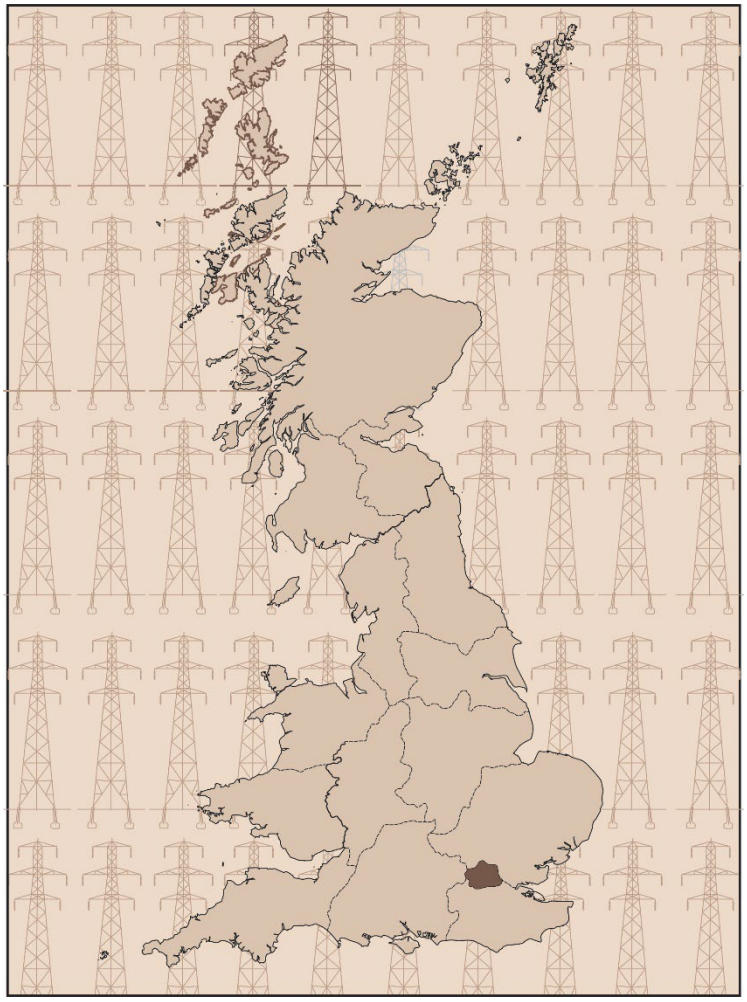

THE LONDON ELECTRICITY BOARD AREA

Regional and Local Electricity Systems in Britain

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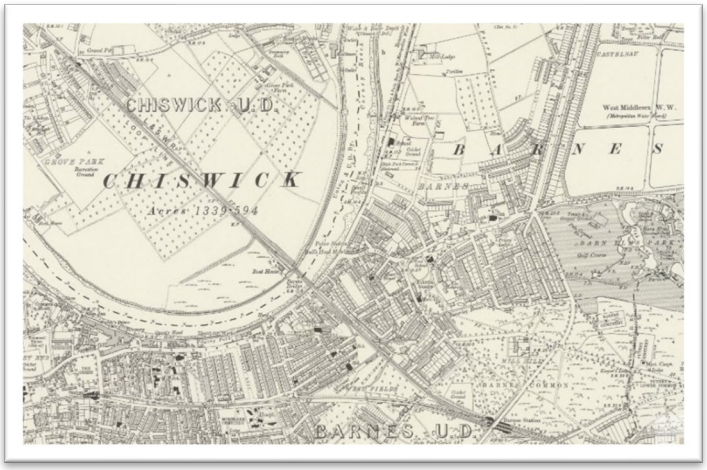

BARNES

The Barnes Urban District Council opened its power station on Mortlake High Street in 1901. Coal was delivered by barge from colliers anchored in the lower Thames. Maximum generating capacity of 6,750kW was reached in the late 1920s. After several years of standby duty, the station was closed in 1959.

Ordnance Survey, Six Inch Map Series, Surrey, Sheet II.SW, 1910 (National Library of Scotland).

Introduction

Public electricity supplies began in Britain during the 1880s. By 1900 most urban places with over 50,000 population had some form of service, at least in the town centre. Gradually the isolated points on the national map began to coalesce, especially when the national grid helped local organisations to connect small towns, villages and eventually farms.

In the process of electrification, hundreds of municipal and company organisations developed local and sometimes regional systems. Before nationalisation in 1948, however, there was little consolidation of areas.

The study of British electricity systems is a remarkably daunting task. While there is a rich legacy of detailed annual surveys, these publications have to be tracked down. The user is then faced with immense alphabetical listings of all sorts of enterprises, often in places which no longer have much meaning except to local residents. Since there are few contemporary maps, listing and grouping the electricity organisations geographically is difficult and often time- consuming.

These notes are offered as an outline guide to the pre-1948 local authorities and companies that developed electricity supplies in London.

The London Electricity Board Area

The area was first defined by the Ministry of Fuel and Power in a White Paper published in January 1947, a month before debate began on the Electricity Bill.[1] Fourteen area boards were to be established for electricity distribution or retailing. Generation and transmission were to be the responsibility of the British Electricity Authority.

The London Area, as defined at this time, had been a part of the London and Home Counties Joint Electricity Authority since 1925. Other parts of the JEA were transferred to the Eastern, South Eastern and Southern Areas to provide an urban base to the large rural areas.

In detail the London Area included the administrative county of London and parts of the counties of Essex, Kent, Middlesex and Surrey.[2] The boundary lines drawn in 1947 continue to be entrenched in the distribution franchise area of the present day.

Constituents of the London Electricity Board

When the London Electricity Board began operations on 1 April 1948 it incorporated the distribution services and areas of 30 local authorities and 11 companies. The constituent areas varied enormously in size from the County of London Electric Supply Co. covering about 52 square miles to the Shoreditch Metropolitan Borough which served only 658 acres. Ilford was the largest local authority area with 13 square miles of territory. Wimbledon was the only local authority to extend its electricity service beyond the municipal boundaries--to include Malden & Coombe and Merton Urban Districts. Morden was part of the County of London Company's supply area.

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[1] Ministry of Fuel and Power, ***Electricity Supply Areas***, Cmd 7007. (London: HMSO, 1947).
[2] Electricity Act 1947, 10&11 Geo 6, Ch 54, First Schedule.

With an area of 253 square miles and an estimated population of about 5,150,000, the London Electricity Board was the smallest of the Electricity Boards in area but the largest in population. Most of the area was already built up although 80 farms were recorded in the Board's territory in 1959. Domestic sales at 42.5 percent were considerably higher than industrial sales at 27.3 percent.[3]

The head office of the Board was established at 46 New Broad Street EC2 (formerly the headquarters of the County of London Electric Supply Co.) Part of the engineering headquarters of the Board was at 60 St Martin's Lane WC2 with the remainder scattered among four other buildings in the surrounding districts.

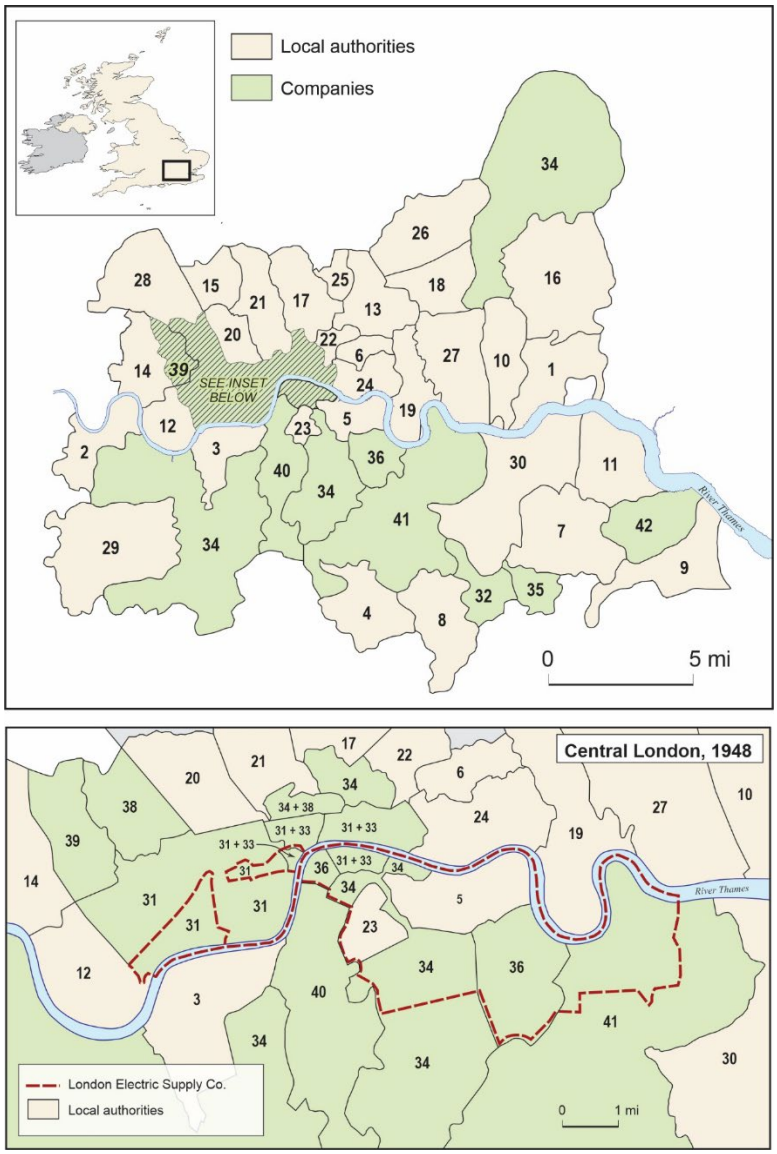

Figure 1 ***LONDON ELECTRICITY BOARD AREA CONSTITUENTS, 1948****.*

[3] The averages for the area boards in England and Wales were 34.5 percent domestic and 50.2 percent industrial in 1948/49. Calculated from data in Electricity Council, ***Handbook of Electricity Supply Statistics*** 1977 edition, pp.64-65.

Table 1 ***LONDON ELECTRICTY BOARD AREA CONSTITUENT UNDERTAKINGS, 1948****.*

MAP #	LOCAL AUTHORITIES
1	Barking MB
2	Barnes MB
3	Battersea MetB
4	Beckenham MB
5	Bermondsey MetB
6	Bethnal Green MetB
7	Bexley MB
8	Bromley MB
9	Dartford MB
10	East Ham CB
11	Erith MB
12	Fulham MetB
13	Hackney MetB
14	Hammersmith MetB
15	Hampstead MetB
16	Ilford MB
17	Islington MetB
18	Leyton MB
19	Poplar MetB
20	St Marylebone MetB
21	St Pancras MetB
22	Shoreditch MetB
23	Southwark MetB
24	Stepney MetB
25	Stoke Newington MetB
26	Walthamstow MB
27	West Ham CB
28	Willesden MB
29	Wimbledon MB
30	Woolwich MetB
MAP #	***Companies***
31	Central London Electricity
32	Chislehurst ES Co.
33	City of London Electric Lighting Co.
34	County of London Electric Supply Co. (part)
35	Foots Cray Electric Supply Co.
36	London Electric Supply Corporation
37	London Power Company[1]
38	Metropolitan Electric Supply Co.
39	Notting Hill Electric Lighting Co.
40	South London Electric Lighting Co.
41	South Metropolitan Electric Light & Power Co.
42	West Kent Electric Co. (part)

Note: [1] Not shown on map. Owner of 6 bulk supply power stations. The Northmet Company also owned the bulk supply power station at Taylor's Lane, Willesden, Middlesex. All the power stations were transferred to the British Electricity Authority.

Key to Abbreviations:

CB: County Borough
EL Co: Electric Light Company
EL&P Co: Electric Light & Power Company
EP Co: Electric Power Company
ES Co: Electric Supply Company
ES&P Co: Electric Supply & Power Company
MB: Municipal Borough
MetB: Metropolitan Borough
RD: Rural District
UD: Urban District

Development of Electricity Supply Areas

The 1948 pattern illustrated in **Figure 1** (with **Table 1**) represented the climax of over 50 years of development. Unusually for a new innovation, electricity for public supply was subject to tight national regulations from an early stage. The Electric Lighting Act 1882 required "undertakings" to apply for a licence or provisional order from the Board of Trade.[4] This requirement followed the precedents for earlier public utilities which had to "break up the streets" to lay mains or tracks. Electric Lighting Orders provided the basic conditions of a franchise to operate within a defined area, limiting the maximum prices that could be charged to consumers and, for private companies, a time limit of 21 years after which the local authority could purchase the system. An amendment in 1888 extended the time period to 42 years. All the Electric Lighting Orders were subject to Parliamentary approval. Major changes such as amalgamation of companies and extension of area required special acts.

While the Board of Trade developed regulations for safety, inspected and approved new systems as well as collecting annual returns, the Board provided no guidance on general policy or technical matters. These were left to the operator and consulting engineer to decide. Consequently after 1888 large numbers of fragmented operators developed DC and AC systems with little attempt at co-ordination. AC systems with frequencies varying from 25 cycles (Hz) to 100 cycles were established. The lack of standardization would become a major problem when interconnection between areas became advantageous.

London was distinctive in the British Isles for its population size and metropolitan complexity. Its history of electricity supply begins much earlier than other regions. So we have defined an earlier first stage of development for London. This outline of London's electrification is presented in four phases: experimental, informal and unplanned schemes from the 1870s to about 1900; a fragmented metropolis to World War I; state intervention to the 1940s; and nationalisation from 1948.

I Experimental Origins

Early electricity supply in London developed in two unplanned and overlapping stages. The first stage, in the 1880s, was informal and experimental. The second stage, in the 1890s, was formal, fragmented and quickly became embedded. Any form of restructuring the systems to meet changing needs and technical development proved very difficult to implement.

Fragmentation was one result of the characteristics of London local government which in the early 1880s consisted of the City of London, 23 Parish Vestries and 15 Board of Works Districts.[5] Parish

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[4] Basic details of this Act and subsequent legislation are outlined in ***Electricity Supply in Great Britain: A chronology*** (London: Electricity Council, 1977).

[5] Census of England and Wales 1881, Volume II, Area, Houses and Population (Registration Counties), Supplementary Tables, pp.29-31. Also published as a Command Paper C3563. Seven new Vestries were created later: Fulham (1886), Hammersmith (1886), St Margaret and St John the Evangelist, Westminster (1887), Battersea (1888), Hackney (1894), Stoke Newington (1894) and Plumstead (1894). The complex boundaries of the Metropolitan Board of Works/London County Council area are illustrated in Figure 3. Penge was part of the Lewisham District until 1900 when it became an Urban District and transferred to Kent.
For additional background on the government of London in the late nineteenth century, see:
John Davis, ***Reforming London: The London government problem 1855-1900*** (Oxford: Clarendon Pres, 1988};

Vestries ranged in size from Camberwell (4,450 acres) to St James Westminster (163 acres) while the Districts varied from Wandsworth (11,145 acres) to St Olave (part of Southwark) with 125 acres. These 39 local government units were the potential franchise areas specified in the 1882 Electric Lighting Act.[6] The only role for the Metropolitan Board of Works was in lighting a few authorised areas such as the Victoria Embankment.

Only a few public electricity systems were established under the 1882 Act. By 21 December 1882 the Board of Trade had received 109 applications for Electric Lighting Orders. After scrutiny by the office and Parliament, 69 ELOs were granted to local authorities and companies. Eight of these came to fruition over the next decade, while the others were abandoned as the early optimism waned given the uncertainties of the market for electricity and the limitations of the early technology.

Thirty-five of the applications in 1882 came from London and Suburbs.[7] The 34 company applications were dominated by the Metropolitan (Brush) Electric Light & Power Co. which submitted 25.[8] Swan & Co. applied for four Electric Light Orders. St Pancras Vestry was the only local authority to apply for an order which was granted in 1883 but not implemented until the end of the decade. All the 29 company ELOs were, however, revoked by the Board of Trade by 1885 since the promoters were unable to raise the capital for developing the schemes.

The Swan United Electric Light Co. with an ELO for the Victoria District came close to implementation (**Figure 2**). A power station[9] was built near the railway terminus but capital ran out before the mains were laid in the core area (area A on the map) and the ELO was revoked in 1885.

Other smaller area schemes were more successful even if short-lived. The Metropolitan Board of Works, in response to the interest in public lighting already established in Paris, illuminated the Victoria Embankment with arc lights from December 1878.[10] Holborn Viaduct and some adjacent properties were served by the Edison Electric Light Co. from early 1882 with a concession from the City of London

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David Owen, ***The government of Victorian London 1855-1889: The Metropolitan Board of Works, the Vestries and the City Corporation*** (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1982).
Peter Barber, ***London: A history in maps*** (The London Topographical Society in association with the British Library, 2012). This volume includes a very clear map of the County of London 1898, Plate 6.1.4., p.226 and a map of Electric Lighting Orders granted by 1890, Plate 6.7.3., p.274.

[6] Electric Lighting Act 1882, 45&46 Vict. Ch.56. Schedule.

[7] "Report by the Board of Trade respecting the applications to and Proceedings of the Board of Trade under the Electric Lighting Act 1882", ***Parliamentary Papers*** 1883. HC 237.

[8] The Anglo-American Brush Co. and its affiliates were very active in the 1882 round of applications for Electric Lighting Orders. Some 47 applications were submitted for places between Aberdeen and Folkestone. Although many ELOs were granted, all were revoked by 1885 since the companies were unable to raise capital to fulfil their obligations. Emil Garcke joined the company as Secretary in 1883 and later became Managing Director of the successor company, Brush Electrical Engineering Company. He was the founder of the British Electric Traction Company and from 1896 published the ***Manual of Electrical Undertakings***. The "Brush Bubble" is noted in J.F. Wilson, ***Ferranti and the British Electrical Industry, 1864-1930*** (Manchester: Manchester University Press, 1988), pp.161-165.

[9] "The Victoria Electric Light Station", ***The Engineer***, Vol.558, 1884, pp.403, 419-421, 441, 459-463.

[10] R.H. Parsons, ***The early days of the power station industry*** (Cambridge: Cambridge University Press for Babcock & Wilcox Ltd, 1939), p.4.

Corporation.[11] Operating costs were high for both schemes and the Embankment lighting reverted to gas in 1884 and the Edison company gave up its experimental system in 1886.

Large establishments such as railway stations and public buildings found many benefits from adding electric lighting. The Reading Room in the British Museum had an arc lamp system of lighting in 1879 and R.E.B. Crompton was active in installing systems in King's Cross railway station and the new Royal Courts of Justice opened in 1882.[12] Other examples noted in **Figure 2** include Gatti's Restaurant and the adjacent Adelphi Theatre in the Strand (1883) and the extensive system of the Great Western Railway at Paddington (1886).[13]

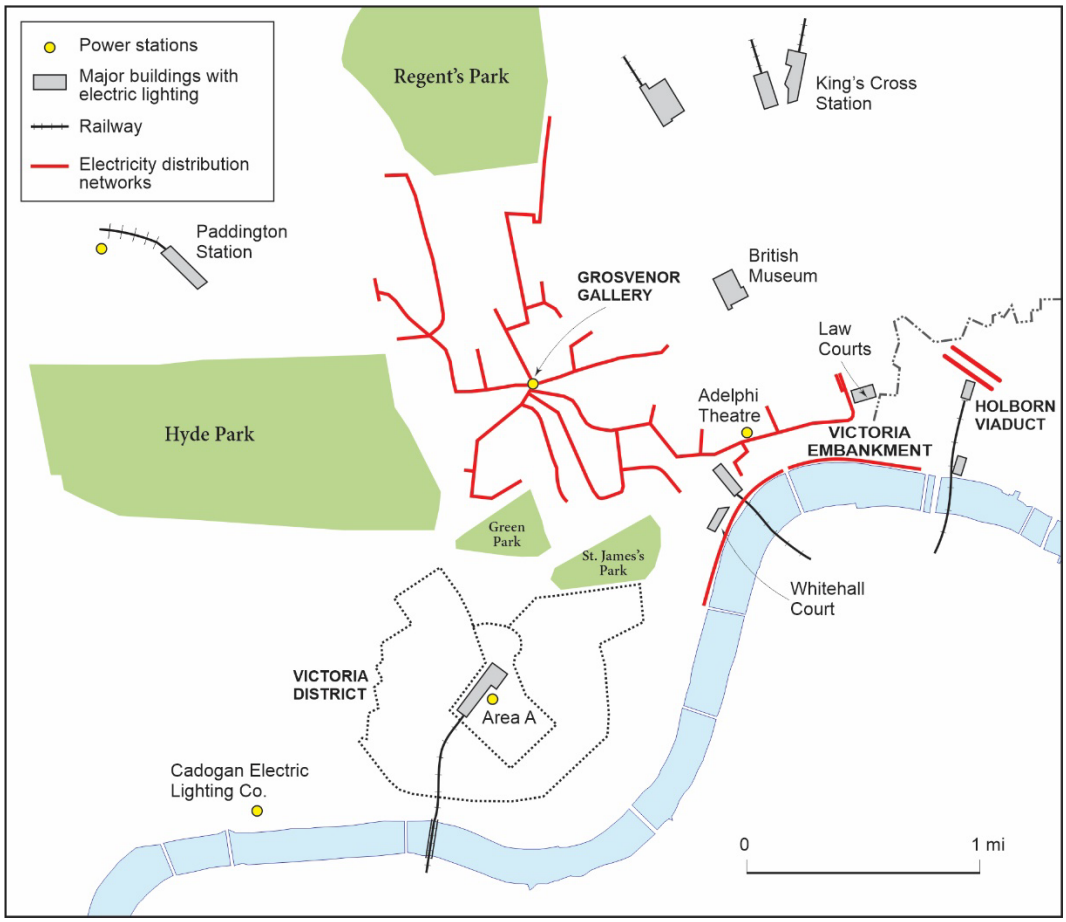

Figure 2 ***CENTRAL LONDON ELECTRICITY SCHEMES 1880s.***

[11] Parsons (1939), pp.10-12. The London station was inaugurated before the more famous Pearl Street, New York plant that opened in September 1882.

[12] Rookes Evelyn Bell-Crompton (1845-1940) occupied an outstanding position in early electrical engineering in Britain. See Brian Bowers, ***R.E.B. Crompton, an account of his electrical work*** (London: Science Museum, HMSO, 1969); R.E. Crompton, ***Reminiscences*** (London: Constable & Co., 1928).

[13] Parsons (1939), pp.42-51. The Paddington system worked successfully for 20 years until replaced by a new power station at Park Royal in 1907.

Private houses were also bring fitted with electric lighting from small generators sited on the property. William Preece installed such a system at Gothic Lodge on Wimbledon Common in 1882.[14] On a larger scale, Kensington Court was provided with an electricity supply from early 1887. Designed and equipped by R.E. Crompton, the system used the subways, built for a hydraulic service, for laying the cables.[15] Whitehall Court, another new residential development, also had its own power station (opened in October 1888) that supplied electricity to nearby hotels on Northumberland Avenue.[16] Both of these schemes became the nucleus of an electricity supply company. Whitehall Court formed the early core of the Metropolitan Company, while Kensington Court served as the first generating station of the Kensington and Knightsbridge Electric Lighting Co.

Another innovative scheme was located in Brixton, a growing commercial node in south London. The retail development centred on Electric Avenue (c.1888) was lit by a small power station.[17] A public supply became available only in November 1899 when the South London Electric Supply Corporation began operations at its power station in Bengeworth Road, Loughborough Junction.

