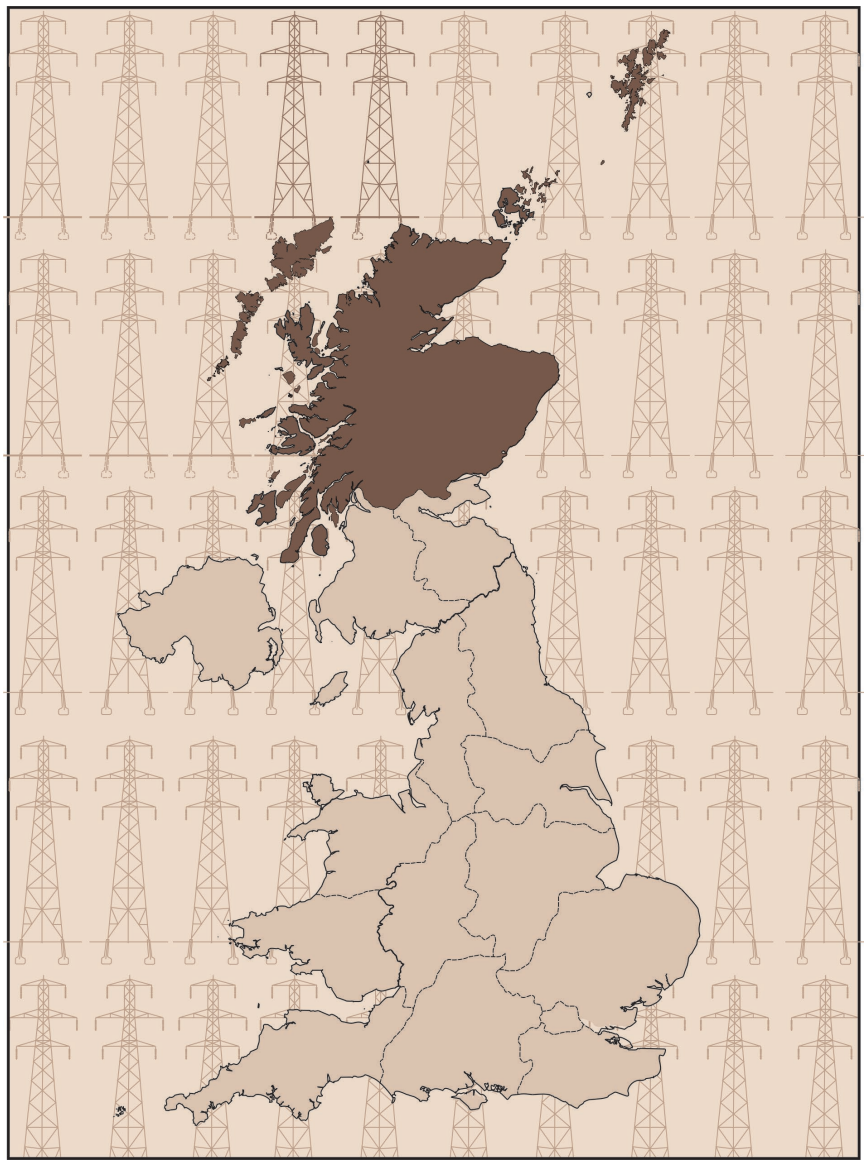

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD AREA

Regional and Local Electricity Systems in Britain

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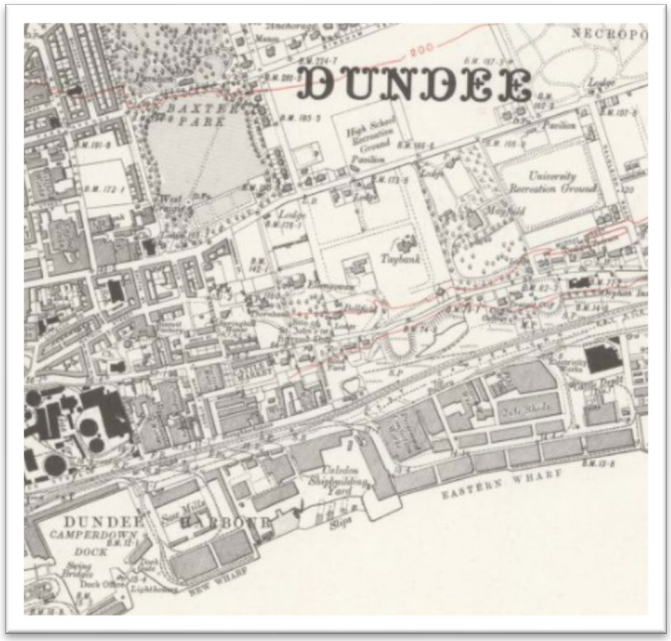
Contents



DUNDEE

The Stannergate or Carolina Port generating station was an AC (50Hz) steam turbine plant opened in February 1910. It was linked to the Central Scotland grid in 1931 and was the largest station (capacity 69,625kW) in the Hydro Board of 1948. A new 30,000kW steam turbine was installed in 1957 as part of its continuing role in balancing the hydraulic systems in the Highlands.

Ordnance Survey Six Inch Map series, Forfarshire (Angus) Sheet LIV.NW, 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 Northern Scotland.

The North of Scotland Hydro-Electric Board Area

Established by the Hydro-Electric Development (Scotland) Act 1943, the Board differed from the area boards in origins and constitution. The Board combined generation and distribution and remained independent from the British Electricity Authority after 1948.

The North of Scotland District defined in the 1943 legislation comprised: the County of the City of Aberdeen, the counties of Aberdeen, Argyll, Banff, Bute, Caithness, Inverness, Kincardine, Moray, Nairn, Orkney, Ross and Cromarty, Sutherland and Zetland, as well as parts of the counties of Angus, Dunbarton, Perth and Stirling.[1] An amendment to the 1943 Act was made by the Electricity Act 1947 to extend the area by including the county of Kinross and the remaining parts of Angus (including Dundee) and Perth counties.[2]

Constituents of the North of Scotland Hydro-Electric Board

Nationalisation of the electricity supply industry which began on 1 April 1948 brought ten local authority and nine company undertakings, as well as the holding company Scottish Power, under the control of the Board. These areas varied enormously in size. The Grampian Electric Supply Co. covered 9,385 square miles while the Burgh of Buckie occupied an area of less than two square miles. Aberdeen Corporation's electricity department served an area of 98 square miles, considerably larger than the city area of only 17.7 square miles. As in many places, electricity service areas did not always coincide with those of local authorities.

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[1] 6 & 7 Geo 6. Ch 32, Second Schedule.

[2] 10 & 11 Geo 6. Ch 54, Third Schedule, Part II.

With a total area of about 21,750 square miles and a population of only about 1.1 million, the Board served every type of district from remote islands to densely populated areas in Dundee.[3]

The Board's head office, at 16 Rothesay Terrace, Edinburgh was first occupied by the staff in early 1944 and remained there for decades.

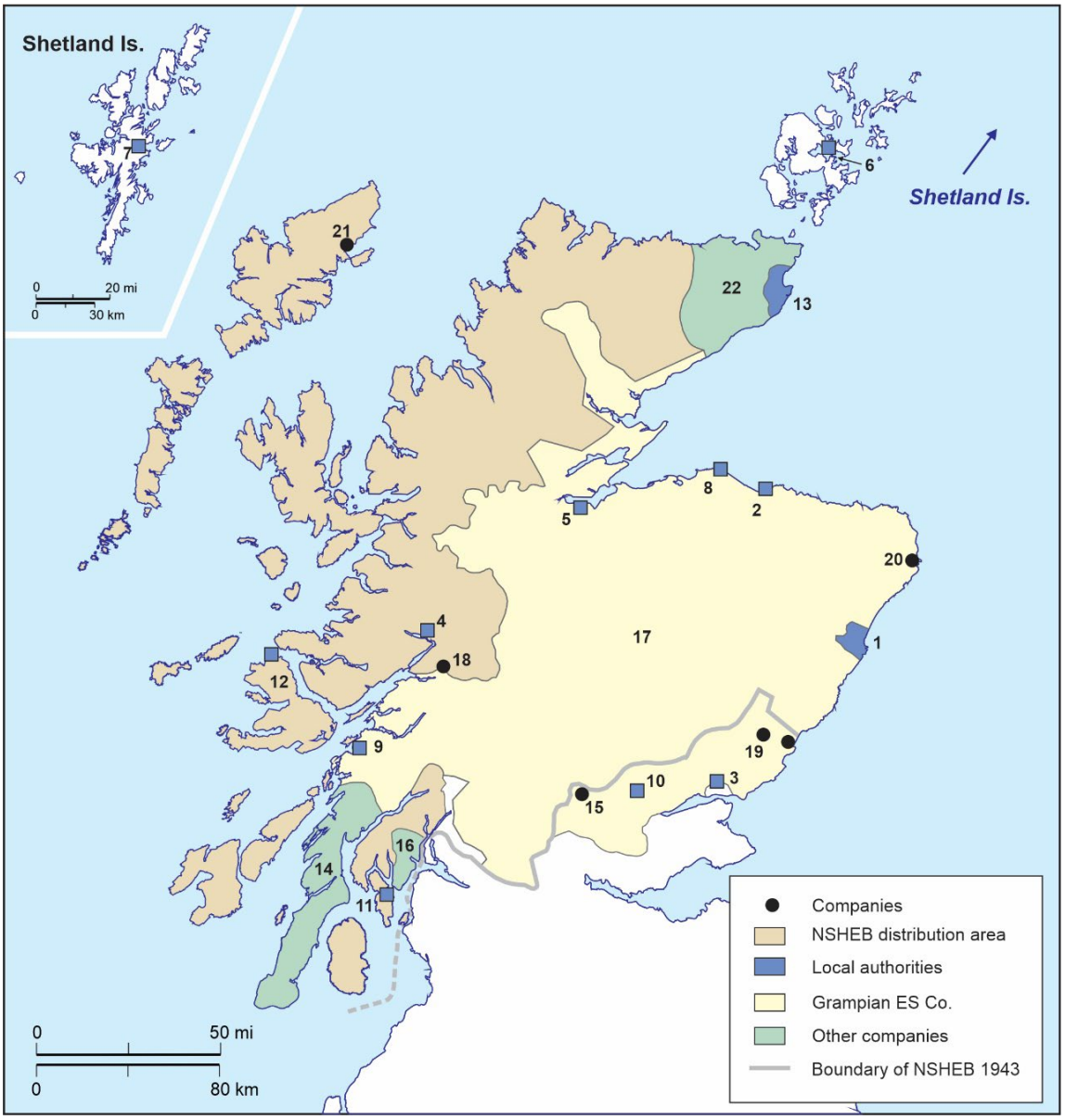

Figure 1 NORTH OF SCOTLAND HYDRO ELECTRIC BOARD CONSTITUENT UNDERTAKINGS, 1948.

[3] The characteristics of this very large region, covering about a quarter of the land area of Great Britain, are well covered in: A.C. O'Dell and K. Walton, ***The Highlands and Islands of Scotland***. Regions of the British Isles. (London: Nelson, 1962); S.J. Jones, ed., ***Dundee and District*** (Dundee, 1965). A regional survey published for the 130th Annual Meeting of the British Association for the Advancement of Science.

Development of Electricity Supply Areas

The 1948 pattern illustrated in **Figure 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.

Table 1 NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD CONSTITUENT UNDERTAKINGS 1948.

