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Resumen

La modernización de las ciudades verificada a partir de mediados del siglo XIX, se inserta en el proceso de globalización que favoreció la circulación de bienes, capital y mano de obra y creó nuevas oportunidades para que las empresas ligadas a las infraestructuras urbanas, en concreto al gas, invirtiesen en otros países. A partir de la segunda mitad del siglo XIX, la inversión extranjera en Portugal fue determinante para la creación de modernas infraestructuras urbanas en las ciudades portuguesas. Esta inversión estuvo acompañada de nuevos procedimientos técnicos y administrativos y de una transferencia de tecnología. Esta transferencia de tecnología se vio también favorecida por la formación de técnicos en el extranjero y por las visitas de estudio de ingenieros e industriales a otras ciudades y a las exposiciones universales e internacionales. Por otro lado, la mayor inserción de las ciudades, sobre todo portuarias, en una economía internacional y en las rutas de circulación de personas, fue determinante para la recualificación urbana y para la modernización de las infraestructuras, de manera que éstas respondiesen a los nuevos patrones de salud pública, higiene, confort y bienestar de las poblaciones urbanas. En este texto se pretende analizar la creación de las redes de gas en Lisboa, teniendo en cuenta algunos de los aspectos anteriormente enunciados, y la evolución del consumo de gas en esta ciudad.

Palabras clave: Alumbrado; Gas; Servicios Públicos; Urbanismo; Historia de empresas; Cambio tecnológico.

Abstract

The modernization of the cities that took place from the middle of the nineteenth century can be placed in the process of globalization that favoured the movement of goods, capital and labour, and created new opportunities for companies linked to urban infrastructures, specifically gas, to invest in other countries. From the second half of the nineteenth century, foreign investment in Portugal was crucial for the implementation of modern urban infrastructures in Portuguese cities. This investment was accompanied by new technical and administrative procedures and by technology transfers. This technology transfer was also helped by technical training abroad, and by study visits of engineers and industrialists to other cities and to universal and international exhibitions. Furthermore, the increased integration of cities, especially port cities, in the international economy and in the circulation of people was crucial for the modernization of urban infrastructures, so that they responded to the new patterns of public health, hygiene, comfort and welfare of urban populations. This paper aims to analyze the development of gas networks in Lisbon, taking into account some of the aspects listed above, and the evolution of gas consumption in this city.

Key words: Lighting; Gas; Public services; Urbanism; Business history; Technological change.

Gas industry and urban modernisation: Lisbon in the 19th and 20th centuries

Ana Cardoso de Matos

1. Globalisation and the modernisation of cities¹

The modernisation of cities that occurred principally from the second half of the 19th century onwards was part of a globalisation process connected with the greater movement of people, goods and information made possible by the development of transport and communications.

This process also encouraged the movement of capital and labour and created new opportunities for companies associated with urban services such as gas or electricity to invest in other countries. In Portugal, a country which in the 19th century was characterised by a lack of capital and industrial initiatives and by a lack of technically qualified manpower, foreign investment in companies associated with urban services was a decisive factor².

Urban infrastructures in the fields of water or gas supply, transport or roads were the sectors which from then onwards encapsulated modern life, the spread of technology and the industrialisation of daily life, while at the same time symbolising the new standards of comfort and wellbeing of urban populations³.

From the second half of the 19th century, the organisation of international exhibitions and congresses, the training of engineers and technicians abroad, and study visits made by industrialists, engineers and scientists⁴ encouraged the

¹ Research activity included in the research project PPCDT/60698/2004 – Networked Cities: urban infrastructures in Portugal (1850-1950).

² This investment was accompanied by new technical and administrative processes and by technology transfer. On this subject, see Matos & Silva (2008).

³ Silva & Matos (2000).

⁴ Matos & Diogo (2007).

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spread of new urban technologies and new concepts of urban salubrity and public health. These were also factors contributing to technology transfer and the spread of new standards of comfort and wellbeing.

This article aims to analyse the creation of the gas distribution networks in Lisbon, taking account of some of the aspects mentioned above, and the growth in gas consumption in the city.

2. Gas distribution companies in Lisbon

The introduction of gas street lighting in Portugal dates from 1848⁵, when Lisbon City Council awarded the gas street lighting concession in the city to the Companhia Lisbonense de Iluminação da Gás (CLIG)⁶.

Until 1887, this company controlled the production and distribution of gas for public and private consumption under a monopoly regime which, although it imposed controls on the price of gas for street lighting, enabled it to sell a significant proportion of its production.

When, in 1887, a new tender was launched for the award of the concession for gas street lighting in Lisbon, several foreign companies submitted bids. The interest of these companies in obtaining the concession for street lighting in Lisbon coincided with the internationalisation of gas companies in the 1880s⁷. The concession was awarded to the Belgian Brussels-based Société Anonyme d'Eclairage du Centre which, together with the other companies that had bid in the tender, formed a new company, Sociedade Gás de Lisboa, to operate the concession⁸. This company concession: Compagnie Générale pour l'Eclairage et le Chauffage par le Gaz – Gás Belga, also from Brussels; Khon Reinach & C^a; and P. M. Oppenheim was formed with the other foreign companies that had also presented tenders for the gas lighting.

