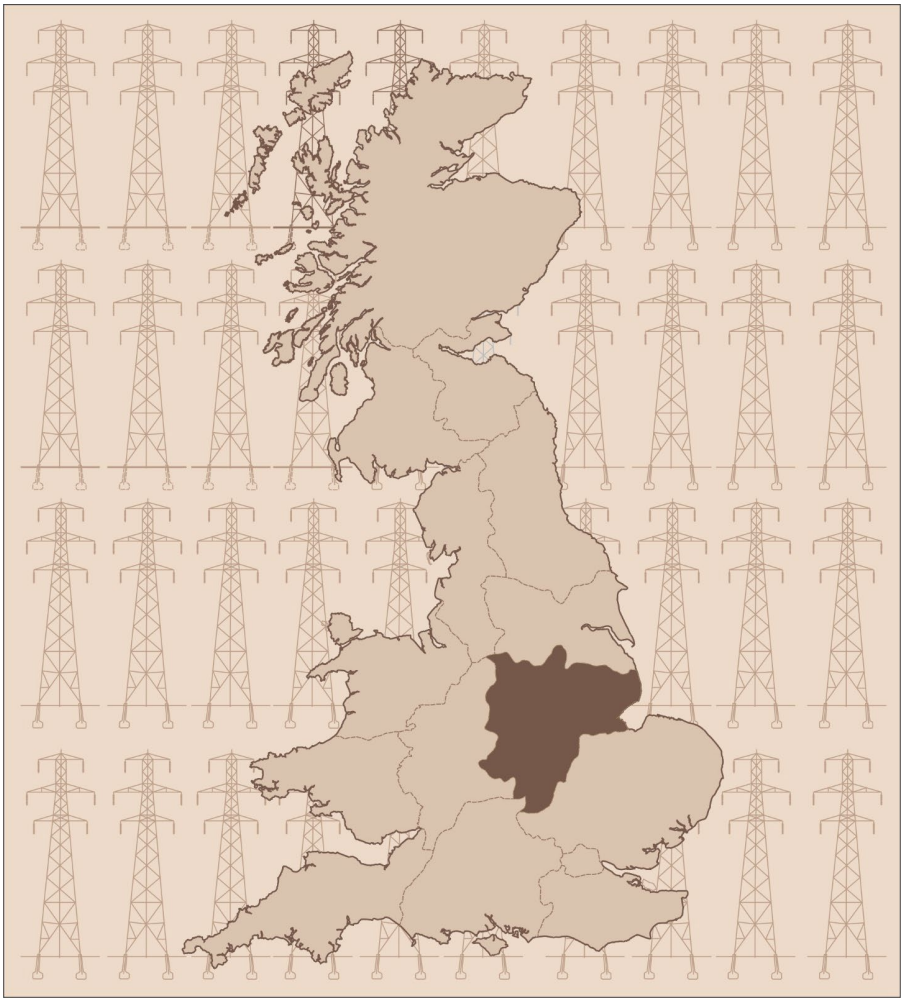

THE EAST MIDLANDS ELECTRICITY BOARD AREA

Regional and Local Electricity Systems in Britain

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Contents

BUCKINGHAM

Despite its small population (about 3,200) Buckingham had an electricity supply as early as 1889. The non-statutory company operated a power station on West Street with a capacity of 80kW DC in 1909. Gas engines provided the motive power. Buckingham became part of the Northampton Electric Light & Power Company's service area in late 1928 and AC supply reached the town soon afterwards.

Ordnance Survey, Six Inch Map Series, Buckinghamshire, XIII, 1920 (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 that 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 the East Midlands Area.

The East Midlands 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.

Each area board was defined to provide a diversity of load between urban and rural areas and, where possible, avoided cutting across distribution networks. In detail the East Midlands Area included Leicestershire, Northamptonshire, Rutland, and parts of Bedfordshire, Buckinghamshire, Derbyshire, Lincolnshire, Nottinghamshire, the Soke of Peterborough, Staffordshire and Warwickshire.[2]

Constituents of the East Midlands Electricity Board Area

When the East Midlands Electricity Board began operations on 1 April 1948 it incorporated the services and areas of 21 local authorities and 13 companies. The constituent areas varied enormously in size. Mid-Lincolnshire Electric Supply covered over 1,600 square miles while the Urban Electric Supply Co. in Stamford occupied an area of only 918 acres. Kettering Corporation's electricity department served an area of 124 square miles, considerably larger than the seven square miles of the Municipal Borough. As in many places, electricity service areas did not always coincide with local government areas.

With an area of about 6,244 square miles and an estimated population of about 3.6 million, the East Midlands Electricity Board Area covered every type of district from rural Lincolnshire to densely populated areas in Coventry. Industrial sales at 55 percent were considerably higher than domestic sales at 34.8 percent.[3]

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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.
[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.

The head office of the Board was established at Mapperly Hall, Lucknow Avenue, purchased from Nottingham Corporation in 1948.[4]

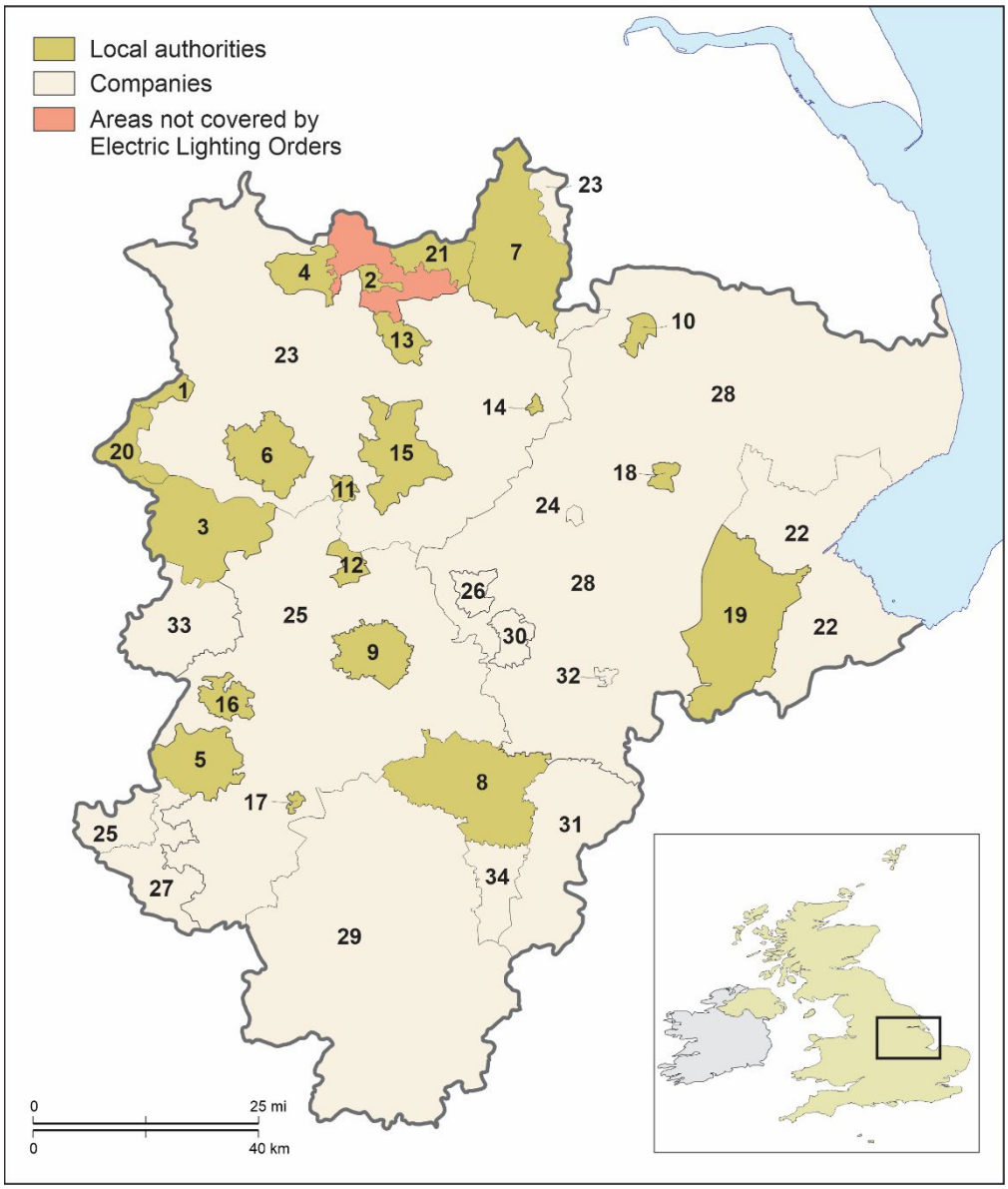

Figure 1 Constituent areas of the East Midlands Electricity Board 1948.

Development of Electricity Supply Areas

The 1948 pattern in **Figure 1** represented the climax of over 50 years of development. Unusually for an 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

[4] Mapperly Hall, built in the 1790s, was used as a men's residence for the University College, Nottingham from 1905 to 1939. Frank Barnes, ***Priory demesne to university campus: A topographic history of Nottingham University*** (University of Nottingham, 1993), p.503.

Board of Trade.[5] This requirement followed the precedents for earlier public utilities that 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.

Table 1 East Midlands Electricity Board Area Constituent Undertakings 1948

MAP #	LOCAL AUTHORITIES
1	Ashbourne UD
2	Bolsover UD
3	Burton-on-Trent CB
4	Chesterfield MB
5	Coventry CB
6	Derby CB
7	East Retford MB
8	Kettering MB
9	Leicester CB
10	Lincoln CB
11	Long Eaton UD
12	Loughborough MB
13	Mansfield MB
14	Newark MB
15	Nottingham CB
16	Nuneaton MB
17	Rugby MB
18	Sleaford UD
19	Spalding UD
20	Uttoxeter UD
21	Worksop MB
	Companies
22	Boston & District ES Co
23	Derbys and Notts EP Co
24	Grantham (Urban ES Co)
25	Leics & Warwicks EP Co
26	Melton Mowbray EL Co
27	Midland EL & P Co
28	Mid-Lincolnshire ES Co
29	Northampton EL & P Co
30	Oakham G & E Co
31	Rushden & District ES Co
32	Stamford (Urban ES Co)
33	Tamworth District ES Co
34	Wellingborough ES Co

Key to Abbreviations

CB: County Borough
EL & P Co Electric Light & Power Company
G&E Co: Gas & Electric Company
UD: Urban District
EL Co: Electric Light Company
ES Co: Electricity Supply Company
MB: Municipal Borough

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

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 early technology.