The most promising of the central area systems evolved from the Grosvenor Gallery in New Bond Street where the owner Sir Coutts Lindsay installed electric lighting in 1883. Operating as a non-statutory company, the Grosvenor Gallery quickly built up an overhead network of distribution lines to serve customers. Sebastian Ferranti[18] joined the company in 1886, replacing much of the earlier equipment with machines of his own design. In August 1887 the assets were transferred to the newly formed London Electric Supply Corporation which had a nominal capital of £1 million.

Ferranti's plan for LESCO was ambitious, involving the building of an ultra-large power station at Deptford (ultimate capacity 150,000hp) and a 10,000-volt cable via the South Eastern Railway to Charing Cross with connections to the existing system at Grosvenor Gallery. The large scale of the powerhouse also allowed for bulk supply to distributors elsewhere in London. Work began at Deptford in April 1888 and some supply was available by mid-1890.

Strong competition was emerging in central London as public electricity schemes began to take off in 1889 and 1890 when applications for Electric Lighting Orders resumed. This activity was prompted by the 1888 amendment to the Electric Lighting Act that extended company franchises from 21 to 42 years. Nationally, there were 17 applications in 1889 and 161 in 1890. Thirteen of the 1889 applications related to London.[19]

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[14] Brian Bowers, ***A History of Electric Light and Power*** (Stevenage: Peter Peregrinus, 1982), p.128. See also: E.C. Baker, ***Sir William Preece FRS: Victorian Engineer Extraordinary*** (London: Hutchinson, 1976), p.234.

[15] Parsons (1939), pp.89-92. R.E. Crompton built his own house on the estate, complete with a laboratory on the upper floors. It was one of the earliest steel-framed houses in Britain. See Jonathan Clarke, ***Early structural steel in London buildings: a discrete revolution*** (Swindon: English Heritage, 2014), pp.251-253.

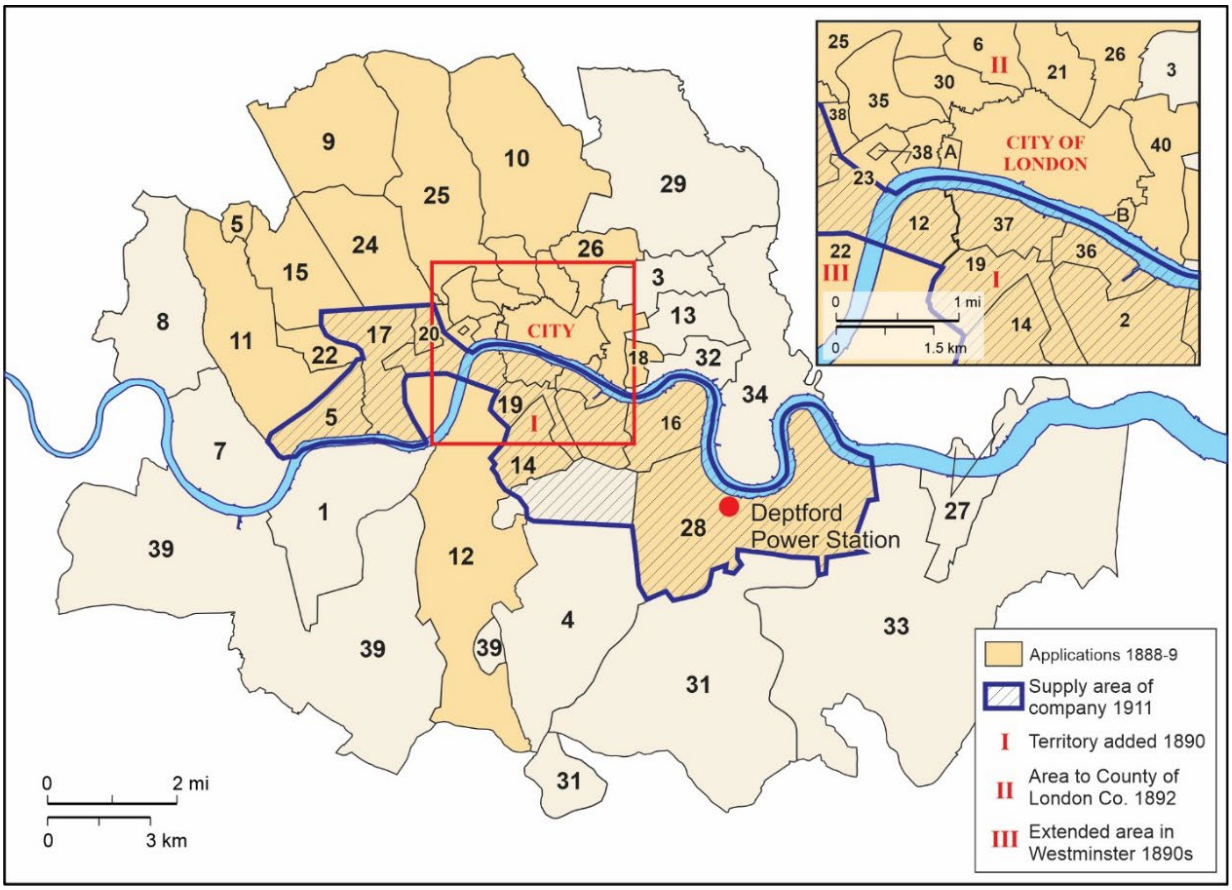
[16] Parsons (1939), pp.72-74.

[17] Ian NaIrn was very excited by the vibrant shopping area, although he did not explore the origins of Electric Avenue. See Ian Nairn, ***Nairn's London*** (Harmondsworth: Penguin Books, 1966), pp.193-194.

[18] Sebastian Ziani de Ferranti (1864-1930) played a key role in the development of electrical technology from the early 1880s. See J.E. Wilson, ***Ferranti*** (1988). Parsons (1939) devotes a long chapter (pp.21-41) to the work at the Grosvenor Gallery and Deptford.

[19] Board of Trade, Proceedings under the Electric Lighting Acts. ***Parliamentary Papers*** 1889. HC 229.

LESCO's application covered a wide area including 20 Parishes with Vestries, 7 Board of Works Districts and the City of London (**Figure 3**). Other major applications were those for the Metropolitan Electric Supply Co., Westminster Electric Supply Co. and the House-to-House Electric Co. Given the multiple applications for the same area (there were six applications for Kensington) the Board of Trade ordered a public inquiry.



Parishes under Vestries

1 Battersea
2 Bermondsey
3 Bethnal Green
4 Camberwell
5 Chelsea
6 Clerkenwell
7 Fulham
8 Hammersmith
9 Hampstead
10 Islington
11 Kensington
12 Lambeth
13 Mile End Old Town
14 Newington
15 Paddington
16 Rotherhithe
17 St George Hanover Square
18 St George in the East
19 St George the Martyr, Southwark
20 St James, Westminster
21 St Luke
22 St Margaret & St John the Evangelist
23 St Martins in the Fields
24 St Marylebone
25 St Pancras
26 Shoreditch
27 Woolwich

Board of Works Districts

28 Greenwich
29 Hackney
30 Holborn
31 Lewisham
32 Limehouse
33 Plumstead
34 Poplar
35 St Giles
36 St Olave
37 St Saviour
38 Strand
39 Wandsworth
40 Whitechapel

Extra-parochial Places

A Temple
B Tower of London

Figure 3 ***LONDON ELECTRIC SUPPLY CORPORATION, APPLICATIONS FOR ELECTRIC LIGHTING ORDERS 1880-1890***

Major Marindin[20] conducted the inquiry held in the Westminster Town Hall, Caxton Street. It began on 3 April and lasted 18 days. Eight companies and 13 local authorities were represented. Among the many issues considered were the merits of AC and DC systems of supply. There were many objections to the LESCO proposals, particularly its reliance on a single power station where an accident might stop the whole system. The long trunk main from Deptford also increased the risk of breakdown while the proposed pressure of 10,000 volts was regarded as a "gigantic experiment".[21] The site however was regarded as excellent and features of the proposed scale of operation were also praised.

The Report, prepared by 18 May, set out the basic principles by which public electric lighting supply was to be introduced in London and included a model application for future Electric Lighting Orders. For LESCO the results of the inquiry were disappointing since it only granted exclusive distribution rights on the South Bank. In the central area the company was to be allowed to supply AC in competition with new DC suppliers. The newly established London County Council observed that, as the representative governing body, it should be appointed the controlling authority and should be given the power of purchase at the time of the specified period, it being" manifestly impossible for any single vestry or district board to purchase a large undertaking supplying many parishes".[22]

A leading article in ***The Engineer***[23] looked forward to a future when electricity used for light and heat would deliver the metropolis from the perpetual presence of smoke:

> *London, rescued from its aerial nuisance would become a new city. It would be seen as it had never been seen before. The grandeur of the buildings would appear and its gardens and open spaces would put on fresh beauty, encouraging to further efforts of a like kind, until trees, shrubs and flowers become the ordinary adornment of the streets. Among the resources of civilisation, perhaps electricity is the most hopeful.*

The editorial also noted:

> *Care is thus being taken that the projects which contemplate the general introduction of the electric light into London shall not be the occasion of any serious mistake such as may cripple the undertakings or prejudice the interests of the public. An error committed now may work mischief for years to come and almost defy remedy.*

After the limited results of the Marindin Report, LESCO attempted another large application in 1890. This covered the City of London, 15 parishes, 7 Board of Works Districts and two areas in Essex, the Borough of West Ham and the parish of East Ham. All the remaining parts of the County of London, not included in the 1889 application, were covered (**Figure 3**). Since few of the local authorities gave their consent to the application, the results were once again a disappointment for LESCO. The only territorial gains in 1890 were the Parish of St George the Martyr, Southwark and part of the Parish of Camberwell. The final shape of LESCO's territory was decided shortly afterwards when Clerkenwell became part of

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[20] Francis Arthur Marindin (1838-1900) joined the Board of Trade as an inspecting officer for the Railways Department in 1877 after service in the Royal Engineers. At the Westminster inquiry he was assisted by Major Philip Cardew RE (1852-1910), appointed in 1888 as the first electrical adviser to the Board of Trade. In this role he developed most of the rules and regulations for the use of electricity for public supply, tramways and railways.
[21] Electric Lighting (Metropolis), Copy of Report made by Major Marindin after his inquiry held by direction of the Board of Trade, June 1889. ***Parliamentary Papers*** HC 189, p.189.
[22] Marindin Report, p.27. The London County Council finally obtained these powers in 1908.
[23] ***The Engineer*** Vol.67, May 24, 1889, pp.443-444.

the County of London Electric Supply Co. area and LESCO was allowed to serve the southern part of the Westminster company's area in the Parish of St Margaret and St John the Evangelist with AC supply.

Meanwhile progress at the Deptford power station was slowed by a series of misfortunes. A fire at the Grosvenor Gallery substation in November 1890 left consumers without power for two months. Installation of the big 10,000hp engine was halted, and Ferranti left the company in 1891. Another fire in March 1892 damaged the high-voltage cable. Confidence in the company collapsed and a Receiver was called in during 1894.[24]

Figure 4 shows the effects of the Marindin Report and subsequent grants of Electric Lighting Orders covering the City of London (1890), Paddington 1890), Clerkenwell (1892) and Islington (1893).[25] By 1897 the whole of the map area was covered by a formal system with many of the boundaries reflecting the pattern of Vestries and Board of Works Districts. Eleven companies and two Vestries, Islington and St Pancras, were providing electricity service at this time. LESCO had been largely relegated to the South Bank east of Westminster Bridge, although it was allowed to offer an AC service to the DC areas of the Chelsea, Westminster, St James & Pall Mall, and Charing Cross company territories. The area was served by 22 power stations plus two others at Eden Grove (Islington) and Deptford not shown on the map (**Table 2**).

Table 2 ***CENTRAL LONDON ELECTRICITY UNDERTAKINGS, 1897****.*

POWER STATION	SYSTEM[1]	OPENED	UNDERTAKING	SALES m kWh 1900-1901
1 Maiden Lane, Strand	DC	1887	Charing Cross ES	3,862,128
2 Commercial Road, Lambeth	DC	1896		
3 Draycott Place	DC	1889	Chelsea ES Co.	1,428,323
4 Flood Street	DC	1894		
5 Bankside	AC(100)	1891	City of London EL Co.	8,549,353
6 City Road	AC(100)	1897	County of London ES C.	920,094
7 Richmond Road	AC(83)	1889	House-To-House EL Co.[2]	1,241,369
8 Kensington Court	DC	1887	Kensington & Knightsbridge EL Co.	2,463,950
9 Cheval Place	DC	1890		
10 Rathbone Place	AC(100)	1887	Metropolitan ES Co.	8,327,939
11 Whitehall Court	DC	1888		
12 Sardinia Street	AC(100)	1889		
13 Manchester Square	AC(100)	1889		
14 Amberley Road	AC(100)	1893		
15 Bulmer Place	DC	1891	Notting Hill EL Co.	665,127
16 Mason's Yard	DC	1889	St James & Pall Mall EL Co.	4,201,104
17 Carnaby Street	DC	1893		
18 St Johns Wharf	DC	1890	Westminster ES Corpn	6,829,545

[24] Subsequent developments are described in two books by Rob Cochrane: ***Cradle of Power: the story of the Deptford power stations*** (London: Central Electricity Generating Board, South Eastern Region, 1985); and ***Pioneers of Power: the story of the London Electric Supply Corporation 1887-1948*** (London: London Electricity Board, 1987).

[25] See Arthur Henry Preece, "The electricity supply of London", Institution of Civil Engineers, ***Minutes of Proceedings***, Vol.134, 1897-98, pp.121-174. The paper includes a detailed map of the County of London with areas of electricity undertakings and power stations.

POWER STATION	SYSTEM[1]	OPENED	UNDERTAKING	SALES m kWh 1900-1901
19 Eccleston Place	DC	1891		
20 Davies Street	DC	1891		
21 Stanhope Street	DC	1891	St Pancras Vestry	2,477,508
22 King's Road	DC	1895		
Other Undertakings				
Deptford	AC(83)	1890	London ES Corpn	3,496,132
Eden Grove	AC(50)	1896	Islington Vestry	1,346,347

Notes: [1] AC frequency in parentheses (Hz). [2] Renamed Brompton and Kensington Electricity Supply Co.in August 1899.
Sources: Compiled from R.H. Parsons, ***The early days of the power station industry*** (1939; ***Garcke's Manual of Electrical Undertakings 1900/01.***

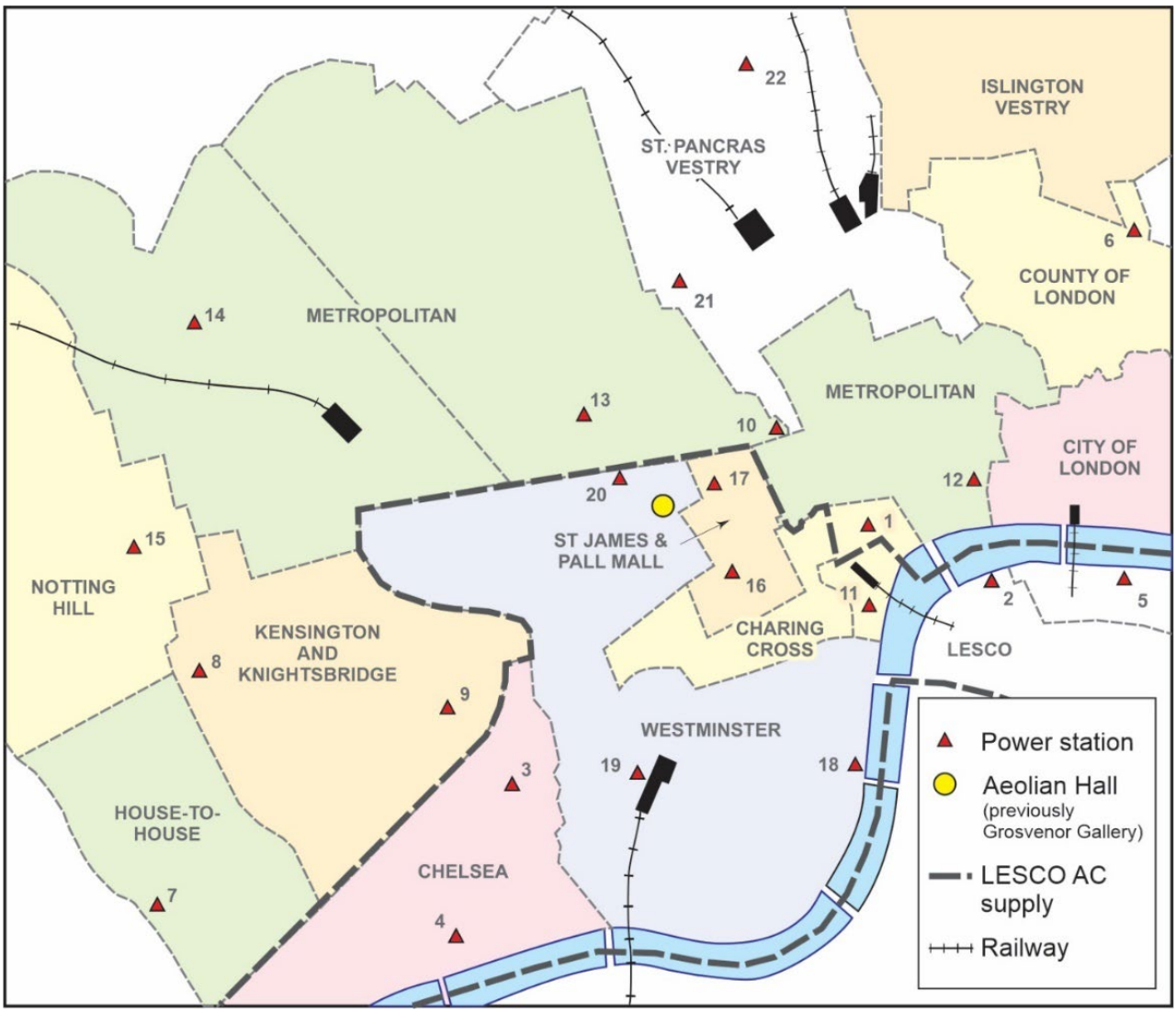

Figure 4 ***CENTRAL LONDON ELECTRICTY UNDERTAKINGS, 1897.***

In addition to the territorial fragmentation, the operating systems were divided between 6 AC systems and 7 DC systems, each further divided by frequency and voltage. Three of the AC systems--the Metropolitan, City of London and County of London—worked at 100 cycles (Hz); two—LESCO and the House-to-House Co.—at 83Hz; and Islington Vestry at 50Hz. The DC systems had voltages of 100 (Charing Cross and Notting Hill), 107 (St James & Pall Mall), 110 (Kensington & Knightsbridge and St Pancras) and 200 (Chelsea and Westminster).

Only a few changes were made in the central area after 1897. The Charing Cross Co. extended further into the Strand and City by 1900 and the newly formed St Marylebone Metropolitan Borough Council was allowed to take over the portion of the Metropolitan Company in the borough by an ELO of 1901. Difficulties in arranging loans to cover the £1,212,000 purchase price, as well as the cost of a new power station at Aberdeen Place, delayed the opening of the municipal system until 1905/6.

By 1897 it was clear that rising demand for electricity would soon exceed the generating capacity of most of the systems in the area. The Mason's Yard station of the St James & Pall Mall Co., for example, occupied a very restricted site and had already reached its full capacity of 1,700kW by 1891. A second station was opened in Carnaby Street two years later but this also soon reached its maximum capacity of 4,480kW.[26] In contrast, the Bankside station of the City of London Co. was one of the few sites capable of expansion since adjacent properties were cheap to acquire. This site also had the benefits of easy access to condensing water and coal supply. Bankside, as a coal-fired steam station, was extended many times from the 1890s until final closure in 1959.

In late 1897 three private Bills promoted by the Metropolitan Co., the St James & Pall Mall/Westminster Co., and Kensington & Knightsbridge/Notting Hill Co. were submitted for Parliamentary approval to build power stations outside their franchise areas. Since these bills and the General Power Distribution Company's proposal in the East Midlands raised important new issues beyond the provisions of the Electricity Supply Acts, a Joint Select Committee of the Houses of Parliament was appointed.[27] Following the Committee's report the London bills were approved and new power stations were built at Acton Lane, Willesden (opened in 1899), Grove Road, St Marylebone (1902) and Wood Lane, Shepherd's Bush (1900).[28] In all the discussion about the provision of new generating facilities, the potential pf the Deptford power station site was apparently forgotten.[29]

The Cross Committee of 1898 also allowed for the development of power companies supplying bulk electricity over wide areas. The North Metropolitan Electric Power Supply Co. formed in 1900 was the first example of this type in the London area. Several unsuccessful attempts to establish power companies in the metropolis were made between 1904 and 1915.

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[26] R.C.R. Brooks, "Electricity supply in Westminster", ***Proceedings of the Institution of Electrical Engineers***, Vol.126(9), 1979, pp.875-883. The paper covers all the undertakings in the extended City of Westminster which by 1979 included St Marylebone and Paddington.

[27] Report from the Joint Select Committee of the House of Lords and House of Commons on Electrical Energy (Generating Stations and Supply); together with the Proceedings of the Committee, Minutes of Evidence and Appendix. May 1898 [Cross Committee] ***Parliamentary Papers***, 1898, HC 213. The tables in the Appendix have details of contemporary London undertakings and the various Electric Lighting Orders in force.

[28] The Charing Cross Co. opened a power station at Bow, West Ham in 1902.

[29] Deptford power station had a capacity of 7,000kW in 1900 (up from 4,450kW in 1895). This was less than one-tenth of the capacity planned in 1889.

The area of Central London (**Figure 4**) which covered a little less than six square miles was very profitable. Sales of the 12 undertakings (excluding LESCO) in 1900/01 amounted to 42.3million kWh.[30] This figure represented about 80 percent of electricity sales in the London Area and approximately one-third of sales nationally. The three largest distributors in the area—the City of London, Metropolitan and Westminster companies—all had sales exceeding Manchester Corporation (6,355,872kWh) then the largest provincial operation. In 1900/01 the Westminster Electric Supply Co. balance sheet showed a profit of £53,000 after deducting all the expenses of operation, interest and depreciation. With a profit of 38.6 percent of revenue and a franchise not due to expire until 1931, the company would be resistant to any changes affecting its status.

Generating electricity in central London was already creating environmental issues of noise, vibration and condensation.[31] In his evidence to the Cross Committee, William Preece[32], responded to a question:

> ***Q:*** *As to the multiplication of power houses, is that becoming a serious evil everywhere?*
>
> ***A:*** *It has become very serious indeed, and more serious of course in London than anywhere else. If these stations grow it will mean that London will be something more like Leeds in the way of chimneys and stacks, and things of that sort. The great evils are the disturbance of the streets, the number of stations, the nuisance of the cartage of coal, and so on.*[33]

Preece observed in reply to a further question from the committee chairman, Viscount Cross:

> ***Q:*** *Suppose you were an autocrat, and you had to start afresh for London, how many generating stations would you provide?*
>
> ***A:*** *I think the whole of London could be very well served, for all the purposes I have enumerated, if we had four or five large stations, say two or three on the banks of the Thames and one or two of them on our leading main railways where water could be obtained; I think that large power stations of that kind, supplying the whole of the power, would remove almost all the difficulties I have enumerated.*[34]

II A Fragmented Metropolis

Figure 5 and **Table 3** provide a snapshot of the development of public supply areas over the previous three decades. London's electricity supply was fragmented, a reflection of the complexity of local government in the metropolis. In 1912 there were 44 undertakings in the Area--28 local authorities and 16 companies. Most of the growth had taken place after 1897 when only six local authorities and twelve companies were in operation.

