CHAPTER X.

ELECTRIC POWER GENERATION AND DISTRIBUTION.

This chapter is based on an article contributed by the Division of Industrial Development of the Commonwealth Ministry of National Development which was published in Official Year Book No. 39. The chapter is divided into three major parts. A.—Introduction, which deals briefly with the resources, generation and distribution, and future developments, of electric power in Australia; B.—The Snowy Mountains Hydro-electric Scheme; and C.—The origins, development, present situation and new projects of electrical systems in each Australian State and Territory (internal and external). A Statistical Summary is appended.

It should be noted that the information contained in the chapter relates to situations existing and projects contemplated in 1955 and that it may be considerably affected by changes in policy or plans, or by developments in the projects themselves.

A. INTRODUCTION.

1. **Distribution of Population and Location of Power Resources.**—The geographical pattern of electric power generation and distribution in Australia has been affected by two main influences—the distribution of population, with a resulting distribution of industry, and the location of fuel and water resources.

The Australian population between 1939 and 1955 increased by approximately 2,233,000 to reach a total of 9,201,000. The two principal centres of population and industry, the metropolitan areas of Sydney and Melbourne, make the greatest demands for electric power. Their growth has been associated with the development of large deposits of coal located relatively close to the source of demand. This, together with the fact that the major water resources are also located in the south-eastern portion of the Commonwealth, materially influences the distribution of industrial population and the location of major electric power stations.

By far the most important source of energy used in the production of electric power in Australia is coal. At 30th June, 1954 thermal power equipment represented 82 per cent., hydro 11 per cent. and internal combustion equipment 7 per cent. of the total installed generating capacity.

Most of Australia is poorly supplied with water, only 15.2 per cent. receiving an annual rainfall of 30 inches or over. This is confined largely to Tasmania and to the narrow coastal strip on the east coast. The possibility of establishing large hydro or steam stations in inland areas is therefore strictly limited by the lack of sufficient water for feed and condensing purposes.

The only region on the mainland of Australia where land is high enough to receive reliable winter snowfall, and from which reasonably constant water supplies throughout the year can therefore be expected, is the mountain chain which stretches from the high plateaux of south-eastern New South Wales through to the north-eastern highlands of Victoria. The hydro-electric potential of this area is considerable, and plans have been formulated to develop more than 3,000,000 kW within the next 25 years. The two major construction schemes in this area are the Snowy Mountains and Kiewa projects. Other hydro-electric potential does exist on the mainland on the rivers of the coastal areas of New South Wales and Queensland, but the amount there available is only a small proportion of the potential of the Alpine region. In Tasmania hydro-electric resources have been estimated at about 50 per cent. of the total Australian hydro-electric potential. Whereas on the mainland the chief source of energy is coal, water occupies this position in Tasmania.

2. **Electric Power Generation and Distribution.**—(i) *Ownership of Undertakings.* At the beginning of this century, Australia's electrical undertakings were carried on mainly by private enterprise, but some measure of governmental control was exercised through various electric light and power Acts. This legislation was designed to provide standards of safety, and to define the scope and obligations of the private organizations engaged in producing electric power for sale. A trend towards public ownership commenced during the 1914–18 War and became more pronounced after the 1939–45 War. By 1955, all major generating stations supplying the public were, in varying degrees, under the control of State statutory organizations, constituted with the object of unifying and co-ordinating the generation and distribution of electricity supplies within the various States. There are, however, still a large number of small private and municipal enterprises generating power for supply to country towns, but, where practicable, central authorities are extending supply to these places. In many areas, however, it has been and remains the practice for central authorities to sell power in bulk to local distributing organizations who undertake local reticulation.

In addition to the private, local government and statutory organizations who generate and/or distribute electricity for sale, there are numerous firms generating power for use in their own establishments, particularly those engaged in mining pursuits remote from the main centres of population. This chapter, however, is concerned mainly with the activities of central electric stations, and the power regularly produced for such internal consumption is, in any case, a relatively small proportion of total power produced.

(ii) *Power Production and Generating Capacity.* In the period between 1938–39 and 1953–54 production of electric power in Australia increased by about 190 per cent. from 4,688 to 13,587 million kilowatt hours.

Since the 1939–45 War, industry and commerce have expanded rapidly, many new houses have been built and the population has increased by approximately 20 per cent. These factors, together with extension of electricity supplies to rural areas and the increased use of domestic electric appliances, have all contributed to bring about a position where the greatly increased demand for power cannot be satisfied by the existing installed capacity of central generating stations.

At 30th June, 1954, installed generating capacity in Australia totalled approximately 3.4 million kW compared with 1.6 million kW in 1939, an increase of about 110 per cent. In 1938–39 each kW of installed capacity produced an average of 3,000 kWh per annum, compared with an average of 3,977 kWh in 1953–54. These figures are based on Commonwealth totals; figures for the States vary, depending on such factors as the distribution of demand, number of consumers, and type of equipment employed. In Tasmania, for example, average output per kW installed was 5,000 kWh in 1938–39 and 4,943 kWh in 1953–54 compared with 2,300 and 3,538 kWh respectively in South Australia.

3. **Future Developments.**—Each central authority has embarked upon constructional programmes to overcome the lag between supply and demand. However, industrial and commercial expansion has continued on a high level, and several projects have been commenced or planned in various parts of the Commonwealth for suburban and main railway line electrification. Other fields directly connected with the demand for power, such as house building, must also be taken into account.

An important factor to be considered in regard to future development is the increasing relative importance of the generation of electric power from water resources.

B. SNOWY MOUNTAINS HYDRO-ELECTRIC SCHEME.*

1. **Geography of Area.**—The Snowy country in south-eastern New South Wales is the only part of the continent in which any altitudes exceed 7,000 feet, and in which there is a substantial area over the altitude of 6,000 feet. The precipitation which results from the presence of this barrier on the line of the prevailing winter depressions of Antarctic origin amounts to as much as 120 inches a year in the vicinity of Mt. Kosciusko, the highest point in Australia. The drainage from the snowfields is practically all to three systems—those of the Murray and Murrumbidgee Rivers, which flow inland, and that of the Snowy, which flows southwards to Bass Strait.

* *See also* Chapter XI.—Water Conservation and Irrigation, §3, para. 4. For more detailed information *see* special article by the Commissioner, Snowy Mountains Hydro-electric Authority (Sir William Hudson), which appears in Chapter XXIX.—Miscellaneous.

2. Historical.—The Murray and Murrumbidgee have been subject to control and intensive development for irrigation for many years; the Snowy, however, flows through mountainous and practically uninhabited country until debouching onto the river flats of East Gippsland, not many miles above its mouth. It has never been controlled in any way, either for the production of power or for irrigation, and a great proportion of its waters flow to waste into the sea. As a result, attention has long been directed towards this river, which has the highest source of any in Australia and which conducts away a large proportion of the waters from the south-eastern New South Wales snowfields, and it has been consecutively considered as a means of supplementing the flow of the great inland rivers, a source of water supply to the rapidly growing metropolitan area of Sydney, a means for developing hydro-electric power and, again, as a source of increasing agricultural production in the rich Murray and Murrumbidgee valleys.

The 1939–45 War, and the plans for post-war reconstruction which then originated, led to a proposal by the State of New South Wales for diversion for irrigation and agricultural purposes of the waters of the Snowy to the Murrumbidgee River—a scheme in which little emphasis was placed on the generation of power. The Victorian Government proposed a counter-scheme, involving very much greater generation of power, and involving diversion, not to the Murrumbidgee, but to the Murray.

The Commonwealth Government, however, being seized with the national implications of these proposals, brought about a meeting in 1946 of Commonwealth and State representatives to discuss the general utilization of Snowy waters, and subsequently a Committee was set up to examine the whole question on the broadest possible basis. This Committee, in a report submitted in November, 1948, suggested consideration of a far greater scheme than any previously put forward. It involved not only the simple question of utilization of the waters of the Snowy, but a general consideration of the possible diversion of a number of rivers in the area, tributaries, not only of the Snowy, but of the Murray and Murrumbidgee. The recommendations of the Committee were generally agreed to by a conference of Ministers representing the Commonwealth and States of New South Wales and Victoria, and it was also agreed that the Committee should continue its investigations. A further report was submitted by the Committee in June, 1949, as a result of which the Commonwealth Parliament passed the Snowy Mountains Hydro-electric Power Act. In the next month the Snowy Mountains Hydro-electric Authority was constituted, and thus was inaugurated the greatest engineering scheme in Australian history.

3. Description of Scheme.—(i) *General.* The proposals at present being implemented fall into two groups, Tumut Development and Snowy-Murray Development—each having its associated plans for hydro-electric power production. The features described hereunder may be identified by reference to the map on page 397. It should be remembered that, as the final designs for practically every element of the scheme have not yet been completed, and in many cases will not be completed for many years, any figures which are now quoted in respect of those elements will undoubtedly be subject to modification in the future.

(ii) *Tumut Development.* The central feature of this part of the plan is diversion to, and regulation of, the waters of the Tumut River, a stream at present completely unregulated, but which contributes approximately half of the flow of the Murrumbidgee River at Gundagai below the existing main storage on the Murrumbidgee at Burrinjuck. To the Tumut will be diverted the waters of the Eucumbene, a major tributary of the Snowy, and the headwaters of the Tooma, a tributary of the Upper Murray. The headwaters of the Murrumbidgee itself will also be diverted to the Tumut, principally to secure desirable electric power.

