

The territorial diffusion of the gas industry in Latin Europe before the competition from electricity

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Keywords: gas, energy, Latin Europe, location, nineteenth century.

JEL classification: L95, N63, N73, O13, Q43.

CHAPTER 2

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Alberte Martínez-López and Jesús Mirás-Araujo¹

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INTRODUCTION

The literature on the origin and development of gas has expanded remarkably over the last two decades. The earliest studies were published in the countries that were the pioneers in the implementation of gas, namely the United Kingdom and France. Subsequently, the range of research has progressively expanded to other nations in which this industry was installed.

The first gas industry was established in the United Kingdom in the 1810s. The diffusion of gas across the continent began in the 1820s and 1830s, first in Belgium and France. In the

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1840s and 1850s it spread to Switzerland, Germany, the Austro-Hungarian Empire, the Scandinavian countries and, somewhat later, to the block made up of the Southern and Eastern European countries. In our opinion, the territorial group composed of France, Italy, Portugal and Spain, that is, what can roughly be named Latin Europe, forms a relatively homogeneous ensemble, with many common elements, although each with its own peculiarities. The epicentre was France, the first country of the group to introduce a gas industry. Its level of implementation was only surpassed by the United Kingdom. It was one of the main drivers of technological innovation in the sector from the outset and promoted a powerful flow of capital investment, technology and knowledge in Europe, but principally in the Mediterranean basin. The area is completed with three peripheral Southern countries. Their gas models were different to the French one due to the delay in their introduction and a less widespread implementation of gas (although with internal geographical dissimilarities) and because they were receivers, mostly but not exclusively, of technology from France.

So far, no global historical reflection has been made of the patterns of gas diffusion in these nations with which to investigate in greater detail the differences and the common elements. For this reason, this chapter seeks to analyse, from a comparative and global perspective, the geographical penetration of what was the first public network utility.

To do this, a source scarcely used by researchers has been selected: the *Annuaire général de l'industrie de l'éclairage et du chauffage par le gaz*¹. We have chosen 1875-1876 as the period of study, as this is when the sector peaked, just before the competition with electricity began in the 1880s. This source provides valuable information regarding the towns and cities that had a gas supply. Assigning these populations to different regions enables us to determine the importance of regional contrasts in gas densification. The geographical approach is therefore the first level of analysis. The cartographic representation of the cities with gas provides a clear visualisation of the location of the gas industry in Southern Europe. A second level of analysis is demographic, whereby the cities are classified by population size. This allows us to discern the degree of gas penetration according to that size.

FRANCE, LEADER IN THE GAS INDUSTRY

According to the theory of innovation cycles and its relationship with urbanisation, a certain and significant technological innovation, in this case gas, would appear first in the largest cities of a country, bestowing them with a comparative advantage, which, in turn led to higher population growth. Innovation would progressively spread, following a hierarchical

diffusion pathway, towards increasingly smaller towns. This allowed these towns to grow comparatively more than large cities, at least until the advent of another significant innovation, such as electricity (Guérin-Pace 1992: 14). In any case, mere access to the knowledge of such an innovation would not be enough for it to spread. A certain material base would also be required, as this would allow this innovation to be viable in economic terms (benefit-cost ratio). In this case, this material base was constituted by a critical mass (demographic size, degree of population concentration), economic accessibility (seaport, railway lines) to the main input (coal), and a certain level and distribution of income.

In the period 1811-1911, the French urban population increased from 4.2 million to 13.8 million (8.9 million in 1876), that is, it more than tripled, while total population only increased by 35%. Moreover, the number of cities (*communes*) rose from 422 to 851 (674 in 1876)². In short, the urban population grew both due to the increase in the number of urban towns and cities and, above all, due to the increase in their population, especially in metropolitan areas. To a large extent, this process was the result of industrialisation and the railway network. The stage of greatest urban acceleration took place in the period 1872-1881. The number of cities logically increased as their size decreased, with the smallest being the most unstable in terms of their evolution. Thus, in 1866, of 694 cities, 356 had between 3,000 and 5,000 inhabitants. Depending on their primary function, cities evolved at different rates. Until 1850, administrative activities, which were located in the departmental capitals, propelled urban growth (Chatel 2012: 523). The Northern mining cities boomed during the Second Empire (1852-1870), as did the Northern and Eastern industrial cities from 1831, while the tertiary cities grew more irregularly. During the nineteenth century, overall, the highly urbanised regions and those whose urban centres grew the most were the North (including Paris), Northeast (Alsace-Lorraine), East (around Lyon) and Côte d'Azur regions.

Within the Latin Europe bloc, France was the most advanced nation in terms of the introduction and diffusion of gas. The chronology of its implementation shows a first wave in the 1820s and 1830s, when the most important cities in the country were illuminated by gas (Williot and Paquier 2005: 24). It then enjoyed a period of prosperity between the beginning of the Second Empire (1852) and the arrival of electricity in the 1880s. Its driving force resided in the demand generated by urbanisation and the implementation, in the 1840s, of many urban renewal projects, which were boosted from the 1870s.

Paris witnessed the earliest initiatives (four companies were founded between 1817 and 1822), acting as a catalyst for the spread of gas across the country. In 1840, 35 cities had granted a concession and in 1850 the number of municipalities that were served increased to 107. In

1891, all municipalities with more than 20,000 inhabitants were connected and almost half of those with more than 2,000 inhabitants had a supply (Williot 2005: 147-160).

French gas technology expanded internationally during the second half of the nineteenth century, especially in the Mediterranean area (Williot 2006). French business groups played a highly relevant role in the expansion of the gas industry in Europe, particularly in Spain and Italy. At the end of the nineteenth century, they supplied 97 municipalities, of which 46 were abroad (24 in Spain and 15 in Italy) (Fàbregas 2003: 114).