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[30] Calculated from financial tables in a supplement to ***Garcke's Manual of Electrical Undertakings 1900/01***.
[31] Since many of the stations worked without condensing, the exhaust steam from the chimney often formed droplets which, when combined with oil and grit, was a hazard to passersby.
[32] William Preece (1834-1913) as chief engineer to the General Post Office gave evidence as an expert witness. He served as consultant on many electric lighting schemes including Bristol's. See: E.C. Baker, ***Sir William Preece FRS: Victorian Engineer Extraordinary*** (London: Hutchinson, 1976). Preece introduced electric lighting at his residence in Wimbledon during 1884 and his son Arthur proposed the scheme for lighting the town in the late 1890s (pp.289-291).
[33] Cross Committee Report, ***Parliamentary Papers*** 1898, HC 213, Question 1993.
[34] Ibid, Question 1996.

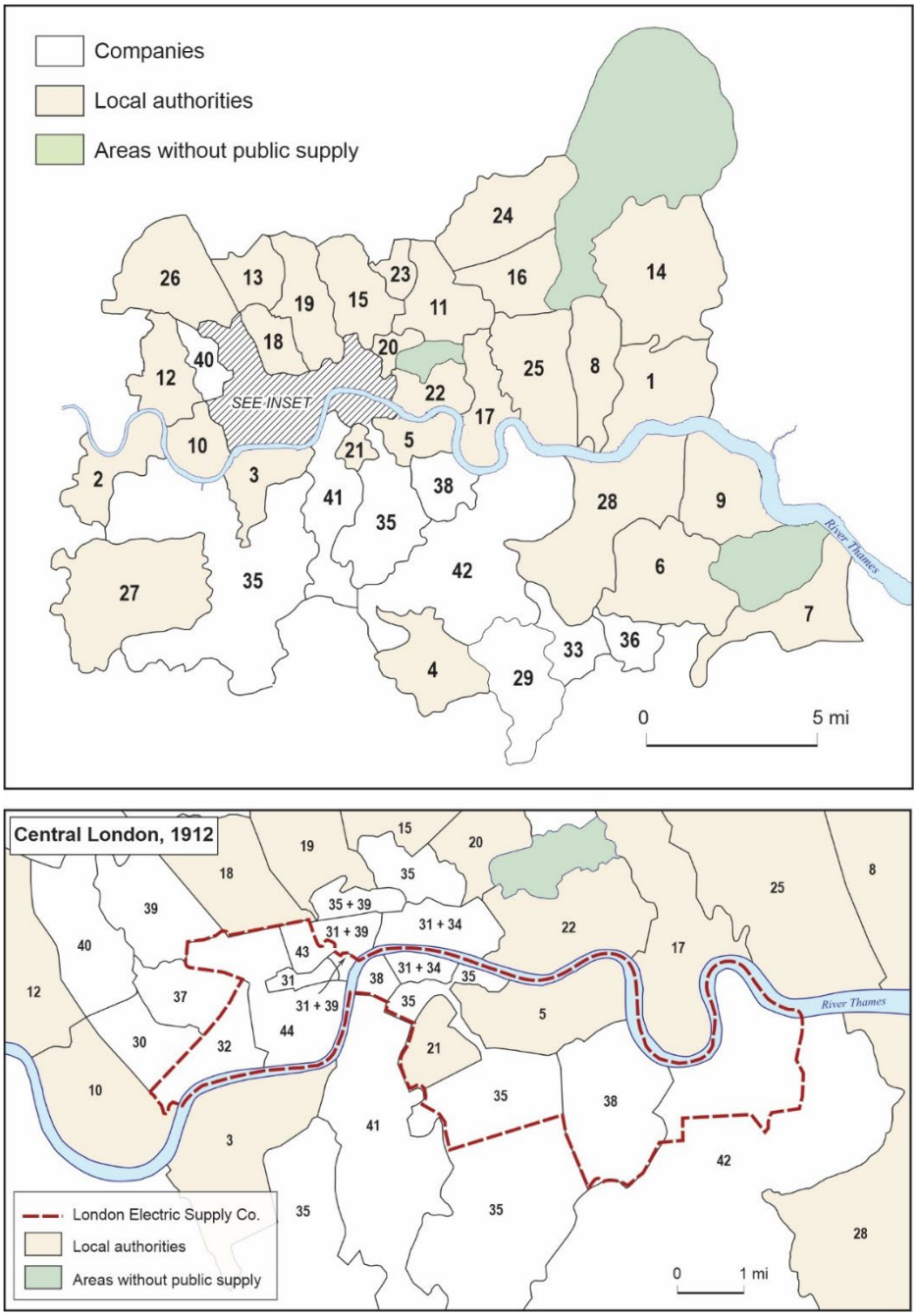

Figure 5 ***LONDON ELECTRICITY SUPPLY UNDERTAKINGS, 1912****.*

Table 3 ***LONDON ELECTRICTY BOARD AREA ELECTRICITY SUPPLY UNDERTAKINGS c. 1912.***

UNDERTAKING	*COUNTY*	*SUPPLY BEGAN*	*SALES m kWh 1911-12*
Local Authorities			
1 Barking Town	Essex	1899	1.5
2 Barnes	Surrey	1901	1.0
3 Battersea	London	1901	4.3
4 Beckenham	Kent	1900	0.8
5 Bermondsey	London	1902	4.1
6 Bexley	Kent	1903	..
7 Dartford	Kent	1901	1.2
8 East Ham	Essex	1901	
9 Erith	Kent	1903	1.8
10 Fulham	London	1901	3.3
11 Hackney	London	1901	6.6
12 Hammersmith	London	1897	9.3
13 Hampstead	London	1894	4.8
14 Ilford	Essex	1901	
15 Islington	London	1896	6.4
16 Leyton	Essex	1896	
17 Poplar	London	1900	9.2
18 St Marylebone	London	1905	13.5
19 St Pancras	London	1891	9.4
20 Shoreditch	London	1897	9.0
21 Southwark	London	1899	1.8
22 Stepney	London	1899	12.0
23 Stoke Newington	London	1906	0.4
24 Walthamstow	Essex	1901	
25 West Ham	Essex	1898	
26 Willesden	Middlesex	1903	2.6
27 Wimbledon	Surrey	1899	2.5
28 Woolwich	London	1893	2.2
Companies			
29 Bromley	Kent	1899	0.9
30 Brompton & Kensington	London	1889	2.9
31 Charing Cross	London	1891	27.1
32 Chelsea	London	1889	4.0
33 Chislehurst	Kent	1899	0.1
34 City of London EL Co.	London	1891	26.6
35 County of London ES Co.	London	1897	20.4
36 Foots Cray	Kent	1907	?
37 Kensington & Knightsbridge	London	1887	5.8
38 London ES Co.	London	1887	20.4
39 Metropolitan ES Co.	London	1890	13.5
40 Notting Hill	London	1891	2.3
41 South London	London	1899	4.5
42 South Metropolitan	London	1900	4.8
43 St James & Pall Mall	London	1889	10.7
44 Westminster	London	1890	19.8

Bulk supply power stations

1. Central ES (Grove Road) 2. Kensington & Knightsbridge/Notting Hill Joint (Wood Lane) 3. Northmet Co. (Taylor's Lane)

Source: Frank Bailey, "Electric supply in London", ***Journal of the Royal Society of Arts***, Vol. XVI, 1913, pp.539-550

London's fragmented electricity supply was unusually complex by international standards. While many world cities had begun, like London, with small generating stations serving limited areas, consolidation into larger units had already taken place. New York City, for example, similar in population to the County of London (about 4.5 million) had only 9 public supply power stations compared with 38 stations in London.[35] The two waterside power stations of the New York Edison Co. had a combined capacity of 220,000kW at a time when few London power stations exceeded 10,000kW. In both cities power supplies for electric railways were generated independently by the transport operators.

Islington Metropolitan Borough (population 327,428 in 1911) was the largest of the 28 local authorities; Bexley Urban District (population 15,895) was the smallest. St Pancras was the first local authority to provide a public supply (1891) while Stoke Newington (1906) was the most recent. Woolwich Metropolitan Borough took over the private company in 1903 and St Marylebone had bought out the Metropolitan company in the borough and began its own supply in 1905. By 1912 St Marylebone had the highest sales of any of the local authorities.

The 16 companies were very varied in area and scale of operation. The St James & Pall Mall Co. occupied only a small area in the West End but had high ranking in sales. In contrast the County of London Co. covered a much more extensive area in the southern suburbs.

Electricity undertakings were also divided as to those operating in the County of London and the others working in parts of Essex, Kent, Middlesex and Surrey. London undertakings were subject to somewhat different rules and regulations while the others were the same as the rest of the United Kingdom. Reorganisation of London local government in 1900 swept away the Vestries and Board of Works districts, replacing them with 28 Metropolitan Boroughs. While these boroughs had more powers than earlier organizations, the legacy of the past remained. The new City of Westminster's electricity supply was divided among six different companies.

The multiplicity of other utility services in London had been partly addressed by the formation of the Metropolitan Water Board in 1903 and the Port of London Authority in 1909. Gas supply, once very fragmented, had been largely consolidated by the Gas, Light & Coke Co. and the South Metropolitan Gas Co.[36]

Hydraulic power was a significant public utility in central London from the 1880s to World War I. The London Hydraulic Power Co. built an integrated system that served warehouses, offices, hotels and theatres. Various types of lifts and elevators were popular installations and the company also provided power for the moving spans of Tower Bridge as well as an innovative vacuum cleaning service used in the Savoy Hotel. Unlike public electricity supply which was hampered by the restrictive 1882 legislation, the hydraulic company was able to break up streets to lay its high-pressure (700psi) water mains. The hydraulic network that eventually extended from Rotherhithe to Kensington, grew from 7 miles in 1883, to 27 miles in 1887 and 76 miles in 1895. Four pumping stations all powered by steam engines were

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[35] "Electricity in New York City", ***Electrical World***, Vol.57, 1911, pp.1271-1230; Frank Bowley, "Electric Supply in London", ***Journal of the Royal Society of Arts***, Vol.LXI, 13 April 1913, pp.539-550. For the international context, see: Thomas P. Hughes, ***Networks of Power: Electrification in Western Society 1880-1930*** (Baltimore: Johns Hopkins University Press, 1983), Chapter IX: "London: the primacy of politics".

[36] Stirling Everard, ***The history of the Gas Light & Coke Company 1812-1949*** (London: A. and C. Black, reprinted 1992 for the London Gas Museum). This volume includes a particularly fine series of maps showing the growth of the service area.

located at Falcon Wharf (on the south bank, east of Blackfriars Bridge), Millbank, City Road and Wapping. Competition from electric motors gradually reduced demand for this service and the system was finally closed in 1976.[37]

With the County of London covered with Electric Lighting Orders by 1900 and a rapidly expanding population in the outer area of Greater London (see Appendix), the attention of promoters now turned to the regional scale. The North Metropolitan Electric Power Supply Co., developed by the British Electric Traction Co., was entering service in 1903/04. With power stations at Brimsdown, Enfield and Willesden (Taylor's Lane) it showed the possibilities of industrial and traction sales as well as bulk supply to existing distributors.[38] London's fragmented systems of small power stations serving limited areas seemed to offer the potential for cost reductions and profitable returns. Several proposals came before Parliament between 1905 and 1907 for regional bulk supply schemes.[39] Although none was successful, some of the proposals have a lasting interest as attempts to reorganise electricity supply in the London area.

Three existing companies saw the opportunity to break out of their restricted areas in Central London and promoted private bills for the 1905 Parliamentary Session (**Figure 6**). The Charing Cross & Strand Electricity Supply Corporation (with a power station at Bow, West Ham opened in 1902) proposed an extension of its area to include the whole of east London, part of north Middlesex and parts of Essex. On the south bank of the Thames, the City of London Electric Lighting Co. planned a bulk supply area extending from Wandsworth to Gravesend that would be served by the Bankside power station. The Metropolitan Electric Supply Co. with a power station at Willesden (Acton Lane) proposed to extend service into West Middlesex. Such an extension would help to make up the loss of territory recently taken by St Marylebone Metropolitan Borough. Parliament, recognising strong opposition from existing suppliers in the north, east and south, rejected the Charing Cross and City of London Company bills. With a few amendments the Metropolitan bill was passed and the company began a long process of western extensions.

The Administrative County of London and District Electric Power Co. Bill was a more comprehensive scheme for regional bulk supply introduced in the 1905 Parliamentary Session. It was promoted by East End manufacturers and by various people associated with the Newcastle-upon-Tyne Electric Supply Co., one of the most successful power companies. Charles Merz, consulting engineer for the company, was particularly active in the London project, not only in the detailed background research but also in the presentations to Parliamentary committees.[40] The large area was to be divided into two zones--the western zone for bulk supply only, the eastern or industrial portion to include both bulk supply and some retail distribution (**Figure 6B**). Two large generating stations were proposed to be located at Greenwich and West Ham, each with an initial capacity of six 15,00kW turbines generating AC at 25Hz.

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[37] B. Pugh, ***The Hydraulic Age: public power supplies before electricity*** (London: Mechanical Engineering Publications, 1980), pp.96-112.

[38] N.C. Friswell, ***Northmet*** (Horsham, 2000), 272pp. The County of Surrey Electric Power Distribution Co. was also promoted by the British Electric Traction Co. from 1900. Renamed the South Metropolitan Electric Tramways & Lighting, the power company built a power station at Sutton and developed a supply area west of Croydon. The electricity undertaking was sold to the London & Home Counties Joint Electricity Authority in 1932.

[39] "London's electricity supply", ***The Engineer***, Vol.104, 1907, pp.306-308.

[40] See Chapter IV in John Rowland, ***Progress in Power: the contribution of Charles Merz and his associates to sixty years of electrical development*** (London: Newman Neame for Merz & McLellan, 1960), pp.38-47.

This frequency was regarded as ideal for conversion to DC for power and traction purposes. While generally commended for its technical competence, the bill was strongly opposed by the London County Council (then in an active phase of interest in reorganizing electricity supply) and failed to pass on a last-minute blocking motion.

*Source: **The Engineer**, Vol.104, 1907, pp.306-307*

*Figure 6 **LONDON BULK SUPPLY PROPOSALS, 1905.***

A second attempt to pass the Administrative County Bill was made in the 1906 Session but was again thwarted by the strength of the LCC opposition. Opposition in the House of Commons had been reinforced by the 1906 election which had returned some 30 current or former members of the Council. The LCC introduced its own bill in 1906 seeking similar powers to those in the Administrative County Bill. The existing new tramway power station at Greenwich would be extended in the proposed scheme and a new station at Battersea would be erected. Since the bill was hastily prepared and weak on technical details, it was rejected by a House of Commons Committee.

In 1907 the LCC promoted a more comprehensive bill that involved the compulsory acquisition of all municipal undertakings within five years as well as the takeover of companies at the end of their franchise terms or by agreement. Two generating stations, one at Barking and the other at Erith, were proposed. The capital involved in the scheme was estimated at between £20 and £30 million. The County Council election of March 1907 changed the composition of the Council from its previous domination by the Progressives to a majority led by the Municipal Reform party. A more conservative approach to public spending resulted in various modifications, especially to the purchase clauses. The revised bill was, however, rejected by Parliament.

Three years of effort by public and private interests had failed to change the structure of London's electricity system. The cost of these efforts was estimated at between £150,000 and £200,000 in expenses, mostly in the Parliamentary process. In addition, a good deal of Parliamentary time had been spent on the proposals. In the 1906 Session, for example, a House of Lords Committee had spent six weeks considering the various London bills.

In 1913 the London County Council commissioned a detailed report on London's electricity supply by Merz & McLellan and a new bill was prepared for submission to Parliament. Wartime priorities intervened and further efforts were abandoned.[41]

Electrification in the region was almost complete by 1912. (See **Figure 5**.) Bethnal Green (population 128,183 in 1911) was still finalising a decision to implement the Order granted in 1899. The only areas without any coverage were Wanstead and Woodford Urban Districts and the two parishes of Crayford (Dartford RD) and Chigwell (Epping RD). Bethnal Green opened a public supply system in 1916 with power generated in Hackney. West Kent Power Co. began work in Crayford. The Essex suburbs of Romford and Dagenham received electric service in the 1920s from the County of London Company.

Lighting was the dominant use for electricity until the late 1890s. The most profitable demand was in shops, offices, hotels, theatres (and later cinemas) and public buildings. Residential sales were more limited—by the expense of installation and the high retail prices. With lighting, much of the load on generating equipment was confined to the evening hours, a feature that also contributed to the high prices. Diversification of the load to other uses, especially in the daytime, was essential if electricity was to become a viable alternative to gas. Such diversification began with the electrification of tramways and the substitution of electric motors for small steam engines and manual power.

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[41] For more detail on the various proposals, see: Sir Henry Howard, ***The London County Council from within: Forty years of official recollections*** (London: Chapman & Hall, 1932), Chapter XXXVI, "London Electricity Supply"; and H.H. Ballin, ***The organisation of electricity supply in Great Britain*** (London: Electrical Press, 1946), Chapter 4, "London's struggle for electrical unification 1900-1915".

ELECTRIC TRAMWAY SYSTEMS IN THE LONDON AREA[1]

	YEARS OPERATING	ROUTE MILES	MAX. NO. OF CARS
Barking Town UD	1903-1929	1.6	10
Bexley UD	1903-1933[2]	5.1	39
Dartford UD	1906-1933	6.5	13
East Ham Corporation	1901-1933	8.3	76
Erith UD	1905-1933	4.7	21
Ilford UD	1903-1933	7.4	57
Leyton UD	1905-1921[3]	9.5	60
London United Tramways Co.[4]	1906-1933	..	..
London County Council Tramways	1903-1933	167.2	2,332
London Passenger Transport Board	1933-1952	328.4	2,630
Walthamstow UD	1905-1933	9.1	72
West Ham Corporation	1904-1933	16.8	162

Twelve electric tramway systems were developed in the region between 1901 and 1906. All the systems open in 1933 became part of the London Passenger Transport Board. The systems were very variable in size, from small systems in Barking, Dartford and Erith to the very large London County Council network. Unlike in many cities, trams were excluded from the central area, and the northern and southern divisions of the LCC were only connected by a subway beneath Kingsway.

From 1906 when the Greenwich power station was opened, the LCC generated all its tramway electricity supply. The power station was one of the last large plants to use reciprocating engines. Turbines were added in 1910 and the total capacity was raised from 14,000kW in 1906 to 62,000kW in 1925/26. By this time it was one of the largest power stations in the metropolis. All the other municipal tramway systems drew the current from their power stations.

Tramway power supply as a proportion of total sales was very important in the early years and ensured the viability of many public supply systems. Tramway power sales were still significant in 1925/26: Leyton 45.0 percent, Bexley 41.7 percent, East Ham 38.9 percent and Walthamstow 19.7 percent.

Electric tramways provided fast, efficient and cheap urban transport and were very profitable before 1914. More flexible motor transport eroded most of the advantages by the late 1920s.

Electric railways in London began with the opening of the 3-mile underground line of the City and South London Railway in 1890. By 1900 the completion of the Waterloo & City and the Central London Railway had raised the total mileage to 15. A burst of new tunnelling and the electrification of the Metropolitan and District systems added a further 83.6 route miles of line by 1910. Seven power stations had been built to serve these largely underground systems.

Railway Power Stations in London 1910[5]

Company	*Opened*	*Capacity (kW)*	*System*	*Location*
City & South London	1890	5,000	DC	Stockwell
Waterloo & City	1898	1,800	DC	Waterloo Station
Central London	1900	9,500	AC	Wood Lane
Great Northern & City	1904	4,600	DC	Hoxton
Metropolitan	1905	25,500	AC	Neasden
*U.E.R.L.**	1905	48,000	AC	Lots Road
Great Western	1906	6,000	AC	Park Royal

*Underground Electric Railways of London (incorporating the District; Baker Street & Waterloo; Great Northern; Piccadilly & Brompton; Charing Cross, Euston & Hampstead). Later amalgamations in 1913 added the City and South London and the Central London companies to the UERL group. The Great Northern & City joined the Metropolitan Railway at this time.

There were many variations in the systems adopted for these power stations. Three different frequencies were used in the AC systems: 25Hz (Central London), $33^1/_3$Hz (Metropolitan and UERL) and 50Hz (Great Western). Standardisation of frequency was an issue for the later integration of the Underground lines.

Suburban line electrification began in 1909 with the "Elevated Electric" system around south London developed by the London, Brighton & South Coast Railway. Unlike the other electric lines, this system used AC current from overhead conductors and purchased power from the London Electric Supply Co. at Deptford.

Two other systems opened during the war: London & South Western Railway from Waterloo and the London & North Western Railway from Euston and Broad Street stations. Independent generating stations were built at Wimbledon (capacity 25,000kW) and Stonebridge Park, Wembley (capacity 20,620kW).

After the war the South Eastern and Chatham Railway in planning the electrification of suburban lines proposed a 150,000kW generating station at Angerstein's Wharf, Charlton. The proposal was opposed by the Electricity Commissioners and the railway company was persuaded to take its power needs from the London Electric Supply Co. at Deptford.[6] This station was extended from 45,250kW in 1920 to 103,700kW in 1925. Almost all subsequent electric railway development used public supplies.

The dominance of traction demand in London's consumption of electricity is illustrated by the following estimates for 1912:[7]

	kWh	***PERCENT***
Railways	271,500,000	40.0
Tramways	130,000,000	19.1
General Supply	277,500,000	40.9
	679,000,000	**100.0**

Notes

[1] Compiled from Keith Turner, ***Directory of British Tramways***, Vol.1 (Stroud: The History Press, 2007).

[2] Transferred to the London Passenger Transport Board July 1933.

[3] Transferred to London County Council Tramways.

[4] London United Tramways, a large system in Middlesex, opened a route from Kingston-upon-Thames to Wimbledon via Malden in 1906/7 and connected with LCC trams at Summerston and Tooting. Power was generated at Chiswick until 1919. Later supply came from Lots Road power station.

[5] W.E. Dalby, "British railways: some facts and a few problems", Presidential Address to Section G, Engineering, British Association for the Advancement of Science, ***Report of the Annual Meeting 1910*** (Sheffield), pp.693-707. Table 5 presented the electric railway details.

[6] ***Third Annual Report of the Electricity Commissioners 1922-23*** (London: HMSO, 1923). The decision, following a public inquiry in May 1922, was presented in Appendix B, pp.106-113.

[7] Frank Bailey, "Electricity supply in London", ***Journal of the Royal Society of Arts*** Vol.LXI, April 11, 1913, p.542.

As already noted in **Table 2**, the first London undertakings adopted AC or DC for their systems. These rival forms of current had advantage and disadvantages. AC could be readily transformed to higher voltages for long-distance transmission and then transformed to low voltage for local distribution. Unlike DC, AC could not be stored and many early AC stations had very high rates of coal consumption since the engines had to be kept running even at times of low demand. Continuous current or DC was most flexible and worked well for motors as well as lighting but was uneconomic at a distance of more than 1-1$^{1}/_{2}$ miles from the power station.[42]

The Metropolitan Company which began with AC at a frequency of 100 cycles (Hz) later converted much of its distribution system to DC. When the Willesden power station was commissioned in 1899, AC generation began again, this time at 60Hz with motor generators producing DC in the local substations. Other central London companies such as the Charing Cross & Strand added AC when they had to build distant power stations. Power from the new station at Bow was transmitted via 11,000-volt cables (50Hz frequency) to the substations in the central area. Mixed AC/DC systems became increasingly common from 1900. Conversion to a full AC system was, however, a long process. The London Electricity Board still had 44,402 DC consumers as late as 1959.[43]

In the search for economies of scale, the introduction of more efficient prime movers became a priority. The Metropolitan Electric Supply Co. introduced turbines (350kW) at the Manchester Square station as early as 1894 to solve the problems of vibration caused by reciprocating engines. Complaints by neighbours were threatening the future of the station. A much larger turbine (3,000kW) was installed at Willesden in 1904 and all further extensions were powered by turbines. The new Marylebone Borough Council station at Aberdeen Place opened in 1905 was the first all-turbine power station for public supply in London. Lots Road and Neasden traction power stations, also opened in 1905, installed turbines from the beginning.