A major dam is being constructed on the Eucumbene River at Adaminaby, creating a storage of at least 3.5 million acre feet, and from this, water will be conveyed by a 14-mile tunnel to Tumut Pond on the upper reaches of the Tumut River, where it will be joined by the waters from the Tooma, diverted by aqueducts and tunnels. From Tumut Pond another tunnel will convey the water to power station T.1 with an installed capacity of about 320,000 kW and a further tunnel to power station T.2 with a capacity of 280,000 kW thence discharging into a smaller storage at Lob's Hole.

As originally planned the waters of the Upper Murrumbidgee were to be brought to the Lob's Hole Reservoir from another major storage at Tantangara, holding 480,000 acre feet by tunnel to power station T.3 with an installed capacity of 150,000 kW, discharging into a pond on the Yarrangobilly River, a tributary of the Tumut, and from Yarrangobilly Pond by further tunnel to power station T.4 with an installed capacity of 150,000 kW which, in turn, would discharge into the Lob's Hole Reservoir. This part of the scheme has been temporarily abandoned and the waters to be stored at Tantangara will now be diverted to the Adaminaby storage through nine miles of tunnel.

Between the foot of the Lob's Hole storage and the top of the Blowering storage will be power stations T.5 and T.6. The total capacity of these stations will be 410,000 kW.

The Blowering storage with its capacity of about 860,000 acre feet, is an adjunct to the Snowy Mountains Hydro-electric Scheme and will be required for the regulation both of the Tumut waters and of the waters diverted into the Tumut. This regulation is essential if the waters impounded are to be fully utilized for irrigation purposes. At the foot of the Blowering Dam will be the last of the Tumut Power stations, T.7, with a capacity of some 60,000 kW, but this station will operate only when water is released for irrigation. The State of New South Wales will be responsible for the construction of the Blowering works.

The total extra new water which will reach the Murrumbidgee is expected to average 528,000 acre feet per annum and the total installed capacity of the various power stations is estimated at 1,310,000 kW (excluding T.7).

(iii) *Snowy-Murray Scheme.* The central feature of this part of the scheme is the diversion of the waters of the Upper Snowy itself from a major dam to be constructed at Jindabyne on that river, a little below its junction with the Eucumbene and the Crackenback Rivers. This reservoir will have a storage capacity of approximately 1,100,000 acre feet and from it a tunnel approximately 28 miles in length will run right through the Great Dividing Range finally discharging into Swampy Plains River, not far above its junction with the Murray proper.

Into this tunnel will be collected a considerable quantity of water from the very high altitude country of the Kosciusko area, and from a number of smaller tributaries of the Murray. The collection from the Kosciusko area commences at the Kosciusko Reservoir at an altitude of 5,725 feet, not many miles below the source of the Snowy. A tunnel will convey water from this reservoir to power station M.1.A. with an installed capacity of 60,000 kW and thence to a pond on the Snowy River, at its junction with the Guthega River.

From the Guthega Pond, a further tunnel and penstock lead to station M.1.B. with a capacity of 60,000 kW (ultimate capacity 90,000 kW), which discharges into a pond at the junction of the Munyang and Snowy Rivers. Construction of this part of the scheme has been completed. Munyang Pond will discharge into a tunnel leading to station M.2.L., with installed capacity of 60,000 kW. This station also receives the flow of a tributary of the Snowy River via station M.2.H. From station M.2.L. the water discharges into a reservoir at Island Bend on the main stream of the Snowy.

From the Island Bend reservoir, a vertical shaft, 1,100 feet deep, will lead to the main tunnel from Jindabyne reservoir previously referred to, passing on its way through power station M.3 with installed capacity of 265,000 kW. Into this main tunnel will also be collected waters from the Upper Murray tributary streams previously mentioned.

Of these, the most important is the Windy Creek-Geehi River series. A pond on Windy Creek, a small tributary of the Geehi, situated at an altitude of over 5,000 feet, will provide water through a tunnel to station M.4 with an installed capacity of 75,000 kW thence by aqueducts and tunnel to station M.5.H. with an installed capacity of 40,000 kW discharging into the M.5.L. Intake Pond on the Geehi River.

A vertical shaft will lead this water into the main tunnel, passing through station M.5.L with an installed capacity of 20,000 kW. The combined waters thus collected into the main tunnel will pass through station M.6 with an installed capacity of 540,000 kW and then discharge into a pond on Bogong Creek, another of the Upper Murray tributaries. At this point, the water is still at an altitude of nearly 2,000 feet, and the main tunnel will thence continue to station M.7 with a capacity of 540,000 kW.

From M.7 the total collected waters will flow into the Swampy Plains River at a point some seven miles, in a direct line, above its confluence with the Murray. It will be necessary, however, to provide on the Murray a further storage for the proper regulation of these waters for irrigation purposes.

The total water flowing to the Murray from these works will amount on the average to 722,000 acre feet per annum, but as 280,000 acre feet which now reaches the Murray from the Tooma will be, as indicated previously, diverted to the Tumut, the total extra water actually reaching the Murray will be, on the average 442,000 acre feet per annum : the total installed capacity of the power stations will be 1,700,000 kW.

An integral part of each development is the construction of hundreds of miles of aqueducts to collect and divert water from the many streams in the area into storages and tunnels.

4. **Utilization of Power.**—The total capacity of all stations in the scheme will be of the order of 3,000,000 kW, which is only slightly less than the present total installed capacity of all the generating stations in the Commonwealth.

If, however, the demand for power continues to increase as is expected, the major source of power must still be thermal stations. The operation of the whole scheme is dependent on the appropriate development and integration of these stations, as otherwise there would be a serious loss in ultimate economy ; all economic estimates therefore postulate that thermal capacity will be expanded so as to preserve an appropriate ratio.

It has been estimated with a reasonable degree of probability that the power available from the scheme will save coal to the order of five million tons annually.

The first call on the power generated under the Snowy Scheme will be by the Commonwealth Government for supply to the Australian Capital Territory of power which it needs in that area, particularly for certain projects with defence significance, and no indication can at present be given as to how great that call will be. It is not likely, however, to amount to more than a relatively small fraction of the total power available, and it has been agreed that the balance will be divided between the States of New South Wales and Victoria in a proportion of two-thirds to New South Wales and one-third to Victoria.

The first power station in the scheme, M.1.B., the Guthega Project, is now producing power. A 132,000 volt transmission line extends from the power station via Cooma to the Australian Capital Territory where it joins into the main New South Wales transmission network. The construction of the Eucumbene-Tumut diversion tunnel, Tumut Pond Dam and Power Station T.1 is in progress. Adaminaby Dam is in course of construction by the Public Works Department of New South Wales on behalf of the Authority. Power Station T.1 will enter the New South Wales network via a 330,000 volt transmission line early in 1959.

C. STATES AND TERRITORIES.

§ 1. New South Wales.

1. **General.**—In Official Year Book No. 39 an account is given in some detail of the origin and development of electricity generation and distribution in New South Wales, describing in particular the growth of the systems of the Sydney County Council, the Department of Railways, the Electric Light and Power Supply Corporation Ltd., the Southern Electricity Supply and the Clarence River County Council (now the Northern Rivers County Council). A description is also given of the legislation existing prior to, and that which constituted, the Electricity Authority of New South Wales and the Electricity Commission of New South Wales. At present, the three main Acts governing electricity supply in New South Wales are :—

(i) The Local Government Act 1919 which lays down the various rights and responsibilities of local government bodies in the establishment and operation of electricity trading undertakings.

(ii) The Electricity Development Act 1945-1948 which established the Electricity Authority of New South Wales as the body responsible for the co-ordination of electricity supply throughout the State.

(iii) The Electricity Commission Act 1950 which constituted the Electricity Commission of New South Wales as the major generating authority and not subject to the provisions of the Electricity Development Act.

2. **Organization.**—(i) *The Electricity Commission of New South Wales.*—The Commission, which was constituted under the Electricity Commission Act 1950, consists of five members of whom one is a full-time Chairman. In its administration the Commission is directly responsible to the Minister for Local Government.

When the Commission was established, 93 per cent. of the State's power requirements were generated by four bodies—the Sydney County Council, the Department of Railways, Southern Electricity Supply (a division of the Department of Public Works) and the privately-owned Electric Light and Power Supply Corporation Ltd. The Electricity Commission Act 1950 and the Electricity Commission (Balmain Electric Light Company Purchase) Act 1950 provided for the acquisition of the power stations and main transmission lines of those bodies. The transfer of the power stations and transmission lines of the Sydney County Council, Southern Electricity Supply and the Department of Railways has now been effected. The date of transfer of the undertaking owned by the Electric Light and Power Supply Corporation Ltd. is dependent upon the determination of the valuation of the undertaking by the Land and Valuation Court.

The main function of the Commission is the generation and transmission of electricity which it sells in bulk to distribution authorities (mainly local government bodies) throughout a large part of the State, to the government railways and tramways and to certain large industrial consumers. As the major generating authority, it is also responsible for the development of new power sources. An important exception is the hydro-electric resources of the Snowy Mountains region which are being developed by the Snowy Mountains Hydro-electric Authority, a Commonwealth Government body.

(ii) *Other Electricity Supply Authorities.* The retail sale of electricity to the public is, in general, carried out by separate electricity supply authorities—municipal and shire councils, electricity county councils (consisting of a grouping of shire and/or municipal councils) or private franchise holders. At 1st July, 1955 there were 123 of these supply authorities throughout the State of which 37 also generated part or the whole of their power requirements. A few authorities—the most notable being Tamworth City Council—also supply in bulk to other councils. The great majority of country power stations are, however, small oil engine plants which are becoming increasingly costly to operate. Consequently, they are gradually being closed down as the main transmission network is extended further afield.

