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THE DEVELOPMENT
OF THE
ELECTRICITY SUPPLY INDUSTRY
IN
GREAT BRITAIN
(VOLUME II)

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PART II.

ELECTRICITY COMMISSION. CENTRAL ELECTRICITY BOARD.
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CHAPTER X.

ELECTRICITY COMMISSION.

1. PROPOSALS OF THE ELECTRIC POWER SUPPLY COMMITTEE.

The Electric Power Supply Committee, which was appointed by the Board of Trade, under the Chairmanship of Sir Archibald Williamson, presented its Report, known as the "Report of the Committee Appointed by the Board of Trade to consider the Question of Electric Power Supply" (Cd. 9062), in 1918. The terms of reference of this Committee were as follows:- "What steps should be taken to ensure that there shall be an adequate and economical supply of Electric Power for all classes of consumers in the United Kingdom and particularly industries which depend upon a cheap supply of power for their development". The Committee pointed out that the then existing conditions was a patchwork system and that their proposals would aim "to adapt it to new and improved conditions". For that reason they recognised as an urgent need for a central authority "to regulate generation and distribution of electricity". That authority was to be the "Electricity Commissioners" to whom all the powers, connected with electricity supply, exercised up to that time by the Board of Trade, formerly also by Local Government Board, Local Government Board of Ireland, and Scottish Office, should be transferred to these Electricity Commissioners. They were to be appointed by the President of the Board of Trade, and through him they would be responsible to Parliament. In order to carry out the necessary re-organisation of the electricity supply the Commissioners "should be endowed with very full powers".
Their /

Their duties were not to be confined "to framing and administering regulations and deciding questions brought before them, but that they should include the encouragement of the supply and distribution of electricity". They recommended that there should be appointed five Commissioners, three of whom would be on a permanent basis, and two part-time service. They should be appointed from a panel of men of engineering qualifications and business experience. The El. Commissioners were to appoint and choose a special staff.

As for the Electricity Supply Industry, at the end of the First World War, it was a complicated organisation, consisting of individual undertakings supplying single and small areas, with no interconnection between them and there was really no national policy of electrical development. In such circumstances reorganisation of the Industry would have to co-ordinate these individual developments and to correct the uneconomical duplication in many areas and to increase the efficiency of the particular undertakings and of the Industry as a whole. The problem was to simplify the types of organisations, to co-ordinate single undertakings into an economical power zone, and eventually to carry out the co-ordination of these zones into a national scheme. There were two methods open - either to use a method of compulsory powers, and probably as a result of such a policy to nationalise the Industry, or to base the reorganisation on a basis of voluntary co-operation. There was, however, a third way, which was accepted by the Act of 1926, namely, the co-ordination of production of electricity on a wholesale basis, and preserve individual undertakings as the distributors.

As the El. Commissioners later pointed out "the reorganisation could not begin ab initio, that this problem resolved itself into the determination of the best method of adopting, modifying and expanding the existing development with the view of ensuring as speedily as possible an improvement in the supply of electricity for the numerous and growing needs of the community". 1) They also observed that as the aftermath of the War, 1914-18, the financial and economic conditions /

1) "First Annual Report of the El. Commissioners", 1921, § 24.

conditions of the country were precarious, that the price for fuel, plants and materials and wages for labour had increased, and for these reasons any reorganisation should be a gradual process and brought about by stages.

In order to reorganise the Industry on the basis of a national scheme still required an educative campaign and to convince the authorised undertakers of a need for a national conception of the Industry as a whole. That conception was too radical and too early for many undertakers to follow them. This was only achieved to a certain extent after the useful work of the El. Commissioners in the first five or six years of their existence. For the forces of tradition, like individualism, a kind of conservatism, the frictions between private enterprise and local authority undertakings were still strong and had to be taken into consideration.

The Williamson Committee recommended that the El. Commissioners should divide the whole country into districts technically suitable for the economical generation and distribution of electricity. In each such district a specially created District Electricity Board should purchase all generating stations of authorised distributors. This new body was to be responsible for the future generation of electricity in their districts and for new generating stations. The existing supply undertakers could retain their powers as distributors in their particular areas of supply, but should purchase electricity in bulk from the District Electricity Boards, who should make no divisible profits. The Committee also suggested that these Boards, should be financed, in whole or in part, by funds raised with Government assistance or supported locally.

Another Committee representing the Federation of British Industries and other associations of electricity supply and manufacture, in conjunction with the Institution of Electrical Engineers was against any general legislation, but recommended the creation of the El. Commissioners with exclusively judicial and advisory functions.

The /

The original Bill of 1919 went along the lines of reorganisation proposed by the Williamson Committee. It did encounter only a little opposition in the House of Commons. But, rather unfortunately, it met a strong opposition in the House of Lords. This opposition was led by Lord Moulton. The arguments of the opposition were that the reorganisation was financially too heavy and the undertakings could not be expected to pay them, and that this new scheme for the Industry meant nationalisation with all the bad consequences of it, and that this "great, modern industrial advance should not be taken because strikers or opponents of law and order may wantonly damage the transmission lines and thus bring industry to a standstill".

As a result of this campaign the original Bill underwent many changes, and the most vital aspect of the Bill, the E.I. Commissioners' compulsory powers were dropped. The amendments of the Bill were described by Lord Birkenhead as: "They cut out from the Bill all the compulsory powers for the establishment of district electricity boards, and secondly, all the compulsory powers for the acquisition of generating stations or main transmission lines, whether owned by local authorities or otherwise. In the third place, they cut out all the financial clauses of the Bill except Clause 19, which provides for the creation of emergency power stations and transmission lines".

However, a substantial measure of the recommendations of the Williamson Committee were adopted in the final Act of 1919. The omissions of the original Bill were rectified by the later Act of 1926. In this connection following the passage of the 1926 Act, Mr. W. S. Kennedy observed that: "If the Act of 1919 had not been emasculated in its passage through Parliament, or if the wolves of the municipalities and the lambs of the private companies had fed together amicably under the aegis of the Commissioners in 1920 and the following years, the present Act would in all probability never have been introduced. It would still have been necessary to remove many of the legislative restrictions which have too long hampered electrical development in this /

this country, but there would have been much less need to recast the whole system, as has now been done".

But, in spite of the shortcomings of the Electricity (Supply) Act of 1919, it was an advance towards a rational ordering of the Industry. It made a provision for voluntary co-operation between supply undertakings on a regional basis, and a central body the El. Commissioners "to promote, regulate and supervise the supply of electricity", and to exercise other powers under Electric Lighting and Supply Acts, delegated to them by the Minister of Transport.

The El. Commissioners inherited a "going concern" to which by the Board of Trade were granted about 1300 Provisional Orders authorising Local Authorities and Companies, and persons to supply electricity for public and private purposes, and 76 Power Acts and 78 other Acts of Parliament relating to electricity supply.

2. APPOINTMENT OF THE ELECTRICITY COMMISSIONERS.

The Minister of Transport, with the concurrence of the Board of Trade, appointed as from January 31, 1920, Sir John Snell (Chairman), Mr. H. Booth, O.B.E., Mr. A. Page, as from March 1, 1920, and Mr. W.W. Lackie, C.B.E., and Sir Harry Howard as the El. Commissioners. Three of them were, according to Section 1 of the 1919 Act, appointed to be whole-time officers, and two part-time officers. The Act also provided that three Commissioners were to be selected for practical, commercial and scientific knowledge and wide business experience. It was also provided that no person, who was directly or indirectly, or had any share of interest in any electricity supply undertaking was eligible to the appointment. The El. Commissioners were allowed to appoint their staff, such as inspectors, officers and servants, who are paid from the special fund.

Past experience in the appointment of the El. Commissioners shows that, as a rule, three of them have always been electrical engineers, with experience in municipal or private undertakings, /

undertakings, while the other two were selected from high administrative circles. The average tenure was over 5 years. The El. Commission acts as a sub-department of the Ministry.

The way of appointment of this body indicated a new attitude of the Government towards the Electricity Supply Industry, which was expressed by the fact that they were to be chosen from the business and technical side of the Industry. A certain measure of financial independence was secured by the fact that the Industry became responsible for the expenses of the El. Commissioners, though the extent of such expenses has to be approved by the responsible Minister.

3. POWERS AND DUTIES IN OR DELEGATED TO THE ELECTRICITY COMMISSIONERS.

Under the Electricity (Supply) Act of 1919, the El. Commissioners were empowered to conduct experiments (§ 3), to appoint Advisory Committees (§ 4), to determine Electricity Districts, to approve or formulate Schemes for improving organisation; under Sections 5, 6, 7 and 26 they were empowered to formulate the Joint Electricity Authorities; they can give or refuse consent to the establishment of a new or the extension of an existing generating station or main transmission line (§ 11); they were endowed with the power of sanctioning the borrowing by Local Authorities (Sections 20 and 33). Then they could require the alteration of the type of current, frequency or pressure employed in the undertakings (§ 24), to make Special Orders in respect of matters arising under the Electricity Lighting and Supply Acts (Sections 26 and 32 (3)), to require accounts and returns from authorised undertakers and Joint Electricity Authorities (Section 27).

Under Sections 2 and 39 of the 1919 Act, the Minister of Transport, was authorised to exercise any powers and duties relating to Electric Lighting Acts, or the Orders and Regulations made thereunder, or under any Local Acts relating to supply electricity or under any enactment relating to matters incidental to such supply through the El. Commissioners.
From /

From February, 1920, these powers and duties were delegated to the El. Commissioners, who since then have acted on behalf of the Minister. These duties and powers were under different electric Acts, powers in regard to the appointment of the Arbitrators and the revocation or cesser of powers under any Act or Order, and powers under any Local, Special or Private Act relating to the supply of electricity, the matters of placing of electric lines above ground, the determination of questions where a consent is unreasonably withheld, the revision of prices, and of the relation between price and dividend, and also powers under Special General Acts, like, for instance, under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, etc.

Under the provisions of Section 31 of the 1919 Act, the El. Commissioners are to give advice to the Minister of Transport on all matters connected with the exercise and performance of the powers and duties transferred to him under the Act, except in cases where any Act or Order by the El. Commissioners is by the Act expressly made subject to the approval of or an appeal to the Minister.

Additional powers were given to the El. Commissioners under the Electricity (Supply) Act, 1922, in relation to financial matters of the Joint Electricity Authorities.

The El. Commissioners were sometimes criticised for defects springing from their limitation of powers, as if they had power to alter it. It is necessary to remember that the reorganisation of the Industry along national lines was an impossible task under the powers they had. As the "Coal and Power" Committee observed, that in order to overcome the then existing difficulties "compulsory powers of acquisition, co-ordination and regulation are necessary and it is from the lack of these powers that the provisions of the Acts of 1919 and 1922 have proved largely abortive. We propose that the necessary powers should be conferred upon the El. Commission". 2) The El. Commissioners were forced to admit that there has so far been no fusion of interest in the generation and transmission of electricity, that they have found themselves unable to secure a thorough reorganisation of the supply of electricity in any district on the lines contemplated by the Act of 1919. For, as one writer pointed out, the El. Commissioners have certain rather negative /

2) "Coal and Power" - Report of an Inquiry presided over by D.Lloyd George, 1924, pp. 114-15.

negative powers - e.g. powers to veto the extension of generating plant - and certain judicial powers, e.g. to hold enquiries for the purpose of extending existing areas of supply or granting new areas - with no positive powers to co-ordinate the whole Industry. 3)

But the El. Commissioners could and did educative work, that is, through their statistics they enlightened opinion and interested persons, that electricity was a national Industry supplying the country as a whole, that rationalisation in that Industry meant lower production costs leading to lower prices, to higher demand of electricity and consequently to greater prosperity for itself and other industries which it fed. Such statistics were appreciated long before in such countries as Canada, Sweden and Switzerland. As the El. Commissioners observed themselves "The lack of these statistics was responsible for a great expenditure of time and effort on the part of Government to secure the proper utilisation and allocation of the resources of the country". 4)

By the Electricity (Supply) Act of 1926, additional powers and duties were conferred upon the El. Commissioners, the most important of which was that of preparing a scheme or schemes of technical development in regard to generation and transmission, with a view to the adoption and carrying out thereof by the C.E.B. The other powers and duties concerned with the matters or affecting the operations of the C.E.B. were as follows:-

(1) To prescribe the exceptions and modifications of the provisions of the Schedule to the Electric Lighting (Clauses) Act, 1899 in their applications to the C.E.B. as an authorised undertaker;

(2) To sanction the borrowing of money by the Board and to determine the repayment period;

(3) To approve the terms of years and of the allowable margin of receipts over expenditure in connection with the tariff fixed by the Board.

(4) /

3) "Socialisation of the Electrical Supply Industry" -

G.H., 1934.

4) "First Annual Report of the El. Commissioners",
1921, § 113.

(4) To approve the principles on which the fixed charge and running charge components of the Grid Tariff are to be based, or, alternatively to determine in what other manner the tariff may be framed.

(5) To prescribe the basis on which the cost of production at Selected Stations are to be allocated as between fixed costs and running costs, for the purpose of ascertaining a price at which electricity is sold by the Board from stations to the owners thereof and also the basis on which such prices are to be adjusted to the power factor of the supply given to such owners.

(6) To fix a scale or scales of depreciation, to apply in the ascertainment of the costs of production at Selected Stations owned by Companies, and in connection with the determination of the price to be paid by the Board on the acquisition of any generating station or main transmission line under the 1926 Act.

Under the Electricity Supply (Meters) Act, 1936, the principal duties were conferred upon the El. Commissioners in connection with such matters as:-

(1) The appointment of Meter Examiners and arrangements for the carrying out of their duties;

(2) the prescribing or approving of suitable apparatus to be provided by authorised undertakers for examination, testing and regulating of their meters; and

(3) the prescribing of the fees to be paid by the undertakers or by any consumer, in respect of certifying or examination of any meter by a Meter Examiner.

The El. Commissioners' influence upon the development of electricity supply was strengthened also by their powers of issuing Orders and Regulations and Rules, which dealt with such matters as authorising the supply of electricity, the compulsory acquisition of land for generating stations and sub-stations, arrangements of sale of undertakings and of bulk supplies, certain questions arising in connection with claims for compensation /

compensation for loss of worsening of employment due to the reorganisation schemes, the breaking up of the streets for cables, etc.

During the Second World War some additional duties were given to the El. Commissioners. They became the "Competent authority" for the purposes of all kinds of wartime measures, such as under the Civil Defence Act, 1939 and the War Damages Act (Section 70). They authorised the acquisition of steel, timber and other materials required by the authorised undertakings; they supervised the fire-guard and fire arrangements in electricity supply undertakings; they were concerned with the problems of man-power and collaborated for that purpose with the Minister of Labour and National Service to secure technical personnel for the Forces; they gave or withheld approval to building and civil engineering works by undertakings; they advised in the protection of power plant and the restoration of plant; and finally they issued directions for the securing of economy in fuel and materials.

4. PLANNING, JUDICIAL AND REGULATING ASPECTS OF THE DUTIES OF THE ELECTRICITY COMMISSIONERS.

The Weir Committee, 1926, observed in their Report, that "Great Britain is unique in having a body of men, who, for over five years, have devoted their entire energies, their patience and their technical and administrative ability to investigating the detailed conditions of this industry and public service throughout the country. The Commissioners, in fact, have functioned as an expert committee carrying out a continuous investigation". 5) But the influences of the El. Commissioners upon the development of the Electricity Supply Industry are more far-reaching than only the investigation aspect. It is generally accepted to divide their functions under three groupings, namely, planning, judicial and regulating functions, as in comparison with the operations of the C.E.B., which as will be shown in the next Chapter, are primarily the executive agency, which /

5) "Report of the Committee appointed to review the National Problem of the Supply of Electrical Energy", 1926, § 3.

which carried into effect the National Grid Scheme. As for the planning functions, it must be admitted that, the activities of the El. Commissioners have been hampered by legislative measures of Parliament and by the Industry itself. In cases, where they have been permitted to prepare schemes, as under the 1926 Act, the results achieved fully justified their existence, but in other cases, where they were limited in their powers, like under the 1919 Act, the results were less prominent. Again, their influence is more evident in planning the whole-side of the Industry, i.e. the generation side than the retail side, that is, distribution. But even here they introduced small measures of improvement.

Under the Act of 1919 they delimited and technically prepared Areas Schemes, but they found that it was too difficult to persuade private enterprise and municipal undertakings, and results, as was evident from the achievements in connection with Joint Electricity Authorities, were disappointing. But, it was a different case under the 1926 Act, particularly under the provisions of Section 4, which provided that the El. Commissioners were responsible for technical preparation and planning and carrying out of Scheme Areas of the Grid. In these planning functions, the El. Commissioners, agreed with the common practice abroad and with technical opinions, that the centralisation was wholly justified in densely populated areas, while inter-connection for wider areas. They concluded in their investigations that it was "fairly obvious that the heart of the problem of electricity supply on a national scale lies in the transmission, and the future of the super-power zone is tied up with it." In the determination of Scheme Areas, the El. Commissioners have been influenced by factors such as the existing groupings, the supply of industrial and populous areas, the avoidance of transmission beyond the point at which it becomes uneconomical (e.g. North of Scotland), equalisation of the load on generating stations, ease of technical administration, and population and industrial trends. In selecting the generating stations the El. Commissioners had to take into account such considerations as the cost of coal delivered to the station, the abundance of water for condensing purposes, technical characteristics of the /

the station such as type and size of the plant units, steam pressure, etc., the load factor, and the possibilities of the site for the further expansion of the station. The El. Commissioners give their consent in the case of extensions and alterations of the generating stations in (a) such as are required by the Scheme and (b) additional alterations and extensions required from time to time by the Board.

The El. Commissioners had powers to intervene in case of disagreement between a municipality and the C.E.B., where the latter was to acquire a municipal generating station or transmission line. In case of a company undertaking being acquired by the Board, the El. Commissioners fixed a scale of depreciation.

The Act of 1926 provided as a normal procedure in the future, the erection of new generating stations under the Board's control and administration. Here again, the Board may neither erect nor operate the new station unless the El. Commissioners are satisfied that no existing body can be found with whom satisfactory arrangements can be made.

The programme for construction of the Grid was not drawn in detail and provisions were made for modifications, if necessary. In the Supplementary Particulars the El. Commissioners set out a preliminary time-table, which might be realised, without, however, committing the Board to a definite programme. The El. Commissioners divided the country into Regional Areas and made a survey of the generating stations, selecting the most efficient stations, scheduling a smaller number for temporary operation during a transitional period and scheduled the remainder for closing down, determining the type, direction and cost of the main transmission system linking up the Selected Stations and estimating the growth of the demand for electricity over a period of 10 years, in order to provide a programme of extensions of Selected Stations to meet future demands. The first Area Scheme adopted was that of Central Scotland in 1927 and the last that of South Scotland in 1931, and the last tower for the main transmission system was erected on /

on the outskirts of the New Forest at the beginning of September, 1933. Apart from these planning functions of the El. Commissioners connected with the Grid, they also were responsible for the planning scheme in relation to standardisation, the extension of distributing areas and generating stations, and other technical matters connected with the normal development of the individual undertaking as well as in relation to the Industry as a whole.

As for regulating and supervision of the supply of electricity, which are more of the administrative functions of the El. Commissioners, they exercised these powers "in scrupulous fairness and with great ability, but the weight and responsibility of these functions alone has assisted the receding into the background of the less defined but vitally important of "promoting" the supply throughout the country". They introduced some measure of co-operation in the Industry by being responsible for such matters as borrowing, permitting bulk supply by agreements between undertakings, revising existing systems, fixing the maximum price for electricity supplied, etc. To mention only one such function, as for instance, their powers as the loan sanctioning authority for electricity supply purposes, whereby the El. Commissioners are in a position to exercise an important measure of control over the development of the electricity undertakings of Local Authorities.

The third aspect of the El. Commissioners' functions is of a judicial character, i.e. they have powers to issue Orders and to establish policies with the duty to hold hearings and to decide controversies. Of course, under no Act, are the El. Commissioners a "court". Their judicial functions arise rather because of the powers provided by legislation, the attitude of the El. Commissioners themselves, and the methods and nature of their procedure, e.g. the hearings on different occasions before Commissioners.

The El. Commissioners in their judicial capacity are not exclusive. For the legal profession also plays part in legal controversies. There are cases that an authorised undertaker may appeal against the findings of the C.E.B. and El. Commissioners to the arbitration of a barrister /

barrister appointed by the Minister of Transport. The barrister, accompanied by qualified assessors in consideration of appeal gives a final verdict, with certain modifications. In several cases the El. Commissioners and the Barrister have supplementary or alternative jurisdictions.

The matters in which the El. Commissioners act in their judicial capacity are concerned with the following:- disagreement regarding the price to be paid for the acquisition of generating stations and main transmission lines, any dispute relative to the obligations and rights of the owners of Selected Stations except those involving the cost of production, in which case the matter is referred to an arbitrator; questions regarding the cost, etc. of alternating frequency, the relative cost of electricity in areas when an owner objects to the requirement that his station should take an exclusive supply from the C.E.B.; disputes regarding the closing of generating stations, applications for Special Orders by gas companies supplying electricity under the Statutory Gas Companies (Electricity Supply Powers) Act, 1925, and whether in application for wage compensation, a given station shall be deemed closed or restricted within the meaning of the 1926 Act.

At these hearings before the El. Commissioners, the parties concerned are frequently represented by counsel, and the whole proceeding is similar to that of the Railway Rates Tribunal or of the Traffic Commissioners.

Sir Charles Wilson criticised the El. Commissioners during the Parliamentary discussion over the Electricity (Supply) Bill of 1926, on the grounds that the El. Commissioners had been given dictatorial powers and that appeals from the Board to the Commission would never be properly heard. 6) However, that fear was not justified, for on the whole, it is admitted that the El. Commissioners discharged their judicial functions /

6) H.C. Debates, Vol. 193, Col. 1731, March 29, 1926.

functions "with scrupulous fairness and good judgment". 7) The past experience proved rather the fact that the authorised undertakers prefer to appeal to the El. Commissioners than the alternative method of arbitration before barristers and assessors.

The Act of 1926 provides the cases in which arbitrations by barristers are allowed. These relate to the schemes for interconnection, the selection, extension, and closing of generating stations, the cost of supply to main transmission lines and generating stations, the determination of expenses incurred through standardisation of the frequency and alterations of transmission lines, the price to be paid for generating stations and main transmission lines, etc. These are important powers but in several cases the El. Commissioners possess an alternative or complementary jurisdiction. For instance, the law relating to the compulsory alteration and extension of Selected Stations, under Section 5 of the 1926 Act, imposes the important duties upon the arbitrator. In a case where the owners are not in a position to accept the financial burdens made necessary by the Board's requirements, they may then appeal to an arbitrator appointed by the Minister of Transport on the ground that to carry out the extensions and alterations would impose an "unreasonable financial burden" on them.

5. RELATIONS WITH THE GENERAL ELECTRICITY BOARD.

The legislators of the 1919 Act thought that the El. Commissioners would become the central authority for generation and main transmission of electricity through their control exercised over the newly created Joint Electricity Authorities. To that effect were the proposals and recommendations of the Williamson Committee and of the original Electricity (Supply) Bill of 1919. Had the original Bill become law, it is probable that there would have been no need for the creation of the C.E.B., as the El. Commissioners would have performed the functions that are now carried out by the Board, and probably they would have gone even further, in course of time, and would have become responsible for the distribution of electricity also.

AS /

7) "British Public Utilities and National Development" - M. E. Dimmock, 1933, Ch. VI, p. 221.

As was already pointed out the El. Commissioners, in effect of legislative limitations and because of their own practice, largely became a judicial, planning and regulating agency in the matters connected with the public supply of electricity. To carry out into practice the measures under the Act of 1926 there was need for a new body - the C.E.B., to carry out the executive functions of building and operating the National Grid Scheme and to control the wholesale side of generation process. Thus it would appear that the relationship between the El. Commissioners and the C.E.B. is largely a result of historical circumstances. The El. Commissioners are related to the C.E.B. in three ways:-

- (a) as to the ordinary undertaking in general;
- (b) as special technical advisers to the Board; and
- (c) as a regulating body, sometimes acting in their judicial capacity, governing the interrelations of the Board with other undertakings, landowners and other interested parties.

The El. Commissioners are responsible for seeing that the C.E.B. do not exceed their powers under the Act of 1926, and the number of these powers is made a subject to approval by the El. Commissioners. On the other hand, it would also appear, that the Legislature was not sure of these relations between the two bodies, because according to the Act of 1926, the El. Commissioners, and not the Board, are responsible for the preparation in the first instance of the Grid Area Schemes. After the Schemes were initially prepared by the El. Commissioners they were transmitted to the Board, which could modify them before adopting them.

"The relation between the Commissioners and the Central Electricity Board forms a unique example of control over a public corporation combining non-political supervision with ultimate responsibility to Parliament". 8) The combination of technical and administrative qualifications, which characterise the El. Commissioners, seems to fit properly such an arrangement. In essence, however, the C.E.B. is "an independent enterprise operating within a very broad legal area /

8) "The Organisation of Electricity Supply in Great Britain" - H. H. Ballin, 1946, Ch. VIII, p. 217.

area under the Electricity (Supply) Acts at its own discretion". As a whole this relationship is quite workable because the Board works in close co-operation with the El. Commissioners on all matters with which both bodies are concerned.

6. STAFF AND EXPENSES.

The El. Commissioners, being appointed in 1920, began their activities at first with a nucleus of staff consisting mainly of the officers of the Board of Trade, who till that time carried on the administration of the Industry under the Electric Lighting Acts. In accordance with their powers under Section 1(7) of the Act of 1919, the El. Commissioners through time appointed a Secretary and such inspectors and servants and clerical staff as were necessary. With the approval of the Minister of Transport, the El. Commissioners decided that the general conditions of service appertaining the appointment in the Civil Service of the Crown should apply correspondingly to members of their staff. On March 31st, 1921, the Staff of the Commission consisted of 19 established officers and 23 temporary officers (including typists and messengers, etc.) numbering 42 in all. With a view to economy in administration, and with the approval of the Minister of Transport, the Establishment Officer of the Ministry was appointed by the El. Commissioners to act as their Establishment Officer, and the Commissioners have also the part-time services of a legal officer and certain other staff of the Ministry. At the end of March, 1939, the Staff of the El. Commission increased to 142 in all, and consisted of 91 established officers and 51 unestablished and temporary officers, inclusive of typists and messengers and Meter Examiners.

The Minister of Transport, under the provisions of Section 1(7) of the 1919 Act, determines the salaries and remunerations of the El. Commissioners and their Staff, and also the pensions and gratuities to be paid to them on retirement. Under the provision of Section 29(5), the Fund of the El. Commissioners, the so-called Electricity Fund, was determined to be a public fund within the meaning of the Superannuation Act of 1892. A superannuation scheme on the lines /

lines of that applying to Civil Servants and covering the case of officers transferred from the other public Departments was approved by H.M. Treasury and by the Minister of Transport. By arrangement with the Treasury, the Electricity Fund is audited by the Comptroller and Auditor-General. At the beginning of each financial year the El. Commissioners are required by Section 29(1) of the 1919 Act to prepare an estimate of their receipts and expenditure during the year and submit it for approval by the Minister of Transport. By the Superannuation (Various Services) Act, 1938, the powers of the Minister of Transport and the El. Commissioners under the Act of 1919, as amended by Section 50 of the Sixth Schedule to the Electricity (Supply) Act, 1926, were extended to enable certain superannuation benefits to be made applicable to the El. Commission. For illustration I submit the Electricity Fund, Income and Expenditure Account for the period from 1st April, 1938 to 31st March, 1939. The Administrative Expenses, on the Expenditure side amounted to over £97,000 for salaries, wages, and administrative expenses. On the Income side, it amounted to the same sum, of which £70,000 was contributed by Authorised Undertakers, and other money came from fees on Special Orders and fees for Certification of Meters (in 1937-38 over £26,000).