The 1912 data do not cover private generation which was very important at the time, not only in isolated establishments but also in urban centres where there was already a public supply. Some examples are outlined here to give a sense of the scale and scope of private generation otherwise absent in most accounts of electrification.

Many public buildings and spaces were lit by independent systems. A new power station for the Imperial Institute in South Kensington was completed in 1911. With a capacity of 1,000kW this station also served the needs of the Royal College of Science, the Victoria and Albert Museum and the Natural History Museum.[44] Expansion of the Northampton Polytechnic in Clerkenwell also included private generation.[45] The General Post Office replaced small power stations in the complex of buildings at St Martins le Grand with a new generating plant on the south bank of the Thames at Blackfriars Bridge (2,500kW).[46] Earlier in the decade the London County Council had built a small gas-engined power station at Charing Cross station to serve the new lighting scheme for the Victoria Embankment.[47]

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[42] See R.H. Parsons, ***The early power station industry*** (1939). Chapter VII. "The battle of the systems".
[43] Electricity Council, ***First Annual Report 1958-59***, p.238.
[44] "New power station at the Imperial Institute", ***The Engineer*** Vol.111, 1911, p.198.
[45] ***The Engineer*** Vol.110, pp.436-438.
[46] "A new power scheme for the General Post Office", ***The Engineer*** Vol.110, pp.540-542.
[47] "Victoria Embankment electric lighting", ***The Engineer*** Vol.91, 1901, pp.210-211.

Railway stations which had been early adopters of electric lighting continued to use independent power supply. The Great Central Railway had small power plants at Marylebone and Neasden, the Midland Company at Kentish Town and the Great Northern at Upper Holloway. At Stretford the Great Eastern Railway had one of the largest lighting stations with a capacity of 3,000kW in 1910. This plant served the workshops, suburban stations and the terminus at Liverpool Street.

Wholesaling and retailing were also served by private generation. Smithfield Markets was lit by a private company from 1892, authorised by a concession from the City Corporation. The powerhouse in Charterhouse Street had a capacity of 1,000kW. Selfridge's department store on Oxford Street opened in 1909 was supported by a private electricity infrastructure including battery-powered delivery vans.[48] The Kensington department store of John Barker & Co. also generated much of its own power in 1915.[49]

Large industrial plants such as sugar refineries, chemical works and shipyards generated their own power. The Clement-Talbot motor works at Ladbroke Hall, Notting Hill, opened in 1903, had its own gas-powered dynamos in a very opulent engine room at the works entrance.[50]

Hotels were early in adopting electric lighting as one of the amenities of high-class modern hospitality. Richard D'Oyly Carte, building on the foundations of the Savoy Theatre (1881 with electric lighting), installed electricity in the adjacent Savoy Hotel opened in 1889.[51] The Whitehall Court Electric Supply Co., established in 1888 to light the new residential building, also served adjacent buildings on Northumberland Avenue including the Metropole and Grand hotels and the church of St Martin-in-the-Fields.[52]

Other institutions of a different type were also adding electric lighting. Claybury Hospital at Woodford Bridge, Essex, opened in 1893 as a London County Council asylum, had its own powerhouse for generating electricity. The large Heath Asylum in Bexley (1898) followed a similar pattern.

Although private generation was usually superseded by public supply after 1920, some new industrial operations that used process steam continued to build private generating facilities. The Wiggins Teape Co. at Dartford opened a power station with a capacity of 11,250kW in 1933 when expanding the paper mills.[53] Park Royal brewery of Guinness & Co., completed in 1936, was also self-sufficient in power with a capacity of 1,500kW.[54]

The war economy from 1914 boosted electricity sales in the industrial zones of London. Power demand at the Royal Arsenal in Woolwich expanded far beyond the limits of its previously independent supply. Sales of Woolwich Borough Council electricity rose from 2.2 million kWh in 1911 to 34.7m kWh in 1918.

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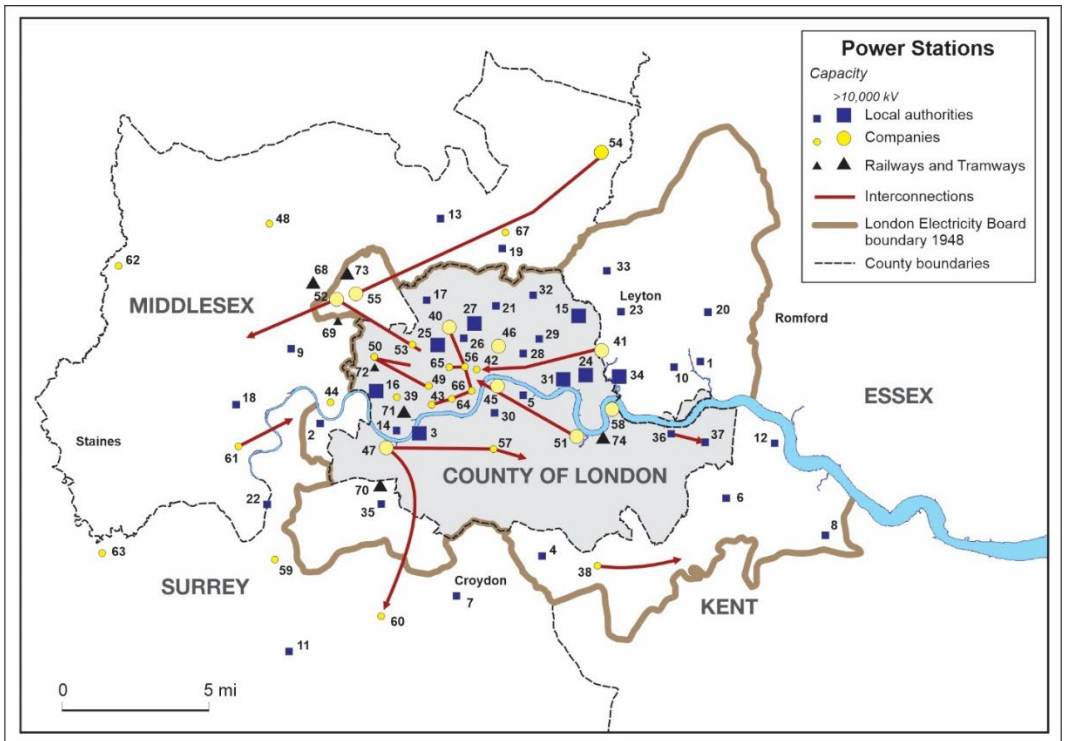
[48] Gordon Honeycombe, ***Selfridges Seventy-five years: The story of a store 1909-1984*** (London: Park Lane Press, 1984). New diesel-powered generating plant was installed in 1949 (p.90).
[49] "A private electrical plant at Kensington", ***The Engineer*** Vol 120, 1915, pp.422-423.
[50] Paul Collins and Michael Stratton, ***British car factories from 1896*** (Godmanstone, Dorset: Veloce Publishing, 1993), pp.130-132.
[51] Elaine Denby, ***Grand Hotels: Reality and Illusion*** (London: Renktion Books, 1998), pp.142-143.
[52] R.H. Parsons (1939), pp.71-74. Whitehall Court power station was bought by the Metropolitan Electric Supply Co. in 1889, giving the company access to a lucrative market area.
[53] "A new paper mill plant", ***The Engineer***, Vol.156, 1933, p.110.
[54] ***The Engineer***, Vol.183, 1947, pp.513-514.

Additional connections were made to the tramway power station at Greenwich and the South Metropolitan Co. at Blackwall Point for supplementary power to Woolwich Arsenal.[55]



Local Authorities

1 Barking Town UD
2 Barnes UD
3 Battersea MetB
4 Beckenham UD
5 Bermondsey MetB
6 Bexley UD
7 Croydon CB
8 Dartford UD
9 Ealing MB
10 East Ham CB
11 Epsom UD
12 Erith MB
13 Finchley UD
14 Fulham MetB
15 Hackney MetB
16 Hammersmith MetB
17 Hampstead MetB
18 Heston & Isleworth UD
19 Hornsey MB
20 Ilford UD
21 Islington MetB
22 Kingston-upon-Thames MB
23 Leyton MB
24 Poplar MetB
25 St Marylebone MetB
26 St Pancras MetB: Stanhope St
27 St Pancras MetB: King's Road
28 Shoreditch MetB: Coronet St
29 Shoreditch MetB: Whiston Rd
30 Southwark MetB
31 Stepney MetB
32 Stoke Newington MetB
33 Walthamstow MB
34 West Ham CB
35 Wimbledon MB
36 Woolwich MetB: Wharf
37 Woolwich MetB: Plumstead

Companies

38 Bromley E&P Co,
39 Brompton & Kensington ES Co.
40 Central ES Co. (Grove Road)
41 Charing Cross ES Co.: Bow
42 Charing Cross ES Co.: Shorts Gardens
43 Chelsea ES Co.
44 Chiswick ES Co.
45 City of London Electric Lighting Co.
46 County of London Electric Supply Co.: City Road
47 County of London Electric Supply Co.: Wandsworth
48 Harrow EL&P Co.
49 Kensington & Knightsbridge EL Co.
50 Kensington & Knightsbridge/Notting Hill Joint station: Wood Lane
51 London Electric Supply Corporation
52 Metropolitan Electric Supply Co.: Willesden
53 Metropolitan Electric Supply Co.: Amberley Road
54 North Metropolitan EP Supply Co.: Brimsdown
55 North Metropolitan EP Supply Co.: Taylor's Lane
56 St James & Pall Mall EL Co.
57 South London Electric Lighting Corporation
58 South Metropolitan Electric Light & Power Co.
59 Surbiton (Callenders Cable & Construction Co.)
60 Sutton (South Metropolitan ET&L Co.)
61 Twickenham & Teddington ES Co.
62 Uxbridge & District ES Co.
63 Walton & Weybridge (Urban ES Co.)
64 Westminster ES Corpn: Eccleston Place
65 Westminster ES Corpn: Davies Street
66 Westminster ES Corpn: Horseferry Road
67 Wood Green (Tottenham & District LH&P Co.)

Railways and Tramways

68 London & North Western Railway: Stonebridge Park
69 Great Western Railway: Park Royal
70 London & South Western Railway: Wimbledon
71 Underground Electric Railways of London: Lots Road
72 Central London Railway: Wood Lane
73 Metropolitan Railway: Neasden
74 LCC Tramways: Greenwich

Figure 7 ***POWER STATIONS IN "GREATER LONDON", 1918.***

[55] Arnold B. Gridley and Arnold H. Human, "Electric power supply during the Great War", ***Journal of the Institution of Electrical Engineers*** Vol.57, 1919, p.410.

Wartime experience of trying to match demand with limited supply illustrated all the weaknesses of a fragmented structure. A government report (April 1917) by the Coal Conservation sub-committee highlighted the issues of duplication (especially the railway traction power stations), lack of interconnection and the wasteful use of coal.[56] National estimates of coal consumption in electric power stations showed an increase from 4.9 million tons in 1913 to 6.6 m tons in 1917.[57]

The fragmented structure of power generation in the London region was of particular concern given its manufacturing contribution to the war effort. In 1918 there were 74 power stations, 37 operated by local authorities, 30 by companies and 7 by transport organisations. (**Figure 7**). Thirty-eight of the power stations were located in the County of London. Only 23 of the 74 stations had generating capacities of over 10,000kW. Lots Road (63,000kW) which supplied much of the Underground system was the largest. Many power stations in the suburbs were quite small: Heston & Isleworth 1,250kW, Twickenham 1,190kW, Erith 2,300kW. Coal consumption was high and seaborne supply was disrupted as the collier fleet was suffering heavy losses from U-boats. Bow power station powered by reciprocating steam engines consumed 4.70lbs of coal for each kWh generated.[58] The Willesden station which had some turbines had a consumption rate of 3.80lbs/kWh.[59] In contrast, the newly completed railway traction powerhouses at Stonebridge Park and Wimbledon were consuming only 2.0-2.5lbs/kWh.

Interconnection was mostly limited to the stations built to supply a central London distribution network. The Wandsworth station of the County of London Co. was unusual in linking with the Sutton plant of the South Metropolitan Electric Traction & Lighting Co. (1916) and the Loughborough Junction station of the South London Co. (1917). The two stations of the Northmet Co. at Brimsdown and Taylor's Lane, Willesden were connected by cable in 1918.

The 1917 report was the first of several major inquiries that began the movement toward active state intervention in the electricity supply industry. All reports emphasised the need for regional integration of electricity generation by district boards.

III State Intervention

Difficulties of interconnection, differences in AC frequencies, and the need for coal conservation by the use of large-scale plant became major issues in World War I when electricity usage nearly doubled. The Electricity (Supply) Act 1919 created a new organisation, the Electricity Commissioners, to replace the role of the Board of Trade. A key mandate of the Commissioners was the restructuring of generation and transmission, by voluntary means since the earlier compulsory powers had been deleted from the

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[56] Coal Conservation sub-committee. "Interim Report on electric power supply in Great Britain", ***Parliamentary Paper*** Cd 888, 1917. Charles H. Merz (!974-1940) was the principal author of the report. As senior partner in the consulting firm of Merz & McLellan, he had played a major role in the development of the Newcastle-upon-Tyne Electric Supply Co. as a regional system. At various times between 1904 and 1915 he prepared power schemes for Greater London anchored by a large power station at Barking. In the later 1920s Merz & McLellan were the consulting engineers for the South East England grid scheme.

[57] B.R. Mitchell and Phyllis Deane, ***Abstract of British Historical Statistics*** (Cambridge: Cambridge University Press), 1962), p.122.

[58] "The Bow generating station", ***The Engineer***, Vol.147, 1929, p.202. New turbine equipment installed after the war reduced coal consumption to 1.81lbs/kWh in 1927.

[59] "The Willesden power station", ***The Engineer***, Vol.147, 1929, p.312. In 1901, before the cooling towers were installed, the station had consumed 8.92lbs of coal for each kilowatt hour generated.

legislation. The first stage of the procedure for establishing Joint Electricity Authorities was the definition of a series of Electricity Districts covering parts of the country where reorganisation was most needed. All electricity undertakings in the defined area were then invited to submit proposals for reorganisation schemes emphasising the technical, administrative and financial aspects of a JEA.

The London and Home Counties Electricity District was defined in July 1920 with wide boundaries far beyond the core area of London. With an area of 1,660 square miles the Electricity District included a population of about 9 million. Six proposals were received by the Electricity Commissioners from:

a) London County Council;
b) Conference of local authorities owning electricity undertakings in Greater London;
c) London Electricity Joint Committee (1920) Ltd;[60]
d) Metropolitan Borough of Poplar;
e) Great Eastern Railway;
f) London, Brighton & South Coast Railway.

An inquiry before the Electricity Commissioners began in June 1921 and lasted 26 days.[61] All the proposals received a hearing. After the meeting the railway companies withdrew and the Poplar scheme for an East London JEA was dropped. The main concerns of the three remaining parties were with the arrangements in the County of London. All were focused on protecting their special interests: the local authorities in favour of some interconnection while retaining all their powers; the private companies concerned about the end of the 42-year franchise in 1931; and the London County Council attempting to develop an integrated system.

After many meetings a settlement was reached in 1924 with the London County Council agreeing to a 40-year extension of the company franchises to 1971. The agreement was embedded in legislation. The London Electricity (No.1) Act 1925 covered four East London companies: County of London, City of London, South Metropolitan and South London. The London Electricity (No.2) Act 1925 covered the ten companies that formed the London Electricity Joint Committee (1920) Ltd. The legislation allowed for the amalgamation of companies and extended the franchise to 1971.[62]

With these arrangements in place the Joint Electricity Authority held its first meeting on 4 November 1925. The constitution of the JEA allowed for a membership of 33[63]:

19 Electricity undertakings (5 companies, 8 local authorities in the County of London, 6 outside);
10 Local authorities (6 from London County Council, 3 from other county councils, 1 City of London);
2 Railway companies;
2 Workers in the industry.

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[60] This group chaired by W.F. Fladgate included ten companies: Brampton & Kensington; Central Electric; Charing Cross; Strand & City; Kensington & Knightsbridge; London ES Corp; Metropolitan; Notting Hill; St James & Pall Mall; and Westminster.

[61] The general proceedings of the meetings are covered in the ***Annual Reports of the Electricity Commissioners*** from 1921-22.

[62] See: Severin Peter Langhoff, Jr.: "Rationalization trends in the electricity distribution systems of Greater London", ***Journal of Land and Public Utility Economics***, Vol.11(2), 1935, pp.133-145.

[63] H.H. Ballin, ***The organisation of electricity supply in Great Britain*** (London: Electrical Review, 1946), p.162. Chapter VII is devoted to the formation of the London & Home Counties JEA.

Three other members were added in the early 1930s to include representatives from the Distribution Area. Alderman Duncan Watson MIEE (St Marylebone) and Major Clement Attlee MA, MP (Stepney) became Chairman and Vice Chairman. S.J Watson, previously Chief Electrical Engineer to the City of Salford, was appointed Chief Engineer to the Authority in 1926.

Figure 8 shows the extent of the JEA in 1939. It covered a very extensive area of about 1,820 square miles, a little larger than the original definition of 1920 that had been modified to exclude Watford but to include a large part of Essex. The JEA area included 87 electricity undertakings in 1925, 43 of which were local authorities. By 1944 the total number had been reduced to 70 with no change in the number of local authorities. The map also shows how the JEA was divided among four Electricity Boards after nationalisation in 1948.

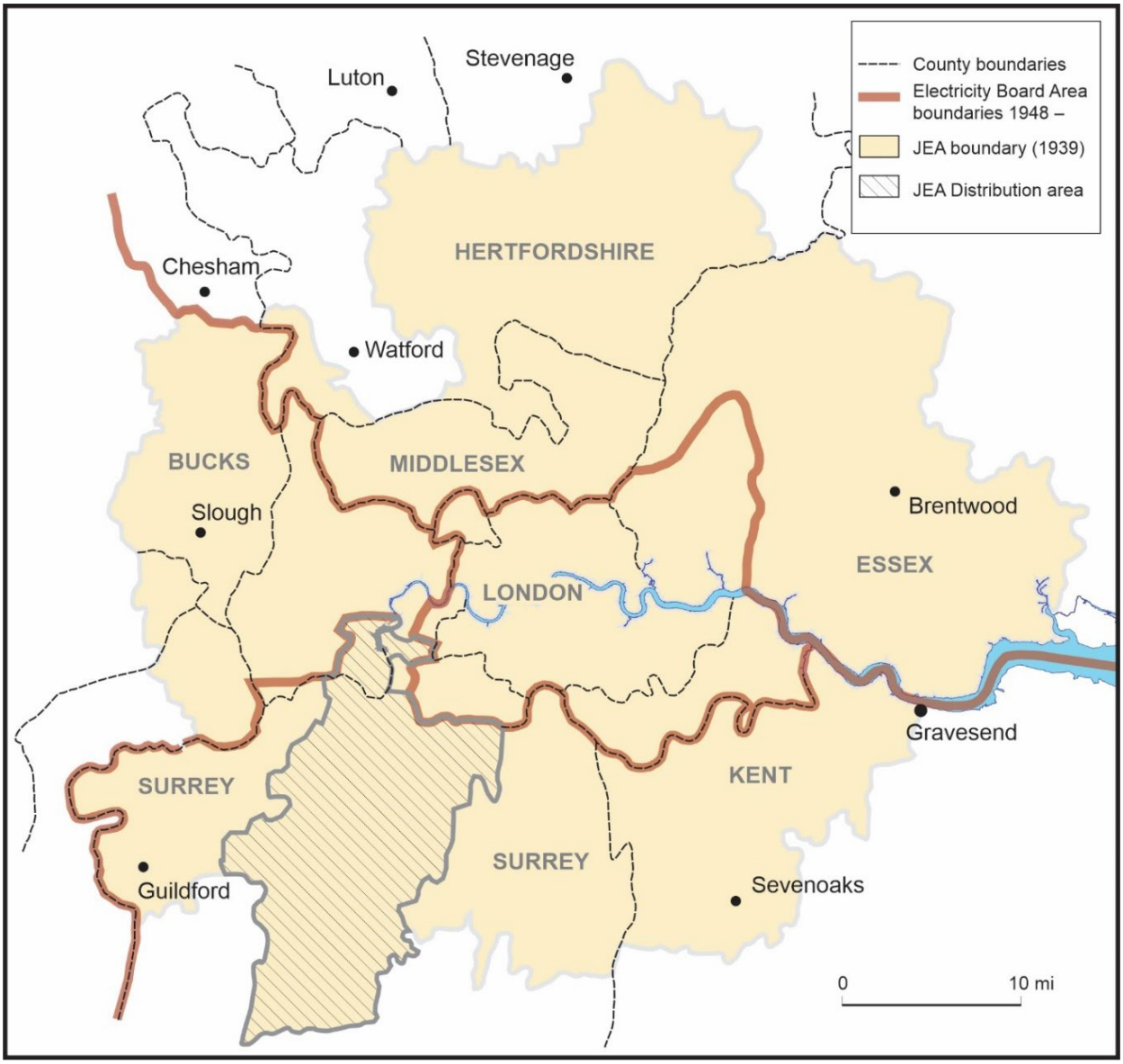

Figure 8 ***LONDON AND HOME COUNTIES JOINT ELECTRICITY AUTHORITY.***

Table 4 ***LONDON AREA ELECTRICITY UNDERTAKINGS, 1925/6.***

UNDERTAKING	SYSTEM	GENERATING CAPACITY kW	PER CAPITA CONSUMPTION kWh
Local Authorities			
Barking Town UD	AC/DC	1,850	67.7
Barnes UD	AC/DC	4,500	167.1
Battersea	AC/DC	12,350	131.5
Beckenham UD	AC	4,025	77.8
Bermondsey	DC	3,400	106.6
Bethnal Green	AC	-	46.8
Bexley UD	AC/DC	-	57.4
Dartford UD	AC/DC	3,800	156.7
East Ham CB	DC	2,700	52.4
Erith UD	AC	3,999	342.8
Fulham	AC	18,100	84.1
Hackney	AC/DC	27,000	95.0
Hammersmith	AC	28,500	189.8
Hampstead	AC	-	160.1
Ilford UD	AC/DC	6,400	122.0
Islington	AC	17,250	62.5
Leyton UD	AC/DC	6,400	122.0
Poplar	AC/DC	26,000	194.6
St Marylebone	AC/DC	45,500	410.4
St Pancras	AC/DC	23,500	110.7
Shoreditch	AC/DC	15,750	153.9
Southwark	AC/DC	4,400	39.0
Stepney	AC/DC	42,000	145.7
Stoke Newington	DC	-	56.1
Walthamstow UD	AC/DC	15,300	94.3
West Ham CB	AC/DC	45,000	195.7
Willesden UD	AC/DC	-	102.5
Wimbledon MB	AC	10,000	112.4
Woolwich	AC/DC	2,000	171.3
Companies			
Bromley EL&P Co.	AC/DC	880	44.2
Brompton & Kensington	AC	8,000	148.2
Charing Cross ES Co.	AC/DC	61,510	1,416.8
Chelsea ES Co.	DC	600	111.3
Chislehurst ES Co.	AC	-	22.9
City of London EL Co.	AC/DC	59,100	551.2
County Of London ES Co.	AC/DC	117,225	80.4
Foots Cray ES Co.	AC	-	31.9
Kensington & Knightsbridge EL Co.	AC/DC	-	393.4
London ES Corpn.	AC	103,700	..
Metropolitan ES Co.	AC/DC	51,000	..
Notting Hill EL Co.	DC	-	55.6
South London ES Corpn	AC	6,700	50.2
South Metropolitan EL&P	AC	20,000	..
St James & Pall Mall EL Co.	AC/DC	-	1,739.0
Westminster ES Corpn	AC/DC	8,100	410.3
West Kent Electric Co.	AC		

UNDERTAKING	*SYSTEM*	*GENERATING CAPACITY kW*	*PER CAPITA CONSUMPTION kWh*
Bulk Supply Power Stations			
Central ES Co. (Grove Road)	AC	75,900	
Kensington & Knightsbridge/Notting Hill Joint Station. (Wood Lane)	AC	13,750	
Northmet Co. (Taylor's Lane)	AC	24,500	

Key to Abbreviations

CB: County Borough
EL Co: Electric Light Company
EL&P Co: Electric Light & Power Company
EP Co: Electric Power Company
ES Co: Electric Supply Company
ES&P Co: Electric Supply & Power Company
MB: Municipal Borough
MetB: Metropolitan Borough
RD: Rural District
UD: Urban District

Source: Electricity Commissioners, ***Engineering and Financial Statistics***, 1925/26.

