled the benefits of using the new fuel - mainly environmental - and studied the evolution of the relative prices of its substitutes: firewood, coal and piped gas.

Among the beneficial effects of LPG use, the suppression of indoor pollution by reducing exposure to smoke from natural fuels or coal has been highlighted (World Bank, 2002). In addition, LPG would have been key to removing the Malthusian limits to economic growth in coal-poor areas, reducing pressure on forests where they exist, and thus helping to avoid deforestation (Kander et al 2014; Rubio and Muñoz 2019). Indeed, in Spain, an apparent reduction in pressure on forests has been observed, coinciding with the introduction of LPG from the 1960s onwards. However, it does not seem that this alone was an efficient cause of the switch from firewood to this new energy source, since everything points to the fact that the "hunger for arable land" was more acute twenty years earlier, in the early 1940s, when the clearing of marginal lands was pretty common (Infante-Amate et al. 2014).

The importance of rural areas in this transition, and the direct and late shift from firewood (and other biomass products) to LPG for domestic heating, has attracted the attention of Infante and Iriarte (2017) and Iriarte and Infante (2019), who have mapped the evolution of biomass availability and appropriation from 1860 to 1960 at the county level. They provide overwhelming quantitative evidence of the persistence of fuelwood use in Spain and of the rewards of household energy switching, which they attribute to unequal access

to modern energy, especially coal and town gas. According to their calculations, 40 percent of the Spanish population was excluded from their use in 1950 and more than a quarter in 1960 (Infante and Iriarte 2017; Iriarte and Infante 2019). Since then, the versatility of LPG and its ease of use have helped to ensure a universal supply of this fossil fuel, especially in areas far from coal trade routes and town gas pipelines.

In its favour was the development of the relative prices of the fuels with which LPG openly competed for domestic caloric usages: biofuels, coal and manufactured gas. Although widely used for lighting, electricity was expensive for heating: up to eight times more expensive than coal in 1948. Much firewood was still consumed by direct appropriation, but the price of coal was more advantageous than that of firewood from the late 1940s, and oil derivatives and electricity did not begin to compete favourably with firewood until the late 1950s (Coll and Sudrià 1987; Infante et al 2014: pp. 22 and 24). Coal was the cheapest primary energy where it was available, although it began to lose competitiveness in the 1950s when real coal prices increased by 130 percent (Coll and Sudrià 1987).

Traditionally, firewood was used in open hearths in dwellings, combining cooking and heating, but with very low energy efficiency and the disadvantages of smoke and dirt. From the 18th century, the construction of closed hearths with chimneys became widespread in northern Europe, and very efficient stoves in eastern Europe. In Spain, open fires seem to have continued to predominate in rural areas. In urban areas, the use of the *anafe/anafre* or portable stove was maintained, often placed in courtyards, corrals or in the street itself to avoid overheating the rooms.[5] It was used for culinary purposes, while the *copa* or *brasero* was used to heat rooms and bedrooms in the cold months, limiting its heating area to the immediate surroundings and producing high concentrations of carbon monoxide (Smil 1994: p. 124). In both cases, charcoal was preferred, albeit of inferior quality, such as *cisco* or *picón*. Cooking techniques themselves were traditionally very sensitive to living standards, with fuel services accounting for a significant proportion of total household expenditure (Hausman 1995). Indeed, when the going got tough, there was no such thing as 'hot food', as evidenced in the Spanish picaresque literature of the Golden Age, where lunchs of bread and cheese, empanadas and grapes proliferate. In eighteenth-century Britain, in the north, where fuel was cheaper, stews and casseroles were common; in the south, to avoid lighting fires, workers opted for cheese, which was more expensive than meat, and went to the bakery (Muldrew 2011: p. 100). As for heating, in the worst cases it was abandoned altogether (Fouquet 2008).

From the mid-19th century, the price advantage offered by coal had led to the spread in Spain of 'iron stoves' that used either coal or firewood. Patented in 1802 by George Bodley, they were called *bilbaínas* because they were produced mainly in Biscay

[5] An example of *anafre* is represented by Velázquez, in *Vieja friendo* huevos, de 1618. https://www.wikiart.org/es/diego-velazquez/vieja-friendo-huevos-1618#:~:text=Una%20anciana%20con%20toca%20blanca,vista%20elevado%20de%20la%20composici%C3%B3n

(Sagardui in Bilbao from 1845, Orbegozo in Zumárraga, Julián in Abando) and later in Santander (Fernández Acebo 2005). Paradoxically, the spread of town gas encouraged its use, since coke, a by-product of gasification, was used as a fuel.

Thus, at the time of their introduction, LPG were cleaner and safer and, although they had a certain price disadvantage compared to coal, they were highly efficient for cooking, water heating and heating due to their high calorific value per volume and mass. In addition, in Spain LPG was delivered door-to-door from the beginning, which was a good thing given the limited number of private cars: 12 cars per 1,000 inhabitants in 1961 and around 40 if lorries, buses and motorcycles are added (DGT 1961, Table 26 V). In short, although in rural areas firewood retained its advantage when obtained outside commercial circuits, in urban areas LPG was in direct competition with coal, which was slowly but inexorably becoming more expensive (Infante et al 2017).

From the early 1960s, both in rural areas and in the consolidated neighbourhoods of Spanish cities, an incomplete transition to LPG began to be observed, in which different energies coexisted for lighting and energy services, forming a complex energy basket (energy stacking), in line with the general phenomenon observed by Rubio and Muñoz (2019). Many testimonies from the early 1960s agree in pointing out that in the Spanish households that had an iron stove, employing coal (or firewood), a gradual transition began in which organic fuels, mineral coal and LPG coexisted, with seasonal and reversible use. Namely, in winter, iron stoves were used to cook and heating the adjoining rooms. The attached boiler provided hot water. In summer, butane was used to prevent the iron stoves from overheating, paving the way for cookers and water heaters.[6]

At that level of urban development, with the explosion of new neighbourhoods in the cities, very few iron stoves were built in the kitchens and the choice was between the portable 'electric stove' and the butane cooker. Although they initially coexisted, the calorific value of electricity was unaffordable for the majority, while butane stoves were available in a wide variety.[7] They ranged from cookers with a single burner to those with four burners and an oven, with or without a base, depending on whether they were used with a 12.5-13 kg cylinder or with the smaller ‘popular bottles’. The latter were tabletop stoves that were used in the summer when the iron stove was not in use. In fact, in 1961 there were more than 2,850,000 popular bottles in Spain - out of a total of eight million in circulation - and their use accounted for 9 percent of the total. Their sizes were very varied, ranging from 100 g (camping sizes) to three kg, although the most common were between 2 and 2.5 kg (Sindicato 1961). These popular containers continued to grow and in 1963 they represented 41.83percent of the containers in circulation, i.e. almost 11,780,409 cylinders, which accounted for 11.31 percent of the total LPG consumed

[6] As in this testimony: https://memoriasdelviejopamplona.com/2014/08/vivencias-usos-y-costumbres-en-el-viejo-2.html

[7] Alcohol burners were used for reheating food, but hardly for cooking.

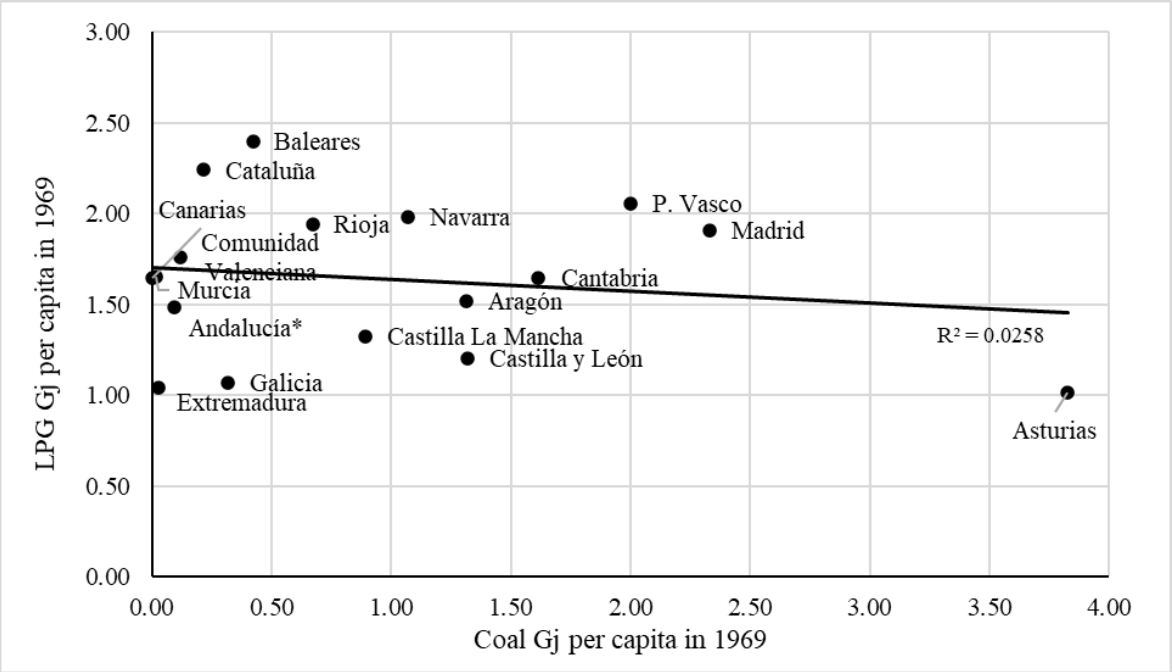
(Sindicato 1963). Since then, Butano and DISA stopped refilling these small cylinders and there is no overall estimate of their subsequent evolution.