Broadly speaking, the highest gas density was located in the north and east of the country, more intensively in the northernmost area, Île-de-France and Normandy (**Figure 2.1**). It was the most industrialised area in France with the best transport (both railways and river channels) and communications and rich coal deposits (Nord department), a high level of urbanisation and income per capita (Île-de-France), or a coastal location and very close to British coal (Normandy)³. The second largest core was structured around Lyon (departments of Rhône, Loire and Isère), which was the second French city and a powerful industrial and gas hub. Finally, the Mediterranean coastal area between the important cities of Marseille and Montpellier had a high population and urban density, and easy maritime access to British coal. A defined north (northwest)-south (southeast) axis may be observed, structured around large urban, industrial and coal-receiving cities: Lille-Paris-Lyon-Marseille.

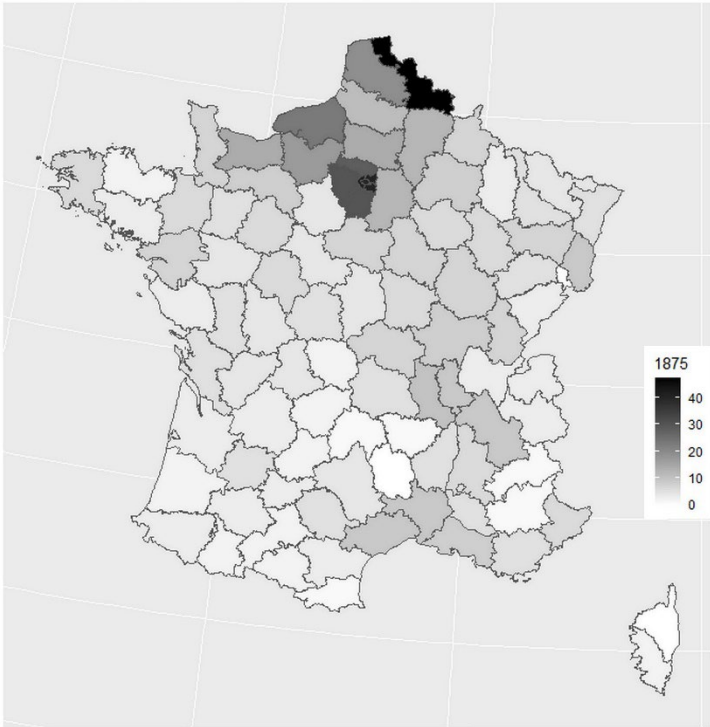


Figure 2.1 Number of municipalities with gas in France, by department, in 1875.
Source: Annuaire Durand, 1875, and population census.

At the other end of the spectrum, that is, with a relatively lower number of municipalities with gas, were vast inland areas, such as the historic regions of Centre, Auvergne, Burgundy, and Limousin, the south-west regions such as Aquitaine or Midi Pyrenees, or the mountainous districts of the Alps, including Savoy. These were, overall, more agricultural and rural territories, with a lower population and income density. In this case, rather than an axis (a diagonal of the weak densities) it can be observed as a vast centre-southwest spot.

In an intermediate position were regions such as Brittany, Pays de la Loire and Alsace-Lorraine (which was actually part of Germany at the time), which had better possibilities to access coal, due to their maritime location close to the United Kingdom or to coal mining areas.

THE ITALY OF CONTRASTS: THE CENTRAL EUROPEAN NORTH VS. THE MEDITERRANEAN MEZZOGIORNO

After France, Italy was the second most advanced nation in Latin Europe to adopt gas. It is a country with a secular urban tradition (Accetturo and Mocetti 2019: 205). Based on a threshold of 6,000 inhabitants, which the Italian census of 1871 considered as urban, it is astounding that the regions with the highest urbanisation rate were located in the south, where Sicily and Puglia exceeded 60% of population in these types of municipalities. These were followed by Lazio (almost 40%), and Campania and Basilicata, also both in the south, with more than 30%. These were different urban models, which, in the words of Musi (1998), swung between Neapolitan monocentrism and Sicilian polycentrism. Nevertheless, despite this urban primacy, the average size of the cities was smaller (Bosker et al. 2008).

In contrast, the levels of the more developed regions of the north are more modest, between 14-18% (Lombardy, Piedmont, Emilia-Romagna, Tuscany), with the exception of Liguria (25%). This is despite the fact that, from medieval times, an important network of small and medium-sized cities still flourished in the north (Hohenberg 2004). However, after the Unification of the country (1861), the process of emigration towards urban centres (mainly the northern ones) intensified (Caracciolo 1981: 133-135), which formed part of the most intense period of urbanisation in the country (Malanima 2005). On the contrary, the total number of cities was higher, especially the larger ones (Sori 1978: 305). Of the total number of cities in the country with more than 40,000 inhabitants in 1871 (16), 9 were located in the north (including Tuscany). Except for Naples and Rome, the urban hierarchy that year was led by the cities of these regions: Naples (448,335 inhabitants), Rome (244,484), Palermo (219,398),

Turin (212,644), Milan (199,009), Florence (167,093), Genoa (130,269), Venice (128,901), Bologna (115,957), etc. On the other hand, urban density was higher in the north where the functionality of the cities was more similar to the urban model of the industrialised European countries, with inner spaces that were built up more compactly (Bielza 1977). This favoured the installation of modern equipment and utilities, such as gas, as their networks were built in the central areas of cities (Calabi 1980: 297). In the south, there was less coincidence between urban growth and industrialisation, although these regions were not exempt from a certain socioeconomic modernisation (Barone 1989).

Italy had to overcome some major obstacles that hampered an early assimilation of gas technology. These included the political fragmentation of the country, the backwardness and dispersion of its industrial and technical development and a poor coal supply (Del Curto and Landi 2008: 8). For this reason, it is not possible to identify a homogeneous model of territorial implementation (Giuntini 2005), observing a differentiation between the two blocks described: the north and centre of the country, where the earliest initiatives were executed and the south, where gas was introduced later, with the exception of Naples (1839).