Two of the applications in 1882 came from the East Midlands Area. Grantham Corporation was granted an ELO but this was revoked in 1892 when no action had been taken. Nottingham Corporation's application was withdrawn at an early point in the procedure.[6] Meanwhile the Chesterfield Town Council was supporting an experimental street lighting system that had begun in October 1881 and continued until March 1884.[7] The system was operated by Hammond & Co which had already installed arc lighting in the Dronfield works of Wilson & Cammell. Although unprofitable, the technical system worked well. Chesterfield was slow in developing a full public supply, opening a municipal service only in 1901.

Although general urban electrification failed to take off in the region, private systems began to develop. Private generation provided a market for electrical equipment, helped the training of workers, and gave opportunities to refine details of the new technology.

By 1885 Robey's Globe Works and Clarke's Crank & Forge Works in Lincoln were using electric lighting for their principal shops. In Grantham, Richard Hornsby's Spittalgate Iron Works was using the Brush system to light the boiler and engine shops.[8] A year earlier Ralph Nevile had contracted with Edmundsons to install lighting in his country house at Wellingore, a village south of Lincoln. Powered by a 6hp portable steam engine, the Siemens dynamo lit the house, private chapel, stables and school.[9]

Early public supply began in Leamington (1887) and Buckingham (1889) Both were started by non-statutory companies operating outside the formalities of the 1882 legislation but with the approval of the local authorities. The Midland Electric Light & Power Co. was "legitimised" in 1900 when it was granted an ELO for the town of Leamington Spa.

Public electricity supply schemes began to take off in 1889-90 when applications for Electric Lighting Orders resumed. Nationally, there were 17 applications in 1889 and 161 in 1890. Eight applications for the East Midlands Area were submitted to the Board of Trade for the 1890 Parliamentary session.[10] Five Electric Lighting Orders were granted-to the Corporations of Burton-upon-Trent, Derby, Leicester and Nottingham and the Northampton Electric Light & Power Co. The three remaining applications, submitted by the Midlands House-to-House Electricity Co, were rejected or not proceeded with. The Northampton company was the first to inaugurate a public system, in 1891. Derby followed in 1893 and the other three towns opened their local systems in 1894.

An ambitious plan to build a power station at Market Warsop in north Nottinghamshire for supplying electricity to all towns and villages within a radius of 25 to 35 miles was promoted in late 1897. The

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[6] "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.

[7] Chesterfield has strong claims to being the first town to commit to electric street lighting despite the popular view that Godalming was the leader. See P. Strange, "Early electricity supply in Britain: Chesterfield and Godalming", ***Proceedings of the Institution of Electrical Engineers***, Vol.126(9), 1979, pp.863-868.

[8] Institution of Mechanical Engineers, ***Proceedings***, 1885. Lincoln summer meeting describes the works,

[9] Ralph H.C. Nevile, "On private installation of electric lighting", I.Mech.E. ***Proceedings***, 1885, pp.376-389.

[10] Board of Trade, Proceedings under the Electric Lighting Acts, ***Parliamentary Paper***s 1890. HC273.

promoters included several influential coal owners, Chesterfield interests[11] and some investors associated with the British Thomson-Huston Company. Based on the principle that it was cheaper to produce electricity at the pithead than to transport coal to generating stations in more distant markets, the project would:

> *…supply electricity on such a vast scale that they will be able to provide the energy so cheaply that manufacturers of all kinds will be induced to discard their steam engines in its favour. Further, it is expected that by producing electricity on so great a scale they will stimulate the introduction of many industries, especially in the villages, and induce the local authorities to illuminate their streets and roads.*[12]

The General Power Distributing Bill was deposited with the Board of Trade, along with three London electricity company bills seeking powers to build generating stations outside their supply areas. Once the provisions of the bill were announced, there was immediate opposition from municipal interests, Although Derby and Nottingham were the only local authorities in the area with electricity systems, other municipal corporations in Sheffield (where the council was in process of buying the private electricity company), Rotherham, Doncaster and East Retford joined the opposition.[13] More distant parties, including Manchester Corporation, also actively opposed the bill.

Given the strength of the opposition and since the bills raised issues not covered by the Acts of 1882 and 1888, a Select Committee of both Houses of Parliament was convened under the chairmanship of Viscount Cross. Witnesses were called and examined, and a detailed report of the proceedings was published.[14] The London bills were passed but the General Power Distributing Bill was rejected by Parliament in the summer of 1898 and failed again the following year along with several other regional power bills.

The work of the Cross Committee had some lasting effects: private bills could now be submitted to Parliament for special electricity schemes and power stations could be located outside the area of supply. The powerful municipal lobby successfully opposed all power company bills in 1899. In the following year, the insertion of the so-called “Kitson Clause” that safeguarded the rights of existing company and local authority undertakings, facilitated the passage of several power bills. The new power companies of 1900 added a new regional layer to the already complex pattern of electricity undertakings. In the East Midlands the Derbyshire & Nottinghamshire Electric Power Act 1901 and the Leicestershire & Warwickshire Electric Power Act 1902 introduced this new form of enterprise. Development of these companies was much slower than anticipated and only began to show their potential after World War I.

Power stations based on coalfields and transmitting power to distant load centres began on a substantial scale only after nationalisation 50 years after the failure of the Warsop project. High Marnham power station (1959-1962) was located on the former Lancashire, Derbyshire & East Coast Railway where the line crossed the River Trent. Warsop would have been a poor site for a large generating station given its limited surface water supplies.

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[11] Warsop had become accessible by the recent completion of the Lancashire, Derbyshire & East Coast Railway from Chesterfield to Lincoln.
[12] “Electrical power development”, ***The Engineer***, Vol.84, 1897, p.503.
[13] The legal and other expenses of opposition were considerable. Nottingham Corporation spent more than £1,500 opposing the Bills, an amount much larger than the total salaries of the Electricity Department. See: Duncan Gray, ***Nottingham through 500 years: A history of town government*** (City of Nottingham, 1960), p.227.
[14] “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.” ***Parliamentary Papers*** 1898. HC213.

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 standardisation would be a major problem when interconnection between areas became advantageous.

An outline of development is presented in three phases: local initiatives from the 1880s to World War I, state intervention to the 1940s, and nationalisation from 1948.

I Local Initiatives

Figure 2 and **Table 2,** derived from a rare map of electricity undertakings in the British Isles, provide a snapshot of the development of public supply areas over the previous three decades.

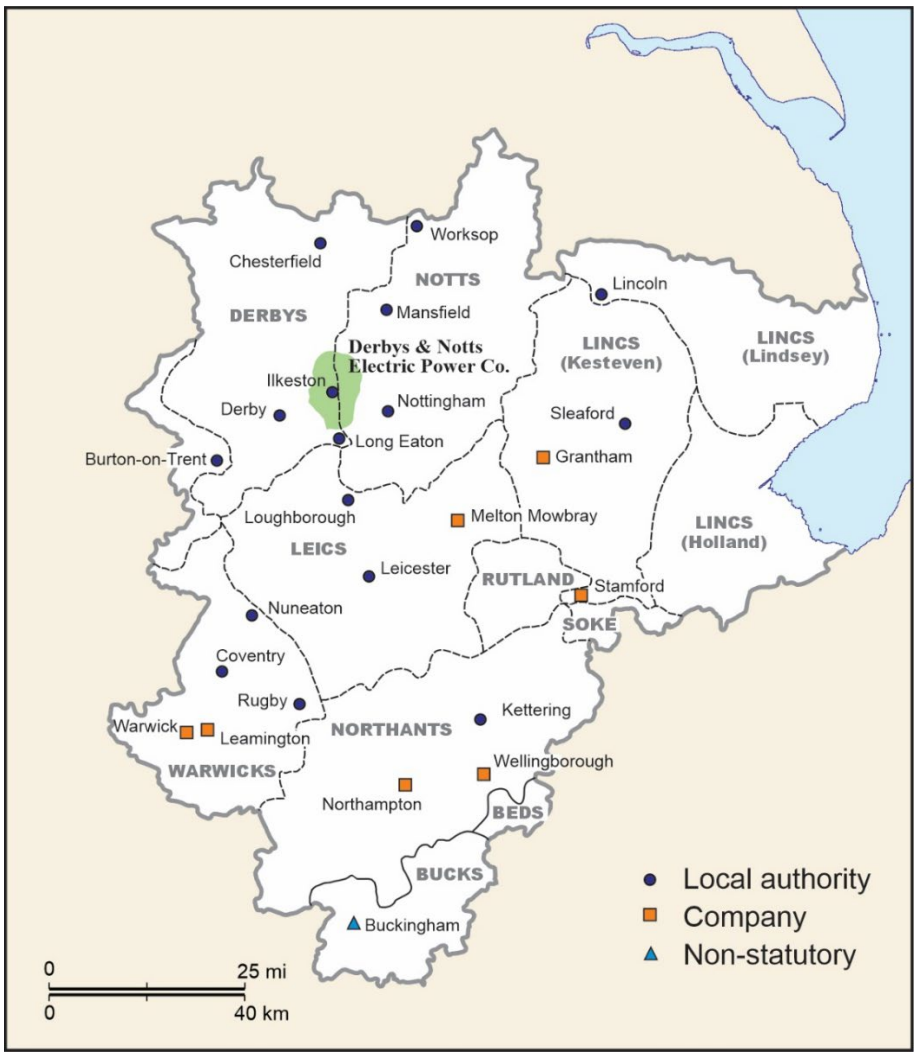

Figure 2 East Midlands Area Electricity Undertakings c1912.

The 16 local authorities were clear examples of local initiative in developing electric light and power. Nottingham Corporation (population 259,901 in 1911) was the largest of the local authorities. Sleaford Urban District (population 6,427) was the smallest. Derby was the first local authority in the region to open a public supply, in 1893.