Over the past few years there has been a distinct trend towards the consolidation of supply areas, many of which have been regarded as being too weak individually to form satisfactory areas for distribution. Generally these consolidations have taken the form of a county district consisting of a number of neighbouring shire and municipal areas grouped for electricity supply purposes only and administered by a county council of representatives elected by the constituent shire and municipal councils.

It is interesting to note that of the 238 shires and municipalities in New South Wales, 135 are included in one or other of the 26 electricity county districts. Twenty-one (21) of these county districts have been constituted since 1945. The largest of the county councils is the Sydney County Council which at 30th June, 1954 was supplying 314,904 consumers in the Sydney Metropolitan Area. Unlike the other county councils, which are constituted under the provisions of the Local Government Act 1919, the Sydney County Council was specially constituted under the Gas and Electricity Act 1935.

(iii) *The Electricity Authority of New South Wales.*—The Electricity Authority was constituted under the Electricity Development Act 1945 for the stated purpose of promoting and regulating the co-ordination, development, expansion, extension and improvement of electricity supply throughout the State. The Authority, which is a regulatory body only, consists of seven members of whom one is a full time Chairman. Like the Commission, it is responsible to the Minister for Local Government.

The main functions of the Authority are as follows :—

(*a*) *Distribution.* Under the Act the approval of the Authority is required, *inter alia*, for the establishment or acquisition of an electricity trading undertaking by a local government council ; for the granting or renewing by such a council of electricity franchise agreements or corresponding agreements with other councils ; and for the giving or taking of bulk supplies of electricity. It also has power to formulate proposals for the establishment of county councils.

In exercising these powers the Authority is mainly concerned to see that distributing authorities are sufficiently strong to provide an economical, efficient and satisfactory service. Its most important activities in this regard are in investigating supply areas and in making recommendations to the Minister for the consolidation of such areas into county districts. Many of the new county districts referred to earlier have been formed largely as a result of the Authority's advice.

(*b*) *Rural Electrification.* The Authority administers the rural electricity subsidy scheme under which rural electrification throughout the State is progressing very rapidly (*see* below).

(*c*) *Safety.* The Electricity Development Act 1945–1948 contains provisions for the making of regulations relating to most aspects of safety and these powers are being used more and more extensively. Safety regulations now in force cover such matters as inspection of consumer's installations, licensing of electricians and electrical contractors, approval of electrical appliances, safety of linesmen and overhead line construction.

(*d*) *Generation and Transmission.* The approval of the Authority is required for the establishment or extension of power stations and main transmission lines (with the exception of those of the Electricity Commission). The Authority may, for example, refuse approval for the establishment of a new power station if it is more economical and in the general interest for the supply authority concerned to purchase in bulk from another body.

3. **Generation and Transmission.**—(i) *General.* Except in the Snowy Mountains district, and in one or two other areas, New South Wales is lacking in major water power potential and for the generation of electricity, the State is, therefore, mainly dependent on steam power stations. During the year ended 30th June, 1954 coal-fired stations generated 94 per cent. of the State's energy requirements, hydro-electric stations 4 per cent. and internal combustion plants 2 per cent.

The proportion of power generated in hydro-electric stations will increase considerably in the future with the development of the Snowy Mountains Scheme by the Commonwealth Government. The possibility of developing the hydro-electric potential of the Clarence River and other rivers is also being investigated. Nevertheless, coal-fired steam power stations will continue to supply the greater part of requirements for the foreseeable future.

(ii) *Major Generating Stations.* In New South Wales the generation of electricity has followed the general world trend towards large centralized power stations supplying large areas through inter-connected transmission networks. The greater part of the coal-fired generating plant is now concentrated within the bounds of the major coalfields, where the big industrial centres and most of the population are also located.

As at 1st July, 1954, the major power stations within the main inter-connected system and their installed capacities were as follows :—*Steam*—Bunnerong "A" and "B" (Sydney), 370,000 kW ; Pyrmont "A" and "B" (Sydney), 182,000 kW ; White Bay (Sydney), 118,000 kW ; Ultimo (Sydney), 80,000 kW ; Balmain (Sydney, 70,625 kW ; Port Kembla, 69,000 kW ; Zarra-street (Newcastle), 67,000 kW ; Maitland, 25,000 kW ; Penrith, 25,000 kW ; Lithgow, 22,000 kW. *Hydro*—Burrinjuck (near Yass), 20,000 kW. There were also various other steam, hydro and internal combustion stations aggregating 69,100 kW. The total installed capacity of the main inter-connected system was 1,117,725 kW.

It will be seen therefore that the greater part of the State's generating plant is concentrated within a hundred mile radius of Sydney—that is, at Sydney itself (five stations), Port Kembla, Newcastle, Maitland, Penrith and Lithgow. The largest single station outside this area is located at Tamworth.

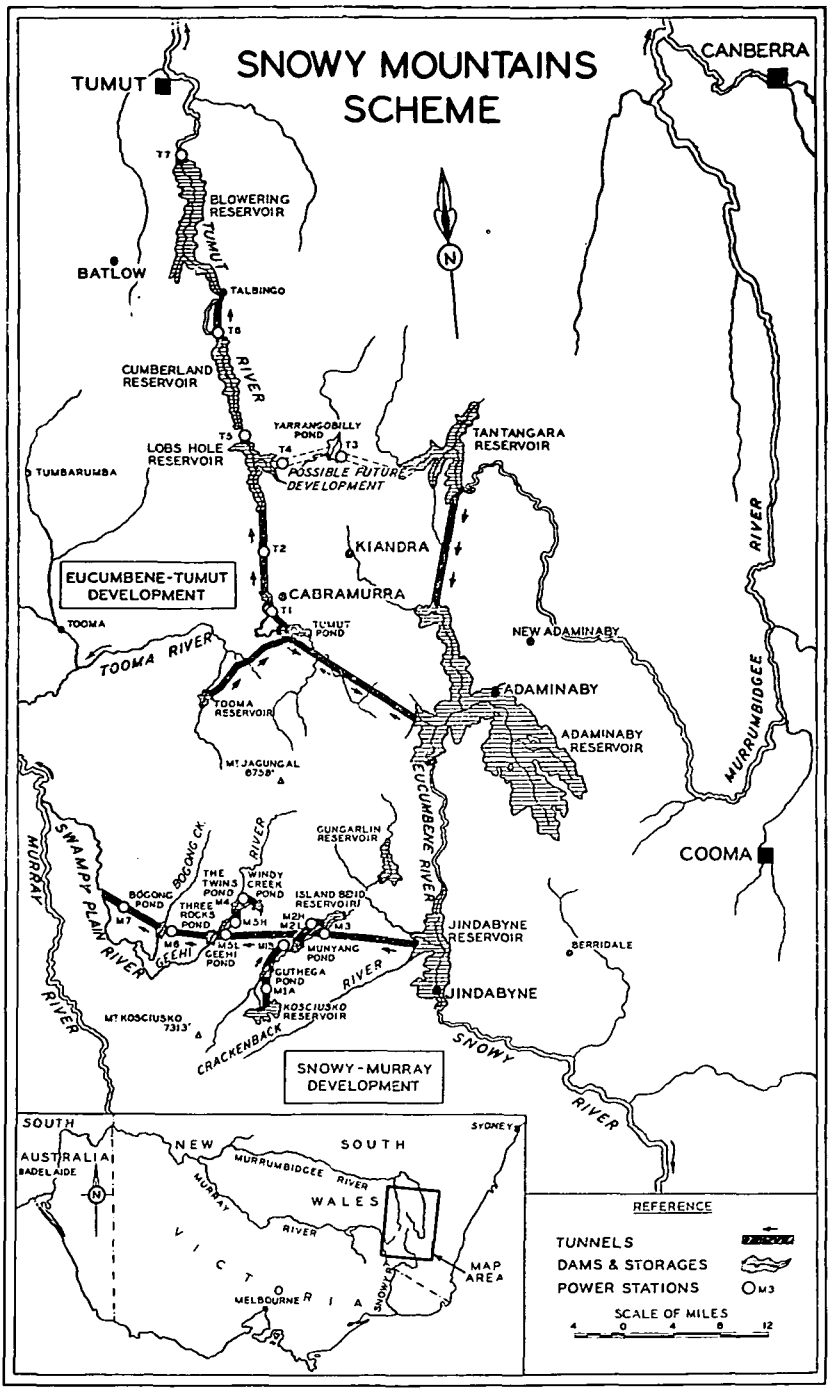
(iii) *Interconnected Network.* Over 90 per cent. of electricity consumers in New South Wales are now supplied through the main inter-connected systems. In this network, transmission lines operating mainly at 132,000, 66,000 or 33,000 volts interconnect the various power stations and distribute power to load centres throughout most of the south-eastern portion of the State and the north coast region. At 30th June, 1954, 132,000 volt transmission lines were in service between Sydney and Newcastle; Sydney and Orange; Sydney and Port Kembla; and Port Kembla and Burrinjuck. The total installed capacity of the interconnected systems, which includes an aggregated capacity of 46,226 kW for various stations, including the Northern Rivers County District, linked with the main system, was 1,163,951 kW (as at 1st July, 1954).