Following the award of the concession for street lighting to Sociedade Gás de Lisboa, the production and distribution of gas in the city became a competitive system, albeit one with imperfect competition⁹. The small size of the Lisbon market and the unlikelihood of a significant increase in gas consumers in the short term made the existence of two gas distribution companies unviable. Thus,

⁵ In Spain the introduction of gas street lighting dates from 1842 (Barcelona) and in Italy from 1840 (Milan).

⁶ CLIG was formed with an initial share capital of 400,000\$000 divided into 8,000 shares with a nominal value of 50\$000 per share. As far as we know the shareholder were all Portuguese. For the financial growth of the company, see Matos (2003 and 2005).

This company involved some of the most important businessmen and politicians of the time, as well as a number of scientists. On this subject, see Matos *et al.* (2005), pp. 21-26.

⁷ On this subject, see Paquier & Williot (2005).

⁸ The others companies were : S. A. Crédit Général de Belgique; Banque d'Escomptes de Paris; Compagnie Générale pour l'Eclairage et le Chauffage par le Gaz; Compagnie Générale Française et Continental d'Eclairage. See Martins & Coelho (1998), p. 24, Matos & Silva (2008).

⁹ Matos *et al.* (2005), Matos & Silva (2008).

in 1891 the two companies merged to form the *Companhias Reunidas de Gás e Electricidade (CRGE)*¹⁰, which continued to operate this business until 1975. The concentration of the exploitation of the networks of gas and electricity in the same company eliminated the competition between these two energies. Thus, while the electricity was gradually replacing gas in street lighting and domestic lighting, the gas was being increasingly used in the kitchen¹¹.

The participation of the foreign companies in CRGE was significant. The companies with the largest number of shares were *Compagnie Générale pour l'Eclairage et le Chauffage par le Gaz*, *S. Propper & Compagnie*, *Société Watel*, *Dehaynin & Compagnie*, *Compagnie Générale Française et Continentale d'Eclairage par le Gaz* and *Crédit Algérie*. In 1913 when the *Société Financière de Transportes et Entreprises Industrielles (Sofina)* subscribe 96,000 new shares the participation of foreign companies in CRGE increased and represented more 68% of the shares¹². Between 1905 and 1913 this company has expanded to southern Europe through investments in transport and electricity enterprises¹³. It was the case in Spain, where in 1905 the SOFINA founded the Tramways of Barcelona and in 1906 the Tramways of Bilbao.

3. The construction of production plants and distribution networks

3.1. The construction of production plants

The first gas works was established in the west of the city at Avenida 24 de Julho, in an area where there were already several industrial establishments. The fact that this production plant was sited at one of the lowest points of the city enabled the gas to rise to the higher parts of Lisbon without the use of great pressure. Its proximity to the river Tagus ensured an abundant supply of the water needed by the process, facilitated the importation of the Newcastle coal used at the plant and helped to direct the fumes from the manufacture of gas towards the river, so reducing the pollution of residential zones.

A concern to blend the factory into the urban landscape led to the factory being constructed with a pavilion whose north-facing façade was designed in the form of a vaulted pavilion with three Romanesque arches¹⁴. In 1865 this structure was demolished to make room for an extension to the gas works. In 1875/76, with the objective of disguising the plant, a residential building façade was erected on the frontage facing Rua 24 de Julho (see image 1).

¹⁰ On the subject of the merger of the two companies, see Matos *et al.* (2006), pp. 96-101. On the main foreign shareholders of CRGE, see Matos & Silva (2008).

¹¹ The company's advertising reflects this reality and the benefits of the use of electricity in lighting were advertised together with the advantages of using gas in the kitchen.

¹² Matos & Silva (2008)

¹³ Hertner (1998), p. 519.

¹⁴ Santos (1996), p. 379.

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Image 1. Plant of the CLIG frontage facing Rua 24 de Julho. FEDP-AH



The site chosen in 1887 for the construction of the gas factory of Sociedade Gás de Lisboa was also on the Tagus riverside, on land reclaimed from the river on which the Lisbon-Cascais railway had been built.

From the beginning of construction, the plant's proximity to the Belém Tower, a monument associated with the Voyages of Discovery, sparked off a flurry of criticism from the Portuguese public. These criticisms were directly related to moves to beautify the Lisbon riverside where the Belém Tower was situated (image 2).