Table 2 East Midlands Electricity Board Area Electricity Supply Undertakings c.1912

UNDERTAKING	*COUNTY*	*SUPPLY BEGAN*
Local Authorities		
Burton-on-Trent CB	Staffs	1894
Chesterfield MB	Derbys	1901
Coventry CB	Warwicks	1895
Derby CB	Derbys	1893
Ilkeston MB	Derbys	1903
Kettering UD	Northants	1904
Leicester CB	Leics	1894
Lincoln CB	Lincs (Lindsey)	1898
Long Eaton UD	Derbys	1903
Loughborough MB	Leics	1904
Mansfield MB	Notts	1903
Nottingham CB	Notts	1894
Nuneaton MB	Warwicks	1897
Rugby UD	Warwicks	1903
Sleaford UD	Lincs (Kesteven)	1901
Worksop UD	Notts	1901
Companies		
Buckingham N/S	Bucks	1889
Derby & Notts EP Co	Derbys/Notts	1904
Grantham	Lincs (Kesteven)	1903
Leamington	Warwicks	1887
Melton Mowbray	Leics	1900
Northampton	Northants	1891
Stamford	Lincs (Kesteven)	1902
Warwick	Warwicks	1905
Wellingborough	Northants	1907

Note: N/S non statutory undertaking (outside 1882/1888 Acts).
Source: "Map showing Electric Lighting, Power and Traction Undertakings in Operation." Supplement to ***Garcke's Manual of Electrical Undertakings.*** Undated but c 1912. [Copy from National Library of Scotland]

The nine companies in the East Midlands were very varied in scale and location. Buckingham was a small non-statutory undertaking in an isolated country town while the Northampton Electric Light & Power Co. served a major town with a varied industrial base. Warwick's public supply was provided by the Leamington & Warwick Electrical Co., the local tramway operator. Most of the companies were local in ownership and management. But the companies in Grantham, Melton Mowbray and Stamford were owned and operated by Edmundsons Electricity Corporation Ltd.[15]

In contrast to these small-scale operations, the Derbyshire & Nottinghamshire Electric Power Co. covered an extensive area of the two counties. The Act of 1901 empowered the company to provide supply to large industrial customers and bulk supply to authorised undertakings. Unlike the usual 42-year franchises granted to companies under the Electric Lighting Act 1888, the power company Acts had no time limits. Generation began in 1903/4 with a power station in Ilkeston but expansion was slow and even by 1912 the power company was only operating within a small radius of the town. At this time, it became a subsidiary of the Tramways Light & Power Co. controlled by George Balfour.[16]

[15] By 1910 Edmundsons was operating 46 systems from Inverness to Guernsey.
[16] The company was renamed Midland Counties Electric Supply Co. in 1921 and in the following year became part of the Power Securities group. Balfour Beatty provided much of the engineering expertise for the companies.

ELECTRIC TRAMWAY SYSTEMS IN THE EAST MIDLANDS[1]

	YEARS OPERATING	ROUTE MILES	MAX. NO. OF CARS
Burton-Upon-Trent Corporation	1903-1929	6.66	24
Burton & Ashby Light Railway	1901-1927	10.12	20
Chesterfield Corporation	1905-1927	3.61	17
Coventry Company/Corporation[2]	1895-1940	13.68	80
Derby Corporation	1904-1934	13.96	78
Ilkeston Corporation[3]	1903-1916	3.78	13
Leamington & Warwick Co.	1905-1930	3.05	12
Leicester Corporation	1904-1949	22.74	178
Lincoln Corporation	1905-1929	1.84	13
Mansfield & District Co.	1905-1932	12.28	30
Northampton Corporation	1904-1934	6.43	37
Nottingham Corporation	1901-1936	24.69	200
Notts & Derbys Tramways Co.	1913-1932	12.72	24

Thirteen electric tramway systems were developed in the region, eight by local authorities and five by companies. Coventry was a pioneer company, beginning a service in 1895, several years ahead of Nottingham which began the first municipal operation. The Burton & Ashby Light Railway was built and operated by the Midland Railway.

Four of the systems had independent power stations. The largest was at Lero, Leicester which was expanded for general city supply from 1908. Coventry tramway power station had a capacity of 1,500kW by the mid-1920s. The other two tramway generating stations were much smaller—Northampton (524kW) and Swadlincote (350kW), the latter being powered by diesel engines.

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. In Coventry, where a private company owned the electric tramways and generated its own power, a later Town Clerk observed:

Every year up to 1904 there was a considerable trading loss and though the Electricity Committee were always predicting that the corner was about to be turned, few believed them. The corner was, however, turned in 1906 as a result of the adoption of the policy of concentrating on the power load rather than the lighting load and of fostering this development by the hiring-out of electric appliances to manufacturers.[4]

A tramway power station built by Leicester Corporation in 1904 not only covered all the traction needs but had capacity for supplying power customers. By 1919 power sales from the Lero power station amounted to 58 percent of the output and 16 percent of the total revenue of the Tramways Department.[5]

Traction sales were still significant in 1925/26, amounting to 32.2 percent of total electricity sales in Nottingham, 30.5 percent in Mansfield and 20.7 percent in Leicester. Places with a high power load such as Derby and Burton-on-Trent had much lower proportions, 9.3 percent and 4.2 percent respectively.

Electrified tramways provided fast, efficient and cheap urban transport and were very profitable before 1914. Motor bus competition after the war quickly undermined the viability of the smaller systems.

Notes

[1] Compiled from Keith Turner, ***Directory of British Tramways***, Vol.2 (Stroud: The History Press, 2009).

[2] Taken over by the Corporation in 1912.

[3] Sold to Notts & Derbys Tramways Co. in 1916.

[4] Frederick Smith, ***Coventry: six hundred years of municipal life*** (Coventry: Corporation of the City of Coventry, 1945), p.152.

[5] Garcke's ***Manual of Electricity Undertakings*** 1920/21, pp.480-481.

Electrification in the region around 1912 was still incomplete, with only a small part covered by Electric Lighting Orders. Some towns still unserved included Newark (population 16,408 in 1911), Wolverton (13,905), East Retford (13,315), The Matlocks (10,343) and Spalding (10,308). Rushden (13,354) was beginning to develop a local system which opened in 1913. In Boston (16,673) and Hinckley (12,834) local systems were completed in 1914. The Leicestershire & Warwickshire Electric Power Co. provided the service in Hinckley where its first power station began operating by 1913. Although empowered by an Act of 1902, the ambitious plans for six new power stations[17] were abandoned and little development took place until the takeover by George Balfour's Tramways Light & Power Co. in 1912.

Lighting was still 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 price. 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, 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.

The limitations of DC supply systems became apparent to larger undertakings by 1900 and in the search for economies of scale the introduction of more efficient prime movers became a priority. Loughborough adopted turbines from the beginning of service in 1904 and added AC generation a decade later as electrification expanded beyond the town centre.[18] Mixed AC/DC systems became increasingly common from this time. Conversion to a full AC system was, however, a long process; Nottingham for example still had many DC customers as late as 1957.[19]

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.

Despite the active promotion of Corporation electricity supply in Coventry and Derby, several large firms developed their own generating facilities. The Coventry Ordnance Works had a capacity of 1,000kW in the powerhouse.[20] Humber Motor & Cycle Works, another new manufacturing complex, generated its own electricity using gas engines (560kW). Other major firms in the town, including Alfred Herbert and J.J. Cash, also produced their own electricity.[21] In Derby, where the Midland Railway had begun its own supply for the head offices and hotel in 1892, the railway company built a new power station (3,000kW capacity) for the locomotive works in 1910.[22] In 1927/28 this plant's output of 13.6million kWh was equivalent to about one third of the total generated by Derby Corporation in that year.

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[17] The proposed stations were to be located at Glenfield (northwest of Leicester), Hinckley, Leek Wooton (north of Warwick), Measham, Newbold-on-Avon (near Rugby) and Whitacre. Only Hinckley was developed but the Whitacre location was to be developed later as the Hams Hall generating complex built by Birmingham Corporation.

[18] Peter Neaverson, "The history of electricity supply in Leicestershire and Rutland up to nationalisation in 1947", ***Transactions of the Leicestershire Archaeological and Historical Society*** Vol.76, 2003, pp.93-110. The author made extensive use of the material held by the Record Office for Leicestershire, Leicester and Rutland.

[19] The East Midlands Electricity Board had 41,296 Direct Current customers in 1958/59. Electricity Council, ***First Annual Report and Accounts 1958/59***, p.239.

[20] "Coventry Ordnance Works", ***The Engineer***, Vol.103, 1907, p.576.

[21] I.Mech.E. ***Proceedings***, 1910. Birmingham summer meeting, pp.1367-1369.

[22] ***The Engineer***, Vol.111, 1911, pp.188-190.

Engineering firms migrating from London found smaller centres such as Newark and Rugby attractive locations with their availability of spacious sites, lower-cost labour and good railway services. The absence of any public electricity was no deterrent to development. A. Ransome & Co., manufacturer of wood-working machinery, had moved from London to Newark in 1900 and by 1920 had a generating capacity of 560kW. Ransome & Marles Bearing Co., a later addition to the town, also supplied its own power (1,150kW).[23] Newcomers to Rugby—Williams & Robinson's Victoria Engine Works and the British Thomson-Houston Co--built their own generating facilities from the start in 1898. For a decade or so from 1909, the BTH Co. provided a bulk supply to the Rugby Urban District Council. The generating capacity at the BTH works reached 4,000kW in 1927.[24]

Railway companies had adopted electricity for larger stations as well as for lighting marshalling yards and locomotive depots by the later 1890s. The Midland Railway had facilities in Wellingborough, Leicester and Nottingham[25] while the Great Central Railway's London Extension included small generating stations at Annesley, Nottingham, Leicester and Woodford Halse.[26] The London & North Western Railway's carriage works at Wolverton was another example of private generation.

Hotels were early in adopting electric lighting as one of the amenities of high-class hospitality. The resorts and spas of the region were slow in developing public supply systems. Matlock for example was without a public system until the mid-1920s. In Woodhall Spa, Lincolnshire, where the Victoria Hotel featured electric light in its 150 rooms (numerous suites),[27] mains supply arrived only in the mid-1930s.

Other large institutions of a different type were also introducing electricity. The Leicestershire and Rutland Asylum at Narborough, opened in 1907, was "delayed by the late running of the electrical installation".[28] In Nottinghamshire the Saxondale hospital (1902) at Radcliffe on Trent and the Rampton Criminal Lunatic Asylum (1912) were both self-contained for their power needs.

The Rugby School Electric Lighting Co., registered in 1893, had a producer gas system and two Crossley gas engines coupled to dynamos with a total capacity of 85kW by 1910 for supplying all the school buildings and masters' houses. Oundle School acquired its first steam engine to be used for generating electricity in 1895. Stowe House, near Buckingham, when converted to a school in the 1920s, built its own powerhouse with a set of diesel engines.