(iv) *Separate Systems and Total State Installed Capacity.* There are a number of separate systems and isolated plants which have not yet been interconnected with the main network and which at 1st July, 1954, had an aggregate installed capacity of 66,405 kW. The most notable are the Tamworth and Muswellbrook Coal Company systems and that of the Bega Valley County Council on the far south coast. The Tamworth system (22,000 kW) supplies power to an extensive district in the north-east of the State through 66,000 volt and 33,000 volt transmission lines. The Bega Valley system is shortly to be interconnected by means of a 66 kV transmission line from Cooma to the Bega Valley County Council's power station at Brown Mountain. Some councils along the Victorian border receive bulk supplies from Victorian authorities.

The aggregate installed capacity for the whole of the New South Wales systems and isolated plants was 1,230,356 kW (as at 1st July, 1954).

(v) *Future Development.* The following major power stations in Sydney are at present being extended by the installation of additional generating plant:—Pyrmont "B", 50,000 kW; Balmain, 43,000 kW; White Bay, 50,000 kW. Construction is also proceeding on new major power stations on the coalfields at Lake Macquarie, near Newcastle (330,000 kW), Tallawarra, near Port Kembla (120,000 kW), and Wallerawang, near Lithgow (120,000 kW). These stations will be linked with Sydney by 132,000 volt transmission lines, and extensive additions to the 132,000 volt system to supply increasing loads at various centres are also planned. A 132,000 volt system will be established around the outer Sydney Metropolitan Area for the supply of load centres at present fed through 33,000 volt circuits direct from the inner Sydney power stations. Future plans provide for the construction of a hydro-electric power station on the Hume Reservoir of 25,000 kW capacity, connected to the New South Wales network through a 132,000 volt transmission line between Hume and Wagga Wagga. Plans provide for the construction of a hydro-electric power station on the Warragamba Dam of 50,000 kW capacity to be connected to the 132 kV Sydney metropolitan network.

In addition to the power stations mentioned above which are under construction or planned for the system controlled by the Electricity Commission, a number of local government bodies have plans in hand for the development of independent power stations. Of these the more important are as follows:—The Northern Rivers County Council is constructing a steam power station at Koolkhan (near Grafton). Plans provide for an installed capacity of 25,000 kW. The first two units, totalling 10,000 kW, were in operation at 30th June, 1954. The Tamworth City Council is proceeding with the construction of a new steam power station at Gunnedah for the augmentation of supply to the separate system now supplied from Tamworth power station. The initial installation will be 30,000 kW and the ultimate now envisaged will be 75,000 kW. The North-West County Council has made plans for the establishment of a 10,000 kW steam power station on the Ashford coal-field. The New England County Council and the Bega Valley County Council are constructing small hydro-electric power stations on the Oakey River (near Armidale), and Georges Creek (near Bega) respectively.


SNOWY MOUNTAINS SCHEME
TUMUT
CANBERRA
BLOWERING RESERVOIR
TUMUT RIVER
BATLOW
TALBINGO
CUMBERLAND RESERVOIR
YARRANGOBILLY POND
TANTANGARA RESERVOIR
LOBS HOLE RESERVOIR
TUMBARUMBA
POSSIBLE FUTURE DEVELOPMENT
KIANDRA
EUCUMBENE-TUMUT DEVELOPMENT
CABRAMURRA
TOOMA
TUMUT POND
NEW ADAMINABY
TOOMA RIVER
ADAMINABY
TOOMA RESERVOIR
ADAMINABY RESERVOIR
MURRUMBIDGEE RIVER
MT JAGUNGAL 6758'
EUCUMBENE RIVER
GUNGARLIN RESERVOIR
COOMA
MURRAY
SWAMPY PLAIN RIVER
BOGONG CK
THE TWINS POND
WINDY CREEK POND
ISLAND BEND RESERVOIR
BOGONG POND
THREE ROCKS POND
GEEHI
GEEHI POND
MUNYANG POND
JINDABYNE RESERVOIR
BERRIDALE
GUTHEGA POND
JINDABYNE
MT KOSCIUSKO 7313'
KOSCIUSKO RESERVOIR
CRACKENBACK
SNOWY RIVER
SNOWY - MURRAY DEVELOPMENT
SOUTH AUSTRALIA
ADELAIDE
NEW SOUTH WALES
SYDNEY
MURRUMBIDGEE RIVER
MURRAY RIVER
VICTORIA
MELBOURNE
MAP AREA
REFERENCE
TUNNELS
DAMS & STORAGES
POWER STATIONS
SCALE OF MILES
4 0 4 8 12

(vi) *Hydro-electricity.* The greater part of the hydro-electric potential of New South Wales is concentrated in the Snowy Mountains Area (*see* Snowy Mountains Hydro-Electric Scheme, p. 390–393). Apart from this area there is, at present, only one hydro-electric station in New South Wales with an installed capacity of more than 10,000 kW. This is the 20,000 kW station at Burrinjuck Dam on the Murrumbidgee River (1927) the largest of the other installations being the 7,000 kW station at Wyangala Dam on the Lachlan River (1947). The output of both these plants is dependent on the release of waters for irrigation purposes.

Similar schemes, for which the water release will be dependent upon other than electrical requirements, are being constructed at the Hume Irrigation Dam on the Murray River and at Warragamba Dam which is being constructed to provide water supply for the Sydney Metropolitan Area. At Hume, two 25,000 kW units are to be installed and the output of the station will be shared equally between New South Wales and Victoria. At Warragamba, a 50,000 kW unit is to be installed.

Of the remaining hydro installations, the largest is that of the Northern Rivers County Council on the Nymboida River, a tributary of the Clarence. This station, which now has a capacity of 4,600 kW, commenced operation in 1924. The County Council also has two 100 kW hydro units in operation at Dorrigo on Bielsdown Creek, a tributary of the Nymboida River. The investigation of a number of much larger schemes for the further development of the Nymboida River is at present in progress.

The Clarence Gorge Scheme is a proposal for combined flood mitigation and hydro-electric generation on the Clarence River about 40 miles from Grafton and 240 miles from Newcastle. In February, 1955, the Clarence Advisory Committee which was set up by the New South Wales Government to report on the scheme recommended, because of economic reasons, against the construction of a dam at the Clarence Gorge either solely for flood mitigation or for the dual purpose of hydro-electric power generation and flood mitigation. The scheme is, however, still being considered, together with other alternatives, as a source of hydro-electric power.

The New England County Council has under construction a 2,500 kW hydro scheme near Armidale on the Oakey River, a tributary of the Macleay River.

The Mullumbimby Municipal Council has in operation two 150 kW hydro units, which were installed in 1925, on Wilson's Creek, a tributary of the Richmond River.

The Bega Valley County Council operates a hydro-electric scheme at Brown Mountain, utilizing the headwaters of the Bemboka River. This installation, which now has a capacity of 1,900 kW, was opened in 1944. Work is in progress on extensions to provide for two further 1,000 kW units.

There are also possibilities of relatively large scale developments on the Shoalhaven and Macleay Rivers. Preliminary investigations have been made by the New South Wales Government but no concrete proposals have as yet been adopted.

4. **Rural Electrification.**—When the Electricity Authority of New South Wales was constituted in 1946, one of its first tasks was the devising of a scheme for subsidizing the cost of rural electrification. At that time only 16,000 New South Wales farms were being served with electricity—less than one-third of those within reasonable reach of public electricity supply systems. In August, 1946 a subsidy scheme was approved by the Government and put into immediate operation. Under this scheme local electricity supplies receive subsidies from the Electricity Authority towards the cost of new rural lines. The amount of subsidy is based on the estimated cost of a proposed extension and the number of consumers able to be served by the new lines. In order that the funds available for subsidy purposes might be used to the best possible advantage, the scheme is designed to encourage local electricity supply authorities to construct the more economic extensions first. This has been achieved by fixing a limit to the cost

eligible for subsidy. Originally this limit was £250 per consumer when averaged over the cost of the whole extension but the limit was raised to £400 in December, 1953. Some subsidy is paid on higher cost extensions but the excess over an average of £400 is not subsidized.

Between August, 1946 and June, 1955 about 17,500 miles of new distribution lines in rural areas were erected at a cost of over £11,250,000. These lines served 25,000 farms and 18,750 other rural consumers. At 30th June, 1955, the Electricity Authority was committed to the payment of £4,285,354 in subsidies of which over £1,804,327 had actually been paid. At that time the percentage of farms connected had been raised from 22 per cent. (in 1946) to 58 per cent.

Surveys have indicated that with the aid of subsidies, it should be possible to supply, from the public mains, about 90 per cent. of the 72,000 farms in New South Wales. At the present rate of progress, which shows no slackening, this target should be reached within the next ten years.

§ 2. Victoria.

1. **General.**—In Official Year Book No. 39 a detailed description is given of the development of electricity generation in the cities of Melbourne, Geelong, Bendigo and Ballaarat up to the time of transfer of control of electricity undertakings in these cities to the State Electricity Commission of Victoria. An account is also given of the events culminating in the establishment of the Commission in 1919, and of the early developments in the Commission's undertakings.

2. **The State Electricity Commission of Victoria.**—(i) *Functions of Commission.* Under the terms of the State Electricity Commission Act, three Commissioners were appointed, who took up duty on 4th March, 1919. Subsequently, in 1921, a full time Chairman was appointed, in addition to the three part-time Commissioners. Their powers authorized them to erect and operate electrical undertakings; to supply electricity in bulk to any corporation; to supply electricity to any person outside any area in which there was an existing undertaking; to carry on any business associated with an electrical undertaking; to make regulations as to precautions to be adopted in the use of electricity and arrange for the licensing of wiremen (powers which were subsequently extended to include the registration of electrical contractors, and the testing and approval of electrical appliances); and to establish and operate State coal winning projects.