The 46 undertakings in the London Area (as defined in 1948) during 1925/26 operated a variety of systems (**Table 4**). Twenty-six were mixed AC/DC systems reflecting a shift from DC that had been popular in the early years of electrification. With an economic operating radius of 1-1.5 miles from the generating plant, DC was suitable only for city centres or small towns and villages. Five places had wholly DC systems—Bermondsey, East Ham and Stoke Newington and the Chelsea and Notting Hill companies. Several undertakings operated AC systems with frequencies different from what had become the national standard of 50Hz. Parts of the Metropolitan Company worked at 60Hz, Brompton & Kensington at 83Hz, London Electric Supply and St James & Pall Mall at 85Hz. A section of the London Electric Supply Co. at Deptford generated at 25Hz for traction supply to the Southern Railway (Brighton Section).

Data on generating capacity show a wide range in size, from London Electric Supply Co. with 103,700kW capacity to Stoke Newington Metropolitan Borough Council with only 77kW (in a small destructor unit). Steam turbines were dominant in all the larger stations and varied in scale from a 600kW machine in Leyton to one of 40,000kW at the new Barking station of the County of London Co. Older reciprocating engines were still common in DC generation such as in East Ham and Bromley. Diesel engines were used in the emergency standby stations of the Charing Cross Co. at St Martin's Lane and Short's Gardens.[64]

Statistics on electricity consumption per head of population reveal major contrasts among electricity undertakings. Twenty-four places in the region exceeded 100.0kWh per person. Each place had a distinctive market profile reflecting the local economic and social geography. West Ham had a profile in 1925/26 consisting of 13.2 percent of sales in the lighting segment, 1.8 percent in public lighting, 13.4 percent for the tramways and 71.6 percent in power. Two undertakings, Hammersmith and Leyton with similar-sized populations (around 130,000) had very different market profiles. Leyton had a varied profile with tramway sales at 45.0 percent, lighting sales at 25.6 percent, and power at 22.6 percent. Hammersmith in contrast was dominated by power sales at 76.3 percent and lighting at 18.9 percent. Annual per capita sales in Hammersmith reached 189.8kWh while Leyton's consumption amounted to only 71.4kWh.

Since the London Area was covered by Electric Lighting Orders and Special Orders from the early 1920s, most attention in the interwar period was devoted to reorganising generation. This was to be achieved

[64] These stations were to serve West End theatres and cinemas in the event of public supply failure.

by building a few large power stations, both to allow for growth in demand and to replace much of the old, small and inefficient plant that had long been characteristic of the region. The main agencies were the Joint Electricity Authority and two large companies.

The JEA began this work during its first year of operation. In August 1926 it applied to the Electricity Commissioners for consent to build a new generating station at Duke's Meadow, Chiswick. The initial capacity was for 100,000kW, eventually rising to 300,000kW. Despite local opposition, the Authority proposed a Bill that was passed by Parliament in July 1927 and the Commissioners followed with their consent in October.[65]

The Weir Report (1925)[66], the Electricity (Supply) Act 1926, the formation of the Central Electricity Board in 1927, and the adoption of the South East England grid scheme in early 1928 all affected the plans of the JEA. When the CEB noted that it could not support the proposed Duke's Meadow power station, much of the intended role of the JEA was diminished. The appointment of Duncan Watson as a member of the CEB and the transfer of S.J. Watson as manager of the CEB South East grid scheme confirmed this change. From this point the JEA turned its attention to distribution, taking over several companies in Surrey and Middlesex.

In the early 1920s the County of London Electric Supply Co. led the way in the building of large power stations. The Romford & District ELO 1913 had authorised the company to take land for a station at Barking and formal consent was approved by the Electricity Commissioners in June 1922. Work began immediately and the station was formally opened by the King in May 1925. This site that had been considered for many schemes over the previous two decades was ideal—ample space for expansion, cooling water in abundance, deep-water access for colliers, and limited possibility of complaints for nuisance (noise and smoke pollution). When completed in 1929, the Barking station had a capacity of 237,500kW. A second station approved in September 1930 began operation in 1933/34 and had a capacity of 300,000kW when completed in 1940.[67] The 75,000kW turbines installed in Barking B were among the largest in the country. Both stations were designed by Merz & McLellan.

The London Power Company was formed in 1926 to amalgamate the stations owned by the ten constituents of the London Electricity Joint Committee (1920) Ltd. This was allowed under the terms of the London Electricity (No.2) Act 1925. Leonard Pearce[68] was appointed chief engineer and plans were quickly made to build a power station at Deptford West, using a site adjacent to the original London Electric Supply Co. station and occupied by an old dry dock. First opened in 1929, Deptford West was powered by large generators and when the final unit was installed in 1937 had a capacity of 215,000kW.

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[65] ***Seventh Annual Report of the Electricity Commissioners 1926-1927*** (London: HMSO, 1927), p.53.

[66] Ministry of Transport, ***Report of the Committee appointed to review the National Problem of the Supply of Electrical Energy*** (London: HMSO, 1927), 32 pp.

[67] The Barking stations were described in ***The Engineer***, Vol.139, 1925, pp.561,568-569; Vol.157, 1934, pp.115-121,144-147.

[68] Standen Leonard Pearce (1873-1947) became chief engineer of the London Power Co. in 1926 and was responsible for the design of Deptford West and Battersea power stations. Earlier in his career he had worked for the Metropolitan Electric Supply Co. and the Central London Railway. From 1901 to 1925 he was with Manchester Corporation where he designed Barton power station. His paper, "A review of forty years development in mechanical engineering plant for power stations", Institute of Mechanical Engineers ***Proceedings***, Vol.142, 1939, pp.305ff., is a very comprehensive survey of technical advances.

Parallel with this work, the London Power Co. also applied for permission to build a station at Brentford in January 1926.[69] When that scheme was rejected the company then applied for a power station at Battersea and consent was approved in October 1927. Concerns about air pollution quickly arose and much effort went into the solution of washing the sulphur dioxide from the chimney emissions.[70] The original utilitarian design was reworked several times, replacing the multiple short chimneys with fewer tall stacks. In late 1929 Francis Fladgate, chairman of the London Power Co., appointed Sir Giles Gilbert Scott as architectural consultant to finalise the exterior appearance. Since the foundation work was already completed and some of the steel frame already erected, Scott's work was largely confined to the exterior and the chimney stacks. Early criticisms of the Scott design quickly gave way to praise and by March 1934 when floodlighting began, Battersea power station was not only a new landmark for London but an icon for the modern electricity industry.[71] Smaller copies of the design incorporating the distinctive fluted chimneys were built after the war at Brighton and Newport, Monmouthshire.

The 15-acre site of Battersea power station occupied ground once used by Southwark and Vauxhall Water Works. It was accessible by rail and well placed for cooling water and coal delivery by barge or steamer. The London Power Co. also invested in a fleet of ten up-river colliers delivered from the shipyards between 1931 and 1940. All the vessels had a low profile and hinged masts and funnels so they could negotiate the ten bridges upstream of Tower Bridge. Navigating the tidal waters of the Thames required careful timing:

> *The collier's master would aim to pass Gravesend at the time of low water at London Bridge, which gave him five hours to reach Battersea, Discharge took seven hours so that the collier would be empty and sitting on the mud by low water. As soon as she was afloat she would have to sail, or else riding high in the water she would not be able to pass under the bridges.*[72]

With all the infrastructure in place, Battersea power station was opened in 1933. The plant included two 64,000kW turbines and one large machine of 100,000kW. Work on the second half, Battersea B, began in 1937 and was completed in 1955 when the last of the four chimneys was finished.[73]

Fulham was the last of the big interwar power stations and was promoted by the Metropolitan Borough Council and supported by the Central Electricity Board and the JEA. Approved in January 1931 by the Electricity Commissioners the station was opened in September 1936. Powered by 50,000kW generators the station reached its full capacity of 360,000kW in 1951 when the last unit was installed.[74] The station followed Battersea with gas washing of the chimney emissions and the municipality also built five up-river colliers.

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[69] Planning for this station was prompted by rising demand in the City and West End which had grown from 58,000kW in 1919 to 168,000kW in 1927. ***The Engineer*** Vol.147, 1929, p.175.
[70] See: John Sheail, ***Power in Trust: the environmental history of the Central Electricity Generating Board*** (Oxford: Clarendon Press, 1991), pp.7-18.
[71] Rob Cochrane, ***Landmark of London: The story of Battersea Power Station*** (London: Central Electricity Generating Board, South Eastern Region, 1984).
[72] D. Ridley Chesterton and R.S. Fenton, ***Gas and electricity colliers*** (Kendal: World Ship Society, 1984), p.74.
[73] See: Andrew Saint, Survey of London, Vol.49, ***Battersea, Part 1, Public, Commercial, Cultural*** (New Haven: Yale University Press, 2013). Chapter 9 reviews the development of Battersea Power Station.
[74] ***The Engineer*** Vol.162, 1936, pp.351-354; Vol.193, 1952, pp.339-341.

The Electricity (Supply) Act 1926 which authorised the construction of a transmission grid to integrate generation on a national scale effectively replaced the role of the London and Home Counties Joint Electricity Authority. Plans were now prepared by the Electricity Commissioners and consulting engineers for implementation by the Central Electricity Board. The South East England scheme, covering an area from Peterborough to Brighton, was submitted to the CEB in September 1927 and adopted in February the following year.

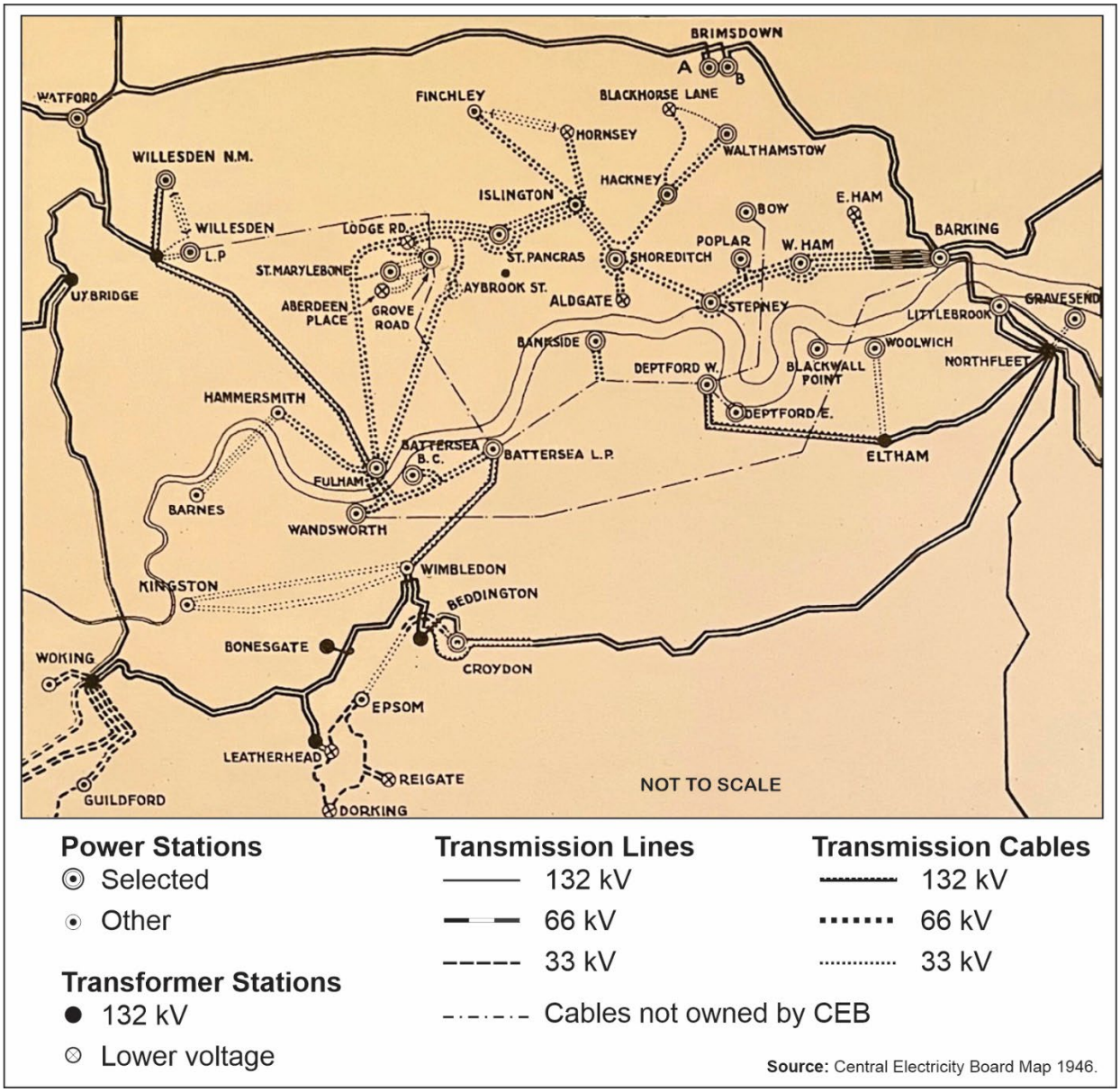

Figure 9 ***LONDON AREA: NATIONAL GRID, 1946.***

A central feature of the scheme was the choice of "selected" power stations which would be interconnected by the grid. Twenty-one of the 32 selected stations in the South East England scheme were located in the London Area.[75] All were generally the largest and most efficient generating plants with potential for expansion.

Figure 9 shows the transmission grid as developed by 1946. A long outer circuit of overhead lines at 132kv connected London with other regions. The Thames crossing at Dagenham, anchored by 487-ft steel lattice towers, was the most spectacular feat of engineering on the project. Power stations in London were linked to this circuit 120kv cables—Eltham to Deptford West, Wimbledon to Battersea, and Willesden to Fulham. Within London the selected stations were connected by underground 66kv cables. The system also included earlier interconnections of the London Power Co. (Bow--Deptford West--Battersea--Acton Lane, Willesden) and the County of London Co. (Barking—Wandsworth).

When trading began on 1 January 1934 in the combined South East England and Eastern England scheme areas, the grid added a new layer to the complex of undertakings that operated the electricity supply system. The Bankside grid control office of the CEB now managed the flows of power on the transmission lines and directed the hour-to-hour operation of the selected power stations. St Pancras power station remained in the ownership and management of the Borough Council but the daily operation was directed from Bankside. Decision-making and planning for the future became increasingly concentrated at the Trafalgar Square headquarters of the Central Electricity Board.

Table 5 shows the situation in 1935/36 when 46 undertakings were in operation, no change from the previous decade. All the wholly DC systems had added AC but full conversion was a much slower process.

Generating technology emphasised economies of scale with larger units that brought significant reductions in coal consumption. While the best performance of the London Power Company's stations in 1925/26 had been at Grove Road with 1.82lbs of coal per kilowatt-hour generated, the new Battersea station burned only 0.96lbs in 1935/36. This was achieved by larger 70,000kW and 105,000kW alternators and higher steam pressures.

[75] Selected stations in London Area, 1934:

Local Authority	*Company*
Battersea	City of London: Bankside
Fulham	County of London: Barking
Hackney	County of London: Wandsworth
Poplar	London Power Co.: Battersea
St Marylebone	London Power Co.: Deptford East
St Pancras	London Power Co.: Deptford West
Shoreditch	London Power Co.: Grove Road
Stepney	London Power Co.: Acton Lane
Walthamstow	Northmet: Taylor's Lane
West Ham	South Metropolitan: Blackwall Point
Woolwich	

Rationalisation of generation and interconnections of undertakings all contributed to reducing the cost of electricity. Other factors such as the growth of radio broadcasting[76] and lower prices for small appliances helped to boost electricity consumption. By 1935/36 all places in the region had per capita consumption levels above 100kWh. The very high level reached by St Marylebone (1,403.3kWh per capita, 92.7 percent in the lighting segment) was a result not only of residential use but also consumption by the stores on the north side of Oxford Street and new office buildings such as Broadcasting House.[77]

Table 5 ***LONDON AREA ELECTRICITY UNDERTAKINGS, 1935/36****.*

UNDERTAKING	SYSTEM	GENERATING CAPACITY kW	PER CAPITA CONSUMPTION kWh
Local Authorities			
Barking MB	AC/DC	-	209.6
Barnes MB	AC/DC	6,750	358.2
Battersea	AC/DC	52,350	308.9
Beckenham MB	AC/DC	4,025	315.2
Bermondsey	AC/DC	-	257.4
Bethnal Green	AC	-	149.3
Bexley UD	AC/DC	-	177.4
Bromley MB	AC	-	248.4
Dartford MB	AC/DC	-	400.2
East Ham CB	AC/DC	-	191.3
Erith UD	AC/DC	-	599.2
Fulham	AC	18,100	227.3
Hackney	AC	61,000	249.1
Hammersmith	AC	28,500	474.0
Hampstead	AC	-	424.2
Ilford MB	AC/DC	3,000	303.7
Islington	AC	29,750	162.8
Leyton MB	AC/DC	-	186.2
Poplar	AC/DC	41,000	360.4
St Marylebone	AC/DC	45,500	1,403.3
St Pancras	AC/DC	49,000	344.8
Shoreditch	AC/DC	25,250	360.5
Southwark	AC/DC	4,800	113.6
Stepney	AC/DC	70,000	351.8
Stoke Newington	AC/DC	77	172.9
Walthamstow MB	AC/DC	20,500	281.2
West Ham CB	AC/DC	76,500	468.3
Willesden MB	AC/DC	-	337.5
Wimbledon MB	AC	25,200	428.9
Woolwich	AC/DC	40,000	414.6

[76] Radio programmes were broadcast from a transmitter at Marconi House from May 1922 to April 1925 and then from masts on the roof of Selfridge's department store until October 1929. A new regional transmitter at Brookman's Park then took over broadcasting for London. Edward Pawley, ***BBC Engineering 1922-1972*** (London: BBC Publications, 1972), p.24.

[77] Stretford (1,408.8kWh/capita) in contrast, was dominated by power sales at 82.7 percent. Crawley, Sussex (2,656.9kWh/capita) reflected traction sales to the Southern Railway that took 94.4 percent of the total.

UNDERTAKING	SYSTEM	GENERATING CAPACITY kW	PER CAPITA CONSUMPTION kWh
Companies			
Brompton & Kensington ES Co.	AC	-	445.9
Charing Cross ES Co.	AC/DC	6,400	..
Chelsea ES Co.	Ac/Dc	-	382.8
Chislehurst ES Co.	AC	-	118.9
City of London EL Co.	AC/DC	94,000	551.2
County of London ES Co.	AC/DC	412,500	..
Foots Cray ES Co.	AC	-	..
Kensington & Knightsbridge EL Co.	AC/DC	-	..
London ES Corpn.	AC	-	..
Metropolitan ES Co.	AC/DC	-	..
Notting Hill EL Co.	AC/DC	-	-
South London ES Corpn.	AC	-	164.7
South Metropolitan EL&P	AC/DC	20,000	199.8
St James & Pall Mall EL Co.	AC/DC	-	..
Westminster ES Corpn.	AC/DC	-	..
West Kent Electric Co.	AC	-	..
Bulk Supply Power Stations			
London Power Co. (6 Stations)	AC	839,900	
Northmet Co. (Taylor's Lane)	AC	38,500	

Key to Abbreviations

CB: County Borough
EL Co: Electric Light Company
EL&P Co: Electric Light & Power Company
EP Co: Electric Power Company
ES Co: Electric Supply Company
ES&P Co: Electric Supply & Power Company
MB: Municipal Borough
MetB: Metropolitan Borough
RD: Rural District
UD: Urban District

Source: Electricity Commissioners, ***Engineering and Financial Statistics***, 1935/36.

The growth of electricity sales, especially in the lighting segment, may be illustrated by the case of West Ham. Total electricity sales grew from 58.91millon kWh in 1925/26 to 129.30m kWh a decade later. The lighting segment which included domestic uses increased from 7.78m kWh to 30.59m kWh. Continued power sales, together with domestic use, raised per capita consumption from 195.7kWh to 468.3kWh.

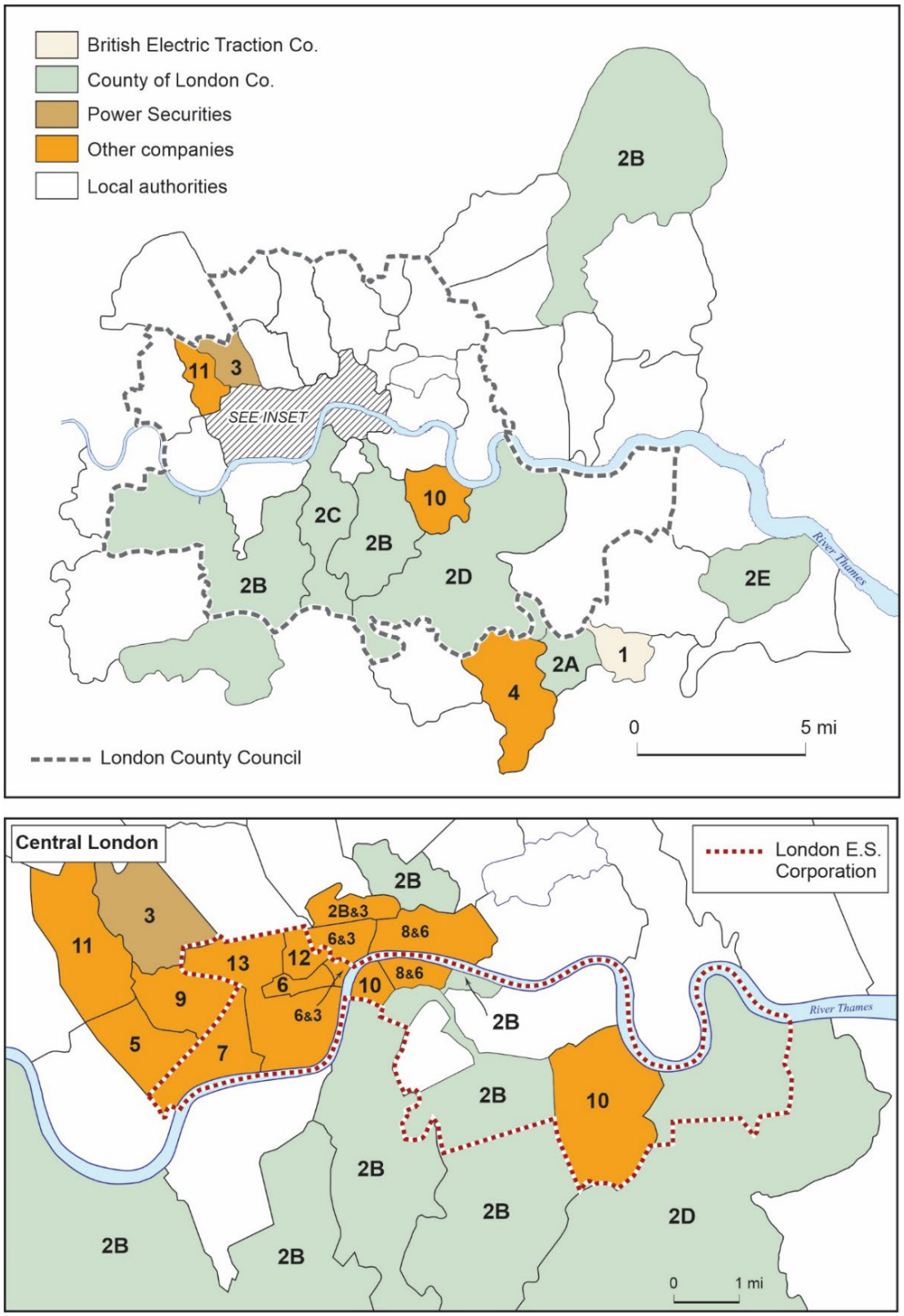

Figure 10 ***LONDON AREA; CORPORATE STRUCTURE AND HOLDING COMPANIES 1934-35.***

The 16 companies distributing electricity in the region were controlled by a variety of interests (**Table 6** and **Figure 10**). British Electric Traction which had owned the small Foot's Cray company sold its interest to the County of London Co. in 1936. The County of London Co. was clearly a dominant corporate influence in the region. Power Securities which owned the Metropolitan Electric Supply Co. also included an interest in the London Power Co. when George Balfour assumed the chairmanship after the death of Francis Fladgate in 1937.