MAP #	***LOCAL AUTHORITIES***
1	Aberdeen Corporation
2	Buckie Corporation
3	Dundee Corporation
4	Fort William Corporation*
5	Inverness Corporation
6	KIrkwall Corporation*
7	Lerwick Corporation*
8	Lossiemouth & Brandenburgh Corporation
9	Oban Corporation
10	Perth Corporation
11	Rothesay Corporation*
12	Tobermory Corporation*
13	Wick Corporation*
	COMPANIES
14	Campbeltown & Mid-Argyll ES Co
15	Crieff ES Co
16	Dunoon & District ES Co
17	Grampian ES Co
18	Loch Leven ES Co
19	North of Scotland ES&P Co
20	Peterhead Electricity Co
21	Stornoway ES Co
22	Thurso & District ES Co

Key to Abbreviations
EP Co: Electric Power Company
ES Co: Electricity Supply Company
Note: * These local authority undertakings had already been taken over by the Board in 1946-47.

Source: Electricity Act 1947, Second Schedule; NSHEB ***Annual Report 1948***, p.44.

[4] 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.

Four of the applications in 1882 came from Northern Scotland. Two were from the local authorities in Aberdeen and Dundee: both were "not proceeded with". The two applications from the Brush Electric Light & Power Co. of Scotland were accepted and an Electric Lighting Order was granted for Dundee but was revoked in 1884 since the company had failed to take any action.[5]

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 the new technology. The new University College in Dundee had an electrical engineering laboratory by 1887 with electric light for the drawing office and other rooms.[6]

Public electricity supply systems 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. There were four applications for the North of Scotland in 1890, two each for the cities of Aberdeen and Dundee. Given the Board of Trade's preference for municipal submissions, ELOs were granted to the cities and the applications from the Scottish House-to-House Electricity Co. were not proceeded with.[7]

With the authority of an ELO, the two local authorities began work on building electricity systems. Dundee opened its system in 1893 and Aberdeen followed in March 1894.

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 become 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.

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[5] "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.

[6] Institution of Mechanical Engineers, ***Proceedings***, 1887, p.459. See also: W.E.J. Farris, "Electrical engineering education before 1960", pp.37-38 in D. Dick, ***A Scottish Electrical Enlightenment*** (Glasgow: IEE, 2000).

[7] "Report by the Board of Trade respecting the applications to and the proceedings of the Board of Trade under the Electric Lighting Acts 1882 and 1888 during the past year", ***Parliamentary Papers*** 1890. HC 273.

I Local Initiatives

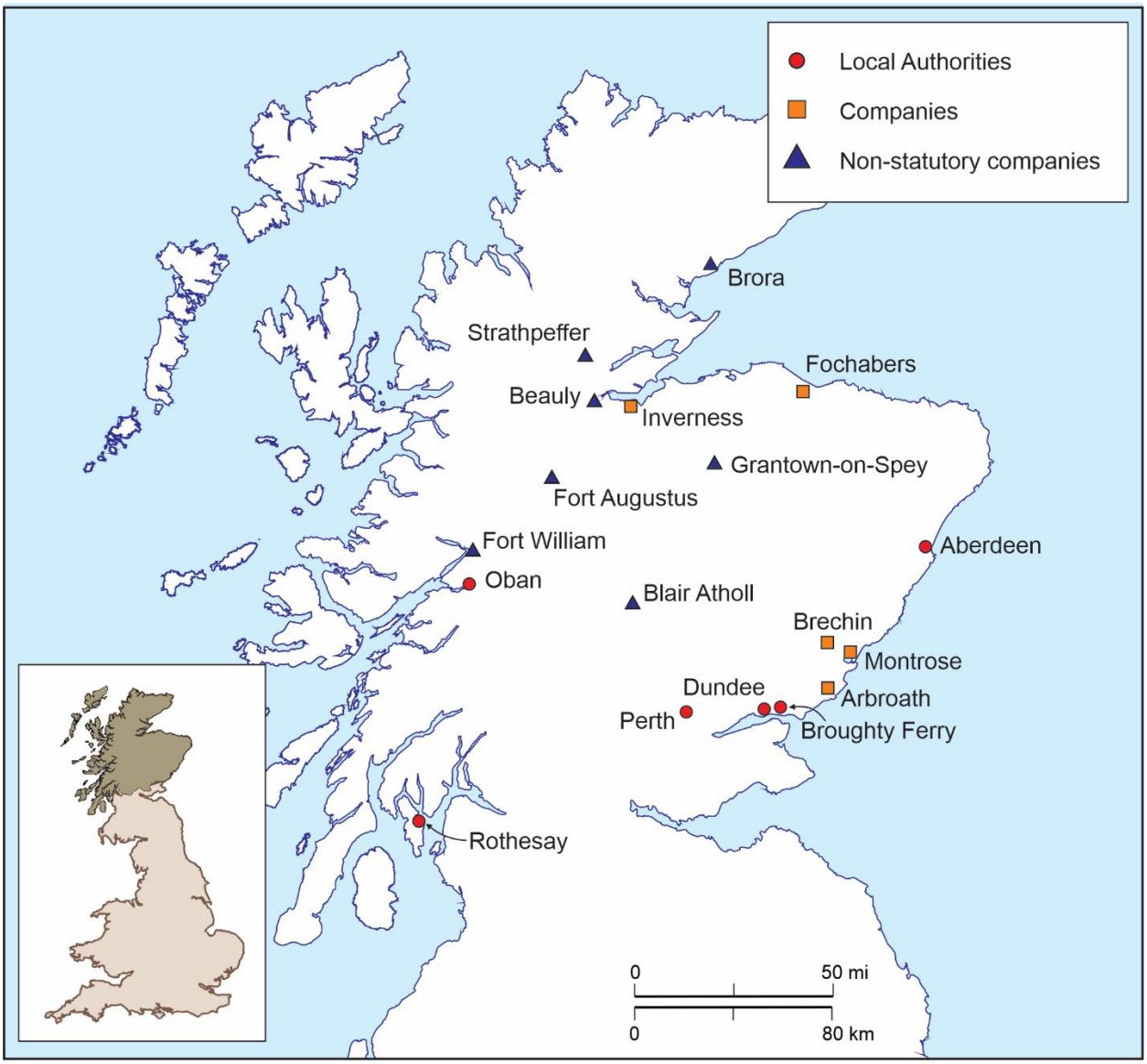

Figure 2 NORTH OF SCOTLAND ELECTRICTY UNDERTAKINGS c. 1912.

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.

The six local authorities were clear examples of local initiative in developing electric light and power. Aberdeen and Dundee were substantial cities with populations around 165,000. Perth, a county town and market centre, had a population of 35,854 in 1911. Broughty Ferry (population 11,058) was a suburban municipality absorbed by Dundee in 1913. Oban was the smallest of the local authorities (population 5,557). Rothesay (population 9,299) had only a small installation for lighting the harbour and the front of the town; a general public supply began in the mid-1920s.

Table 2 NORTH OF SCOTLAND AREA: ELECTRICITY UNDERTAKINGS c.1912.

UNDERTAKING	*COUNTY*	*SUPPLY BEGAN*
Local Authorities		
Aberdeen	Aberdeen	1894
Broughty Ferry	Angus	1902
Dundee	Angus	1893
Oban	Argyll	1903
Perth	Perth	1901
Rothesay	Bute	1899
Companies		
Arbroath	Angus	1908
Beauly N/S	Inverness	1912
Blair Atholl N/S	Perth	1910
Brechin	Angus	1901
Brora N/S	Sutherland	1912
Fochabers	Moray	1904
Fort Augustus N/S	Inverness	1890
Fort William N/S	Inverness	1896
Grantown-On-Spey N/S	Moray	1911
Inverness	Inverness	1905
Loch Leven	Argyll	1910
Montrose	Angus	1901
Strathpeffer N/S	Ross & Cromarty	1903

Notes: N/S Non-statutory undertaking.
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 thirteen companies in the region were very varied in scale and location. The North of Scotland Electric Light & Power Co. was a subsidiary of Edmundson's Electricity Corporation with establishments in Brechin, Montrose and Inverness. In Fochabers the electricity system was part of the estate of the Duke of Richmond, Gordon and Lennox. Loch Leven Electric Supply Co. was a subsidiary of British Aluminium which supplied residents in the company town of Kinlochleven.

Seven of the companies were non-statutory, operating outside the constraints of the Electric Lighting Acts. Non-statutory companies were significant in rural areas from the 1880s to the late 1920s when larger undertakings began to expand beyond town boundaries. St Benedict's Abbey in Fort Augustus was an early example of this type, beginning in 1890 to serve the local community and lasting until 1951 when taken over by the North of Scotland Hydro-Electric Board.[8]

Electrification in the region around 1912 was still incomplete with only a small part covered by Electric Lighting Orders. Among the larger towns without any electricity service were Peterhead (population 13,613 in 1911), Forfar (10,849), Fraserburgh (10,574) and Wick (9,086). The

[8] R.B. Anderson, "The development of electricity supplies in the North of Scotland", ***Proceedings of the Institution of Electrical Engineers*** Vol.108A, 1961, p.30.

Lossiemouth and Brandenburgh Town Council (population 4,207) was beginning to take action and opened a small power station on 14 July 1914.

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 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.

The limitations of DC supply became apparent to many larger undertakings after 1900 and in the search for economies of scale the introduction of more efficient prime movers became a priority. Dundee adopted AC (50Hz) in 1909 when the new Stannergate power station with 2,000kW turbines was completed. Aberdeen which had adopted AC in 1908 installed its first turbine unit in 1911. Conversion to a full AC system was, however, a long process and Dundee still had some DC consumers as late as 1957.

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 many accounts of electrification.

James Keiller & Sons' confectionery and jam factory in the centre of Dundee was "…lighted by electricity generated on the premises and the same power is used for driving the machinery and lifts".[9] In 1933 two large industrial concerns were generating their own power--the Dundee Floorcloth and Linoleum Co. and D.C. Thomson & Co. magazine publishers and printers. The generators at the latter works were powered by gas engines.[10] In Aberdeen the Northern Co-operative's warehouse, oatmeal mill and bakery had its own generators powered by gas engines.[11] Pullar's dyeworks in Perth had developed its own electric supply long before the town began a public system.[12]

Isolated engineering works, such as the Consolidated Pneumatic Tool Co. in Fraserburgh had built a powerhouse at the time of opening in 1904. The Great North of Scotland Railway which has moved its workshops to Inverurie was also "all electric" with independent generating facilities.[13]

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[9] Institution of Mechanical Engineers, ***Proceedings*** 1907. The summer meeting in Aberdeen included visits to works in the city, Dundee and the northeast coast.
[10] I.Mech.Eng. ***Proceedings***,1933 Edinburgh meeting, pp.104-106.
[11] I.Mech.Eng. ***Proceedings***, 1907.
[12].Albert W. Harding, ***Pullars of Perth*** (Perth: Perth & Kinross District Libraries, 1991). The company had installed electric lighting in a dyehouse as early as 1878.
[13] I.Mech.E. ***Proceedings***, 1907, pp.838-848.

By far the largest private generating facilities were the hydro-electric stations of the British Aluminium Company.[14] Low-cost power was an essential requirement for the reduction of alumina which, even in the 1930s after decades of improvement, needed about 26,000 kWh of electricity to produce one ton of aluminium.[15] Foyers, on Loch Ness, opened in 1896 with a capacity of 5,000 kW and was one of the largest power stations of its time.[16] A second, much larger plant was completed at Kinlochleven in 1909 with an initial capacity of 19,150kW. In 1911 the generators were producing an annual output of 150million kWh at very low cost. Such a plant, working continuously, had a very high load factor approaching 100 percent.[17] The Loch Leven Electric Supply Co. was a small subsidiary of British Aluminium serving the company town of Kinlochleven.[18]

Hotels were early in adopting electric lighting as one of the amenities of high-class hospitality. The Cruden Bay Hotel, opened in 1899 by the Great North of Scotland Railway with 96 rooms, not only featured electric light but also the electric tramway between station and hotel.[19] Large hydropathic establishments such as Philip's in Dunblane and Glenburn in Rothesay had to develop their own generating plant to serve the visitors.[20]

Other large institutions of a different type were also introducing electric lighting. The Kingseat Hospital near Newmachar north of Aberdeen, opened in 1904, included a powerhouse to serve the villas on the extensive site.