Image 2. Plant of the Sociedade Gás de Lisboa. FEDP-AH



At the beginning of 1910¹⁵, the City Council ordered CRGE to transfer the plant to another site by the end of the first quarter of 1911, so as to free the area near the Belém Tower to be landscaped as public gardens. However, this order did not yield practical results despite the City Council taking the company to court¹⁶. In the following years, in the light of continual objections by the press and a number of associations, such as the Commercial Association of Lisbon Shopkeepers, the Sociedade Propaganda de Portugal [Association for the Promotion of Portugal], the Society of Fine Arts and the Society of Portuguese Architects, the city council sought to reach an agreement on the matter with CRGE. Nevertheless, in 1928 the issue of the relocation of the plant remained unresolved. As a result, the contract signed in that year between CRGE and Lisbon City Council contained a condition that the plant must be relocated to another part of the city within three years.

Thought was initially given to building the plant on a site in the Belém area (in Rua Bartolomeu Dias), but the fact that a residential development was planned for that area thwarted that option. It was not until 1934 that it was finally decided that the new plant would be sited on land next to Quinta da Matinha in the eastern part of Lisbon bordering the river Tagus, from which it was expected that land would be reclaimed.

The initial plan to dismantle the Belém plant and re-erect it at Matinha was abandoned owing to the technical difficulties involved, and it was decided to build a new plant from scratch, which CRGE forecast would be completed in 1942 or 1943¹⁷. Constructing a new plant would be less costly and would avoid the need to interrupt the gas supply. Additionally, as it would be equipped with more powerful and modern machinery, it would be possible to increase the quantity and quality of the gas produced.

Although the plant was virtually completed in 1941, the war prevented the delivery of pipes that had been ordered from the USA, which were only delivered at the end of that year. The difficulties of obtaining fuel supplies in the following years delayed the start up of the production plant until January 1944.

In the years following the Second World War, works were undertaken with the objective of increasing the output of the Matinha plant¹⁸. Despite continual expansions of the Matinha Plant from the outset, increasing consumption meant that it was necessary to keep the Belém plant operating for some years. It was

¹⁵ This order arose from a decision by the city council.

¹⁶ The court action was eventually won by CRGE which, however, was prepared to move the plant to another site provided that it received compensation and that suitable land was provided elsewhere in the city.

¹⁷ “A great industrial company joining in the commemorations of the Second Centennial. The Companhias Reunidas de Gás e Electricidade are to build a plant at Quinta da Matinha unequalled in the Peninsula”, in *Indústria Portuguesa*, No. 132, February 1939, p. 11.

¹⁸ Works were undertaken in 1945 to increase the production plant’s capacity from 70,000m³ to 100,000m³ of gas. Report of the Board of Directors. Financial year 1945, p. 6.

In 1946, production capacity was increased to 150,000m³. Report of the Board of Directors. Financial year 1946, p. 12.

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not until February 1949 that CRGE finally closed it and handed over the site to Lisbon City Council¹⁹.

3.2. Foreign technology in the gas industry

A crucial factor in the construction of the gas distribution networks in Lisbon was the transfer of knowledge and technologies associated with the gas industry. The practice of purchasing machinery from abroad, either because of the lack of response capacity by Portuguese industry or as a result of the involvement of foreign firms in the gas production and distribution companies in Lisbon, was also significant. The technical improvements that were made to the gas distribution networks over the years also benefited from the arrival of foreign engineers in Portugal and study visits made to foreign countries by the directors and engineers of the gas companies which enabled them to learn about developments in the industry in the major European cities²⁰. In seeking to benefit from the transfer of technologies, the gas companies were, however, forced to adapt them to Lisbon's geological and geographical characteristics.

The contract for the construction of the first plant in Lisbon was initially awarded to Jacinto Dias Damásio and Imberton e Silva, but in 1850 responsibility for the works was transferred to the Frenchman Luis João Gosse, who had also directed the construction of other gas works in France²¹. Foreign engineers were involved in the construction of the first gas works, such as the French engineer Beraud who installed the initial machinery²².

CLIG's reports reveal the directors' interest in learning about the new technologies associated with urban infrastructures and in improving the profitability and quality of the services they provided to the urban population and the City Council²³.

Following the award of the concession for gas supply to Sociedade Gás de Lisboa, this company submitted plans for a plant modelled on the gas works that Léon Somzée had built in Brussels²⁴. As this was a polluting industry included in Class 2 of the table annexed to the Decree of 21 October 1863²⁵, the construc-

¹⁹ The plant was finally demolished in 1950.

²⁰ Matos (2006), pp. 556-558.

²¹ The Board of the Company stated that "as João Luis Gosse has headed other gas companies in France, we were able to benefit from the experience that he had gained in them". AHFEDP, Directors' Report of the Companhia Lisbonense de Iluminação a Gás, 1851, manuscript, pp. 11 and 11v.