The most prevalent cylinder certainly was the 12.5 kg cylinder on the mainland and the 13 kg cylinder on the Canary Islands. In a period in which the general price index almost doubled between 1958 and 1968 (Ojeda 1988), one of the items that increased the least was 'general household expenditure' (57percent). Among these was LPG, whose average tariffs in current prices fell over the decade, from 10.324 PTA per kg of butane to 9.972 in 1968, reaching a low of 9.407 PTA per kg in 1970 (Cores 1960-2020). In addition to the specific butane cooker, from 1964 the basic butane equipment had a total cost of 1,266.95 PTA, which included the contract for two cylinders (with a consideration of 1,000 PTA for Butano SA and nothing for DISA), a regulator, the 1.5 metre pipe and the clamps. This contract cost could be paid with a down payment of 366.9 PTA and 10 monthly instalments of 100 PTA. If the contract was for a single cylinder (i.e. without refilling), the cost was reduced to 644.95 PTA. This initial cost was gradually reduced, and in 1969 the cost of a two-cylinder butane contract was 1,264.75 PTA, and the payment facilities were still in force (Table 1). By 1970, butane was as affordable as it was popular. The total cost of access was one third of the minimum monthly wage in 1970 - 3,600.59 PTA (Ministry of Labour Decree of 21 March; BOE of 24 March), but for most the deferred payment made it easier to overcome this barrier to entry.

7. LPG and their substitutes in household heating services

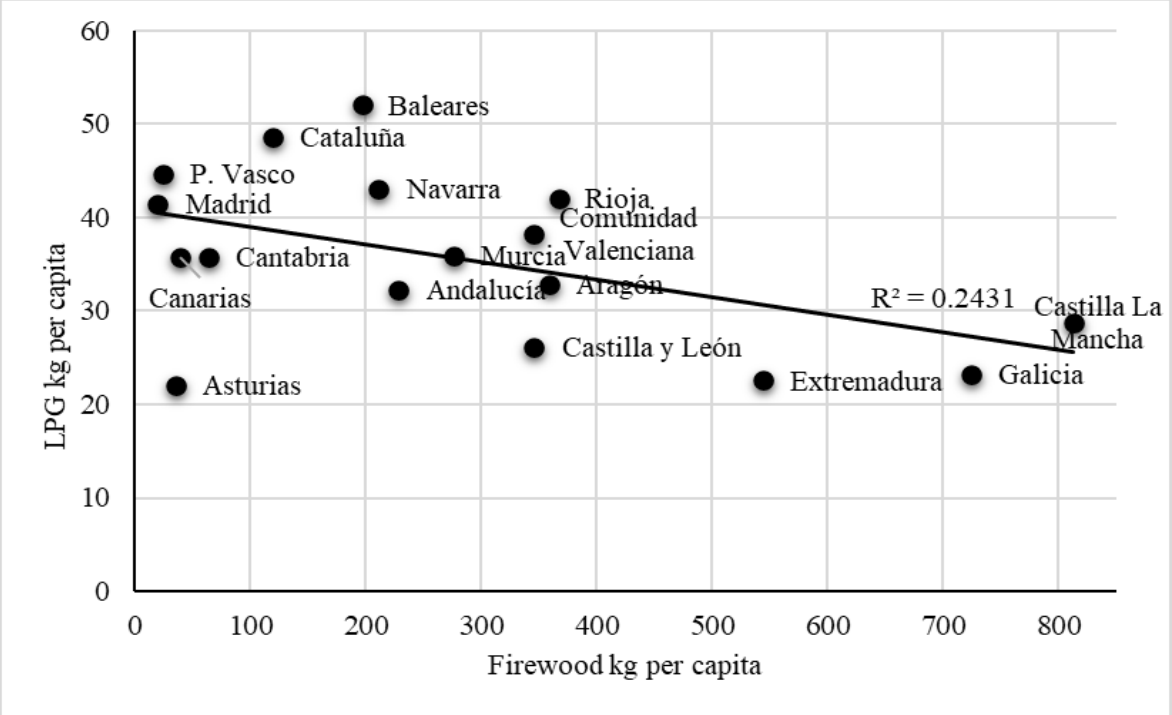
Overall, the consumption of oil products overtook that of coal from 1965 onwards (Sudrià 1995), and LPG gradually replaced biofuels and coal in domestic use. Figure 5 reconstructs domestic coal consumption per inhabitant in 1969 at regional level (Gigajoules per inhabitant per year) and relates it to that of LPG. There is little correlation between the two. A distinction can be made between a group of regions that had either abandoned coal for domestic use (such as Catalonia and the Balearic Islands) or never used it at all; another group that continued to combine the two, such as Madrid, the Basque Country and Cantabria; and finally, Asturias, which maintained the prevalence of the mineral. The better supplied regions had not suddenly abandoned its use, and the geography of coal consumption in 1970 still depended on the availability of the resource and ease of access.

FIGURE 5. Regional dispersion of LPG consumption and domestic use of coal, in 1969 (in GJ per capita and year)



Note: For coal, each of the types of coal consumed for residential use have been transformed into GJ using the provincial statistics.
Source: Sindicato (1969) and Estadística del Consumo de Carbones (1969).

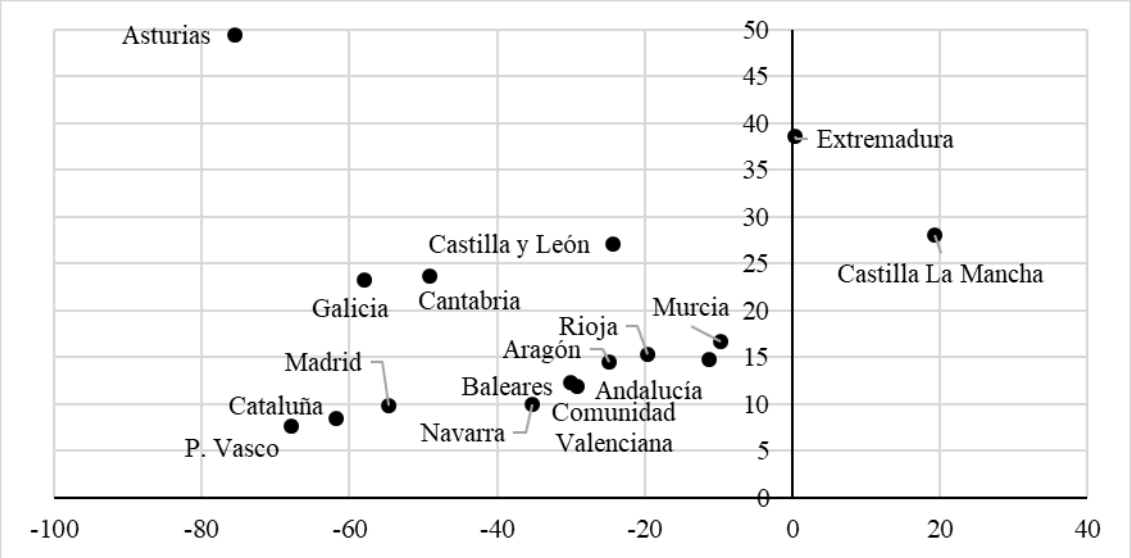
FIGURE 6. Regional dispersion of LPG consumption and domestic use of firewood, in 1969 (in kg per capita and year)



Note: Firewood has been calculated, as the portion for domestic use, as 0.7033 of that produced in 1970, from Infante et al (2014; 2017).
Source: Sindicato (1969).