Throughout the region country houses, estates and large farms added electricity. Balmoral Castle installed two Gilkes turbines in 1898.[21] Altyre House near Forres had a purpose-built generating house from about 1902.[22]

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[14] For general background on the company and power development, see: Andrew Richard, ***Aluminiumville: Government, Business and the Scottish Highlands*** (Lancaster: Crucible Books, 2012); Peter L. Payne, ***The Hydro*** (Aberdeen University Press, 1988), pp.4-15.

[15] George Boex, "The Aluminium industry in Scotland", I.Mech.E. ***Proceedings***,1933, p.18.

[16] Glasgow Corporation's power stations had a capacity of 1,937kW in 1896.

[17] The load factors for Aberdeen (20.65 percent) and Dundee (23.9 percent) were about average for urban undertakings at the time but compare poorly with a large industrial generator. ***Garcke's Manual 1913/14.***

[18] Mary J.F. Gregor and Ruth M. Crichton, ***From croft to factory: the evolution of an industrial community in the Highlands*** (Edinburgh: Thomas Nelson, 1946).

[19] H.A. Vallance, ***The Great North of Scotland Railway*** (Newton Abbot: David & Charles, Revised edition, 1989), pp.95-96.

[20] ***Bradshaw's April 1910 Railway Guide*** (reprinted Newton Abbot: David & Charles, 1968), p.1006.

[21] ***The Engineer***, Vol.86, 1898, p.47.

[22] Elizabeth Benton, "Ancillary estate buildings", Chapter 9 in Geoffrey Stell et al. eds. ***Scotland's Buildings***, Vol.3 in ***Scottish Life and Society*** (East Linton: Tuckwell Pres, 2003) p.205. The Ordnance Survey, Six Inch Map, Elginshire X:NE shows the estate with an "electric light works".

ELECTRIC TRAMWAY SYSTEMS IN THE NORTH OF SCOTLAND[1]

	YEARS OPERATING	*ROUTE MILES*	*MAX NO. OF CARS*
Aberdeen Corporation	1899-1958	15.78	168
Aberdeen Suburban Co.	1904-1927	4.59	11
Cruden Bay Hotel	1899-1932	0.66	2
Dundee Corporation	1900-1956	16.57	109
Dundee, Broughty Ferry & District	1905-1931	5.10	16
Perth Corporation	1903-1929	5.02	12
Rothesay Tramways Co	1902-1936	4.87	24

Seven electric tramway systems were developed in the region between 1899 and 1905, three by local authorities and the others by companies.

Private power stations at Cruden Bay, Broughty Ferry and Rothesay generated the DC current for the tramway services. The Rothesay station in the 1920s sold electricity to the Corporation for its public supply system.

Tramway power supply, as a proportion of total sales, was very important in the early years and ensured the viability of many municipal undertakings. In 1906, for example, tramway power supply (to the corporation and Suburban Company tramways) represented 50.6 percent of Aberdeen's electricity sales. The proportion had declined to 24.2 percent in 1914, as sales especially for power had expanded. Tramway sales were still significant in 1925/26—16.9 percent in Aberdeen, 13.5 in Dundee, and 12.9 in Perth.

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

In 1919 a 3-ft-gauge electric railway was one of Lord Leverhulme's early ideas for improving communities on the Isle of Lewis.[2] Stornoway was to be the centre of a network of over 100 miles of line. The estimated cost of £1.5million, however, quickly put an end to this project.

[1]Compiled from Keith Turner, ***Directory of British Tramways***, Vol.3 (Stroud: The History Press, 2010).
[2]Nigel Nicolson, ***Lord of the Isles: Lord Leverhulme in the Hebrides*** (London: Weidenfeld & Nicolson, 1960), pp.107-110.

II 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 consumption nearly doubled. These issues prompted the Board of Trade to appoint a Water Resources Committee in 1918 "…to examine and report upon the water resources of the United Kingdom and the extent to which they could be made available for industrial purposes". Under the chairmanship of Sir John Snell (later chairman of the Electricity Commissioners) the Committee published three interim reports and a final report in 1921. Detailed investigation of 39 schemes in the Scottish Highlands gave a potential generating capacity of 189,000kW, much larger than the actual development of the two hydro-electric plants of British Aluminium (28,000kW).[23] For the next twenty years the reports of the Water Resources Committee provided a comprehensive view of the regional potential and a base for more detailed research for possible development projects.

The Electricity (Supply) Act 1919 created a new organisation, the Electricity Commissioners, to replace the role of the Board of Trade. While the initial proposals for national restructuring were thwarted, the Electricity Commissioners managed to develop plans for more efficient and lower-cost generation and to encourage the expansion of service areas to supply small towns and rural villages.

Table 3 NORTH OF SCOTLAND AREA: ELECTRICITY SUPPLY UNDERTAKINGS 1925/26.

UNDERTAKING	*COUNTY*	*SYSTEM*	*GENERATING CAPACITY kW*	*PER CAPITA CONSUMPTION kWh*
Local Authorities				
Aberdeen	Aberdeen	AC/DC	26,500	152.9
Dundee	Angus	AC/DC	25,320	199.8
Invergordon	Ross & Cromarty	DC	100	29.3
Kirkwall	Orkney	DC	197	15.7
Lossiemouth	Moray	DC	110	21.0
Oban	Argyll	DC	317	55.4
Perth	Perth	DC	4,600	83.2
Rothesay	Bute	DC	-	7.1
Companies				
Arbroath El&P Co	Angus	DC	2,050	76.1
Ballater[1]	Aberdeen	DC	80	31.7
Brechin[2]	Angus	DC	246	27.0
Crieff ES Co	Perth	DC	162	8.7
Dunblane & District ES Co	Perth	AC	-	3.6
Elgin ES Co	Moray	DC	102	5.6
Ellon[1]	Aberdeen	DC	80	43.0
Fochabers[3]	Moray	DC	166	124.2
Inverness[2]	Inverness	DC	1,600	48.6
Loch Leven ES Co	Argyll	DC	-	113.0
Montrose[2]	Angus	DC	507	42.3

Notes:
[1]Duncans ES Co
[2]North of Scotland EL&P Co
[3]Duke of Richmond, Gordon & Lennox
Source: Compiled from Electricity Commissioners, ***Engineering and Financial Statistics 1925/26.***

[23] J.F. Crowley and E.M. Bergstrom, "The development of natural water power resources: illustrated by a study of Scottish water powers"; and A.H. Gibson, "A review of the water power resources of Great Britain and Ireland". These papers were published in the ***Transactions of the First World Power Conference 1924*** Vol.I (London: Lund Humphries, 1925), pp.349-391.

Table 3 lists the statutory undertakings in 1925/26. The non-statutory undertakings noted earlier in Table 2 generally continued in existence until acquired by new supply companies. Two new local authorities began a public supply in the early 1920s. Both Invergordon and Kirkwall had acquired redundant equipment from adjacent naval bases. In the company sector, Duncan's Electricity Supply Co. had opened systems in Ballater (1914) and Ellon (!915). Other small companies began service in Elgin (1922), Crieff (1924) and Dunblane (1925).

The 19 undertakings in 1925/26 (Table 3) operated a variety of systems. DC was dominant with 16 systems and 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. Aberdeen and Dundee had mixed AC/DC systems. Dunblane which took a bulk supply from the Scottish Central Electric Power Co. was the only place with a wholly AC system.

Data on generating capacity show that all but three of the undertakings generated their own power. Rothesay was supplied by the local tramway company and Loch Leven drew its power from the aluminium plant. Most power stations had capacities of less than 1,000kW.

Steam turbines were dominant in all the larger stations and varied in size from a 10,000kW unit in Aberdeen to one of 750kW in Inverness. Older reciprocating steam engines were still in use but the Dudhope Crescent Road station of Dundee Corporation was the only generating plant still wholly dependent on this type of prime mover. Producer gas plants were operated in Lossiemouth, Ballater and Ellon, while diesel engines were used in all the other small stations.

Statistics on electricity consumption per head of population reveal major contrasts among electricity undertakings. Only four places—Aberdeen, Dundee, Fochabers and Loch Leven--exceeded 100.0kWh per person. Kinlochleven was unusually high for a small settlement, a result of its location in the shadow of the mountains and its earlier free supply of electricity to the residents.[24] Each place had a distinctive market profile reflecting the local economic and social geography. Aberdeen had a well-balanced profile in 1925/26, consisting of 28.4 percent of sales in the lighting segment, 1.4 percent in public lighting, 16.9 percent for the tramways and 53.3 percent in power. Two towns, Arbroath and Inverness, with similar-sized populations (around 21,000) had very different market profiles. Arbroath was dominated by power sales at 80.4 percent, while Inverness was almost evenly balanced between power and lighting sales.

After 1925/26 several new undertakings began public supply in the North of Scotland. Four were local authorities:

1927	Tobermory
1928	Wick
1931	Buckie
1932	Lerwick

[24] Gregor and Crichton, ***From croft to factory*** (1946), p. 54. Free electricity to tenants in the village ended in 1921.

Six new company undertakings were established in the region:

1926 Lairg Electricity Supply Co.
1929 Peterhead Electricity Co.
1930 Dunoon & District Electricity Supply Co.
1932 Stornoway Electric Supply CO.
1934 Thurso & District ES Co.
1935 Campbeltown & Mid Argyll ES Co.

Three of the non-statutory companies already operating in 1912 were "legitimised" by Special Order: Ross-shire Electric Supply Co. (1921—previously Strathpeffer & Dingwall Electric Co.), Beauly Electric Supply Co. (1930), and Grantown-on-Spey Electricity Supply Co. (1931).

The Grampian Electric Supply Company was by far the largest of the new undertakings which emerged after 1925/26. An Act of 1922 authorised the company to serve an area of 4,214 square miles covering Perth and parts of adjacent counties. Power generation would use the waters of Loch Ericht, Loch Rannoch and Loch Tummel. The local promoters of the scheme had difficulty raising capital and turned to George Balfour and the new Power Securities Corporation for assistance.

Local distribution began in 1926 first around Kingussie, then in Angus, when the Arbroath station was purchased and extended. Construction work on the hydro-electric scheme began in 1927 when a contract with the Central Electricity Board ensured its economic viability. Rannoch power station entered service in November 1930, with power flowing along the 132kv transmission line to the substation at Abernathy.

The supply area of the Grampian Company was doubled by the Scottish Highlands Electricity Special Order of 11 November 1932 which covered the northeastern counties. Power for this extended area came initially from the Ross-shire Company (also owned by Power Securities/Scottish Power).

Some indication of the growth of Grampian Company is shown in the following table:

Grampian Electric Supply Co.[25]

YEAR	*TOTAL SALES MILLION kWh*	*LOCAL SALES MILLION kWh*	*BULK SUPPLY MILLION kWh*	*CUSTOMERS*
1929	2.58	0.28	2.30	1,007
1935	153.07	11.54	141.53	7,189
1939	242.88	31.31	211.57	20,320

A high proportion of the bulk sales was to the CEB Scottish grid scheme. Over the same period the generating capacity was increased from 7,135kW to 92,800kW.

[25] Garcke's ***Manual*** 1930/31; ***Engineering and Financial Statistics*** 1935-36, 1939-42.