In addition to these powers, the Commissioners were to enquire into and report to the Government as to the steps which should be taken to co-ordinate and concentrate all electrical undertakings in Victoria; to secure the efficient inter-connexion of such undertakings by adopting the necessary standards of plant, voltages, etc.; to encourage and promote the use of electricity for industrial purposes; to report to the Government on the prospects of establishing new industries in Victoria requiring large quantities of electrical energy; and to carry out investigations of coal deposits or hydro-potential that could be used for the generation of electrical energy.

(ii) *Newport and Yallourn Power Stations.* Action was taken to investigate the practicability of utilizing the State's brown coal and water power resources for the production of electricity. In a Report dated 26th November, 1919, the Commissioners concluded, *inter alia*, that the brown coal field located at what is now known as Yallourn in the neighbourhood of Morwell should be developed and a power house established thereon by 1923, with an initial capacity of 50,000 kW. As to water power, they were of the opinion that consideration of hydro-electric power schemes should be deferred until further investigations then being undertaken were completed. It was further concluded that in order to obtain maximum economy, the proposed station in the neighbourhood of Morwell and any other power house to be erected in connexion with the

proposed State electricity supply scheme should be interconnected with the Railways Department power station at Newport and operated under the control of a single authority.

The actual transfer of the Railways Department station at Newport did not take place until 1951, and in the meantime two new stations had been constructed by the Commission and were in operation. By the latter months of 1954, the total installed generator capacity of the Newport power station, consisting of Newport " A " (originally under the control of the Railways Department), Newport " B ", and Newport " C ", was 311,000 kW, which, added to Spencer Street (Melbourne City Council—89,000 kW) and Richmond (53,000 kW), made a total of 453,000 kW installed in the Melbourne metropolitan area.

To implement one of the main reasons for the establishment of the State Electricity Commission, namely, development of Victoria's brown coal resources, particularly for production of electrical energy, construction commenced in 1920 of the Yallourn power station, designed for an initial capacity of 50,000 kW, but increased within a few years by the addition of two further machines. On 24th June, 1924, power was first transmitted on a commercial basis from Yallourn to Melbourne.

The site chosen for the power station on the bank of the Latrobe River, about 6 miles from Morwell, had numerous advantages. Adequate water was available for the station's requirements, land nearby provided a good town site, while, most important of all considerations, an initial area of one square mile, adjacent to the station, contained proved reserves of brown coal totalling about 150 million tons with averages of 174 feet thickness and 33 feet overburden. By the use of mechanized methods for open-cut coal winning, the coal could be extracted and delivered to the power station at a cost of only a few shillings a ton. Development of these resources was designed to ensure to a large degree the State's independence in fuel requirements for the production of electrical energy.

Subsequent investigation in the Latrobe Valley has revealed what are believed to be the largest continuous deposits of brown coal in the world.

Proven coal suitable for open cut working totals 20,000 million tons. The Yallourn-Morwell brown coal-field, covering an area of 40 square miles and estimated to contain 10,000 million tons of brown coal capable of being won by open cut methods, forms an important part of the Latrobe Valley coal belt.

As the Yallourn station was intended to carry the base load of the system, steps were taken to augment its capacity to keep pace with the anticipated and continually increasing demand for electric power, and by the middle of 1955 Yallourn " A ", " B " and " C " had a total capacity of 275,000 kW. In addition, an average of 8,000 kW of by-product electricity is fed into the system from the Yallourn briquette factory.

(iii) *Hydro-electric Development.* Development of the State's hydro-electric potential, the necessity of which was foreseen in the Commissioners' initial Report of November, 1919, but deferred pending further investigations, commenced in 1922. The project selected was dependent on the waters of the Goulburn River and adjacent mountain streams in the Cerberean Range, about 65 miles north of Melbourne. These two sources of water power provided a distinct advantage in that one was mainly summer flow and the other winter flow, thus permitting the continuous generation of power. Five small stations, namely, Sugarloaf (Eildon Dam, 15,000 kW), Rubicon (9,100 kW), Lower Rubicon (2,700 kW), Royston (840 kW), and Rubicon Falls (275 kW), were installed totalling approximately 27,900 kW. The complete project was in service by 1929. In conjunction with the new Big Eildon Dam, the Sugarloaf station has since been replaced by one designed for an ultimate total installed capacity of 135,000 kW. Two new generators, totalling 120,000 kW capacity are in process of being installed, while the two 6,750 kW machines in the former Sugarloaf power station have been re-built and re-installed at the revised rating of 7,500 kW each. The new power station, already in

partial operation, will operate on the increased flow of water from the new Big Eildon Reservoir constructed by the State Rivers and Water Supply Commission of Victoria. The power station is scheduled for completion early in 1957.

Located within a few miles of Eildon Dam is a group of four hydro-electric power stations operating on the natural flow of the Rubicon and Royston Rivers. With a total installed capacity of 12,900 kW, the group has an average annual production of 75 million kWh. The Rubicon and Royston stations form the oldest existing hydro development in Victoria. The stations came into service in 1928 and for 25 years operated in conjunction with the former Sugarloaf power station (at the old Eildon Dam). Maximum production of the group is in winter and spring when water flow is at its greatest. The Rubicon and Royston stations will continue to offset the winter-time reduction in output at the new Eildon power station, which is designed to operate primarily on the summer-time release of water for irrigation purposes.

In a Report to Parliament during 1920, the Commissioners included details of a large-scale project for harnessing the Kiewa River in the valleys and tablelands of the Bogong High Plains area of the Main Dividing Range, located approximately 150 miles north-east of Melbourne. At that time the Commission was not prepared to recommend adoption of the plan, but, on the other hand, suggested further consideration of the smaller Sugarloaf and Rubicon scheme. However, during the following 17 years, hydrological investigations were carried out in the Kiewa area which greatly facilitated the subsequent planning of a major hydro-electric project. On 12th June, 1937, a further Report was submitted to Parliament recommending adoption of a plan to provide an ultimate capacity of 117,000 kW from the Kiewa project. The plan, which included construction of four power stations with an initial installation comprising 20,000 kW to be in service by 1942, was approved and its provisions embodied in the State Electricity Commission (Extension of Undertaking) Act 1937. Construction commenced during 1938, but the war delayed progress and it was not until September, 1944 that the first station came into partial operation with 13,000 kW—a second unit of 13,000 kW was brought into service in April, 1945 and is contributing annually an average of 57 million kWh of electricity to the State system.

The 1937 Kiewa project, prior to its submission to the Government, was critically reviewed by a group of oversea consulting engineers, and their report confirmed that an enlarged scheme might be possible after further detailed investigation of the water power resources of the terrain adjacent to the Bogong High Plains. On 21st November, 1947, the Commission submitted proposals for expanding the original Kiewa scheme of 117,000 kW to one of 289,000 kW. Approval for the amended scheme was contained in the State Electricity Commission Act 1948. In accordance with this revised project, a second power station of 62,000 kW capacity began operation in 1955 and is due for completion early in 1956. On completion early in 1957 of a new supplementary diversion tunnel, combined production of the two power stations at Kiewa will average more than 200 million kWh annually. Work is in progress in connexion with a third power station of 96,000 kW, which is due to start operating in 1958; and work, suspended for three years on account of financial conditions, has been resumed on one of the main storage reservoirs at Rocky Valley on the Bogong High Plains.

Continued investigation of the area has resulted in further modification of the scheme to provide for an ultimate capacity of 333,000 kW, and an average annual production exceeding 800 million kWh.

Irrigation water will also be utilized at the Hume Reservoir where a new power station being erected for the Electricity Commission of New South Wales will serve both Victoria and New South Wales. Initially, the installed capacity of the power station will be 50,000 kW. Production of electricity, averaging about 200 million kWh a year, will be shared equally by the two States, each contributing its quota of the

annual cost. Victoria's share of the electricity generated will be fed into the State system. The power station is due to begin operating in 1957. Victoria will also buy its allotted share of electricity from the Snowy Mountains Hydro-electric Authority. Power will be fed into the Victorian system by a high voltage transmission line from the Snowy undertaking, connecting initially to the Victorian network near Kiewa. Transmission from the Snowy Mountains to the Victorian system is due to start in 1959.

(iv) *State Supply System.* (*a*) *Growth and Extent.* Since its inception, the Commission has gradually extended the State's system of supply so that it now serves two-thirds of the populated area of the State, in which nine-tenths of the population reside, and certain towns in New South Wales, including Albury. The following comparative table indicates the growth of the Commission's State system between 1929 and 1954

VICTORIA : STATE ELECTRICITY COMMISSION SYSTEM.(*a*)

Particulars	Year ended 30th June—			
	1929.	1939.	1949.	1954.
Installed Capacity .. .. kW	148,000	(*b*)281,400	480,300	(*c*) 811,500
Units Generated .. million kWh	422	898	2,148	(*c*) 3,502
No. of consumers (approx.) (including bulk supply areas)	230,000	368,000	500,000	657,000
Country and Provincial Centres Served	141	419	699	973
Farms Served	700	4,985	14,419	27,082

(*a*) About 99 per cent. of electricity produced in Victoria is now generated by the State Electricity Commission, which also supplies 96 per cent. of consumers. Statistics for 1949 and 1954 include 1,800 kW and 20,000 kW, respectively for regional power stations not at present connected with the State system. (*b*) Includes Geelong power station (acquired 1st September, 1930) and Ballarat power station (acquired 1st July, 1934, but not in 1939 connected with the rest of the State system); excludes Spencer-street power station, which was not connected with the State system until 1st January, 1941. (*c*) Includes 25 cycle generation at Newport Power Station.