Although the introduction of new lighting began to be considered at the end of the 1830s, the transition to gas began in the 1840s. The first city to authorise a gasometer was Turin in 1837. This was followed by Venice, in 1841 and in the middle of the decade some of the main Italian cities also began to install them. Between 1845 and 1847, Milan, Bologna, Florence, Vicenza, Treviso, Padua, Verona and Parma began to light their streets with gas. In a sequence that was similar to Spain, though more vigorous, the next advancement took place during the 1850s and 1860s: Cuneo (1852), Vercelli (1855), Brescia and Trento (1859), Ancona, Tortona and Casale (1860), Palermo (1861), Lodi and Pavia (1862), Bergamo, Monza and Lucca (1863), Mantova (1864), etc. The late introduction of gas in two locations is striking: Rome, the last Western European capital to incorporate it (1854), and Genoa (1858) (Giuntini 1997: 173).

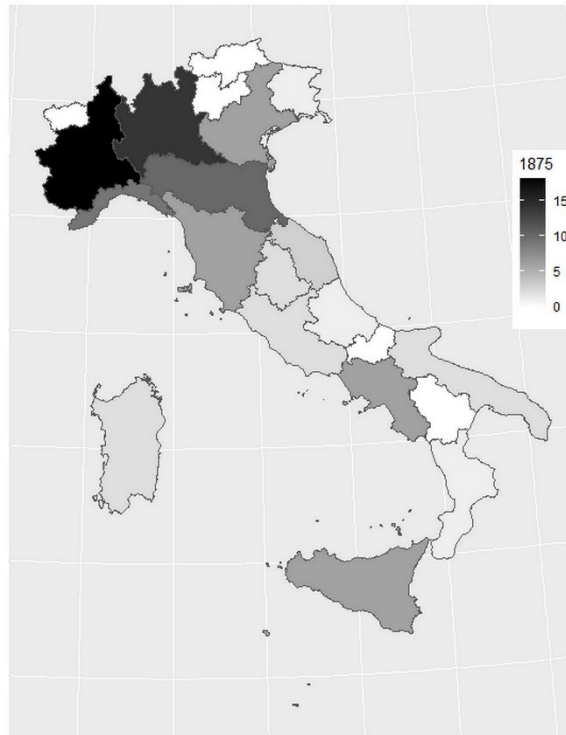


Figure 2.2 Number of municipalities with gas in Italy, by region, in 1875.

Source: Annuaire Durand, 1875, and population census.

At the beginning of National Unification, all large and medium-sized capitals had gas networks, although the penetration in small cities had barely started (Giuntini 2011: 203-204). The fall in the costs of coal transport that took place in the 1860s, thanks to the decrease in freight rates and the construction of the railways, played a decisive role (Giuntini 2007: 156). In 1865, there were 57 gas factories, and by 1870, 55 cities had a factory (Franco 1988: 29-30). The next twenty years until the emergence of electricity constituted the definitive boom in the sector (Giuntini 1997: 198).

The location of gas in Italy had a more European profile, since the regional distribution was more balanced than that of Spain and Portugal, and more similar to that of France (**Figure 2.2**). In 1875, 89 cities had gas. The facilities and networks were built and managed mostly by foreign companies (Bigatti et al. 1997), mostly French and, to a lesser extent, British, Swiss, Belgian and German firms, which provided assets, technology, knowledge and management techniques (Del Curto and Landi 2008: 15). Therefore, it is not surprising that the highest concentration was recorded in Piedmont (with 20% of the cities with gas in the country), Lombardy (16%), Emilia-Romagna (11%) or Liguria (10%). The main exception was Campania, whose capital, Naples, was the most populous city in the country and had undergone the largest demographic growth until Unification (Bartoletto 2004: 706), and was one of the

first to install street lighting by gas (Bartoletto 2000). Its polyfunctionality (political, administrative, financial...) explains its role as the main capital of the Mezzogiorno (Musi 1998: 478), a feature shared by the other large capital of the south, Palermo.

The northern regions constituted the industrial heart of Italy and were the territories symptomatically closest to the Swiss and, above all, French border. The process began with the introduction of gas in Italy in the late 1830s, as part of the expansion of the gas industry in Lyon, a city that preserved its traditional role as the hub of commercial and financial interrelationships between France, Piedmont and Switzerland through the transalpine valleys (Caiazza 2013: 36). Therefore, in some way, a centre-periphery pattern was recreated, similar to the Spanish one, but less accentuated, as a consequence of the fact that the list of regions undergoing an industrialisation process was more extensive in Italy.

The factors that explain this location pattern were related, first, to demand variables. Since the launch of the new technology in Europe, the industrial regions were most inclined to a high consumption of gas, although not always necessarily through direct demand from manufacturers. In such cases, it was a result of the cumulative effect on the demographic growth of the most dynamic cities. The market was not large enough, lacking industrial and private demand. In fact, the narrowness of the markets favoured the fragmentation and geographical dispersion of companies (Giuntini 2005: 243).

However, the main Italian urban centres were undergoing dramatic changes in terms of the expansion of infrastructures and urban planning (Schisani and Caiazza 2016: 208), so the projects of bourgeois transformation of the cities were primarily responsible for the extension of public lighting (Giuntini 2021). This occurred mostly in small and medium-sized provincial cities, which incorporated the new technology somewhat later than the larger cities (Giuntini 2009: 40). The progressive dissipation of the distrust of citizens towards the new energy source explains that between the 1860s and the 1890s the sector enjoyed its golden age (Giuntini 2011: 202-209).

The development of the Italian railway network and the relative proximity of most of the country to a port, which was a necessary condition for the import of coal (mainly from UK), were critical factors. At the time of the proclamation of the Italian state, virtually the only existing railways were found in the northern part of the country. They began to expand in the early 1870s longitudinally along the Adriatic and Tyrrhenian coasts (Maggi 2017). Foreign capital, predominantly French, once again played a relevant role in their construction. The limited propensity for investment in high-risk businesses by national capital, combined with the abundance of oil with which to alleviate the shortage of coal, have also been cited as

conditioning factors. However, aspects associated with social prestige that accompanied the modernising impulse of the most dynamic centres of the country (the northern ones) should not be underestimated either (Franco 1988: 15).