Under the provisions of Section 29, the Electricity Fund, out of which the annual expenses of the El. Commissioners are defrayed, is provided by contributions each year from all Authorised Undertakers in the United Kingdom, in proportion of the number of units of electricity generated by, or on behalf of, such authorities and undertakers during the preceding year. Then Section 7 of the 1922 Act provided that the administrative expenses of the El. Commissioners among all authorised undertakers is made on the basis of "units of electricity sold" in the calendar year preceding that of the apportionment. The contributions of the Electricity Supply Industry towards the administrative expenses of the El. Commissioners for the year 1938-39 involved £70,000, or a payment of about 0.89d. per 1000 units sold to consumers by each authorised undertaker concerned.

Annex 4

CHAPTER XI.

CENTRAL ELECTRICITY BOARD.

1. INTRODUCTION.

I shall briefly recapitulate the position of the Electricity Supply Industry in Great Britain prior to the operations of the National Grid Scheme under the direction of the Central Electricity Board. The business of electricity supply was carried out by a very large number of small undertakings, private and local authority, operating within small and often uneconomical areas and under the regulations of the various central authorities. The commercial development of electricity supply took place in a period of municipal collectivism, and, therefore, this Industry did not grow up in the conditions of freedom as railways and gas undertakings. Municipal trading in electricity supply became a cause, additional to those deriving from the technical and commercial nature of the Industry, for the piecemeal character of it. The Industry was strongly attached to local sphere of operations, and local conditions of administration and control, and even in matters of technique the Industry preserved its provincial independence. There were also technical reasons which contributed to such an uneconomical development. For the process of generating electricity was scientifically developed long before that of transmitting it over distances, and the commercial use of electricity for lighting came before the industrial purposes. The specific conditions in Great Britain resulted in reliance on steam rather than on water-power for generation, the wide distribution of coal fields, encouraged both the establishment of a large number of generating stations and naturally enough also a diversity of current, frequencies and voltages employed. Other factors, which were not present in other countries, were ample supply of cheap power steam, the developed state of the gas industry, the reluctance of British manufacturers to become dependent upon new and outside sources of supply. Then finally, the /

? means?
was not economical development

the Legislature aimed at giving due scope to the operations and jurisdiction of local authorities, and restraining in the interest of "healthy competition", monopolistic tendencies on the part of private companies. The situation of the electricity supply at the end of the First World War was that of "innumerable statutory and non-statutory undertakings supplying very small areas without any working arrangement between themselves for the interchange of electric current". The admitted economies and other advantages of large-scale generation of electricity have not hitherto been obtained. As was already pointed out, the provisions of the 1919 Act aimed at such a new organisation of the Industry, but because the cohesion necessary to give executive force to the Schemes was lacking, the results were poor. However, meantime it was generally accepted, that technical development encouraged the view that the best plan was to envisage the whole country as one area for the purposes of generation. In 1925 experts agreed that only about half of the generating stations in Great Britain justified their existence from the point of view of efficiency and price to the consumer.

The new ideas, in accordance with the technical development of the Industry and requirements of the country, were underlying the Weir Committee's recommendations and the Electricity (Supply) Act of 1926. The main conception was that the generating side of the Industry should be placed under central control by an independent public service corporation. A vast "gridiron" covering almost the whole country (the North of Scotland being excepted) was constructed and power is supplied by a small number of large generating stations, which work under the direction of the C.E.B. From this system a supply is given to authorised undertakers as distributors according to their requirements. Stations, considered as efficient and large, were selected as Selected Stations, and others were mainly closed down, if and when certain conditions intended to safeguard the interests of their owners had been complied with. This great task has been accomplished in the comparatively short period between /

between 1927-34, by which year the network of transmission lines had been constructed and a standardisation of frequency secured. All the power generated for supply purposes over and above the requirements of Selected Stations is purchased by the Board and then sold to the various undertakers. Thus the problem of generation of electricity for the whole country has been solved. The distribution side was not touched. Within a few years after the War, 1914-18, the Electricity Supply Industry grew from a local utility into a great national service. A new partnership has been evolved, a central body brought into operations and local interests preserved. The C.E.B. with its control over the method of generation and ownership and of the means of long distance transmission lines, can be described as a middleman. The function of the Board is "to co-operate with the Supply Industry in reducing cost of production to a minimum and concurrently in increasing availability of supply, thus leading to an acceleration of the growth of output and consumption which of itself is the surest means of bringing about the desired benefits to consumers". 1)

2. WEIR COMMITTEE'S PROPOSALS.

The Labour Government, which was in ^{the} power in 1924, was convinced of the failure of then existing legislation relating to electricity supply and therefore made plans to restore the deleted clauses of the original Bill of 1919 and to offer State assistance for the general standardisation of frequency, but its removal from office delayed any immediate progress. However, in January, 1925, the Conservative Government under Mr. Baldwin decided, before formulating a policy of its own, to appoint a small Committee consisting of Lord Weir of Eastwood, Lord Forres, and Sir Hardman Lever, with Sir John Snell, the El. Commissioners' Chairman, as technical adviser, to review the entire problem.

The Weir Committee was in a better position than any previous official Committee, for it had the advantage of using statistics collected by the El. Commissioners, since 1920, and, therefore, it /

1) "First Annual Report of the C.E.B.", 1929.
Introduction.

it was able to review the problems of electricity supply in detail and to estimate, with some degree of reliability, economies which might be effected by the new proposals for reorganisation of the Industry.

This Committee recommended the establishment of main transmission line "Gridiron", for the purpose of interconnecting the principal generating stations throughout the country. It recommended as a necessary step that the frequency of alternating current should be standardised. The savings to be derived from the interconnection had been proved by foreign practice and on the North-East Coast, where a Power Company had already constructed a grid on a smaller scale. The Committee proposed that the generation should be carried in 58 stations, connected with one another and with existing regional transmission and distribution systems. The capital cost of the Grid was estimated at £25 m., and that of standardisation at £10.5 m.

This technical scheme was restricted to reorganisation of the generation and high-pressure transmission only. The Committee did not see a need for administrative reorganisation of distribution, although they recognised the existence of some shortcomings of it. But generation was considered as a priority need, and, the Committee feared to attempt too much knowing the opposition of existing undertakings and "was influenced by the unhappy experience of 1919 Bill in the House of Lords". 2) The Committee considered distribution as "essentially a local matter, and a suitable function for decentralisation".

This Grid Scheme was to be carried out by a new authority, the Central Electricity Board. Two main considerations underlined their proposals for a public authority, first, "that the large amount of capital required would probably necessitate some form of State assistance or guarantee", and second, that "a beneficial mechanism created by the help of the State must be operated so as to secure the best results for all, and the realised economies must ensure in the main to the consumer". 3) Six years before, the Committee of Chairmen on Electric /

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- 2) "Socialisation of the Electrical Supply Industry" - G.H., 1934, p.16.
3) Weir Committee's Report, 1926, § 38.

Electric Power Supply also recommended State regulation and financial support from it. The above Committee also recommended "the appointment of an Electricity Board consisting of six members, selected from men of proved business capacity and experience of affairs, accustomed to handle large commercial undertakings". 4)

According to the Weir Committee, the C.E.B. was to be appointed by the Minister of Transport, with a Managing Director and an expert executive staff. This public body would be authorised to raise the necessary capital by the issue of stock in the open market, carrying a Treasury guarantee. To ensure even the most elementary uniformity in the distribution of Grid economies, it was essential, according to the Report, both that bulk supply prices be based on total cost rather than on marginal costs for each separate contract and that some overriding authority be in a position to determine in advance a generating programme over wide areas, allocated to the most efficient plant. On the other hand, the Committee feared that ownership of all stations by the Board would involve difficulties and would lead to "stereotyped practice, check development, remove incentive from the officials and tend to bureaucratic administration". 5) Therefore, a compromise was evolved, superimposing the Board on the existing system by giving it control of stations left formerly in the hands of their owners. Past experience led the Committee to suggest that the El. Commissioners should have compulsory powers to close down inefficient stations.

The Weir Committee succeeded probably because of the clear distinction that they made between the wholesale side of electricity supply, that is, generation and transmission of electricity, and the retail side, distribution of electricity. The Committee based its recommendations on the view that failure to take full legislative action on the lines suggested by the Williamson Committee had retarded progress towards a cheaper and more efficient national supply of electricity, and that the existing powers /

4) "Report of the Committee of Chairmen on Electric Power Supply", 1919, § 17.

5) Weir Committee's Report, 1926, § 43.

powers of the El. Commissioners were "inadequate to produce effective results".

3. THE ELECTRICITY (SUPPLY) ACT, 1926.

The Act of 1926 followed the traditional British method of reform, in which "logically coherent theories play a secondary part to practical requirements, including the requirements of practical politics". According to H. O'Brien the following positive forces were behind its passage:-

- 1) the circumstance that undertakings had not chosen to make fuller use of the opportunities for consolidation extended to them by the Act of 1919;
- 2) the detailed information made available by the El. Commissioners and the Weir Committee with respect to the backward and unco-ordinated state of the Industry considered as a national unit and contrasted with conditions in certain foreign countries;
- 3) the trade depression of the period, which produced economical consequences in the Coal and General Strikes of 1926; and
- 4) the natural desire of the Government under these distressed conditions to obtain the credit for a major piece of economic reconstruction. 6)

The Electricity (Supply) Bill before it became an Act was strongly criticised for not going far enough in reorganisation, i.e. nationalisation of the whole Electricity Supply Industry. On the other hand, the Conservative Party's critics opposed the Bill for being "socialistic". The fear was expressed that the C.E.B. would not be "responsible" to Parliament. Then the majority of local authorities and companies, who owned power stations also criticised the Bill because they feared losing their monopoly of generation. The chief alterations, which left untouched /

6) "British Experiments in Public Ownership and Control" - T. H. O'Brien, 1937, Ch.II, p.37.

untouched the essential principles, but had some influence on the future working of the Act, were as follows:-

(a) The El. Commissioners and not the Board were to prepare the technical schemes for particular Areas;

(b) The removal of the costs of standardisation of frequency from the C.E.B. directly unto the entire Industry; and

(c) The insertion throughout the statute of the principle of arbitration whenever the Board's interest came into contact with those of other undertakers.

With these modifications a final Bill was passed and received the Royal Assent on December 15, 1926.

The Act of 1926 is a bit complicated because of subject matter and terminology. Its object was to place cheap bulk supplies of electricity at the service of authorised undertakers for distribution to their consumers. For this purpose the fullest use was to be made of the Joint Electricity Authorities and Power Companies already possessing powers to supply electricity in bulk to authorised distributors in their areas.

There were three broad principles on which the Act was founded, namely, the minimum of State control, the minimum of State interference and the allowance of maximum freedom to existing undertakers.

The Act went in its provisions along the line of the recommendations of the Weir Committee, namely it provided schemes, which included:-

(1) Main transmission lines linking up the various generating stations for the purpose of inter-changing supplies.

(2) The provision of new generating stations.

(3) The whole of the generations owned by authorised undertakers have been divided into two classes:- Selected and Non-Selected Stations.

(4) /

(4) The creation of the Central Electricity Board, which duties were defined under three headlines, namely, (a) Construction, (b) Trading, and (c) Development.

The policy embodied in the Act was to be carried out as follows:- The El. Commissioners prepared and transmitted to the C.E.B., Scheme Areas. Each Scheme consisted of the following matters:-

- (1) It determined what generating stations were to be "Selected Stations" at which electricity is generated for the purposes of the Board.
- (2) It provided for the interconnection - by means of main transmission lines, which were constructed by the Board and acquired by them - of the Selected Stations with one another and with the systems of authorised undertakers in the particular area and with the system of the Board in an adjoining area.
- (3) It provided for standardisation of frequency for the needs of interconnection.
- (4) It enabled temporary arrangements to be made whereby one authorised undertaker could supply another on agreed terms until the Scheme was in full operation.

The Board was required to publish each Scheme as received from the El. Commissioners and to give not less than one month's notice of a date by which authorised undertakers and other persons interested could make representations thereon. After representations and eventual inquiries, the Board adopted the Scheme with or without modifications and was obliged again to publish this in a new form Scheme. Thereafter it was a duty of the Board to carry the Scheme. In case of any additional obligations imposed on authorised undertakers, they could refer the matter to arbitration.

Although the Act of 1926 gave the C.E.B. most essential powers, it also imposed upon it certain limitations, e.g. a non-selected station taking a supply from the Grid can only be shut if it can be shown that the cost of the Grid supply over a period of seven years is less than the present /

present cost of generation. It is laid down in the Act that no account shall be taken of charges on the capital expenditure of the undertaking, i.e. the comparison is between the Grid price, which includes charges on capital expenditure, and the operating costs of the undertaking. The Act was also criticised because "it contains no adequate provision to secure to the general public the benefit of economies effected",⁷⁾ even, if there is a provision for the revision of prices by the El. Commissioners, or for a relating of these to dividends, but the basis of such revision is not clearly defined. It was also criticised on the grounds that there is no power to force the undertakings to adopt a progressive policy, in result "It makes impossible to utilise the Grid to its full capacity".

It is often argued that the comparative success of the 1926 Act's reorganisation scheme, as compared with the failure under the 1919 Act, is not due to the insertion of compulsory powers, which have been little if ever used as a "bargaining lever", but is mainly because of the establishment of a new administrative body, independent of existing undertakers, empowered to carry through the desired reforms.

Since 1926 the only further legislation directly affecting the Board was the Act of 1935, the main purpose of which was to give the Board the powers to supply railway companies directly instead of through the local supply authority as required by the 1926 Act, and to give supplies on special terms in certain circumstances. These powers can be exercised with approval of the El. Commissioners in each particular case.

4. THE NATURE OF PUBLIC CORPORATION.

The Central Electricity Board, like the British Broadcasting Corporation, is "an autonomous commercial organisation", regulating its own personnel, generally its own financial arrangements, on a non-profit-making basis and is governed by the Board appointed by the Minister of Transport. The C.E.B. is a new type of administrative and commercial organisation, usually named a "public corporation".

"In /

7) "The Socialisation of the Electrical Supply Industry" - G.H., 1934.

"In essence the public corporation represents an attempt to apply to public administration, when extended to commercial enterprise the type of organisation evolved for large-scale private commercial administration by the joint stock company". 8) This type of commercial organisation of public utilities on joint stock lines was also practised abroad. For example, in the U.S.A. the Emergency Housing Corporation, the Electric Home and Farm Authority, the Reconstruction Finance Corporation, the Inland Waterways Corporation, some of which were only of a temporary character, but those like the Inland Waterways Corporation and the already described Tennessee Valley Authority are still performing their duties. These American bodies are characterised in this, that on the governing board there is an official representative of the national executive body, and all or a majority of the voting securities are in the Government's possession, and hence the Government has a dominant influence in management. But they are not under any direct control of Congress and, therefore, there is no political pressure, but still there may be a certain measure of political influence from the Administration. This is in contrast with the limited Ministerial control over corresponding bodies in Great Britain. Similar organisations like the C.E.B. we find in Ontario and also in South Africa.

The board of directors of the British type of Public Corporation is comparatively free in its economic activities. But usually it is limited as far as the method of appointment is concerned, and there is usually an indirect control exercised by Parliament, which in day-to-day matters of the C.E.B. has just perhaps a little more control than over any other electricity supply undertaking.

This type of administrative and commercial organisation is also named "Public Boards", "Semi-Public Bodies", "Independent Statutory Authorities" and "Public Corporations". Mr. Herbert Morrison expressed his opinion on Public Corporation in these words:- "We are seeking a combination of public ownership, public accountability and business /

8) "The Public Corporation in Great Britain" -
L. Gordon, 1938, Ch. I.

business management". 9) It was also described by T. H. O'Brien as "an experiment in the recon: ciliation of conditions under which the production and distribution of wealth require over large units of organisation, an increasing degree of individual administrative ability and creative skill for the direction of vast and complex operations, and a growing measure of participat: ion or co-operation in some form of the State, with the democratic belief in accordance with which the plain citizen enjoys both the right and the opportunity to inform himself about and pass judgement upon the major public activities and issues of the society of which he forms a fraction". 10)

Being an independent body, the C.E.B. tried to avoid making use of the Treasury guarantee, secured under the provisions of the 1926 Act, and rather to raise money on the Board's own security. This policy aimed at being a Non-Departmental public body, and, the C.E.B. largely succeeded in this respect.

The C.E.B. exercises a great influence on the whole Electricity Supply Industry, as far as generation and transmission are concerned. It is true that over 99% of the electricity is generated in Great Britain by authorised undertakings is under the direction of the C.E.B., but it is also true that generation is about one-third only in terms of capital expenditure expended by the Industry. But its importance lies in the fact, that it represents public control over a major public utility service, it controls a national production of electrical energy, that its area of operation is national in scope. Being "immune largely from political pressure", and their stocks do not bear with them voting rights, and therefore the shareholders exercise no control over the policy of the Board, it can make its own arrangements with supply undertakings, fix its own tariffs, of course, with the approval of the El. Commissioners, and control its own administrative organisation.

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9) "Socialisation and Transport" - H. Morrison, 1933.

10) "British Experiments in Public Ownership and Control" - T. H. O'Brien, 1937, p. 27.

The final body that decides the broad lines of policy of the C.E.B. is Parliament. The following opportunities may be given to M.P.s to discuss the problem of the C.E.B.:-

(1) The Vote on the Ministry of Fuel and Power's Estimates, where the Minister may or may not include a reference to the C.E.B. in presenting the Vote for his Department, or the discussion about the C.E.B. may be introduced during that discussion by the Private Member. However, since 1932, it was ruled that owing to its complete autonomy in regard to sources of revenue, the Board may not be discussed on the annual Ministry's Vote (Ruling of Sir Dennis Herbert, Chairman of Committees, at 265 H.C. Deb. 5s. 1449, 6 May, 1932).

(2) During Question Time, the responsible Minister may answer on behalf of the Board and use the phrase "I am informed by the Board that"

(3) A debate on a Private Member's Motion, or subject to the Speaker's Ruling, on a Motion for the Adjournment.

On the whole, however, the C.E.B. was rarely criticised in the House of Commons, simply because of its evident success, and because the Board's activities are complex and technical in their character. Parliament tried to avoid "political interference", and to leave the C.E.B. undisturbed in its ordinary operations, reducing Parliamentary supervision to a minimum. For the Board, consisting of experts and public-spirited men, is able "to carry out the specific duties which Parliament has assigned to it".

The Minister of Fuel and Power now answers the questions in the House of Commons relating to the C.E.B.'s activities. He is, by virtue of Parliamentary Acts, a final administrative authority over the E.I. Commissioners and the C.E.B. But the Board is not under obligation to submit detailed estimates of the cost of administration for approval by a Government Department. But still the Board is subject to a certain measure of supervision. It must submit an Annual Report to the responsible Minister, which Report is presented to Parliament; it must obtain the consent /

consent of the Minister of Fuel and Power and the El. Commissioners to the issue of new stock and the conditions under which such stock is raised, and its accounts are audited by auditors appointed by the responsible Minister. The Board in its activities, as for example the raising of capital, is treated and similarly restricted by the El. Commissioners as any other authorised undertaking. But because of the semi-permanent position of the members of the Board their position is strengthened in relation to the changing Ministers. Usually the contact between the responsible Minister and the C.E.B. is through the Secretary of the Minister and the Secretary and the Solicitor of the Board.

On the whole it would appear that neither Parliament nor the Minister are really exercising a definite control or supervision over the C.E.B. This duty is to a greater extent exercised by the El. Commissioners.

The other central Government Department with which the C.E.B. is in touch is the Treasury, in relation to raising new capital and to the provision of information as to the manner in which the Board has spent the money advanced to it out of the Unemployment Assistance Fund. The Board in its financial business deals usually with the Bank of England.

5. APPOINTMENT AND COMPOSITION OF THE BOARD AND STAFF.

The members of the Board are nominated by the Minister, who in selection takes into account such special qualities as knowledge of industrial organisation, finance and the control of large manufacturing establishments. Thus the ability of any particular person is the principal test of selection, although, a selection may be made from persons occupied in special industries, like railways, labour, local authorities and electrical supply companies. Members of Parliament are not eligible for appointment, and also no full-time member of the Board may hold shares in the Industry, while a part-time member must declare any such holdings. There are no other disqualifications laid down by the Act as regards /

regards membership of the Board. The Board consists of a Chairman and seven other members. The Chairmanship is a whole-time appointment, all other members holding part-time appointments. They may be re-appointed after a period of 5-10 years. There is no provision in the Act for cancelling the appointment of members unless they be absent for six months or more, or become disqualified for the above mentioned reasons. This system of selection by the Minister avoids the difficulties connected with a system of direct representation, but ensures the selection of suitable and experienced men. Then the possibility of re-appointment gives the advantage of continuity of services. The Chairman may be compared to the Managing Director of a Company, who takes an active part in the executive works of the Board. The remuneration (which in 1927 amounted to £7,000 per annum for the Chairman, and £750 for each other member of the Board) of the members is at the discretion of the responsible Minister. This is rather a specific provision in the constitution of public corporation. It is argued sometimes that this method may open the way for political pressure by a Minister upon the Chairman. However, it is unlikely to happen because of British character. The individual members of the Board are not in any way responsible for particular departments, into which the Board is divided, and, with the exception of the Chairman, have little to do with the day-to-day working of the Board.

The first appointment of the members of the Board was made by Colonel Ashley (later Lord Mount Temple), the Minister of Transport in 1927. He refused to give details of the interests he consulted, but indicated only that there were 60 or 70 bodies among them, and no specified section of categories mentioned in the 1926 Act were probably omitted. 11) The selection made included men of administrative, industrial, financial and engineering experience, but not agricultural. But it was criticised for the uneven distribution of membership among the particular industries. "The Economist" observed that "Local government, commerce, industry, transport and labour" were crowded into two members. 12)

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11) 207 H.C. Deb. 5s. 1661 (21 June, 1927).

12) "Economist", 1927, No. 104, p. 317.

The first members of the C.E.B., appointed by the Minister of Transport in March 1927, were as follows:-

Sir Andrew R. Duncan (Chairman)
Sir James Devonshire, K.B.E.
Mr. Frank Hodges
Sir James Lithgow, Bart.
Mr. W. Walker
Sir Duncan Watson
Mr. W. K. Whigham
and Lord Barnby, C.M.G.

The C.E.B. usually holds a regular monthly meeting, but at first during the period of intensive work in connection with construction of the Grid it had meetings more often. It has formed a few small sub-committees to deal with special phases of the Board's work, which are assisted in their discussions by leading members of the permanent staff, particularly by the heads of the Secretariat, Legal, Accounts, Engineering and Commercial Departments. The matters discussed concern such subjects as the broad policy of commercial and financial questions, technical research and construction, propaganda and educational works, etc. The most important sub-committees are those which deal with authorisation of all acquisitions of land required for sub-stations sites and other purposes of the Board, and those which deal with all questions of obtaining of wayleaves.

The Headquarters of the Board consists of five Departments according to the nature of their work. These Departments are:- The Secretary and Solicitor's Department, which is concerned with the general and legal matters; the Chief Engineer's Department, which deals with technical questions; the Commercial Manager's Department, to which belong such subjects as negotiations with supply undertakings, tariffs, etc.; the Chief Accountant's Department and finally the Economic Research and Public Relations Department. Each of them is subsequently divided into some particular branches, e.g. the Engineering Department is divided into the construction, the operating, the research and the supply sections. With the exception of the last Department, all others have a head of Department and his deputy.

Board / As for the provincial offices of the

Board there are seven district offices, in Glasgow, Manchester, Leeds, Birmingham, London and Bristol. These district offices are responsible for the operation and maintenance of the Grid in each of the nine Scheme Areas. In two cases, however, the Central Scotland and South Scotland, South-East England and East England, the two Areas are operated from one office. Each district office is under a District Manager, who is endowed with some powers to deal with the matters affecting his particular Area. All matters concerning general policy, finance, capital expenditure, etc. and engineering problems, other than purely local problems, are left to the Headquarters in London. Thus the primary authority is centralised, but close relations are maintained between the Head Office and each District Office and between the District Offices themselves. The division of powers and functions between a central authority and local offices, and a tendency to centralisation is justified because of the important technical and economic functions of the C.E.B., and, therefore, comparatively little scope for "devolution of general responsibility is left to District Offices".

I should like to mention here the activities of the Economic Research and Public Relations Department, which has been created since 1931. This Department is responsible for statistics, specialised information for "Annual Reports", which are available to all those concerned in the Industry. It also makes available photographs, graphs, etc. in schools and public exhibitions. The Board have kept in close touch with electrical development and participated in the Faraday Centenary Celebrations in September, 1931, and organised a special Exhibition at the Albert Hall in London. The Department in conjunction with the General Post Office Film Unit produced documentary films, like "Power", which illustrated the constructions of the Grid; "Electricity: From Grid to Consumer", which presented the whole process of electrical generation, transmission and distribution; it also prepared six educational films showing different phases of national industrial development, collectively entitled "The Peace of Britain". This Department also carried out a great campaign of education and publicity in order to rouse a popular interest in national electricity planning. It /

It was very successful in this work.

The Board is entirely free to appoint its own staff. The method of recruiting is not standardised. Usually the chief officers made appointments from outside. In many cases the members of the staffs of the consulting engineers and of the constructors engaged in the constructional work of the Grid have been absorbed into the Board's staff. The promotion is not generally by seniority, but is influenced by qualifications. Because of the nature of the Board, a large proportion of the staff has technical qualifications, although there are also persons employed with legal, accountancy, and administrative qualifications. Salaries paid to principal officers are perhaps higher than those in the Civil Service, but as regards the remainder of the Staff the average is probably about equivalent to the Civil Service scale, taking account of the pension and insurance. The salaries paid to the Board's officers and servants are not published.

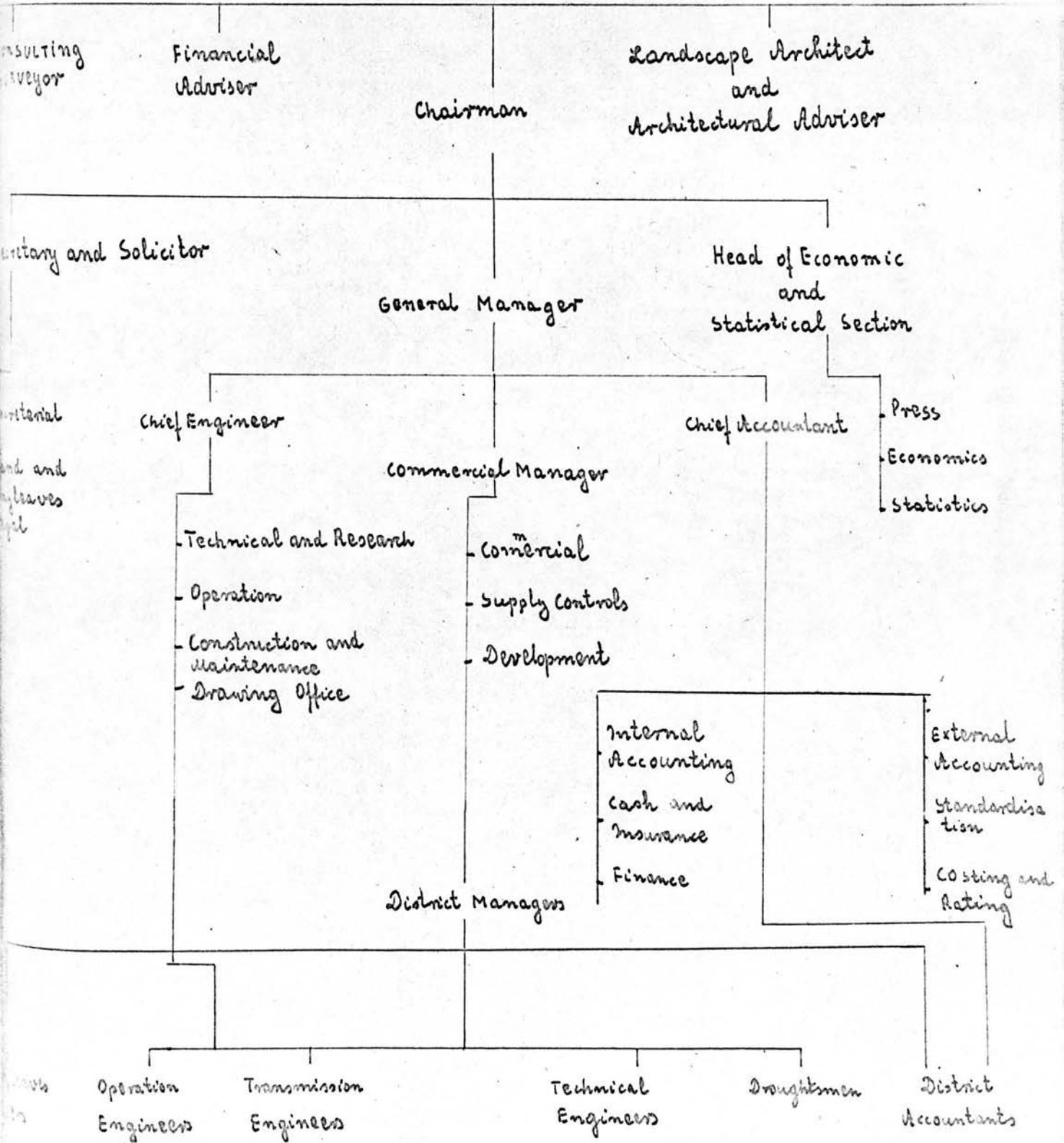
The Staff of the Board at the end of 1928 consisted of 59 persons in London and 48 in the District Offices. By 1937 this total number increased to 700 persons, or 1300 including manual workers.