Regarding to firewood, we have regional appropriation statistics (Infante and Iriarte 2017). For household consumption at the provincial level until 1970, the substitution of fuelwood for LPG was only partial and/or seasonal and not very intense (Figure 6), although in all regions LPG consumption increased in the 1960s and in most regions fuelwood consumption decreased significantly (Figure 7). The regions where fuelwood consumption decreased the most had the best biomass endowment, being part of humid Spain (Galicia, Asturias, Cantabria and the Basque Country). In Catalonia and Madrid, there was little reduction in fuelwood consumption, as it was already low (Infante et al. 2014). In another group, the decrease in fuelwood consumption was balanced by the increase in LPG. In this group, Rioja, Aragón and Comunidad Valenciana stand out. In the more rural but arid areas, fuelwood consumption hardly changed, as in Castilla León, Murcia and Andalusia, although LPG consumption increased. Interestingly, in Extremadura and Castilla-La Mancha the increase in fuelwood consumption went hand in hand with the increase in LPG consumption. The rates of substitution and adoption were therefore complex and uneven, and the tenacious coexistence of different fuels for domestic use during this period is evident.

FIGURE 7. Regional dispersion of the difference between 1960-1970 of domestic firewood consumption in kg per capita and LPG consumption (per thousand)



Source: Sindicato (1969).

There is also a preference for butane over piped gas (manufactured or natural) for domestic caloric usages. Even in capital cities with a century-old distribution network, such as Barcelona and Madrid, this anomaly can be observed. Anomalous is that butane and propane tend to be displaced by natural gas as their distribution networks develop in mature economies (World Bank. World LP Gas Association 2002: pp. 23 and 29).[8] In

[8] LPG remains the fuel of choice for heating and cooking (in residential and commercial uses) only in remote areas, where the natural gas network does not reach or in developing countries, where there is only occasional distribution of natural gas to residential consumers (World Bank. World LP Gas Association 2002: 18).

1950, around 334,700 households throughout Spain had town gas, compared to more than five million households with electricity (almost seven million in 1960), but by 1970 the advance of piped gas was already evident: the service reached more than 807,100 households. By that time, however, the number of butane gas users was over eight million, the same number as for electricity (Tafunell 2005: 493. Table 6.8). In the competition between the two gases for caloric services, town gas was significantly overtaken by butane.

This choice by more than seven million new consumers of butane gas has been sensibly attributed to the severe limitations of gas companies to enlarge their distribution pipelines (Sudrià 2017). The role played by relative prices per MJ (megajoule) in resolving this dilemma remains controversial as shown by the examples of some Northern cities (Valdaliso et al. 2022: 206) and those in some Andalusian cities (Table 3), where the conditions for renewing installations and improving production techniques were met during this period (Fernández-Paradas 2017).

TABLE 3. Price comparison between piped gas and LPG per Mj, in Andalucía (1961-1967)

	Piped gas			LPG	
1961	**PTA/ m3**	**PTA/Mj (3,500 kcal m3)**	**PTA/Mj (4,500 kcal m3)**	**PTA/ kg**	**PTA/Mj**
Cádiz	3.75	0.256	0.199	10.181	0.215
Granada	3.35	0.229	0.178	10.181	0.215
Málaga	3.90	0.266	0.207	10.181	0.215
San Fernando	3.85	0.263	0.204	10.181	0.215
Sevilla	2.45	0.167	0.130	10.181	0.215
1965	**PTA/ m3**	**PTA/Mj (3,500 kcal m3)**	**PTA/Mj (4,500 kcal m3)**	**PTA/ kg**	**PTA/Mj**
Cádiz	4.17	0.285	0.221	9.689	0.205
Málaga	4.26	0.291	0.226	9.689	0.205
Sevilla	2.53	0.173	0.134	9.689	0.205
1967	**PTA/ m3**	**PTA/Mj (3,500 kcal m3)**	**PTA/Mj (4,500 kcal m3)**	**PTA/ kg**	**PTA/Mj**
Cádiz	4.17	0.285	0.221	9.729	0.206
Málaga	4.26	0.291	0.226	9.729	0.206
Sevilla	3.77	0.257	0.200	9.729	0.206

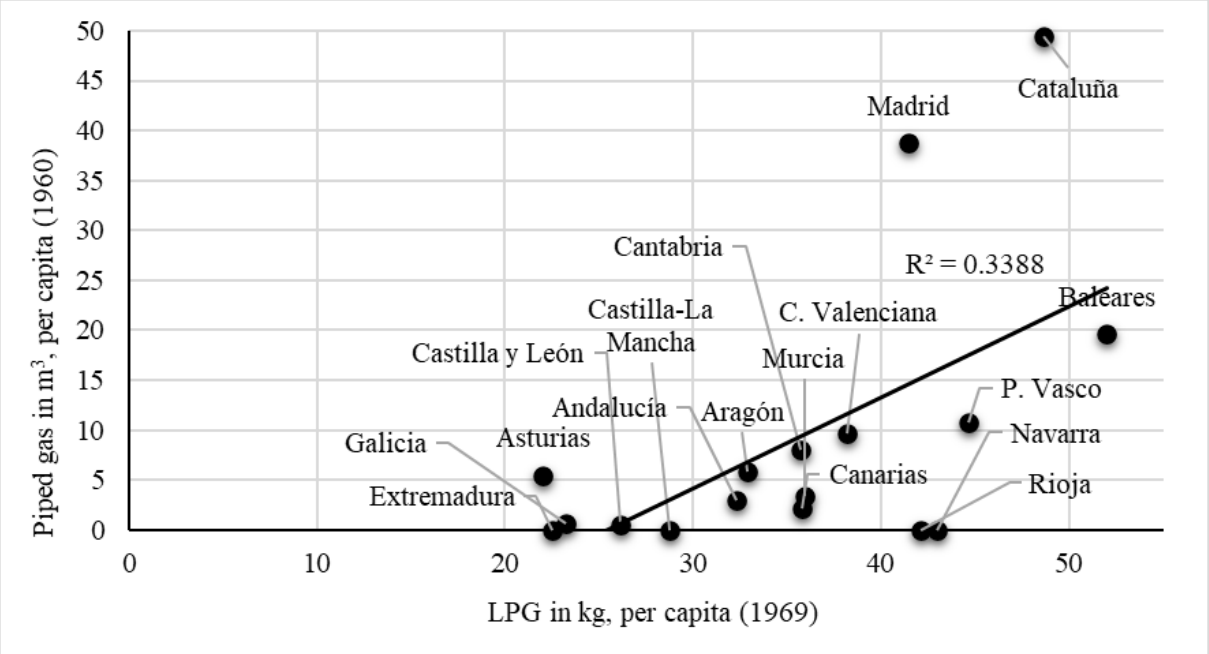
Source: Sindicato (1961; 1965; 1967); Ministerio de Industria y Energía. Base de datos energéticos 1959-1982.

In Andalucía, a comparison of the prices in MJ of these two types of gas, piped gas and LPG for domestic use, between 1961 and 1967, shows that butane gas gradually became cheaper, even using an optimistic range of values for the calorific capacity of town gas. It was particularly advantageous for low-consumption households to substitute LPG for manufactured gas, as the additional caloric energy services – such as cookers – added to

the price advantage and made it more attractive in cookers. The conversion to butane consisted of adapting the gas inlet nozzles (and burners) to the calorific capacity of butane. In the city of Malaga, the savings per average subscriber (544.2 m3) in 1968 was just over 122 PTA if they opted for a similar availability of butane and abandoned town gas (Bartolomé, Fernández-Paradas and Martykánová 2017: p. 13). However, since the average Spanish butane gas costumer in 1968 used about 9.8 butane gas refills (12.5-13 kg) per year. The family's expenditure was around 1,196 PTA per year, almost half of the 2,318.3 PTA of the average urban piped gas customer in Malaga in 1968.

The manufactured gas market was thus fragmented between those consumers with higher gas consumption, who benefited little from the switch to LPG, and those new consumers, seasonal or with low incomes, who took advantage of the versatility of use and the low fixed and maintenance costs of butane installations.

FIGURE 8. Regional dispersion of LPG consumption per capita in 1969 and piped gas consumption in 1960



Source: Sindicato (1960-1969) and Nicolau (2005).