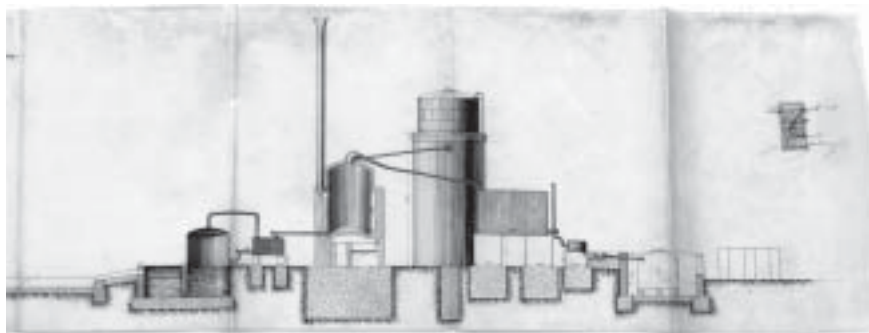
²² According to Costa Goodolphim, Beraud came to Portugal at the invitation of José Detry. Goodolphim (1892), p. 9.

²³ This interest was not unrelated to the fact that some members of the corporate bodies of the company were engineers, such as Francisco da Ponte e Horta, or chemists, like Agostinho Vicente Lourenço.

²⁴ Léon Somzée sent Lisbon City Council a reproduction of the plans of the plant he had built in Brussels. Martins & Coelho (1998).

²⁵ This decree stipulated that no establishment classed as insalubrious, hazardous or noxious could be founded without prior licensing and an Order of 23 November 1865 laid a duty on admin-

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Source: Arquivo Municipal de Lisboa/Arquivo do Arco do Cego. SGO Cx 106.

In the construction of the plant, foreign technology was used to construct both the gasometer and the various process buildings²⁷. In the construction of the 250 kilometres of gas mains, the Somzée system, already in use in Germany, Great Britain and Belgium using rubber rather than lead joints between pipes was used.

When, in 1899, CRGE took over the gas works and mains of the former gas companies, their condition was far below the quality standards of the time, giving rise to considerable losses throughout the distribution network. This situation was due in large part to lack of investment by CLIG in maintenance and replacement of gas mains during the company's final years of existence.

From 1913 onwards, the Société Financière de Transportes et Entreprises Industrielles (SOFINA)²⁸ played a decisive role in the company's management, and from 1914 onwards, all studies for the construction of new plants or modification of existing ones were undertaken by this company²⁹.

Consequently, when it was decided to build a new plant at Matinha, the studies and plans and the decisions on the construction processes and materials to be used were undertaken by SOFINA and the *Sociedade de Estudos Técnicos*, a company that had been formed on the initiative of SOFINA³⁰.

The construction works for the Matinha plant were awarded to various foreign and Portuguese companies: the foundations to the Sociedade Comercial Portuguesa de Estudos e Construções and "Monnoyer", Pieux Franki; the distillation shop to the Compagnie Générale pour la Fabrication de Fours, the firm Duarte Ferreira & Filhos and the Companhia União Fabril; the treatment and purification shop to the Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz; the gasometer was ordered from the Société Anonyme Baume

²⁷ Martins & Coelho (1998), pp. 27-30.

²⁸ Brion (1994).

²⁹ On this subject, see Matos & Silva (2008).

³⁰ Jorge (1999/2000), note 12, p. 202.

& Marpent and erected by L. Dargent Ld^a; and the gas mains were ordered from the Société Anonyme pour la Distribution du Gaz “Distrigaz”³¹. According to an article published in *Indústria Portuguesa* in 1940, “No perfection has been overlooked in the new premises of these gas works, either from the point of view of industrial efficiency or that of the quality and refinement of production”³².

In the years that followed, the increase in gas consumption made several expansions of the plant necessary³³ and in 1962 the Matinha plant began to receive gas from Sociedade Portuguesa de Petroquímica, which in the first year alone supplied 40% of the gas distributed. By December 1964, Petroquímica produced all the gas distributed by CRGE.

3.3. The distribution network

In 1847, when the tender was launched for the street lighting concession in Lisbon, it was laid down in which streets gas mains would first be installed. In the years that followed, the network was extended to other streets, but all of them were located in the cultural and commercial zones of the city and the upper class residential areas³⁴.

The installation of new gas mains and the frequent need to renew them were two factors that regularly featured strongly on the gas companies’ balance sheets. In addition, the spatial layout of Lisbon, with its dispersed and hilly nature, posed problems for the distribution of gas in the city, both because it required a more extensive distribution network and because the relief made it difficult to maintain the same gas distribution pressure in different parts of the city³⁵.

The gas mains built in Lisbon were scarcely profitable because of the small number of lamp posts per linear metre, since the payment for street lighting was made per lamp post³⁶.

From 1870 onwards, Lisbon underwent an important series of initiatives designed to modernise the city. Among these were the creation of the so-called New Avenues such as Avenida da Liberdade and the extension of Avenida 24 de Julho from Santos to Alcântara, the modernisation of public transport, the appearance of the first mechanical elevators, the enclosure in conduit of the Alviela river, and the

³¹ *A Nova Fábrica de Gás da Matinha*, 1944, inside cover.