Although state intervention had begun to rationalise electricity generation, the efforts of the Electricity Commissioners to reduce the very large numbers of distributors were unsuccessful. The McGowan Report published in May 1936[78] and the subsequent government proposals were strongly opposed by many sections of the electricity supply industry. A recommendation in the McGowan Report, that all undertakings with annual sales of less than 10 million kWh should be amalgamated, was particularly controversial. Only three undertakings in London fell into this category: Stoke Newington Borough and the Chislehurst and Foot's Cray companies. The government's Outline of Proposals was published in April 1937[79] replacing the London and Home Counties JEA with several districts. Continued opposition and more pressing issues of the time meant that reorganisation of distribution was set aside.

Table 6 ***LONDON ELECTRICITY BOARD AREA CORPORATE STRUCTURE OF ELECTRICITY HOLDING COMPANIES 1934/35.***

1. British Electric Traction Co. Ltd	1.1 Foots Cray ES Co.[1]
2. County Of London Co.	2.1 Chislehurst ES Co. 2.2 County of London ES Co. 2.3 South London ES Corpn (pt) 2.4 South Metropolitan EL&P Co. 2.5 West Kent E Co. (pt)
3. Power Securities Corpn Ltd	3.1 Metropolitan ES Co.
Other Companies	4. Bromley EL&P Co. 5. Brompton & Kensington ES Co. 6. Charing Cross ES Co. 7. Chelsea ES Co. 8. City of London EL Co. 9. Kensington & Knightsbridge EL Co. 10. London ES Corpn 11. Notting Hill EL Co. 12. St James & Pall Mall EL Co. 13. Westminster ES Corpn

Note: [1] Sold to County of London ES Co. in 1936.
Key to Abbreviations
EL Co: Electric Light Company
EL&P Co: Electric Light & Power Company
EP Co: Electric Power Company
ES Co: Electric Supply Company
ES&P Co: Electric Supply & Power Company
Source: Political and Economic Planning, ***Report on the Supply of Electricity in Great Britain*** (London: PEP, 1936), pp.140-141.

[78] Ministry of Transport, ***Report of the Committee on Electricity Distribution, May 1936*** (London: HMSO, 1936). The report noted that there were no fewer than 635 separate authorised undertakings in Great Britain in 1934, comprising the Central Electricity Board, 3 Joint Electricity Authorities, 5 Joint Boards, 373 Local Authorities and 253 Companies and persons.
[79] Ministry of Transport, ***Electricity Distribution: Outline of Proposals*** (London: HMSO, 1937).

The Charing Cross Co. and others governed by the terms of the London Electricity (No. 2) Act 1925 took note of the McGowan proposals and began moves toward amalgamation. In 1938 Central London Electricity Ltd merged six companies:

Brompton & Kensington
Charing Cross
Chelsea
Kensington & Knightsbridge
St James & Pall Mall
Westminster

The complex pattern of distribution in central London that had evolved from the decisions of the Marindin Inquiry 1889 was now reorganized in a more rational way.

Table 7 ***LONDON ELECTRICITY BOARD AREA CONSOLIDATIONS.***

UNDERTAKING	***YEARS IN OPERATION***	***NEW OWNER***
Woolwich EL&P co.	1893-1903	Woolwich MetB
Crystal Palace & District ES Co.	1893-1904	South Metropolitan EL&P Co.
Power Stations Acquired c1926[1]		
Bow (Charing Cross)	1902-	London Power Company
Deptford East (LES Co.)	1889-	London Power Company
Grove Road (Central Electric)	1902-	London Power Company
Willesden (Metropolitan Co.)	1899-	London Power Company
Amberley Road (Metropolitan Co.)	1893-1926	London Power Company
Horseferry Road (Westminster Co.)	1910-1927	London Power Company
Alpha Place (Chelsea Co.)	1894-1928	London Power Company
Richmond Road (Brompton & Kensington)	1889-1928	London Power Company
Wood Lane (K&K/Notting Hill Joint)	1900-1928	London Power Company
Undertaking	**Years in operation**	
Bromley EL&P Co.	1899-1927	Bromley MB
Brompton & Kensington ES Co.	1889-1938	Central London Electricity Ltd
Charing Cross ES Co.	1891-1938	Central London Electricity Ltd
Chelsea ES Co.	1889-1938	Central London Electricity Ltd
Kensington & Knightsbridge EL Co.	1887-1938	Central London Electricity Ltd
St James & Pall Mall EL Co.	1889-1938	Central London Electricity Ltd
Westminster ES Corporation	1890-1938	Central London Electricity Ltd

Note: [1] ***The Engineer*** Vol.147, 1929, pp.174-175.

Much effort had been expended on schemes to reorganise electricity supply in London after 1918, but what was achieved? Power generation had been expanded and four large new stations had ben built, at Barking, Battersea, Fulham and Deptford West. The number of power stations in the London Area had been reduced from 53 in 1918 to 35 in 1938. Only a few changes, however, had been made in distribution (**Table 7**). According to W.A. Robson:

> *The position in regard to electricity supply and distribution within the metropolis is clearly unsatisfactory, and its defects are obvious to any competent engineer or administrator. The multitude of authorised undertakers remain in operation under separate management until 1971; the division of the territory between public and private is unscientific and undesirable; the London and Home Counties Joint Electricity*

> *Authority is a weak federal body, cumbersome in structure and feeble in function, unable to exercise effective control over the vital aspects of electricity distribution*.[80]

Demand for electricity, especially by industrial users, grew rapidly after 1936 with rearmament. New capacity was added at Barking B, the new Fulham station and elsewhere. During the war, however, the effects of bombardment, the dispersal of strategic industries, and curtailment of outdoor lighting contributed to a surplus of generating capacity. In 1942-43, for example, there were substantial transfers of power from the South East to the Midlands and South West.[81] Transfers to the latter region were facilitated by construction of a 132kv line from Watford to Gloucester and Ebbw Vale.

IV Nationalisation

After three decades of discussion the whole organisation of electricity was restructured following the Electricity Act 1947. From 1 April 1948, the London Electricity Board took over the assets of 41 local authorities and companies (**Figure 1**). The generating stations and transmission lines of the Central Electricity Board were transferred to the British Electricity Authority.

Electricity Distribution

The London Electricity Board was responsible for integrating all the undertakings. Systems had to be standardised and the multiplicity of tariffs reduced. For administrative purposes, the Board area was subdivided into seven sub-areas and 46 districts. **Figure 11** shows the geographical organisation in 1957 when there were 18 districts. One notable feature is the network of 71 service centres where customers could pay their bills and purchase appliances.[82] These service centres were an important and profitable part of the Board's business.

Repairing wartime damage was a high priority in the years after 1945. The effects of the war were reflected in the changed ranking of the London Electricity Board that fell from first in sales in 1938 to fourth in 1948/49. New housing was a major feature of construction after nationalisation. When building restrictions were removed, office development in the central area added 50 million square feet of space between 1954 and 1961.[83] Sales in the commercial sector rose from 950 million kWh in 1948/49 to 2,175m kW, with a proportional increase from 26.0 percent to 30.5 percent of total sales.[84]

London after the war faced many constraints on expansion. The green belt checked suburban development. Restrictions on industrial space, new planning legislation, and the creation of New Towns were all part of the design to decentralise people and work from the London area.[85] All these changes were reflected in the declining population of the London Electricity Board Area that fell from 6.0 million

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[80] W.A. Robson, ***The Government and Misgovernment of London*** (London: Allen & Unwin, 1939), pp.241-242.
[81] J. Hacking and J.D. Peattie, "The British grid in wartime", ***Journal of the Institute of Electrical Engineers***, Vol.94 (part II), 1947, p.469.
[82] ***Electricity Supply Handbook 1958*** (London: Electrical Times, 1958), pp.71-78.
[83] J.T. Coppock, "The growth of London and its related problems", Chapter 7 in J.A. Steers ed., ***Field studies in the British Isles*** (London: Nelson, 1964), p.103.
[84] On the early work of the London Electricity Board see: D.B. Irving, "The supply of electricity in the London Area", ***Proceedings of the Institution of Electrical Engineers***, Vol.102(6), 1955, pp.808-822.
[85] Many of these changes stemmed from Patrick Abercrombie, ***Greater London Plan 1944*** (London: HMSO, 1945). Detailed plans for inner London were shaped by J.H. Forshaw and Patrick Abercrombie, ***County of London Plan prepared for the London County Council*** (London: Macmillan, 1944).

in 1931 to 5.1 million in 1951 and 4.9 million in 1951. The number of consumers expanded from 1,525,000 to 1,760,000. Employees of the Board increased from 15,690 in March 1949 to 17,120 a decade later.

Figure 11 ***LONDON ELECTRICITY BOARD, 1957.***

Over the decade 1948/9 to 1948/9 total sales of electricity in the region grew from 3,655million kWh to 7,110m kWh. The number of consumers expanded from 1,525,000 to 1,760,000. Employees of the Board increased from 15,690 in March 1949 to 17,120 a decade later.

Electricity Generation and Transmission

The London Division of the British Electricity Authority covered the same area as the distribution board. It was an amalgamation of the 132kv and 66kv cable transmission system developed by the Central Electricity Board and the power stations owned by the companies and local authorities. The main tasks from 1948 were to integrate the various generating stations and their workforces, to modernise and standardise operations, and to expand capacity to meet the rapidly growing demand.

Table 8 ***CENTRAL ELECTRICITY GENERATING BOARD: POWER STATIONS IN THE LONDON DIVISION, 1948/49.***

POWER STATION	GENERATING CAPACITY kW	TYPE[1]
Barking A & B	522,250	S
Deptford East & West	367,000	S
Battersea A & B	345,000	S
Fulham	300,000	S
Acton Lane	157,895	S
Woolwich	102,500	S
Hackney	91,000	S
Bankside	89,000	S
Stepney	81,250	S
Grove Road	80,250	S
Taylor's Lane	76,500	S
West Ham	66,500	S
Bow	51,500	S
Lombard Road	50,000	S
St Pancras	49,066	S
St Marylebone	46,000	S
Poplar (2 Stations)	40,000	S
Wimbledon	25,200	S
Shoreditch	24,500	S
Islington	23,750	S
Wandsworth	22,000	S
Hammersmith	20,000	S
Walthamstow	19,500	S
Barnes	6,750	S
Southwark	6,000	S
Beckenham	4,750	S
Ilford	3,000	S
Short's Gardens	2,925	I
	2,674,686	

Note:[1] S – Steam; I--Internal combustion (diesel).
Source: Compiled from British Electricity Authority, ***Annual Report 1948-49***, Appendix 15.

Table 8 shows the 32 power stations in the new organisation. They ranged in size from large stations with over 250,000kW capacity to a few plants with less than 10,000kW. The Short's Gardens station in Central London was the only diesel-powered operation.

The London Division was the largest centre of electricity generation in Britain with 20.4 percent of national capacity. There had been substantial growth during the interwar period as London power stations made a major contribution to the larger metropolitan and, with the grid, to southeastern England.

As part of the plans for renewal and meeting the rising demand, final extensions were made to the Battersea, Fulham and Woolwich stations. Seven new power stations were commissioned between 1949 and 1954:[86]

[86] H.V. Pugh. "The generation of electricity in the London area", ***Proceedings of the Institution of Electrical Engineers*** Vol.102A, 1958, pp.484-502.

1949 West Ham B
1951 Blackwall Point
1952 Bankside B, Barking C, Brunswick Wharf
1954 Acton Lane B, Hackney B

Table 9 ***CENTRAL ELECTRICITY GENERATING BOARD; POWER STATIONS IN THE LONDON DIVISION 1958/59****.*

POWER STATION	GENERATING CAPACITY kW	TYPE[1]
Fulham	360,000	S
Brunswick Wharf	346,000	S
Barking B	303,500	S
Battersea B	266,000	S
Battersea A	245,700	S
Deptford East	235,000	S
Barking C	232,500	S, S(O)
Deptford West	222,000	S
Barking A	218,750	S
Woolwich	178,750	S
Acton Lane B	150,000	S
Bankside B	120,000	S, S(O)
West Ham B	120,000	S
Hackney B	96,000	S
Blackwall Point	94,500	S
Hackney A	91,000	S
Stepney	84,250	S
Grove Road	80,250	S
Taylor's Lane	75,500	S
West Ham A	64,000	S
Bow	51,500	S
Lombard Road	50,000	S
St Pancras	47,566	S
St Marylebone	38,600	S
Acton Lane A	30,000	S
Poplar Watts Grove	25,000	S
Shoreditch	24,500	S
Wimbledon	24,200	S
Islington	22,000	S
Wandsworth	22,000	S
Hammersmith	20,000	S
Walthamstow	19,500	S
Poplar (Glaucus St)	15,000	S
Short's Gardens	2,800	I
	3,976,466	

Note:[1] S – Steam; S(O)--steam, oil-fired; I--Internal combustion (diesel).
Source: Compiled from Central Electricity Generating Board, ***Annual Report 1958-9***, Appendix 1.

The building of a new station at Bankside, on a prominent site opposite St Paul's Cathedral, was particularly controversial in 1946-47, not only on grounds of amenity but also air pollution.[87] With the substitution of oil firing for coal, construction was approved and the station entered service in 1952. A further extension was completed in 1963.

Table 9 shows the situation in 1958/59 when 34 stations were operating. The seven stations completed after 1949 had added another 1,125,000kW to the London Division's generating capacity. Bankside A, closed in 1958, was the largest of the stations taken out of service in the decade. The site had been occupied by a power station since the early 1890s and after clearance was used for the eastern section of Bankside B.

Belvedere was the last big power station to be built in the London Area. Located on the Erith Marshes, the site had been acquired by the East Kent Power Co. in 1919. Consent was granted in 1954/55 and the first unit entered service in May 1959. When completed in 1962 Belvedere had a capacity of 480,000kW and like Bankside was oil-fired. The London Area reached its maximum capacity of 4,593,166kW in 1963/4 but within three years had been overtaken by the East Midlands and Yorkshire Divisions.

Although much effort had been expended on reorganizing electricity generation after 1919, London was still served by a large number of power stations. **Figure 12** shows the locations of the 34 generating stations operated by the London Division of the Central Electricity Generating Board on 31 March 1959. Twenty of these stations had been working in 1919 (compare with **Figure 7**). Many had been modernised and extended over the years and would remain in service for another decade, by which time the CEGB would have its new 2,000,000kW and some nuclear stations in operation. By 1959 London's electricity generation was dominated by the output of the larger and most efficient stations at Barking, Battersea, Deptford and Fulham. The map also shows the locations of the 31 generating stations that closed between 1921 and 1939.

Air pollution was a longstanding concern in the London Area. The ***Greater London Plan*** noted:

> *In spite of improved methods of combustion, this trouble is still in existence; a pall of smoke has at various times been observed hanging over the land in the neighbourhood of the large generating station on the Thames at Barking*.[88]

In the aftermath of the London smog disaster of December 1952, the Clean Air Act 1956 brought new measures of control over emissions from power station chimneys.[89] New stations were generally developed beyond urban areas and all were subject to inspections under the Alkali Act.

During its first decade of operation the London Division built seven new power stations and raised generating capacity from 2,109,602kW to 3,976,466. The transmission line capacity was increased to 263 route miles. Over the period the numbers employed rose from 8,632 to 9,020.

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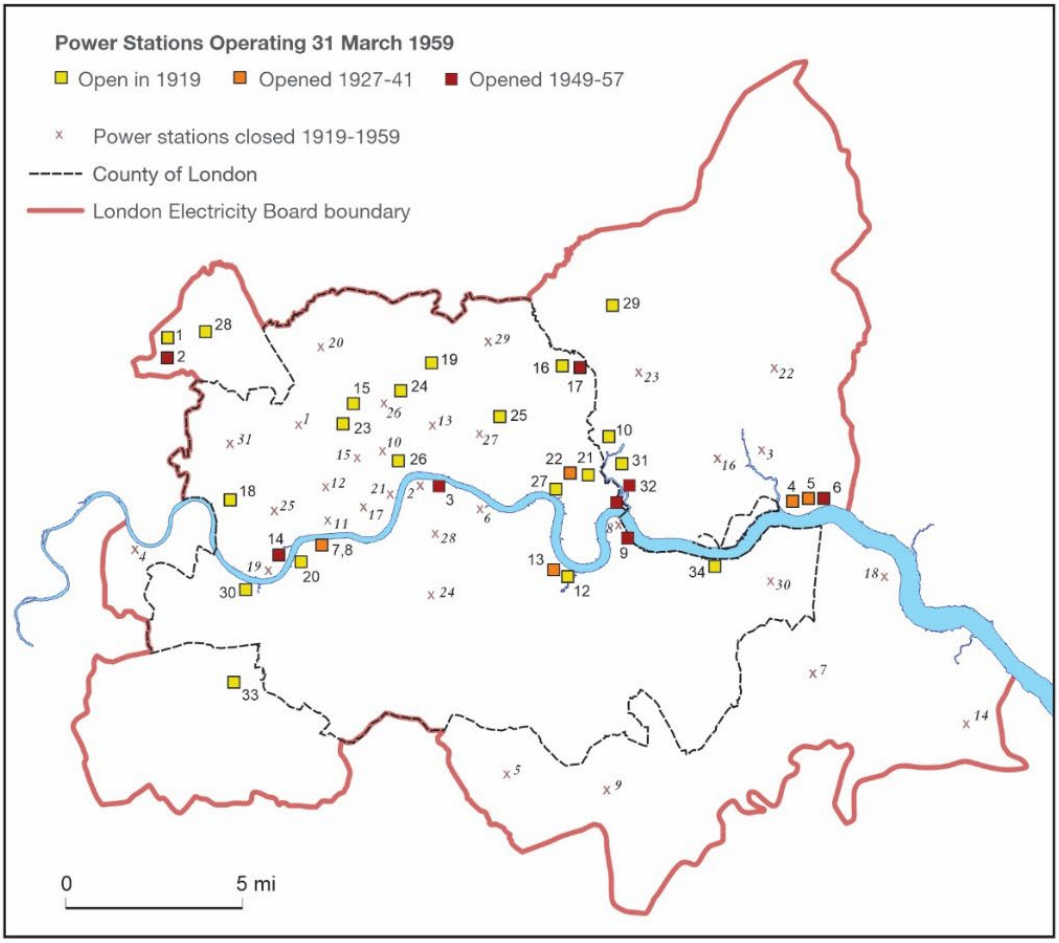
[87] John Sheail, ***Power in Trust: the environmental history of the Central Electricity Generating Board*** (Oxford: Clarendon Press, 1991), pp.38-44; S. Murray, "Electrifying the City: power and profit at the City of London Electric Lighting Co. Ltd", ***London Journal*** 43(1), 2018, pp.72-91.

[88] Patrick Abercrombie, ***Greater London Plan 1944***, p.122. The planners saw the smoke pall as a disfigurement, not a health hazard.

[89] Peter Thorsheim, ***Inventing pollution: coal, smoke and culture in Britain since 1800*** (Athens: Ohio University Press, 2006), pp.161-172; Peter Brimblecombe, ***The Big Smoke: a history of air pollution in London*** (London: Methuen, 1987).



A: Power stations operating 31 March 1959

1	Acton Lane A	13	Deptford West	25	Shoreditch
2	Acton Lane B	14	Fulham	26	Shorts Gardens
3	Bankside B	15	Grove Road	27	Stepney
4	Barking A	16	Hackney A	28	Taylor's Lane
5	Barking B	17	Hackney B	29	Walthamstow
6	Barking C	18	Hammersmith	30	Wandsworth
7	Battersea A	19	Islington	31	West Ham A
8	Battersea B	20	Lombard Road	32	West Ham B
9	Blackwall Point	21	Poplar Glaucus Street	33	Wimbledon
10	Bow	22	Poplar Watts Grove	34	Woolwich
11	Brunswick Wharf	23	St Marylebone		
12	Deptford East	24	St Pancras		

B: Power Stations closed 1919-1959

1	Amberley Road	1926	*12*	Cheval Place	1923	*23*	Leyton	1927
2	Bankside	1959	*13*	City Road	?	*24*	Loughborough Junction	1928
3	Barking Town	1927	*14*	Dartford	?	*25*	Richmond Road	1928
4	Barnes	1959	*15*	Davies Street	1921	*26*	St Pancras Stanhope St	1925
5	Beckenham	1959	*16*	East Ham	1931	*27*	Shoreditch Coronet St	?
6	Bermondsey	1930	*17*	Eccleston Place	1922	*28*	Southwark	1952
7	Bexley	1925	*18*	Erith	1927	*29*	Stoke Newington	?
8	Blackwall Point	1939?	*19*	Fulham	1936	*30*	Woolwich Plumstead	1920
9	Bromley	1931	*20*	Hampstead	1922	*31*	Wood Lane	1928
10	Carnaby Street	1923	*21*	Horseferry Road	1928			
11	Chelsea Flood Street	1928	*22*	Ilford	1952			

Figure 12 ***LONDON ELECTRICITY BOARD AREA POWER STATIONS 1919-1959.***

From January 1958, when the Central Electricity Generating Board took over from the Central Electricity Authority, there were changes in the administrative structure. A new South East Region was established incorporating the Eastern, London and South Eastern Divisions.[90] Under the new arrangements the regional director in London became responsible for the higher-order planning and administration of 75 power stations, 1,457 route miles of transmission lines and 15,872 employees. Design work on new power stations was transferred to the Southern Project Group working at the old Finchley generating station and transmission development was centralised at Guildford.

Summary

London, as the largest urban centre in Britain, was always different from the other regions, not only in size but in complexity. **Table 10** shows various indicators of growth from 1900. Company undertakings had taken the lead in establishing electricity systems in the late 1890s and remained dominant until nationalisation.