The substitution of manufactured gas by LPG in Spain is therefore a red herring as the Northern experience illustrate. Though prices of LPG were higher than those of piped gas in 1971, not only was LPG consumption increase substantially larger than that of town gas in Bilbao, provided with a sparse network, but also in San Sebastián, with a significant penetration of town gas (Valdaliso et al. 2022:293). Both cities reaching the highest per capita rates of LPG consumption in 1971. Paradoxically, in Oviedo and Gijon, where LPG's prices compared favourably with those of manufactured gas, the consumption of the former grew at a slower pace.

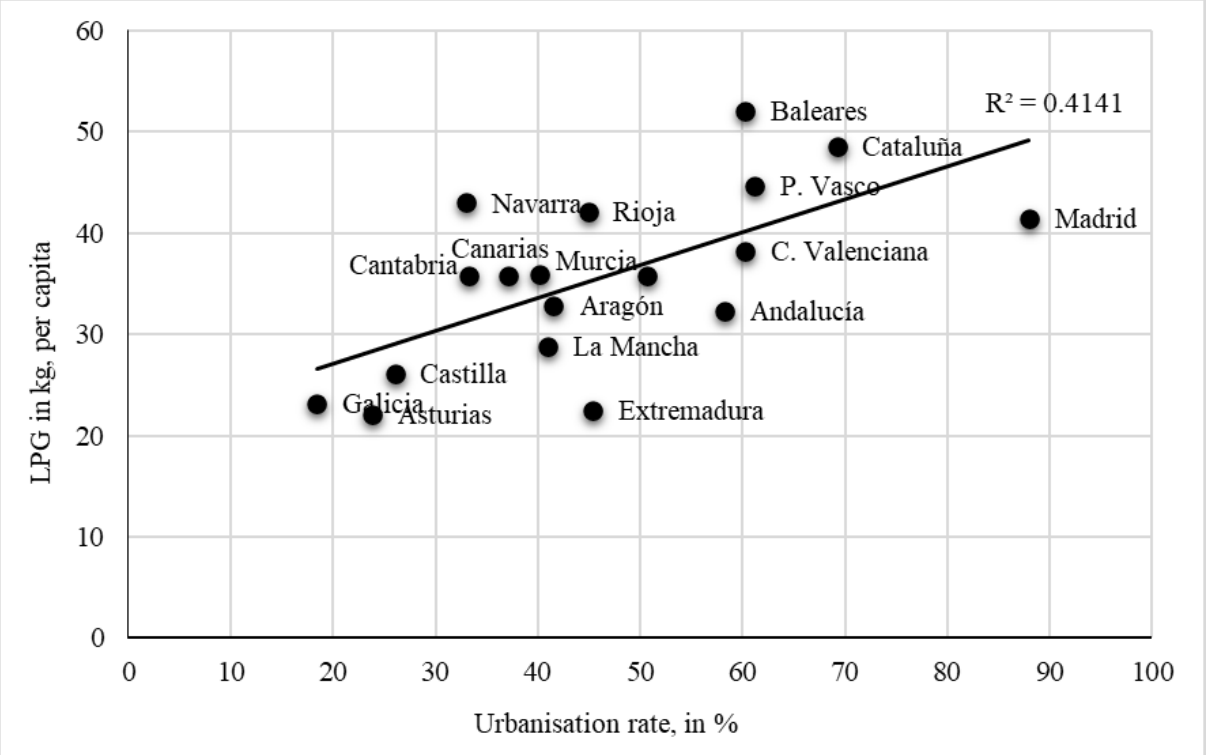
LPG consumption augmented most where piped gas was already available in 1960 (Figure 8), coinciding with highly urbanised regions. In residential areas where piped gas was at disposal, butane was installed not to replace it but to complement it, targeting new

groups of small consumers or new uses, such as cooking by seasonal consumers. Gas works often became butane distributor, though there were some exceptions to this coexistence. LPG led to the closure of some piped gas companies. A case in point is Alicante, where LPG consumption multiplied by more than 47 between 1960 and 1971, reaching 1,560 thousand tonnes. The pipeline company, Gas Alicante, had to close down its installations and become the official distributor of Butano SA. This was despite having previously invested heavily in the expansion and improvement of the distribution network (García de la Fuente 2006: pp. 280 and 284).

8. Developmentalism: internal migration and precarious housing

In developing countries at present, household demand for LPG is assumed to have high income and price elasticities. Indeed, a strong affinity has been found between increases in household income and LPG consumption, especially at lower income levels (The World Bank I World LP Gas Association 2002: p. 47). Between 1954 and 1970, average GDP growth rates in Spain exceeded 6 per 100 per year, and per capita income in Spain doubled between 1958 and 1970 (Prados 2005: p. 1342, Table 17.8). However, even if Spain experienced accelerated growth in the 1960s, there is only a very weak linear relationship between the regional cumulative growth rates of household disposable income between 1960 and 1970 and the corresponding increases in LPG consumption - an R^2=0.0993, with data from Prados (2005: Table 17.26).

FIGURE 9. Regional dispersion of LPG consumption in 1969, in kg per capita, and rate of urbanisation in 1960, in percentage



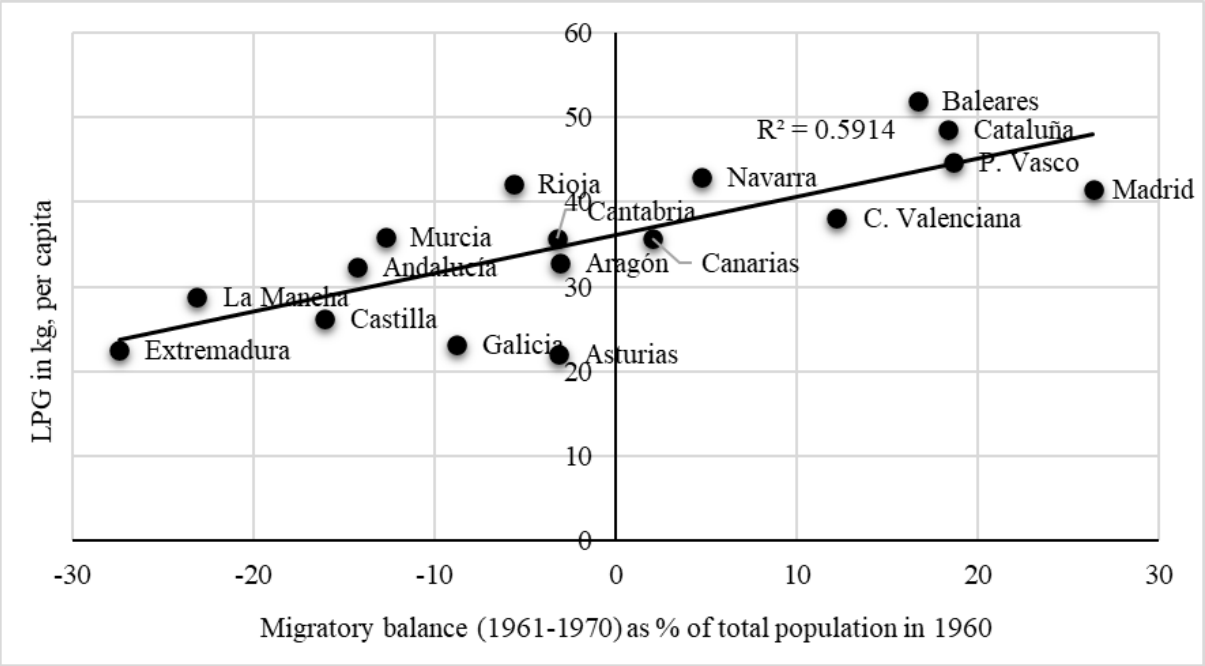
Source: Sindicato (1969) and Nicolau (2005, p. 152).

The intensity of growth that characterised this period was accompanied by other idiosyncratic features, such as internal migration and precarious housing. In the 1950s, around two and a half million Spaniards changed their place of residence within the country, and the process accelerated and intensified in the following decades, with at least five and a half million people estimated to have done so between 1961 and 1975. In other words, around one fifth of the Spanish population (35 million in 1975) had participated in internal migration. During these years, the sending and receiving areas are clearly distinct. Most of the migration was permanent and long-distance (interprovincial and interregional), originating in rural areas and ending in urban areas. Specifically, these flows were at the origin of the phenomenon of the metropolitan belts of Madrid, Barcelona and Bilbao from the second half of the 1960s (Romero Valiente: 2003: p. 215).