The organisation of the C.E.B. is presented overleaf:- 13)

13) "The Public Corporation in Great Britain" -
L. Gordon, 1938, Ch. III.

CENTRAL ELECTRICITY BOARD.

Organisation at 30th September,
1936.



6. POWERS AND FUNCTIONS OF THE BOARD.

The principal powers of the C.E.B. have been laid down with much detail in the Act of 1926 and, partly in subsequent legislation. It was perhaps necessary to lay down the powers of the Board in such a detailed manner, as the Board was a new body and had to face the initial difficulties. But, on the other hand, the various provisions lead to difficulties of interpretation, like that of Section 7 (1).

The main powers possessed by the Board are as follows:-

- 1) Power to borrow up to £70,000,000. This sum is the maximum amount which may be borrowed, subject to the consent given by the El. Commissioners, under the Electricity (Supply) Act, 1926 and the Central Electricity Board (Increase of Borrowing Powers) Special Orders, 1930 to 1941, for the construction of the Grid and the standardisation of frequency.
- 2) Power to issue Central Board Stock.
- 3) Power to suspend sinking fund for a period of not more than 5 years and to pay interest out of capital for such a period as the El. Commissioners may approve as being the period during which the expenditure anticipated to be unremunerative.
- 4) Power of compulsory purchase of main transmission lines belonging to existing supply authorities.
- 5) Power to declare a Grid Tariff at which supplies are given to all authorised undertakers other than owners of Selected Stations, with the approval of the El. Commissioners, or to fix special terms in certain instances subject also to approval of the El. Commissioners.
- 6) Power to select efficient generating stations and to operate them as required, and to sell back to the owners thereof the quantities required for their own use as distribution authorities. The Board has power to compel owners of generating stations to enter into a national scheme, and, in cases of refusal by any authorised undertaker to co-operate, it may acquire the generating station after /

after a complicated Parliamentary proceeding. But before the Board may acquire such a station it must give any Joint Electricity Authority, in whose district the station is situated, the opportunity of acquiring the station. But the Order of compulsory acquisition does not become effective until it has been laid for thirty days without protest being made before both Houses of Parliament.

- 7) Power (exercisable by the El. Commissioners) to close down inefficient stations subject to the cost of the Grid supply being less than the cost of generation at such stations.
- 8) Power to acquire compulsory wayleaves, to break up roads and to acquire land; similar to the powers of local authority undertakers.
- 9) Power to standardise the generation frequency, and power to recover the costs of standardisation by means of levy made by the El. Commissioners on all authorised undertakers.

Endowed with these powers the Board did not use them to the full, but rather it tried to reach a compromise and agreement whenever it was possible, e.g. they avoided compulsory acquisition of wayleaves. But, such a policy did not prevent the Board from being a real controlling body of Selected Stations. It issued from time to time operating instructions to such stations, which were based on a scientific analysis of actual operating costs of each Selected Station. The Board is in a monopolistic position, but it was not abused and is partially effective.

The main duties of the Board under the 1926 Act are as follows:-

- 1) To concentrate the output of electricity for public supply systems in Selected Stations and to control their operations.
- 2) To arrange for extensions and alterations of the Selected Stations and for the construction of such new stations by authorised undertakers.
- 3) To effect the interconnection of the Selected Stations with one another and with systems of authorised undertakers.
- 4) /

4) To standardise frequency throughout Great Britain.

5) To supply, either directly or indirectly, any authorised undertaker requiring electricity in any area in which the Board are ready to supply.

In discharging its duties the Board encountered some difficulties, which arose either because of the limited powers of the C.E.B., under the Act of 1926, or because of the resistance of some of the supply undertakings. Therefore the Board had to accept a policy of compromise over such questions as the selection of certain power stations.

During the Second World War additional powers were given to the Board. For instance, under the Emergency Powers (Defence) S.R. and O., 1940, 1673, the C.E.B. was granted powers to provide and operate generating stations themselves. By the Civil Defence Act (Section 42 and First Schedule), 1939, the Board received a duty of administering the Electricity (Civil Defence) Fund. The object of that Fund was to enable additional measures to be taken for securing the due functioning of the public electricity supply systems during the War.

The duties and functions of the Board are conveniently grouped under three items:- (I) adoption of technical Schemes; (II) implementation of Schemes; and (III) purchase and sale of energy. The first two groups are of technical character, and are connected with generation of electricity. They involved the chief function of the physical construction of the Grid. They constitute the groundwork of the national power plan. As for the third group it deals mainly with the trading questions. The C.E.B. unlike the London Passenger Transport Board and the various Docks and Harbour Boards, is not a body trading with individual consumers. The C.E.B. is principally a bulk supplier. During a period of construction it was a policy of the Board to meet individual undertakers' requirements of supply before the Grid was completed in their areas. For that purpose it concluded temporary arrangements and, where necessary, constructed portions of the Grid in advance of the normal programme. Thus it saved /

saved the authorised undertakers from uneconomical expenditure on the extension of small generating stations.

Conditions to the Board's freedom of operation in its relations with authorised distributors, owners of stations and other interests are numerous (Act 1926, §§ 5 (3), 6 (2), 10 (1)(a), 20 (3)(b), 21 (1); and 1935 Act, §§ 1 (1)(2), 2 (1), 4 (1)(3)). The El. Commissioners must be satisfied that no undertaker can construct a new Selected Station or to operate an existing or new generating station, before the Board itself may carry out these functions. They are not to authorise compulsory acquisition of land for transmission lines unless satisfied that wayleaves are unobtainable. Their consent is required for direct supply by the Board for power purposes in unoccupied areas. The El. Commissioners' consent is necessary for the electricity supplies by the Board provided under the Electricity (Supply) Act, 1935, when El. Commissioners must be satisfied that arrangement will result neither in financial loss to the Board nor prejudice to other undertakers.

All the above provisions are the discretionary limitations on the C.E.B.'s positive powers, designed to secure other undertakings against "unfair competition". In addition, detailed application of the provisions for purchase and sale of energy by the Board is in each case subject to regulation by the El. Commissioners, who determine scale of depreciation for company plant in calculating "cost of production" at Selected Stations, fix load and power factor formulae, allocate costs between fixed and running charges.

According to official statement, the C.E.B. has succeeded by constant readiness to negotiate concessions and compromises in avoiding any recourse to arbitration whatsoever. At the same time the El. Commissioners have not shown themselves biased in the Board's favour. Applications by the Board for Special Orders are followed by the most thorough investigations, sometimes resulting in adverse judgements. 14)

7. /

14) "Eleventh Annual Report of the El. Commissioners", 1932, § 236.

7. ECONOMIC AND FINANCIAL STATUS.

"The Board is given control over an aspect of economic life, which it must manage as an entrepreneur in the open market, paying its way through the economies it achieves. Its quasi-monopoly over an important service, including complete monopoly of most of the high tension transmission systems and partial control of selected generating stations, allows it a margin within which it may arrange its operations at discretion".

The C.E.B. is granted powers to borrow money for the following purposes:-

- (a) the construction or acquisition of main transmission lines and generating stations;
- (b) any other payment or any permanent work it is authorised to do, the cost of which should, in the opinion of the El. Commissioners, be spread over a term of years;
- (c) the payment of interest on capital during the period when this remains unremunerative; and
- (d) the provision of working capital, and for any other purpose for which the Act of 1926 gives specific authorisation to borrow.

The Board's borrowing powers are subject to Regulations made by the Minister of Transport with the approval of the Treasury (1926 Act, 27 and 28; and the Central Electricity Board Borrowing Regulations 1928, S.R. and O., 1928, No. 466). Separate consents for each borrowing must be obtained from the El. Commissioners. The nominal advisers of the C.E.B. are the responsible Minister, the El. Commissioners, the Treasury and the Bank of England. These bodies impose certain restrictions, which are for the purpose of protecting shareholders, but also safeguard authorised undertakers and other vendors. "The system of co-ordination without ownership, with its correlative special status for selected stations as distributors, has necessitated provision for outside intervention to preserve this status". The shareholders of the C.E.B. Stock, however, do not acquire voice in the appointment of managers of the Board, have no control over further /

further issues of stock, and, therefore, they are not owners of the Board's property but are like the holders of municipal loans. Because of these limitations, the Board is not like a limited liability company, but unlike the Post Office or other Central Government Departments, it possesses legally an independent ownership of the property and assets which it "creates and administers". The best description will be that of public trusteeship, because it is under control of Public Departments. But the Board is free to husband its capital in the way it likes. "The attribution of "public" status of the Board refers to a relationship between the Board and the general public both of ownership and control". Any borrowing must receive the consent of the El. Commissioners, and it is to be carried out subject only to regulations, as to repayment and the like, laid down by the Minister and approved by the Treasury. The C.E.B. Regulations, 1928, provided that "No security shall be issued or granted as a security in respect of which the payment of the principal and interest or the principal or interest is guaranteed by the Treasury until the amount, price, rate of interest, date and method of issue and redemption of such security, the arrangements for the application of the proceeds of the issue for the repayment of the proceeds and for the provision, applications and management of and Redemption Fund in respect of such security have been approved by the Minister after consultation with the Treasury, and no variation of any such arrangements shall be made without the like approval". 15) All sums borrowed by the Board are to be repaid as the El. Commissioners may determine, and that period is not to exceed 60 years. In respect of money borrowed for standardisation the period stipulated is 40 years. The Board may suspend interest and sinking fund payments for a period not exceeding five years, subject to the consent of the El. Commissioners.

All sums received by the Board must be paid into a separate account with the Bank of England. These accounts must be audited and published once a year.

The Board's raised loans amounted in total to £55,995,546 (of which £39,762,521 was borrowed for /

15) The C.E.B. Borrowing Regulations, 1929, S.R. and O. No. 466. Reg. 61.

for General Purposes and £16,233,025 for standardisation) by 31.12.1945. The borrowing powers, for which consent has been given, not yet exercised amounted to £13,879,454. All these loans were raised without Treasury guarantee. It is argued that this independence from the Treasury was important in the early stages of the Board's activities, because thus the Board was able to secure the non-interference of the Treasury on development of the Industry. And that this argument is not valid now when the Board is well founded and the Industry developed. It is also argued, however, that the mere possibility of Treasury guarantee makes it possible to raise money at a lower rate of interest. This point is often questioned. Some writers argue that the refusal of accepting Treasury guarantee was detrimental to the Electricity Supply Industry, and through it to consumers, for the rate of interest had to be higher than need be. It is estimated that about £400,000 per annum was thus lost.

The following is the list of Central Electricity Stock Issued and Outstanding at 31.12.1945.

Description of Stock	Amount Issued	Purpose of Issue		Amount Outstanding at 31.12.1945
		General Purposes	Standardisation	
	£			
4% 1959-89	3,000,000	2,400,000	600,000	2,912,649
5% 1950-70	10,000,000	7,150,000	2,850,000	9,934,209
4½% 1951-73	6,000,000	4,620,000	1,380,000	5,978,844
5% 1955-75	7,000,000	4,725,000	2,275,000	6,659,683
4½% 1957-82	10,000,000	7,000,000	3,000,000	9,758,556
3½% 1963-93	8,000,000	5,200,000	2,800,000	7,769,071
3½% 1974-94	9,500,000	5,630,000	3,870,000	9,250,333
	53,500,000	36,725,000	16,775,000	52,263,345

The "Economist" criticised the borrowing policy of the C.E.B. on the ground, that "As to the cost of borrowing, the currency of the C.E.B. stocks, it is a point of criticism, not infrequently made in the City, that the Board is handicapped by an excessive interest charge which, in the absence of early maturity dates, cannot be reduced for a long time ahead". 16) The Author further /

16) "Economist" Vol. 118. p. 1320.

further argues, that the whole scheme was settled as long ago as 1926, and, therefore, the Board could not defer its financing to a time when interest rates after 1930 were comparatively low. But, it was a mistake to raise a loan of £10 m. a month before the War Loan conversion in 1932, when the rate of interest dropped. It is also suggested that the Board made a mistake by not claiming earlier options of redemption which it would probably have done at the cost of little or no concession in issue prices. Thus there would be a lower percentage, and consequently less capital expenditure on Grid and Standardisation.

Parliament in 1926 provided that the "maximum" sum which the Board was allowed to borrow was to be £33.5 m., but that this sum could be increased by the Board obtaining a Special Order under the Act of 1919. This was done subsequently by (Increase of Borrowing Powers) Special Orders, 1930-41, and the maximum sum was raised to £70 m.

The C.E.B. derives its revenue almost exclusively from a sale of energy to Selected Station owners, distributors owning Non-Selected Stations, other authorised distributors, and to railways supplied directly by the Board. The trading provisions of the 1926 Act are so framed as to leave in the hands of the Board to meet the costs of the Grid, a part of the savings arising from the more extensive use of the Selected Stations, i.e. these economies accrue when "the load on the public electricity supply systems connected to the Grid is able to absorb the spare plant capacity potentially brought into revenue-earning category by construction of the Grid." From such a revenue the Board has to cover not only expenditure, but also interest and sinking fund charges, with such margins as the E.I. Commissioners may allow, not annually, but over a period of years. These annual savings increased in course of time with further growth of demand. For that reason, in their tariff policy the Board envisaged revenue deficits in the earliest years of trading, only to be recovered by surplus derived from the larger volume of business in the later years. Prior to 1934 no detailed accounts were published by the Board. However, later Annual Reports showed that sinking fund payments were suspended during /

during construction period and that the interest was paid out of capital as provided for in the Act of 1926. The financial position of the C.E.B. at the end of 1945 was as follows:- The gross receipts from the sale of energy amounted to over £85 m. The credit balance on the general purposes revenue account increased by that year to £6,945,883. A further sum of £1 m. making a total of £2 m. has been set aside as a reserve for the Board's prospective liability for Income Tax. After meeting all outgoings, including interest and amortisation the credit balance of the net revenue and appropriation account was raised to £8,841,731. 17)

8. THE NATIONAL GRID.

The country is divided into areas, each with its own network of lines to which all stations in that area are linked, and with a control centre. The control station is able to forecast with fair accuracy what the demand will be at different times of the day for the particular times of the year. There are two fundamental purposes to be achieved from the Grid, namely:-

- (a) To reduce the proportion of reserve plant required in individual stations; and
- (b) To secure the highest practicable load factor for the most efficient plant on the system.

The Grid construction and standardisation of frequency was begun in 1927, and required almost six years to finish. On 5th September, 1933, the last tower was erected, and practically the whole Grid was finished by the end of 1936. During the transition period 1926/27 and 1930/31 the amount of new generating plant sanctioned was 3,069 m. Kw. or an average of over 600,000 Kw. per annum, of which 90% was sanctioned for existing or new generating stations, which became Selected Stations. But already during the next three years 1931/32 to 1933/34, when the various Grid Schemes were progressively brought into commercial operation, the amount of new generating plant sanctioned for dealing with the more immediate increases in the demand for public supplies only amounted to 268,000 /

17) "Eighteenth Annual Report of the C.E.B.", 1945.

268,000 Kw. or an average of about 89,000 Kw. per annum, of which total over 91 % was sanctioned for Selected Stations. Only about 1930 the Board began trading operations. Full trading operations in the first two areas, namely, Central Scotland and Mid-East England, did not commence till January 1, 1933.

The "Supplementary Particulars" contained projected revenue and expenditure in each year. They were not binding but provided an "illustration of a method whereby the C.E.B. can be assured of meeting the expenses incurred by them in establishing the transmission system and of being in a position to reduce the cost of electricity to the various undertakers concerned when the transmission system is completed". 18) The Board has published these "Supplementary Particulars" with the Draft Schemes. They were very helpful both to the Board and to Authorised Undertakers in their consideration of Schemes.

The principal accomplishment of the C.E.B. has been the completion of 5,158 miles of transmission lines at the end of 1945. Of these, 3,626 were operated at 132,000 volts and 1,532 at 66,000 volts or lower voltages. The Grid also included at the end of that year 349 switching and transforming stations having an aggregate transforming capacity of 13,646,150 KVA. The actual construction of high-tension transmission lines has been carried out a year in advance of the programme. The plans for the construction of Grid were not drawn up in absolute detail, because it was expected that some modifications and changes would become necessary during the actual construction. And indeed these modifications were made in some cases as a result of representations made by the bodies interested.

The transmission lines are steel-covered aluminium capable of taking 50,000 Kw. These lines are borne principally on transmission towers ranging in height from 70 to 487 feet. The largest towers weigh as much as 290 tons, and the Thames crossing towers near Dagenham have a span length of 3,060 feet. For primary transmission lines at 132,000 volts, about 6 towers are /

18) Mid-East England Electricity Scheme, 1928, "Supplementary Particulars", p. 9.

are required per mile and for secondary lines operating at 33,000 volts about 8 towers. Thus for the Grid about 18,000 towers are required for primary lines and nearly 10,000 for secondary lines. The towers lay from the Grampians to the South Coast, and from East Anglia to Land's End.

The switching stations are linking up different areas without transformation of electricity. At each Selected Station a transforming station raises the voltage of generation to the transmission voltage of 132,000 volts, while at the other end of the circuit a second transforming station will reduce it to 33,000 volts, or lower pressure, to make it available to authorised distributors. Then finally the distribution sub-stations transform energy from 33,000 volts to the lower voltage required for supply direct to consumer. Thus it would appear that the Grid carries about half of the process from the production of electricity to its consumption by the public, and remaining half is performed by distributors. The secondary transmission lines of 66,000 KV are in the London area. The 132,000 volts underground cables in London were the first of this pressure used in Europe. Although the voltage of 132,000 volts is now no longer a standard of the International Electro-Technical Commission, it is still extensively used in Australia, Brazil, France, India, Italy, Spain, Sweden, the U.S.A. and Switzerland. The British 132,000 volts transmission lines differ from those employed abroad in their magnitude and complexity, and "the density of the lines per unit area of country served being very high as compared with similar networks elsewhere", and these features "tend in the direction of requiring automatic discrimination and complete control of load regulation and switching operations if a reliable supply of satisfactory quality is to be given". The main 132,000 volts transmission lines are interconnected throughout from Dundee in the North to Hayle, near Land's End in the South-west, with many ring mains in between. The Board, by its decision, increased the number of Selected Stations to 142 in 1945 from the original proposed number of 118, and also increased the number of primary lines and transforming stations, and in some instances altered their location. Generation of electricity in Scheme Areas /

Areas is controlled from seven central control rooms, connected with the various generating and transforming stations by telephonic circuits, which "combine automatic indication of the technical situation in the area at any given time with verbal communication between the control and operating engineers".

The total estimated tonnage of steel required for the construction of the Grid, inclusive of sub-stations and river crossing towers, was about 150,000 tons, while aluminium required for the complete system was about 12,000 tons, which was mainly supplied from Scottish sources, produced by hydro-electric power.

The cost of the Grid has been approximately £27 m., which was about 2½% above the original estimates made by the El. Commissioners.

The construction of the Grid was responsible for the intensive activities in other industries, particularly in coal mining, iron and steel manufacture, cable-making industry, electrical engineering, cement and pottery industries, building and contracting, and it is also estimated that the Grid contracts influenced employment, directly and indirectly, of about 240 m. man-hours of work. The work of construction was carried out under contracts granted by the Board, supervised by consulting engineers. Several innovations had also to be made, particularly in design of large towers for river crossings, special metering equipment, transformers, switching stations, and communication systems for central control. The C.E.B. being a Public Corporation, was allowed by Parliament a huge expenditure during trade depression and unemployment period. The Board concluded the contracts with the British firms. A serious potential obstacle to economy of construction, it is sometimes suggested, lay in so-called manufacturers' "rings". The right to accept foreign-made equipment was therefore specially reserved as a safeguard against monopolistic prices. 19) But the very fact that such a threat existed was enough to make their use unnecessary. The P.E.P. Group, 1936, expressed an opinion that, "the introduction of a measure of planning in electricity supply just before the last trade crisis may actually have prevented /

19) 225. H.C. Deb. 5s. 1750 (23.VII.1931).

prevented a collapse in new generating plant business, and probably because of the requirements for heavy generating plant by the Board, the whole electrical manufacturing and ancillary industries went through slumps safely and prosperously". 20)

The Board accepted fully a policy of co-operation with such authorities like the Post Office, the Air Ministry, local authorities, railway companies, etc., even with non-statutory bodies like the Farmers' Union. In cases where the Board failed to secure co-operation, legal measures were undertaken. But that method was employed to a small extent, for instance, in 1931, only 2.36% of all wayleaves secured were obtained compulsory, although 10,000 wayleaves were obtained in that year.

In dealing with the routes of transmission lines the Board has collaborated with the concerned Societies, like Ancient Monuments Board and Local Authorities concerned in preservation of amenities. In some cases local agitation was particularly strong, like that in the Lake District, the South Downs, Oxford and the New Forest, and parts of the lines from Malton to Whitby. On the whole, however, the amenity matters did not retard the progress of the Board's plans and the construction of the Grid was accepted in principle by the public opinion.

The technical experts were satisfied that the Board discharged its duties in constructing the National Grid Scheme with "high measure of technical and economic success". The policy of co-operation and of compromise with concerned bodies made possible to avoid unnecessary friction. The works could be carried out speedily and according to the prepared plans. The Board by its initiative appeared to the public as being progressive, and secured "the support and enthusiasm" of the engineers, interested in technical efficiency and scientific development, of industrialists and politicians, who considered the progress of electricity supply as "a means to the improvement of their own business or a key to the revival of the British industries", and of the public opinion, to whom the extensive supply of electricity meant a certain economic gain, labour-saving, or greater comfort and convenience of living. /

20) "Report on the Supply of Electricity in Great Britain" - P.E.P., 1936, p. 26.

living.

The importance and value of the Grid during war-time was summed up by Mr. E. R. Wilkinson, Commercial Manager of the C.E.B., in his Presidential Address to the Association of Supervising Electrical Engineers, on 21st October, 1944. 21)

"In regard to war conditions, far greater flexibility in operation was coupled with a much enhanced security, since one undertaking's busbars could be fed at need from other stations.

"An appreciable shift of load followed the evacuation from cities and the provision of military accommodation, including that required for soldiers from other countries. At the same time, the construction of hundreds of new factories, with individual loads of from 20,000 to 100,000 Kw. and the change-over of existing works to war production caused an unprecedentedly great and rapid expansion in power demand. The new factories were often, in view of war conditions, situated away from normal industrial centres, which the Grid made possible, and this resulted in heavy load transfers Practically all factories constructed since the start of the War had obtained their electricity from public system and in no case had a supply not been available. As war factories could be built more quickly than generating plant, the setting to work of the former had been expedited. Moreover, the additional generating plant had only been the minimum required by the growth of load, partly because the energy could be transmitted from areas where demand had fallen and partly because of pooling of stand-by capacity on account of Grid interconnection."

9. GRID SCHEME AREAS.

According to the C.E.B. the most economical operating programme for an area is the one, which "allocates the maximum practicable output to those stations having the lowest running cost, due regard being had to the necessity for providing adequate time for periodical overhauls of the plant in each station and for restricting, within suitable limits, the transfer of energy over the Grid /

21) "Electrical Review", 27th October, 1944, p.587.

Grid lines". 22) In delimiting the particular Grid Scheme Areas, not only the power generating plants were considered, but a broad view of economic and industrial aspects of the whole areas were also taken into account. Thus the North-East England area covers the shipbuilding, iron and steel, chemical and coal-mining industries of the North-East Coast, and adjacent areas. The North-West England Scheme covers Lancashire with its textile industries, coal mines, iron and steel plants, and engineering works near Manchester, as well as in Cheshire, with its chemical industries round Runcorn and Widnes, while the Mersey estuary with its grain-milling and seed-crushing industries, shipbuilding and soap works is also included. The Mid-East England Area covers the three main industries of woollen textiles, coal-mining and iron and steel; Central England Area includes engineering and electrical manufacturing industries, metal-working generally and automobile construction. The South-West England Scheme and South Wales Scheme cover the whole mines, iron and steel plants of South Wales, confectionary and tobacco, and paper-making works in and around Bristol. It covers also the great part of Southampton and runs near Oxford with its automobile industries. The South-East England Area, which has been one of the most recently industrialised areas of Great Britain, possesses a number of small industries supplying commodities in general consumption or materials required for building construction. It has three important industries, paper-making, cement and electrical cable-making manufactures. It also includes part of London. Scotland as a whole, has very large shipbuilding yards, iron and steel plants, coal mines, and a great number of smaller industries like chemicals, oil refining, cotton and woollen textiles, paper-making and printing. Such was the industrial character of the above Areas before the War, 1939-45. Naturally, War brought some changes connected with war-time production.

The delimitation was based on a principle that each Grid Scheme Area should be ultimately in a position to meet costs of operation and capital charges by itself, without subsidies from other Areas. The South Scotland Area is an interesting /

22) "Sixth Annual Report of the C.E.B.", 1934.



interesting case in this that the Grid is essential to electrical development and where interconnection with other areas is necessary to economic operation of the Grid in that Area. Part of its supply is taken from water-power stations in the North.

At the end of 1945 the relative position of the Grid Scheme Areas was as follows:- 23)

Area	Area in Square Miles	Civilian Population at Mid-year (estimated)	Electricity generated by Authorised Undertakers for Area. (mill. of units) (provisionally)	Selected Stations at the end of 1945.	
				Number	Generating Plant Installed (Kilowatts)
Central & South Scotland	9,288	3,880,000	2,973.36	16	987,055
North-East England	5,049	2,466,000	2,410.34	6	557,900
North-West England & North Wales	9,082	6,657,000	6,594.37	29	1,980,475
Mid-East England	7,546	4,633,000	4,095.40	18	1,248,675
Central England	7,311	5,884,000	6,035.50	18	1,789,950
South-East England & E. England	12,266	12,096,000	9,940.34	38	3,585,601
South-West England & So. Wales	17,090	6,198,000	4,585.58	17	1,166,275
Total in Grid Scheme Areas	67,632	41,814,000	36,634.89	142	11,315,931
North Scotland	20,509	760,000	736.39	-	-
Total Great Britain	88,141	42,574,000	37,371.28	142	11,315,931

23) "Eighteenth Annual Report of the C.E.B.", 1945, p.52.

10 SELECTED STATIONS.

The Selected Stations are the most efficient and modern stations suitably situated from the point of view of load. These stations work under the control of the C.E.B., which, however, does not own them, and are operated under the existing technical staff of the given undertaking.