Throughout the region, country houses, estates and large farms added electricity. Chatsworth House (1893) and Ashton Wold, Northamptonshire (c1900) both used water turbines for generating electricity.[29]

The incessant demand for munitions and supplies created a range of new industries in the East Midlands: Hotchkiss machine guns in Coventry, cellulose acetate in Derby, Sopwith aircraft subcontracting in Lincoln[30] and shell-filling on a vast scale at Chilwell near Nottingham.[31] All these production lines needed electric power—very evidently in Coventry where electricity sales expanded

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[23] I.Mech.E. ***Proceedings***, 1920. Lincoln summer meeting, p.824.
[24] I.Mech.E. ***Proceedings***, 1910, 1927. Birmingham summer meetings.
[25] I.Mech.E. ***Proceedings***, 1898. Derby summer meeting, pp.562-563.
[26] Ruth Irons and Stanley C. Jenkins, ***Woodford Halse: a railway community*** (Usk: The Oakwood Press, 1999), p.50.
[27] ***Bradshaw's April 1910 Railway Guide*** (reprinted Newton Abbot: David & Charles, 1968), p.1187.
[28] www.countyasylums.co.uk noted under "Carlton Hayes Hospital".
[29] Ian West, "Worthy of the Palace of Aladdin? The introduction of gas and electricity in the country house", Chapter 7 in P.S. Barnwell and Marilyn Palmer, eds. ***Country House Technology*** (Donnington, Lincs: Shaun Tyas Publications, 2012), p.121.
[30] About one-fifth of Sopwith's British output of aircraft came from the Lincoln engineering firms of Ruston, Proctor & Co. (2,421) and Clayton & Shuttleworth (621). See Bruce Robertson, ***Sopwith: the man and his aircraft*** (Letchworth: Air Review, 1970), p.164.
[31] Wayne D. Cocroft, ***Dangerous Energy: the archaeology of gunpowder and military explosives manufacture*** (Swindon: English Heritage, 2000), p.176.

from 17 million kWh in 1914 to 53m kWh in 1918.[32] Public supply systems struggled to meet the demand while isolated factories had to build independent generating facilities. These varied in size from large power stations at Spondon to much smaller operations in the military camps and airfields such as the Royal Naval Air Service training establishment at Cranwell opened in 1916.

While much of the wartime production capacity was quickly sold off for scrap, some facilities had more lasting value. Lincoln Corporation acquired the Clayton & Shuttleworth power station in 1919 and was able to move from the old, cramped site to a location with space for future expansion.[33] In Coventry, surplus factory space gave opportunities to develop mass production of engines and motor vehicles.

II State Intervention

Difficulties of interconnection, differences in AC frequencies, and the need for coal conservation by the use of larger- 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.

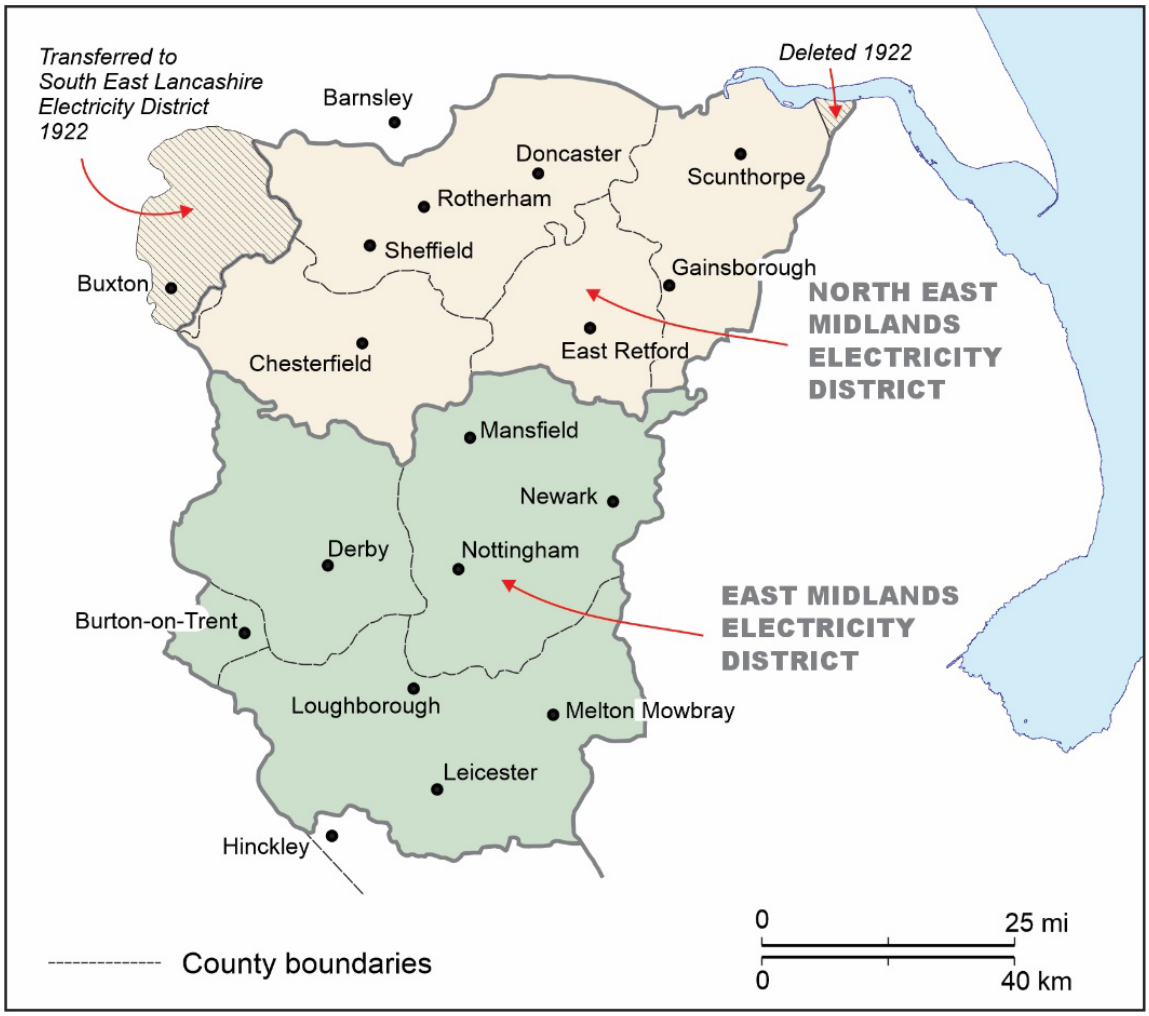

Figure 3 Electricity Districts 1920.

[32] 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.407.
[33] I.Mech.E. ***Proceedings***, 1920, pp.783-785.

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 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.

Two Electricity Districts were defined in 1920 covering parts of the East Midlands Area: the North East Midlands and the East Midlands (**Figure 3**). The deliberations that followed illustrate the difficulties faced by the Electricity Commissioners in attempting to create Joint Electricity Authorities that would consolidate generation in a single regional entity.

Sheffield Corporation prepared a scheme for a JEA in the North East Midlands Electricity District. This was considered by a local inquiry in Sheffield during December 1922. Lack of agreement between Sheffield and Rotherham Corporations stalled any action so that by 1925 the Electricity Commissioners gave up further attempts at reorganisation. East Retford seems to have been stirred into action and began a public supply in 1927. This was one of the last local systems to include a generating station.[34] One lasting effect of the North East Midlands Electricity District was the southern boundary that was used in defining the Mid East England Electricity Scheme for the grid, thus separating northern Derbyshire and Nottinghamshire from the Midlands grid scheme.

Local authorities in the East Midlands Electricity District had, in contrast, more cooperative attitudes towards reorganisation. Instead of a Joint Electricity Authority, the electricity undertakings in the District proposed an Electricity Advisory Board (similar to that already adopted in South East Lancashire). There was general agreement at the local inquiry held in Nottingham in January 1923 and the Electricity Commissioners prepared a draft order approved at a second inquiry in July. Parliamentary approval followed in June 1924 and the first meeting of the East Midlands Electricity Advisory Board was held at the Nottingham Guildhall on 24 July.[35] In the first few years the Advisory Board was fairly active in supporting the interconnection of the Spondon and Hinckley power stations, a bulk supply from the power company to Mansfield Corporation, and Newark's electrification. As the grid system began to develop, the meetings of the Board became less frequent and there were suggestions of dissolution.

Only two new undertakings were formed in the early 1920s: Tamworth Borough Council began a public supply in October 1924 and the Oakham Gas & Electricity Company followed in 1925. But the larger companies in the region were actively expanding. The Leicestershire & Warwickshire Power Co. built a new power station at Emscote, Warwick in 1920; its initial capacity of 6,000kW was tripled by 1925.[36] A site beside the River Avon provided adequate cooling water and the railway gave access for coal supplies. The Derbyshire & Nottinghamshire Electric Power Co., also under the active management of Balfour Beatty, changed from its original 25Hz frequency to 50Hz after the war and in late 1922 acquired the Spondon power station from British Celanese. The old Ilkeston power station was closed and capacity at Spondon was raised to 24,000kW by 1925. Northampton Light & Power also modernised and expanded with a new station at Hardingstone Junction. With such expanded generating capabilities, these companies were ready to seek new Special Orders for extending their market areas. The Derbyshire & Nottinghamshire Electric Power Co. which held only two Electric Lighting Orders in 1920,

[34] "Gas engine driven generators at East Retford power station", ***The Engineer***, Vol.148, 1929, p.102.
[35] ***Fourth Annual Report of the Electricity Commissioners 1923-24*** (London: HMSO, 1924), pp.25-26. A summary annual report was published as an Appendix in the Fifth and subsequent annual reports of the Electricity Commissioners.
[36] Chris Capewell, "Warwick Emscote Power Station", Warwickshire Industrial Archaeology Society website: www.warwickshireias.org/contributors

added four more by 1925 and another four by 1929. The company's sales of electricity rose from 39.8million kWh in 1926 to 110.5m kWh in 1929.

The 28 undertakings in 1925/26 (**Table 3**) operated a variety of systems. Fifteen were mixed AC/DC, reflecting the shift away from Direct Current (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. Only five places had wholly DC systems—the Long Eaton and Sleaford Urban Districts and the companies in Grantham, Melton Mowbray and Stamford. Apart from Burton-on-Trent where part of the town had an AC frequency of 75 cycles (Hz), all the other places with AC operated at what had become the national standard of 50Hz.