Table 10 ***Summary of Development in the London Electricity Board Area.***

YEAR	NUMBER OF UNDERTAKINGS[1]	LOCAL AUTHORITY UNDERTAKINGS	NUMBER OF POWER STATIONS	GENERATING CAPACITY (kw)	PER CAPITA CONSUMPTION (kWh)[2]
1900	30	13	43	..	.. (4)
1912	44	28	52	..	.. (36)
1925/6	46	29	46	945,582	172.1 (133)
1935/6	46	30	35	2,109,602	454.9 (374)
1948/9	..	..	32	2,674,686	709.7 (821)
1958/9	..	..	34	3,976,466	1,442.8 (1,765)

Notes:
[1] Excluding all non-statutory undertakings.
[2] Calculated from data in Electricity Council, ***Handbook of Electrical Supply Statistics 1977***, p.63 and census returns. Great Britain 1900-1948/9 from Leslie Hannah, ***Electricity Before Nationalisation: a study of the electricity supply industry in Britain to 1948*** (London: Macmillan, 1979), pp.427-8.

The 43 power stations working in 1900 reflected the extreme fragmentation which was to be the hallmark of London's electricity supply. Attempts at consolidation all ended in failure. State intervention from 1920 in the forms of the Joint Electricity Authority and then the South East England grid scheme brought rationalisation of generation but not distribution. Creating a standardised distribution system had to wait until nationalisation. The legacy of some early power stations was long-lasting. Some became transformer stations while the Deptford East site chosen by Ferranti in 1887 remained in service, with several phases of re-equipment, until October 1983.

A sense of the rapid growth of demand from the mid-1920s is illustrated by the two final columns in the table. Economies of scale were reflected in the increasing size of power stations. By the 1930s large generators of 75,000kW capacity were installed in new stations at Barking and Battersea. Despite rationalisation several small stations remained in service for another two decades.

[90] The headquarters was established in Ergon House, Horseferry Street, originally built for the London Power Co.

Per capita consumption in the London Area (with Great Britain in parentheses) was generally higher than the national average until World War II. The data for St Marylebone show the high levels that could be achieved in a prosperous section of the urban core. Dispersion of population and the revival of heavy industry in other regions contributed to London's lower than average consumption levels after 1945.

Electrification was a much slower process than the enthusiastic promoters of the 1880s expected. Much effort and expenditure were needed to create viable electricity undertakings in the larger urban centres. The point of viability was reached about 1900 but extending the benefits of electricity over wider areas took much longer and universal electricity was probably not achieved until the 1950s.

Note on Sources

For the period before state intervention, Garcke's ***Manual of Electricity Undertakings***, first published in 1896, is the indispensable source. This annual volume lists all municipal and company electricity and tramway systems in comprehensive detail. Technical information on the generating and distribution systems is noted for each undertaking, as well as statistics on sales, revenue and expenditure. There are also full details of personnel and company directors. Garcke also covers many of the non-statutory companies that were often significant in rural areas.

The contents of the ***Annual Reports*** of the Electricity Commissioners (1st, 1920-21 – 23rd, 1947-48) highlight the role of state intervention during this period and reflect the power of the Electricity (Supply) Act 1919. Under this legislation all power station and transmission line construction required consent of the Commissioners. Loans for local authority electricity undertakings, extensions of areas and transfers of ownership all required approval from London. Even the payment of subscriptions to associations such as the British Electrical Development Association and the Incorporated Municipal Electrical Association had to have the Commissioners' consent. The detailed supervision of expenditure also included the purchase of proceedings of conferences or meetings and the expenses of members and officers attending such meetings.

The ***Engineering and Financial Statistics***, also published by the Electricity Commissioners, were equally detailed. Local authorities and companies are separately listed with detailed tabulations of generating equipment, fuel consumption, output as well as sales (by type). Such data provide effective evidence on the scale and depth of electrification. The financial statistics cover revenue, expenditure and capital investment.

The Electricity Commissioners also published more specialised reports on plans for integrating local systems which formed the basis for the 132kv grid developed from 1927. All the publications of the Electricity Commissioners were issued under the authority of the Minister of Transport.[91] They were, however, Non-Parliamentary Publications of HMSO and consequently were not always acquired by libraries at the time.

The Annual Reports of the Central Electricity Board from 1929 to 1947 contain, especially in the earlier years, comprehensive details of the progress of constructing the transmission grid. CEB reports were privately published and are rare items in library collections.

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[91] See ***Annual Catalogues of British government publications 1920-1970*** (Bishop's Stortford: Chadwyck-Healey. 1974).

After nationalisation, details of the electricity supply industry become more accessible, although in some points less comprehensive. For the generating and transmission sector, the Annual Reports and Accounts of the British Electricity Authority (1948-1954), Central Electricity Authority (1955-57)[92] and the Central Electricity Generating Board (1958-1989) contain useful data. These reports were all published as House of Commons sessional papers until 1971-72. Thereafter they were no longer published by HMSO and became increasingly glossy in appearance and content. From 1964 many details, previously available in the Annual Reports were published in the CEGB ***Statistical Yearbook***. This was not published by HMSO and is comparatively rare.

The London Electricity Board annual reports and accounts were also published as House of Commons sessional papers until 1971-72. After this time the reports were no longer published by HMSO.

From 1958-59 the Electricity Council, created to provide more linkages and coordination beyond the national and regional bodies, also published annual reports and statistical compilations. The ***Handbook of Electricity Supply Statistics*** published at intervals between 1966 and 1989, includes helpful summaries. ***Electricity Supply in Great Britain: A Chronology***, also published in various editions, is especially useful for details of legislation and major events, especially technical changes from Michael Faraday's fundamental discoveries of 1831.

In the postwar period the ***Electricity Supply Handbook*** (published annually by the ***Electrical Times*** from 1947) is a very useful compendium of facts, figures and personnel in the industry. The detailed maps of the grid system are especially important. Like many annual reference works of its type, these volumes are quite scarce.

Notable studies of electricity in London include:

Stephen Andrew Murray, "Bankside power station: Planning, politics and pollution", PhD thesis, Centre for Urban History, University of Leicester, 2014. (Available online). See also: S. Murray, "Electrifying the City: power and profit at the City of London Electric Lighting Co. Ltd", ***London Journal*** 43(1), 2018, pp.72-91.

B.J. O'Neil, "The development of the electrical supply industry in North West Kent 1882-1914", ***The Local Historian*** 30(1), 2000, pp.23-38.

For context on the development of parts of the London Area, see: ***Victoria County History*** for ***Middlesex*** (Vols 8-12 which cover several London boroughs) and ***Essex*** (Vols.4-6). Volumes of the ***Survey of London*** (begun in 1894 but still incomplete) have detail on buildings including in Volume 49 a very detailed account of Battersea power station.

Maps of London provide valuable detail on the locations of power stations at various scales. The Six Inch map series of London c1913-14, Sheets A-T cover the urban area at a critical time of development. These maps are accessible online at the National Library of Scotland, Map Images website. Larger scale maps (reduced from the 25 Inch series) are most accessible through the reprints of Alan Godfrey Maps. See the online catalogue at www.alangodfreymaps.co.uk

[92] The change of title from British Electricity Authority resulted from the formation of the autonomous South of Scotland Electricity Board from 1 April 1955.

Most material of interest to historians of electricity supply may be found somewhere in the universe of London libraries and archives. The online catalogues are generally helpful in finding items of particular interest and in planning the next steps in any research.

The London Metropolitan Archives has collected the records of the former London Electricity Board and the predecessor undertakings. Detailed descriptions are available in the catalogue: LMA/4278/01 for undertakings 1882-1948; and LMA/4278/02 for the London Electricity Board 1948-1990.

The British Library holds a full set of ***Garcke's Manual of Electrical Undertakings*** (1896-1960). The map collection there includes all the Ordnance Survey series and many others such as the Goad Fire Insurance Plans.[93] Full sets of Parliamentary Papers are also available.

The National Archives in Kew has extensive holdings of national material for the former Ministry of Power. The POWE 11-15 groups include records of the Electricity Commissioners, consents for power stations and special orders. John Sheail made use of these and other national documents in his book ***Power in Trust*** (1991). The notes on pp.287-296 illustrate the range of documents consulted.

The Guildhall Library has a large collection of material on the history of London. Other special collections cover business history (including trade directories and the Stock Exchange Yearbook) and Parliamentary Papers.

Most London archival centres have acute storage problems and have to keep many items offsite. This has been the case with the Science Museum where the extensive library and archives (with much material on electricity)[94] have been moved to Wroughton, Swindon.

BARKING

Three stations at Barking with a total capacity of 754,750kW in 1959 represented the largest concentration of electricity generation in London. A site for a large power station at Barking had been a prominent part of several unsuccessful proposals for bulk supply in London between 1904 and 1915. Cheap land and deep-water access would facilitate low-cost generation. The first Barking station, built for the County of London Electric Supply Co., was opened by George V in 1925. Later B and C stations were completed in 1933-40 and 1952-55 respectively. The stations served much of South East England via the 132kv transmission grid shown on the map with 487-foot pylons.

Ordnance Survey 1:25,000 series, Sheet TQ48, 1959 (National Library of Scotland.

[93] The British Library, On Line Gallery: Fire Insurance Maps and Plans offers a selection of Goad plans prepared between the 1889s and later 1920s. These were published at the scale of 1:480 (40 feet to the Inch). The London sheets in this selection are very early for electricity but Vol.IX, sheet 209, March 1889 shows the new power station of the St James & Pall Mall ES Co. in Mason's Yard, and Vol.K, sheet K10 illustrates the details of Electric Avenue, Brixton.

[94] The Science Museum published many items of electricity interest such as: D.G. Tucker, ***How towns got electric light and tramways: A case study of Gloucestershire and neighbouring towns*** (London: Science Museum, 1978). Brian Bowers, a Senior Curator at the Museum from 1967, published many studies including ***A History of Electric Light and Power*** (Stevenage: Peter Peregrinus in association with the Science Museum, 1982).

Appendix

Defining London

Most of the discussion in this chapter has focused on the London Electricity Board Area defined in 1947 as part of the reorganisation of the British electricity supply industry under state ownership. The LEB Area was, however, only part of the larger metropolis which from 1925 had been an integral section of the London and Home Counties Joint Electricity Authority. Other parts of the metropolis were allocated in 1947 to the newly constituted Eastern, Southern and South Eastern Electricity Boards. One consequence of this division was that the administrative headquarters of each of these boards would be located away from London—near Ipswich, near Maidenhead, and in Hove.

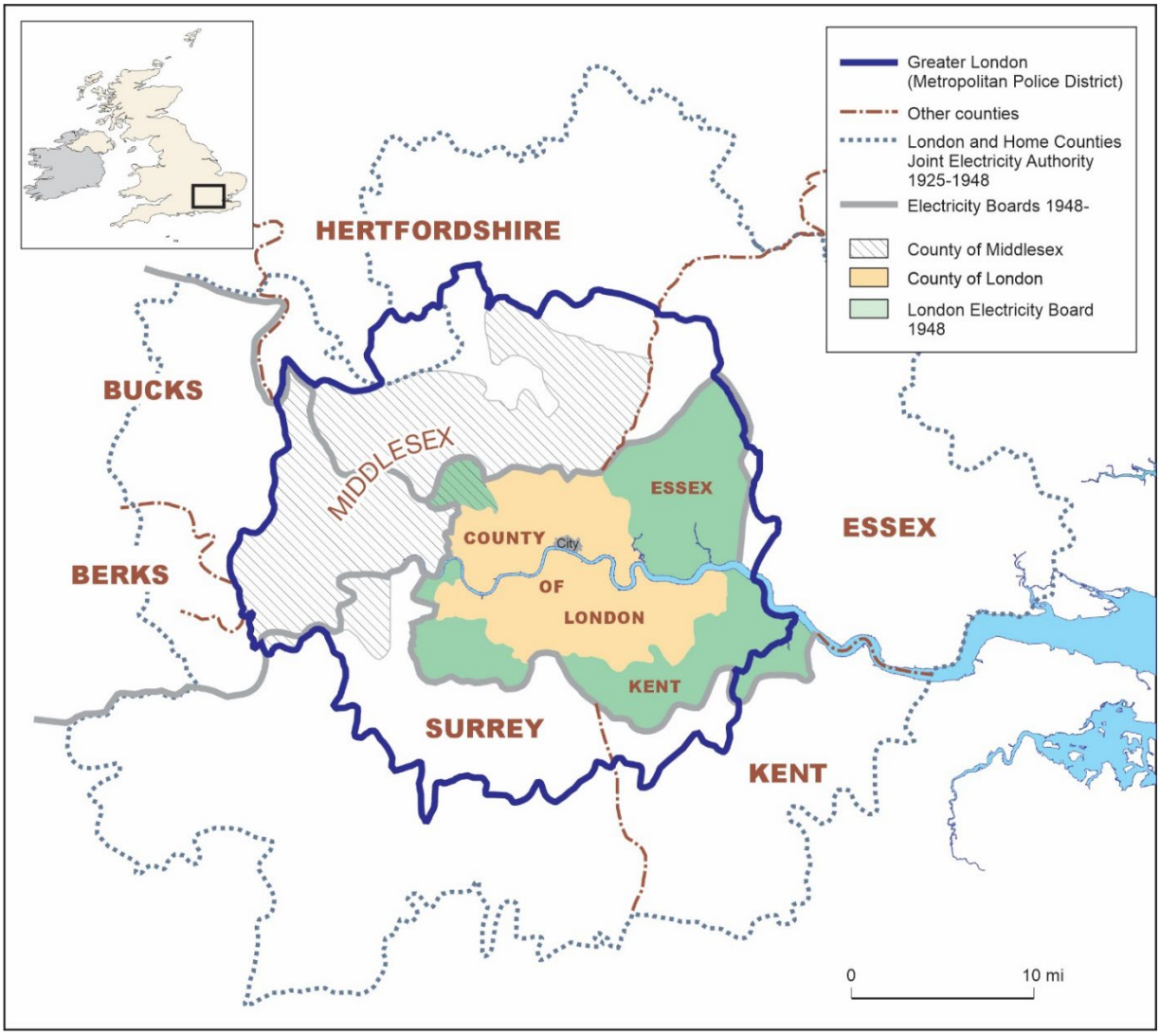

*Figure A: **Defining London 1939.***

Figure A shows the major boundaries of "London" from the 1880s to the 1960s. At the core was the County of London, first defined in 1855 and established as a county in 1888. Even by this time it was clear that there was already a substantial population living in areas beyond the county boundary. A larger urban region, Greater London, was defined using the Metropolitan Police District as the outer boundary. This Outer Ring beyond the County of London was a particularly dynamic area of growth. In 1881 this area accommodated about 20 percent of the total population, 40 percent in 1921, and 60 percent in 1961.

The Electric Lighting Act 1882, in laying the foundations of franchise areas through the grant of Electric Lighting Orders, used the framework of local government areas. In the County of London these areas were Parishes with Vestries and Board of Works Districts; elsewhere the areas were the recently established Urban Sanitary Districts and Rural Sanitary Districts.[1] Although the connections between electricity supply and local government ended with nationalisation in 1948, some features of old boundaries have remained. One example was in the London Borough of Kingston upon Thames (formed in 1965) where electricity supply was divided between the London and South Eastern Electricity Boards. The explanation of this division lies in the decision by the Malden & Coombe Urban District Council to become part of the Wimbledon Corporation's supply area in 1911 and consequently become part of the London Board in 1947.

1. **The City of London**, unlike most ancient cities, remained within its medieval boundaries, resisting all attempts to extend its limits.[2] Its population of 129,100 in 1801 declined decade by decade to 52,000 in 1881 and only 8,720 in 1939, Despite its small size the City was a centre of wealth and power. Some of its wealth was used for the benefit of the metropolis, as with the purchase of Epping Forest (5,560 acres) for use as a park. The City Livery Companies through the formation of the City and Guilds College in the late 1870s played a major role in developing early training in electrical engineering.

The City Corporation supported the Edison Company's lighting of Holborn Viaduct in the early 1880s and granted a concession for the lighting of Smithfield Market.[3] With a very high concentration of commercial property the City was a prized market for electricity. The City of London Electric Lighting Co. shared the area with the Charing Cross and Strand Co. (later Central Electric). Fleet Street, the centre of newspaper printing and publishing, was a significant part of the City market for electric power. As a world centre of finance, the City provided capital for the electricity industry in Britain and overseas. The Public Works Loan Board, always located in the City, assisted many local authority electricity schemes with low-interest loans.

2. **The County of London**, only named as such from 1888, had evolved in the second half of the nineteenth century as an attempt to create more effective administration for public services in a rapidly growing area. Earlier state intervention affecting London had established a Metropolitan Police force

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[1] Public Health Act 1872. These areas became Urban and Rural Districts after the Local Government Act 1894. Kingston upon Thames was the only municipal borough in the region until Croydon and West Ham were granted charters later in the nineteenth century.

[2] See: W.A. Robson, ***The Government and Misgovernment of London*** (London: Allen & Unwin, 1939). This volume is an invaluable guide to all the complex features of London local government.

[3] "The electric lighting of Smithfield market", ***The Engineer*** Vol.74, 1892, pp.431-433. The concession ended in 1932 and the powerhouse in Charterhouse Street was closed.

(1829) and 50 Poor Law Unions (1835-) from groupings of parishes.[4] These areas also served as districts for the registration of births, marriages and deaths (1837). Through its work in publishing statistics of mortality and the conduct of the census, the General Register Office had an important though largely unrecognized role[5] in defining London.

Major outbreaks of cholera prompted the passing of the Public Health Act of 1848. Implementation was difficult in London where a jumble of parishes and ad hoc authorities stood in the way. St Pancras parish, for example, had 21 distinct and independent bodies responsible for paving, cleaning and lighting the streets.[6] The Metropolis Management Act 1855 created a new organisation, the Metropolitan Board of Works, covering a wide area that later became the County of London and remained unchanged until 1965. The 99 parishes within the area were reorganised as 23 Vestries and 15 Board of Works Districts.

Within a decade the Metropolitan Board of Works had built a trunk sewer network and pumping stations and outfall works at Beckton and Crossness. Other lasting works included the Thames embankments, supervision of the London Building Acts and the formation of the London Fire Brigade. The vestries and other miscellaneous ad hoc bodies survived until 1899 when they were replaced by 28 Metropolitan Boroughs. The City of London remained intact through all these changes.

Other legislation affecting London such as the Education Act 1870 (which established the London School Board) and the Tramways Act 1870 adopted the same area as the Metropolitan Board of Works. In the Tramways Act the Metropolitan Board of Works would become the residual owner when the 21-year tramway franchises expired. The Electric Lighting Act 1882, however, failed to recognize any role for the Board of Works and left local vestries and districts as the relevant local authorities. Fragmentation of electricity supply quickly followed from the results of the Marindin inquiry of 1889.

The London County Council that was taking over from the Metropolitan Board of Works at the time of the inquiry had little influence on the development of electricity in London. Various attempts to establish a regional bulk supply system were made by the County Council between 1906 and 1915. In 1908 the County Council became the residual owner when the private company 42-year franchises were due to expire in 1931.[7] As part of the negotiations around the formation of the London & Home Counties Joint Electricity Authority, the County Council allowed a further extension of these powers to 1971.

Public electricity supply was quickly established in central London. Ten companies and St Pancras Vestry were all in operation by 1891 and over the next decade most of the County of London was covered by Electric Lighting Orders. In 1912 there were 15 Metropolitan Boroughs and 13 companies providing electricity supply in the County. Bethnal Green that began service in 1916 was the last new electricity

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[4] Peter Higginbotham, ***The Workhouse Encyclopedia*** (Stroud: The History Press, 2012).

[5] Interdepartmental Committee on Social and Economic Research, ***Guide to Official Sources No.2, Census Reports of Great Britain 1801-1931*** (London: HMSO, 1951), pp.100-101. For other details of the work of the Registrar-General in defining London from the 1830s, see: T.W. Freeman, ***The Conurbations of Great Britain*** (Manchester: Manchester University Press, 1959), pp.16-18; and T.W. Freeman, ***Geography and Regional Administration: England and Wales 1830-1968*** (London: Hutchinson, 1968), Chapter 6: "The special problem of London".

[6] Robson (1939), p.22.

[7] H.H. Ballin, ***The organisation of electricity supply in Great Britain*** (London: Electrical Press, 1946), p.84.

undertaking to be established in the County of London. By 1939, after some amalgamations in the centre, the number of undertakings had been reduced slightly to 24.

The formation in 1888 of the County Councils of Essex, Hertfordshire, Kent, Middlesex and Surrey, as well as the independent County Boroughs of Croydon and West Ham effectively contained any expansion of the administrative County of London. Except for the transfer of Penge to Kent in 1900, there were no significant boundary changes between 1888 and 1965.

3. **The Outer Ring** was a large territory between the County of London and the boundary of Greater London. Usage of the term Greater London began in the 1870s when the Registrar-General noted that the functional area of London extended well beyond the Metropolitan Board of Works.[8] Greater London, defined by the 1840 boundary of the Metropolitan Police District, was however primarily a statistical concept.

One of the striking features of the Outer Ring was the rapid growth of population, rising from 0.9 million in 1881 to 2.7 million in 1911 and 4.7 million in 1939 (**Table A**). Over this period the number of urban local authorities increased from 47 in 1888 to 65 in 1939.[9]

Table A: ***London Population 1881-1961****.*

Year	*County of London*[1]	*Outer Ring*	*Greater London*[2]
1881	3,830,297	936,364	4,766,661
1891	4,227,954	1,405,852	5,633,806
1901	4,536,367	2,045,135	6,581,402
1911	4,521,685	2,729,673	7,251,358
1921	4,484,523	3,003,889	7,488,352
1931	4,397,003	3,818,670	8,215,673
1939[3]	4,013,400	4,714,600	8,728,003
1951	3,347,982	5,000,041	8,348,023[4]
1961	3,195,114	4,976,788	8,171,902[4]

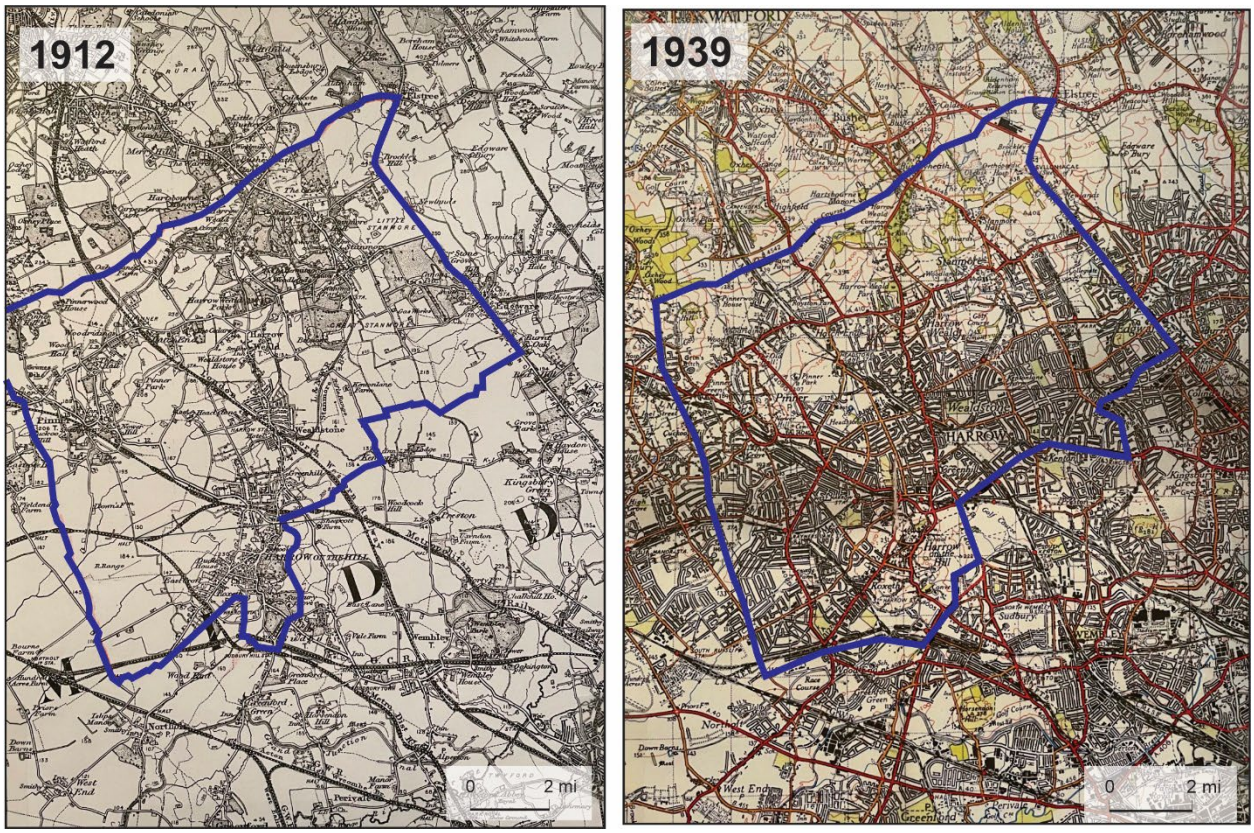
Notes:
[1] Includes the City of London.
[2] Defined by Metropolitan Police District 1840. Boundaries modified slightly in 1946.
[3] Mid-year estimates.
[4] Greater London also defined as the London Conurbation in 1951 and 1961.
Source: Compiled from Table H, p.10, General Register Office, ***Census 1961, England and Wales Preliminary Report*** (London: HMSO, 1961).