³² *Indústria Portuguesa*, Year 14, No. 150, August 1940, p. 5.

³³ On the construction of this plant and subsequent expansions, see Matos *et al.* (2005), pp. 171-180.

³⁴ For example: Rossio, the Baixa Pombalina, Terreiro do Paço, Chiado, Rua do Alecrim or Rua das Janelas Verdes.

³⁵ On the difficulties in constructing the gas distribution network, see Silva & Matos (2004).

³⁶ The number of lamp posts and lamps per linear meter was much smaller in Lisbon than in other European cities. In 1856/57, while in Paris there was one lamp post per 25 metres of gas main and one gas lamp per 2.5 metres, in Lisbon there was only one lamp post per 54 metres of gas main and one gas lamp per 10 metres. See Silva & Matos (2004).

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launch in 1879 of a tender for the construction of the port of Lisbon. As part of this modernisation process, concern about the quality of the street lighting was greater than ever. Ressano Garcia³⁷, the engineer who managed the Technical Department of Lisbon City Council from 1874 and who was the driving force behind the modernisation of the city³⁸, attempted to improve the city lighting by obtaining expert technical opinions on lighting quality and the siting of lamp posts.

With the growth of the city's technical department and the growing importance of its engineers, the planning of works in the city became a regular occurrence³⁹. One of Ressano Garcia's concerns was to plan and coordinate the installation of subterranean gas and water mains and sewers and road-laying works so as to make economical use of the scarce financial resources at his disposal.

On the eve of the First World War there were 485 km of gas mains in Lisbon, a figure that remained practically unaltered by the end of the war. The interruption of the production and distribution of gas in 1918 and again in 1920 added to the state of deterioration of the mains network⁴⁰. Consequently, when CRGE decided in 1923 to restart gas production, it had to invest heavily in restoring and extending the mains network. By 1939, the gas distribution network had increased to 734km.

The construction of the Matinha plant in the 1940s made it necessary to install new mains to connect it to the existing network. These works involved complicated technical problems and brought serious disruption to the life of the city since they meant extending the principal conduit by some 12 kilometres, from Rua Augusta to the new plant. The 1-metre diameter conduit had to pass along several of the most heavily used streets in Lisbon, with the result that traffic had to be suspended⁴¹.

At this time, the increased consumption of gas made it necessary to install gas mains parallel to the existing ones in the areas of the city where consumption was highest. In addition, the urban expansion resulting from the creation of new streets and the construction of new residential neighbourhoods required an increasingly extensive mains network. In 1946 new gas mains were laid in recently built neighbourhoods such as Encosta da Ajuda, Campolide and Madre de Deus. In 1948 the laying of gas mains began in the Alvalade district, where there were already 1,500 consumers.

³⁷ Ressano Garcia (1847-1911), who attended the School of Bridges and Roads in Paris between 1866 and 1869 and from which he graduated with distinction, knew at first hand the improvements that had been made in that city. On Ressano Garcia, see Silva (1989).

³⁸ According to Raquel Henriques da Silva, Ressano Garcia, who was appointed to Lisbon City Council to reorganise its Technical Department, was chiefly responsible for the modernisation of the city and created a modern and effective team headed by the engineer António Maria Avelar and the architect José Luís Monteiro. Silva (1994), pp. 50-51.

³⁹ According to Álvaro Ferreira da Silva, "The reinforcement of the City's technical services in municipal decisions can be regarded as a foreseeable development given the complexity of the problems facing the administration of a great city like Lisbon". Silva (1997), vol. 1, p. 140.

⁴⁰ In the cities where gas production was dependent on imported coal the war had negative consequences in the production of gas. It was for instant the case of Barcelona. Arroyo (1996)

⁴¹ AHFEDP, CRGE, Minute Book of the Board of Directors, 1932/39, p. 52.

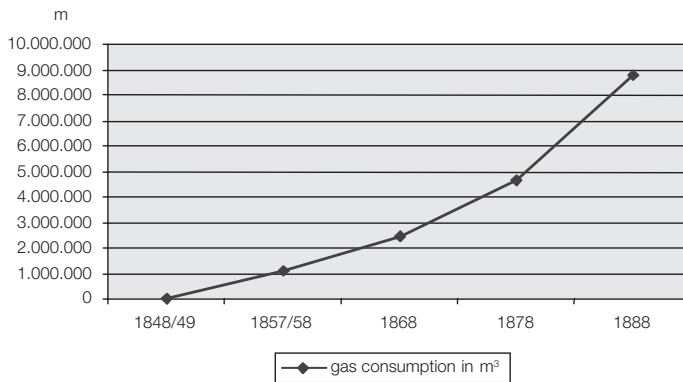
By 1951 the length of the gas distribution network had risen to 509,524 linear metres, of which 23,257 metres were high pressure mains and 486,267 metres were low pressure mains⁴². From the mid-1950s, numerous modifications were made to the routes of gas mains due to the construction of the Lisbon Metro, and the network continued to be expanded to new districts⁴³.