Table 3 East Midlands Electricity Board Area Electricity Supply Undertakings 1925/26

UNDERTAKING	*COUNTY*	*SYSTEM*	*GENERATING CAPACITY kW*	*PER CAPITA CONSUMPTION kWh*
Local Authorities				
Burton-on-Trent CB	Staffs	AC	16,200	319.6
Chesterfield MB	Derbys	AC/DC	6,680	114.1
Coventry CB	Warwicks	AC	31,200	428.5
Derby CB	Derbys	AC/DC	28,250	168.7
Kettering UD	Northants	AC/DC	5,830	95.1
Leicester CB	Leics	AC/DC	41,750	171.0
Lincoln CB	Lincs (Lindsey)	AC/DC	16,385	260.8
Long Eaton UD	Derbys	DC	1,450	80.5
Loughborough MB	Leics	AC/DC	5,850	165.0
Mansfield MB	Notts	AC/DC	2,100	67.0
Nottingham CB	Notts	AC/DC	43,041	79.3
Nuneaton MB	Warwicks	AC/DC	3,000	95.4
Rugby UD	Warwicks	AC	-	55.0
Sleaford UD	Lincs (Kesteven)	DC	180	17.0
Tamworth MB	Staffs	AC	-	46.1
Worksop UD	Notts	AC/DC	500	58.9
Companies				
Boston & Dist ES Co	Lincs (Holland)	AC	1,000	7.4
Derby & Notts EP Co	Derbys, Notts	AC	24,000	..
Grantham[1]	Lincs (Kesteven)	DC	780	31.4
Leamington[2]	Warwicks	AC/DC	-	31.6
Leics & Warwicks EP Co	Leics, Warwicks	AC	26,200	..
Melton Mowbray EL Co	Leics	DC	1,150	68.5
Northampton EL&P Co	Northants	AC/DC	12,840	66.9
Oakham G&E Co	Rutland	AC	60	3.6
Rushden & Dist ES Co	Northants	AC/DC	595	25.2
Stamford[1]	Lincs (Kesteven)	DC	580	31.6
Warwick[3]	Warwicks	AC/DC	-	78.5
Wellingborough ES Co	Northants	AC/DC	675	28.6

Notes:

[1] Urban Electric Supply Co

[2] Midland Electric Light & Power Co

[3] Leamington & Warwick Electrical Co. Also provided the tramway services.

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

Data on generating capacity show a wide range in size from Nottingham Corporation with 43,041kW to Oakham Gas & Electric Co. with 60kW. Steam turbines were dominant in the larger stations and varied in scale from a 75kW machine in Melton Mowbray to the largest turbine of 12,500kW in the new Freeman's Meadow power station in Leicester. Older reciprocating steam engines were still common in DC generation. Gas engines were employed only at Oakham, although private generation at iron and steel works frequently used blast furnace and coke oven gas to power engines.

Statistics on electricity consumption per head of population reveal major contrasts among electricity undertakings. Seven places exceeded 100.0kWh per person. Each place had a distinctive market profile reflecting the local economic and social geography. Nottingham had a balanced profile in 1925/26 consisting of 33.4 percent of sales in the lighting segment, 0.3 percent in public lighting, 32.2 percent for the tramways and 34.1 percent in power. Two towns, Chesterfield and Lincoln with similar-sized populations (around 66,000), had very different market profiles. Chesterfield had a fairly balanced profile with lighting sales at 20.3 percent, tramways at 7.0 percent and power at 72.2 percent of total sales. Lincoln in contrast was dominated by power sales at 90.6 percent, lighting at only 8.0 percent and tramways at 1.3 percent. Annual per capita sales in Lincoln reached 260.8 kWh while Chesterfield's consumption was only 114.1 kWh.

Electrification and extension of supply areas were given a new impetus following the Weir Report (1925),[37] the Electricity (Supply) Act 1926 and the formation of the Central Electricity Board in 1927. Even before the detailed regional plans for the National Grid were announced, there was a quickening of interest in the formation of new companies and applications for Special Orders. Over the next decade almost all the empty areas of the map were covered by new or extended supply areas.

Six new local authority undertakings began an electricity service:

1927	Bolsover, East Retford, Spalding
1928	Newark
c.1930	Ashbourne, Uttoxeter

In the company sector the Mid-Lincolnshire Electric Supply Co., registered in October 1931, acquired the Special Orders granted to R. Borlase Matthews.[38] The orders of 1930 and 1932 covered territory in Holland and Kesteven as well as extending into parts of Leicestershire, Rutland and the Soke of Peterborough. By this time the whole region was covered by distribution orders except for a zone around Staveley where a non-statutory company, Staveley Electric Supply Co., had provided a supply since March 1918. Power at the unusual frequency of 30Hz was derived from the Staveley Coal & Iron Co.

Transmission lines supported by tall steel towers became the most visible effect of state intervention as they appeared in the landscape during the early 1930s. Construction of a national grid was authorised by the Electricity (Supply) Act 1926. Plans were prepared by the Electricity Commissioners and consulting engineers for implementation by the Central Electricity Board.

Two grid schemes covered the East Midlands area. The Central England Electricity Scheme was adopted by the Central Electricity Board in May 1928 and the Mid-East England Electricity Scheme which covered

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[37] Ministry of Transport, ***Report of the Committee appointed to review the National Problem of the Supply of Electrical Energy*** (London: HMSO, 1927), 39 pp.

[38] Richard Borlase Matthews (1878-1943), a consulting engineer, had first published ***Electricity for Everyone: A popular handbook dealing with the uses of electricity*** in the home and business in 1909. The fifth and last edition was published in 1932. After the war he devoted his attention to the application of electricity to farming work and established his own electric farm at Greater Felcourt near East Grinstead where he published books and a monthly magazine on "Electro-Farming".

Lincolnshire followed in March 1929. The national grid was designed to connect “selected” power stations. These were generally the largest and most efficient generating plants that had potential for expansion. Ten power stations in the region received this designation.

The selected power stations were linked by three distinct sections of the grid:

a. A central 132kv circuit from Hams Hall power station in Birmingham which connected Coventry, Leicester, Nottingham, Spondon and Burton-on-Trent. Lower-voltage lines connected Hinckley with Coventry and Derby with Spondon.
b. A southern line from Hams Hall via Warwick and Northampton to Bedford (in the South East scheme). Kettering was linked to Northampton with a lower-voltage line.
c. An eastern line from Rotherham via Lincoln to Peterborough (in the South East scheme). Lower-voltage lines from Peterborough served Boston, Sleaford, Grantham, Bourne, Stamford, Oakham and Melton Mowbray.

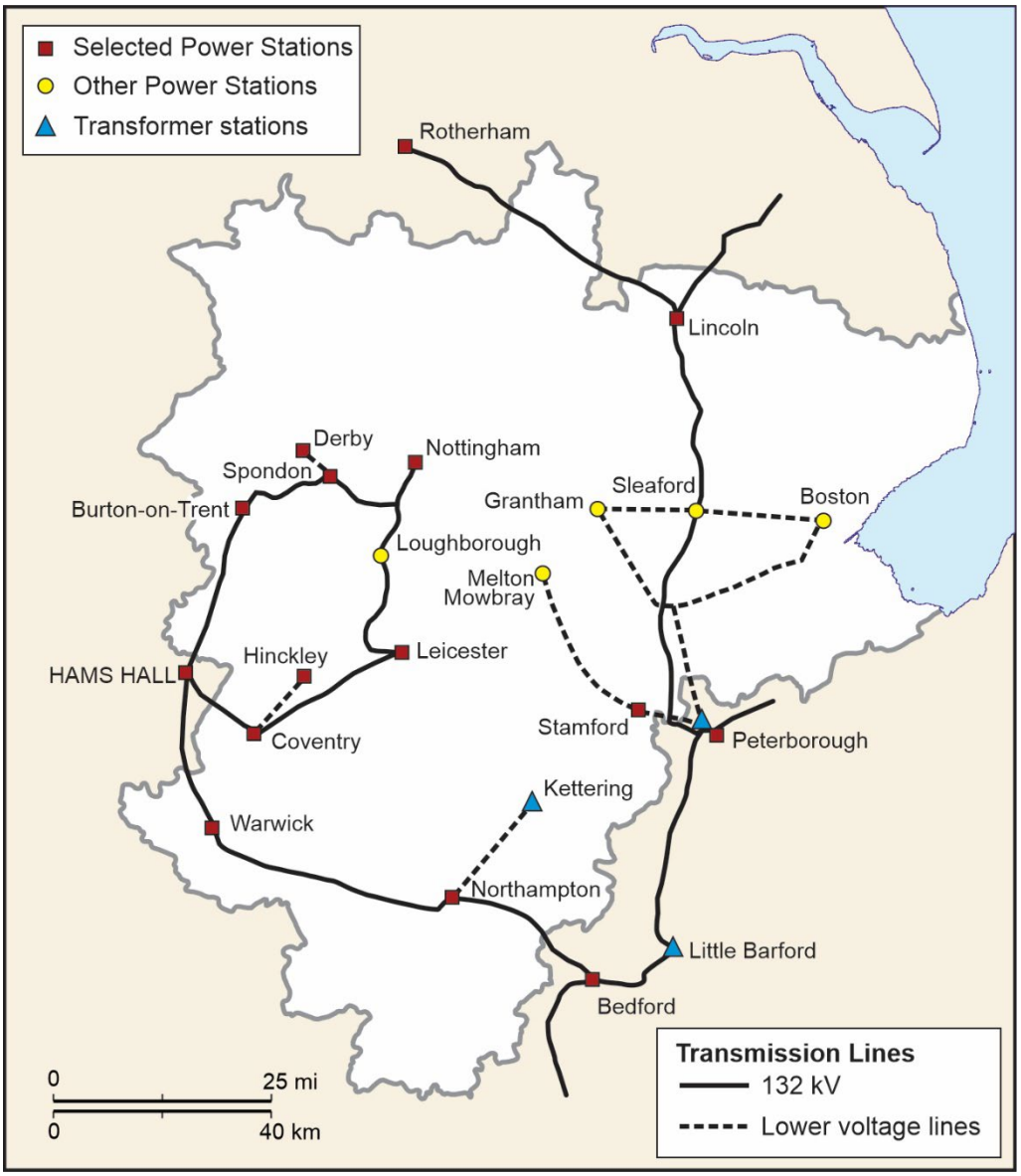

Figure 4 East Midlands Area: National Grid 1933.

When trading began on 1 January 1933 in the Mid-East England scheme area, the grid added a new layer to the complex of undertakings that operated the electricity supply system. The Leeds grid control office of the Central Electricity Board now managed the flows of power on the transmission lines and directed the hour-by-hour operations of the selected power stations. The St Swithins, Lincoln power station remained in the ownership and management of the Lincoln Corporation but the daily operation was directed from Leeds. Trading on the Central England scheme began on 1 April 1934 and power stations such as North Wilford, Nottingham were now directed from the grid control office in Birmingham. Planning for the future became increasingly centralised, particularly from London.