TWO SIDES OF THE SAME COIN: BETWEEN THE SPANISH AND CATALAN GAS MODELS

Spain was the third country in the global gas ranking of Latin Europe. After some hesitant beginnings during the first third of the nineteenth century, a long period of slow socioeconomic transformations began, which were reflected in the rising urbanisation of the country, enabling a progressive coupling with the patterns and rhythms of Western Europe, although less dynamically than the leading nations. The process underwent an acceleration in the last third of the century (although with many vicissitudes), with an urbanisation rate that grew from 19.5% in 1800 to 18% in 1850, and then to 22.5% in 1870 and 34% in 1900 (Mirás 2018: 16, 24). The period of strongest growth took place between 1860 and 1887, further heightening the dominance of the largest cities (Tafunell 2005).

Rural population flows were the main basis of urban growth. However, the underlying factors in this change were, among others, the new territorial organisation that emerged after the liberal revolution (which benefited the provincial capitals), together with certain technological innovations related to industrialisation: the new means of transport (chiefly the railway) and the implementation of the first public utilities. Its evolution of urban growth followed the lines of industrial growth, particularly in the coastal periphery, although medium-sized cities also evolved, being sustained by a specialisation based on the tertiary sector. Towards the end of the century, the rhythm of urban transformation accelerated and more rapidly in the three decades preceding the Spanish Civil War (Mirás 2020: 231).

The introduction of the gas industry in Spain (as in Italy) occurred around two decades later than in the most advanced countries. While in Central Europe (Germany and Switzerland) and Nordic Europe, the main cities had gas supply from the 1820s and 1830s, and the small and medium-sized towns from the 1860s (Thomas 2018: 146-156), in southern Europe only some of the largest cities implemented it in the 1840s, although, in general, the service became widespread in the 1860s (Williot and Paquier 2005: 28-31).

Initiatives were launched early in Spain. The first gas lighting tests were carried out in Cadiz and Granada as early as 1807, which were later continued in other cities (Alcoy in 1818, Barcelona in 1826, Madrid in 1833) (Barca and Alayo 2013). Nevertheless, the diffusion

process compared to other countries, occurred later and was, slower, more modest and, from a spatial point of view, unbalanced (Sudrià 1983: 97). The initial gap with respect to Italy was not excessively wide. The first factory came into operation somewhat later, in 1842, in Barcelona. The next cities to have the service were Valencia (1844), Cadiz (1846), Madrid (1847), Bilbao (1849), Seville (1850), Santander and Sabadell (1852), Malaga (1853), etc. During the first stage of implementation of the industry, which took place between 1842 and 1861, the main difference with Italy did not lie in the chronology but in the intensity of the process, which was less geographically spread in the Spanish case. The same occurred during the consolidation stage of the sector, 1862-1901, when the strongest expansion in the opening of new factories was registered, especially during the last two decades of the century, a period in which 34 facilities were inaugurated, compared to 29 in 1862-1880. As a result, in 1861 there were 28 factories operating in the country, increasing to 81 in 1901 (Alayo and Barca 2017: 142-144, 318-320). In short, some of the main cities were furnished relatively early, but the smaller towns (and not all of them) did not receive a supply until several decades later. The Spanish differential factor lies, therefore, in the fact that this energy had a spatially limited presence, as it was far from being widespread. Besides, in many cities the energy transition jumped directly from traditional lighting systems to electricity, without the intermediate stage characterised by the use of gas (Mirás 2017).

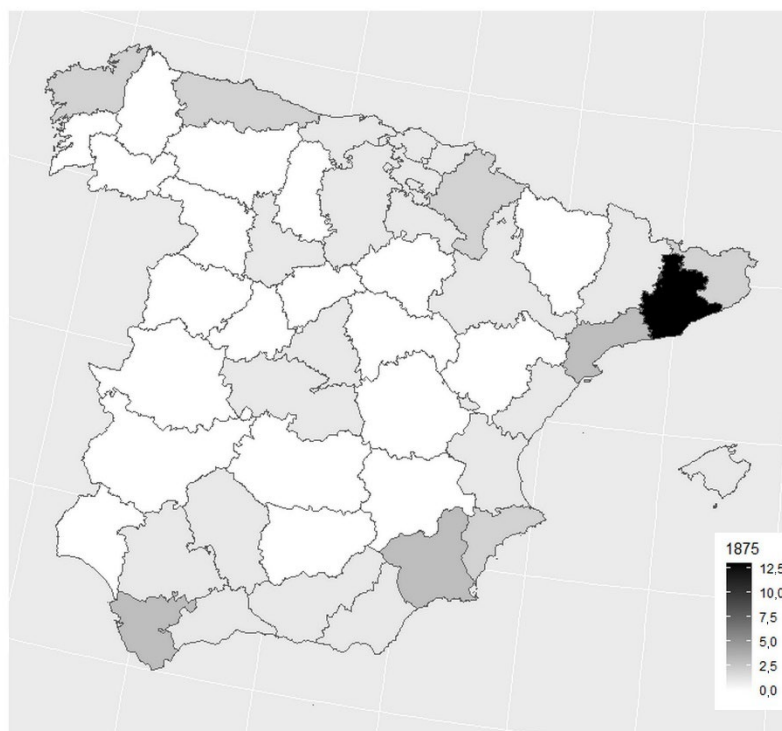


Figure 2.3 Number of municipalities with gas in Spain, by province, in 1875.

Source: Annuaire Durand, 1875, and population census.

The highest Spanish gas density was clearly concentrated in the coastal periphery or in provinces that were relatively near the coast, with the exception of Madrid and its sphere of influence (**Figure 2.3**). Nonetheless, one region clearly stands out above the rest, Catalonia, with 19 municipalities (38% of the total in Spain). The only territory that came relatively close was Andalusia, a region with a fairly early chronology and a reasonably extensive gas density (Fernández-Paradas et al. 2021a). However, the concentration was very different, since in this case the ratio of towns with gas per 10,000 km² of territory was 0.91, while in Catalonia it was 5.9, with the Spanish average standing at 1.