The national transmission grid, authorised by the Electricity (Supply) Act 1926 and implemented by the Central Electricity Board, had only a limited effect on the region. The Central Scotland Electricity Scheme was approved in mid-1927 and largely completed by 1930. Dundee was connected in early 1931 with Carolina Port as a selected station. Some preliminary investigations for a grid scheme in North Scotland were made by the Electricity Commissioners in 1929-1931. Further work was suspended when the Grampian Company applied for a Special Order covering the central Highlands and northeast coast.[26]

When trading began on 1 January 1933, the grid had added a new layer to the complex of undertakings that operated the electricity supply system. The grid control office of the CEB at Broomhill Drive, Glasgow, now managed the flows of power on the transmission lines and directed the hour-to-hour operation of the selected power stations. These stations, such as the one at Dundee, remained in the ownership and management of the Corporation but the daily operation was now directed from Glasgow. Planning for the future became increasingly centralised, particularly from London.

Table 4 shows the situation in 1935/36 when 31 undertakings were in operation. Over the previous decade many changes had taken place. The introduction of AC in many places was an important shift which allowed for long-distance transmission and interconnection. Only three in 1925/6 were mixed AC/DC or wholly AC. In 1935/36 there were 15 mixed AC/DC and AC systems.

Generating technology emphasised economies of scale with larger units which brought major reductions in coal consumption. Aberdeen improved its thermal efficiency with coal consumption declining from 2.46lbs per kilowatt-hour generated in 1925/26 to 1.54lbs a decade later. While steam turbines were the principal prime movers in all the larger stations, diesel engines provided most of the generator power in the smaller plants.

The development of hydro-electric power from the late 1920s had a profound effect on the structure of generation in the North of Scotland. In 1925/6 there were two small hydro-electric plants, at Crieff and Fochabers, with a combined capacity of 113kW.[27] By 1935/36 as well as the small hydro stations at Crieff, Fochabers, Inverness and Tobermory (all less than 100kW), there was a larger plant at Loch Luichart (2,450kW) and two very large stations at Rannoch (48,000kW) and Tummel (34,000kW). The total capacity of these hydro-electric stations was 84,726kW or about 47 percent of the total regional generating capacity. The water turbines at Rannoch and Tummel (16,000kW and 17,000kW) were larger than the largest steam turbines in Aberdeen or Dundee. One effect of this new hydraulic generating capacity was to reduce the dominance of Aberdeen and Dundee in the structure of regional generating capacity from 83.3 percent in 1925/26 to 42.6 percent a decade later.[28]

[26] Electricity Commissioners, ***Twelfth Annual Report 1931-1932***, p.15.
[27] Other small hydro-electric plants were owned by non-statutory companies.
[28] The combined sales of electricity in Aberdeen and Dundee represented 79.1 percent of the regional sales in 1935/36 although the two towns accounted for only 30.7 percent of the total population of the North of Scotland.

Table 4 NORTH OF SCOTALND AREA: ELECTRICITY SUPPLY UNDERTAKINGS 1935/36.

UNDERTAKING	SYSTEM	GENERATING CAPACITY kW	PER CAPITA CONSUMPTION kWh
Local Authorities			
Aberdeen	AC/DC	37,000	283.0
Buckie	DC	370	43.5
Dundee	AC/DC	39,625	411.5
Inverness	AC/DC	2,410	144.7
Kirkwall	DC	234	64.4
Lerwick	DC	377	76.4
Lossiemouth	DC	258	98.7
Oban	AC/DC	1,072	151.2
Perth	DC	-	219.0
Rothesay	DC	795	80.4
Tobermory	DC	45	27.3
Wick	AC/DC	833	56.7
Companies			
Arbroath	AC/DC	-	84.7
Ballater	DC	-	59.0
Beauly	AC	-	96.0
Brechin	DC	246	61.7
Campbeltown	AC	200	1.0
Crieff	AC/DC	162	34.9
Dunblane	AC	-	60.3
Dunoon & District	AC	1,260	80.0
Elgin	DC	637	60.2
Ellon	DC	84	56.3
Fochabers	DC	172	158.2
Grampian	AC/DC	92,800	17.6
Grantown-On-Spey	DC	136	54.9
Lairg	AC/DC	224	71.4
Loch Leven	DC	-	198.3
Montrose	DC	432	70.2
Peterhead	AC	424	23.0
Ross-Shire	AC	2,450	45.4
Stornoway	DC	395	42.6

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

Rationalisation of generation and interconnection of undertakings, though still limited in this vast region, helped to reduce the cost of electricity. Other factors such as the growth of radio broadcasting and lower prices for small appliances helped to boost electricity consumption, especially in the larger centres. By 1935/36 there were seven places in the region with per capita consumption levels above 100kWh.

The growth of electricity sales, especially in the lighting segment which included domestic uses, may be illustrated by the case of Aberdeen. Total electricity sales grew from 26.78million kWh in 1925/26 to 54.74m kWh a decade later. Over the same period, per capita consumption in

Aberdeen rose from 152.9kWh to 283.0kWh. The number of consumers grew from 13,037 in 1929 to 32,375 in 1935/36.[29]

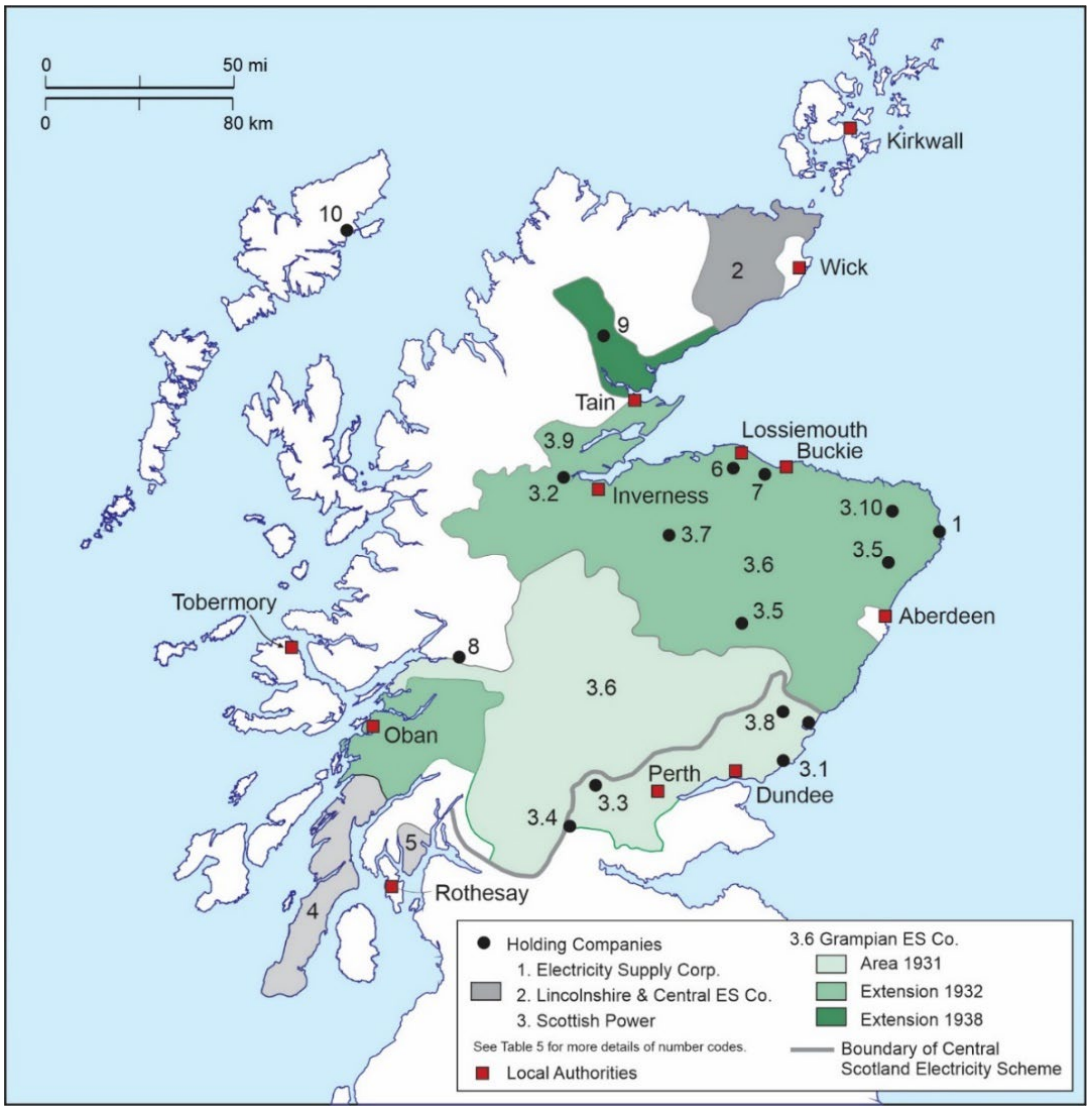

Figure 3 NORTH OF SCOTLAND CORPORATE HOLDINGS 1934-35.

Table 5 and **Figure 3** illustrate the dominance of Scottish Power Co. Ltd in the corporate structure of electricity undertakings in the region. This company, formed in 1909 and dominated by George Balfour (1874-1941), became a core interest of Power Securities in 1922. From the mid-1920s, Scottish Power began to acquire assets in the north beginning with the Grampian Company. By 1934 it owned ten companies in the region (including the small non-statutory Strichen company in Aberdeenshire).

[29] Hugh C. Mackenzie, ed. ***The City of Aberdeen. Third Statistical Abstract of Scotland*** Vol.4 (Edinburgh: Oliver & Boyd, 1953), pp.363-368. This volume contains a useful review of electricity supply.

Other holding companies included the Electric Supply Corporation in Peterhead and the newly formed Thurso & District Electric Supply Co. owned by the Lincolnshire & Central Company.[30]

Table 5 NORTH OF SCOTLAND: CORPORATE STRUCTURE OF ELECTRICITY HOLDING COMPANIES 1934/35.

1. Electric Supply Corporation	1.1 Peterhead Electricity Co.
2. Lincolnshire and Central	2.1 Thurso & District
3. Scottish Power	3.1 Arbroarth EL&P 3.2 Beauly ES 3.3 Crieff ES 3.4 Dunblane & District 3.5 Duncans 3.6 Grampian Co. 3.7 Grantown-on-Spey 3.8 North of Scotland EL&P 3.9 Ross-shire 3.10 Strichan
Other Companies	4. Campeltown & Mid-Argyll 5. Dunoon& District 6. Elgin 7. Gordon Richmond Estates Co. 8. Loch Leven ES Co. 9. Lairg ES Co. 10. Stornoway Co.

Source: Political and Economic Planning, ***Report on the Supply of Electricity in Great Britain*** (London: PEP, 1936), pp.140-141.

The efforts of the Electricity Commissioners to rationalise distribution, reflected in the McGowan Report published in May 1936[31] had little relevance to the North of Scotland. A recommendation in the Report, that all undertakings with annual sales of less than 10 million kWh should be amalgamated, was controversial and highlighted disparities in the region. Only Aberdeen, Dundee and the Grampian Company had sales above this limit. The government's Outline of Proposals published in April 1937[32] had little support and more pressing issues of the time meant that reorganisation of distribution was set aside.

Power station development after 1935/36 was limited to extensions, mainly of the steam plants at Aberdeen and Dundee. A 12,500kW turbine was added at Aberdeen by 1939 and a 30,000kW unit installed at the Carolina Port station in Dundee. Although the region's emphasis shifted to hydro-electric power after 1943, these two stations continued in service long after nationalisation. A further 30,000kW turbine was installed at Dundee in 1957.

[30] The Thurso company began as a non-statutory operation in 1934 and was granted a Special Order in February 1937. By 1940 the Lincolnshire & Central Company also owned the Campbeltown & Mid-Argyll Co. How this Northwood, Middlesex company came to be interested in the North of Scotland is worth investigation.