Table 4 East Midlands Electricity Board Area Electricity Supply Undertakings 1935/36

UNDERTAKING	SYSTEM	GENERATING CAPACITY	PER CAPITA CONSUMPTION
Local Authorities			
Ashbourne UD	AC	-	61.4
Bolsover UD	AC	-	28.1
Burton-on-Trent CB	AC	20,500	372.1
Chesterfield MB	AC/DC	6,6250	262.6
Coventry CB	AC	37,500	792.8
Derby CB	AC/DC	45,500	367.5
East Retford MB	AC	870	141.0
Kettering UD	AC/DC	8,500	949.7
Leicester CB	AC/DC	69,750	437.3
Lincoln CB	AC/DC	12,000	286.0
Long Eaton UD	AC/DC	1,250	248.0
Loughborough MB	AC/DC	5,500	482.7
Mansfield MB	AC/DC	-	117.0
Newark MB	AC	-	371.7
Nottingham CB	AC/DC	88,200	332.1
Nuneaton MB	AC/DC	3,000	233.8
Rugby UD	AC	-	253.2
Sleaford UD	AC/DC	400	86.3
Spalding UD	AC	-	58.9
Uttoxeter UD	AC	-	183.1
Worksop MB	AC/DC	640	287.7
Companies			
Boston & Dist ES Co	AC	-	57.1
Derby & Notts EP Co	AC	94,000	..
Grantham[1]	DC	1,180	63.1
Leics & Warwicks EP Co	AC	26,000	..
Melton Mowbray EL Co	AC/DC	1,075	102.0
Mid-Lincolnshire ES Co	AC	-	127.5
Midland EL&P Co	AC/DC	-	87.0
Northampton EL&P Co	AC/DC	33,000	228.3
Oakham G&E Co	AC	-	34.2
Rushden & Dist ES Co	AC/DC	-	152.7
Stamford[1]	DC	580	48.8
Tamworth Dist ES Co	AC/DC	-	107.4
Wellingborough ES Co	AC/DC	-	122.9

Notes:

[1] Urban Electric Supply Co

Table 4 shows the situation in 1935/36 when 34 undertakings were in operation. Over the previous decade many changes had taken place. The number of AC and AC/DC systems had grown while wholly DC systems had shrunk to two (Grantham and Stamford).

Generating technology emphasised economies of scale with larger units that brought significant reductions in coal consumption. The Longford, Coventry station (opened in 1928)[39] with 18,750kW turbo-alternators consumed 1.80lbs of coal for every kilowatt hour generated compared with 2.69lbs a decade earlier at the Sandy Lane station. In 1935/36 the best regional performance was at Spondon which burned only 1.37lbs per kWh. This station also had the largest generators in the region with capacities of 25,000kW and 30,000kW.

Rationalisation of generation and interconnection of undertakings all contributed to reducing the cost of electricity. Other factors such as the growth of radio broadcasting and lower prices for small appliances helped to boost electricity consumption. By 1935/36 there were 23 places in the region with per capita consumption levels above 100kWh. The very high level reached by Kettering Urban District reflected power sales to the new steel works at Corby.[40]

The growth of electrification, especially in the lighting segment, may be illustrated by the case of Nottingham. Total electricity sales grew from 27.79million kWh in 1925/26 to 121.30m kWh a decade later. The lighting segment that included domestic uses expanded from 9.27m kWh to 79.3m kWh. Over the same period, per capita consumption in the city rose from 79.3kWh to 332.1kWh.

Table 5 East Midlands Electricity Board Area Corporate Structure of Electricity Holding Companies 1934/35

1. British Electric Traction Co. Ltd	1.1 Boston & District ES Co.
2. Edmundsons Electricity Corporation Ltd	2.1 Melton Mowbray EL Co. 2.2 Urban ES Co, Grantham 2.3 Urban ES Co, Stamford
3. Lincolnshire & Central Electric Supply Co. Ltd[1]	3.1 Mid-Lincolnshire ES Co.
4. Power Securities Corporation Ltd/Balfour Beatty	4.1 Derbys & Notts EP Co. 4.2 Leamington & Warwick Electrical Co.[2] 4.3 Leics & Warwicks EP Co. 4.4 Midland EL&P Co.
Other Companies	5. Northampton EL&P Co. 6. Oakham G & E Co. 7. Rushden & District ES Co.[3] 8. Tamworth & District ES Co. 9. Wellingborough ES Co.[3]

Notes:
[1] Owned by British & International Utilities Ltd. See: Hausman et al., ***Global Electrification*** (2008), p.193.
[2] Merged with Midland Electric Light & Power Co., 1 January 1935.
[3] Controlled by Northampton EL&P Co.
Source: Political and Economic Planning, ***Report on the Supply of Electricity in Great Britain*** (London: PEP, 1936), pp.140-141.

The 14 companies in the region were controlled by a variety of interests (**Table 5**). Power Securities Corporation was the largest of the holding companies with 73.3 percent of all company sales in the East

[39] ***The Engineer*** Vol.146, 1928, pp.491-494, 522-524.
[40] The original plan of Stewarts & Lloyds Ltd in 1930 included an independent power station of 15,000kW capacity. Sir Andrew Duncan, chairman of the Central Electricity Board, persuaded the company to take a bulk supply from the grid via a 33kv line from Northampton and Kettering. See: Frederick Scopes, ***The development of Corby Works*** (Stewarts & Lloyds Ltd, 1968), pp.120-121.

Midlands in 1935/36. An intermediary company, Midland Counties Electric Supply, held all the shares of the four subsidiaries in the table. Despite its title, the Midland Counties Company did not provide any electricity supply. Lincolnshire and Central Electric Supply was the last foreign-owned electricity company in Britain. Formed in 1930 as British and International Utilities Ltd, the company had provided the capital for developing Borlase Matthews' Special Order for a large area of central and southern Lincolnshire. The company had complex relationships with various European utilities, one of the factors in the government takeover when Italy declared war in May 1940.[41]

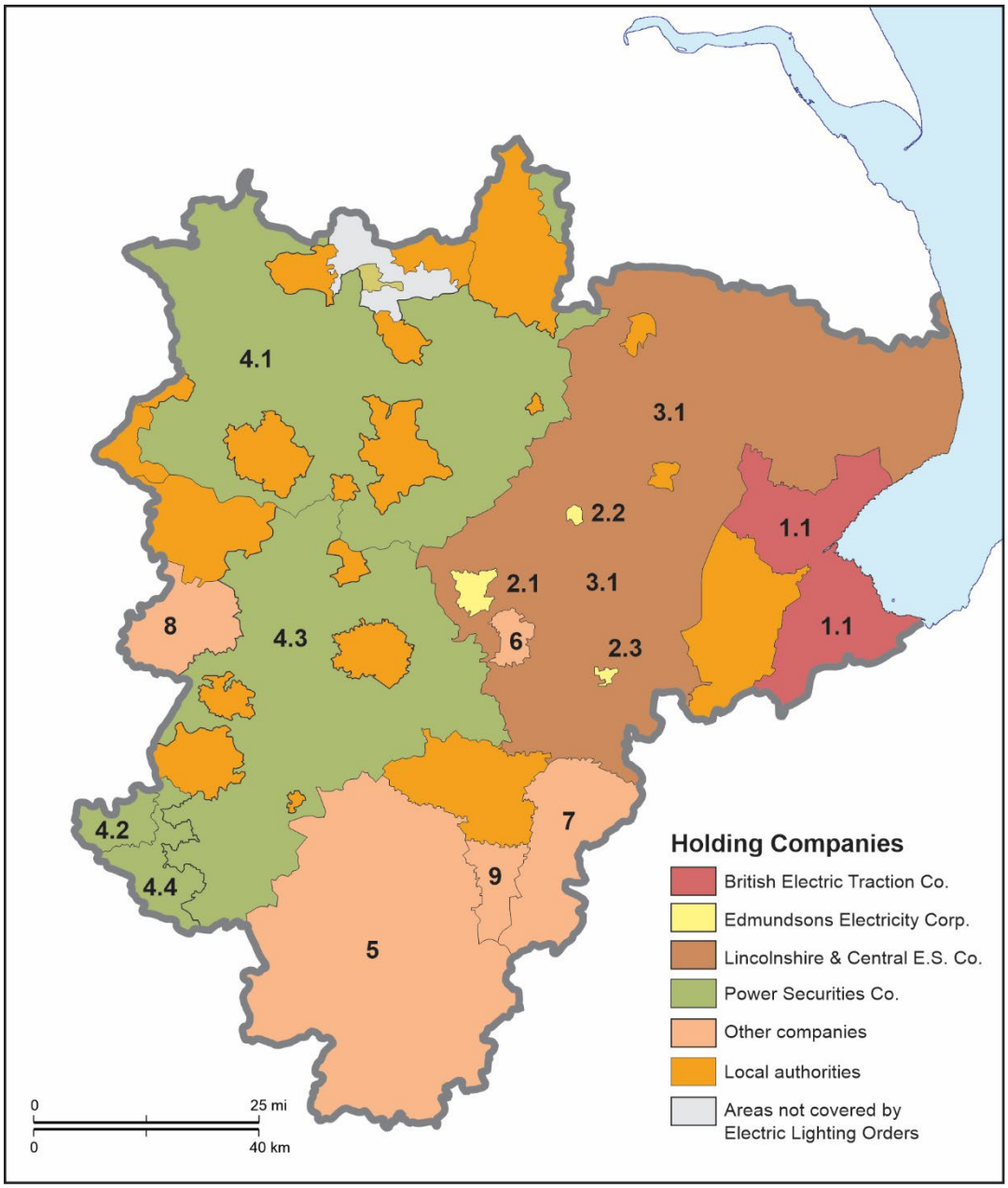

Figure 5 Electricity Holding Companies 1934-35.

[41] William J. Hausman, Peter Hertner and Mira Wilkins, ***Global Electrification: multinational enterprise and international finance in the history of light and power 1878-2007*** (New York: Cambridge University Press, 2008), pp.193,209.

The remaining companies—Northampton Light & Power (together with its subsidiaries in Rushden and Wellingborough), Oakham Gas & Electric and the Tamworth & District Co. were all locally controlled.

Although state intervention had begun to rationalise electricity generation, the efforts of the Electricity Commissioners to reduce the very large numbers of distributors had been unsuccessful. The McGowan Report published in May 1936[42] 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 ten of the 21 local authorities were above this threshold and many small towns objected to the idea of amalgamation with larger authorities or companies. The government's Outline of Proposals published in April 1937[43] was met with strong opposition and more pressing issues of the time meant that reorganisation of distribution was set aside.