This predominance was supported by supply and demand factors. Among the former, the most important were the availability of capital, technology and coal for gas distillation. This explains the prevalence of foreign companies in the take-off of the sector and the location of the vast majority of the factories in coastal regions or close to a railway connection that enabled access to foreign (British) or Asturian coal. From the demand point of view, a certain market threshold was necessary to guarantee the profitability of the business, which was linked to a critical size that was determined by income levels.

If these elements are combined, Catalonia is a unique case. It was characterised by an earlier implementation and a higher geographical density; therefore, it was more similar to the advanced European standards (Fernández-Paradas and Sudrià 2018). Even though the only factory that was inaugurated during the 1840s was in the city of Barcelona, the sector took off in the 1850s and 1860s, with the installation of 18 factories. In the 1870s and 1880s, notably during the latter, the industry was definitively consolidated, with 16 new facilities (Alayo and Barca 2017: 317-322). On the one hand, the presence of local (regional) capital and business initiatives during the nineteenth century was outstanding (Aubanell 2020). And although the technology was predominantly French, the participation of professionals that had graduated from the Barcelona School of Industrial Engineering helped the development of the sector (Alayo and Barca 2019: 158-159). On the other hand, income levels were among the highest in the country, in addition to the fact that the urbanisation process was more intense than in the rest of the national territory. As this service was located in cities, the existence of a well-balanced urban hierarchy was essential, whereby large cities (Barcelona) coexisted alongside a range of intermediate or even small prosperous towns that were endowed with a solid economic base. All of this ultimately highlights the pioneering industrialisation of Catalonia (Moyano 2011: 32), and the boost that it generated in the domestic market (Rosés 2003).

In addition to the noteworthy weight of the gas industry of Catalonia as a whole, the fact that the service was present in all the provinces is remarkable. This circumstance did not occur in the rest of Spain, except in Valencia or in the single-province regions. However, the location of the factories was concentrated in the province of Barcelona and particularly in the immediate surroundings of the capital. The structure was then highly atomised. This trait was repeated throughout the nineteenth century, since there was a predominance of small local-scale companies, which were often promoted in their initial inauguration by each city council and were established with the financing of local entrepreneurs (Moyano 2012).

While in Spain as a whole the municipalities that had gas lighting were provincial capitals or cities of a certain size and economic relevance, in Catalonia the distribution was relatively homogeneous, because populations of various sizes were supplied, many of them small. In fact, the first-generation gas companies were predominantly located in towns with a population threshold of 10,000-50,000 inhabitants, although most were in the range of 10,000-20,000 inhabitants. However, during the years of the industry's greatest expansion, the 1870s, most of the intermediate towns in the urban hierarchy had gas, and there was even a significant presence in small villages of between 1,000 and 5,000 inhabitants, which seems to be almost bizarre when compared to the Spanish model (Mirás and Martínez-López 2021).

Andalusia was the other Spanish region where gas was prominent. In 1860, the four largest municipalities in the region (Cadiz, Malaga, Seville and Jerez) had gas, with populations ranging from 43,142 inhabitants in Jerez to 115,856 in Seville, and almost all of them were port cities. In 1870, 7 localities had gas, when Almería, Granada and Cordoba were incorporated. In 1890, there were 13 municipalities with gas, with a population threshold of 18,000 inhabitants. The dominance of foreign capital, as in the rest of the country, was overwhelming in the early decades of the gas industry, although from the 1880s, Spanish capital began to make an appearance (Fernández-Paradas et al. 2021b: 104-105).

Likewise, the Northern provinces were also noteworthy, due to their proximity to British or Asturian coal and their incipient industrialisation, enabling a continuum to be drawn from the northwest of the country to the French border, extending to La Rioja, Navarre and part of Aragon (Saragossa). However, a huge gap can be observed in inland Spain, in predominantly agrarian regions, which were weakly integrated with the Spanish market (and with each other), due to the insufficient rail transport network. In some regions with a low-income level (Galicia) or a low population density (Extremadura, Castile-La Mancha, Castile-Leon), gas was installed in cities that were connected by sea (A Coruña) or railway (Valladolid).

PORTUGAL, LAGGING BEHIND AND TERRITORIALY POLARISED

Similarly to Spain, Portugal was 'premature' in its political unification. It was a relatively important colonial power during the Modern Age, although under British tutelage and when its industrialisation process partially failed, it was relegated to the European periphery.

The Portuguese economy was marked by colonial trade, which strengthened and polarised economic activity in its main ports: Lisbon and Oporto. Its role redistributing colonial commodities and European manufactures hindered endogenous industrial growth, which was harmed by weak urbanisation and by low- and unbalanced-income levels, even though in the period 1870-1913 a modest but remarkable industrial boom can be detected (Costa et al. 2016). In 1864, there were only 10 cities (with more than 10,000 inhabitants), and only two (Lisbon and Oporto) exceeded 17,000 inhabitants. In 1900, there were only 12 urban centres, and the third largest did not reach 22,000 inhabitants. In 1890, the urban population represented only 11%. Meanwhile, urban wages barely increased by 16% between 1865 and 1898 (Valério 2001: 37, 133-134, 644-646). This context, obviously, did not favour the development of urban infrastructures such as gas.

Portuguese engineers were in touch with gas technology through technical publications and the specialised press, study visits, and international exhibitions and fairs. Thus, for example, the *Boletim das Obras Públicas e Minas*, published by the Portuguese Association of Civil Engineers, addressed this issue (Cardoso 2006). On the other hand, in the mid-nineteenth century, some Portuguese engineers completed their training abroad, especially at the *École des Ponts et Chaussées* in Paris, and also made study visits to the main European cities (Cardoso 2005: 359-362).