[31] 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.

[32] Ministry of Transport, ***Electricity Distribution: Outline of Proposals*** (London: HMSO, 1937).

The rejection of the Caledonian Power Company scheme by Parliament in March 1936 began a long period of uncertainty about the future of hydro-electric development in the Highlands.[33] Further attempts to move the Caledonian bill in 1937 and 1938 also ended in failure. A later effort by the Grampian Company to develop Glen Affric was defeated in 1941. Opposition to these proposals came from various groups, including the coal lobby, environmentalists and nationalists as well as local community interests.[34]

At the same time, other groups such as the Highland Development League and the Scottish Economic Committee, both formed in 1936, were pressing for development projects that would alleviate unemployment and reduce outward migration from the Highlands.[35] Many of the proposals were inspired by the model of the Tennessee Valley Authority which combined flood control and hydro-electric plants with economic and social development.[36] Implementation of such plans would require a fairly high degree of state intervention.

The appointment of Tom Johnston (1881-1965)[37] as Secretary of State for Scotland in February 1941 began a series of political moves that eventually broke the impasse. These may be summarized as follows:[38]

- September 1941: Creation of a Council of State comprising former Secretaries of State to examine priorities for postwar development.
- October 1941: Appointment of Cooper Committee to consider further developments in the use of water-power in Scotland.
- December 1942: Cooper Committee report published (Cmd 6406). For future development "…there was no realistic alternative to the creation of a new public service corporation called the North Scotland Hydro-Electric Board."[39]
- February 1943: Second reading of Hydro-electric bill.
- August 1943: Hydro-Electric Development (Scotland) Act passed.
- September 1943: Appointment of North of Scotland Hydro-Electric Board. Four members appointed jointly by the Secretary of State and Minister of Fuel and Power; one nominated by the Central Electricity Board.

Edward MacColl (1882-1941), as deputy chairman and chief executive of the Board, was the most important appointment. He had extensive experience in electrical engineering, with Glasgow tramways, the Clyde Valley Electrical Power Co. and, from 1927, as engineer and manager of the Central Scotland area of the Central Electricity Board. In the later 1930s he had

[33] "Caledonian Power Scheme", ***The Engineer*** Vol.161, 1936, pp.334, 341.
[34] See Bill Luckin, ***Questions of Power: Electricity and environment in inter-war Britain*** (Manchester: Manchester University Press, 1970), Chapter 7 "Exploiting the Highlands".
[35] Scottish Economic Committee, ***Highlands and Islands of Scotland—a review of economic conditions, with recommendations for improvement*** (Glasgow, 1938).
[36] Political and Economic Planning reviewed the TVA in its broadsheet ***Planning*** No.76, June 2, 1936 and the "state of the Highlands" in No. 81, Sept 8, 1936. See also: Julian Huxley, ***TVA: adventure in planning*** (London: The Scientific Book Club, 1943).
[37] Russell Galbraith, ***Without quarter: A biography of Tom Johnston*** (Edinburgh: Birlinn, 2018).
[38] P.L. Payne, ***The Hydro*** (1988), Chapter 3, "The genesis of the North of Scotland Hydro-Electric Board."
[39] P.L. Payne, ***The Hydro*** (1988), p.41.

worked on various schemes for hydro-electric development in Scotland, including a 360,00kW pumped storage plant at Loch Sloy.[40]

The work of the Board was specified in the Act of Parliament:

a) To initiate and undertake the development of all further means of generation of electricity by water power within the North of Scotland District;
b) To distribute electricity to ordinary consumers in areas outside the areas of supply of other Authorised Undertakers;
c) To provide electricity in bulk to other Authorised Undertakers operating in the North of Scotland District, either direct or through an Authorised Undertaker;
d) To provide electricity for large power users in the District, either direct or through an Authorised Undertaker;
e) to supply electricity to the Central Electricity Board.

All new waterpower generating capacity in the North of Scotland from 1943 was to be built and operated by the Board. Existing facilities would continue to be owned and operated by the companies. Each new project or constructional scheme required the approval of the Electricity Commissioner, confirmation by the Secretary of State and the Order was laid before Parliament for 40 days.

The distribution area of the Board beyond the limits of the authorised undertakings was a particularly challenging zone. Low population densities, isolated communities and a difficult environment made this difficult and expensive zone to service. For many places this would mean a localised system with small generating plants, often diesel. All distribution systems required the approval of the Secretary of State.

Constructional scheme No.1 included three power stations—Loch Sloy (130,000kW), Lochalsh (625kW) and Monar (360kW). The large station at Loch Sloy was designed to produce revenue from power sales to the Central Electricity Board, which would help to finance the small plants for local communities, such as the two attached to this scheme. Approved in principle by the Electricity Commissioners in June 1944 and by the Secretary of State, the scheme was published. Since there were many objections, a public inquiry was held in Edinburgh during December. This proved to be acrimonious and protracted, but in the end was confirmed by the Secretary of State and became operative on 28 March 1945 after the laying before Parliament for the statutory 40 days. The project was launched on 11 June with a formal ground-breaking at the construction site.

[40] Peter L. Payne, "Sir Edward MacColl", in ***Dictionary of Scottish Business Biography*** Vol.2 (Aberdeen: Aberdeen University Press,1990), pp.238-241; Norrie Fraser, ed. ***Sir Edward MacColl: a maker of modern Scotland*** (Edinburgh: Stanley Press, 1956).

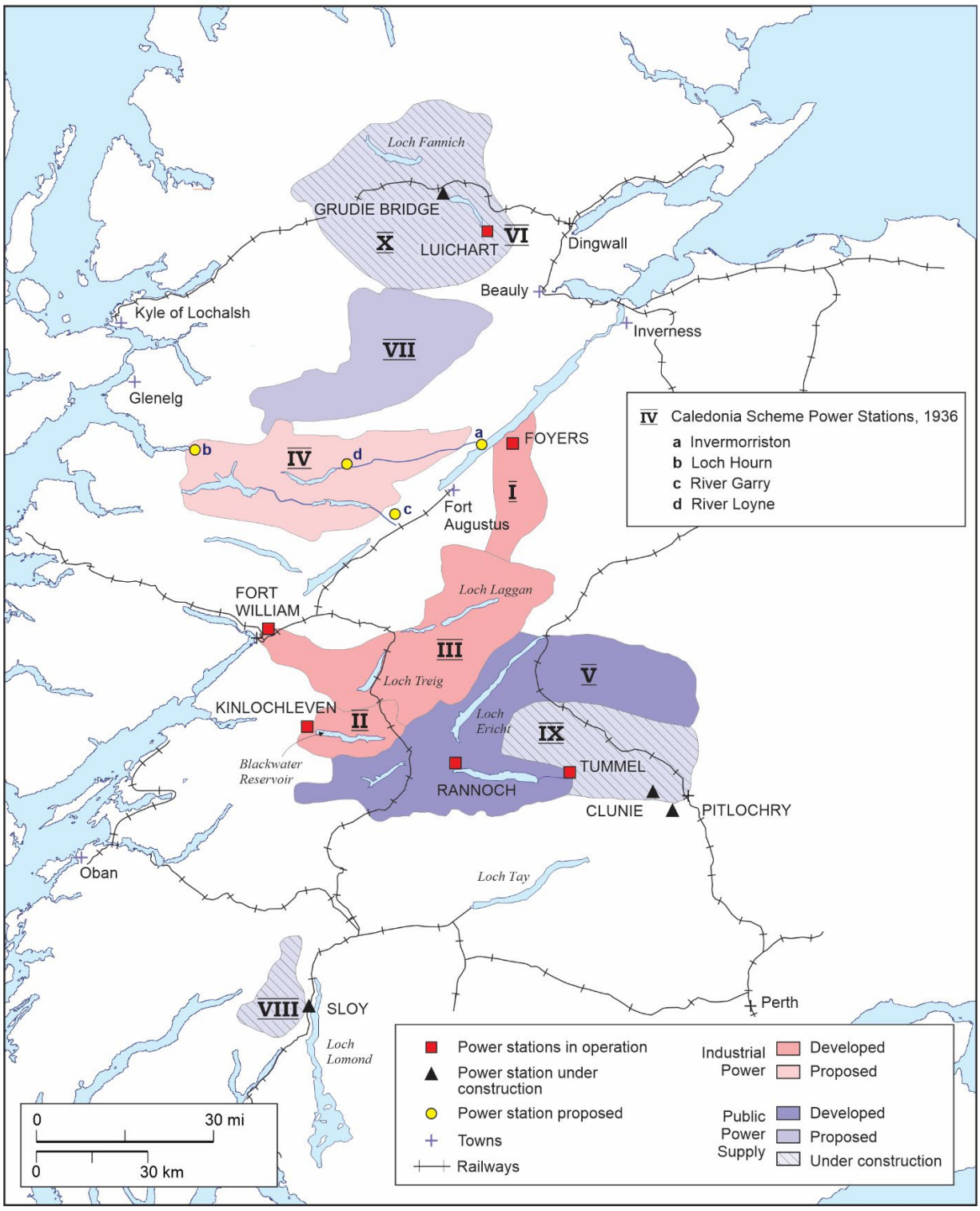

Figure 4 HYDRO-ELECTRIC POWER DEVELOPMENT IN THE SCOTTISH HIGHLANDS 1896-1946.

HYDRO-ELECTRIC POWER DEVELOPMENT IN THE SCOTTISH HIGHLANDS, 1896-1946

Three types of hydro-electric power schemes are shown in **Figure 4**: industrial power, public supply, and the approved schemes of the North of Scotland Hydro-Electric Board.

		1926	*1936*	*1946*
Industrial power	Generating capacity kW	28,700	61,200	112,700
AREAS I-IV	Power stations	2	3	3
Public supply	Generating capacity kW	-	84,450	84,450
AREAS V-VII	Power stations	-	3	3
NSHEB plans	Generating capacity kW	-	-	230,200
AREAS VIII-X	Power stations	-	-	4

I **Foyers**
Built by the British Aluminium Co. and opened in 1896 as an early smelter, accounting for 10 percent of world capacity. Water was taken from an intake over the Upper Falls of Foyers. A small dam at the exit from Loch Garth created a substantial reservoir later named Loch Mohr. The catchment area of c.100 square miles was acquired by private agreement. Initial capacity of the power station on Loch Ness of 3,750kW was later raised to 5,000kW.

II **Kinlochleven**
The second smelter of British Aluminium was authorised by the Loch Leven Water Power Acts of 1901 and 1904. A large concrete dam 86 feet high and 3,000 feet long created the Blackwater Reservoir in the upper reaches of the Leven valley. The power station, smelter and town of Kinlochleven were built at the head of the sea loch. The initial capacity of 19,150kW was raised to 23,700kW by 1920.
Map: ***Proceedings of the Institution of Civil Engineers*** Vol.187, 1911-12, after p.28.

III **Lochaber**
For the third aluminium smelter, Lochs Trieg and Laggan were used as natural reservoirs. The catchment area of 303 square miles was authorised by the Lochaber Water Power Act 1921. Multiple dams and 15 miles of tunnel were part of the complex hydraulic engineering for the Fort William power station. The initial capacity of 32,500kW in 1930 was raised to 84,000kW by 1943.
Map: ***The Engineer*** Vol.149, 1930, p.457.

IV ***Caledonian Schemes***
The West Highland Power Company's scheme to develop the water power of the River Moriston and Lochs Qurich and Garry (potential 41,000kW) was rejected by Parliament in 1929.
Map: ***The Times*** 16 November 1928, p.13.

In a revised proposal, with the support of the British Oxygen Company, the Caledonian Power scheme planned four power stations linked with a carbide factory at Corpach, west of Fort William. The private bill failed to secure Parliamentary approval in the sessions of 1936, 1937 and 1938.
Map: ***The Engineer*** Vol.161,1936, p.334.