During 1953-54 electricity was reticulated to the various classes of consumers in the following proportions—domestic, 35 per cent.; commercial, 14 per cent.; industrial, 40 per cent.; public lighting, 1 per cent.; and traction (including railways), 10 per cent.

To 30th June, 1954 the Commission had acquired 85 country undertakings in addition to those acquired in the metropolitan area and in provincial cities. It carries out retail distribution throughout its area of supply, except for part of the metropolitan area where eleven municipal undertakings, operating under Orders-in-Council granted before the foundation of the Commission, purchase their electricity in bulk from the Commission. Bulk supply is given to the following New South Wales border municipalities and shires: Albury, Berrigan, Coreen, Corowa, Moama and Wentworth, and to a number of irrigation settlements bordering the River Murray. There were, at 30th June, 1954, 50 independent undertakings in various country towns in Victoria generating and distributing their own supplies. Operations of independent undertakings are governed by the Electric Light and Power Act 1928, which the Commission administers.

(*b*) *Composition and Control of Inter-connected Generating System.* Included in the inter-connected State generating system there were at 30th June, 1954 fifteen steam-electric, hydro-electric and diesel-electric power stations located at different centres in the State, and all comprised in one State-wide system. The distribution system comprised approximately 19,200 miles of high and low voltage power lines, nine terminal

receiving stations and 9,900 distribution sub-stations. The Commission's inter-connected generating system comprises three principal groups of power stations, namely :—

Steam stations.

Yallourn—burning raw brown coal; Metropolitan and provincial stations—burning mainly briquettes and brown coal. (Supplementary fuels used in metropolitan power stations comprise oil fuel, black coal and coke).

Hydro stations.

Kiewa; Eildon (commenced August, 1954); Rubicon-Royston.

Diesel stations.

Shepparton; Warrnambool.

In meeting the total demand on the system which, of course, fluctuates throughout the day and from month to month throughout the year, each group of stations is assigned a predetermined function dependent upon the availability of power from each group and the overall economics of generation. The various stations are utilized in a combination that will most economically meet the system load at a given time. For a description of the arrangement of the system thus involved *see* Official Year Book No. 39, p. 1170.

(c) *Organization.* In the Commission's organization, the functions of generating and distributing electrical energy are under the control of two separate departments—the Production Department in charge of power stations, brown coal winning, briquette manufacture, terminal stations and main substations, and the Electricity Supply Department, responsible for distribution to consumers. Energy throughout the inter-connected system is delivered by the Production Department to the Electricity Supply Department from the main transmission network, and not specifically from local power stations, since all power stations in the interconnected system, wherever they are situated feed into a common "pool". The territory covered by the Electricity Supply Department is divided into nine areas, each constituting a supply branch. Isolated areas, not at present included in the interconnected system—namely, Mildura and Wimmera (Horsham undertaking acquired in June, 1955)—operate as sub-branches of the North Western Region. The Metropolitan Branch supplies Melbourne and suburbs, with the exception of certain areas supplied by City Councils reticulating Commission electricity. Energy is supplied by the Production Department to the Metropolitan Branch, and those metropolitan municipal supply authorities which purchase electricity in bulk, at metropolitan terminal stations and a number of main transmission sub-stations. Supply to the Eastern Metropolitan Branch (which has its headquarters at Dandenong) is on similar lines.

Headquarters of the Electricity Supply Department's branches outside the metropolis are located at Dandenong (Eastern Metropolitan), Traralgon (Gippsland), Geelong, Colac (South Western), Ballaarat, Castlemaine (Midland), Benalla (North Eastern), and Bendigo, which is also the headquarters of the North Western Region.

Supply to the Gippsland Branch is obtained from the system via Yallourn power station at 22,000 volts and by 66,000 volt transmission lines extending within the branch to Maffra in the east, Leongatha in southern Gippsland and Warragul in western Gippsland.

Supply to the Geelong Branch is obtained from the two Geelong power stations and Geelong terminal station, the three being inter-connected with the rest of the system by a 66,000 volt transmission line to Newport power station.

Supply to the South Western Branch is obtained through Geelong terminal station by a 66,000 volt transmission line extending through Colac to Warrnambool, and also from Warrnambool power station and Hamilton power station which was interconnected with the rest of the system in November, 1954.

Ballaarat Branch obtains its supply through the two Ballaarat power stations and Ballaarat terminal station which are inter-connected with the rest of the system by a 66,000-volt transmission line from Sunshine terminal station in the Melbourne Metropolitan area.

Both the Midland and Bendigo Branches obtain their supply through the 66,000-volt power line from Thomastown terminal station, one of the major metropolitan terminal stations in the system.

For the North Eastern Branch, supply is obtained through Rubicon "A" switching station and the Kiewa hydro-electric undertaking, while local reinforcement of supply is provided by Shepparton power station. Inter-connexion with the rest of the system is provided by the 66,000-volt transmission line extending from Thomastown terminal station to Kiewa via Rubicon "A" and Benalla, with branches to Shepparton and Kyabram, Yarrawonga and Mulwala (New South Wales), and via Wangaratta to Wodonga for supply to Albury.

The two isolated sub-branches not at present included in the interconnected State supply network are served by regional stations located as follows :—

Mildura sub-branch—
Mildura and Redcliffs (locally interconnected).

Wimmera sub-branch—
Horsham.

(v) *New Capacity.* Approved new electric power projects, all due for operation by 1960, will add about 500,000 kW to the installed capacity of the State generating system. This total does not include Victoria's half share in the hydro station now being built at Hume Dam, nor the quota it is proposed to take from the Snowy Mountains hydro-electric scheme ; nor does it include additional plant at Yallourn programmed for service in 1960 but not yet formally authorized.

Major works brought into service since 30th June, 1954, or now under construction include—

(*a*) *Thermal stations.*

Yallourn extension—156,000 kW (under construction). Of this total, one 50,000 kW generator came into service in May, 1955. Further extensions (in addition to those now in progress) are to be made later.

Morwell—91,000 kW (initial stages), being the generating capacity available for public supply by 1960 at the new power station to be built in association with two new brown coal briquette factories. Further expansion would be possible, but development after 1960 has not yet been decided.

Metropolitan—40,000 kW at Spencer-street (Melbourne City Council) power station, comprising 15,000 kW brought into service for the latter months of 1954 and a 25,000 kW generator scheduled for service in 1959.

(Plant on order also includes a 40,000 kW steam-electric generator, the location of which has not yet been determined).

(*b*) *Hydro Stations.*

Kiewa—62,000 kW station (in partial service 1955) to be completed early 1956 ; 96,000 kW station ; and a further construction to follow at a later date.

Eildon Dam—135,000 kW—comprising 120,000 kW of new plant (under construction) and 15,000 kW from re-designed plant.

Hume—25,000 kW representing Victoria's share of a 50,000 kW power station shared equally by Victoria and New South Wales (under construction).

A 220 kV transmission line from the Kiewa undertaking to Thomastown terminal station in Melbourne was completed in 1955 and is now being linked with the completed new 200 kV line built from Yallourn to Malvern terminal station to reinforce the existing 132 kV circuits already linking Yallourn with metropolitan terminal stations.

The Commission's long-term plans for State-wide extension of electricity supply involve the construction of a 220 kV transmission line from Kiewa to Mildura by way of Shepparton—a distance of approximately 350 miles. Construction has begun of the first section of this line to Shepparton, with a 220 kV spur line to Bendigo. The new regional station for Mildura at Redcliffs will function primarily as a peak-load station when the line is completed.

The Commission has submitted to the State Parliament its plan for the final phase of rural electrification of Victoria, extending supply to all populated regions of the State. The plan provides for the extension of State Electricity Commission supply to every home in Victoria except for about 15,000 homes located in the most isolated parts of the State.

§ 3. Queensland.

1. General. In Official Year Book No. 39 an account is given of the growth of electricity generation in Queensland, with particular reference to the City Electric Light Co. Ltd. of Brisbane (now the Southern Electric Authority of Queensland), the Brisbane City Council and the Toowoomba Electric Light and Power Co. Ltd.

The first of these organizations, which was operating in Brisbane well before the end of the last century, now supplies a large part of Brisbane's electric power requirements and a considerable rural area in the south-east corner of the State. By 1933 this organization was operating a modern power station at Bulimba, a suburb of Brisbane, with an installed generator capacity of 37,500 kW, from which it supplied more than 16,000 consumers and generated about 60 million kWh of energy per annum. Capacity is now 95,000 kW at Bulimba "A" plus 10,000 kW, "packaged plant" at Abermain (near Ipswich) and 60,000 kW at a new generating station known as "Bulimba B". The output from a 3,200 kW hydro-electric unit installed at Somerset Dam near Brisbane is fed into the Southern Electric Authority system. With these plants 553 million kWh were generated in 1953-54 while the total number of the Authority's consumers at 30th June, 1954 was 75,311.

The Brisbane City Council established an electricity supply service after the 1914-18 War, and by 1938 it was supplying an area of about 365 square miles, purchasing energy in bulk from a power station located at New Farm (administered by the Tramways and Power House Department) and from the City Electric Light Co. Ltd. Growth of the Council's electrical undertaking and power production is indicated by the following comparisons between 1937-38 and 1953-54 figures, respectively :—Installed capacity, 56,250 kW and 75,000 kW plus a 10,000 kW "packaged" plant erected at Tennyson; units purchased and generated, 71 million kWh and 438 million kWh; consumers, 57,000 and 111,230. Since 30th June, 1954 the first 30,000 kW set at a new power station at Tennyson has been commissioned by the Council.