In the diffusion of gas, Portugal followed a similar pattern to that of Spain, although with a narrower geographical scope. Gas began to spread from the end of the 1840s, but only in the largest cities: Lisbon (1848), Oporto (1855) and Coimbra (1856). The most significant feature is the long period of time (at least four decades) between the installation in those cities and the other urban centres. In the 1880s, the decade of greatest diffusion, 5 new cities adopted this lighting system. In 1896, there were only 11 factories, the same as in 1907 (Cardoso 2017: 77-78). The gas expansion was slowed down by the appearance of electricity, in particular hydraulically generated power, which reduced the energy dependence on British coal (Madureira 2005: 113).

Unlike Italy and, above all, Spain, in which the participation of French capital was predominant, in Portugal most of the concessionaires were British (Mata 2008: 194), with the most powerful companies being *Companhias Reunidas de Gás e Electricidade* (Lisbon, Sofina) and *Companhia Geral de Iluminação a Gás* (Oporto and other cities, English) (Cardoso 2005: 364-365).

In 1875, only 5 Portuguese cities had a gas supply: Lisbon, Oporto, Braga, Setubal and Coimbra. Significantly, these were the five largest cities in the country, not counting the capitals of the islands of the Azores and Madeira. Only the first two had more than 100,000 inhabitants, while the remaining three were much less populated, with between 13,000 and 20,000 inhabitants.

The chronology of its implementation also reflects, to a large extent, that population bracket: Lisbon (1848), Oporto (1855), Coimbra (1856), Braga and Setubal in the 1870s. The minimum threshold for establishing gas was then around 13,000 inhabitants.

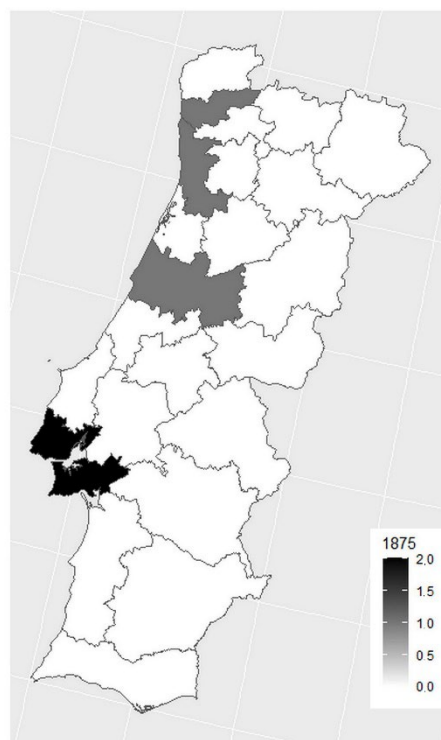


Figure 2.4 Number of municipalities with gas in Portugal, by statistical sub-region, in 1875.

Source: Annuaire Durand, 1875, and population census.

With respect to the geographical location (**Figure 2.4**), three cities were located on the coast (and the other two, Braga and Coimbra, less than 50 km from the nearest seaport), which helped the import of British coal, a key input in this industry and which Portugal lacked. The active Portuguese trade with the United Kingdom made such transport cheaper. In addition, all

of these cities had a railway connection in 1878 (Silveira et al. 2011: 38). Finally, the five cities were located in the North Atlantic region, which was the most populated, urbanised and economically buoyant.

On a provincial level, Portuguese cities with gas represented only 6.5% of the municipalities in their respective districts. But these cities were those with by far the largest population in their district, as they represented between 15%-38% of that population, with a predominance of 15%-24%.

LATIN EUROPE: AN OVERALL PERSPECTIVE

In the nineteenth century, industrialisation and, more specifically, the coalfields and the railways were the driving force of European urbanisation. In that century, the rate of urbanisation tripled. In 1870 it was 20.6%, although with important national and regional differences: Western Europe had a rate of 32.8%, compared to 11.2% in Scandinavia, with Mediterranean Europe in an intermediate position with 23.2%. In Latin Europe, there was considerable homogeneity in the data for the large countries (though with significant internal contrasts, especially in Italy and Spain), as Italy had 25.0%, France 24.3%, and Spain 22.5%, while Portugal only reached 15.0% (Bairoch 2002: 200).

In the different variables of gas implementation that we have considered, a marked contrast is broadly observed between the leading country in Latin Europe, France, and the rest, even though a clear descending intensity can be observed in Italy, Spain and, above all, Portugal.

Table 2.1 Number of municipalities with gas in 1875

<i>Country</i>	<i>Number of municipalities with gas (A)</i>	<i>Total number of municipalities (B)</i>	<i>% A/B</i>
<i>France</i>	630*	34,479	1.83 %
<i>Italy</i>	89	8,259	1.08 %
<i>Portugal</i>	5	300	1.67 %
<i>Spain</i>	48**	7,800	0.62 %

* Including the 18 from Alsace-Lorraine.

** The municipalities of San Andrés de Palomar and Gràcia (which were annexed in 1897) were included in Barcelona.

Source: Annuaire Durand, 1875, and population census.

In terms of the number of municipalities with gas, France far exceeded the rest of Latin Europe as a whole, with Portugal in an anecdotal position (**Table 2.1**). However, the differences are drastically reduced if we look at the percentage they represented of the total number of municipalities (between 0.6% and 1.8%), although it is true that this was largely due to the very high number of local administrative entities in France in contrast to the small number in Portugal.

The percentage by population range seems more significant (**Table 2.2**). In this case, we can observe how in Italy, Spain and, above all, Portugal, the vast majority of municipalities with gas were cities over a certain size, and only where the population was among the high ranges (more than 50,000 inhabitants) did they have complete gas coverage. In contrast, in France almost all the cities with more than 10,000 inhabitants were already endowed with gas in 1875 and the principal novelty was that a significant proportion of smaller towns, between 2,000-10,000 inhabitants also had a supply. In summary, the minimum population threshold in France was well below that of the rest of Latin Europe.