While private generation tended to peak around 1920 some establishments continued to invest in new generation facilities especially in areas without any public supply. Staveley Coal & Iron Co. used the blast furnace gas in its central powerhouse and in the mid-1930s was generating over 100m kWh to supply the works, collieries and some settlements in north Derbyshire.[44] The Kelham sugar beet works on the edge of Newark generated its own electricity when opened in 1922.[45] Similarly Ketton Cement in Rutland (1929) included a 1,850kW turbine to power the works.[46]

Private generation in well-provided urban areas was still common in the mid-1930s. The British United Shoe Machinery Co. in Leicester had two powerhouses supplying most of the electricity used in the works. Loughborough College was completely self-sufficient using diesel engines for generation. In Nottingham the University College on its Highfield campus produced all its needs as did the nearby Beeston works of the Boots Pure Drug Co.[47]

Demand for electricity, especially by industrial users, grew rapidly after 1936 with rearmament and then the war effort. Major extensions added capacity to all the larger power stations. Three 30,000kW turbo-alternators were installed at Coventry and Spondon and two similar-sized units at Nottingham.

One effect of the grid was the closure of small power stations that were no longer economic to operate. Stations closed after 1935/36 included Grantham, Long Eaton. Melton Mowbray, Nuneaton, Worksop and Stamford.

Table 6 East Midlands Electricity Board Area Consolidations

UNDERTAKING	***YEARS IN OPERATION***	***NEW OWNER***
Ilkeston Corporation	1903-1916	Derbys & Notts EP Co
Buckingham Electric Light Co.	1889-1928	Northampton EL&P Co.
Tamworth Corporation	1924-1935	Tamworth & District ES Co.
Leamington & Warwick Electrical Co.	1887-1935	Midland EL&P Co.

[42] 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.
[43] Ministry of Transport, ***Electricity Distribution: Outline of Proposals*** (London: HMSO, 1937).
[44] I.Mech.E. ***Proceedings***, 1937. Leicester summer meeting, p.115.
[45] "The Kelham beet sugar factory", ***The Engineer*** Vol.134, 1922, pp.161-164.
[46] "The Ketton Portland cement works", ***The Engineer*** Vol.148, 1929, pp.640-643.
[47] I.Mech.E. ***Proceedings***, 1937. Leicester summer meeting.

Very few consolidations took place in the East Midlands (**Table 6**). The last two non-statutory companies were taken over by larger companies--Buckingham by Northampton Light & Power in 1928 and Clay Cross by Derbys & Notts Electric Power Co. in 1932.

Hyperbolic reinforced-concrete cooling towers became a new landscape feature in the region, first in Leicester (1926-27), then at Coventry (1928) and Northampton (1934-5). The building of these large structures had largely passed without comment. Plans for the extension of the St Swithin's station at Lincoln, submitted to the Electricity Commissioners in 1944—that included two cooling towers 230 feet high—were more controversial.[48] At the public inquiry held in October, Geoffrey Jellicoe, President of the Institute of Landscape Architects, described the towers as "colossal structures which would be like carbuncles on a man's face".[49] The Electricity Commissioners decided to approve the power station extensions but with the proviso the height of the cooling towers should not exceed 90 feet and the chimneys should be reduced in height. Four cooling towers were built in 1948-49 at this lower height.

III Nationalisation

After three decades of discussion, the whole organisation of electricity was restructured following the Electricity Act 1947. From 1 April 1948, the East Midlands Electricity Board took over the assets of 34 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 East Midlands 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 nine sub-areas. The existing local authority supply areas of Burton-on-Trent, Coventry, Derby, Leicester and Nottingham were retained as sub-areas.

Figure 6 shows the geographical organisation in 1957 when there were 9 sub-areas and 25 districts. One notable feature is the network of 62 service centres where consumers could pay their bills and purchase appliances.[50] These service centres were an important and profitable part of the Board's business.

Postwar economic development brought new demands for power. This was very evident in Coventry where the release of wartime shadow factories provided space for expanding motor vehicle production—Rootes group (Humber and Hillman) at Ryton on Dinsmore, Standard at Canley and Banner Lane (assembly of Ferguson tractors), and Jaguar cars at Browns Lane. In the early 1950s Coventry accounted for nearly a quarter of British car production and one third of farm tractors. The rapid growth of Coventry's population from 178,000 in 1931 to 306,000 in 1961 stretched the infrastructure especially in housing. Increasing government restrictions forced the large vehicle manufacturers to build new factories in Merseyside and Scotland by the end of the decade.

Over the decade 1948/9 to 1958/9, total sales of electricity in the region grew from 2,939m kWh to 6,431m kWh. The number of consumers expanded from 935,000 to 1,304,000. Employees of the Board increased from 7,547 in March 1949 to 9,927 in 1959.

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[48] John Sheail, ***Power in Trust: the environmental history of the Central Electricity Generating Board*** (Oxford: Clarendon Press, 1991), pp.31-33.
[49] ***The Times***, 6 October 1944, p.2. A composite photograph of the proposed power station and the cathedral was published in the issue of 7 October, p.8.
[50] ***Electricity Supply Handbook 1958*** (London: Electrical Times, 1958), pp.106-111.

Figure 6

Electricity Generation and Transmission

The East Midlands Division of the British Electricity Authority covered the same area as the distribution board. It was an amalgamation of the 132kv transmission system developed by the Central Electricity

Board and the power stations previously owned by the local authorities and companies. 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 7 British Electricity Authority: Power Stations in the East Midlands Division 1948/49

POWER STATION	GENERATING CAPACITY (kW)	TYPE[1]
Spondon	172,000	S
Nottingham	148,500	S
Coventry	130,750	S
Leicester	89,250	S
Northampton	88,500	S
Derby	65,500	S
Warwick	48,000	S
Buxton	45,000	S
Lincoln	30,000	S
Kettering	8,500	S
Chesterfield	6,380	S
Hinckley	6,000	S
Loughborough	5,500	S
East Retford	870	I
Sleaford	400	I
	845,150	

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

Table 7 lists the 15 power stations in the new organisation. They varied in size from large turbine-powered stations at the top to small diesel-engine powered units at the bottom.

From an early stage in the strategic planning of the BEA, the East Midlands began to take a prominent place in the expansion of the generating system. The middle and lower stretches of the River Trent had many advantages for the location of new power stations. Although cooling towers would be needed at all the power plants, the river flow would sustain several large-scale operations. The railway network that crossed the river at many points offered good access to productive collieries with longterm potential in the East Midland coalfield.

By the end of 1953 plans were ready for developing the potential of the Trent Valley.[51] There were two interrelated parts to the plans:

1. A high-voltage transmission system at 275kv, in which a single-circuit had a carrying capacity six times larger than the 132kv circuits of the 1930s grid. With these economies of transmission, coalfield power stations could supply distant load centres more cheaply than the traditional movement of trainloads of coal. The first section of the 275kv Supergrid from Staythorpe to West Melton near Barnsley, a distance of 41 miles, was energised in July 1953. By March 1959, 926 route miles of Supergrid had been brought into service in England and Wales.
2. The construction of seven large power stations that incorporated improvements in generating technology was a major part of the 1953 plans. Significant details were as follows:

[51] British Electricity Authority, ***Power and Prosperity*** (London, 1954), 122p. This book, printed at 1/-- (5p.), presented a popular account of the achievements of the BEA and outlined the plans for the Supergrid and the new power stations (Appendix 2). See also: E.M. Rawstron, "The salient geographical features of electricity production in Great Britain," ***Advancement of Science*** Vol.12 (no.45), 1955, pp.73-82; and E.M. Rawstron, "Power stations and the River Trent: a note on further developments", ***East Midland Geographer*** Vol.14, 1960, pp.27-32.

a. Staythorpe A (first unit commissioned March 1950) and Drakelow A (December 1954) used 60,000kW generating sets. Boiler units at Staythorpe produced 240,000lbs of steam per hour at 900lbs per square inch, while the larger boilers (515,000lbs/hour) at Drakelow had a high pressure at 1,550lbs psi.
b. Castle Donington (November 1956) and Willington A (December 1957) had 100,000kW generating sets and boilers of 830,000lbs/hour capacity at 1600lbs psi.
c. Drakelow B (April 1959) and Staythorpe B (July 1960)[52] had slightly higher boiler capacities at 860,000lbs psi.
d. High Marnham (October 1959) included larger generators at 200,000kW and correspondingly larger boilers of 1,460,000lbs/hour at 2,450lbs psi.

The higher boiler pressures all contributed to improvements in thermal efficiency. Castle Donington achieved a rating of 31.53 percent in 1957 compared with 27.60 percent at Staythorpe. Coventry power station, unchanged from 1941, was rated at only 17.60 percent in 1957. Later stations such as High Marnham reached 33.66 percent in 1966.[53]

ELECTRICITY GENERATION: WORKS COST PER KWH SENT OUT FROM POWER STATIONS 1958/59

DIVISION/REGION	*WORKS COST (D.)*	*INDEX NO.*
London	0.8317	128.5
South Eastern	0.7413	114.6
South Western	0.7254	112.1
Eastern	0.6974	107.7
North Western	0.6765	104.5
England & Wales	0.6470	100.0
Southern	0.6398	98.8
North Eastern	0.6110	94.4
Midlands	0.6019	93.0
South Wales	0.5969	92.2
Yorkshire	0.5340	82.5
East Midlands	0.5141	79.4

Source: Compiled from Central Electricity Generating Board, ***Annual Report***, Statement 6, p.115.

The low works cost of the East Midlands and Yorkshire divisions would be a major factor in the siting of new coal-fired power stations over the next decade. "Merry-go-round" coal trains introduced in 1965[1] brought reductions in transport costs and also allowed a few exceptions such as the large stations at Didcot near Oxford and Fiddlers Ferry near Widnes.

In an industry converting one form of energy into another, fuel was now the dominant cost, amounting to 89.7 percent of the works cost in the East Midlands. The cost of fuel included the purchase of coal from the National Coal Board, handling and preparation (pulverising) as well as the flue gas treatment and ash disposal after combustion. The remaining costs were repairs and maintenance 4.8 percent and operation 5.5 percent.

Note:
[1] David Monk-Steel, ***Merry-go-round on the rails*** (Ripley, Derbys: Historical Model Railway Society, 2011).