During 1905, the Toowoomba Electric Light and Power Co. Ltd. established supply in Toowoomba, and has since supplied a considerable area including portion of the Darling Downs. Power was generated at the Company's diesel stations of 3,300 kW supplemented by bulk supplies purchased from the Southern Electric Authority of Queensland. In 1940 the company purchased the power undertakings at Warwick, and in 1946 the Killarney undertaking. The Toowoomba Electric Light and Power Co. Ltd. has now been absorbed by the Southern Electric Authority of Queensland.

The generation and distribution of electric power in Queensland had, until the last decade, tended to lag behind developments in this field in other States of Australia. The comparatively slow growth in the production and consumption of electricity can be attributed to some extent to the absence, prior to 1938, of a central statutory authority constituted to undertake the functions of co-ordinating, unifying and controlling the production and transmission of electric power. In addition, Queensland's vast area, coupled with a low population density, made large-scale rural electrification, elsewhere than in the south-eastern portion of the State which surrounds the major centres of industry and population, an uneconomic proposition.

Before establishment of the Regional Electricity Boards in 1945, no attempts had been made to unify or co-ordinate electricity supplies outside of South Eastern Queensland, and rural electrification, apart from reticulation within certain townships, was practically unknown.

2. **Royal Commission on Generation and Distribution of Electric Power in Queensland, 1936.**—On 5th December, 1935, the Queensland Government appointed a Royal Commission to inquire into and make recommendations on matters relating to the generation and distribution of electric power in Queensland. An account of the results of its investigations and of the alternative proposals put before it will be found on p. 1182 of Official Year Book No. 39.

3. **The State Electricity Commission of Queensland.**—In 1937, the State Government legislated to constitute a State Electricity Commission (legislation administering the generation and distribution of electricity in Queensland prior to the establishment of the Commission is referred to on p. 1181 of Year Book No. 39), which commenced to function during January, 1938—to it was passed administration of the Electric Light and Power Acts 1896–1938. The Commission's main powers were :—to secure a proper and efficient supply of electric power; review tariffs; grant licences to supply electricity; secure the safety of the public; and control and advise electrical undertakings generally. It was thus a controlling authority as distinct from an operating authority. In addition, the Commission was empowered to co-ordinate the industry's development throughout Queensland. Between 1938 and 1954, the number of private companies was reduced by absorption and acquisition from twenty-one to six, and publicly owned undertakings, by amalgamation into Regional Authorities, from forty-seven to forty-one including thirteen new schemes for small Western Queensland towns.

By agreement with the Commission in 1939, the City Electric Light Co. Ltd. (now the Southern Electric Authority of Queensland) became the co-ordinating authority for the provision of electricity in an area of some 10,062 square miles, extending from the New South Wales-Queensland border to Gympie, north of Brisbane. The Company acquired the undertakings at Boonah, Beaudesert, Gympie, Coolangatta, Ipswich, Nambour, Southport, Redcliffe and the Somerset Dam supply and transmission line to Brisbane. Certain restrictions were placed on the Company's dividend rate, namely, limitation to the rate on Commonwealth bonds plus 2 per cent. During 1940, a similar agreement was made with the Toowoomba Electric Light and Power Co. Ltd. for the supply of electricity in the Toowoomba, Warwick, Killarney and Allora districts, subsequently being extended to cover a comprehensive area of 9,324 square miles, including Stanthorpe and other districts. Transmission line extensions since that year have made supply available to a number of adjacent districts on the Darling Downs. The City Electric Light Co. Ltd. was converted to a public authority as from 1st February, 1953 by the Southern Electric Authority of Queensland Act of 1952 (*see* para. 5 below).

Amending legislation, passed by the Queensland Parliament in March, 1948, changed the constitution of the State Electricity Commission from a body corporate to a corporation sole. On 1st July, 1948, a Commissioner for Electricity Supply was appointed in lieu of the previous Commission of four Commissioners. Since its inception in 1938,

the Commission has made considerable progress in its task of developing the State's power resources and promoting a more widespread use of electric power. The degree of utilization of electrical energy in Queensland now compares favorably with other States in the Commonwealth.

4. **Regional Electricity Boards.**—With a view to facilitating the control and development of electricity supply in areas of low population density or those having a predominantly primary producing economy, the Government in 1945 passed the Regional Electric Authorities Act. This legislation, as later amended, provides for the creation of regions of electricity supply and constitution of Regional Electricity Boards. The Act provided for transfer to the Boards of local authority electricity undertakings in their regions, and for acquisition by the Boards of privately owned undertakings when purchasing rights fell due. Each Board comprises representatives of local authorities in the region and a representative of the Commission. Financial operations of the Boards are under the control of the Commission.

Soon after passage of the Regional Electric Authorities Act, four regions were defined and four Regional Boards constituted, namely, Wide Bay, Capricornia, Townsville and Cairns. A fifth Board, entitled South Burnett, became an operating authority in October, 1947, but on 1st July, 1951 was absorbed in the Wide Bay Regional Board and the organization is now known as the Wide Bay-Burnett Regional Electricity Board. As power was to be obtained from the Wide Bay Regional Board's station at Howard, the Commission decided that development of the two regions could be planned more effectively by a single authority.

Activities of the four Regional Boards in 1953–54 compared with operations of the stations located in regions in 1945–46, and totals for Queensland as a whole, are shown in the following table :—

QUEENSLAND : REGIONAL OPERATIONS.

Region.	1945–46.		1953–54.	
	Units Generated.	No. of Consumers.	Units Generated.	No. of Consumers
	m.kWh		m.kWh	
Wide Bay–Burnett	13.7	11,467	46.1	21,910
Capricornia	19.5	11,196	69.5	17,483
Townsville	25.8	11,612	70.0	17,532
Cairns	22.7	9,722	67.6	16,212
Total	81.7	43,997	253.2	73,137
Queensland	487.0	194,429	1,388.0	305,636

Generator capacity of the four existing Regional Boards installed at 30th June, 1955 was :—Wide Bay-Burnett, 22,500 kW ; Capricornia, 22,500 kW ; Townsville, 22,500 kW ; Cairns, 17,070 kW ; total, 84,570 kW.

5. **Creation of Southern Electric Authority of Queensland.**—A further major step in electrical progress, comparable with that taken when the agreements with the City Electric Light Co. Ltd. and Toowoomba Electric Light and Power Co. Ltd. were first entered into, was taken by the passing of the Southern Electric Authority of Queensland Act of 1952. This Act constituted the City Electric Light Co. Ltd. as a public authority to be known as the Southern Electric Authority of Queensland.

Two Government representatives are included on the Board of the new Authority, whose establishment prepares the way for the complete amalgamation, in due course, of the electrical undertakings serving the south-eastern Queensland area of supply.

An important advantage gained by the creation of this Authority is that on 30th June, 1968, acquisition of the Authority by the State Government can be effected without the necessity of a cash payment as the Government will have the power to convert the Authority's existing stock to inscribed stock. Furthermore, the replacement of the City Electric Light Co. Ltd. by the Southern Electric Authority as a public body relieves electricity consumers in the Authority's area of supply from the burden of taxation which has hitherto been payable by the City Electric Light Co. Ltd., but will not require to be met by the new Authority. An agreement has been signed between the State Government and the Southern Electric Authority giving effect to the principles contained in the new legislation.

As from 1st July, 1954 the Southern Electric Authority acquired the Toowoomba Electric Light and Power Co. Ltd., thus bringing this company's area of supply under its control. The Southern Electric Authority is now responsible for the electrical supply and development of a consolidated area of 19,386 square miles.

6. New Capacity.—(i) *Regions.* To provide for development of the electric power resources in the regions, the State Electricity Commission formulated a ten-year programme divided into two five-year periods. In the first, it was planned to erect main transmission systems to connect existing power stations located within the regions and supplement generating capacity by the construction of new stations. Work on this section of the plan is now nearing completion. In the second period, the transmission system will be extended to more sparsely settled areas, the ultimate purpose being the provision of "ring" transmission lines throughout each region and inter-connexion between the regions.

A number of new generating stations have been commissioned as follows:—Wide Bay (Burnett Region), of which 15,000 kW was placed in service during September, 1951—a further 7,500 kW in 1954 and a further set of 15,000 kW is scheduled for installation in 1956; Rockhampton (Capricornia Region) of which 22,500 kW was placed in service during September, 1952 and a further 15,000 kW is scheduled for installation in 1955; and Townsville (Townsville Region) of which 22,500 kW was commissioned in July, 1953, with a further 15,000 kW to follow in 1955. Each of these stations will have an ultimate capacity of 52,500 kW and be steam-operated. In the Cairns Region, construction is proceeding on the Tully Falls hydro-electric scheme and two 18,000 kW turbo alternator sets should be giving a supply of electric power by the end of 1956. The scheme is designed for an ultimate installed capacity of 92,400 kW. To augment existing capacity and to meet anticipated demands pending operation of Tully Falls, the Cairns Regional Board has installed nineteen diesel units with a total capacity of 13,110 kW.

The Tully Falls scheme is planned to link with the Townsville Regional Electricity Board's system for the purpose of marginal supply, and construction of this interconnexion has now commenced. Plans for the development of the Burdekin Falls Hydro-electric project are also proceeding. These schemes and the existing Barron Falls hydro-electric plant will exploit North Queenland's principal hydro-electric potential estimated conservatively at more than 316,000 kW.