In determining the selection of generating stations, a classification into three groups was made:-

1. Base Load Stations - These are most economical, modern, which ensure the efficient and cheap supply of electricity. They operate continuously, with a certain margin of safety and reliability, so that maximum economies could be realised. A considerable part of energy generated is used for the owners of such stations for the purpose of their own distribution requirements, and the remainder is exported to the Grid for transmission to other undertakings.
2. Two-Shift Stations - These are usually less efficient and may be operated for two-thirds of maximum time and are usually closed down during the night when a load is comparatively light, or during week-ends or during summer.
3. Peak-Load Stations - These are required to operate only during a period of peak-load like in winter time or in the early evening. They may be used also as reserve stations.

The location and extension of the stations is a matter for the Board, which must have regard to the strategy of the Grid development. In determining the location of generating plant the Board has regard to (a) anticipated incidence of the load; (b) the capacity of the Board's transmission system and any extension of that system, which may be involved; and (c) the room for expansion at existing stations. In that respect the Board is advised by its District Consultive Committees and must obtain consent from the El. Commissioners. "The general strategy of power-station operation is settled by the Board, but the tactical day-to-day operation is also jointly in the hands of the /

the power companies or local authorities". 24) The danger exists, because power station staffs are employed by the undertakings but receive instructions for the part of their duties relating to switching from the C.E.B. Thus the station staffs are faced with divergent interests.

At the time when the 1926 Act was being drafted it was assumed that generation would be concentrated in about 50 Selected Stations, but the subsequent period proved that this number had to be increased to over 140. This was due to those provisions of the 1926 Act, which protect the non-selected station owners against compulsory closing down of their stations. In order to secure sufficient load to pay its cost the Board was compelled to widen the number of Selected Stations with a view to ultimately scrapping them after a certain time. This arrangement, no doubt, was disadvantageous to the Grid as a whole, for less efficient stations were still kept operating and their capital charges were thereby placed on the Grid. However, in the period between 1927-1933, 146 generating stations ceased to operate, of which 39 were closed down due to the operations of the Board. 25) At the end of 1945 the 142 Selected Stations were responsible for 11,315,931 Kw. out of the total installed capacity of all authorised undertakings of 12,297,000 Kw.

As for the charges for electricity supplies from the Grid they are complicated, perhaps, because the Board does not own the stations but has to operate them, or at least control them. The two principles involved are "adjusted station cost" and "calculated cost under independent operation". Once the station is selected the Board takes over the financial obligations connected with it. The Board makes arrangements with the owners of Selected Stations, operated under the provisions of the 1926 Act, and for such extensions and alterations thereof as may be required by the scheme, and for such additional extensions and alterations as are necessary.

The price paid by the Board is "cost of production", which includes operating charges (fuel, salaries and wages, maintenance, and a proportion /

25) "British Public Utilities and National Development" - M.E.Dimmock, 1933, Ch.VII, p.245.

24) "Power Station Owners" - J.F.Field - "Electrical Review", Vol. CXXXIV. May 19,1944, p.699.

proportion of management cost), rent, rates, taxes, interest on capital and working capital, and allowance for depreciation. In the case of local authority and Joint Electricity Authority undertakings interest is calculated at the average rate paid on their securities and depreciation on the actual sinking fund charges. The private companies are paid at the average rate of combined interest and dividend during the preceding year, but not less than 5% and no more than 6 $\frac{1}{2}$ % while depreciation is calculated according to Scale of Depreciation (Cost of Production at Certain Selected Generating Stations) Special Order, 1931, S.R. and O., 1931, No. 701. These owners of Selected Stations may demand to be supplied back with energy, amount not exceeding at their own stations, at "cost of production" adjusted according to load and power factors of the supply, according to the Electricity (Adjustment of Price according to Power Factor) Regulations, 1929, of the El. Commissioners, S.R. and O. No. 1016, plus a proportion of administrative expenses incurred by the Board. Section 13 of the 1926 Act provided that "Where any authorised undertakers being the owners of an existing generating station which by virtue of this Act becomes a selected station, who take a supply of electricity from the Board prove to the satisfaction of the El. Commissioners that the cost of taking that supply from the Board on the terms provided by this Act in any year exceeds the cost which they would have incurred had this Act not been passed in themselves generating the like quantity of electricity, then the charges by the Board to those undertakers for the supplies of electricity furnished to them shall be so adjusted that the amount charged in that year does not exceed the cost which, in the opinion of El. Commissioners, the undertakers would have incurred in themselves generating the electricity".

The criticism of the above arrangement went along the lines that the Selected Stations' plant "is being used on a large scale at their cost, to afford supplies via the Grid to other undertakings at cost which the latter could not secure for themselves". 26) In other words the distribution of savings derived from the Grid is disproportionate /

26) "Some Aspects of Municipal Electricity Supply Finance" - W.E.Foden, 1937, p. 135.

disproportionate to the service rendered to the Scheme by the individual undertakings. This was also reaffirmed by the Board itself. In some cases attempts were made to overcome this difficulty. Thus, for instance, in North-West England and North Wales the arrangement provided for the pooling and distribution among the Selected Station owners in that Area, at quinquennial intervals during the first tariff period, of the savings which would otherwise have enured to the benefit of a few. Another difficulty is in determining the hypothetical independent working cost of undertakings, and a great amount of effort and work to compile the necessary data. This was to a certain extent relieved by the fact that the Board, in collaboration with representatives of Selected Station owners, have initiated uniform systems of recording the financial and technical results of generating station operation. These records are also useful in preparing operating programmes supervising day-to-day operation of the stations.

During 1945 two points arose in connection with the interpretation of Section 7 and 13 of the Act of 1926. The first point concerned the trading relations between the Board and Company owners of the Selected Stations. So far, it was the practice of the Board to divide the money paid in dividends and interest on the share and loan capital of a company by the amount of money raised. One Company, however, claimed that this should be done by dividing the amount of money paid in dividends and interest by the nominal value of their share and loan capital. The Arbitrator and then the High Court gave decision in favour of the Company's interpretation. The other point of interpretation concerned the price payable by the company to the Board for their electricity requirements. According to the practice in the past, in estimating the cost which the owner of the Selected Station would have incurred in generating his electricity requirements independently, to include interest on the money which he would have spent for capital purposes at a rate calculated in the same manner as that used in determining the interest rate payable for the purposes of the costs of production at the station. According to Company, the rate of interest should be determined by dividing the money paid in dividends and the interest on their share and loan /

loan capital by the money raised, and not by the nominal value of that capital. The El. Commissioners gave their verdict in favour of Company's method. "These interpretations allow considerable profits merely by raising Company's capital in such a way that the nominal value of the share and loan capital is lower than the amount of money raised." 27)

The Board has under its direction also non-selected stations, which in 1945 numbered 51 in all. The owners of these stations are protected by Section 14 of the 1926 Act, which provides that no such undertaker can be compelled to close down his station and buy his supplies from the Grid, unless the cost of the Grid supply can be shown to be less than the cost of production, excluding capital charges. But Grid Tariff includes capital charges on generating stations and on the Grid. It follows that the works costs of the majority of the non-selected stations are lower than the Grid Tariff. Thus only few non-selected stations with high costs of production are deemed to be closed down. But, it is useful for the Board to supply the owner of station wholly, and for the station to be operated under the directions of the Board for peak load, the Board paying appropriate rental for its use. "As the outstanding capital decreases, that rental can gradually be reduced and ultimately it will be to the advantage of the owner of the station to purchase the whole of his requirements from the Grid under the Tariff, and shut down his station". With that view the Board entered into special agreements with such undertakers. Since 1935 that practice has been recognised by Section 1 of 1935 Act.

11. SOME EFFECTS OF AND ECONOMIES DERIVED FROM THE GRID.

One of the most important effects of the National Grid Scheme, which is capable of expansion whenever demand renders it necessary, is an abundant supply of electricity, which is available to industrial and urban centres, and to a lesser degree to rural areas. It was also responsible for bringing down the price of electrical energy during the last two decades. Taking the Electricity Supply Industry as a whole, the greatest benefit /

27) "Eighteenth Annual Report of the C.E.B.", 1945.

benefit perhaps was achieved by smaller undertakings, because their supplies from the Grid and the Grid Tariffs are lower than the total costs they would have to pay for an independent generation. The C.E.B.'s Report for 1938 shows a fall of 22% in the average inclusive cost of generation per unit since 1932. Even when the contributions to the expenses of the C.E.B. are taken into account, there was still a national average reduction of 17% in the cost of production per unit.

Another effect of the Grid Scheme is the increased reliability of supply and the possibility of transmitting energy to new industrial centres, which was of particular value during the Second World War.

Finally, the Grid made it possible to use electricity for wider areas from hydro-electric stations, particularly in Scotland, where the Grampian Electricity Company and the Galloway Water Power Company, provided in the past, electricity for the Grid lines, and such supply is also provided to come under the North of Scotland Electricity Board.

The savings derived from the operation of the National Grid Scheme under the directions of the C.E.B. may be divided into three groups, namely, (a) Capital Economies; (b) Operating Economies; and (c) Increased Demand Economies.

(a) Capital Economies.

These economies are derived from the fact, that because of interconnection and control of Selected Stations, it is possible to make savings in capital expenditure. Firstly, it is possible to concentrate production in larger and more efficient generating stations. Secondly, it is possible to release, for active production, a large part of existing generating plant, which under independent generation had to be held in reserve in case of breakdown or in case of a sudden increase of demand. Under the Grid Scheme it is possible to offer mutual assistance in such cases and thus a reduction of stand-by plant is possible. The Grid made it possible to correlate the generating capacity to demand, with a consequent saving in investment. In effect the Grid was responsible /

responsible for bringing down the amount of reserve plant from a maximum of 83% in 1930 to 22% in 1937. This represented a saving of £17 m. in capital expenditure by the end of 1937, or more than half of the capital expended on the construction of the Grid and its extensions and reinforcements. By the end of 1938 the capital savings due to reduction in proportion of reserve generating plant was approximately £22 m. or nearly three-quarters of the capital expenditure on the Grid (See Appendix XIX). From the Diagram of Relationship between Aggregate of Maximum Demand on Stations owned by Authorised Undertakers and Total Installed Capacity of All Generating Stations owned by Authorised Undertakers, it will be seen that the ratio is decreasing. This fact reflects the increased amount of existing generating plant brought into productive use by the operation of the Grid System. It will be seen from this Diagram that the proportion of spare plant was actually increasing until the end of 1929, that the increase was arrested during the next three years, due largely to the temporary arrangements made by the Board during the Grid construction period, and since normal trading began in 1933, there has been a progressively rapid decline. In 1934 and 1935 there was a big increase in plant sanctioned. This indicated that most of the reserve capacity has been absorbed by the Grid, and that regular annual increase had to be made according to the demand anticipated.

Before the operation of the Grid Scheme there was always a certain amount of the capital, representing the difference between the capacity of plant being utilised at the time and the maximum available capacity. Now, when the reserve plants are "pooled" the Industry as a whole, needs much less of this idle capital spent on reserve plants than formerly. This adjustment of capacity thus enable full use to be made of capital investment in generating stations and ensures that the new capital investment is spent for most productive purposes, and becomes almost immediately remunerative.

During the War, 1939-45, these economies were not so evident. Simply because, it was necessary to keep a larger amount of relatively inefficient /

inefficient generating plant ready to meet an emergency. That fact was the reason for reduction of the revenue derived by the Board. As the C.E.B. pointed out, that from the outbreak of War, the generating policy has been designed, in the national interest, to ensure the maximum practicable security of supply, and, therefore, "the loss of efficiency, the increased cost of operating both the generating stations and the Grid itself, and the necessary increase in the margin of installed generating plant capacity over the load to be met, caused, that the Board's revenue did not cover working expenses and capital charge". 28) This was, however, only of a temporary character. For already by 1943 the Board was able to balance their expenditures, mainly because of the increased load factor. Using of the older generating plant during the War had a twofold result. It had an adverse effect on thermal efficiency of the generating stations, which in 1943 was 1% below the 1939 level, and the greater percentage of generating plant was out of service. In the pre-war years, at the time of peak-load, this percentage was approximately 6%, whereas on the day of maximum demand in 1944 the figure was over 18% of the aggregate output capacity of all generating stations operating under the directions of the Board. According to the C.E.B. this increase has been caused by the following factors:-

- 1) The prolongation of the period during which heavy demand persisted.
- 2) An increase in the breakdown of plants.
- 3) The necessary retention in service of obsolete plant, with consequent reduction in reliability.
- 4) The increased maintenance of boilers caused by the inferior and variable quality of coal.
- 5) The shortage of labour for carrying out maintenance work and effecting speedy repairs; and
- 6) To a small extent only, the result of damage caused by hostile action. 29)

(b) Operating Economies.

These /

28) "Fourteenth Report of the C.E.B.", 1941.

29) "Seventeenth Annual Report of the C.E.B.", 1944.

These economies are derived from the fact that the construction of Grid made possible the reduction of working costs arising from the allocation to the more efficient and larger stations, of the long hours or high load factor requirements of the area. As a result of such an arrangement, great economies are derived from the reduced consumption of fuel per unit generated. Then the closing down of secondary generating stations altogether or during certain periods of the year or day permits of the incidental economies in other operating expenses. The Grid made it possible to concentrate production of electricity in fewer and larger and more efficient generating stations and opened the way to take advantage of the economies derived from large-scale production in super-power stations. These economies were explained already in Chapter I. Here, I may mention the economies in fuel consumption due to the operation of the Grid. For the greater concentration of production of electricity has been the principal contributing factor in reducing the average fuel consumption per unit sent out from the generating station operating under the control of the Board. This was in 1935 over 11% as compared with the average consumption of such stations when operating under independent conditions in 1932. This represented a saving of £920,000 in the operating costs for the year 1935. 30) By 1936 this percentage increased to 14%. The average fuel consumption per unit achieved in 1937 was nearly 17% less than that under the conditions of independent operation prevailing in 1932. By 1938 it increased to 20%. At the average price of fuel in 1938 the savings were some £2,250,000 as compared with the 1932 level of fuel consumption.

During the War, 1939-45, the lower quality of coal had also an adverse effect on thermal efficiency and the average coal consumption per unit was slightly higher in 1944 than in 1938.

"The real criterion of the contribution of the Grid towards the national economy is the extent to which the normal downward trend in production costs due to advance in a technique, which was, of course, in evidence before inauguration of the Grid Scheme, has been increased since /

30) "Eighth Annual Report of the C.E.B.", 1935.

since the Board began operations". 31) It is quite probable that the reduction in number of generating stations after a period of years would decrease even without the construction of the Grid. But, of course, the inefficient stations would operate longer than they would otherwise need to, and expansion of generating plant capacity would be unco-ordinated. "There would consequently have been over-valuation of assets as far as old and inefficient stations were concerned, and waste of new capital in the provision of unnecessary extensions".

Apart from the economic aspects of the Grid operations there are also other achievements due to the Grid system. Namely, the various indirect benefits accruing to undertakers from collective operation, the common general gain from technical experiences acquired by the Board, and the helpful assistance of the Board's staffs to the owners of Selected Stations in their endeavouring to operate their undertakings "with due regard to economy and efficiency" as required by the 1926 Act. However, it is another matter, whether these savings in operating and capital costs, which accrue not to the Board, but to the existing undertakings, are handed on to the public in full or not.

(c) Increased Demand Economies.

These economies are mainly derived from the fact that the Grid made it possible to develop electrically some new areas, previously "unoccupied" and considered as uneconomical from the point of view of authorised undertakers. The economies and co-ordination of services in generation under the C.E.B. are a contributing factor towards lower retail costs and extended the variety of uses to the greater number of consumers. These economies are enhanced, of course, by corresponding economies and rationalisation of services on the part of the distribution. In generation and transmission a capital risk is now assumed by the Board, and, therefore, the supply undertakings do not require as great a margin of net revenue on a given capital expenditure on distribution as was necessary before Grid operations. Much of the /

31) "Eleventh Annual Report of the C.E.B.", 1938.

the progress since 1933 has been due to the "readiness of the Electricity Supply Industry to develop an area on a narrower margin of net revenue than formerly, under conditions of economy in capital expenditure and of reduced capital risk". It is considered that the construction of Grid is only a first stage in organising the Electricity Supply Industry for the services of the whole country. But, "not until an equally large task has been performed in the field of distribution can the consumer reap the full benefit of what has been done in transmission". 32) On the whole, the Grid is financially stable, already contributed net dividends to the Industry and to national prosperity. It is sometimes argued that the profit incentive is not focussed upon efficiency in operation, as there is little left of initiative to the owners of Selected Stations. "Rationalisation on a national scale demands complete control in every aspect, financial as well as technical; to divorce such control from nominal ownership is meaningless and wasteful concession to individual dogma." 33)

12. CRITICS OF THE C.E.B.

It is sometimes said that the C.E.B., as an executive agency of a nation-wide planning body for the Electricity Supply Industry did not grasp the whole responsibilities in relation to the electrification of the country and particularly in industries. This criticism is not so much against the technical schemes and achievements of the C.E.B. as rather against its administrative, economic and social responsibilities. It is also said against the Board, that it does not possess a sound planning policy in extension and developing of the existing schemes, in relation to mineral resources, communications and transport, population and consumption. That schemes are prepared in secret and issued by instalments, and this generally is not "a planning but misleading the public".

Mr. Hugh Quigley criticised the C.E.B. on the following grounds:- 34)

The C.E.B. failed to keep the national interest /

32) "Planning" No. 52. June 4, 1935, p.2.

33) "The Public Corporation in Great Britain" -

L. Gordon, 1938.
34) "Electricity in its Regional Setting" - Report prepared for the Architectural Review by the Assocn. for Planning and Regional Reconstruction-April 1945, pp. 16-20.

interest paramount. Its primary duty was not the interconnection of generating stations, but to universalise and cheapen the cost of electrical energy through the use of this interconnected system. Otherwise the Industry could achieve the same aim without creating the C.E.B. at all. He also criticised the C.E.B.'s policy of co-operation and compromise with various interests of the Electricity Supply Industry, on the ground that by doing so the C.E.B. did not have a policy of its own. That the Board was rather "hard" to small undertakers and as result the large undertakings, whether private or public derive greatest advantage of the Grid System. And on the whole, "the cost of electrical energy to the public was not reduced or the service markedly extended as the result of the Board's operation".

The second criticism of the C.E.B. is that it has not carried out any research or development work on its own and relied exclusively on the electrical manufacturing industry, with the result that the Industry is "over-elaborate, over-equipped, excessively costly plant and apparatus".

The third argument against the Board is that it exercised no control over location; siting and elevation of generating stations, observed no aesthetic or architectural standards. Again that the Board failed to work out "any national power plan and to fit this into national economic and social requirements as well as to extend electricity into rural areas". Some of the above criticism is, of course, exaggerated, and some parts should not be directed under the address of the C.E.B., but under the address of Legislature, which invented that ingenious body in order to compromise with all the interests within the Industry.

The Author suggested the following recommendations in order to improve the efficiency and workability of the C.E.B.:-

1) The control and administration of selected generating stations should bear with it a uniform remuneration, no matter how large the station may be.

2) The C.E.B. must be made directly responsible for the design, location and construction of all new generating stations.

3) /

3) The proposals of the C.E.B. for new generating plant should be published and, before assent is given to them, they should be subject to public inquiry.

4) The entire conception of the Grid requires revision to make it more applicable to a plan of post-war reconstruction. The complete apparatus of generation, transmission and distribution must be reassessed by an independent expert body and a scheme drawn up for the next ten years.

CHAPTER XII

MAIN CHARACTERISTICS OF THE VARIOUS STAGES
OF THE DEVELOPMENT OF THE ELECTRICITY
SUPPLY INDUSTRY

Introduction.

According to B.S.E. Britton there are five fundamental conditions connected with the Electricity Supply Industry, namely:-

1. No matter how adverse the circumstances, the use of electricity for all purposes advances and will continue to progress.
2. The present extent of electricity supply is primarily due to the boundless inherent benefits of the utility of electricity.
3. No undertaking should be confined to parochial boundaries as such.
4. The pros and cons relating to local authority versus company administration are irrelevant and both should be abolished in favour of small public board or boards.
5. The fullest practical use of electricity has been prevented by unsuitable legislation, statutory bodies, the influence of parochialism and the silent, active power of vested interest. 1)

But, unfortunately for the Industry, these conditions did not exist; for from the birth of public electricity supply in Great Britain the Industry and consumers were burdened by unsuitable legislation, by the lack of the planning and competent controlling body for a long time, by excessive parochialism, that prevented the normal technical/

1) "Electrical Review" Vol. CXXXII, May 14, 1943, p.643.

technical and economic tendencies of the Industry to develop, the lack of understanding on the part of Parliament. As a result of such disadvantageous circumstances, neither the public in general nor industries had been offered fullest possible services and benefits of electricity on the most economical terms.

As was already observed, in many respects and in comparison with other countries of similar economic and industrial structure, the British Electricity Supply Industry was comparatively backward, in spite of the very fact that, since 1882 up to the present day, the Industry was constantly increasing its actual production. For five or six decades of its development there was, indeed, no strong public reaction to bring this Industry to workable conditions as in other countries.

But, during all those years there was, no doubt, a considerable progress in technical matters, an improvement in organisation of electricity supply, particularly on the side of generation and transmission, except in distribution, which was more or less untouched. It is sometimes observed that "if all powers concerned in the Industry had the will to act with purpose and vigour, the Industry would be put on a sound financial, commercial and national footing".

In discussing the particular phases of the development of the Electricity Supply Industry, it is necessary to bear in mind the remarks made in the "Introduction" about the influences of industrial and trade fluctuations on electricity output. As, for instance, the years 1921-22, and 1929-31, in which economic crisis the rate of increase was slowed down, although the actual production of electricity still tended to progress. At least there was such a tendency in this country. Abroad, in countries like the U.S.A. and Canada, the industrial and trade fluctuations were strong enough to outweigh the upward movement of electricity production. These economic conditions which are of an external character, but which still play an important part upon the development of electricity supply, must be considered carefully. In fact, it is necessary to bring into consideration of this development almost any factor which tends to increase or decrease the rate of growth of electricity production.

I propose to divide the whole period of the electricity supply development into two parts. The first period will extend from the appearance of the first Electric Lighting Act, 1882, to the end of 1919, that is, to the last year before the operation of the El. Commissioners, as the first attempt to organise the Electricity Supply Industry on the more rational basis. The Second period will cover the years from 1920 to the end of 1945, a period which witnessed an enormous development of the electricity supply, which became a national asset and a basic industry, under the planning and control of the El. Commission and the C.E.B. But, of course, such a division is only a conventional one. Then, I shall differentiate further distinctive Sub-periods within the above division. Thus, I suggest, to divide the First Period into two parts, namely, the Sub-Period 1882 to 1914, to the outbreak of the First World War, and the second part, the years 1914-19, during which the Industry stimulated by the needs of war-time production, almost doubled its production, but at the same time brought to the surface the fundamental weaknesses in its technical and administrative spheres. The Second Period I propose to divide into three marked Sub-Periods. The first one from 1920 to 1926, the Sub-Period covering the activities of the El. Commissioners as the only planning central body for the whole Industry. The Second from 1927 to the end of 1938-39, that is, the period of operation of the C.E.B. as the executive body in the new organisation under the 1926 Act and as an agency primarily responsible for the National Grid Scheme, to the year prior to the outbreak of hostilities. The Sub-Period during which the generation and transmission aspects of the Electricity Supply Industry have been re-organised and based on the technical and national requirements. Finally, the third Sub-Period covering the years of the Second World War, 1939-45, which in many respects was similar, but also with substantial differences, to the Sub-Period of 1914-19. In making any comparisons between these different periods and sub-periods, I shall try to draw attention not only to the actual progress made by the Industry itself, as measured by the installed capacity of generating plants, units generated, units sold, etc., but also to the main conditions connected with or outside the Industry. For it is impossible to separate these conditions from the advance in production, which is organically connected with the administrative machinery, legal/

legal position, political forces, and last but not least with the economic conditions of the country.

(A) FIRST PERIOD, 1882-1919.

During this period the Electricity Supply Industry was based upon the statutory powers under the Electric Lighting Acts of 1882, 1888, 1889 and 1909. For about 40 years this Industry had to face numerous difficulties of the defective legislation, some of which was already out-dated and entirely unsuitable to the new technical and economic requirements. For during that period, as was already observed, there was a technical progress with regard to generation transmission and distribution. The old methods and plants adopted and used by the authorised undertakers in the early years, naturally became unsuitable to subsequent requirements and became liable to obsolescence.

The "Electrician", in 1917, attributed the lack of progress during that period to main, five factors, namely:- 2)

- 1) Defective electrical supply legislation.
- 2) Compulsory purchase of private undertakings without adequate compensation.
- 3) Municipal policy in favouring the development of small undertakings and the maintenance of municipal boundaries coupled with distrust of private enterprise.
- 4) Lack of co-operation between undertakings which should be interlinked.
- 5) High cost and uncertainty of Parliamentary procedure.

We may add to this list two other factors, namely,-

- (a) Lack of central controlling and planning authority responsible for the technical and administrative development of the Industry as a whole, and
- (b) Policy of Parliament in preventing association between undertakings tended to encourage variations in systems of supply, frequencies and voltages.

The progress, which saw at first some failures of earlier companies and a reluctance of the local/

2) "Electrician" Vol. LXXVII, March 30, 1917, p. 759.

local authorities in entering the electricity trading, was of a speculative character, and depended on the enterprise, energy and initiative of particular individuals. As a result of the above factors, the development was uneven, chaotic and haphazard. Nevertheless, from 1900, the first steps were made in supplies of energy in bulk and for power purposes by Power Companies, a generation on a large scale was begun; electricity was used not only for lighting but also to an increasing extent for industrial purposes; the cost of production and prices charged decreased substantially, supply service became more reliable, the establishment and operation of electricity undertakings became commercially possible, and the Electricity Supply Industry generally adapted itself quickly and successfully to the new requirements during the national emergency in the First World War. So in 1915, it could be said that "electricity is no longer the infant that it was formerly pictured, and cannot be expected to continue the rate of the infant. It is obtaining to the vigour and strength of manhood. It is contrary to natural law that either a child or an industry can have rapidity of growth and at the same time strength and stability of character". 3)

(I) SUB-PERIOD, 1882-1914.

It is unfortunate that it is impossible to ensure absolute accuracy in the statistics for this Sub-Period. Nevertheless, the data used will give us the general tendencies in the development process of the electricity supply. The figures prior to 1914 are mainly taken from Garcke's Manuals.

The progress of electricity supply between 1882 and 1888 was temporarily held up by technical difficulties of transmitting low voltage direct current over long distances, and by financial troubles of the earlier years, and by the discouraging effect upon private enterprise of the provisions of the 1882 Act. "The fault of the Government in enacting Act 1882, with its 27 Section, was that it looked too far ahead to shield the public from the dangers of a hypothetical monopoly/

3) "Electrical Review" Vol. LXXVII. September 10, 1915., p.345.

monopoly, and not far enough as regards the immediate requirements of the situation." ⁴⁾ Between the years 1882 and 1888, electrical enterprise in this country was confined mainly to small independent installations for hotels, railway stations, large shops and industrial premises for lighting purposes only. In 1888 there were only eight electricity supply works in operation, all company undertakings, for local authorities still feared to embark in this risky business. That the progress was so slight, was not only due to faulty legislation or inherent technical difficulties, but also to the trade depression in the years between 1882 to 1887. The actual total number of units generated annually by authorised undertakings increased from 1.5 m. units to 5.4 m. units, or by 260%, i.e. 37.1% per annum in a period 1882 to 1888.