V ***Grampian***
Approved by Parliament in 1922, the Grampian Electric Supply Company was empowered to develop a watershed of some 418 square miles with Lochs Ericht and Rannoch as natural reservoirs. Construction began after capital support from Scottish Power and a bulk supply contract with the Central Electricity Board in 1927 ensured the

viability of the project. The Rannoch station (48,000kW) was completed in 1930 and the Tummel station (34,000kW) in 1933.
Maps: ***The Engineer*** Vo.138. 1922, p.572; ***The Engineer*** Vol.152, 1931, p.148—a revision of the original 1922 plans.

VI ***Luichart***
A modest scheme promoted by the Ross-shire Electric Supply Company (successor to the earlier non-statutory development at Strathpeffer from 1913). The power station was built at the Falls of Conon using Loch Luichart as a natural reservoir. Water rights were negotiated with the local owners so no special legislation was required. With managerial and financial help from Scottish Power, the first stage of 1,250kW was completed in 1929. This capacity was doubled by 1936.

VII ***Affric Scheme***
The Grampian Company promoted a bill to develop the waterpower potential (59,000kW) of Loch Affric and the rivers flowing into the Beauly Firth. It was defeated in the House of Lords. A later revival of the scheme for development after the war was rejected by Parliament in 1941. The failure of this scheme and other surrounding controversies helped to further the cause of state intervention in the Highlands.

VIII ***Sloy***
The first construction scheme of the North of Scotland Hydro-Electric Board received Parliamentary approval on 28 March 1945. A large concrete dam 160 feet high and 1,160 feet long transformed the shallow Loch Sloy into a high-level reservoir for the 130,000kW power station on the western shore of Loch Lomond. Opened by Queen Elizabeth on 18 October 1950, the event was well publicised as a triumph of engineering and public ownership.

IX ***Tummel-Garry***
The second construction scheme of the NSHEB, approved by Parliament on 19 November 1945 was a continuation of development proposed by the Grampian Co. in the 1920s. Two new power stations at Clunie (61,20kW) and Pitlochry (15,000kW) were under construction in 1946 and both were opened in 1950.

X ***Conon Valley***
The first stage of this large catchment area of 400 square miles was approved in 1946. It was an expansion of the earlier Luichart scheme of the 1920s. The first of six power stations, at Grudie Bridge (24,000kW), was opened in 1950.

More details of the schemes may be found in:

Peter L. Payne, ***The Hydro: a study of major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board*** (Aberdeen University Press, 1988).

James Miller, ***The dam builders: power from the glens*** (Edinburgh: Berlinn, 2002).

History of the British Aluminium Company, 1894-1955 (London: The Company, 1956).

A.A.Campbell Swinton, “Electricity from water-power.” British Association meeting Cambridge. ***The Electrical Engineer*** August 26, 1904. Notes an early proposal to develop Loch Sloy.

W.T. Halcrow, “Scottish hydro-electric stations.” British Association meeting Aberdeen. ***The Engineer*** Vol.158, 1934, pp.256-257.

Between 1944 and 1947, twelve constructional schemes were approved by Parliament, involving 16 generating stations with a total capacity of 440,000kW. During the same period 19 distribution schemes covering 4,000 square miles of the undeveloped area were submitted for approval. Plans were also made and contracts placed for 320 miles of 132kv transmission lines to connect the various generation projects.[41]

Although the Board was engaged in many large civil engineering projects across the region, its actual electricity supply operations were modest. At the beginning of 1948 there were 12 isolated generating stations with a total capacity of 9,864kW, nearly all diesel-powered. The largest of these was at Rothesay (2,150kW) which was closely followed in size by the stations at Kirkwall and Lerwick. The only hydro-electric stations were two very small operations at Tobermory (25kW) and Ullapool (20kW). A steam turbine unit of 500kW at Wick complemented the adjacent diesel units.[42]

Table 6 NORTH OF SCOTLAND AREA CONSOLIDATIONS TO 1947.

UNDERTAKING	YEARS IN OPERATION	NEW OWNER
Broughty Ferry Corporation	1902-1913	Dundee Corporation
Invergordon Corporation	1923-1932	Ross-shire ES Co
Taim Corporation	1929-1936	Grampian ES Co
Grantown-On-Spey ES Co	1911-1937	Grampian ES Co
Beauly ES Co	1912-1939	Grampian ES Co
Ellon (Duncan's)	1915-1939	Grampian ES Co
Ballater (Duncan's)	1914-1941	Grampian ES Co
Fochabers	1904-1941	Grampian ES Co
Elgin Es Co	1922-by 1946	Grampian ES Co
Laing ES Co	1926-by 1946	Grampian ES Co
Ross-Shire ES Co	1903-by 1946	Grampian ES Co
Fort William	1896-1947	North of Scotland HEB
Kirkwall	1924-1947	North of Scotland HEB
Lerwick	1932-1947	North of Scotland HEB
Rothesay	1899-1946	North of Scotland HEB
Tobermory	1926-1947	North of Scotland HEB
Wick	1928-1947	North of Scotland HEB

Table 6 lists the undertakings consolidated in the region between 1913 and 1947. Most of those were taken over by the Grampian Company. The last group were the six municipal undertakings taken over by the Board in its early plans for extending electrification in the islands and western Highlands.

[41] R.B. Anderson, "The development of electricity supplies in the North of Scotland", ***Proceedings of the Institution of Electrical Engineers*** Vol.108A, 1961, pp.30-32.
[42] North of Scotland Hydro-Electric Board, ***Annual Report 1948***, p.50.

III Nationalisation

The North of Scotland Hydro-Electric Board was the only undertaking in Britain to retain its independence after the Electricity Act 1947 restructured all the other undertakings under state control. Until the formation of the South of Scotland Board in 1955, it was the only Board that combined distribution and generation of electricity. Tom Johnston, who had become chairman of the Board in 1946, championed the cause of independence against all the centralising tendencies of London.[43]

From 1 April 1948, the operations of the Board were transformed. The area was extended southwards by the inclusion of parts of Angus, Perth and Kinross, and the assets of seven local authorities and nine companies were taken over. Generating capacity rose from 9,864kW to 242,513kW. At the beginning of the year. Diesel-power capacity amounted to 94.4 percent of the total. By the end of 1948, steam generation at 56.6 percent was now dominant and hydro-electric capacity increased from 0.3 to 35.4 percent. Total sales grew from 20 million kWh in 1947 to 427.3 million in 1948 (including sales of 79 million kWh to the British Electricity Authority).

In order to manage these expanded assets, the Board organized its territory into 14 Areas (**Figure 5**).[44] These varied in size from Perth City (12 square miles) and Dundee (22 square miles) to the Northern Area with headquarters at Dingwall covering 5,243 square miles. The 1957 map also shows the network of 46 showrooms where consumers could pay their bills and purchase appliances. These showrooms were an important and profitable part of the Board's business.

"Let there be light in the glens and plains of Scotland", said the Rev. George F. McLeod, Moderator of the General Assembly of the Church of Scotland and leader of the Iona Community at a simple ceremony to switch-on light and power for Iona in September 1957.[45] Although only a small distribution scheme for the 60 homes on the island (25 already wired and 25 waiting for the electrician), Tom Johnston, with his flair for publicity saw the symbolic benefits of this particular scheme and invited 120 guests including a correspondent of ***The Times***.[46] The lengthy report in the next day's newspaper noted that the ancient Iona Abbey would also be wired when funds were available. Only another £3,000 had to be raised to complete the restoration work.

Work on the distribution schemes began as quickly as possible after the war. The first distribution pole was erected near Mallaig in March 1946 and the first settlement, the hamlet of Finstoun west of Kirkwall, Orkney, was connected in December.[47] In the Lochalsh and Skye district which covered 1,422 square miles with a resident population of 13,362 in 1956, the

[43] Leslie Hannah, ***Engineers, managers and politicians: The first fifteen years of nationalised electricity supply in Britain*** (London: Macmillan, 1982). Chapter 12. "The North of Scotland Hydro-Electric Board, 1943-1960."
[44] Note the error in the location of KInlochleven.
[45] ***The Times*** 20 September 1957, p.6.
[46] James Miller, ***The dam builders: power from the glens*** (Edinburgh: Birlinn, 2002).
[47] Details from the book ***Loch Sloy Hydro-Electric Scheme 1950*** published to commemorate the formal opening by Queen Elizabeth.

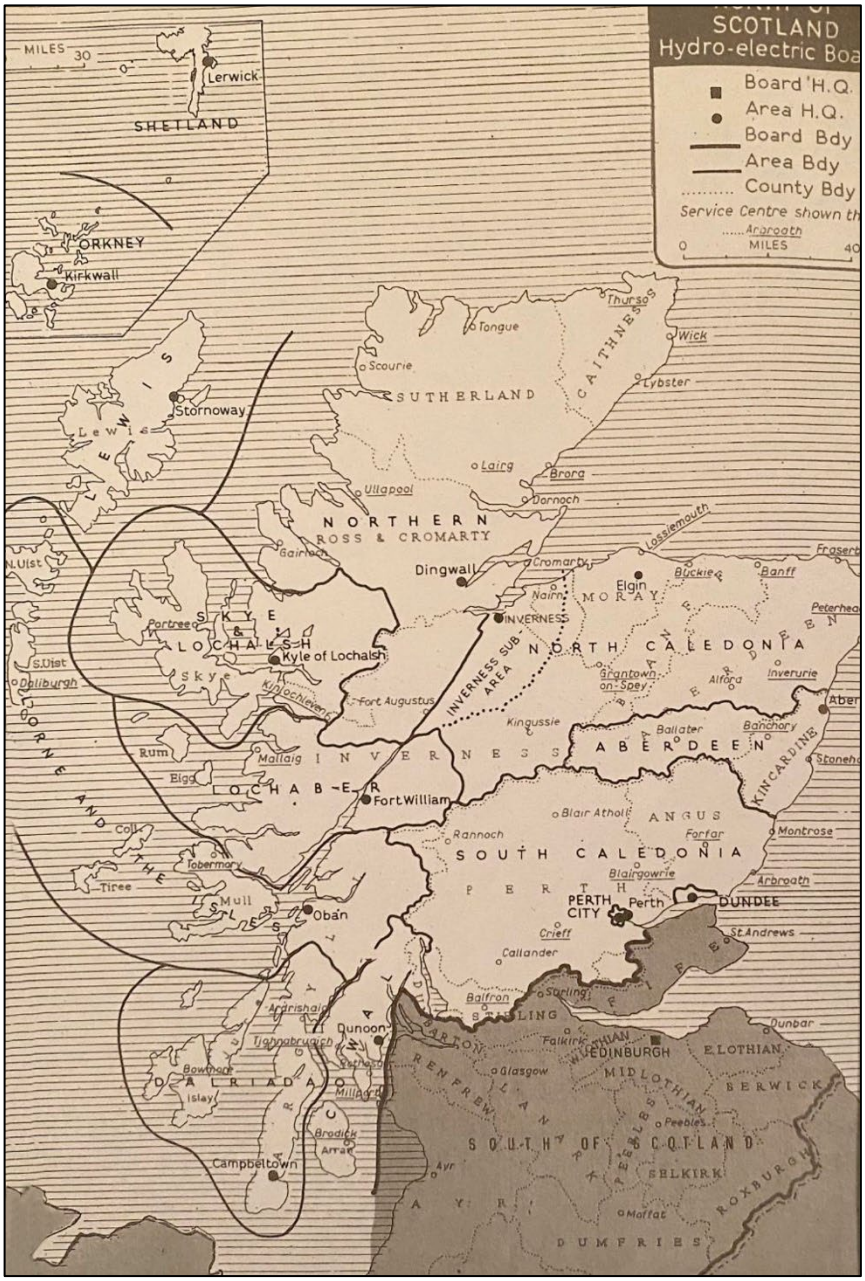

Figure 5

existing supply (660kW diesel) was extended from Kyle of Lochalsh to Plockton in January 1947. Further extension became possible in December 1948 when the first hydro-electric generator at Nostie Bridge was commissioned. Electrification of Skye began with the opening of the Storr Lochs scheme (2,150kW) on 31 May 1952. These new developments resulted in the very substantial growth of electricity sales from 909,000kWh in 1948 to 7,811,000kWh in 1956.[48] Similar projects took place in other parts of the western districts, while the Board was also extending the rural networks already established by the Grampian Company.