[52] The 1953 plans were later modified to use 120,000kW units and larger boilers.
[53] Drax power station achieved a thermal efficiency of 36.85 percent in 1984/85. This was about the maximum ever reached by coal-fired steam turbines.

All seven stations were completed by 1962 when they represented nearly 10 percent of all generating capacity in England and Wales. By 1963/64 the same power stations contributed 15 percent of all electricity sent out from generating plants.[54]

Changing styles of power station buildings in the Trent valley after 1948 were apparent in the two built at Staythorpe, each with a capacity of 36,000kW. Staythorpe A, designed in the 1940s, was a long, horizontal structure (a "brick cathedral") housing six generators and three boiler houses. In contrast, Staythorpe B was much more compact. While some brick was used for the façade of the turbine house, the rest of the building was encased in aluminium cladding. A single boiler house provided steam for the turbines and the one concrete chimney stack contrasted with the three brick chimneys of the older station.

With the exception of Staythorpe A, the other six stations required cooling towers in order to avoid overheating the River Trent especially in periods of low water levels. The hyperbolic reinforced-concrete cooling towers at Castle Donington were 300 ft high and capable of cooling 4.5 million gallons per hour. Later towers at High Marnham were 340 ft high and had capacities of cooling 5.4 million gallons per hour.

Power station development faced new obstacles in the postwar period as legislation such as the Town and Country Planning Act and Clean Air Act took effect, as well as rising public concern about environmental and community issues. High water temperatures on the River Derwent affecting local fishing were the basis of a court case in 1952 and the British Electricity Authority was forced to build additional cooling towers at Spondon.55 Concerns about air pollution in Newark required the modification of plans for the Staythorpe B station with the chimney height being extended by 100 feet. The proposal to build a 2,000,000kW station at Holme Pierrepoint in 1960 on the eastern edge of Nottingham was rejected after a public inquiry in 1960-1.56

The main components of the national grid transmission system as completed in 1933 are illustrated in **Figure 7**. The southern line via Northampton connected with the South East England Electricity Scheme at Bedford. This was the only link between the East Midlands and other sections of the grid. By 1946 the principal change was the building of a new 132kv line from Leicester to a new power station at Little Barford which also gave a direct link to the high-demand centre at Corby. A transformer station at Bourne reinforced supply for the lower-voltage lines in the south Lincolnshire area.

By 1957 the map emphasises the role of Staythorpe as the anchor of much of the transmission system in the region. There were three substations. One at 66kv linked Staythorpe with Spondon and other parts of the older Derbys & Notts Electric Power Co. network. A 132kv substation was for new lines to Corby and Boston. The 275kv Supergrid point was part of the new high-voltage link northwards to Yorkshire, south to the London area and west to Drakelow and on to Carrington near Manchester. Many extensions to the Supergrid would be added after 1957.

During the first decade of operation the East Midlands Division built four new power stations and raised generating capacity from 845,150kW to 2,528,500kW. The transmission line capacity was increased to 781 route miles of which 173 route miles were part of the 275kv Supergrid. Over the period numbers employed rose from 2,264 to 3,656.

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[54] Central Electricity Generating Board, ***Statistical Yearbook***, 1963/64.
[55] John Sheail, ***Power in Trust*** (1991), pp.61-68.
[56] Sheail (1991), pp.153-155.

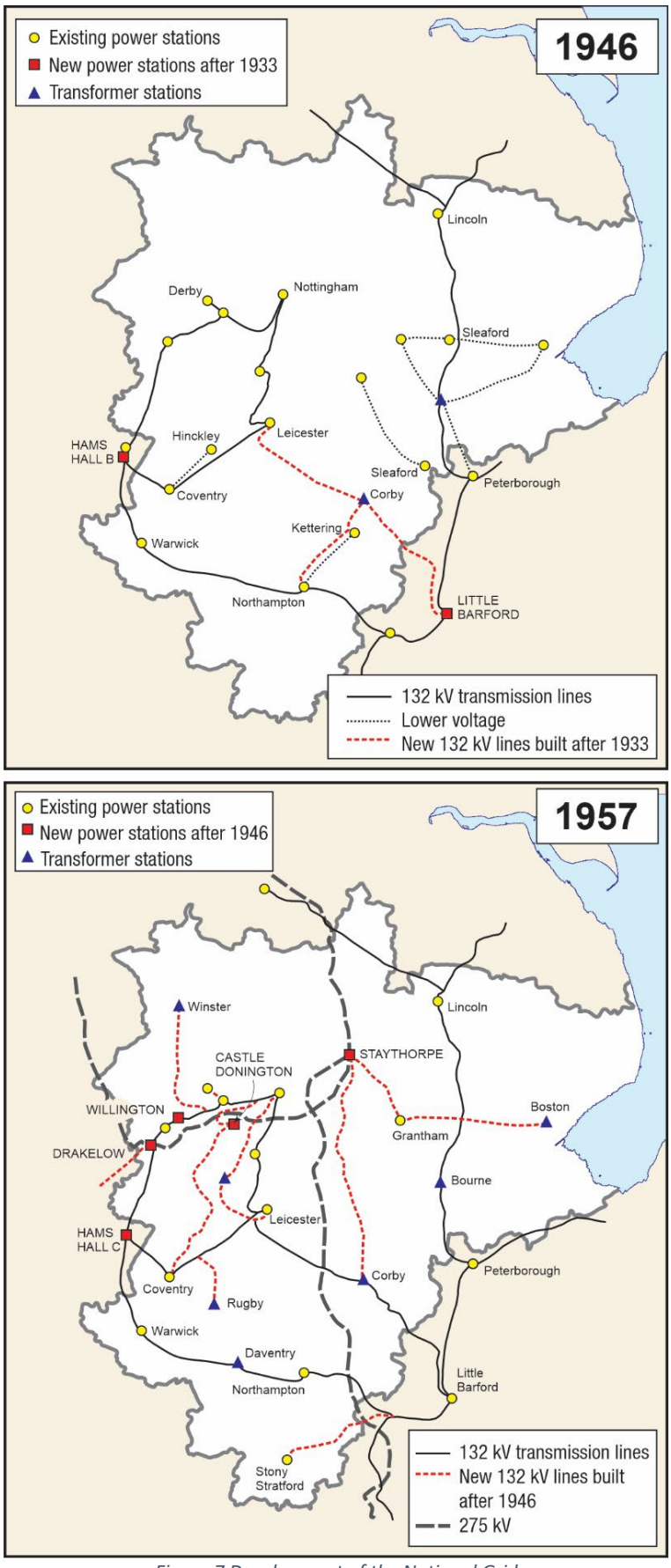

Figure 7 Development of the National Grid

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 Midlands Region was established incorporating the Midlands and East Midlands Divisions. Under the new arrangements the regional director at Warwick House, Redhill Road, Birmingham, became responsible for the higher-order planning and administration of 29 power stations, 1,242 route miles of transmission lines and 8,040 employees. Design work on new power stations was transferred to the Midlands Projects Group at 59 Wake Green Road, Birmingham and transmission development was centralised in Guildford.

Table 8 Central Electricity Generating Board: Power Stations in the East Midlands Division 1958/59

POWER STATION	GENERATING CAPACITY (kW)	TYPE[1]
Castle Donington	500,000	S
Staythorpe A	360,000	S
Nottingham	314,000	S
Willington A	300,000	S
Drakelow A	240,000	S
Spondon	172,000	S
Northampton	142,500	S
Leicester	138,250	S
Coventry	130,750	S
Lincoln	80,000	S
Derby	65,500	S
Buxton	43,500	S
Warwick	42,000	S
	2,528,500	

Notes:
[1] S – Steam
Source: Compiled from Central Electricity Generating Board, ***Annual Report 1958-9***, Appendix 1.

Summary

Table 9 Summary of Development in East Midlands Electricity Board Area

YEAR	NUMBER OF UNDERTAKINGS[1]	LOCAL AUTHORITY UNDERTAKINGS	NUMBER OF POWER STATIONS	GENERATING CAPACITY (kW)	PER CAPITA CONSUMPTION (kWh)[3]
1900	9	7	7	..	.. (4)
1912	24	16	25	..	.. (36)
1925/6	28	16	30	270,296	90 (133)
1935/6	34	21	22	456,070	324 (374)
1948/9	..	..	15	845,150	813 (821)
1958/9	..	..	13	2,528,500	1673 (1765)

Notes:
[1] 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.

Table 9 shows various indicators of the growth of electrification from 1900. Seven of the nine undertakings in that year were local authorities, a point that illustrates the strong municipal role in the region. The Northampton Light and Power Co. should not be overlooked, however, as a fairly rare example of an enterprise developing from an urban core to serve the town's larger hinterland. After a

slow start, the two power companies in the region came to prominence as they gradually covered their statutory areas with a public supply network.

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 are reflected in the increasing size of power stations. Spondon was the earliest to adopt 30,000kW units by the mid-1930s. These generators were surpassed after the war by 60,000kW machines at Staythorpe (1950), 100,000kW at Castle Donington (1956) and 20,000kW at High Marnham (1959). When completed in 1962, with a total capacity of 1,000,000kW, High Marnham was the largest power station in Europe.

Per capita consumption in the East Midlands area (with Great Britain in parentheses) shows substantial rates of growth although always less than the national average. Coventry was an exception with high levels of consumption between the wars as the town consolidated its position as a major centre of vehicle manufacturing.

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 even in the larger urban centres. This 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 full details of personnel and company directors. Garcke also covers many of the non-statutory companies which 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.[57] They were,

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

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.

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)[58] 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 East Midlands 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.

Two collections have material relevant to the East Midlands Area:

> The University of Nottingham Manuscripts and Special Collections has many of the company records once held by the East Midlands Electricity Board. These include the Derbys & Notts Electric Power Co. (Catalogue BEDN), Leics & Warwicks Electric Power Co. (BEL) and Northampton Light & Power CO. (BEN). Such records offer many possibilities for research on the electrification of large areas beyond the municipalities.
>
> The Museum of Science and Industry in Manchester holds the records of the former Electricity Council. These include reports of the Electricity Commissioners, the Central Electricity Board and all the organisations after 1948. The archives also has an accessible set of Garcke's ***Manual.***

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

WILLINGTON

Located midway between Derby and Burton-upon-Trent, the two stations were planned as part of the strategy of building large power stations in the East Midlands coalfields. The A station (first commissioned December 1957) had four 100,000kW turbo-alternators while the B station (June 1962) had two 200,000kW machines. The stations were connected to the 132kv and 275kv grid transmission lines.

Ordnance Survey 1:25,000 series, Sheet SK32, 1966 (National Library of Scotland)