Causes of demand

Meantime two factors contributed towards the improvement of the Electricity Supply Industry. First of a technical character, namely, transmission which became possible over wider areas with the development of the transformer. Then Ferranti by equipping the Grosvenor Gallery generating station at Deptford, London, proved that it was possible to have high voltage alternating current generators. Local authorities began now to take an active part in the electricity supply trading. The second factor was the passing of the 1888 Act by Parliament. Between 1888 and 1900, 342 Provisional Orders were taken out by local authorities, and 123 by companies. Some of the local authorities did not pursue their works, in spite of the provision of the Board of Trade in such Orders to begin the electricity works within a period of two years. As a result in 1900 only 250 towns were supplied with electricity. At the same time, however, large sections of the rural districts of the Midlands and the North, together with the smaller towns in those districts, were being covered by the operation of the newly created Power Companies. But again the costs of transmission were greatly influenced by the conditions and restrictions imposed by the Regulations related to the protection of the public, requiring "the highest quality and maximum safety in conductors and switchgear to such an extent that critics complained of the precautions being/

4) "The Early Days of the Power Station Industry" - R.H.Parson, 1940, Ch. X, p. 187.

being excessive and hampering growth". 5) In England alone, in 1896, there were 66 towns with a population of over 30,000 that had no electricity works; and 106 towns with a population of over 20,000, and 212 town with over 10,000 inhabitants in which electricity was unknown. 6)

Mr. R. Percy Selton attributed this backwardness to the following factors:-

- 1) Reckless speculation and subsequent loss of public confidence in electrical undertakings.
- 2) The unforeseen commercial expansion of America and Germany which was cutting into engineering trades amongst others.
- 3) Unfavourable labour conditions at home.
- 4) The apathy of electrical engineers and manufacturers. 7)

In spite of all these hampering factors the Electricity Supply industry improved its position. The total units generated annually by authorised undertakings increased from 12.4 m. in 1889 to 163.5 m. units in 1900, that is by 1210%, or over 100 per annum in those 12 years.

The capital expenditure involved in electricity supply undertakings in 1900-1 amounted to £26,211, 199, of which companies contributed £12,434,827 and local authorities £13,776,372. 8) As for capital outlay per kilowatt installed in 1901, in the case of municipalities it amounted to £83, and in the case of companies £113. These figures were lower than in 1894, when the respective figures were £87 and £124. As for the costs of production of electricity there was a constant tendency to reduction. Thus in case of municipalities, the average cost per B.T.U. decreased from 3.95d. in 1897 to 2.20d. in 1901. The respective figures for companies were 3.70d. and 2.75d. There was also a steady decrease in prices charged for electricity. Thus in the period of 1896 to 1901, the companies reduced their average charge from 6.01d. to 4.96d., while municipalities reduced/

5) "Electrician" Vol. 42, p. 644.

6) "Electrical Review" Vol. XXXVIII No. 962. May 1, 1896, p. 555.

7) "Electrical Review" Vol. XLIX No. 1,527. Dec 27, 1901, p. 1073.

8) "The Electrical Engineer" Vol. XXXII. July 17, 1903, p. 83.

reduced from 5.38d. to 4.27d.

After 1900 the most important event in the Electricity Supply Industry was the invention of the steam-turbine by Sir Charles Parson. Then the development was strengthened by the possibility of alternating current distribution. Technical improvements rendered possible generation on a large scale at high voltage. Power Companies were established to supply electricity in bulk and to larger power users. Costs of production were still further reduced and the application of electricity to industrial purposes became more practicable and more economical. In the period of 1900-7, trade/conditions generally were not very favourable for a rapid development of electricity, as industry in general and commerce were stagnant and the foreign competition became still more acute. The old causes of backwardness remained. Nevertheless the period from 1901 to the outbreak of the First World War witnessed a general cheapening of electricity for illumination and other domestic purposes. Inventors and manufacturers improved appliances from prime movers and generators to the controller switch and the metallic filament lamps. Lower production costs brought by improvements in generation and transmission increased demand for electricity. "Thus it is that current is now available not only for the wealthy and smaller income-earned middle classes but for the artisan and cottager generally", ⁹⁾ observed the "Electrical Engineering". Also some improvement and simplification was made in housing electrical installation.

During the period 1901-1914, the total units generated annually by authorised electricity supply authorities increased from 229.8 m. units in 1901 to 2,107.3 m. units in 1914, i.e. it increased by 812.2%, or 58% per annum. During the same period the capital expenditure involved in electricity works increased from £26,211,199 in 1900-1 to £71,551,088 in 1914-15, of which £45,085,611 was contributed by municipalities and £26,465,477 by companies. In that period the average cost per unit decreased principally through the increase in output and the better load-factor conditions, less steam consumption, higher boiler pressures/

9) "The Electrical Engineering" Vol. XLVI. Dec 30, 1910, p. 317.

pressures, etc., and perhaps the most important was the gradual reduction in the price of electrical plant and appliances. The average cost per B.T.U. in case of municipalities decreased from 2.20d. in 1901 to 0.79d. in 1914-15; the respective figures for companies were 2.75d. and 1.17 d. Naturally in the same period there was again a steady decrease in charges for the electricity supplied. Thus, the municipalities reduced their charge per B.T.U. from 4.27 d. in 1901 to 1.55 d. in 1914-15, and the respective figures for companies were 4.96d. and 2.10d.

In the U.S.A. in 1912 there were 6,500 supply stations, of which 85% served communities having a population of less than 5000. In U.K. the position was exactly reversed, electrical undertakings of the size mentioned numbered less than 15% of the total number. In Britain about 75% of the undertakings served towns with populations of over 10,000 inhabitants. 10) The output of all generating stations in the U.S.A. in 1912 amounted to nearly 12 m. units or six times more than the U.K. The power output per capita was 122 units, whereas in Great Britain it probably amounted only to 60 or a little over.

There was also a rapid increase of electricity supply undertakings in Germany. According to the "Elektro-technische Zeitschrift" in April, 1907, there were 1,530 stations. The rate at which new stations came into operation during the years 1900-1908 was 114 per annum. The total number of stations according to "Verband Deutscher Elektro-techniker" in April, 1913, amounted to 4,040, or 215 stations per annum between 1907-1913. The number of localities that have been supplied with electricity amounted to 17,500.

(II) FIRST WORLD WAR

The outbreak of War, 1914-18, commenced a new era in the development of the Electricity Supply Industry in Great Britain. For the four years of war saw a development of electrical output practically equivalent to that of the previous 32 years. This subject of the role of the electricity supply in the service of the nation during/

10) "Electrician" Vol. LXIX. February 2, 1912.
p. 678.

during the War, 1914-18, was discussed by Messrs. A.B. Gridley and R.H. Human, in their Paper, which was published in "The Journal of the Institution of Electrical Engineers", and some essential extracts are to be found in the "Electrical Review" (11).

The following data will give some idea of the great expansion in the generating plant capacity and output by public electricity supply undertakings, during the war. From the statistics below, power stations supplying railways or tramways only and private plants are excluded. During the four years of war 103 municipal and 33 company-owned power stations were extended or built. The plant capacity of 327 undertakings owned by local authorities increased from 705,000 kw. installed in June, 1914, to 1,490,000 kw. installed or on order in October 31, 1918. As for companies, they expanded their installed capacities from 430,000 kw. to 788,000 kw. The additional plant capacity installed or ordered during the war, therefore, aggregated 1,143,000 kw. which was almost equal to the plant capacity existing before the war. Thus the annual increase of installed capacity of generating plant during the years 1914-18 was 288,000 kw.

The capital outlay involved on these extensions, with additions to mains and substations, was approximately £23,000,000. Before the war, the average size of the generating unit installed was 522 kw. and the largest unit in operation was of 8,000 kw. capacity. The average size of unit on order in October 31, 1918, was 7,044 kw. and also units of 25,000 kw. and 30,000 kw. were already built. The output of electricity generated increased to almost twice that of before the war, that is, from 2.5 m. to 4.5 m. units. During the years 1914-18 the coal consumption per unit sold decreased from 4.1 lb. in 1914 to 3.75 lb. in 1918, in spite of the inferior quality of fuel. In 1918 the load factor of all municipal stations combined was 28% and of all company stations was 33%. The units sold per kw. of plant installed were 1,658 by the municipalities and 1,882 by the companies.

In some areas, for instance, the great steel and armament centre of Sheffield, and machine-tool and motor-engine building district of Coventry, expanded their supplies enormously for industrial/

11) "Electrical Review" Vol. LXXXV. No. 2788.
August 22, 1919, p. 253.

industrial purposes. Thus Sheffield sold 26,500,000 units and Coventry 17,000,000 units in 1914, but the respective figures increased by 1918 to 177,000,000 and 53,000,000 units. No other industrial area - Sheffield covered about 38 sq. miles - could show so large a consumption of electricity per sq. mile. Some of the big armament factories had their own generating stations.

According to official statistics supplied by the El. Commissioners the general position at the end of 1918 with regard to generation of electricity for public supply purposes other than traction was as follows (statistics also include Ireland):-

Generation of electricity in United Kingdom
(Approximate position at December 31st, 1918)

Undertakings	Number	Generating Plant Installed	Capital Expended on Lands, Buildings, Sidings, Wharves, etc. and Generating Plant, excluding distribution items.	
			Total	Average per Kw Installed
Local Authorities	239	1,450,619 Kw.	£30,313,111	20.9
Companies	182	354,483 Kw.	£10,721,085	30.2
Power Companies	17	370,053 Kw.	£7,258,840	19.6
Totals	438	2,175,155 Kw.	£48,293,036	22.2

In 1919 the plant capacity of supply undertakings increased to 2,500,000 kw. and the yearly output amounted to 4.5 m. units.

It is asserted that the electricity output although stimulated by the war requirements would have progressed just the same without the war. For the annual rate of increase before the war/

war was near the war-time rate; and that progress made by many undertakings during the years immediately prior to the war was considerably more than this. This argument would seem to be supported also by the development of electricity supply in the U.S.A. where from 1912 to 1920, the output quadrupled, that is, it increased from 11 m. to 43 m. units per annum. In France, on the other hand, where the conditions were like those in Great Britain in the period between 1913 and 1924 the output of electricity increased over three times.

But there is no doubt that the 500 generating stations which Great Britain possessed during the First World War were an asset from the military point of view. And almost all writers and experts agree that without them the necessary output of ammunitions would have been impossible. For the war definitely established the pre-eminence of electricity as the motive power for industry. As the El. Commissioners observed that "it was recognised to an increasing extent that an abundant supply of cheap power was almost as essential as labour and materials for rapid and economical production of all forms of industry, and it was only by the aid of electricity and by the ready and efficient adaptability of the electric motor to the tools and machinery used in workshops and factories that the necessarily urgent expansion in the production of ammunitions was accomplished". 12) During the war the factories built for production of ammunition were electrified to the extent of 95%. Before the war, electrification of new works, however, became a rule. Still there was a number of workshops and factories in which mechanical driving was retained either because of lack of capital or an incomplete redemption on old plants. During the war, however, when ammunition production increased, the inadequacy of mechanical driving and generation in private plants became obvious. It became evident whenever extension or new works were planned, as every skilled man was needed in the workshops, and the depletion of private boiler room and engine house staffs became more acute. Then another difficulty arose in connection with coal supplies. Under these conditions the satisfactory maintenance of private plant became very difficult indeed. For these reasons the whole problem of power production was relegated to public electricity supply undertakings, whose efficiency and/

12) "First Annual Report of the El. Commissioners",
1921, 49.

and reliability were comparatively high. "The exigencies of war have broken down those barriers of conservatism and hesitancy to incur capital outlay, which have so often in the past kept electric driving from what is technically and economically its own". 13) Many manufacturers had become fully acquainted with the advantages of electrical energy, and realised the desirability of purchasing energy from public sources. The Government supported such a policy during the war. Nevertheless there were also considerable orders placed for private electrical generating plant, particularly in extensions of the iron and steel industry.

In the first few weeks of war the existing engineering works and workshops were extended and the construction of new factories began. The representatives of many firms were called in to advise Government Departments and were appointed to responsible posts in creating, organising, accelerating manufacture of every kind of war munition. This process of adoption to the war-time requirements was eased by the fact that many supply undertakings were able to deal with additional load by using all generating plant, including reserve, until the stations were extended. Through time, however, it was a real struggle to extend the public generating stations in industrial areas rapidly enough to meet the demand for larger supplies of electrical power. It was necessary to economise labour and materials used by electricity supply undertakings. For these reasons a certain measure of Government control became necessary, in order to secure that the most urgent and essential extensions were carried out. Special priority certificates were issued for that purpose by a special Electric Power Supply Department of the Ministry of Munitions, which was not established until May, 1916. Apart from this check on orders dealt with, manufacturers were little interfered with. In 1917 a Committee of members of the British Electrical and Allied Manufacturers Association was set up under the chairmanship of the technical advisor of the Electric Power Supply Department. This new Committee was to express its views and recommendations before the Ministry of Munitions whilst the manufacture and disposal of electrical plant was controlled, particularly dynamos and motors.

The/

13) "Electrical Review" Vol. LXXVII. October 29, 1915. p. 545.

The Ministry of Munitions issued only two Control Orders. The first dated April 15th, 1918, restricted the manufacture of converting plant (Conventor Plant Control Order, 1918), which, however, was cancelled on February 28th, 1919, after 193 licenses had been issued. The second Control Order was the Electricity (Restriction of New Supply) Order, 1918, issued on November 8th, 1918. At the same time the Coal Controller rationed the use of electricity and gas for domestic purposes. This last restriction was lifted on January 10th, 1919. There was close co-operation between the Department of the Coal Controller and the Electric Power Supply Department of the Ministry of Munitions. Of the 103 municipal and 33 company extensions, 70 of the municipal and 22 of the company schemes were considered and sanctioned by the Ministry of Munitions. The remainder were put in hand before the priority system was established. In order to secure a closer co-operation between Government Departments, the War Cabinet Priorities Committee set up, during 1918, the Electrical Services Supply Committee, which was responsible for the uniformity in use and requirements of the various Government Departments.

The Treasury decided that interest-bearing loans might be made to municipalities and companies, which were to be repayable by annual instalments over 15 years or so, and further that the Ministry of Munitions might guarantee to bear the difference between the cost of carrying out extensions during the war and the estimated cost of the same work if carried out at some period after the conclusion of hostilities, usually one or two years, and also the cost of any portion of the extensions found to be in excess of the post-war needs of the undertaking. Of the £23,000,000 which was incurred on extensions of power houses and mains during the war, about £3,150,000 was advanced by the Ministry of Munitions.

During the war/^{the} most serious difficulty with which the industries in general and electricity supply undertakings had to cope had been the high price and the shortage of fuel supplies. "In comparison with Great Britain the rulers of Germany understood at the outbreak of War that control of fuel meant national supremacy, not only commercial supremacy in peace, but military supremacy in War"/

War". 14) Germany secured supplies of coal by the invasion of Belgium and by seizing most important coalfields of Russia. From the beginning of War German Government controlled the production and price of coal. But in Great Britain the forces of tradition, the conservatism of the business people were against any such control for a long time. The Government in this country interfered with the coal trade only when troubles arose. Coal prices rose, output fell, coal miners demanded large increases in wages and strikes were attempted. The first step towards control of coal was the Price of Coal Act, in 1915, which limited the price of coal at the mine to not more than 4 s. advance per ton above the price prevailing in the year ending June, 1914. This Act protected the home consumer, but left the coal industry free to profiteer from exports of coal to Russia, Italy and France. In 1916 arrangements were made to control prices of export coal. In May 1915, a joint Conference was called of electricity and gas supply authorities, at which it was decided to represent to the Government the seriousness of the position in respect of coal. In March, 1916, the District Coal and Coke Supplies Committees were formed, but this step did not bring much relief. By the end of 1916, the Board of Trade issued a letter that the electricity and gas undertakings must reduce consumption of coal by 10%. But how it ought to be done, it was not said.

The First World War had the most useful effect on the Electricity Supply Industry in one particular aspect, namely, the spirit of co-operation for patriotic reasons brought a movement of vital importance - the movement towards interconnection of electricity supply undertakings, which was initiated by the Institution of Electrical Engineers, developed partly by the Lancashire and Cheshire Committee, and supported by the Board of Trade, which on 25th May 1916, addressed a letter urging the need of and economies derived from interconnection. The local interests, parochial prejudices, and divergent views of supporters of private and public enterprise, became less acute as formerly, and a new desire arose for treating electricity supply as a national problem for the general/

14) "Government Control and Operation of Industry in Great Britain and the United States during the World War" - Ch. W. Baker, 1921, Ch.XI, p. 104.

general public benefit. This positive tendency was supported by the Institution of Electrical Engineers, and I.M.E.A., and J.E.E.P.C.. It was already understood that "to supply at low prices, it is necessary to secure a high load factor, a good diversity factor, and a large output, whilst keeping down capital outlay and running costs; all these objects are best attained by extending the area of operations and increasing the magnitude of the undertaking". 15) That understanding was the most beneficial effect of the War 1914-18. But these schemes for the reasons explained in the previous chapters could not be carried out because of technical difficulties, chief of which were the lack of standardisation, and political prejudices.

P.E.P. Group summarised the effects of the War, 1914-18, upon the Electricity Supply Industry in the three following points:-

- 1) It proved the value of electricity as power and heat for industrial purposes.
- 2) It caused expansion in the resources of those undertakings supplying current to areas concerned with the manufacture of food, munitions and war supplies.
- 3) It was necessary to use obsolete plants.

After the Armistice for a short time the output of electricity remained almost stationary. But after a certain time, however, a reduction took place in the demand for power, due to the closing down of many munition factories. This period of slump was accompanied by a considerable increase in costs due to an advance in the price of fuel and wages. The situation again changed when the factories began post-war production and, therefore, the need for power increased. As for the charges for electricity supplies during the War, this matter was already discussed in Chapter VIII.

B SECOND PERIOD, 1920-1945.

(1) SUB-PERIOD, 1920-26.

This Sub-Period of the development of the Electricity Supply Industry in Great Britain covers the years/

15) "Electrical Review" Vol. LXXVIII. June 16, 1916.
p. 665.

years of operations of the El. Commissioners, from the beginning of 1920 to the end of March, 1927, that is, to the year when another re-organisation of the Industry was begun under the directions and control of the C.E.B. I consider those years of 1920-1926 as a separate period because it has been an essential phase of the development of electricity supply, as for the first time in its history a central body was established to direct, regulate and control the main tendencies of its growth; then for the first time it was definitely realised that there was a need for far-reaching reforms of rationalisation, and a considerable progress was made in output, technique and the financial position of the Industry itself.

At the commencement of 1920 there were 532 separate authorised undertakers owning 475 generating stations, which contained 2,309,000 kw. of generating plant, or on average 4,850 kw. per station. As was observed in the previous paragraph, during the First World War it was necessary to use old and obsolete types of plant. These had to be replaced and extended after the War and adapted to new peace-time requirements. In spite of trade depression in 1921-22, considerable progress was made in building new stations, and remodelling and enlarging the existing ones. During those seven years the El. Commissioners sanctioned the establishment of 117 new generating stations, 53 by authorised undertakers and 64 by non-statutory undertakings, which were mainly built for the purpose of affording public supplies. The additional installed capacity of public supply undertakings increased in this period by 644,706 kw. Another 153,000 kw. were added by the development of 4 hydro-electric schemes in Scotland. These newly sanctioned stations were, however, of small capacity, because of lack of interconnection. Of the total number of sanctioned stations, 79 were less than 250 kw. each. When account is taken of the stations which were commenced before 1920, and the acquisition of some stations from non-statutory undertakers, the total number of new generating stations during these seven years amounted in all to 89. During the same period the El. Commissioners gave their consent for extension of existing stations, sanctioning the installation of 2,684,670 kw. of generating plant. This figure, however, does not represent a nett addition to the plant capacity as the installation of the new plant involved the displacement of obsolete equipment in many cases. The/

The improved facilities of bulk supplies caused the close-down of some of the less economic stations. Thus local generation was discontinued at 101 stations, and some became stand-by stations. At the end of March, 1927, there were 623 separate authorised undertakers, including the C.E.B., owning 479 generating stations. Thus in a period of seven years the number of authorised undertakers increased by nearly 90 and the number of generating stations increased only by 4. During this period there was a steady tendency to operate larger generating stations, an improvement in efficiency of the plant equipment, due to the technical progress in the design and manufacture of steam-turbo units, and to the adoption of such units in many smaller stations. There was also a considerable reduction in coal consumption per unit generated, due to the improved thermal efficiency, to the extended use of steam-turbines. The average fuel consumption of the steam generating plant fell from 3.42 lb. in 1920-21 to 2.33 lb. in 1926-27, or a reduction of 47%. These technical improvements achieved were due to individual efforts and not to collective economy, as the majority of authorised undertakers still preferred an individual and un-co-ordinated development than to participate in the newly provided Joint Electricity Authorities". "Thus the spirit of the Electricity (Supply) Act of 1919, for co-operative action and pooling of generating resources for the common good of the industry as a whole and for the consumers have not constituted a prominent feature of the developments during the period 1920-27". 16) The main reasons may be summarised as: the interconnection on zonal basis was technically difficult and financially burdensome, because of great variety in frequencies, systems and voltages, the weak economic position of the industry after the War, 1914-18, and lack of understanding amongst undertakers themselves. However, some progress in these directions was made, and such schemes were eased by the facilities granted by the Unemployment Grants Committee. The El. Commissioners advised this Committee in cases of applications made by the local authorities for the grants towards expenditure upon electricity supply schemes and extensions carried out for the relief of unemployment.

During the years under consideration a progressive adoption of the higher voltages for the transmission/

16) "Seventh Annual Report of the El. Commissioners" 1927.

transmission and distribution to substations was made. The principal voltages adopted were 6,600, 11,000 and 33,000 volts and 66,000 volts. Another feature of the post-war development was the increased utilisation of overhead lines for transmission and distribution in rural areas. Over 1000 consents were given by the El. Commissioners for that purpose. This extensive use of overhead lines was eased by the new Code of Regulations adopted by the El. Commissioners in 1923, which was submitted by a Special Committee appointed by the Institution of Electrical Engineers and representatives of the Industry.

Some of the smaller undertakings were unable to cope with the increasing demand for electricity for domestic use, which comparatively increased very much. Some undertakers were rather unwilling to supply domestic consumers or to encourage such use as they considered further capital expenditure on the provision of distribution facilities too heavy. The El. Commissioners observed that "a practice still prevailed of laying distributions of such small size as to tend to restrict or preclude their employment for dealing with any considerable development of the domestic load and that by a comparatively small additional expenditure on cable of a large size, provision could have been made for a load of at least twice as great as that capable of being dealt with the cable actually laid".

During the above period there was a large extension in the operation of electricity supply in new areas, and a tendency to promote schemes of distribution for large areas. The El. Commissioners issued about 330 Special Orders, mostly conferring new or additional distribution powers. "The widespread extension of distribution areas has not only enlarged the scope of operation of the Industry, but also resulted in a corresponding addition to the obligations of the Industry towards the public, consequent upon the large accession of potential new consumers having statutory rights to requisition for supplies."

In spite of the fluctuating conditions of trade and industry during this period, and the temporary retarding effects of the Coal Strike after the War, 1914-18, these seven years as a whole witnessed a progressive and substantial increase in annual production and consumption of/
of/

of electricity. The total units generated annually by authorised undertakings increased from 4,275.1 m. units in 1920-21 to 6,992.3 m. units in 1926-27, or yearly production within seven years increased by 63%, or an annual rate of increase was 9.7%. The average consumption per head of population increased from 82 units in 1920-21 to 133 units in 1926-27. During this period there was a marked tendency for manufacturers using electrical energy to rely on public supplies rather than to generate the power requirements themselves.

The charges for electricity supplied were considerably reduced, particularly after the industrial depression and the coal strike of 1921, when a definite improvement in economic conditions took place in 1922-23, resulting in reductions in the cost of coal and plant, and adjustment in the rates of wages. This process of reduction of costs and charges of electricity continued until the set-back caused by the prolonged coal strike in 1926, which compelled many undertakers to raise their scales of charges, at least for the time being. The working expenses (including cost of energy purchased in bulk, but excluding Capital Charges) per unit sold decreased from 1.73d. in 1920-21 to 1.13d. in 1926-27. The average revenues per unit sold (excluding bulk supplies) also decreased from 2.48d. for all purposes in 1920-21 to 1.76d. in 1926-27.

During the period under review, there was a large investment of additional capital in the extension of the existing and establishment of new undertakings, and an improvement in the output and general working results of the Industry as a whole. Thus the total capital expenditure charged to capital account by authorised undertakers increased from £143,716,260 in 1921-22 to £238,727,634 in 1926-27. It is evident that in spite of the financial difficulties experienced in the post-war period, the large capital requirements for electrical development were forthcoming. Some financial facilities were afforded to public utilities by the Government in order to relieve unemployment and revive trade conditions. During these seven years, loans amounting to £4,373,600 for the electricity schemes by company undertakers were guaranteed by the Treasury as to the interest and/or principal under the provisions of the Trade Facilities Acts. In addition, local authorities received grants for extension and alteration/

alterations of electricity schemes from the above mentioned Unemployment Grants Committee, to the extent of £7,731,169.

As for the general financial results of the operations of the electricity undertakings there was a steady increase in the ratio between turnover (as represented by the amount of electricity sold to consumers) and capital expenditure during that period. The sales of electricity per £100 of capital expenditure advanced from 2,189 units in 1921-22 to 2,458 units in 1926-27. The gross surplus shown by the operations of the Industry per £100 of capital expenditure increased from £8.82 in 1921-22 to £10.42 in 1922-23, and £9.06 in 1925-26.

The development of the Electricity Supply Industry during the above period was accelerated by the "growing recognition of the value of the concerted efforts and judicious expenditure on propaganda and research as contributory factors to the progressive development of the electricity supply". These educational and technical works were carried out by Associations and Organisations on a non-profit-making basis. Their work and efforts have been appreciated by the El. Commissioners, who observed that "the results which have so far accrued have been of material value to the Industry and have amply justified the efforts of those concerned, and also the financial support which has hitherto been accorded by the various sections of the Electrical Industry" and that "the experience of recent years have served to emphasise that a rapidly growing Industry, such as that of electricity supply, must be adequately equipped with facilities for organised propaganda and research if full advantage is to be taken of the opportunities for further expansion and technical improvement which are continually presenting themselves". 17)

In spite of great progress made in this country, still the relative position of electricity supply in other countries was better. Thus, for instance, the Table below shows the progress made in the U.S.A.:- 18)

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- 17) "Seventh Annual Report of the El. Commissioners", 1927.
18) "Power Capacity and Production in U.S.A." - Washington, 1928, pp. 132-165.

Year	Total Production	Produced from Water-Power	% of Total	Produced from Fuel	% of Total
1920	43,554,880 Kwh	16,149,709 Kwh	37.1	27,405,171 Kwh	62.9
1926	73,791,064 Kwh	26,188,801 Kwh	35.5	47,602,263 Kwh	64.5

Much of the electricity produced has been consumed for industrial purposes.

In making international comparison, Mr. H. Quigley took as a basis the capital cost per kilowatt installed in the U.S.A., Switzerland, Canada and France. According to his estimates, in 1922 in the U.S.A. the capital outlay per kilowatt amounted to £62, in Italy to £35, in Switzerland to £50, in France to £50, and in Canada to £62 in 1923. In Great Britain in 1922-23 the relative figure was £51. Thus the comparative position of Great Britain was not bad. But the earning capacity of generation plant, i.e. kilowatt-hours per kilowatt of plant installed in Britain (1922) amounted only to 1,200 units, whereas in the U.S.A. (1923) the figure was 2,700 units, and the respective figures for Switzerland (1922) was 2,430; Italy (1923) 2,640. 19) Thus the capital expenditure per kilowatt installed of generating plant was not greater in Great Britain than in other countries, but the effective demand upon it was much less. In result, costs and charges of electricity in this country were higher than in the above mentioned countries. Thus according to the same author, the national averages per unit sold in Britain (1922-23) was 2.07d.; the U.S.A. (1923) 1.05d.; Canada (1923) 0.72d.; Switzerland (1923) 0.6d.; Northern Italy (Edison Group of Companies (1924) 0.46d. 20) As for the output per head of population, according to H. Quigley, it amounted to 155 kwh. in 1923 in Great Britain, to 528 kwh. in the U.S.A., 129 kwh. in Italy, to 1850 kwh. in Norway (1922), 805 kwh. in Switzerland, and 910 kwh. in Canada. Thus, from this point of view it would appear that in comparison with Great Britain, Norway was 1,400% more highly developed/

19) "Electrical Power and National Progress" - H. Quigley, 1925, p. 57.