In 1973 CRGE had 5 gasometers with a capacity of 240,000 m³ and the length of the mains network exceeded 800km.

4. Gas consumption in Lisbon

Lisbon residents took to gas lighting from the start and by 1850 there were 442 private consumers, rising to 1,000 in the following year⁴⁴.

Fig. 1. Trend in gas consumption in Lisbon – 1848/1888



Source: Goodolphim (1892), p. 41.

Between 1848 and 1888 gas consumption increased significantly in Lisbon, almost doubling every ten years.

Over the years there was great variation in the numbers of consumers who had contracts with CLIG, and every year a large number of consumers⁴⁵ cancelled their contracts, at the same time as other contracts were signed with new customers. If some of the cancellations can be explained by customers moving house, it is

⁴² In the same year, construction work was begun on the new gasometer in Avenida Infante Santo, which was completed with its connection to the network in 1953.

⁴³ At the same time, construction of the new 100,000 m³ gasometer at Matinha was completed, increasing gas supply capacity.

⁴⁴ In 1850 there were two private gas outlets for each street lighting outlet. In 1851 this ratio became 3:1, corresponding to 3,090 gas outlets in private homes, shops or industries and also representing an increase in the number of gas outlets per metre of gas main.

⁴⁵ CLIG Minute Book

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also possible that many customers found that gas lighting took a higher proportion of their family budget than they had at first expected or that the quality of lighting did not match their expectations.

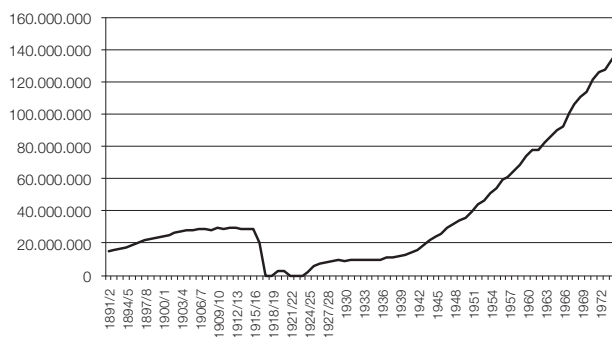
The 1880s saw an increase in residential building in Lisbon⁴⁶, a situation that prompted some of the city's inhabitants to move to new homes. In the light of this situation, CGLI published an announcement in several newspapers asking people who were moving house, and those who were moving into a house that already had a gas supply and wished to continue to consume it there, to inform the Company⁴⁷. At this time, the existence of piped gas was a factor that added value to a house and house sale advertisements therefore began to mention this fact.

The reduction in the price of gas of CLIG (70/m³ réis between 1848 and 1870 and 22.5 réis in 1890) was a further factor that contributed to its wider adoption. In 1890, competition forced CLIG to reduce the price to 27 réis. The price reduction also had effects in terms of improvements in gas manufacturing and distribution methods, the expansion of the mains network, increased public and private consumption of gas and the Company's financial results⁴⁸.

Gas consumption per inhabitant was low, however, which is partly explained by the mild climate which created little demand for heating, and also by the low income per capita of Lisbon's population and the difficulty in promoting the widespread use of gas for cooking.

After CRGE took over the supply of gas to Lisbon and its suburbs, consumption showed a rising trend until the eve of the First World War, when there was a sharp fall caused by inadequate supplies of fuel to maintain production levels.

Fig. 2. Trends in the sale/coconsumption of gas (1891-1974) (m³)



Source: CRGE Annual Reports 1891-1974.

⁴⁶ As Álvaro Ferreira da Silva remarks on the granting of building licences in Lisbon, a phase began in 1878 which ended "in 1896, thereby completing a cycle of intense and rapid growth in the issuance of licences". Silva (1997), vol. 1, p. 140.

⁴⁷ Announcement published, for example, in the *Diário de Notícias*, 10 December 1880, p. 3.

⁴⁸ The contract stipulated that when the share dividend exceeded 10%, which occurred at this time, the company was obliged to reduce the price at which it sold the gas.

In the inter-war period gas consumption remained at low levels, but after the end of the Second World War consumption showed a marked rising trend. At this time, however, the use of gas was markedly different from that at the end of the 19th century when street and domestic lighting accounted for a major proportion of total gas consumption.

By the second half of the century, gas had ceased to be important as a source of lighting and the increase in consumption is explained by its use for other purposes, mainly cooking and heating. Since the end of the 19th century, CRGE had sought to encourage the adoption of gas stoves by establishing a showroom/warehouse and creating a system of purchase by instalments⁴⁹. At the same time, it sought to encourage the introduction of gas engines in industry by selling gas to factories at a lower price. The wider use of gas engines and gas stoves was essential to maintain gas consumption during the daytime so as to make production cost-efficient since the consumption of gas for lighting occurred mainly at night. Appreciating the role that advertising could play in promoting the consumption of gas, CRGE regularly advertised in the leading national newspapers. For a similar purpose, it published around this time the “O GAZ”⁵⁰ an illustrated brochure written in everyday language which promoted the various advantages of the using gas. In 1892-1893 average gas consumption was 733m³ per consumer and 97m³ per lighting outlet⁵¹.