Table 2.2 Municipalities with gas compared with total municipalities, by population range, in percentage, in 1875

<i>Country</i>	<i><2,000</i>	<i>2,000-9,999</i>	<i>10,000-49,999</i>	<i>50,000-200,000</i>	<i>>200,000</i>
<i>France</i>	0.07	15.21	81.68	100	100
<i>Italy</i>	0	0.14	17.70	100	100
<i>Portugal</i>	0	0	2.33	100	-
<i>Spain</i>	0	0.11	14.07	100	100

Source: Annuaire Durand, 1875, and population census.

These contrasts between France and the rest of Latin Europe are confirmed when examining the percentage represented by municipalities with gas compared with the total entities that had this energy (**Table 2.3**). Indeed, we can observe that in France most of the municipalities with gas were very small towns. Yet, in Italy, Spain and Portugal the archetype of gas-powered entities were medium-sized cities.

Table 2.3 Municipalities with gas, by population range, over total municipalities with gas, as a percentage, in 1875

<i>Country</i>	<i><2,000</i>	<i>2,000-9,999</i>	<i>10,000-49,999</i>	<i>50,000-200,000</i>	<i>>200,000</i>
<i>France</i>	3.33	66.19	26.35	3.65	0.48

<i>Italy</i>	0	5.62	70.79	16.85	6.74
<i>Portugal</i>	0	0	60.00	40.00	0
<i>Spain</i>	0	4.17	58.33	31.25	6.25

Source: Annuaire Durand, 1875, and population census.

As for the population with actual access to gas, France again stands out, chiefly in absolute terms, compared to the rest, with almost ten million people being supplied, compared to less than half a million in Portugal (**Table 2.4**). Conversely, in relative terms, the differences were lessened, clearly showing anew the gradation from France (25%) to Portugal (9%).

Table 2.4 Population with gas, in thousands, in 1875

<i>Country</i>	<i>Population with gas (A)</i>	<i>Total population (B)</i>	<i>% A/B</i>
<i>France*</i>	9,647	38,174	25.27 %
<i>Italy</i>	4,513	26,801	16.84 %
<i>Portugal</i>	409	4,153	9.85 %
<i>Spain</i>	1,963	16,618	11.81 %

* Including Alsace-Lorraine.

Source: Annuaire Durand, 1875, and population census.

Geographically and roughly speaking, a Northwest-Southeast diagonal can be observed, running from the north of France to north-west Italy⁴, above which there was a high gas density, compared to the area below the northeast-southwest diagonal, characterised by a scarce presence of gas, above all in the Iberian Peninsula (**Figure 2.5**). It is important to note that, on the whole, but chiefly outside of France, gas factories tended to be located preferably on the coast, given the much higher costs involved in transporting coal by land.

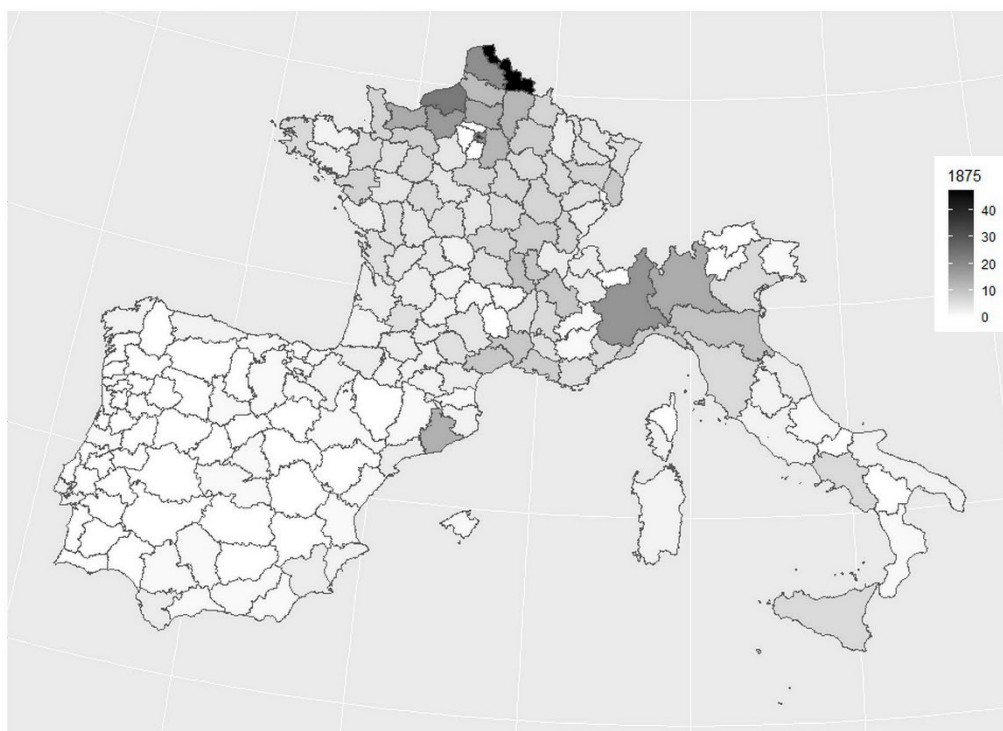


Figure 2.5 Number of municipalities with gas in Latin Europe, by province⁵, in 1875.

Source: Annuaire Durand, 1875, and population census.

On a provincial level, we can observe that the number of gassified municipalities (**Table 2.5**) contrasts sharply between France and Italy, which had high average figures (though these were overestimated in Italy due to the regional scope of the data), and the Iberian Peninsula, in which usually only the provincial capital was endowed with gas. However, there were significant provincial differences (measured by the coefficient of variation), particularly in France, which was largely due to the size of the sample (demarcations with gas). In this sense, it is important to highlight the differences in the percentage of provinces with gas over the total number of provinces: 19.1% in Portugal (districts), 56% in Spain (provinces), 80% in Italy (regions), 98.9% in France (departments)⁶, which reveals the different degree of geographical diffusion of gas in these countries.