In metropolitan areas and recipient cities, the flood of migrants was absorbed by the proliferation of precarious housing and, later, by the construction of new neighbourhoods. Both in the self-built neighbourhoods (shantytowns, shacks and even caves) and in the new neighbourhoods, biomass was only available to its inhabitants in commercial cycles. The limited space available in the dwellings discouraged the storage of solid fuels (coal, the cheapest) and the corresponding installation of iron stoves, which also required a higher investment and a non-reversible use of space. According to the 1950 census, the main housing stock in Spain included more than 1,300,000 dwellings with only one or two rooms (including bedroom, kitchen and dining room) and 1,248,000 with three rooms (out of a total of 6,370,000 dwellings in 1950 and just over 7,726,400 in 1960). The latter exceeded 1.5 million in 1960 and remained at similar levels in 1970. As regards the surface area of the dwellings, in 1970 almost 40 percent were smaller than 60 m2 - half a million were smaller than 30 m2 and 2,665,800 were between 30 and 60 m2, out of a total of 8.5 million first dwellings (Tafunell 2005: Table 6.8.). These tiny dwellings, often shared by several families, did not provided sufficient space to store and use coal and biofuels, the cheapest alternative. The use of butane gas for caloric energy usage was the simplest and most affordable alternative for cooking, water heating and space heating. And it was always a reversible option. Nothing was better suited to a disadvantaged housing environment than butane. As Figure 9 shows, it was precisely in the most urbanised regions in 1960 that butane consumption flourished most in 1969.[9]

[9] In contrast, in Portugal, the success of LPGs has been associated with the relevance of the rural and dispersed habitat (Henriques 2011).

FIGURE 10. Regional dispersion of LPG consumption in 1969, in kg per capita, and rate of urbanisation in 1960, in percentage



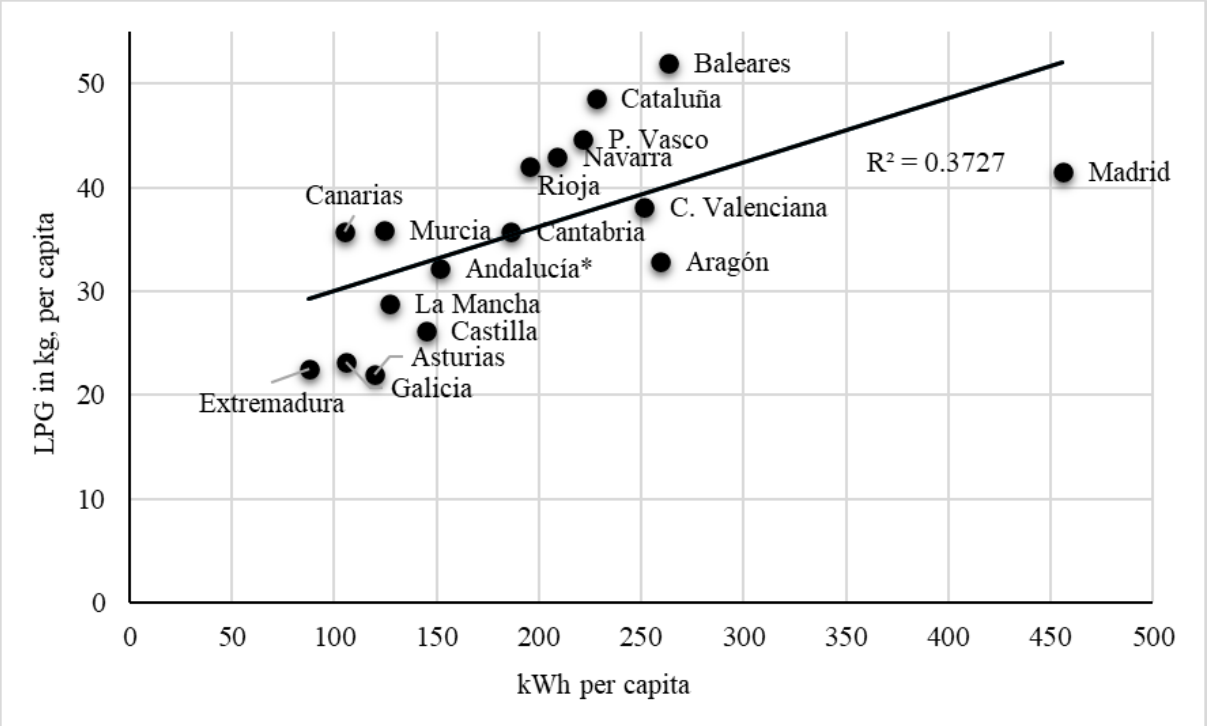
Source: Sindicato (1969) and Nicolau (2005, pp. 152-153).

In Spain, the increase in LPG consumption was not linked to the rural areas, where coal did not reach, but to the more urbanised regions which received a greater influx of immigrants, such as Madrid, Catalonia, the Balearic Islands, the Basque Country and the Valencian Community. As can be seen in Figure 10, a certain correlation between the migration balance of the Spanish regions in the period 1960-1970 appeared to be, as a percentage of their population in 1960, and per capita LPG consumption in 1969. In the regions of departure, such as Extremadura and Castilla-La Mancha, LPG consumption remained low, because emigration actually favoured a higher per capita consumption of firewood (Figure 7). It was only in the first half of the 1970s that LPG consumption increased significantly in these regions. Galicia, Asturias and La Rioja, with average consumption, would show a slight variation in relation to the general pattern, downwards in the former and upwards in the latter. As far as high consumption is concerned, the relationship between the reception of immigrants and higher per capita LPG consumption is also evident. This solves the paradoxical behaviour of the Northern cities experience: beyond the relative prices, where migration and urban growth was less pronounced (Oviedo and Gijón), the LPG consumption rate grew slower than in Bilbao and San Sebastian during the 1960s, given the static boundaries of the manufactured gas networks. It seems that the influx of immigrants in urban areas has contributed to the intensive use of LPG for domestic calorific uses.

The spread of domestic LPG use was preceded by the electrification of households, which was already very significant in 1950. Suffice it to note that in 1960, while just over five million Spanish households had access to electricity, only 3,300,400 had toilets, compared to 4,679,000 households with toilets and almost seven million with electricity

in 1970 (Tafunell 2005: 493, Table 6.8). In the 1960s, electricity behaved as a complementary energy to LPG, as its price for caloric purposes was a deterrent - it was three times that of coal and almost twice that of LPG, so that from 1958 domestic use of both electric cookers and heaters was pushed into the background. Electricity covered lighting (and the first domestic appliances) and in the 1960s it acted as a complementary energy source to firewood, coal and LPG in Spanish households.

FIGURE 11. Regional dispersion of LPG consumption, in kg per capita, and domestic consumption of electricity, in kWh per capita, in 1969



Source: Sindicato (1969) and Ministerio de Industria (1970b).

Figure 11 shows the close relationship between electricity and LPG consumption per inhabitant in the Spanish regions in 1969. Both services grew at the same rate as urbanisation, interregional labour migration and income growth. Both were, in that decade, the flourishing components of the energy basket of the new, albeit precarious, households of Spanish developmentalism.

9. Conclusion

LPG consumption in Spain increased significantly during the 1960s, with notorious regional variations in terms of per capita consumption. The benefits of gas, including its cleanliness and versatility, contributed to its proliferation, as did the support provided by the Franco regime through the establishment of Butano SA. This initiative ensured a reliable fuel supply to households while generating substantial revenue for the Spanish Treasury, albeit with its regressive nature.

The gradient of inequality in the regional distribution of LPG consumption in the 1960s was very high and cannot be explained solely by interregional climatic differences or the

heterogeneous distribution of the industrial sector. Nor does it coincide with a period of increased pressure on biomass resources, which favoured its use in less favoured regions. So far, two factors have been highlighted: the absence of manufactured gas networks and the obstacles to access to coal for the inhabitants of a large number of Spanish regions. These two obstacles to the transition from fossil fuels in the household sector would have been overcome by LPG, while the disposable monetary income of Spanish households has increased; however, there is no evidence of an effective and parallel increase in LPG consumption and income at regional level. Paradoxically, it was in the regions with manufactured gas supply, and not in those with no access to coal, where LPG consumption increased most during these years.

Other changes at the heart of 1960s developmentalism may have been more decisive: inward migration and precarious housing. Where there was no easy access to biomass, houses were reduced and spaces for cooking, heating and storage were eliminated (or were reversible, multifunctional). All the evidence suggests that this is where LPG flourished most, with its complementary energy, electricity, growing in parallel. However, this claim would require further analysis.