During the First World War the shortage of fuel pushed up the price of gas⁵² and made it necessary to impose restrictions on its use, for example by shortening shop opening hours and delaying the time when street lamps were lit, which resulted in a 28% reduction in gas consumed. Despite this, the number of consumers increased⁵³.

However, because of the high price of fuel during the war years, losses on the supply of gas were so great that in 1917/1918 CRGE decided to suspend the distribution of gas⁵⁴. The decision to close the gas plant was possible because the terms of

⁴⁹ In June 1893, the number of gas stoves in private consumers' homes was 4,970. *Report of the Board of Directors of CRGE, 1892 – 1893*, p. 6. This showroom/warehouse was closed in 1912 because it was thought that “it is costly; the usefulness it had some years ago is now doubtful”. AHFEDP, *Minute Book of the Board of Directors of CRGE 1907-1915*, p. 132.

⁵⁰ Although the exact date of publication of this brochure is unknown, it must have been between 1895 and 1900. In the archive of the EDP Foundation there is a photocopy of the brochure annexed to Cunha Santos's “Information about the Company” (undated), a reprographed document handed out at company training events.

⁵¹ Report of the Board of Directors of CRGE – 1892-1893, p. 8.

⁵² In December 1915, the difficulty in obtaining coal and its high price forced the company to raise the price of gas for street lighting and engines and to end the concession to private consumers of lower prices for cooking gas. AHFEDP, *Minute Book of the Board of Directors no. 8 – 1915-1922*, p. 24.

⁵³ Report of the Board of Directors of CRGE – 1916-1917, p. 5.

⁵⁴ In this year the company made a loss of 767,627\$614 due to the price of coal and transporting it and increases in salaries and other costs. Report of the Board of Directors of CRGE – 1917-1918. In other Portuguese towns like Oporto the production of gas had also problems because of the difficult on the importation of coal.

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the contract with Lisbon City Council allowed gas lighting to be replaced by electric lighting, and CRGE was simultaneously operating gas and electricity distribution networks in Lisbon and some parts of the city were already lit by electricity⁵⁵.

Gas distribution was resumed in July 1919, but at the end of that month it was noted that the resumption of gas production had resulted in a loss of 72,000 escudos⁵⁶, an increase on the loss of 40,000 escudos in November⁵⁷. Faced with these poor financial results, in April 1920 the company decided to suspend the production and distribution of gas and replace gas street lighting with oil illumination, as it had done when it suspended the distribution of gas in 1918⁵⁸. This solution was far from satisfactory for the company, the City Council or the city's inhabitants, with the result that negotiations were resumed in 1922 with a view to restoring gas lighting in the city.

On 1 September 1922, a new agreement was signed between the City Council and CRGE⁵⁹, under the terms of which the company undertook to replace 6,000 gas street lamps by electric lights. In return, CRGE would be allowed to increase the retail price of gas whenever it was justified. Although this new agreement was aimed at the resumption of gas production, it clearly reveals an interest in making electric street lighting the norm⁶⁰.

When gas production was resumed in 1925⁶¹, domestic customers responded almost immediately in rising numbers. However, consumption remained very low for almost two decades and did not return even to the level it had been in 1916. Even allowing for the fact that the consumption figures prior to the interruption had in large part been due to consumption for street lighting, this picture is symptomatic of the low level of gas consumption between the end of the First World War and the beginning of the Second World War.

The fall in gas consumption at the time of the First World War was only reversed in the 1940s when other uses for gas, such as cooking and heating, became widespread.

A factor contributing to the spread of wider uses for gas, which remained limited to the higher income groups⁶², was CRGE's marketing activity, which

⁵⁵ On this subject, see Matos *et al.* (2005).

⁵⁶ AHFEDP, Minute Book of the Board of Directors no. 8 – 1915-1922, p. 168.

⁵⁷ The loss on the gas business was aggravated by the sharp rise in the exchange rate. *Idem*, p. 173

⁵⁸ *Idem*, p. 187.

⁵⁹ This agreement only became effective on the signature of a public deed by the City Council and CRGE in June 1923.

⁶⁰ At this time, the company was investing in electricity generating equipment at Tejo Generating Station with the installation after the war of generators 2 and 3 by AEG and the expansion of the electricity distribution network, of which the replacement of street lamps was merely a part. Faria, Cruz & Barbosa (2008).

⁶¹ As remarked earlier, the poor condition of the gas distribution network made it necessary to postpone the start of gas production and distribution, initially planned for 1923, to 1925.