[48] NSHEB ***Annual Report*** 1948 and ***Electricity Supply Handbook*** 1958.

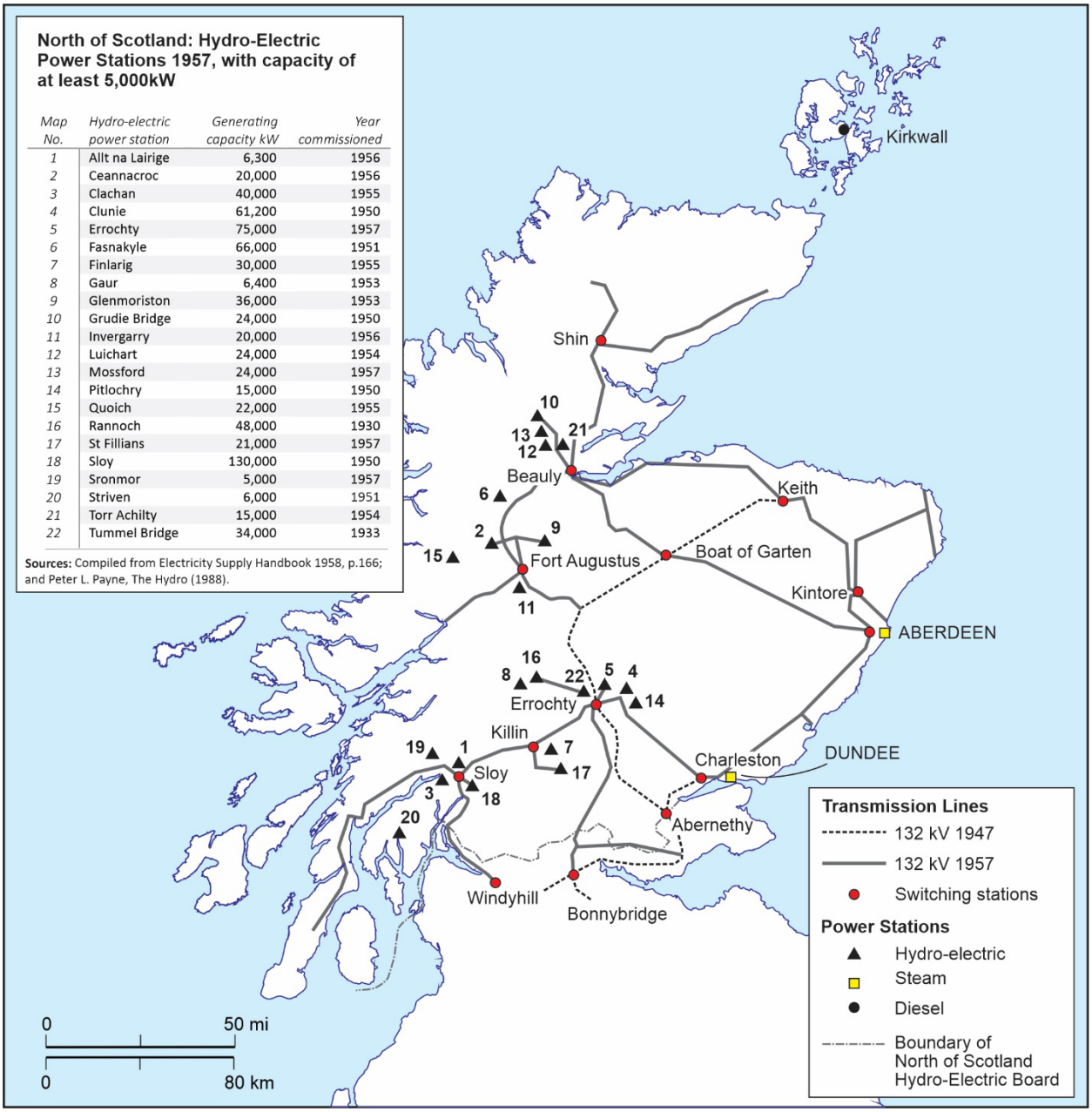

Figure 6 NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD LARGER POWER STATIONS AND TRANSMISSION LINES 1957.

Most of the transmission network inherited by the Board had been built by the Grampian Company. A southern network of 33kv lines was developed from Arbroath in the late 1920s and later from the new hydro-electric stations at Rannoch and Tummel. These two stations were also linked into the grid system at Abernathy by a 132kv line. In the north, the company derived its power from the Ross-shire associate company at Luichart where a 33kv line was constructed first to Nairn and Forres (1934) and later extended eastwards.[49] The northern and southern networks were connected in 1937 by a 33kv line from Tummel Bridge to Elgin. A 132kv line was

[49] H. Hamilton ed. ***Moray and Nairnshire: Third Statistical Account of Scotland*** Vol.17 (Glasgow: Collins, 1965) p.91.

commissioned in 1939 from Tummel to Keith. The towers on this connecting line were unusual in carrying two different circuits: 132kv on one side and 33kv on shorter arms on the other side.[50] A final extension of the Grampian network was a 33kv link to Oban completed in the early 1940s.

Planning a more extensive grid system for the region began in 1944, with construction when the war ended. From the original core of the system at Tummel Bridge, several new 132kv lines were built:

- To Sloy hydro-electric station and southwards to connect with the Central Electricity Board at Windyhill on the northern fringes of Glasgow.
- To Bonnybridge to link the expansion of generating capacity of the Tummel-Garry scheme with the CEB.

In the north a new line was built from the Conon Valley via Beauly to Boat of Garten where it joined the original Grampian Company circuit which was also extended from Keith to Aberdeen. Dundee and Aberdeen were also connected for the first time. All these lines were in operation by 1950 when the big hydro-electric stations entered service.

Figure 6 shows the transmission network completed by 1957 when more lines had been added. These included direct links to Aberdeen and Dundee as well as connections to the later power developments in the north. Caithness was joined to the grid, first at Lybster and then later to the nuclear complex being built at Dounreay. This project, commissioned by the UK Atomic Energy Authority, was the construction of an experimental reactor of the breeder type. Work began in 1955 and was largely completed by 1958 and the first reactor went critical one year later. Development in Dounreay brought many changes to the region, especially in Thurso. Contrasts between the new and the old were particularly sharp in the parish of Reay where electricity from the NSHEB became available only in 1954.[51]

Pitlochry was the control centre for the grid, coordinating the output from all the Board's hydro and steam stations. Port-na-Craig House near the Pitlochry dam had been bought by the Board in 1946, and also served as a residential training centre for staff being employed in the new power stations.[52] By the late 1950s the North of Scotland Board was in the early stages of planning a Supergrid at 275kv which would link up with the new Kincardine power station of the South of Scotland Board and run via Dundee, Aberdeen and Keith to Beauly. This system would further reinforce the interconnections between the northern and southern power stations of Scotland.

Over 30 power stations were operated by the Board at the end of 1948 (**Table 7**). Five stations with over 5,000kW capacity accounted for 88 percent of the total generating capacity. Half the capacity was represented by the two steam turbine stations in Aberdeen and Dundee. Only two

[50] R.B. Anderson, "The development of electricity supplies in the North of Scotland", ***Proceedings of the Institution of Electrical Engineers*** Vol.108A, 1961, p.30.
[51] J.S. Smith ed. ***Caithness: Third Statistical Account of Scotland*** Vol.19A (Edinburgh: Scottish Academic Press, 1988), pp.155-160.
[52] D.B. Taylor ed. ***Perthshire and Kinross: Third Statistical Account of Scotland*** Vol.27 (Coupar Angus, 1979), p.61.

small hydroelectric stations at Lochalsh (625kW) and Moray (360kW) had been built since the formation of the Board and both were commissioned in December 1948.

Table 7 NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD POWER STATIONS IN DECEMBER 1948.

POWER STATION	CAPACITY KW	TYPE[53]
Dundee	69,625	S
Aberdeen	54,500	S
Rannoch	48,000	H
Tummel	34,000	H
Arbroath	7,250	S
Perth	3,000	S
Loch Luichart	2,750	H
Inverness	2,660	S, H
Rothesay	2,150	I
Kirkwall	1,970	I
Lerwick	1,967	I
Dunoon	1,700	I
Campbeltown	1,540	I
Lochalsh	1,285	H, I
Wick	1,280	I, S
Oban	1,178	I
Stornoway	1,130	I
Buckie	940	I
Ardrishaig	800	I
Thurso	743	I
Brora & Lairg	694	I
Elgin, Fochabers & Ballater	671	I
Brodick	614	I
Fort William	404	I
Mallaig	360	1
Moray	360	H
Lossiemouth	258	I
Ullapool	245	I, H
Bowmore	225	I
Millport	110	I
Tobermory	100	1, H
	242,513	

Note: [1] S – Steam; H – Hydro-electric, I – Internal combustion (diesel).
Source: Compiled from North of Scotland Hydro-Electric Board, ***Annual Report 1948***, p.50

The massive construction work on hydro-electric stations, started in 1945, began to show results five years later when four stations were commissioned. Loch Sloy (130,000kW) was the largest and its formal opening by Queen Elizabeth on 18 October 1950 was well publicized. The other stations at Clunie (61,200kW), Grudie Bridge (24,000kW) and Pitlochry (15,000kW), also opened in 1950, were much smaller. All the hydro-electric stations built by the Board were

smaller than contemporary steam stations constructed in other parts of Britain. Braehead, commissioned in Glasgow in 1950/51, had an initial capacity of 210,000kW.

Table 8 NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD POWER STATIONS IN NOVEMBER 1957.

POWER STATION	*CAPACITY kW*	*TYPE*[54]	*POWER STATION*	*CAPACITY kW*	*TYPE*[1]
Sloy	130,000	H	*Wick*	4,680	I
Errochty	75,000	H	*Campbeltown*	3,140	I
Fasnakyle	66,000	H	*Brodick*	2,952	I
Clunie	61,200	H	*Storr Lochs*	2,700	H
Aberdeen	57,280	S	*Bowmore*	2,400	I
Rannoch	48,000	H	*Mallardoch*	2,400	H
Dundee	45,625	S	*Lussa*	2,400	H
Clachan	40,000	H	*Achanalt*	2,400	H
Tummel Bridge	34,000	H	*Dunoon*	2,300	I
Finlarig	30,000	H	*Kilmelfrot*	2,000	H
Glen Moriston	36,000	H	*Daliburgh*	1,500	I
Grudie Bridge	24,000	H	*Kerry Falls*	1,250	H
Luichart	24,000	H	*Nostie Bridge*	1,250	H
Mossford	24,000	H	*Loch Dubh*	1,200	H
Quoich	22,000	H	*Ardrishaig*	11,045	I
Ceannacore	20,000	H	*Thurso*	1,043	I
Invergarry	20,000	H	*Tobermory*	925	I
Pitlochry	15,000	H	*Lochalsh*	910	I
Torr Achilty	15,000	H	*Rothesay*	900	I
Kirkwall	8,600	I	*Morar*	750	H
Lerwick	7,680	I	*Aultben*	525	I
Stornoway	7,680	I	*Brora*	470	I
Gaur	6,400	H	*Mallaig*	350	I
Allt na Lairige	6,000	H	*Tobermory*	280	H
Striven	6,000	H	*Brodick*	135	H
Sron Mor	5,000	H	*Bucht*	120	H

Note: [1] S – Steam; H – Hydro-electric, I – Internal combustion (diesel).
Source: *Electricity Supply Handbook 1958* p.166.