Harrow was one of the areas transformed by suburban expansion.[10] In 1881 the population of the district later the Borough of Harrow was around 20,000 with the largest concentration (5,558) in the Harrow-on-the-Hill Urban Sanitary District. The 1921 census recorded a total of 49,090—19,628 in Harrow UD, 13,520 in Wealdstone UD and 15,942 in Hendon RD (which included Pinner and Stanmore).

[8] The Post Office had recognised the discrepancy as early as 1857 when the London Postal Districts and the compass-point subdistricts were defined. See: Peter Barber, ***London: A History in Maps*** (London: London Topographical Society/British Library, 2012), pp.222-223.
[9] Freeman (1959) has a very effective series of maps showing the evolution of local government in the Outer Ring from 1888 to 1955.
[10] A.A. Jackson, ***Semi-detached London: Suburban development, life and transport 1900-1939*** (London: George Allen & Unwin, 1973), p.117.

These three areas were amalgamated in the mid-1930s and by 1939 the population had increased nearly fourfold to 190,200.

Figure B shows the transformation of Harrow from two small Urban Districts (Harrow-on-the Hill and Wealdstone) and four parishes (Pinner, Harrow Weald, Great Stanmore and Little Stanmore) into the unified Urban District of 1939. The extension of London underground electric railways provided the infrastructure for development. Harrow and the Uxbridge branch were served by the Metropolitan Railway electrified line from Baker Street in 1905. Building the Harrow Garden Village (one of the Metropolitan Railway Country Estates properties) from 1929 created a new suburban node around Rayner's Lane station, originally a minor country halt. A new road, Imperial Drive/Alexandra Avenue (A4090) was soon lined with parades of shops and reinforced by an Odeon cinema (1936) and a new Underground station (1938).



Source: i. Ordinance Survey. One Inch Series, Sheet 256 (1913); ii. Ordinance Survey. New Popular Edition, Sheet 160 (1945)

Figure B: ***Growth of Harrow.***

Public electricity supply in the Outer Ring began during 1893 in Kingston on Thames and Richmond, closely followed by Ealing in 1894. By 1912 a mixture of 19 local authorities and 18 companies were supplying electricity to places in the outer zone. Virtually all parts of the Outer Ring had access to electricity supply by the mid-1920s. While fragmentation of supply areas was less of an issue than in central London, some districts could be awkwardly divided as in the case of Harrow. Electricity supply by a small local company had begun in Harrow-on-the-Hill Urban District in 1896. Electrification beyond the town came later and by different companies: Pinner parish (1914) by the Colne Valley Electric Supply Co., Wealdstone UD (1915) by the large Northmet Co. After the war the remaining parishes of Hendon

Rural District (Harrow Weald, Great Stanmore and Little Stanmore) were developed by the Northmet Co.[11] When all the areas were united in the enlarged Harrow UD, the Pinner district remained part of a different electricity system.

Some consolidation of electricity undertakings took place. By the late 1930s the Northmet Company, following the acquisition of the Harrow and Hendon companies, controlled the whole of North Middlesex except for the municipal enclaves of Finchley and Hendon. In Surrey the London & Home Counties Joint Electricity Authority had created an extensive distribution area after purchasing several local companies.

The London & Home Counties Joint Electricity Authority was one of several administrative bodies created after World War I in an attempt to control services that extended well beyond the existing limits of the County of London. First defined by the Electricity Commissioners in mid-1920[12], the wide boundaries of the London & Home Counties Electricity District were also followed (with the addition of Watford) by the London & Home Counties Traffic Advisory Committee. Set up by the London Traffic Act 1924, the committee had an important role in planning major roads. The Metropolitan Traffic Area (for licensing public service vehicles) created by the Road Traffic Act 1930 took in an even larger area from Luton to Horsham and Chipping Wycombe to Tilbury.[13] A similar large area became the zone for the extended operations of the London Passenger Transport Board in 1933.[14]

The uncontrolled expansion of London came to an abrupt end in 1939-40. Most new building was halted when the war began and the Blitz brought massive destruction that hastened the population exodus from the County of London. Some constraints were already beginning before the war. In 1935 the London County Council decided to establish, as far as it could, a green belt around London. A fund of £2 million offered grants to county councils to acquire or sterilise land against development. The offer was open for three years and by July 1928 some 68,000 acres (100 square miles) had been acquired or preserved.[15] Further extensions were made after the war, effectively containing extension of the built-up area of 1939.

National concerns about the contrasts between prosperous London and adjacent areas and the declining industrial regions of northern and western Britain resulted in the Royal Commission on the Distribution of the Industrial Population (1937-1940). Its report was followed by a detailed study of the London that reported in 1944.[16] Postwar planning legislation, restrictions on industrial development and the building of New Towns were all aimed at constraining the growth of London.[17] The results are reflected in the declining population of Greater London after 1951.

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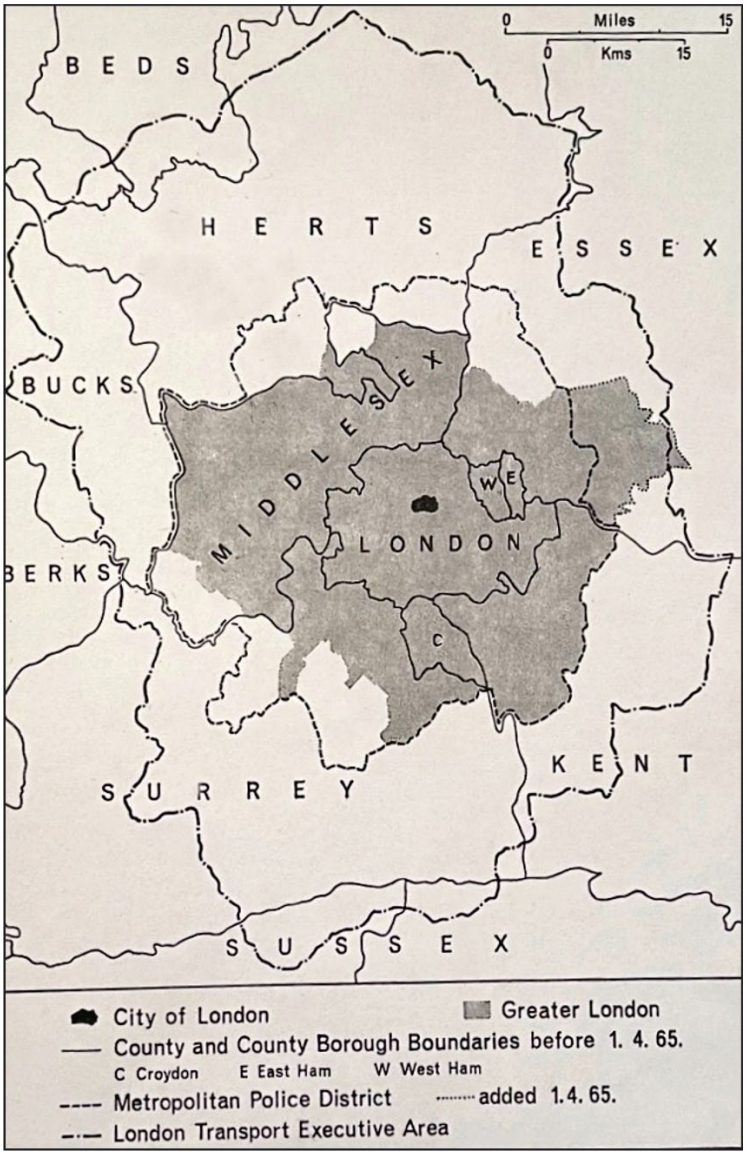
[11] N.C. Friswell, ***Northmet*** (Horsham, 2000), pp.115-117.
[12] Electricity Commissioners, ***First Annual Report 1920-21*** (London: HMSO, 1921), Appendix C, p.84
[13] Geoffrey Jones, ***75 Years of the Traffic Commissioners: a lawyer's personal view*** (Stourbridge: Roads and Road Transport History Association, 2006).
[14] The London Transport Executive, the nationalised successor to the London Passenger Transport Board, still covered the same area in 1965. (See Figure II)
[15] Robson (1939), pp.184-185.
[16] Patrick Abercrombie, ***Greater London Plan*** (London: HMSO, 1945).
[17] See Donald L. Foley, ***Controlling London's Growth: Planning the Great Wen, 1940-1960*** (Berkeley: University of California Press, 1963).

London Redefined

Following the inquiry of a Royal Commission 1957-1960, the London Government Act 1963 made sweeping changes to the local government of Greater London. The old counties of London and Middlesex were abolished and the boundaries of Essex, Kent and Surrey were redrawn (**Figure C**). A new Greater London Council took office on 1 April 1965 with 32 London Boroughs replacing 81 local authorities.[18] The City of London and Harrow Municipal Borough remained unchanged.



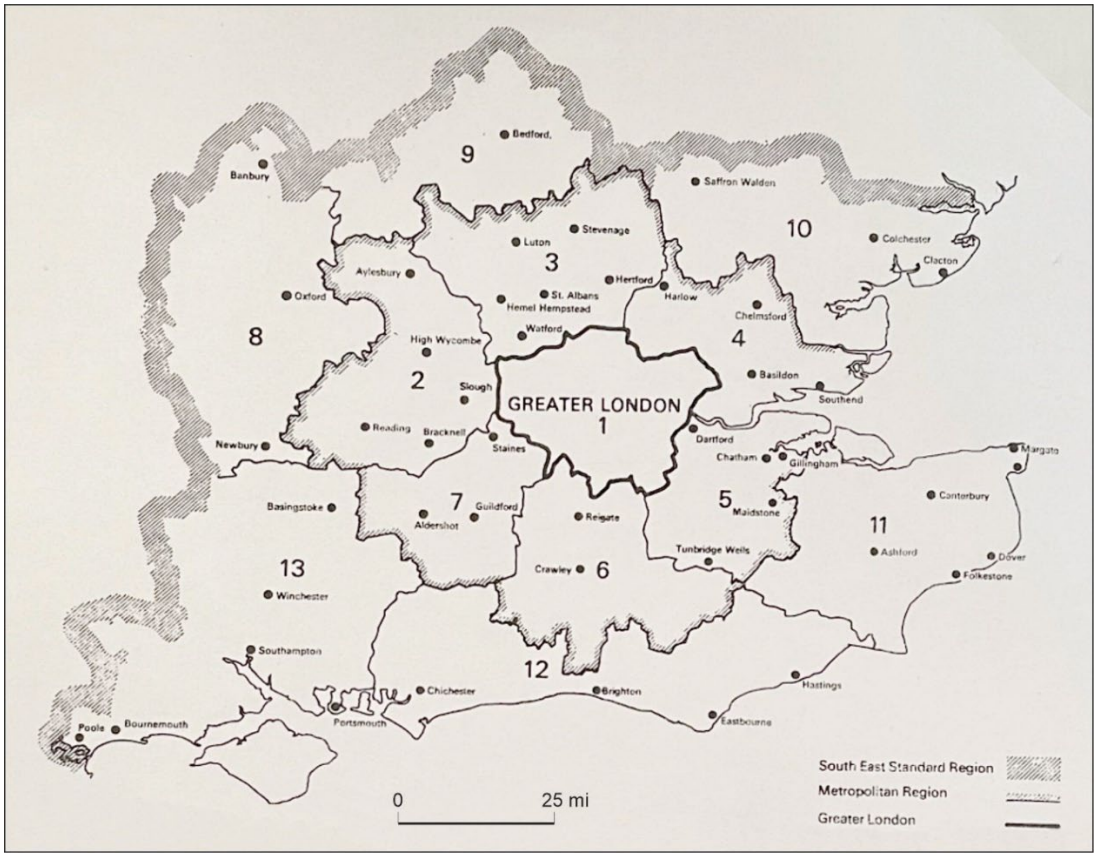
Source: *Gerald Rhodes, The Government of London: The struggle for reform (1970), p.261.*

Figure C: ***Greater London County, 1970.***

[18] Gerald Rhodes, ***The Government of London: The struggle for reform*** (Toronto: University of Toronto Press, 1970). Covers the background to the passing of the London Government Act 1963.

The new area of the Greater London County Council added areas in Essex previously outside the limits of Greater London. At the same time several areas originally part of the review were removed. These included: Cheshunt UD and Elstree RD in Hertfordshire; Potters Bar in Middlesex; Waltham Holy Cross in Essex; Banstead UD, Caterham & Warlingham UD, Epsom & Ewell MB, Esher UD, Walton & Weybridge UD in Surrey; Staines UD and Sunbury-on-Thames UD in south Middlesex.

While the Greater London County covered most of the built-up area of London, the larger functional and commuter zone of the metropolis had continued to expand outwards. A renewed interest in strategic planning brought changes in the national statistical areas.[19] In 1965 a revised Standard Region for the South East was defined along with a new concept, the Metropolitan Region (**Figure D**). This area brought in Reading, Luton, Southend, the Medway towns, parts of Sussex and Aldershot. The Outer Metropolitan Area included 128 local authorities ranging in size from Southend-on-Sea County Borough (162,000) to Baldock Urban District (6,300).[20]



Source: *South East Economic Planning Council, A Strategy for the South East (London: HMSO, 1967), pxii.*

Figure D: ***London Metropolitan Region 1965-1974****.*

[19] Ministry of Housing and Local Government, ***The South East Study, 1961-1981*** (London: HMSO, 1964); South East Economic Planning Council, ***A Strategy for the South East*** (London: HMSO, 1967). These reports show the evolution of the Metropolitan Area concept and the final boundary.

[20] Office of Population Census and Surveys, ***Census 1971, England and Wales, Preliminary Report*** (London: HMSO, 1971). Appendix C listed all the local authorities.

Table B: ***London Metropolitan Area Population (000).***

Year	*Greater London County*	*Outer Metropolitan Area*	*Total*
1931	8,110	2,599	10,709
1951	8,197	3,457	11,654
1961	7,992	4,456	12,448
1971	7,379	5,290	12,669

Note: Boundaries as of 1971. The boundaries of the Outer Metropolitan Area were altered after the 1974 reorganisation of local government in England. In the 1981 Census, the Henley, Oxfordshire area and part of East Sussex were no longer included.

Source: Compiled from ***Census 1971 Preliminary Report***; 1931 details compiled from ***Census 1951 Preliminary Report***.

Population growth from 2.6 million in 1931 to 5.3 million in 1971 illustrated the new dynamism of the Outer Metropolitan Area (**Table B**). The eight New Towns established after 1946 had grown by some 338,700 residents between 1951 and 1971. Mobility in the region had been increased by the rise in car ownership. Private car registrations in the South East Region had increased from 789,000 in 1950 to 3,246,000 in 1963 and 4,336,000 in 1971.

The relationships between London and the peripheral Outer Metropolitan Area had old roots in food supply and paper making. Railway development from the 1830s enhanced all the connections and facilitated decentralisation from the congested urban core. Aldershot (population 20,155 in 1881) had grown with military barracks and training facilities once concentrated in Woolwich. The building of Tilbury docks in the 1880s extended the port area into the Thames estuary. Public schools, institutions, hospitals and factories moved out of London to take advantage of cheap land and fresh air. Southend-on-Sea expanded from 8,000 population in 1881 to 72,000 in 1911 as the town developed as a resort and place for commuting to London. Longer-distance commuting in the region grew rapidly with the later electrification of railways.

Innovations were often pioneered in this outer zone of the metropolis, notably in aviation and motor vehicles. State interest in military aviation developed from the building of the HM Balloon Factory at Farnborough in 1905.[21] The first airship was launched two years later, and aircraft design was added by 1910. Aircraft manufacturing became a major industry in World War I with a proliferation of factories and airfields. As the Royal Aircraft Establishment devoted to research and development, Farnborough was a key point in the further growth of the British aerospace industry.

Events such as an early display of motor vehicles drawing a crowd of 10,000 spectators to Tunbridge Wells in October 1895 helped to promote motoring, abolish restrictions on road use and create a new industry.[22] Motor racing which began at the specially built racetrack at Brooklands (Weybridge) in 1907 gave additional publicity. By 1912 there were substantial motor vehicle manufacturing firms in Guildford (Dennis), Luton (Vauxhall, Commer), Letchworth (Lacre, Phoenix) and Maidstone (Tilling-Stevens). Vauxhall, under General Motors ownership, raised output of cars and trucks from 1,513 in 1926 to

[21] Percy B. Walker, ***Early Aviation at Farnborough: balloons, kites and airships*** (London: Macdonald. 1971). The use of balloons for aerial observation had begun by the Royal Engineers, first at Woolwich in 1878 and moved to Chatham in 1882. A factory at Aldershot was opened in 1892. Plans to build an airship needed a larger shed, hence the further move to Farnborough.

[22] Maurice A. Hammond, ***Motorcade: a dictionary of motoring history*** (London: G. Bell & Sons, 1969), p.7.

50,704 in 1936.[23] This was achieved by the introduction of the powered assembly line and new marketing methods. Mass production became a feature of the new factories on the Slough Trading Estate from the 1920s and also at the East Tilbury works of Bata Shoes. All these new industries were major users of electric power.

Electrification in the Outer Metropolitan Area began early with the experimental system in Godalming (1991-1884). A permanent system was opened in Chatham-Rochester in 1887; Reading followed in 1889 and Chelmsford and Woking in 1890. By 1912 most towns in the region had a local system. Some integration with Greater London had developed by the mid-1920s. The Metropolitan Electric Supply Co. was providing a bulk supply to the Egham & Staines and Slough & Datchet companies from its Willesden power station. Barking station of the County of London company was supporting the undertakings at Brentwood and Grays-Thurrock with bulk supply. In the north the Northmet company was supplying much of the demand in Hertfordshire from its Brimsdown generating plant.

Table C ***London Metropolitan Area Generating Capacity.***

Year	*Greater London County*		*Outer Metropolitan Area*		*Total*	
	Capacity kW	*# Power Stations*	*Capacity kW*	*# Power Stations*	*Capacity kW*	*# Power Stations*
1935/36	2,220,527	44	160,107	27	2,380,634	71
1948/49	3,063,550	40	418,517	24	3,482,067	64
1958/59	4,687,236	42	1,233,175	17	5,920,411	59
1968/69	4,668,870	26	3,483,766	12	8,152,636	38
1978/79	2,531,700	12	6,416,266	9	8,767,966	21
1988/89	385,000	2	9,905,000	7	10,290,000	9

Sources: Compiled from Electricity Commissioners, ***Engineering and Financial Statistics***; British Electricity Authority, ***Annual Reports***; Central Electricity Generating Board, ***Annual Reports*** and ***Statistical Yearbook***.

Table C shows the growth of generating capacity in the London Metropolitan area from 1935/36 to the late 1980s and illustrates the shift away from Greater London to the Outer Metropolitan Area. Regional integration was just starting after the beginning of trading in the South East England grid scheme on 1 January 1934. Most of the power stations were now connected to the transmission grid by 132kv or lower-voltage lines. By 1935/36 Luton and Southend were taking all their electricity supply from the grid. Other places like Maidstone and Reading were in transition. Guildford and Watford at this time still remained independent from grid supply.

Expansion of generating capacity in the Outer Metropolitan Area began during the war with the opening of two 120,000kW stations at Littlebrook (Dartford, 1940) and Earley (Reading, 1942-45). Further extension of capacity in the 1950s included four new stations at Rye House (near Hertford), Littlebrook B and C, and Tilbury A. All these stations used 30,000kW or 60,000kW turbo-generators.

[23] Alfred P. Sloan, ***My years with General Motors*** (London: Pan Books, 1967), p.471.

In the next phase of expansion the power stations were developed around substantially larger turbo-generators designed for higher steam pressures and greater thermal efficiency.

Power station	***Years under construction***	***Generating sets (kW)***
Northfleet	1960-63	120,000
West Thurrock	1962-69	200,000/300,000
Tilbury B	1968-72	300,000
Kingsnorth	1970-72	500,000
Grain	1979-85	689,000
Littlebrook D	1983-85	705,000

The last two stations and Northfleet were oil-fired. All these stations on the Thames and Medway estuaries took advantage of low-cost land, cooling water and easy access to water-borne coal supplies. In the mid-1980s the Central Electricity Generating Board commissioned three bulk carriers of 19,000 tons to deliver coal to these stations.

The building of these large stations was part of the plan to move to a nationally integrated system formulated by the Central Electricity Generating Board around 1960 and basically completed by the early 1970s. All the power stations were connected to the Supergrid transmission system operating at 275kv and 400kv. The power line corridors developed across the region were accompanied by the building of large substations at Sundon (Luton), Wymondley (Hitchin), Fleet (Aldershot) and, closer to London, at Elstree, West Weybridge and Northfleet. Large batteries of transformers reduced the voltage from 400kv to lower levels for local distribution.

As the Outer Metropolitan Area gradually dominated generating capacity in the larger region, other energy supplies were being developed. By 1970 three oil refineries at Shellhaven, Coryton and Isle of Grain had a total capacity of 27 million tons and represented about a quarter of British refining capacity. As well as the two refineries, Canvey Island included the liquid natural gas terminal. From 1964, when the terminal and pipeline system was completed, the gas industry began converting from coal to natural gas, first with imports from the Sahara and then, beginning in 1967, from the North Sea.[24] These developments on the Thames Estuary were part of the long energy transition from coal to oil and natural gas.

When electricity was nationalised in 1948 the British Electricity Authority organised generation and transmission into Divisions based on the same areas as the distribution boards. The awkward relationships of these Divisions with Greater London were recognised by the new Central Electricity Generating Board a decade later. A South Eastern Region replaced the three Divisions and was responsible for much of the large-scale planning and construction that changed the landscape in many parts of the Outer Metropolitan Area. The South Eastern Region was very similar to the pre-war South East England grid scheme area developed by the Central Electricity Board.

[24] Central Office of Information, ***Britain 1971: An Official Handbook*** (London: HMSO, 1971) included a section on Fuel and Power, pp.254-268.