20) Ibid, p. 72.

developed, Canada 585, Switzerland 512% and the U.S.A. 340%. 21)

(II) SUB-PERIOD, 1927-39.

This Sub-period under consideration witnessed the reorganisation of the generating side of the Electricity Supply industry. The tendency towards multiplicity of undertakings, which marked the early development of the electricity supply, ceased. Considerable changes occurred in the types of generating plants utilised, and there was a definite tendency towards larger units in generating stations and boilers. The development of the distribution side was less definite and went along different lines. The prominent feature of distribution was the predominance of underground transmission and distribution lines.

During these years there was a continuous tendency towards increased consumption, particularly in the increase of consumption for domestic purposes. The demand for electricity was increasing extensively rather than intensively. Naturally the increase in demand caused a rapid rise in the maximum load.

From the passing of the Act of 1926 the financial aspects of electricity supply underwent a radical transformation. The authorised undertakers, companies and local authorities, increased their loans and capital. In the case of local authority undertakers their net debt fell. In the case of companies, loans were also approximately a similar proportion to capital, but ordinary capital showed a decisive increase over preference capital, a movement probably resulting from "the capitalisation of undistributed profits earned during the period carried to reserve and employed in providing capital assets".

During the period under review a great amount of research studies was made not so much perhaps in technical engineering problems as in economic and statistical questions. The technical problem of generation's economies has been solved under the guidance of the C.E.B.. It still remains to/

21) Ibid, p. 91.

to solve the complex problem of distribution side of the Electricity Supply Industry.

At the end of March, 1939, there were 581 authorised undertakers holding powers to supply electricity. This number was a little less from that in 1926-27, which amounted to 623. The total capacity of generating plant increased from 4,682,069 kw. in 1926-27, to 9,498,000 kw. at the end of March, 1939. Thus in the period of 13 years the total capacity of generating plant installed by authorised undertakers increased by about 100%. The total number of new public generating stations sanctioned by the El. Commissioners during these years amounted to 131, thus making the total 184 since the appointment of the El. Commissioners in January 1920 up to 31st March 1939. These figures are exclusive of hydro-electric schemes in Scotland authorised by Special Acts. During the same period of 19 years, the extensions to existing stations sanctioned amounted to 8,900,040 kw. Of the total new generating plant sanctioned during 1920-39 - namely 10,313,193 kw - approximately 57% was for stations of local authority undertakers, about 36% for stations of company undertakers and the remaining 7% for stations owned by railway and tramway authorities, and non-statutory undertakings, some of the latter eventually became authorised undertakings. Some of the less efficient stations were closed down and the approximate number of generating stations owned by authorised undertakers amounted to about 400 at the end of March, 1939. This reduction from 479 generating stations in 1926-27, was brought about mainly because of the operations of the National Grid.

The above plant generated 24,810 kwh., an advance from 6,9992.3 kwh. in 1926-7. All but 1/10 of the total units generated was produced under the directions of the C.E.B. In addition 160 m. kwh. were purchased from outside sources and 88 m. units as an excess of inter-purchase, over inter-sales, making total gross public supply of over 25,058 m. units, After deducting energy used on works and lost in distribution, approximately 20,827 m. units were sold to consumers. The consumption per head of population increased from 133 units in 1926-27 to 450 in 1938-39.

There was again a considerable reduction of coal consumption per unit generated, which fell from/

from 2.33 lb. in 1926-27 to 1.40 lb. in 1938-39. This reduction was brought about by the concentration of generation in larger and more efficient stations under the Grid Scheme.

The capital expenditure on electricity works by authorised undertakers increased from £238,727,634 in 1926-27 to £648,465,125 at the end of March, 1939. Working expenses (including cost of energy purchased in bulk, but excluding Capital Charges) fell from 1.13 d. in 1928-27 to 0.623d in 1938-39. The average revenue per unit sold (excluding bulk supplies) fell from 1.76d. in 1926-27 to 1.040d. in 1938-39.

Since 1927, Great Britain has been making up some part in the deficiency of electricity consumption, and over the five years 1927-1931 the expansion in the output of electricity from public supply undertakings has been 34.9% in Britain, as compared with 16.3% in the U.S.A. and 14.6% in Germany; 12.6% in Canada and 21% in Italy. The decline in consumption of electricity during 1931 by British industry was more than made good by extension of domestic and commercial supplies. By 1932, Great Britain for the first time occupied third place in the world production of electricity. This, no doubt, contributed to higher competitive efficiency in British industry, and further substitution of electricity from the public supply for power produced by private plants has afforded greater flexibility in industrial expansion. Under the C.E.B.'s secondary transmission lines it was possible to open up new and outlying areas in Sussex, Lincolnshire, Cumberland and South Scotland.

The tendency towards more rapid increase in the output of electricity in Great Britain than in the rest of the world continued almost to the outbreak of the War, 1939. By the end of 1937 the increase of electrical production over the period of 1929 to 1937 was of the order of 123%, whereas in the rest of the world it was about 45%. 22) This greater percentage here can be attributed to the Government's rearmament policy, which led to the extension of many manufacturing premises and the erection of new factories, particularly/

22) "Tenth Report of the C.E.B.", 1937.

particularly in iron and steel, engineering, ship-building, and automobile construction, as also in other industries chiefly serving the home market. Other factors contributing to the increase in consumption were the carrying out of extended railway electrification schemes, the greater utilisation of electric light in factories and workshops and commercial premises, the greater use of electricity for street lighting and a continued expansion of the use of electricity for all domestic purposes, and in rural areas. A temporary reduction in the rate of increase, which for the first time since 1932 fell below 10%, occurred in 1938.

During the above period the Electricity Supply Industry strengthened its financial position. The Industry was favoured by the investing public as a medium for the remunerative employment of capital. It even attracted foreign capital, particularly from America, who by acquiring shares represented a controlling interest in various electricity Companies in this country.

However, during the economic crisis of 1929-33, it was necessary for the Government to afford some financial help to the Industry. Thus by the enactment in July, 1929, of the Development (Loan Guarantees and Grants) Act, provision was made for Government Grants or guarantees to public utility undertakers in respect of the costs of the carrying out of works in acceleration of normal development in order to stimulate the revival of trade and to promote employment in the United Kingdom. This Act expired on 31st August, 1931. The Unemployment Grants Committee approved electricity development schemes involving capital expenditure of £24.5 m. The amount of the Government grants to electricity was 12.8% of the total State contributions towards public works. Then in 1930, another legislative measure was passed, namely, the Public Works Facilities Act, which had its object of expediting the procedure for empowering local authorities and statutory undertakers to execute works in order to relieve unemployment, and of facilitating the acquisition by such authorities and undertakers of land and easements.

During the year 1933-34 the first definite and sustained improvement in the general industrial and trading conditions in Great Britain took place. The improvement extended practically to all/

all trades and industries, but was less pronounced in the industries concerned in the export markets. This revival led to an increase of employment and to a greater consumption of electrical energy for industrial purposes. In the industrial areas covered by the Regional Grid Schemes for Central Scotland and North-East England, which were most affected by the trade depression, the level of electrical production in 1933-34 attained the level of 1929-30. The reaction of the Electricity Supply Industry on the difficult industrial and commercial conditions reflected by the output attained, which in 1929-30 was progressively exceeded in the four subsequent years by 5.1%, 10.2% and 34.6%. This tendency of progressive production continued during the following years as trade and industrial conditions improved.

Already during the year 1938-39 the Electricity Supply Industry was being prepared for war-time requirements and inconveniences. Additional provisions were made for future increased demand. Early in 1938, the El. Commissioners convened a National Committee of the representatives of the Industry to assist them in reviewing the problem of civil defence and air-raid precautions in relation to electricity undertakings. The El. Commissioners co-operated in these matters with the Air Raid Precautions Department of the Home Office, which Department prepared a Memorandum embodying recommendations of the National Committee. About the same time the El. Commissioners also issued to all electricity undertakers the Report on Fire Risks at Generating Stations, 1938, prepared by a special Technical Committee appointed by the El. Commissioners.

The comparison of electricity consumption with the indices of production and general business activities in the years 1929-38 is afforded by Mr. M. Compton. The Table below shows a continuous progress of electricity consumption in spite of disturbances in industrial and commercial conditions, caused by the Economic Depression. 23)

23) "British Industry" - M. Compton and E.H. Bott, 1939, p. 288.

	1929	1932	1937	1938
Indices of Production				
London and Cambridge Economic Service 1924=100	110.6	84.9	124.0	109.5
Board of Trade 1930=100	108.5	90.5	132.8	124.3 [†]
"Economist" Index of Business Activity 1935=100				
Electricity Consumption	68	71.5	126.5	131.5

[†]Preliminary Figures

From the Table below, computed by SOFINA, which shows the development of power production by distributors (excluding private plants) between the years 1929-1937, it is again evident that within those years Great Britain made the greatest progress in comparison with leading electrified countries. The year 1929 being represented by the index 100. The data was estimated by "Banque pur Enterprises Electriques", Zurich. 24)

Country	1929	1932	1933	1934	1935	1936	1937
Germany	100	78	85	101	115	134	158
England	100	119	131	150	170	196	221
Belgium	100	105	113	113	126	139	162
France	100	92	100	104	107	111	115
Holland	100	127	130	135	138	145	162
Switzerland	100	107	114	123	132	140	149
World Production (without U.S.A.)	100	97	106	118	130	144	165
U.S.A.	100	85	88	94	102	117	121
Canada	100	89	97	118	130	142	147
World Production	100	89	104	104	114	128	142

24) "Beama Journal" Vol. 42, October 1938, p. 95.

In spite of this comparative progress of the electricity supply in this country, and the gradual increase of electricity consumption from 1920 to 1938-39, it is still considered as unsatisfactory because there was a vast number of potential consumers, who were not supplied with electrical energy, and particularly in undeveloped rural areas. H.H.Ballin enumerates the following reasons for this unsatisfactory progress, namely:-

- 1) Some undertakers did not make efforts to increase their sales of electricity, particularly for domestic consumers, as it would necessitate further capital expenditure.
- 2) Another reason for the unsatisfactory progress was the great number of small and uneconomical supply undertakings.
- 3) The third factor retarding the development was the variety and multiplicity of systems and voltages.
- 4) Finally the progress was slowed down by the variety of methods of charge employed by authorised undertakers. 25)

The above anomalies have existed in the Electricity Supply Industry for many years past, which the industry unfortunately has been unable to remove by voluntary methods and as a result the industry probably did not make such progress as it could otherwise achieved.

(III) SECOND WORLD WAR, 1939-1945

In comparison with the year 1914, when the First World War broke out and when the Electricity Supply Industry was characterised by uncoordinated and different policies, the undertakings working in small and isolated areas, generally on a small-scale, and at different frequencies and voltages, the outbreak of the Second World War in 1939 found the industry, after a thorough reorganisation of the generation side and after the construction of the National Grid Scheme, in a stage of development that ensured generally a reliable supply of electricity throughout the country under constantly changing conditions, and with/

25) "The Organisation of Electricity Supply in Great Britain" - H.H.Ballin, 1946, Ch. IX, pp. 238-247.

with remarkable efficiency. This great task was discharged by the Industry in spite of the apparent trend towards wholesale upsetting of ideas by consideration of urgency, over-loading, air raid effects, etc.. Supplies were made available at once to the hundreds of new factories, which were built for war-time requirements, as well as to military camps. The Electrical Development Association was right in pointing out that the electricity during the war is "the life-blood of a nation". The nearly 40,000 m. units of electricity used in 1944 in Great Britain as compared with over 4,000 m. units in 1918, is the indication of the immense ^{increase} in the "range and responsibility" of the Electricity Supply Industry during a national emergency. The Government Departments have been relieved from the necessity of designing, constructing and operating generating stations, because the Industry was ready to undertake new demands upon it. Capital has been saved, which would otherwise have been needed for temporary works, and the material resources and manpower have been released for the immediate reduction of ships, guns, tanks and planes. Essential industries for war production such as magnesium, light alloys, aluminium and special heat-treated steels would be inconceivable without electricity and powerful electric heating furnaces.

The most valuable asset during the War was the National Grid System. "The national interconnection provided an added factor of security and a degree of flexibility in the system of public electricity supply throughout the country which proved to be invaluable in war-time". 26) Because of the Grid it was possible to build factories in remote places, and in view of war conditions, they had to be situated away from normal industrial centres. This, of course, resulted in a heavy load transfers. The flexibility of the Grid System enabled a more rapid expansion of munition output to be achieved than would otherwise have been possible. Then, in cases where supplies of electricity were interrupted by enemy action, the additional requirements were met from the Grid. These developments involved a change in the location of demands, and the/

26) "Seventeenth Annual Report of the C.E.B.",
1944.

the Grid could be used for the transfer of "large blocks of energy continuously from Areas where, owing to fall in demand, there was generating capacity to spare, to areas where the demand had outgrown the generating capacity". Some idea of the magnitude of these transfers may be conveyed from the following illustration:-

<u>Year</u>	<u>South-West England and South Wales Area</u>	<u>South-East England Area</u>
	Thousand Kilowatts	Thousand Kilowatts
1938-39	7 export	96 import
1940-41	103 import	80 export
1943-44	116 import	280 export

Before the War, the South-West of England and South Wales Area was an exporting area, whereas the South-East England was an importing one. On the outbreak of War, however, the load in the latter Area fell off to a greater extent than in any other Area and so released plant capacity for export, particularly to South Wales, where a considerable concentration of war factories was rapidly being established. With cessation of hostilities, the consumption of electricity in the areas in which war industries had been established declined, while in South-East England it increased again.

The C.E.B., instructed by the Government, constructed additional Grid lines as measures, under Sections 37 and 42 of the Civil Defence Act, 1939, for securing the due functioning of the Grid system, particularly for the purpose of transferring energy from one Grid Area to another. War-time movement in industry from east to west necessitated the construction of some 365 miles of 132-KV lines with associated substations and equipment. 27) The Government partly financed the installation of additional generating plant in order to relieve the Grid undertakings of the/

27) "Electrical Review" Vol. CXXXIX, No. 3596,
October 25, 1946, p. 650.

the burden of the capital charges. In order to expedite works, the Minister of Transport issued two Orders, under Regulation 56 of the Defence Regulations 1939. The first Order relaxed some of the obligations and limitations imposed on the Board, under Electricity (Supply) Acts (1882-1936) in connection with the construction of main transmission lines and the acquisition of wayleaves. The second Order relaxed some limitations imposed on the Board by the 1926 Act with regard to construction, ownership and operation of generation stations. The whole of the war emergency plant was completed by April, 1943. It also appeared that a larger proportion of plant than was necessary in peace conditions had to be kept in constant readiness in order to ensure continuity of supply.

The original idea of the Grid Scheme, that is, the interconnection of Selected Stations in such a way that "the demand for electricity could be met with a high degree of economy and reliability" was upset by the sudden and widespread change in the distribution of load, in result of which the transmission lines were often overworked and because of shortage of materials and labour the obsolete equipment could not be replaced in time. Often the generating stations have carried on without adequate maintenance or extensions of plant, and in result the supply system was "strained almost to breaking point".

The expansion of the Electricity Supply Industry would be impossible without the manufacturing resources of the electricity firms. For the latter the War lasted not six but eleven years, as they were contributing the necessary equipment for the Industry since 1934. The electrical manufacturing industry built up subsidiaries to Woolwich Arsenal in South Wales, Lancashire, North-East England, and Scotland. The industry had research laboratories and development shops, which were able to discharge their additional tasks imposed on it by the Government. The great laboratories at Trafford Park, Wembley and Rugby, which were linked up with electrical manufacturing industry, were supplemented by laboratories owned by specialist firms/

firms, as at Hollinwood and Edinburgh. 28) This industry had to provide additional Grid requirements in generating plant, transformer, switch-gear, and control equipment. One firm supplied 1,833,000 kw. of generating plant and 2,352,000 h.p. of electrical motors. On the other hand, the manufacture of consumers' apparatus for domestic purposes and otherwise, had to be restricted. The Board of Trade Limitation of Supplies Order, 1940, limited the production of electric appliances for domestic consumers. But on the other hand, domestic appliances on a large scale have been installed throughout the country as facilities for communal feeding, e.g. British Restaurants. In large restaurants preparing about 12,000 meals per day, the average electricity consumption was as low as 0.1 units per meal.

As was pointed out, already before the War steps were taken to reduce the risk of war damage to the Grid. The Board has provided emergency control rooms in all areas, as far back as 1935. The programme of construction of generating stations was to some extent effected by the view of the Government that construction of stations or accumulation of large quantities of plant in areas, which were particularly exposed to enemy action, should be avoided. In 1938 the Board took the preliminary steps to build walls round the stations of over 50,000 volts. They constructed 13 stores, in which they housed the following equipment:- 94 transformers, 350 switch equipments, 118 miles of single core cable, 39 miles of overhead line components, mobile cranes, timber baulkes, etc.. They also took steps to provide alternative accommodation for the Staffs at Headquarters and at the District offices.

According to the Report of the C.E.B., from the outbreak of War to the end of 1943, there were 1,979 faults attributable to war causes, two thirds of which were cleared without interruption to the supplies. Of those faults, nearly 73% were caused by barrage balloons, about 13% were caused by low-flying aircraft, while only 14% were directly attributable to enemy action. Some of the Control rooms/

28) "British War Production, 1939-45" - A Record compiled by the Times, 1945, pp. 121-23.

Rooms, and even emergency ones, were destroyed. By the end of 1943, there had been 19 issues of equipment from the National Pool of Spares. Only 12, however, had been required. It was estimated that savings in annual costs through pooling spare generating plant were substantially the same as the annual charges due to the Grid itself, so that the economies and advantages of the Grid were net peace-time benefits. The loss of output capacity varied, but never exceeded 400,000 kw. at any time. The total number of generating stations affected by enemy action was 65, with an aggregate plant capacity of just over 5,600,000 kw. It is estimated that the War caused something like £10,000,000 damage. 29) During 1945, on the day of maximum demand, some 16% of the output capacity of all generating stations operating under the directions of the C.E.B. was out of service. Of the factors affecting the amount of generating plant out of service the most conspicuous was again the shortage of labour for maintenance and repair of plants.

A separate fund known as the Electricity (Civil Defence) Fund has been established by and under the control of the C.E.B. Into this Fund were paid (i) the sums payable by the Exchequer, (ii) the money borrowed by the Board for the purposes of the scheme, (iii) the proceeds of the levy upon the Industry as a whole, and (iv) the proceeds of the sale of the equipment in the pool, when dispersed. Out of this Fund were paid the expenses, approved by the El. Commissioners and incurred (I) by the Board, in acquiring and storing the equipment forming the pool, (II) by the Board and other authorised undertakers in carrying out the approved measures for securing the due functioning of their undertakings, and (III) by the Board in administering the pool and the Fund, including interest and sinking fund payments. The money borrowed by the Board for the purposes of the scheme was raised by the issue of the "Electricity (Civil Defence) Stock".

At the end of 1945, the Fund was limited to a maximum of £6,000,000, and the grants receivable amounted to £2,611,514.³⁰⁾ Borrowing powers remained at £3,000,000. The El. Commissioners gave/

29) "Seventeenth Annual Report of the C.E.B.", 1944. Appendix II.

30) "Eighteenth Annual Report of the C.E.B.", 1945.

gave their consent for borrowing a total of £2,700,000.

During the War the public control over fuel and power industries was increased. It aimed at (1) ensuring fuel and power for war production, with minimum interference with normal channels of trade; and at later stages of war at (2) minimising war-time inequities as between consumers and between units in each industry; and (3) avoiding an increase in the cost of living and inflation.³¹⁾ As in the First World War, so during the last one, no single fuel and power policy has emerged. Only from time to time specific controls have been applied according to immediate needs. The war-time restrictions fell most heavily upon domestic and commercial consumers. Domestic consumption e.g. had risen only by 12% by the end of 1942 as compared with 1938. In normal times the increase would have been 40-50%.³²⁾ The first restriction was imposed by the Fuel and Lighting Order, 1939, which originally restricted the consumption of coal, gas and electricity to 75%, and later to not more than previous year's consumption. Every household was entitled to a minimum of 200 units of electricity; where electricity was used for working, the minimum allowance was 1000 units a year. Each local authority appointed a Fuel Overseer, who decided the amount of current allowed to consumers in his area. In October, 1941, a Report by the Selected Committee of National Expenditure suggested practical economies in lighting, heating and cooking, especially between the hours of 8 a.m. and 12 noon on Mondays to Saturdays, when industrial demand was at its height. As a result of the rationing proposals made in 1939, the Joint Gas and Electricity Committee was formed in order to avoid competition between the two industries. In the cases where there was a doubt as to whether new electricity supplies or development should be undertaken, reference was made to the El. Commissioners, who were guided by the national interests.

The electricity undertakings had to face additional difficulties in connection with the inferior/

31) "Fuel and Power" - Fabian Research Group, 1945. Ch. II.

32) "Planning" No. 204, 1943, pp. 9-10.

inferior quality of coal consumed. The average consumption of fuel per Kwh. increased and the boiler availability was reduced. Because of the poorer coal thermal efficiency of the leading undertakings before the war fell from 23% to 20%. This caused a greater consumption of coal, which, for instance, amounted in 1941 to $1\frac{3}{4}$ million tons more than it would be in case, if the coal were of normal quality. However, this deterioration in many cases has been offset by improved load-factor as the result of the three-shift working arrangements in many factories. Then the greater preponderance of the industrial load has resulted in better load-factor, which meant that "the increased output has not involved a proportionate increase in plant capacity". It was not until the winter 1941-42 that the national peak-demand exceeded that recorded in 1938. The peak demand, owing to "black-out" restrictions and the continuance of "summer-time" throughout the winter months, moved from between 4 and 5 p.m., as in pre-war years, to 9 am. and 9.30 a.m.. As a result of "black-out" restrictions it became more difficult to control the working of a plant, and generating stations' instruments deteriorated quickly, due to lack of ventilation during the hours of darkness.

During the War, some information with respect to the expansion and operation of the Grid and the generating statistics associated therewith, have been omitted from the C.E.B.'s Reports by the Statutory Rule and Order, No. 2,631, relaxed that ban. *but*

In December, 1944, the then Minister of Fuel and Power, Major Lloyd George, said that output had increased by over 51% since the war started, which reached its war-time peak of 38,356,000,000 units. There has been little increase in domestic, but mainly in industrial, consumption. Over the whole war period power sales rose by 86%, and domestic sales by 33%. The significance of that increase lies in the fact that it has been achieved under difficult war-time conditions. As a matter of comparison, it may be said that in the four years period preceding 1938/39 the annual output showed a rise of 50%, while in the four years before, 54%. It is thus "conceivable that the war so far from speeding up the progress of electricity/

electricity may have actually retarded it; that the natural growth of the public demand, which the war has checked is greater than the requirements of the war machine". According to data supplied by the "Monthly Bulletin of Statistics" issued by the United Nations Organisation, in August 1946, the output between 1939-44, went up in the U.S.A. by 73%, in Great Britain and Canada by 43%, in India by 57% and in New Zealand by 39%.

After the cessation of hostilities there was a decrease in the electrical output, which reflected broadly the reduction, which was to be expected, in the requirements of war factories, although this was offset to some extent by an increase in the consumption for domestic and commercial purposes. In May, 1945, the Ministry of Fuel and Power informed the C.E.B. that, in future, orders for manufacture of the electrical plant could be placed without reference to the Government.

The figures relating to output of electricity for the year 1945, reflect, in variations in demand, the transition from war to peacetime conditions. 33) During that year 37,276 m. units were generated at public supply stations, 2.8% less than in 1944, but 53% more than in 1938. All except 1% of electricity supplied, excluding North Scotland, was produced in 193 stations operated under the directions of the C.E.B. Sales to domestic and farm premises increased from 7,799 m. units in 1944 to 8,848m. in 1945, while supplies to factories and other industrial premises decreased from 19,999 m. units in 1944 to 17,692 m. units in 1945. The number of authorised undertakers at March 31, 1945, was 570, including 375 public authorities and 195 companies. The number of stations owned by authorised undertakers was 346 in 1945, and their installed capacity amounted at the end of that year to 12,297,000 Kw. The consumption of coal by electricity undertakings increased from 18.8 m. tons during the year 1940-41 to 24.0 m. tons in 1945-46. The generation of electricity at factory power stations decreased from 4,598 m. units in 1944 to 4,493.2 m. units in 1945, and at colliery power stations it decreased also from 1,567.9 m. units in 1944 to 1,544.6 m. in 1945.

33) Statistical Digest issued by the Ministry of Fuel and Power (Cmd. 6920).

The over-all manpower of the Industry during the War decreased by 30,542. In the same period there was an increase of 7,168 in the number of female employees.

It was estimated by the El. Commissioners that the capital expenditure contemplated during the first five post-war years will amount to £155,000,000 in respect of generators and some £227,000,000 for all other purposes.

34)

34) "Twentieth Annual Report of the El. Commissioners", 1939-1945.

TRANSITION PERIOD, 1946-7.

1. POST-WAR RECONSTRUCTION.

During 1946 electricity was supplied publicly by the C.E.B., the North of Scotland Hydro-Electric Board, 365 local authorities, 169 distribution companies, 26 power companies, 5 Joint Boards and 3 Joint Electricity Authorities, a total of 570 authorised undertakings with £800 m. of capital expenditure. 35) These undertakings generated 41,240 m. units of electricity in the year 1946, 36) which was about 10.4% more than that of 1945. During the first two months of this year electricity output increased by 9.8% compared with that of the same two months of 1946, despite the restrictions imposed upon the domestic consumers. (1946 - 7, 604 m. units, 1947 - 8,351 m. units). The North of Scotland Hydro-Electric Board is proceeding with the schemes of the Mullardoch-Fasnakyle-Affric project in Inverness-shire, at Loch Sloy, Dumbartonshire, Loch Lomondside, Pitlochry, Perthshire, and at Clunie Dam.

After the War electrical manufacturing industry began to manufacture on a bigger scale electrical appliances for domestic consumers and electrical apparatus, machinery and instruments for the Electricity Supply Industry. Thus in April 1946, there were 236,000 employed on manufacturing apparatus, 152,000 on electrical engineering, and 64,000 on making instruments, being 74,000 more than in 1939 and 81,000 fewer than in 1945 when the industry was producing warlike stores. 37) Since VJ, in face of every difficulty, electricity has been supplied to nearly 200,000 new consumers. In spite of the greater availability of electrical appliances, domestic and industrial consumers were handicapped by fuel restrictions. Thus in December 1946 the Minister of Fuel and Power by Statutory Order, S.R. & O. 2,087, restricted by $2\frac{1}{2}\%$ all electricity consumption by industrial users who normally /

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- 35) "Electrical Review" Vol. C XXXIX No. 3595, Oct. 18, 1946, p. 618.
36) Monthly "Digest of Statistics" No.15, March 1947, Central Statistical Off.
37) "Electrical Review" Vol. CXXXIX No. 3594, Oct.11th, 1946, pp. 565-66.

normally used more than 13,000 units in January, February and March of 1947 with November of 1946 as the base period. It was provided also that in exceptional cases ad hoc assistance in supplies may be provided to particular firms with approval of Regional Controller of the Production Department. Thus, the industry on the one hand is called upon to cut consumption of electricity and, on the other hand, is asked to increase production of export goods and for a domestic market. The effect of the Fuel Crisis experienced early in 1947 may be gaged from the number of unemployed and the reduction in the production of basic industries. Thus according to the President of the Board of Trade, at the peak count of February 22nd, unemployment has risen as a result of the power cuts to a figure six times that of mid-January, while on March 5th after all cuts had been restored, the total number of unemployed was still twice that of the January level. As for decrease in production, the basic industries, for example, the steel industry fell to 86% of the January output. Though the electricity supply and manufacturing industries had settled down after the interruption caused by the coal crisis, circumstances are however still abnormal. The Electricity Supply Industry is allocated with about 500,000 tons of coal per week, but this quantity makes difficult to build up necessary stocks. As for the future position in the next two winters, a pessimistic opinion was expressed by Mr. Harold Hobson, Chairman of C.E.B., in the following words, "It is no use blinking the fact, that there is no physical possibility of re-establishing of plant and demand in this country before 1949 and probably 1950. It may be a little better in 1949 but I think it will be 1950 before we can get back to pre-war services". 38)

Apart from the coal difficulties another dominating factor arises, namely, a shortage of plant. During the War, provision for the future requirements of power stations had to give way to the more pressing needs of war equipment, with the result that at the end of the War, there was, and still is, a shortage of generating plant. /

38) "The Electrician" Vol. CXXXVI, 20th Decr. 1946, p. 1756.

plant. It will take a considerable time to balance a demand upon the Industry and the generating capacity. The present generating capacity of the country will of necessity delay the growth of electrical development to its natural dimensions. As an indication of the position, for example, on January 30th, 1947, when the generating capacity of the country was short by 1535 m. W. compared with 170 m. W. in same month last year. 39) It is estimated that the present shortage of installed capacity amounts to 2 m. Kw. About 350,000 Kw. of plant has been put into commission since the end of War. The C.E.B. made arrangements with authorised undertakings during 1946 for additions to be made to the generating capacity of the selected stations aggregating to 2,321,000 Kw. and involving an expenditure of about £100 m. by 1950. Not always can these plans be achieved because of shortage of labour, materials and manufacturing works; thus for instance, the Board's programme for 900,000 Kw. of new plant for 1946 was materialised only to the extent of 200,000 Kw.