⁶² As also in other European cities. For example, Barcelona. Arroyo (1996).

began in the 1930s⁶³. The company's advertising department, aided by French know-how⁶⁴, organised a series of strategies that can be summarised as follows: Credit sales of all gas or electric appliances in co-operation with retailers; more systematic use of advertising by means of posters, illuminated advertising, press advertisements, promotional films, radio talks, displays in their own sales outlets and appliances given away as prizes in competitions; consumption bonuses or discount vouchers on gas consumption when purchasing appliances. The advertising department also organised free cookery classes for housewives and domestic servants (kitchen servants), who received a certificate attesting to their skills in using the appliances the company sold. As a means of promotion, between 1932 and 1938 it published a magazine –*O Amigo do Lar*– promoting the advantages of gas appliances. In 1936, gas stoves accounted for almost 70% of domestic consumption, with water heaters accounting for 30% and the remaining gas consumption by room heaters accounting for only 0.2%.

Despite all these incentives to consume gas, consumption per head continued to be very low, and it was not until the 1950s that a consistent rising trend was established.

During the period of energy restrictions brought about by the Second World War, gas was the only fuel whose price remained unchanged⁶⁵, leading some consumers to opt to use gas instead of electricity. Therefore, the increase in gas consumption in the fifteen years between the beginning of the 1930s and the end of the Second World War, of the order of 6.4% a year, was in large part due to the wartime situation.

A contributing factor in the increase in gas consumption from the 1950s onwards was the introduction by CRGE in 1944 of regressive tariffs to encourage the consumption of gas by industry and commerce. This sector was regarded by the Board of Directors as “a huge field of great opportunities that is being methodically cultivated by our industrial gas department”⁶⁶. However, although gas sales had shown a marked rising trend, the existence of regressive tariffs was insufficient incentive in the post-war period to bring about a change in consumption patterns and lead to a significant increase in consumption per household⁶⁷, which was only to occur in the following decade.

⁶³ For the marketing activity in Barcelona see Arroyo (2003).

⁶⁴ In 1913, SOFINA became the majority shareholder of CRGE and the strategies employed by SOFINA in the electricity advertising campaigns that it launched in France in 1928 were applied in Lisbon. On these campaigns in France, see Boin (1987).

⁶⁵ According to Diego Bussola, gas was the “only fuel whose price remained unchanged until March 1943, making it a substitute for charcoal and electricity for cooking and heating. In 1942-43, CRGE managed to sell gas at the price dictated by the government – below cost price – because the losses on the gas business were offset by the profits on the electricity business”, Bussola (2005).

⁶⁶ Report of the Board of Directors of CRGE. Financial Year 1949, p. 7.

⁶⁷ See Bussola (2005), p. 63. The regressive tariffs began in June 1944, with only one alteration in 1947 Bussola (2005), p. 62.

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From the 1950s onwards, in spite of the increasingly widespread use of electricity in homes, domestic gas consumption maintained a rising trend. The operation of gas and electricity businesses by the same company envisaged complementary uses. The company's advertising reflected this fact and the case of the *Thunderbolt* character⁶⁸, representing electricity, and *Dona Chama* [Mrs Flame], representing gas, is a perfect example of this co-ordination of efforts to harmonise the operation of these two energy sources.

On 23 February 1961, CRGE celebrated its 100,000th gas consumer and by 1974 over 60% of the population of Lisbon had gas in their homes as CRGE's distribution network expanded to match the city's geographical expansion.

5. Conclusions

This study of the gas distribution networks in Lisbon has shown that from the earliest days of these ventures there was a constant concern to update the technical knowledge associated with gas production and distribution and the management of the business. The same type of interest was evident in Lisbon City Council, with its desire to modernise and improve the city. The constant preoccupation with expanding the urban area served by the gas distribution networks was paralleled by the wish to provide the city's residents with a better standard of life and new patterns of consumption. However, the introduction of gas mains brought with it problems such as contamination of the air or soil, which in time were minimised or resolved.

The siting of the gas plants, chosen to meet the ideal conditions for the business, clashed with moves to improve the riverside area of the city and triggered criticisms from the public.

The establishment of gas distribution networks in Lisbon was an investment area that interested foreign companies from the middle of the 19th century onwards which were seeking to expand the scope of their businesses beyond their national frontiers, during a period when national economies were becoming increasingly engaged with the world economy.

Foreign investment was a decisive factor in ensuring the viability of gas-related business ventures. Its importance can be seen in the Sociedade Gás de Lisboa and later in CRGE. The involvement of foreign shareholders in these companies prompted the introduction of new management styles and technology transfer which were a crucial factor for achieving progress in the way gas was produced and distributed in Lisbon.

The increase in the domestic consumption of gas brought new consumption patterns and standards of comfort which by the end of the period under study applied to the great majority of Lisbon's population.

⁶⁸ Campaign commissioned by CRGE from the American agency Ready.

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