Finally, the energy transition of residential caloric energy services in Spain in the 1960s proved to be very complex, with an energy basket that still included very significant amounts of firewood and coal, in addition to manufactured gas. In consolidated urban neighbourhoods and until 1970, coal and town gas remained quite strong, especially the former; in rural areas, fuelwood also remained relevant, especially in those areas of emigration. At the same time, the use of LPG and electricity grew rapidly in the new neighbourhoods of the immigrant-receiving regions.

In Spain, the consumption of LPG hardly increased in the rural and dispersed environment, but rather as a result of the accelerated and chaotic urbanisation processes of developmentalism; not at the same rate as its substitutes, firewood and coal, but at the rate set by its complements, especially household electricity, whose prices for heating and cooking had limited its demand.

The Spanish case illustrates the complexity of the energy transition in the residential sector. The combination in the fuel basket of traditional and modern forms and sources of energy for domestic heating was exacerbated in Spain in the 1960s, when the divergence of access to energy sources between rural and urban areas was added to the divergence between the metropolitan areas of large cities and their traditional neighbourhoods.

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Author contribution statement

Isabel Bartolomé-Rodríguez: framework, methodology, dataset, investigation, writing. Pablo Gutiérrez-González: framework, methodology, visualization and writing.

References

Álvarez Pelegry, Eloy. 2022. 'Demanda y usos de gas en España. Una aproximación a 120 años de Historia (1900-2020)'. In *Energía y política. Una historia del petróleo en España*, edited by Gloria Quiroga, 273–305. Madrid: Catarata.

Bartolomé, Isabel. 2007. *La industria eléctrica en España (1890-1936)*. Madrid: Banco de España.

Bartolomé, Isabel, Mercedes Fernández-Paradas, and Darina Martykánová. 2017. 'La crisis de la industria de gas en Málaga: del gas de carbón al de nafta (1950-1968)', *Transportes, Servicios y Telecomunicaciones*, 32: 102–123.

Carreras, Albert, and Xavier Tafunell. 2018. *Entre el Imperio y la globalización: historia económica de la España contemporánea*. Barcelona: Crítica.

Coll, Sebastián, and Carles Sudrià. 1987. *El carbón en España, 1770 - 1961*. Madrid: Turner.

Colomer, Marcelo, Marcos Lyra, Camila Pires-Alves, and Luiz Carlos Delorme Prado. 2020. 'The market of LPG (Liquefied petroleum gas) in Brazil: a brief structural, institutional-historical perspective', *Entreprises et Histoire*, 2020/2(99): 21–34.

Comisión Nacional de los Mercados y de la Competencia. 1927-1992. *Estadísticas de Hidrocarburos 1927-1992. Consumo anual de productos petrolíferos por provincias*. Madrid: Comisión Nacional de los Mercados y de la Competencia [online]. https://campsa.cnmc.es/estadisticas-de-hidrocarburos/consumo-anual-de-productos-petroliferos-

Comisión Nacional de los Mercados y de la Competencia. 2020. *Panel de Hogares*. Madrid: Comisión Nacional de los Mercados y de la Competencia [online]. https://data.cnmc.es/panel-de-hogares/conjuntos-de-datos/estadisticas-panel-de-hogares

CORES. 1960-2020. *Consumo de productos petrolíferos por grupo*. Corporación de Reservas Estratégicas de Productos Petrolíferos [online]. https://www.cores.es/es/estadisticas

DGT. Jefatura Central de Tráfico. 1962. *Boletín Informativo 1961*. Madrid: Hauser.

Dirección General de Industria. Sección de Estadística e Información Industrial. 1959: *Estadística de la Industria de Energía Eléctrica. Resumen del año 1958*. Madrid.

Ekouevi, Koffi, and Tuntivate Voravate. 2012. *Household Energy Access for Cooking and Heating: Lessons Learned and the Way Forward*. Washington DC: World Bank.

Fernández Acebo, Virgilio. 2005. *De Talleres Corcho a BSH Electrodomésticos España, S.A. Siglo y medio de evolución en una industria de Santander*. Santander: BSH Electrodomésticos España ed.

Fernández-Paradas, Mercedes. 2017. 'El dilema de la industria del gas ciudad en la Andalucía de los años 1960: renovarse o morir', *Ayer*, 107: 257–284.

Folgado, Mª Antonia, Tomás González, and Antonio Lafuente. 2007. *Repsol Butano 50 años cerca de ti*. Barcelona: Lunwerg Editores.

Fouquet, Roger. 2008. *Heat, Power and Light: Revolutions in energy services*. Cheltenham [u.a.]: Edwar Elgar.

García De La Fuente, Dionisio. 2006. *Una historia del gas en Alicante*. Madrid: Lid.

Garrido-Lepe, Martín. 2024. 'Consumo de energía y subsistencia en sociedades preindustriales. Mejorando el ratio de bienestar'. Working Paper 01/2024. UHE Working Paper. Barcelona: Universitat Autònoma de Barcelona.

Grubler, Arnulf. 2008. 'Energy transitions'. In *Encyclopedia of Earth*, edited by Cutler J. Cleveland. Washington, DC: Environmental Informat [online]. http://www.eoearth.org/view/article/152561/

Grubler, Arnulf. 2012. 'Energy transitions research: Insights and cautionary tales', *Energy Policy*, 50(1): 8–16.

Hausman, William J. 1995. 'Long-term trends in energy prices'. In *The State of Humanity*, edited by Julian L. Simon, 280-286. Oxford: Basil Blackwell.

Henriques, Sofia Teives. 2009. *Energy Consumption in Portugal (1856-2006)*. Napoli: Consiglio Nazionale delle Ricerche.

Henriques, Sofia Teives. 2011. 'Energy Transitions, Economic Growth and Structural Change: Portugal in a Long-run Comparative Perspective'. PhD Thesis. Lund: University of Lund.

Hepbasli, Arif. 2003. 'Liquefied Petroleum Gas in Turkey's Energy Sources', *Energy Sources*, 25(5): 373-382.

INE (2019). *España en Cifras 2019*. Madrid: INE.

Infante-Amate, Juan, David Soto, Iñaki Iriarte-Goñi, Eduardo Aguilera, Antonio Cid, Gloria I. Guzmán, and Manuel González de Molina. 2014. 'La producción de leña en España y sus implicaciones en la transición energética. Una serie a escala provincial (1900-2000)', *DT-AEHE*, 1416. Madrid: Asociación Española de Historia Económica.

Infante-Amate, Juan, and Iñaki Iriarte-Goñi. 2017. 'Las bioenergías en España. Una serie de producción, consumo y stocks entre 1860 y 2010', Documentos de Trabajo de la Sociedad de Estudios de Historia Agraria, 1702. Sociedad de Estudios de Historia Agraria.

Iriarte-Goñi, Iñaki, and Juan Infante-Amate. 2019. 'Continuity, change, and geographical differences in Spain's firewood consumption: A new estimation (1860-2010)', *Historia Agraria*, 77: 33-57.

Kander, Astrid, Paolo Malanima, and Paul Warde. 2014. *Power to the people: Energy in Europe over the last five centuries*. Princeton: Princeton University Press.

Kojima, Masami (2011). 'The Role of Liquefied Petroleum Gas in Reducing Energy Poverty', *Extractive Industries for Development Series*, 25. Washington: World Bank.

Kroon, Bianca Van der, Roy Brouwer, and Pieter J.H. van Beukering. 2013. 'The energy ladder: Theoretical myth or empirical truth? Results from a meta-analysis', *Renewable and Sustainable Energy Reviews* 20: 504-513.

Masera, Omar R., Barbara D. Saatkamp, and Daniel M. Kammen. 2000. 'From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model', *World Development* 28(12): 2083-2103.

Matthews, William G., and Hilmar R. Zeissig. 2011. *Residential Market for LPG: A Review of Experience of 20 Developing Countries*. Houston: Houston International Business Corp. Energy and Environmental Policy Consultants.

Ministerio de Industria y Energía. Base de datos energéticos 1959-1982.

Ministerio de Industria. 1962. *Comisión parala distribución del carbón (1961): Estadística general de consumo de carbones por las distintas industrias y de distribución por almacenistas*. Madrid: Rivadeneyra.

Ministerio de Industria. 1970a. *Estadística General de Consumo de Carbones por las distintas industrias y de distribución de almacenistas*. Madrid: Ministerio de Industria.