On January 17th, 1947, an agreement was made by the National Joint Industrial Council for the Electricity Supply Industry, standardising the Wage Rates and working conditions of all manual workers engaged in the Industry throughout Britain and Northern Ireland, with the exception of those in the London Area. This agreement replaced 13 distinct agreements which had been operating for 26 years. The National Agreement improved the workers' position. The system of A and B Zone rates is preserved in districts where zoning is in operation and the new A zone rates in general, range from 30d. for a fitter to 24d. for a labourer, with a margin of $\frac{3}{4}$ below those rates for B zone. The above rates are day rates, and the shift increase of 3d. per hour for all hours worked by shift workers is preserved. This agreement lasts till Oct. 1st, 1947.

NATIONALISATION /

39) "The Electrician" Vol. CXXXVIII, 14th Feb., 1947, p. 494.

2. NATIONALISATION PLANS.

As was already observed in Chapter III the Labour Party has for some years past urged as part of its legislative programme the nationalisation of the Electricity Supply Industry. It is also necessary to state the fact that public control of this Industry was a national policy since the first Electric Lighting Act 1882, and during the last War the Coalition Government proposed a large measure of public control.

The usual arguments for nationalisation are that this Industry is a public utility of national importance and for that reason should be co-ordinated and regulated by the State. The opponents of nationalisation argue, however, that, what is most important for the Industry is not the principle of supervision or that of ownership, but to find a way in which this supervision should be carried out, to define a common and agreed policy, which would be embodied in a plan for both short-term and long-term activities. "The defect of most schemes put forward in the past has been their bias towards a particular form of ownership and control. It would be more original and convincing to accept the fact that efficiency is not a function of form of ownership, but is far more a question of management, and to proceed from the assumption to concentrate on economic and administrative matters". 40)

In November, 1946 the Labour Government announced proposals to nationalise the Industry. Then on January 10th 1947, the Government introduced the Electricity Bill, "To provide for the co-ordination under public ownership of the electricity supply industry in Great Britain". Under its provisions 570 authorised undertakings are to be nationalised, the C.E.B. and probably the El. Commission dissolved and stockholders compensated. The origin of these proposals may be traced back to 1932, when the Labour Party issued a report demanding the complete nationalisation of the Industry and the /

40) "The Electrician", Vol. CXXXVI, March 15th, 1946, pp. 653-55.

the establishment of a National Electricity Board.

The Bill which still is being shaped in the Committee stage, consists of sixty one clauses and three schedules, is described in Preamble as a Bill to provide for the establishment of a British Electricity Authority and Area Electricity Boards which together with the North of Scotland Hydro-Electric Board, are to exercise and perform the functions relating to supply of electricity and certain other matters; it provides also for the transfer to these new bodies of property, rights, obligations and liabilities of electricity undertakers and other bodies; to amend the law relating to the supply of electricity; to make certain consequential provision as to income tax.

The main features of the new organisation of the Industry are as follows:-

A British Electricity Authority, to be known as "the Central Authority", is to be established and empowered from the vesting date, to generate or acquire supplies, co-ordinate distribution of the Area Boards and exercise a general control over their policy, and also supply direct to large consumers. It may also manufacture, sell, hire, install, repair and maintain plant and fittings. Thus, this body is to maintain and develop an efficient, co-ordinated and economical system of electricity supply for all parts of Great Britain, except North of Scotland. The Central Authority shall have power to carry on all such other activities as may appear to the Authority to be requisite, advantageous, or convenient for them to carry on in connection with the performance of their duties. In the Central Authority the assets and liabilities of the C.E.B., power companies, and holding companies, together with all generating stations and main transmission lines, and all investments and cash of any authorised undertakers, other than such as vest in North of Scotland Board. The Authority will consist of a chairman and not more than six members appointed by the Minister of Fuel and Power on account of their technical and other qualifications. It will also be a duty of the Authority and /

and in some circumstances the Boards, to conduct and assist research, and to make provision for the training of employees, the improvement of equipment, and methods of working. It will present report to the Minister at the end of financial year, and the Area Boards will present to the Central Authority which reports will be laid before Parliament by the Minister. Central Authority and any Area Board may, with the consent of the Minister, promote or oppose Bills in Parliament. The Central Authority is also empowered to issue British Electricity Stock for the purpose of borrowing money for capital purposes. Both the Control Authority and the Area Boards may raise temporary loans, but the total sum outstanding at any time in respect of stock issued, is not to exceed £700 m. in respect of the above bodies, and £100 m. in the case of the North of Scotland Board. It will be the duty of the Authority to secure that the combined revenues of the Authority and the Boards are not less than sufficient to meet their combined expenses. The Authority will establish a central reserve fund for the purposes of the Authority and Area Boards, in order to prevent fluctuations in charges. Area Boards may themselves establish reserve funds out of their surplus revenues. All accounts must be laid before Parliament annually and audited by auditors appointed by the Minister.

The Area Boards' policy is to use all economical methods of generating, transmitting and distributing electricity; to cheapen supplies of electricity, to avoid any preference in the provision of such supplies, to simplify methods of charge, to standardise systems of supply and types of electrical fittings. Apart from these general duties any Area Board may:-

- (a) By agreement with any other Area Board and with the approval of the Central Authority, give to, or acquire from other Area Board bulk supply of electricity;
- (b) With the approval of the Central Authority, acquire bulk supplies of electricity from any person other than an Electricity Board;
- (c) By agreement with any other Area Board, supply /

supply electricity to consumers in the area of that other Area Board.

(d) To sell, hire, or otherwise supply electrical fittings and to install, repair, maintain or remove any such fittings.

In the Area Boards will be vested, all assets and liabilities of authorised undertakers remaining after those which will be vested in the Central Authority, and other than such as vest in the North of Scotland Board.

Each Area Board is to consist of a Chairman and not more than seven members selected by the Minister on account of their qualifications (which may include knowledge of Local Government matters), and in addition, the Chairman of the Consultative Council in that Area.

Authorisation may be given by the Minister to the Boards to purchase compulsorily any land required for the discharge of their functions. The Boards are not exempted from any taxes, rates or other general or local charges. Present tariffs in an area of supply are to remain in force until varied or replaced by tariffs fixed by Area Board. Electricity Board will establish method of settling terms and conditions of employment of their staffs, either separately or in conjunction with other Boards, and it will also be a duty to consult with appropriate organisations on matters affecting safety, health, and welfare of persons employed.

A White Paper (Cond. 7007) issued in conjunction with the Bill, gives details of the methods used to fix boundaries of the fourteen Area Boards, which have been drawn in accordance with geographical, administrative and technical considerations. Boundaries have been drawn through lightly-populated districts, taking into consideration such factors as load diversity, a balance of urban and rural population in each Area. In almost every Area there are local industries which will require special attention from the Area Board.

A special problem arose in connection with the London Area, which has between 1/4 and 1/5 of the total population of Great Britain and /

and accounts for about 1/5 of the electricity supplies of the whole country. The new London Electricity Area has been kept to the smallest limits consistent with the administrative and technical requirements, in order not to deprive adjoining Areas of some of London's suburbs.

Area Boards and Populations (1000's) †

Area	Urban	Rural	Total
1. London	6,273	-	6,273
2. South Eastern	2,380	591	2,971
3. Southern	2,080	923	3,003
4. South Western	1,366	569	1,935
5. East Anglian	2,923	1,005	3,928
6. East Midlands	2,199	948	3,147
7. Midlands	3,040	658	3,698
8. South Wales	1,485	444	1,929
9. Merseyside and North Wales	2,153	517	2,670
10. Yorkshire	3,584	595	4,179
11. North Eastern	2,336	538	2,874
12. North Western	4,097	408	4,505
13. South East Scotland	923	357	1,280
14. South West Scotland	1,913	633	2,546

† Figures are approximate only.

The North of Scotland Board will be in a special position and will discharge in its district, those functions undertaken elsewhere by the Central Authority and the Area Boards. It will not be under control of the Central Authority, but will be responsible to the Secretary of State for Scotland. The Board will consist of nine members, appointed by the Secretary of State and the Minister, acting jointly. In addition to the exclusive rights to hydro-electric resources within its area, conferred by the 1943 Act, the new Board will acquire all other types of generating stations. The District will have an area of 21,600 sq. miles, i.e. 73% of the total area of Scotland and will serve a population of 1,165,000.

The Bill provides that the shareholders in electricity supply companies are to be compensated on the basis of Stock Exchange, and the compensation terms will be settled by negotiation /

negotiation between the Minister and representatives of shareholders; in case of disagreement, settlement will be by arbitration. The value of quoted securities will be taken as the average market values on either of two groups of dates, whichever is more favourable to the shareholders. The dates specified are six, i.e. between November 1 and 8, 1946; February 15, March 15, April 16, May 15, June 15, and July 16, 1945. The shareholders will be compensated in negotiable British Electricity Stock and of such amount as, in the opinion of the Treasury, is of a value equal on the date of issue to the value of the securities. The payment after January 10, 1947, of interest and dividends on securities of transferred bodies is to be limited to permitted maxima. Compensation to local authorities will be made by the Central Authority, on a basis of net outstanding debt. Where a local authority has established a loan redemption fund, capital payments will be made to provide for the repayment of the same within the redemption period. Where provision has been made by the authority for the redemption of a loan by instalments, the Central Authority, subject to certain regulations, will pay to the authority capital payments equal to the interest due on the loan. Where the instalments represent payments of interest and principal combined, capital repayments and amounts to cover interest will be made concurrently.

The total amount of compensation is not stated, but it is estimated that the compensation payable to companies alone (including the C.E.B.) be at £370,000,000.

In each Area Board and in the North of Scotland District there will be established a Consultative Council. These will consist of 20 - 30 members appointed by the Minister, half from local authorities and the remainder representing consumers and other interested persons. The Councils will be concerned with matters affecting distribution, like tariffs and the provision of new or improved services and facilities.

The Minister of Fuel and Power will issue general directions to the Central Authority on matters affecting the nation's interest and lay down lines of re-organisation and development. The /

The Minister and the Secretary of State for Scotland may make joint regulations providing for pensions in respect of personnel who have not been taken by an Electricity Board, and for making any necessary amendments to existing pension schemes. The Minister may order the dissolution of the El. Commissioners and the transfer of their property, rights and obligations, but compensation will be paid to the El. Commissioners, if dissolved, their Staff and to the members and Staff of the C.E.B.

Thus from the above review it appears that the Central Authority will be concerned with generation and bulk distribution of electricity, while the latter will retail the bulk supplies taken from the Central Authority. Uniformity of charges is not contemplated.

In relation to other schemes for industrial development, such as £150 m. for coal industry and provisionally £168 m. for steel industry, a total of £300 m. is to be spent for electricity supply. This is considered by "The Economist" to be rather high, having regard to the capital already invested. "It suggests an intention to go forward with rural electrification on the grand scale, but it also raises the issue whether capital development of this sort - desirable as it is - should not be given a much lower priority rating in the programme of national re-equipment than the schemes for coal, transport and steel". 41)

The Incorporated Municipal Electrical Association, which represents 348 local authority undertakings, comprising 95% of all local authorities owning electricity undertakings, agreed to the principle of public ownership in the Industry as a whole and considered that "in the best interests of the consumers and of the nation the maximum amount of local authority administration and control be ensured on the distribution side of this vital public service." On the other hand, the Incorporated Association of Power Companies considered that State ownership is "entirely opposed to the interests of taxpayers, /

41) "The Economist", January 18, 1947, p. 111.

taxpayers, electricity consumers, and employees of the Industry". The Electricity Companies stated that within a few years in their areas 95% of premises would be supplied with electricity, that in last 10 years before the War, they reduced their charges by 54% for domestic supplies and by 30% for power supplies. They reaffirmed their ability to carry out their five year programme of general development at a cost of £150 m. and the proposals to expand electricity supply in the rural areas, at a cost of £72 m. The Companies stated that nationalisation will "seriously dislocate our whole industrial system, will result in management becoming increasingly centralised and stereotyped, entailing increased prices and inefficient service". The Bill itself was being criticised by Companies for putting first politics before economics, that the Board could dictate its own charges, and the Consultative Councils, on which consumers would be in a minority, would have no real powers. The compensation clauses were being criticised on the ground that many small shareholders' incomes would be cut by third. The Federation of British Industries, as representing a large body of consumers of electricity, expressed an opinion that the new proposals will increase the costs and lower standards of service. The London Chamber of Commerce in their Memorandum submitted to the Prime Minister and Minister of Fuel and Power, criticised the Bill on the grounds that nationalisation will require larger administrative staff, that new proposals will result "in confusion, hesitation, and misunderstandings", the fact that the Central Authority will manufacture and sell electrical fittings will mean that the State will put "a large number of small concerns completely out of business."

The Bill was also criticised by "The Electrician" as being drawn up without proper regard to the future of electricity supply, that the aims of the present Bill could be achieved, without nationalisation at a time when "the existing tasks of post-war reconstruction are the main concern", that the compensation terms are inadequate since they make no allowance for "the goodwill established, the risks taken and the fact that the Industry has an assured future bound up with the steady expansion", and that compensation /

compensation is based on Stock Exchange prices and not on the net maintainable revenue of the Industry. Then that the Bill does not disclose plan "for the improvement of the Industry nor for the provision of a more abundant or cheaper supply of electricity". 42)

"The Economist" also considered the compensation terms as not being fair, and the nationalisation of this Industry at this moment is inappropriate, and "To insist on shareholders taking the present capital value of their contractual rights to income, at a time when they have no chance of re-investing their money to produce the same income, is confiscation". However, the Author seems to accept the principle of nationalisation as the economic justification because "Theoretically, the "single ownership" could be private or public; in practice it could only be public". 43)

The Electricity Supply Industry was reminded by the Government about a year ago that it was expected to continue its development in the interim period till the nationalisation will come into effect, and this task is being carried out faithfully by the Industry, whether by private or public bodies, just as in the past, in spite of the present labour and materials difficulties.

(42) "The Electrician", 17, January, 1947, pp. 186-7.
(43) "The Economist", January 18, 1947, pp. 92-93.

APPENDICES.

NOTES - The whole of the figures, contained in E. Garcke's "Manuals of Electrical Undertakings", under the various headings are not obtainable in regard to all undertakings, consequently the averages are based, not on all undertakings in the Manuals, but only on those in regard to which the necessary data are published.

The figures prior to 1920 are therefore not complete nor strictly comparative, but the trend of development is nevertheless well illustrated.

APPENDIX I.

GENERATION OF ELECTRICITY

ANNUAL RATE OF INCREASE IN %.

Year	Basis	Percentage
1882 - 1883	on basis of 1882 figures	37.1
1889 - 1900	on basis of 1889 figures	100.0
1901 - 1914	on basis of 1901 figures	58.0
1921 - 1922	on basis of 1920-21 figures	(-)9.0
1921 - 1923	on basis of 1920-21 figures	6.2
1923 - 1924	on basis of 1922-23 figures	16.4
1924 - 1925	on basis of 1922-23 figures	32.6
1925 - 1926	on basis of 1924-25 figures	10.0
1926 - 1927	on basis of 1925-26 figures	5.5
1927 - 1928	on basis of 1926-27 figures	21.0
1928 - 1929	on basis of 1927-28 figures	10.0
1929 - 1930	on basis of 1928-29 figures	11.5
1930 - 1931	on basis of 1929-30 figures	5.2
1931 - 1932	on basis of 1930-31 figures	5.3
1932 - 1933	on basis of 1931-32 figures	7.0
1933 - 1934	on basis of 1932-33 figures	12.7
1934 - 1935	on basis of 1933-34 figures	12.0
1935 - 1936	on basis of 1934-35 figures	15.3
1936 - 1937	on basis of 1935-36 figures	14.2
1937 - 1938	on basis of 1936-37 figures	12.1

APPENDIX II.

TOTAL UNITS GENERATED PER ANNUM.

m. units.

Year	Total	Public Author- ities	Companies
1882	1.5	-	1.5
1883	1.65	-	1.65
1884	2.0	-	2.0
1885	2.6	-	2.3
1886	2.8	-	2.8
1887	3.2	-	3.2
1888	5.4	-	5.4
1889	12.4	4.2	8.2
1890	14.8	5.8	9.0
1891	15.7	8.1	7.6
1892	20.4	9.7	10.7
1893	24.1	11.9	12.2
1894	25.0	8.9	16.1
1895	34.3	17.0	17.3
1896	51.0	23.9	27.1
1897	62.3	26.8	35.3
1898	94.2	49.3	43.9
1899	137.9	69.9	68.0
1900	163.5	95.6	67.9
1901	229.8	146.1	83.7
1902	294.4	188.8	105.6
1903	403.0	262.9	140.1
1904	470.0	298.3	171.7
1905	612.3	391.7	220.6
1906	731.4	435.6	295.8
1907	883.2	530.8	352.4
1908	1,012.3	606.7	405.6
1909	1,093.5	665.6	427.9
1910	1,198.1	725.0	473.1
1911	1,389.1	881.3	507.8
1912	1,528.0	943.8	584.2
1913	1,765.5	1,110.2	655.3
1914	2,107.3	1,423.8	683.5
1920-21	4,275.1	2,660.9	1,614.2
1921-22	3,890.4	2,459.5	1,430.9
1922-23	4,541.2	2,952.6	1,588.6
1923-24	5,288.7	3,481.8	1,806.9
1924-25	6,022.2	3,910.4	2,111.8
1925-26	6,618.6	4,348.0	2,270.6
1926-27	6,992.3	4,601.7	2,390.6
1927-28 /			

Appendix II (contd.)

1927-28	8,451.4	5,309.9	3,145.5
1928-29	9,323.7	5,863.1	3,460.6
1929-30	10,400.9	6,383.0	4,017.9
1930-31	10,947.5	6,544.7	4,402.8
1931-32	11,532.7	6,905.6	4,627.1
1932-33	12,347.3	7,449.1	4,898.2
1933-34	13,914.9	8,272.6	5,642.3
1934-35	15,587.1	8,735.1	6,852.0
1935-36	17,970.8	9,686.7	8,284.1
1936-37	20,524.5	11,089.0	9,435.5
1937-38	23,011.6	12,434.7	10,576.9
1938-39	24,809.7	13,580.6	11,229.1
1939-40	26,813.9	14,752.0	12,061.9
1940-41	29,204.1	16,402.3	12,801.8
1941-42	32,986.7	18,605.4	14,381.3
1942-43	35,290.0	12,244.1	16,045.9
1944	x 38,354.0	-	-
1945	x 37,276.0	-	-
1946	x 41,240.0	-	-

x Subject to revision.

APPENDIX III.

PLANT INSTALLED

. KW.

Year	Total	Public Authorities	Companies
1894	32,108) Compiled from "Lighting" and "Electrical Times"	
1899	112,631		
1904	454,565		
1909	795,036		
) From 1910 to 1920 compiled from E. Garcke's "Manuals of Electrical Undertakings"	
1910	962,760	623,910	338,850
1911	990,927	626,712	364,215
1912-13	1,070,851	696,673	374,178
1913-14			

Appendix III (contd.)

1913-14	1,119,617	736,236	383,381
1914-15	1,349,321	910,882	438,439
1915-16	1,315,210	909,883	405,327
1916-17	1,461,516	1,080,783	380,733
1917-18	1,491,014	1,109,616	381,398
1918-19	1,555,259	1,168,881	386,378
1919-20	2,223,661	1,372,456	851,205
1922-23	3,093,679	2,081,084	1,012,595
1924-25	3,723,514	2,529,320	1,194,194
1925-26	4,421,602	2,969,319	1,452,283
1926-27	4,682,069	3,157,031	1,525,038
1927-28	5,258,257	3,462,810	1,795,447
1928-29	5,801,770	3,786,315	2,015,455
1929-30	6,600,225	4,162,661	2,437,564
1930-31	6,945,805	4,424,178	2,521,627
1931-32	7,194,571	4,665,160	2,529,411
1932-33	7,365,869	4,721,539	2,644,330
1933-34	7,837,154	4,719,799	3,117,355
1934-35	7,785,206	4,656,473	3,128,733
1935-36	8,099,870	4,811,097	3,288,773
1936-37	8,398,241	5,051,890	3,346,351
1937-38	8,913,478	5,341,207	3,572,271
1938-39	9,498,000	-	-
1942-43	11,679,042	-	-

APPENDIX IV.

LOAD FACTORS.

Combined load factors for the whole of the generating plant of undertakers in Great Britain taken collectively. Since 1941 the figures are for the Grid System only.

Year	Load Factor in %	Year	Load Factor in %
1899	11.0	1930-31	33.0
1904	14.7	1931-32	33.3
1909	18.7	1932-33	33.9
1920-21	30.0	1933-34	33.1
1921-22	27.0	1934-35	33.6
1922-23	28.0	1935-36	33.9
1923-24	29.0	1936-37	35.5
1924-25	30.0	1937-38	36.1
1925-26	30.0	1941	47.0
1926-27	30.0	1942	50.0
1927-28	30.0	1943	48.0
1928-29	31.6	1944	47.6
1929-30	33.0	1945	45.0 (provis- ional)

APPENDIX V.

Relationship between (A) Aggregate of Maximum Demand on Stations owned by Authorised Undertakers and (B) Total Installed Capacity of All Generating Stations owned by Authorised Undertakers.

Year	Aggregate of Maximum Demand. KW.	Installed Capacity KW.	Ratio
1899	78,866	112,631	100:170
1904	269,680	454,565	100:159
1909	501,941	795,036	100:163
1910	578,196	962,760	100:171
1911	604,226	990,927	100:164
1912-13	661,762	1,070,851	100:161
1913-14	711,342	1,119,617	100:157
1914-15	803,715	1,349,321	100:167
1915-16	814,279	1,315,210	100:161
1916-17	851,591	1,461,516	100:171
1917-18	945,096	1,491,014	100:157
1918-19	1,029,301	1,555,259	100:151
1919-20	1,232,390	2,223,661	100:180
1922-23	1,829,557	3,093,679	100:169
1923-24	2,074,772	-	100:169
1924-25	2,298,182	3,723,514	100:162
1925-26	2,557,956	4,421,602	100:173
1926-27	2,700,594	4,682,069	100:173
1927-28	3,235,188	5,258,257	100:162
1928-29	3,369,166	5,801,770	100:172
1929-30	3,600,820	6,600,225	100:183
1930-31	3,801,342	6,945,805	100:183
1931-32	3,950,928	7,194,571	100:182
1932-33	4,156,410	7,365,869	100:177
1933-34	4,802,032	7,837,154	100:163
1934-35	5,297,462	7,785,206	100:134
1935-36	6,044,011	8,099,870	100:134
1936-37	6,609,132	8,398,241	100:127
1937-38	7,284,410	8,913,478	100:122

APPENDIX VI.

COAL /

Appendix VI.

COAL CONSUMED PER UNIT.

Average Fuel Consumption per Unit Generated
(coal and coke, and fuel oil expressed as
equivalent coal).

Year	lb. per unit	Year	lb. per unit
1920-21	3.4	1929-30	1.97
1921-22	3.2	1930-31	1.86
1922-23	2.8	1931-32	1.78
1923-24	2.71	1932-33	1.72
1924-25	2.55	1933-34	1.64
1925-26	2.43	1934-35	1.57
1926-27	2.33	1935-36	1.53
1927-28	2.16	1936-37	1.47
1928-29	2.04	1937-38	1.42

APPENDIX VII.

AVERAGE OUTPUT PER TON OF FUEL.

The ratio of output per ton of fuel in 1938-39 as
compared with 1920-21 was 2.40.

Year	Units	Year	Units
1920-21	655	1930-31	1,206
1921-22	690	1931-32	1,225
1922-23	802	1932-33	1,303
1923-24	825	1933-34	1,364
1924-25	877	1934-35	1,423
1925-26	921	1935-36	1,462
1926-27	960	1936-37	1,526
1927-28	1,038	1937-38	1,575
1928-29	1,098	1938-39	1,640
1929-30	1,135		

APPENDIX VIII. /

APPENDIX VIII.

COAL AND COKE CONSUMED IN GENERATION.

Year	Thousand Tons	Year	Thousand Tons
1920-21	6,348.0	1932-33	9,074.4
1921-22	5,362.5	1933-34	9,820.3
1922-23	5,480.6	1934-35	10,490.6
1923-24	6,173.9	1935-36	11,743.5
1924-25	6,661.5	1936-37	12,885.3
1925-26	6,996.7	1937-38	13,991.0
1926-27	7,004.5	1938-39	14,444.7
1927-28	7,957.0	1939-40	15,707.2
1928-29	8,228.8	1940-41	17,935.6
1929-30	8,883.6	1941-42	20,179.3
1930-31	8,685.4	1942-43	20,866.0
1931-32	8,736.1		

APPENDIX IX^a.

AVERAGE CAPITAL EXPENDITURE PER KW. INSTALLED.

The Average Capital Expenditure for All Undertakings (inclusive of distribution, etc.) per KW. of Generating Plant Installed. Figures for the period 1894-1901 are supplied by "The Electrical Engineer" Vol. XXXII, July, 17, 1903. The average total figures for the period 1932-1938 are for the Electricity Supply Industry as a whole, inclusive of Capital Expenditure by the C.E.B.

Year	Total £	Public Authorities £	Companies £
1894	105.5	87.0	124.0
1895	100.5	87.0	114.0
1896	106.0	96.0	116.0
1897	110.0	99.0	121.0
1898	107.0	96.0	118.0
1899	101.0	87.0	115.0
1900	98.5	86.0	121.0
1901	98.0	83.0	113.0
1904	84.0	-	-
1909	72.0	-	-
1922-23	51.0	49.8	54.1
1924-25 /			

Appendix IX^a (contd.)

1924-25	52.1	49.5	57.5
1925-26	49.1	46.9	53.6
1926-27	51.0	48.4	56.2
1927-28	51.2	48.9	55.5
1928-29	51.3	48.8	56.0
1929-30	49.6	48.1	52.0
1930-31	51.0	48.9	54.6
1931-32	52.9	49.0	58.8
1932-33	59.2	-	-
1933-34	59.4	-	-
1934-35	63.6	-	-
1935-36	65.6	-	-
1936-37	67.8	-	-
1937-38	68.3	-	-

APPENDIX IX^B.

AVERAGE CAPITAL EXPENDITURE ON GENERATION PER
KW. INSTALLED.