Table 2.5 Municipalities with gas by province ⁷, in 1875 (average, mode and coefficient of variation)

<i>Country</i>	<i>Average</i>	<i>Mode</i>	<i>Coefficient of variation</i>
<i>France*</i>	6.8	3	1.22
<i>Italy**</i>	5.6	6	0.87
<i>Portugal</i>	1.25	1	0.35
<i>Spain</i>	1.7	1	1.01

* Including Alsace-Lorraine.

** Regions.

Source: *Annuaire Durand*, 1875, and population census.

However, the differences are smaller if we take into account the percentage of municipalities with gas over the total entities in every province (**Table 2.6**). In this case, the average is still higher in France, but with a strong inter-provincial variation due to the high values of some departments, such as those surrounding Paris, which reached figures of around 40%. In Spain, the values are considerably lower and so is their variation, although higher densities (around 7%) are also observed in certain provinces such as Cádiz and Murcia and, to a lesser extent, Barcelona. In Italy, the figures are similar to those of Spain, although with less variation as the demarcation (region) was larger. Even so, the figures were around 3% in some northern regions such as Emilia-Romagna and Liguria. Finally, Portugal was a somewhat atypical case, with high figures and small variation, due to the small size of the sample and the small number of municipalities in its districts.

Table 2.6 Percentage of municipalities with gas by province⁸, average and coefficient of variation

<i>Country</i>	<i>Average</i>	<i>Coefficient of variation</i>
<i>France*</i>	3.12 %	2.34
<i>Italy**</i>	1.26 %	0.68
<i>Portugal</i>	6.50 %	0.15
<i>Spain</i>	1.53 %	1.14

* Including Alsace-Lorraine.

** Regions.

Source: *Annuaire Durand*, 1875, and population census.

If we now look at the provincial percentage of the population with access to gas (**Table 2.7**), we can see that the contrasts are not as noticeable, either in the average or in the coefficient of variation, as in the case of the municipal level. This reinforces the idea that the main difference between France and the rest of Latin Europe was the limitation of gas in the latter to the most populated and industrialised provinces. The average was around 16%-19%, and coefficients of variation were also more homogeneous, between 0.7-1.0, with the exception of Portugal, due to the small number of cities with gas, which were the most populated.

Table 2.7 Percentage of population with gas by province⁹, average and coefficient of variation

<i>Country</i>	<i>Average</i>	<i>Coefficient of variation</i>
<i>France*</i>	19.54 %	0.81
<i>Italy**</i>	19.07 %	0.97
<i>Portugal</i>	23.00 %	0.36
<i>Spain</i>	15.55 %	0.71

* Including Alsace-Lorraine.

** Regions.

Source: Annuaire Durand, 1875, and population census.

We believe that the variables that explain the higher or lower gas density in the interior of each country (accessibility to coal, population density, degree of urbanisation and industrialisation, income level, length of railways and river canals), to a large extent, also explain the contrasts between the countries of Latin Europe. Among them, we consider that the economic factors (industrialisation and income) were more relevant than the availability of coal, as evidenced by the limited depth in Portugal, a country that was in a comfortable position to receive British coal, unlike the French or Spanish Mediterranean coast, or even Italian Lombardy.

CONCLUSION

Latin Europe, with certain nuances in relation to France, displays some predominant common features: Mediterranean climate and agriculture, difficulties in the industrialisation processes due to the deficiencies of the institutional structures, lack of energy resources (coal), low levels of urbanisation, low and unequally distributed per capita income, strong financial and technological dependence on foreign capital and notable territorial contrasts. In this geographical space, France, particularly for Spain and Italy, represented the institutional benchmark and the most relevant source of capital and technology.

These elements are also reflected in the gas industry. France pioneered the implementation of this technology in the nineteenth century. Later, and largely due to French influence, gas spread throughout southern Europe. The different levels of geographical and social diffusion of gas reflect this core/periphery dualism.

France had a much higher geographical and social coverage than the rest of Latin Europe. In the latter there was also a descending intensity from Italy to Portugal. While virtually the entire French territory (departments) had a gas factory, in the other Latin countries there was an extreme territorial polarisation, so that only the most populated and industrialised demarcations had gas.

The most outstanding contrast and one that embodies the differences can be seen in the coverage by population size. In France, the minimum threshold was much lower, with a predominance of factories in very small towns. By contrast, the rest of Latin Europe concentrated its factories in medium-sized cities.

These differences within Latin Europe were mainly caused to a greater extent by the different levels of industrialisation and per capita income than by the economic accessibility to coal.

SOURCES

Annuaire Général de l'industrie de l'éclairage et du chauffage par le gaz, par Émile Durand, Paris, 1875-1876.

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¹ Later, in 1910-1911, it was renamed as *Annuaire général des industries de l'éclairage, du chauffage et de la force motrice par le gaz et l'électricité*.

² Dupeux (1974: 180) considers urban municipalities those with a central core of 3,000 or more inhabitants. The data from 1871 do not take Alsace and Lorraine into account, which were annexed by Germany. Guérin-Pace and Pumain (1990: 6), who consider as urban the settlements with more than 2,000 inhabitants, recorded 782 cities in 1831, 1,162 in 1876, and 1,583 in 1911.

³ See in this regard the maps of the main traffic of mineral fuels in France in 1859, tons transported by rail and river channels in 1861, ship tonnage in French ports in 1857, British coal exports in 1860, tonnage transported by national roads in France in 1877, communication routes by French department in 1875, and railway development in Europe in 1830-1886 (Dainville 2001: 228-232, 237-239).

⁴ Somewhat overestimated for Italy as the data correspond to a regional, not provincial level.

⁵ Departments in France, regions in Italy, provinces in Spain, and statistical sub-regions in Portugal.

⁶ Only the department of Lozère, in the mountainous and inland area of Occitania had no gas supply.

⁷ In the variables by provinces (regions in Italy) we have only considered those that had one or more municipality with gas.

⁸ In the variables by province (regions in Italy) we have only considered those that had one or more municipality with gas.

⁹ In the variables by province (regions in Italy) we have only considered those that had one or more municipality with gas.