Ministerio de Industria. 1970b. *Estadística de Energía Eléctrica*. Madrid: Ministerio de Industria.

Ministerio de Industria, Energía y Turismo. Secretaría de Estado de energía. 2011. *La energía en España*. Madrid: Ministerio de Industria, Energía y Turismo. [online]. https://www.miteco.gob.es/content/dam/miteco/es/energia/files-1/balances/Balances/LibrosEnergia/Energia_2011.pdf.

Muldrew, Craig. 2011. *Food, Energy and the Creation of Industriousness. Work and Material Culture in Agrarian England, 1550-1780*. Cambridge: Cambridge University Press.

Muñoz-Delgado, Beatriz, and Mª del Mar Rubio-Varas. 2024. 'Transiciones energéticas en España'. in *Impactos ambientales del crecimiento económico de España, una perspectiva histórica*, edited by Iñaki Iriarte Goñi, and Juan Infante-Amate, 123-143. Zaragoza: Prensas de la Universidad de Zaragoza.

Nicolau, Roser. 2005. 'Población, Salud y Actividad'. in *Estadísticas históricas de España, ss. XIX y XX* , coordinated by Albert Carreras, and Xavier Tafunell, 77-154. Bilbao: Fundación BBVA.

Ojeda Elseley, Alonso de (1988). *Índices de precios en España en el período 1913-1987*. Madrid: Servicio de Estudios del Banco de España.

Pope, Daniel, Nigel Bruce, James Higgerson, Hyseni Lirije, Debbi Stanistreet, Bertrand Mbatchou, and Elisa Puzzolo. 2018. 'Household Determinants of Liquified Petroleum Gas (LPG) as a Cooking Fuel in SW Cameroon', *EcoHealth*, 15: 729-743.

Prados de La Escosura, Leandro. 2005. 'Renta y Riqueza', in *Estadísticas históricas de España, ss. XIX y XX*, coordinated by Albert Carreras, and Xavier Tafunell, 1297-1376. Bilbao: Fundación BBVA.

Raslavičius, Laurencas, Artūras Keršys, Saulius Mockus, Neringa Keršienė, and Martynas Starevičius. 2014. 'Liquefied petroleum gas (LPG) as a medium-term option in the

transition to sustainable fuels and transport', *Renewable and Sustainable Energy Reviews*, 32: 513-525.

Romero Valiente, Juan M. 2003. 'Migraciones', in *Tendencias demográficas durante el siglo XX en España* , coordinated by Andrés Arroyo Pérez 209-53. Madrid: INE.

Rubio-Varas, Mª del Mar. 2005. 'Energía, economía y CO2: España 1850-2000', *Cuadernos económicos de ICE*, 70: 51-76.

Rubio-Varas, Mª del Mar, and Beatriz Muñoz-Delgado. 2019. 'Long-term diversification paths and energy transitions in Europe', *Ecological Economics*, 163: 158-168.

Sedigas. 2016. *Informe anual 2016. El gas en España*. Sedigas. Asociación Española del Gas [online]. https://www.sedigas.es/informeanual/2016/wp-content/uploads/2017/04/Informe-anual-2016-EL-GAS-EN-ESPA%C3%91A.pdf

Sindicato Vertical de Agua, Gas y Electricidad. 1960. *Estadística comparativa de la industria del gas durante los años 1957, 1958 y 1959*. Madrid: Sindicato Vertical de Agua, Gas y Electricidad.

Sindicato Nacional de Agua, Gas y Electricidad. 1962-1969. *Datos estadísticos de la industria del gas*. Madrid: Sindicato Vertical de Agua, Gas y Electricidad.

Smil, Vaclav. 1994. *Energy in world history*. Boulder: Westview Press.

Sudrià, Carles. 1987. 'Un factor determinante: La energía', In *La economía española en el siglo XX: Una perspectiva histórica*, edited by Carles Sudrià, Jordi Nadal, and Albert Carreras 313–65. Madrid: Ariel.

Sudrià, Carles. 1995. 'Energy as a limiting factor to growth', in *The Economic Development of Spain since 1870*, edited by Pablo Martin-Aceña, and James Simpson, 268–309. Londres: Edward Elgar.

Sudrià, Carles. 2017. 'El butano ¿gas para los pobres? Notas sobre el papel del gas butano embotellado en el desarrollo energético de España', in *Globalización, nacionalización y liberalización de la industria del gas en la Europa Latina (siglos XIX-XXI)*, edited by Isabel Bartolomé, Mercedes Fernández-Paradas, and Jesús Mirás, 279–291. Madrid: Marcial Pons.

Tafunell, Xavier. 2005. 'Urbanización y vivienda', in *Estadísticas históricas de España, ss. XIX y XX*, coordinated by Albert Carreras, and Xavier Tafunell, 455–500. Bilbao: Fundación BBVA.

Teixeira Coelho, Suani, Alessandro Sanches-Pereira, Luis Gustavo Tudeschini, and José Goldemberg. 2018. 'The energy transition history of fuelwood replacement for liquefied petroleum gas in Brazilian households from 1920 to 2016', *Energy Policy*, 123: 41–52.

Toole, Rebecca. 2015. 'The Energy Ladder: A Valid Model for Household Fuel Transitions in Sub-Saharan Africa?'. Master Thesis, Somerville: Tufts U.,

Tortella, Gabriel, Alfonso Ballestero, and José Luis Díaz Fernández. 2003. *Del Monopolio al libre mercado. La historia de la industria petrolera española*. Madrid: LID Editorial Empresarial.

UNEP. 2010. 'Liquefied Petroleum Gas (LPG). Demand, Supply and Future Perspectives for Sudan', Synthesis report of a workshop held in Khartoum, 12-13 December 2010.

Valdaliso, Jesús M. dir., Carlos Alvarado, and Patricia Suárez. 2022. *Nortegas (1845-2021). Historia de la industria del gas en el norte de España.* Madrid: Marcial Pons.

Vela, Antonio. 1995. *El gas como alternativa energética.* Madrid: Alianza Editorial.

World Bank and World LP Gas Association. 2002. 'The Role of liquefied petroleum (LP) Gas in Meeting the Goals of Sustainable Development'. Working Paper, 79797. Washington DC: World Bank.

Wrigley, E. Anthony. 2016. *The Path to Sustained Growth. England's Transition from an Organic Economy to an Industrial Revolution*. Cambridge: Cambridge University Press.

Yang, Chi-Jen, Yipei Zhou, and Robert B. Jackson. 2014. 'China's fuel gas sector: History, current status, and future prospects', *Utilities Policy*, 28: 12–21.

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Consum energètic residencial a Espanya durant la dècada de 1960. El butà i la precarietat del «desarrollismo»

RESUM

Aquest article il·lustra un episodi clau de la transició energètica dels combustibles tradicionals als fòssils, un patró sovint observat en els països en desenvolupament. Examina el fort increment del consum de Gas Liquat de Petroli (GLP) per a ús domèstic a Espanya durant la dècada de 1960, centrant-se en les disparitats regionals. Tot i que el règim franquista va promoure activament l'ús del GLP a través de l'empresa Butano SA, les diferències regionals no es poden explicar plenament per les variacions en el clima o en el teixit industrial. Per explorar-ho, l'estudi analitza el consum de GLP juntament amb altres fonts d'energia substitutives per a usos calorífics (llenya, carbó, gas ciutat) i fonts d'energia complementàries per a la il·luminació (electricitat). A continuació, s'avaluen els factors que van impulsar l'adopció d'aquestes fonts d'energia. Els resultats posen de manifest la complexitat de la transició energètica en les llars espanyoles i confirmen l'existència de desigualtats importants en l'accés a l'energia entre les zones rurals i urbanes. S'hi introdueix una perspectiva innovadora: el GLP es va associar estretament a les grans ciutats espanyoles i les seves àrees metropolitanes, on les precàries condicions de l'habitatge van jugar un paper fonamental en la seva adopció generalitzada.