Table 8 shows the results of the Board's development plan of 1943/44. Twenty-eight new hydro-electric stations had been commissioned by the end of 1957. Half had 15,000kW capacity or larger; the smaller stations served more localised areas. Hydro-electric stations that represented only 35.4 percent of total generating capacity in 1948 now accounted for 82 percent of total capacity. Steam stations, with over half the total capacity in 1948, were reduced to only 12.2 percent. The smaller steam stations at Arbroath, Perth, Inverness and Wick had all been closed once the basic transmission system was completed. Diesel-powered stations, especially in Kirkwall, Lerwick and Stornoway, were all extended to provide power in areas without hydro potential.

The North of Scotland Board also experimented with alternative sources of power. A 150kW wind turbine was installed at Costa Head in Orkney in 1951. The Carolina Port station had

15,000kW gas turbine as early as 1948/49. In Caithness a peat-fired gas turbine development was attempted but without success.[55]

Over the period from 1949 to 1959 total electricity sales in the North of Scotland region grew from 535 million kWh to 1,421m kWh. Sales to the South of Scotland Board area expanded from 56m kWh in 1949 to 550m kWh a decade later. The number of consumers grew as electricity service was extended to new areas. Employment by the Board amounted to 2,682 in 1951 and 3,038 in 1958.

By the late 1950s most of the objectives set out in the 1943 act were in sight of fulfilment. Generation in the hydro-electric plants had quadrupled between 1949 and 1959, distribution had been extended to all but the most remote regions, and the power contribution to the south had continued on a large scale. However, although the Board had tried to support local initiatives such as the Alginate Industries Ltd in South Uist[56], no new large power users had established plants in the Highlands. British Aluminium's investment in the Lochaber scheme between 1924 and 1943 was not repeated after the war. Lower capital-cost production in Canada and Norway led to expansion outside Scotland.[57]

Summary

Table 9 shows various indicators of electrification from 1900. Two of the three local authorities in that year, Aberdeen and Dundee, were dominant in the region and even as late as 1948 accounted for 51 percent of all retail sales. That dominance was challenged from the late 1920s by the rise of the Grampian Company which pioneered hydro-electricity on a large scale and exported power to the southern regions.

Table 9 SUMMARY OF DEVELOPMENT IN THE NORTH OF SCOTLAND.

	NUMBER OF UNDERTAKINGS[1]	LOCAL AUTHORITY UNDERTAKINGS	NUMBER OF POWER STATIONS	GENERATING CAPACITY (KW)	PER CAPITA CONSUMPTION (kWh)
1900	3	3	3	..	.. (4)[2]
1912	12	6	13	..	.. (36)
1925/6	19	8	17	62,137	60.6 (133)
1935/6	31	12	31	179,641	144.0 (374)
1949	..	..	34	250,970	464.5 (821)
1959	..	..	51	1,047,248	1,227.1(1,765)[3]

Notes:

[1] Excludes all non-statutory undertakings.

[2] 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.

[3] Calculated from data in Electricity Council, ***Handbook of Electrical Supply Statistics 1977***, p.63 and census returns.

[55] P.L. Payne, ***The Hydro*** (1988), pp.198-200.

[56] The Board had built a diesel station at Loch Brisdale in 1949 to serve the seaweed processing factory. H. Barron, ed. ***The County of Inverness: Third Statistical Account of Scotland*** Vol.16 (Edinburgh: Scottish Academic Press, 1985), p.624.

[57] See K.J. Lea, "Hydro-electric power generation in the Highlands of Scotland", ***Institute of British Geographers Transactions*** 46, 1969, pp.155-165.

The huge size of the North of Scotland limited the potential for economies of scale and the substantial role of British Aluminium with its private generation left few possibilities for other industrial power sales. Generating capacity quadrupled between 1949 and 1959 as the new hydro-electric stations of the North of Scotland Board entered service and were connected by an extensive regional grid system.

While per capita consumption levels were always much lower than the national average, they compare favorably with other regions with little heavy industry. Individual towns such as Perth were frequently above comparable places elsewhere. In 1935/36 Perth's per capita rate of 219kWh was well above Hamilton, Lanarkshire which had a rate of 140.7KwH.

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. This point of viability was reached about 1900 but extending the benefits of electricity over wider areas took much longer and universal electricity in this region was not achieved until the 1960s.

Note on Sources

The records of electrification in Scotland have some distinctive features reflecting the history, legislation and culture of North Britain. After the Electric Lighting (Scotland) Act 1890, the Secretary for Scotland had a role in reviewing applications for Electric Lighting Orders and loans to local authorities. The Secretary of State for Scotland gained new powers with the Hydro-Electric Development (Scotland) Act 1943. Full control of Scottish electricity came in 1955 with the Electricity Reorganisation (Scotland) Act 1954 when all the powers were transferred from London to Edinburgh.

Many aspects of regional identity are expressed in the 31 volumes of the ***Third Statistical Account of Scotland*** published between 1951 and 1992. Most of the city and county volumes include details of public utilities such as gas, water and electricity. Parish accounts in the Inverness volume (1985), for example, note the very positive effects of the North of Scotland Hydro-Electric Board. Referring to the opening of the Storr Lochs (Isle of Skye) hydro-electric scheme (2,700kW) on 31 May 1952, the author of the Snizort parish account noted:

> The houses are now wired and bright light is the blessing of all who participate in the scheme. Many houses have also electric cookers and fires. Surely then this is the greatest advance of all, from the days of the **cruisgean**, which was an article somewhat resembling a jellyfish, coming to a point at one end where a piece of cloth was lit and fed by oil extracted from fish caught by the men of the household.[58]

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

[58] H. Barron, ed. ***The County of Inverness: Third Statistical Account of Scotland*** Vol.16 (Edinburgh: Scottish Academic Press, 1985), p.527.

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. All the returns for Scotland were tabulated separately, reflecting the legislative background and perhaps also recognising the differences in the local authorities' financial year.[59]

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.[60] 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.

The first Annual Report of the North of Scotland Hydro-Electric Board was published inn 1945. From 1949 the reports were published as House of Commons sessional papers. After 1971-72 they were no longer published by HMSO. A full set of the reports is available on the Scottish and Southern Electricity website (sse.heritage.org.uk).[61]

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[59] Generally the Scottish local authority financial year ended on 15 May. There were, however, some variations such as Edinburgh (20 May) and Glasgow (31 May). See: ***Municipal Year Book 1970***, p.1793. In the Electricity Commissioners' ***Engineering and Financial Statistics***, the City of Aberdeen's financial year ended on 31 July.

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

[61] The SSE archive has 1,690 items including copies of the NSHEB annual reports from 1945 to 1998 and the house magazine ***Hydro News*** 1973-1995.

Some publications of the Electricity Council (established in 1958 to provide coordination in England and Wales) include Scottish material.

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 Scotland include:

John C. Logan, "An economic history of the Scottish electricity supply industry 1878-1930". PhD thesis, University of Strathclyde, 1983, 2 vols.

David Dick, ed. ***A Scottish Electrical Enlightenment: Celebrating 100 years of the Institution of Electrical Engineers in Scotland 1899-1999*** (Glasgow: IEE, 2000).

Other works that have references to electricity include: ***Scottish Life and Society: A Compendium of Scottish Ethnology*** (14 volumes), 2000-

The following books cover all aspects of hydro-electric development:

Peter L. Payne, ***The Hydro: a study of major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board*** (Aberdeen University Press, 1988).

James Miller, ***The dam builders: power from the glens*** (Edinburgh: Birlinn, 2002).

Emma Wood, ***The Hydro boys: Pioneers of renewable energy*** (Edinburgh: Luath Press, 2002).

Historic Scotland, ***Power to the people: The built environment of Scotland's hydro-electric power*** (Edinburgh c.2010). A pdf version is available from Historic Environment Scotland: www.historicenvironment.scot/publications

Since there is no specialised museum and archives for electricity in Scotland, the principal centre for any study must be in Edinburgh:

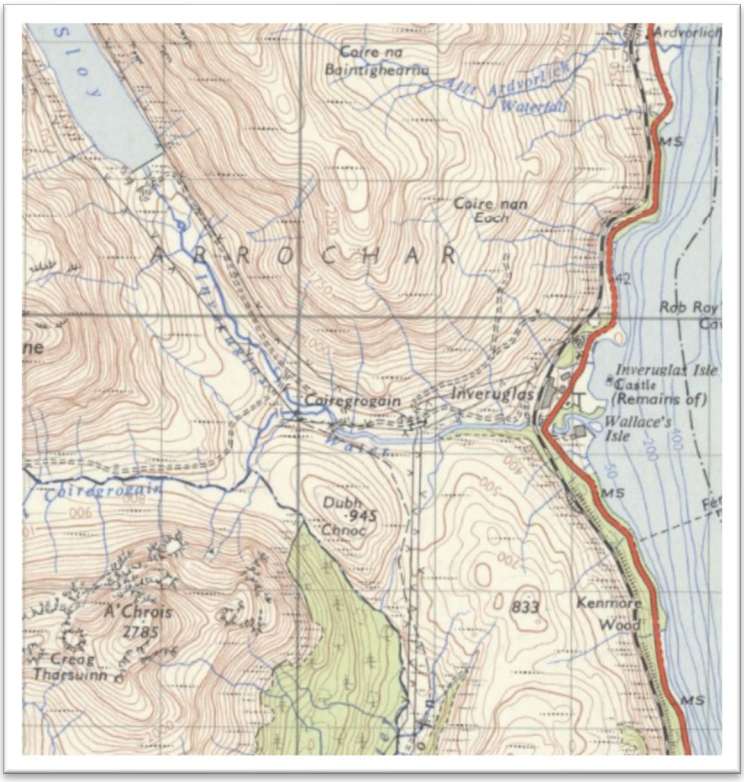
1. The National Library of Scotland has rich resources such as a complete set of Garcke's ***Manual of Electrical Undertakings*** 1896-1948 and important series such as the ***Electrical Review*** 1892- and ***Electricity Supply Handbook*** 1948-2004. The excellent map collection is also available online at www.maps.nls.uk.

2. National Records of Scotland (previously Scottish Record Office, National Archives of Scotland) holds general legislative material on electricity supply (DD11/1-154) and official records such as minutes and annual reports of the North of Scotland Hydro-

Electric Board (NSE) and the South of Scotland Hydro-Electric Board (SSE).

The files once held records of pre-nationalisation undertakings but these appear to have been dispersed. Tracing their locations may be possible through the Scottish Archives Network (SCAN), also maintained by National Records of Scotland.

3. Historic Environment Scotland has material on industrial archaeology collected earlier by the former Royal Commission on the Ancient and Historical Monuments of Scotland. Many power station sites are included on the Canmore website at www.canmore.org.uk.



SLOY

At this small scale the power station, north of Inveruglas and tucked in between the A82 and the West Highland line, is barely visible. The 120,000kW hydro-electric turbine house was designed to minimize the effects of the huge Loch Sloy project on the views and amenities of Loch Lomond. Transmission lines to Windyhill, Glasgow were also routed to the west via Glen Loin and Loch Long.

Ordnance Survey, One Inch Seventh Series, Sheet 53, Loch Lomond, 1958 (National Library of Scotland).