Year	Total £	Public Author- ities £	Companies £
1922-23	23.8	23.7	24.0
1924-25	23.6	23.1	24.8
1925-26	21.5	21.3	22.1
1926-27	21.4	21.1	22.0
1927-28	21.2	20.8	21.8
1928-29	21.0	20.4	22.3
1929-30	19.8	19.1	20.8
1930-31	19.6	18.6	21.2
1931-32	19.6	18.1	22.2
1932-33	19.6	18.0	22.4
1933-34	18.6	-	-
1934-35	18.8	-	-
1935-36	19.1	-	-
1936-37	19.4	-	-
1937-38	19.2	-	-

APPENDIX X.

AVERAGE WORKING EXPENSES PER UNIT SOLD - PENCE.

The /

Appendix X (contd.)

The figures for a period 1894-1901, are taken from "The Electrical Engineer", Vol. XXXII, July, 17, 1903, for a period 1909 to 1921, from E. Garcke's Manuals Vol. 1909 to 1920-21. Since 1921 official figures are given, which exclude Capital Charges.

Year	Total	Public Author- ities	Companies
	d.	d.	d.
1894	3.82	3.95	3.70
1895	3.67	3.50	3.85
1896	3.35	3.10	3.60
1897	3.10	2.60	3.60
1898	2.75	2.25	3.25
1899	2.52	2.20	2.85
1900	2.80	2.45	3.15
1901	2.47	2.20	2.75
1905	1.60	-	-
1909	1.12	1.00	1.45
1910	1.12	0.92	1.54
1911	0.92	0.81	1.18
1912-13	0.96	0.87	1.16
1913-14	0.89	0.77	1.21
1914-15	0.89	0.79	1.17
1915-16	0.87	0.76	1.17
1916-17	0.82	0.69	1.21
1917-18	0.90	0.76	1.39
1918-19	0.99	0.84	1.56
1919-20	1.08	0.95	1.51
1920-21	1.47	1.37	1.81
1921-22	1.73	1.80	1.61
1922-23	1.15	1.18	1.10
1923-24	1.04	1.08	0.98
1924-25	1.01	1.05	0.94
1925-26	0.94	0.98	0.90
1926-27	1.13	1.18	1.05
1927-28	0.84	0.86	0.81
1928-29	0.77	0.81	0.72
1929-30	0.751	0.816	0.669
1930-31	0.742	0.813	0.655
1931-32	0.776	0.825	0.659
1932-33	0.702	0.739	0.618
1933-34	0.664	0.725	0.604
1934-35	0.658	0.799	0.700
1935-36	0.642	0.776	0.686
1936-37 /			

Appendix X (contd.)

1936-37	0.609	0.751	0.670
1937-38	0.614	0.760	0.663
1938-39	0.623	0.775	0.685
1939-40	0.614	0.716	0.690
1940-41	0.651	0.789	0.728
1941-42	0.657	0.784	0.737
1942-43	0.656	0.801	0.715

APPENDIX XI.

AVERAGE REVENUE PER UNIT SOLD.

The figures for a period 1895-1921 are taken from E. Garcke's Manuals, Vol. 1895-1921. Official figures given since 1921 exclude bulk intersales.

Year	Total	Public Author- :ities	Companies
	d.	d.	d.
1895	5.75	5.32	6.08
1896	5.47	5.18	5.77
1897	5.15	4.68	5.62
1898	4.93	4.35	5.51
1899	4.66	4.06	5.26
1901-2	4.38	3.82	4.94
1909	2.19	2.02	2.71
1910	2.15	1.89	2.81
1911	1.91	1.77	2.22
1912-13	1.80	1.69	2.04
1913-14	1.77	1.62	2.17
1914-15	1.70	1.55	2.10
1915-16	1.61	1.46	2.06
1916-17	1.49	1.33	1.97
1917-18	1.49	1.30	2.16
1918-19	1.56	1.35	2.32
1919-20	1.59	1.43	2.12
1920-21	2.12	1.99	2.54

AVERAGE REVENUE PER UNIT SOLD FOR DIFFERENT PURPOSES.
Pence per Unit Sold.

Year	Lighting & Domest- :ic Pur- :poses	Public	Traction	Power	Unalloc- :ated	Total
1921-22 a)	5.75	2.90	1.73	1.69	2.39	2.48
b)	41.5%	1.8%	7.4%	43.6%	5.7%	100.0%
1922-23/						

Appendix XI (contd.)

1922-23	a)	5.30	2.45	1.45	1.30	2.00	2.07
	b)	44.4%	1.8%	6.8%	40.3%	6.7%	100.0%
1923-24	a)	4.52	2.31	1.36	1.14	2.4	1.86
	b)	48.6%	1.9%	6.8%	42.1%	0.6%	100 %
1924-25	a)	4.20	2.10	1.29	1.07	2.01	1.75
	b)	49.0%	1.9%	6.4%	42.1%	0.6%	100 %
1925-26	a)	3.82	1.96	1.13	1.00	-	1.65
	b)	51.4%	1.9%	6.3%	40.4%	-	100 %
1926-27	a)	3.55	2.61	1.17	1.14	-	1.76
	b)	49.7%	2.4%	6.4%	41.5%	-	100 %
1927-28	a)	3.39	1.81	0.99	0.94	-	1.55
	b)	53.2%	1.9%	5.9%	39.0%	-	100 %
1928-29	a)	3.05	1.69	0.88	0.86	-	1.44
	b)	55.1%	1.9%	5.5%	37.5%	-	100 %
1929-30	a)	2.86	1.61	0.81	0.82	-	1.38
	b)	56.0%	1.9%	5.2%	36.9%	-	100 %
1930-31	a)	2.67	1.54	0.77	0.81	-	1.38
	b)	58.4%	2.0%	4.9%	34.7%	-	100 %
1931-32	a)	2.54	1.49	0.73	0.79	-	1.36
	b)	60.1%	2.1%	4.6%	33.2%	-	100 %
1932-33	a)	2.41	1.39	0.67	0.77	-	1.33
	b)	61.4%	2.0%	4.2%	32.4%	-	100 %
1933-34	a)	2.28	1.30	0.63	0.73	-	1.26
	b)	61.6%	1.9%	4.1%	32.4%	-	100 %
1934-35	a)	2.129	1.258	0.614	0.689	-	1.196
	b)	62.0%	2.0%	3.8%	32.2%	-	100 %
1935-36	a)	1,921	1,170	0.589	0.659	-	1.125
	b)	62.4%	1.9%	3.6%	32.1%	-	100 %
1936-37	a)	1.797	1.107	0.582	0.649	-	1.085
	b)	62.3%	1.8%	3.4%	32.5%	-	100 %
1937-38	a)	1.693	1,063	0.585	0.643	-	1.047
	b)	61.7%	1.8%	3.3%	33.2%	-	100 %
1938-39	a)	1.598	1.046	0.587	0.655	-	1.040
	b)	56.97%	1.67%	3.11%	29.76%	-	100 %
1939-40	a)	1.574	1.624	0.596	0.643	-	1.009
	b)	55.85%	0.93%	2.99%	32.16%	-	100 %
1940-41	a)	1.642	5.717	0.670	0.677	-	1.033
	b)	53.89%	0.34%	2.81%	35.69%	-	100 %
1941-42	a)	1.603	4.569	0.708	0.715	-	1.034
	b)	51.70%	0.30%	2.62%	38.80%	-	100 %
1942-43	a)	1.640	4.019	0.728	0.718	-	1.010
	b)	47.96%	0.26%	2.59%	43.19%	-	100 %
x 1943-44	a)	1.631	3.885	0.753	0.738	-	1.013
x 1944-45	a)	1.558	2.462	0.807	0.803	-	1.066

- a) Average price per unit sold.
 b) Percentage of Revenue.
 x Figures subject to revision.

APPENDIX XII.

CAPITAL EXPENDITURE

Figures covering a period 1882 to 1894 are taken from "Electrical Review", Vol. XLI, Nov. 12, 1897, p. 684, and for a period 1895 to 1921 from E. Garcke's Manuals. The official figures since 1921 in respect of companies are inclusive of the Capital Expenditure incurred by the combined undertakings.

Year	Total	Public Author- :ities	Companies
	£	£	£
1882	8,500	-	-
1883	18,500	-	-
1884	25,000	-	-
1885	30,000	-	-
1886	45,000	-	-
1887	60,000	-	-
1888	150,000	-	-
1889	450,000	-	-
1890	650,000	-	-
1891	2,950,000	-	-
1892	3,885,000	-	-
1893	4,195,000	-	-
1894	6,246,000	-	-
1895	6,107,680	1,772,323	4,335,357
1896	8,762,363	3,392,229	5,370,134
1897	11,001,653	4,662,909	6,338,744
1898	14,975,741	6,979,150	7,996,591
1899	23,279,347	11,834,214	11,445,133
Vol. 1901-2	27,934,239	15,946,535	11,987,704
1908-9	53,206,084	31,470,771	21,835,313
1909-10	62,684,342	37,260,784	25,423,558
1910-11	63,858,689	38,587,450	25,271,239
1911-12	65,323,559	39,080,229	26,243,330
1912-13	67,185,844	41,107,751	26,078,113
1913-14	66,547,126	41,459,094	25,088,032
1914-15	71,551,088	45,085,611	26,465,477
1915-16	70,383,194	45,250,532	25,132,662
1916-17	75,706,178	49,424,226	26,281,952
1917-18	75,333,692	49,375,009	25,958,683
1918-19	76,353,041	49,246,295	27,107,746
1920-21	92,831,420	62,651,558	30,179,862
1921-22	143,716,260	92,115,513	51,600,747
1922-23	158,224,336	103,477,827	54,746,509
1923-24			

Appendix XII (contd.)

1923-24	173,858,064	113,668,066	60,189,998
1924-25	194,019,658	125,312,527	68,707,131
1925-26	217,038,306	139,205,654	77,832,652
1926-27	238,727,634	152,981,602	85,746,032
1927-28	269,002,093	169,386,684	99,615,409
1928-29	297,677,012	184,743,505	112,933,507
1929-30	327,070,153	200,291,250	126,778,903
1930-31	354,098,038	216,455,119	137,642,919
1931-32	380,369,161	231,619,501	148,749,660
1932-33	436,196,964	244,179,254	159,389,923
	C.E.B.	+32,627,787	
1933-34	466,212,475	256,649,687	168,717,813
	C.E.B.	+40,844,975	
1934-35	494,992,800	271,054,807	177,754,197
	C.E.B.	+46,183,796	
1935-36	531,328,563	287,617,615	193,048,518
	C.E.B.	+50,662,430	
1936-37	569,751,259	309,033,892	207,644,892
	C.E.B.	+53,072,475	
1937-38	608,675,067	330,399,068	223,098,040
	C.E.B.	+55,177,959	
1938-39	648,465,125	351,152,671	240,543,945
	C.E.B.	+56,768,509	
1939-40	680,626,460	367,218,722	254,847,770
	C.E.B.	+58,559,968	
1940-41	701,742,760	377,891,449	263,771,759
	C.E.B.	+60,079,552	
1941-42	724,783,815	389,053,430	273,045,095
	C.E.B.	+62,685,290	
1942-43	746,457,778	400,377,303	281,044,723
	C.E.B.	+65,035,752	

APPENDIX XIII.

Index of Development.

The relation between the amount of electricity sold to consumers and the total capital expenditure. The figures from 1930 relate to the Electricity Supply Industry as a whole, including the C.E.B. Sales of Electricity per £100. of capital expenditure.

Year	Units per £100 of capital expenditure.	Year	Units of £100 of capital expenditure.
1921-22	2,189	1931-32	2,372
1924-25	2,624	1932-33	2,340
1925-26	2,583	1933-34	2,460
1926-27	2,458	1934-35	2,692
1927-28	2,603	1935-36	2,832
1928-29	2,620	1936-37	3,009
1929-30	2,649	1937-38	3,165
1930-31	2,497	1938-39	3,118

APPENDIX XIV

RATES OF DIVIDEND.

Average rate of dividend or interest paid by Electricity Supply Companies on Ordinary Capital, Preference Capital and Loan Capital. Statistics are taken from E. Garcke's Manuals.

Year	Ordinary Capital %	Preference Capital %	Loan Capital %	Total Average %
1896	5.22	6.05	4.69	5.23
1897	7.04	5.97	4.70	6.28
1898	5.57	5.90	4.46	5.32
1899	5.93	5.82	4.61	5.51
1900	5.04	4.80	4.38	4.79
Vol. 1902-3	4.52	4.64	4.37	4.50
1903-4	5.29	5.36	4.43	5.03
1904-5	5.58	4.96	4.46	5.03
1905-6	5.57	5.14	4.53	5.11
1906-7	4.94	5.08	4.29	4.73
1907-8	4.18	4.79	4.52	4.49
1908-9	3.83	4.77	4.42	4.23
1909-10	3.91	4.83	4.49	4.32
1910-11	3.80	4.43	4.41	4.32
1912-13				4.14

APPENDIX XIV (Continued)

Year	Ordinary Capital. %	Preference Capital. %	Loan Capital. %	Total Average %
1912-13	3.91	5.03	4.58	4.43
Vol. 1913-14	4.73	4.90	4.74	4.77
1914-15	4.02	5.11	4.71	4.57
1915-16	4.04	5.22	4.72	4.59
1916-17	3.48	4.90	4.69	4.30
1917-18	3.86	5.03	4.77	4.51
1918-19	4.44	5.83	4.77	4.89
1919-20	4.95	5.74	4.82	5.08
1920-21	6.51	5.25	4.88	5.58
1921-22	6.34	5.96	5.22	5.79
1922-23	6.55	5.73	5.34	5.80
1923-24	7.33	6.07	5.23	6.18
1924-25	8.17	5.76	5.16	6.29
1925-26	8.56	6.01	5.14	6.51
1926-27	7.49	6.05	5.19	6.21
1928-29	7.75	6.25	5.16	6.36
1929-30	7.91	6.32	5.15	6.46
1930-31	7.90	6.41	5.07	6.52
1931-32	7.69	6.57	5.03	6.48
1932-33	7.63	6.32	5.03	6.39
1933-34	7.31	6.07	5.00	6.23
1934-35	7.21	5.83	4.83	6.04
1935-36	7.37	5.67	4.57	6.04
1936-37	7.61	5.60	4.49	6.14
1937-38	7.57	5.82	4.42	5.93
1938-39	7.51	5.73	4.29	6.09
1939-40	7.59	5.77	4.24	6.08
1940-41	7.29	5.72	4.05	5.87

APPENDIX XV

AVERAGE CONNECTED LOAD AND MAXIMUM
DEMAND PER CAPITA.

The average figures per head of population for a connected load and the average of maximum demand. The figure for 1908 is according to "Electrical Review", November 20, 1908, p.735.

Year	Connected Load per capita watts.	Year	Maximum Demand per capita watts
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1908/

APPENDIX XV (Continued)

Year	Connected Load per capita watts	Year	Maximum Demand per capita watts
1908	21.8		
1922-23	128.0	1922-23	50.0
1924-25	150.0	1924-25	60.0
1925-26	170.0	1925-26	70.0
1926-27	185.0	1926-27	74.0
1927-28	203.0	1927-28	85.0
1928-29	225.0	1928-29	92.0
1929-30	250.0	1929-30	99.0
1930-31	288.0	1930-31	105.0
1931-32	320.0	1931-32	110.0

APPENDIX XVI

UNITS SOLD TO CONSUMERS.

(Excluding Bulk Supplies).

Figures prior to 1921 are taken from E. Garcke's
Manuals.

Year	Totals	Lighting & Domestic Purposes	Public Lighting	Traction	Power	Misc.
1895	30.2	-	-	-	-	-
1896	43.3	-	-	-	-	-
1897	60.1	-	-	-	-	-
1898	85.1	-	-	-	-	-
1899	125.1	-	-	-	-	-
Vol. 1901-2	196.4	-	-	-	-	-
1902-3	246.9	-	-	-	-	-
1903-4	344.5	-	-	-	-	-
1904-5	448.0	-	-	-	-	-
1905-6	533.6	-	-	-	-	-
1906-7	712.7	-	-	-	-	-
1907-8	749.6	-	-	-	-	-
1908-9	954.9	-	-	-	-	-
1909-10						

APPENDIX XVI. (Continued)

Year	Totals	Lighting & Domestic Purposes	Public Lighting	Traction	Power	Misc.
1909-10	1,027.4	-	-	-	-	-
1910-11	1,097.4	-	-	-	-	-
1911-12						
1912-13	1,235.5	-	-	-	-	-
1913-14	1,317.7	-	-	-	-	-
1914-15	1,635.4	-	-	-	-	-
1915-16	1,694.2	-	-	-	-	-
1916-17	2,001.0	-	-	-	-	-
1917-18	2,366.9	-	-	-	-	-
1918-19	2,716.4	-	-	-	-	-
1919-20	3,078.6	-	-	-	-	-
1920-21	3,086.4	-	-	-	-	Unallo-
1921-22	a) 3,145.8	563.6	49.5	333.2	2,014.0	cated. 185.5
	b) 100.0%	19.5%	1.6%	11.5%	67.4%	-
1922-23	a) 3,789.1	657.7	58.6	366.1	2,444.8	262.1
	b) 100.0%	18.9%	1.6%	10.3%	67.7%	1.5
1923-24	a) 4,462.7	890.8	67.6	415.5	3,067.5	21.3
	b) 100.0%	20.0%	1.6%	9.3%	69.1%	-
1924-25	a) 5,092.1	1,037.6	78.3	445.3	3,503.7	27.2
	b) 100.0%	20.3%	1.6%	8.8%	69.3%	-
1925-26	a) 5,606.1	1,244.5	89.7	511.8	3,760.1	-
	b) 100.0%	22.2%	1.6%	9.1%	67.1%	-
1926-27	a) 5,868.1	1,443.4	96.4	561.2	3,767.1	-
	b) 100.0%	24.6%	1.6%	9.6%	64.2%	-
1927-28	a) 7,003.4	1,707.9	114.3	643.6	4,537.6	-
	b) 100.0%	24.4%	1.6%	9.2%	64.8%	-
1928-29	a) 7,800.1	2,035.7	127.8	710.0	4,926.6	-
	b) 100.0%	26.1%	1.6%	9.1%	63.2%	-
1929-30	a) 8,660.0	2,344.0	144.1	769.9	5,408.0	-
	b) 100.0%	27%	1.7%	8.9%	62.4	-
1930-31	a) 9,073.7	2,744.3	164.1	794.3	5,371.0	-
	b) 100.0%	30.2%	1.8%	8.8%	59.2%	-
1931-32	a) 9,501.2	3,071.6	182.8	811.3	5,435.5	-
	b) 100.0%	32.4%	1.9%	8.5%	57.2%	-
1932-33	a) 10,210.0	3,468.8	198.4	849.8	5,693.2	-
	b) 100.0%	34.0%	1.9%	8.3%	55.8%	-
1933-34	a) 11,467.3	3,916.1	218.6	941.0	6,391.6	-
	b) 100.0%	34.2%	1.9%	8.2%	55.7%	-
1934-35	a) 13,029.8	4,534.7	243.3	966.8	7,284.9	-
	b) 100.0%	34.8%	1.9%	7.4%	55.9%	-
1935-36	a) 15,049.4	5,504.7	270.1	1,023.9	8,250.0	-
	b) 100.0%	36.6%	1.8%	6.8%	54.8%	-
1936-37/						

APPENDIX XVI. (Continued)

Year	Totals	Lighting & Domestic Purposes	Public Lighting	Tract- ion	Power	Misc.
1936-37 a)	17,147.2	6,453.7	302.3	1,078.6	9,312.6	-
b)	100.0%	37.6%	1.8%	6.3%	54.3	-
1937-38 a)	19,262.8	7,348.5	341.1	1,151.0	10,422.2	-
b)	100.0%	31.1%	1.8%	6.0%	54.1%	-
1938-39 a)	20,828.0	8,438.4	379.2	1,253.6	10,756.8	-
b)	100.0%	40.51	1.82%	6.02%	51.65	-
1939-40 a)	22,601.4	8,803.3	142.0	1,246.3	12,409.8	-
b)	100.0%	38.95	0.63%	5.51%	54.91%	-
1940-41 a)	24,312.0	8,886.2	16.3	1,137.3	14,272.2	-
b)	100.0%	36.55%	0.07%	4.68	58.70%	-
1941-42 a)	27,944.4	9,976.9	20.2	1,145.9	16,801.4	-
b)	100.0%	35.70%	0.07%	4.10%	60.13%	-
1942-43 a)	30,049.2	9,446.8	20.7	1,147.7	19,434.0	-
b)	100.0%	31.44%	0.07%	3.82%	64.67	-
X 1943-44 a)	31,831.7	9,721.3	20.1	1,139.9	20,950.4	-
b)	100.0%	30.5%	0.1	3.6%	65.8%	-
X 1944-45 a)	32,473.1	11,223.3	34.6	1,171.4	20,043.8	-
b)	100.0%	34.6%	0.1%	3.6%	61.7%	-

a) Thousand millions of units

b) Percentage of total sales.

X Subject to revision.

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APPENDIX XVII.

NUMBER OF CONSUMERS CONNECTED TO SUPPLY SYSTEMS.

Year	Total	Public Authorities	Percentage of total.	Companies	Percentage of total.
			%		%
1927-28	2,599,617	1,899,129	73.1	700,488	26.9
1928-29	3,006,621	2,180,101	72.5	826,520	27.5
1929-30	3,471,607	2,517,897	72.4	958,710	27.6
1930-31	4,012,188	2,907,515	72.5	1,104,673	27.5
1931-32	4,646,486	3,355,062	72.2	1,291,424	27.8
1932-33	5,336,847	3,850,517	72.1	1,486,330	27.9
1933-34	6,109,595	4,367,653	71.5	1,741,972	28.5
1934-35	6,902,702	4,858,439	70.4	2,044,263	29.6
1935-36	7,704,468	5,347,745	69.4	2,356,723	30.6
1936-37	8,557,175	5,876,860	68.7	2,680,315	31.3
1937-38	9,358,010	6,344,927	67.8	3,013,083	32.2
1938-39	10,113,452	6,766,059	66.9	3,347,393	33.1
1939-40	10,558,938	7,019,713	66.5	3,539,225	33.5
1940-41	10,498,675	6,919,877	65.9	3,578,798	34.1
1941-42	10,574,265	6,951,778	65.7	3,622,487	34.3
1942-43	10,687,642	7,018,683	65.7	3,668,959	34.3

APPENDIX XVIII-A

CONSUMPTION PER HEAD OF POPULATION.

Year	Units	Year	Units
1920-21	82	1930-31	203
1921-22	73	1931-32	212
1922-23	88	1932-33	226
1923-24	102	1933-34	253
1924-25	117	1934-35	287
1925-26	128	1935-36	330
1926-27	133	1936-37	374
1927-28	158	1937-38	419
1928-29	176	Dec.31 1938	441
1929-30	195		

APPENDIX XVIII-B /

APPENDIX XVIII-B

CONSUMPTION PER CONSUMER.

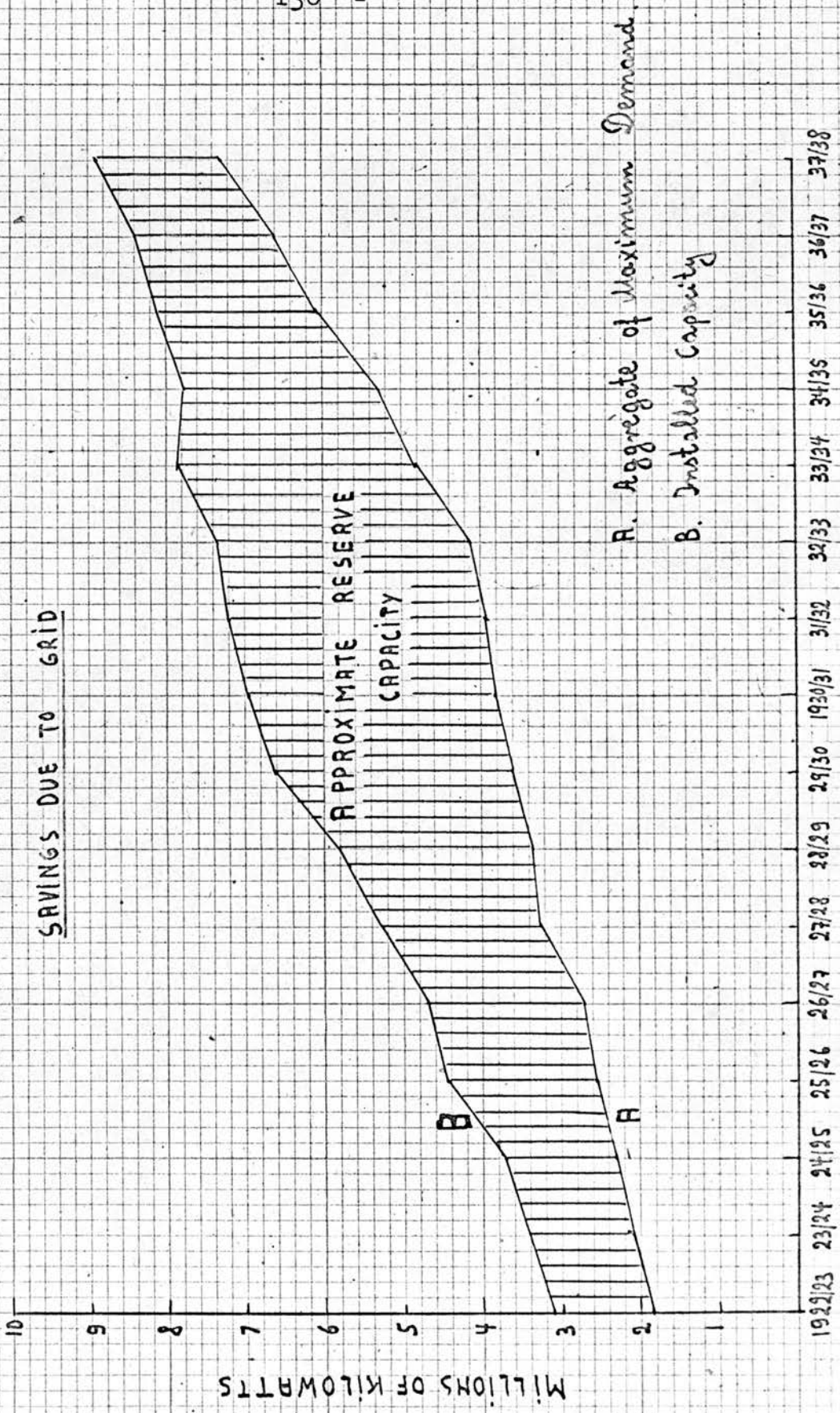
Year	Units	Year	Units
1932-33*	1,913	1936-37	2,003
1934-35	1,888	1937-38	2,058
1935-36	1,953		

APPENDIX XIX.

SAVINGS DUE TO GRID.

Approximate reserve capacity is equal to the difference between (A) Aggregate of Maximum Demand on Stations owned by Authorised Undertakers and (B) Total Installed Capacity of All Generating Stations owned by Authorised Undertakers. This aggregate of maximum load on generating stations does not take into account the maximum loads in respect of bulk supplies received.

Year	Aggregate of Maximum Demand	Installed Capacity	Approximate Reserve Capacity.
	K.W.	K.W.	K W
1922-23	1,829,557	3,093,679	1,264,122
1923-24	2,074,772	-	-
1924-25	2,298,182	3,723,514	1,425,332
1925-26	2,557,956	4,421,602	1,863,646
1926-27	2,700,594	4,682,069	1,981,475
1927-28	3,235,188	5,258,257	2,023,069
1928-29	3,369,166	5,801,770	2,432,604
1929-30	3,600,820	6,600,225	2,999,405
1930-31	3,801,342	6,975,805	3,144,463
1931-32	3,950,928	7,194,571	3,243,643
1932-33	4,156,410	7,365,869	3,209,459
1933-34	4,802,032	7,837,154	3,035,122
1934-35	5,297,462	7,785,206	2,487,744
1935-36	6,044,011	8,099,870	2,055,859
1936-37	6,609,132	8,398,241	1,789,109
1937-38	7,284,410	8,913,478	1,629,068



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