PARAULES CLAU: Transició energètica, GLP, Espanya, «desarrollismo»

CODIS JEL: N34, N74, N94

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Consumo energético residencial en España en el decenio de 1960. El butano y la precariedad del desarrollismo

RESUMEN

Este artículo ilustra un episodio clave de la transición energética de los combustibles tradicionales a los fósiles, una pauta observada a menudo en las naciones en desarrollo. Examina el fuerte aumento del consumo de Gas Licuado de Petróleo (GLP) para uso doméstico en España durante la década de 1960, centrándose en las disparidades regionales. Aunque el régimen franquista fomentó activamente el uso del GLP a través de la empresa Butano SA, las diferencias regionales no pueden explicarse plenamente por variaciones en el clima o en tejido industrial. Para explorarlo, el estudio analiza el consumo de GLP junto con otras fuentes de energía sustitutivas para usos de caloríficos (leña, carbón, gas ciudad) y fuentes de energía complementarias para la iluminación (electricidad). A continuación, se evalúan los factores que impulsan la adopción de estas fuentes de energía. Los resultados ponen de manifiesto la complejidad de la transición energética de los hogares españoles y confirman la existencia de importantes disparidades en el acceso a la energía entre las zonas rurales y urbanas. Se introduce un argumento novedoso: el GLP fue una energía asociada estrechamente a las grandes urbes españolas y sus áreas metropolitanas, donde las malas condiciones de la vivienda desempeñaron un papel clave a la hora de impulsar su adopción generalizada.

PALABRAS CLAVE: Transición energética, GLP, España, desarrollismo

CÓDIGOS JEL: N34, N74, N94

Appendices

The reconstruction of per capita domestic energy consumption in caloric and lighting services for the 1960s by region in Spain is hindered by two significant obstacles: first, the lack of disaggregation of certain sources; and second, the limitations associated with the conversion of data to common units. Residential consumption has been regarded as insignificant and, consequently, not separable from the overall consumption of these energy sources. Therefore, using the available provincial data, we have proceeded to disaggregate this consumption.

In the case of gases, this was relatively straightforward, as the provincial consumption of butane gas and manufactured gas, as recorded in the data set (1961 and 1970), fulfilled this requirement. The remaining energies, namely electricity, coal and firewood, have presented a far greater challenge. While provincial statistics on the appropriation of firewood (forestry and woody crops) are available, no distinction is made between this and domestic consumption. Consequently, an estimate has been made as a percentage of provincial appropriation, based on Infante et al (2014) and Infante and Iriarte (2017). In the case of firewood, manufactured gas and butane, the starting units have been the kilogram consumed. In their conversion to gigajoules (GJ), each of these has been considered as a homogeneous product. With regard to coal, provincial consumption statistics are available, also in units of mass. However, at least seven varieties of coal are distinguished each with different calorific capacities, either from stockists or consumed at source. In addition, a percentage of 4.5 of the total coal consumed in 1960 and 6 percent in 1969-70 is not regionalised. Thus, each variety had to be considered for conversion to GJ. Finally, the official statistics on domestic electricity consumption are presented at the provincial level, but significant problems of disaggregation by tariff type persist. Data are expressed in MWh at the source, so they had to be converted, like the rest of the energy units, to GJ using the conversion table of the Ministry of Industry and Energy (2011).

TABLE A1. Domestic energy consumption per capita by region (1960-61, 1969-70), in GJ

	1960/1961					1969/1970						
	Substitutes: caloric services				Complementary: lighting services	Substitutes: caloric services				Complementary: lighting services	Total 1960 (1)	Total 1970 (2)
Region	Firewood	LPG	Manufactured Gas	Coal	Electricity	Firewood	LPG	Manufactured Gas	Coal	Electricity	GJ per capita	GJ per capita
Andalucía*	4.62	0.09	0.057	0.25	0.16	4.11	1.49	0.05	0.09	0.55	5.19	6.29
Aragón	8.59	0.10	0.110	1.84	0.28	6.46	1.51	0.18	1.32	0.93	10.91	10.40
Asturias	2.61	0.02	0.103	3.05	0.16	0.64	1.02	0.16	3.83	0.43	5.94	6.07
Baleares	5.00	0.19	0.371	0.49	0.35	3.54	2.40	0.60	0.42	0.95	6.40	7.90
Canarias	1.51	0.00	0.041	0.06	0.24	0.70	1.65	0.01	0.00	0.38	1.84	2.74
Cantabria	2.25	0.07	0.152	1.90	0.07	1.15	1.65	0.14	1.62	0.67	4.44	5.22
Castilla La Mancha	12.27	0.05	0.000	1.13	0.09	14.63	1.33	0.00	0.89	0.46	13.52	17.31
Castilla y León	8.21	0.04	0.009	1.79	0.17	6.22	1.21	0.03	1.32	0.52	10.23	9.29
Cataluña	5.61	0.24	0.934	1.12	0.29	2.14	2.24	1.41	0.21	0.82	8.19	6.83
Comunidad Valenciana	8.87	0.13	0.184	0.15	0.61	6.21	1.76	0.13	0.12	0.90	9.95	9.12
Extremadura	9.76	0.03	0.000	0.05	0.05	9.80	1.04	0.00	0.03	0.32	9.89	11.18
Galicia	30.96	0.04	0.014	0.43	0.24	13.03	1.07	0.00	0.32	0.38	31.69	14.80
Madrid	0.77	0.18	0.733	7.50	0.58	0.35	1.91	1.09	2.33	1.64	9.76	7.32
Murcia	5.51	0.09	0.065	0.05	0.11	4.97	1.65	0.04	0.02	0.45	5.82	7.13
Navarra	5.86	0.18	0.000	1.84	0.30	3.80	1.98	0.00	1.07	0.75	8.18	7.59
P. Vasco	1.35	0.24	0.203	2.73	0.40	0.43	2.06	0.22	2.00	0.80	4.93	5.51
Rioja	8.23	0.12	0.000	0.35	0.29	6.61	1.94	0.00	0.67	0.70	8.99	9.93
Total general	7.96	0.11	0.238	1.48	0.23	4.78	1.65	0.40	0.82	0.74	10.02	8.39

Source: Sindicato (1960, 1962-69); Ministerio de Industria (1970a; 1970b); Infante et al (2014) and Infante and Iriarte (2017). Ministerio de Industria, Energía y Turismo (2011) for unit conversions.

TABLE A1. Domestic energy consumption per capita by region (1960-61, 1969-70), in GJ

	1960/1961					1969/1970				
	Substitutes: caloric services				Complementary: lighting services	Substitutes: caloric services				Complementary: lighting services
Region	**Firewood**	**LPG**	**Manufactured Gas**	**Coal**	**Electricity**	**Firewood**	**LPG**	**Manufactured Gas**	**Coal**	**Electricity**
Andalucía*	89.14	1.83	1.11	4.76	3.16	65.33	23.65	0.85	1.49	8.67
Aragón	78.70	0.90	1.01	16.83	2.56	62.10	14.56	1.72	12.65	8.97
Asturias	43.94	0.34	1.74	51.31	2.68	10.50	16.72	2.66	63.03	7.09
Baleares	78.11	2.91	5.80	7.66	5.52	44.78	30.32	7.56	5.35	11.99
Canarias	81.75	0.00	2.25	3.22	12.78	25.70	60.12	0.40	0.00	13.78
Cantabria	50.72	1.51	3.41	42.75	1.61	21.97	31.52	2.75	30.94	12.82
Castilla La Mancha	90.70	0.34	0.00	8.32	0.65	84.55	7.66	0.00	5.16	2.64
Castilla y León	80.26	0.42	0.09	17.53	1.70	66.87	12.97	0.37	14.17	5.61
Cataluña	68.50	2.89	11.40	13.68	3.53	31.39	32.79	20.67	3.14	12.00
Comunidad Valenciana	89.22	1.33	1.85	1.48	6.13	68.10	19.28	1.40	1.29	9.92
Extremadura	98.71	0.27	0.00	0.50	0.52	87.66	9.29	0.00	0.23	2.82
Galicia	97.71	0.14	0.04	1.37	0.74	88.06	7.22	0.00	2.14	2.58
Madrid	7.88	1.81	7.51	76.82	5.98	4.76	26.09	14.94	31.80	22.41
Murcia	94.53	1.61	1.11	0.81	1.95	69.71	23.21	0.57	0.23	6.29
Navarra	71.66	2.20	0.00	22.46	3.68	49.98	26.07	0.00	14.06	9.89
P. Vasco	27.47	4.88	4.13	55.37	8.16	7.87	37.38	3.92	36.35	14.48
Rioja	91.49	1.33	0.00	3.92	3.26	66.62	19.52	0.00	6.76	7.10
Total general	79.42	1.11	2.38	14.77	2.32	57.01	19.67	4.73	9.73	8.86

Source: Sindicato (1960, 1962-69); Ministerio de Industria (1970a; 1970b); Infante et al (2014) and Infante and Iriarte (2017). Ministerio de Industria, Energía y Turismo (2011) for unit conversions.