At Mackay, where supply was first given in 1924, and Bowen, both situated on the coast between the Capricornia and Townsville Regions, the local Councils operate power stations of 4,500 kW and 1,000 kW respectively. The Mackay City Council has embarked on a scheme for rural development under an agreement with the State Electricity Commission. To cater for the anticipated growth in demand, the capacity of its station will be increased to 9,500 kW in 1954–55. At Bowen, the Town Council,

which established the service in 1925, is extending the station's capacity by installation of one 1,000 kW unit. During 1935, a small (3,800 kW) power house—Australia's first underground hydro station—was placed in service at Barron Falls near Cairns. When the Cairns Regional Board was established during 1946, operation of the station passed to the Board's control and now comprises part of its generating plant, totalling 15,370 kW, supplying an area of approximately 42,000 square miles.

(ii) *Western Queensland.* In Western Queensland, where a number of small isolated generating stations supply power to some of the larger towns, the Commission has evolved a plan to increase and modernize existing capacity. It involves installation of small internal combustion units ranging in size from 100 kW to 600 kW according to the load likely to be experienced, and conversion from direct to alternating current supply. The Government is assisting the scheme by subsidy—a feature of electrical development in Queensland. In general, the assistance provided comprises subsidies of up to one-third of capital cost on annual loan charges, with special subsidies of up to 50 per cent. for authorities in isolated areas.

In addition to improving supplies to the larger western towns, a scheme has been devised for electricity supplies for smaller towns in the western districts, where consumers range from 50 to 200. Subsidies of 65 and 60 per cent. will apply in those cases where the number of consumers supplied is less than 100 and 200, respectively. This plan is now being implemented and at 30th June, 1955, twenty-two townships in the west of Queensland have been provided with the amenities of electricity. Work is at present proceeding on similar schemes for a further four townships and such supply is expected to be available before the close of 1955. In addition investigations of the possibility of supply are being carried out at eleven other centres. The power is being supplied by small oil driven generating sets with automatic controls which can be run with a minimum of operating attendance.

Coal-burning gas producers have been successfully commissioned for public electricity supply purposes in the West. They have been or are now being installed at Longreach, Clermont, Dalby, Blackall and Barcaldine and further extensions of their use in Western Queensland is predicted, as lower tariffs and more efficient production of electricity should follow their use.

(iii) *South-eastern Queensland.* To increase the availability of electric power in the south-eastern area of the State, the two major generating authorities, in conjunction with the Commission, have power station projects under construction which are designed to place in service by 1956 new generating units totalling 335,300 kW. The Southern Electricity Authority is building a station known as Bulimba "B" on a site adjacent to Bulimba "A"—60,000 kW has been installed, but the ultimate capacity may reach 180,000 kW. A 3,200 kW unit at Somerset Dam near Brisbane is now in service and feeds into the Southern Electric Authority's system. At Tennyson in the Brisbane area the Brisbane City Council is constructing a new power station—initial capacity 60,000 kW which may be ultimately increased to 180,000 kW. The first 30,000 kW set has been commissioned and the second set is scheduled for commissioning in 1956. To supplement capacity pending operations of these projects, "packaged" generating units totalling 20,000 kW were obtained from overseas and commissioned early in 1953, one 10,000 kW set having been installed at Tennyson and another 10,000 kW set at Ipswich.

The power stations of the two major generating authorities at New Farm and Bulimba are interconnected at 33,000 volts.

(iv) *The Burdekin River Hydro-electric Project.* In the vicinity of Townsville, the Commission, acting on behalf of the Burdekin River Authority, has investigated the proposed hydro-electric development of the Burdekin. This project is linked with the plan to conserve the waters of the river for irrigation and flood mitigation and surveys undertaken indicate that approximately 80,000 kW could be generated. It has been

estimated that a hydro-electric station approaching this size should meet the requirements of Townsville and the coal mines in the region of Collinsville, for at least 20 years, and also transmit supply to Bowen and Proserpine and possibly to the Mackay area, and by obviating the continuous operation of thermal plant achieve significant savings in fuel.

(v) *The Tully Falls Hydro-electric Project.* The development of the Tully Falls for the hydro generation of electricity is now well advanced, the initial plant installation being 36,000 kW, and is scheduled for commissioning in 1956. This installation comprises a storage weir upstream from the falls, with an underground power station in the gorge at the foot of the falls. Arrangements were recently approved whereby a marginal supply of electricity will be provided from the project to the Townsville Regional Electricity Board, and tenders have been accepted for a further 36,000 kW of hydro generating plant to be installed. This hydro scheme is capable of development to supply the electrical needs of North Queensland for many years to come.

7. Hydro-electricity.—Behind the coastal plain of the Cairns-Ingham area is an extensive plateau, the elevation ranging from 2,000 to 3,000 feet, although isolated peaks exceed 4,000 feet. The short coastal streams which rise on the plateau descend rapidly into deep gorges, which they have cut through the old divide. With heavy monsoonal rainfall on their catchments and concentrated fall, these streams represent a considerable potential source of power, but storage, which can in most cases be provided, is essential to control the very variable flow.

The Barron Falls scheme, 14 miles north-west of Cairns, came into operation in 1935. The installed plant operates under a head of 410 feet and comprises three 2,000 h.p. turbines each connected to a 1,320 kW generator. Average rainfall varied from 80–150 inches along the ranges to less than 35 inches in the western portion of the catchment. There is extreme variation from year to year, resulting in great fluctuation of stream flow which, at Kuranda, has varied from a maximum of 117,000 cusecs in 1911 to a minimum of 30 in 1915. Storage to regulate the flow is possible but has not yet been provided. During periods of low flow the supply of electricity is supplemented by fuel plants at Cairns, Atherton and Innisfail. Power is distributed over 22,000 volt transmission lines serving the tableland and extending southward along the coast to Tully.

A small hydro-electric scheme on the Mossman River, 5 miles from Mossman, North Queensland, comprises two 120 h.p. turbines operating under a head of 200 feet.

A hydro-electric power scheme at Tully Falls is being constructed. Water controlled by Koombooloomba Dam to be built on the upper Tully River will be diverted, a short distance above Tully Falls, through a tunnel and steel penstocks to Pelton-driven generators under a head of 1,485 feet. Ultimate installation will be four 18,000 kW sets, two of which will be installed initially. Future automatic power plants upstream and downstream from Tully Falls will consist of two 7,500 kW sets under 405 feet head and one 5,400 kW set under 230 feet head. The combined peak load for the three plants will be 69,000 kW. Interconnexion of the Townsville area, currently supplied by a thermal station, with the Tully scheme has been authorized and revision of the 160 mile duplicate 132 kV transmission line is under way. On present estimates power from the Tully scheme will be sufficient to supply the interconnected area until 1965, when addition power will be required. A full investigation by the State Electricity Commission of the electricity supply industry in North Queensland is proceeding and the terms of reference include the survey of additional hydro-electric projects.

Other northern schemes which have been investigated include Freshwater Creek (3,900 kW); North Johnstone–Russell Rivers (32,000 kW); Beatrice–North Johnstone Rivers (9,000 kW); South Johnstone River (25,000 kW); extension of Barron Falls scheme (22,000 kW); Herbert River (90,000 kW). The total potential of the plateau region is therefore about 250,000 kW at 50 per cent. load factor.

A power plant immediately below the Burdekin Falls Dam of the proposed Burdekin River Irrigation scheme will operate under an average head of 225 feet. The output of firm power will depend upon the varying demand for water for irrigation, but it is expected to average about 50,000 kW.

South of the Burdekin River no appreciable hydro-electric development is practicable. A plant of 3,200 kW capacity has been installed to utilize the outflow from Somerset Dam on the Stanley River a few miles above its confluence with the Brisbane River.

§ 4. South Australia.

1. **General.**—An account referring to the companies generating electric power in South Australia prior to the advent of the Adelaide Electric Supply Co. Ltd., and describing the development of that company's activities, was given in Official Year Book No. 39. Also included in the account was some reference to the early measures of public control over electricity supply in South Australia and the extent to which they were applied, and also to the inquiries into the activities of the Adelaide Electric Supply Co. Ltd. in 1932 and 1935.

Following upon an inquiry instituted by the Government in 1943 relative to measures for increasing electricity supply to the metropolitan area and country districts the Electricity Act 1943 was passed which, *inter alia*, established the South Australian Electricity Commission. However, until the State assumed full responsibility for the supply of electric power, this body was not able to do much more than exercise the formal functions conferred on it by the Act.

Under the provisions of Section 3 of the Adelaide Electric Supply Company Act 1944, a Royal Commission was appointed to inquire into and report upon the supply of electricity by the Company and upon all matters concerning it. The Commission presented its report on 28th August, 1945, the main substance of which was, subject to certain considerations and assumptions, that the Government acquire the assets and liabilities of the Adelaide Electric Supply Co. Ltd., and the responsibility for the generation and transmission of electric power in South Australia be vested in a public authority to be called the South Australian Electricity Trust, or, alternatively, if acquisition were not considered desirable, that prices charged for the supply of electricity by the Company be fixed by regulation and determined from time to time by a Committee appointed by the Governor in Council, giving due regard to the interests of the public and a fair return to the shareholders of the Company. The Commission also recommended that an inquiry be held forthwith by the South Australian Electricity Commission regarding the co-ordination of electricity supplies in the State, and that the Commission have power to veto any proposals for the construction of works to generate and transmit electric power.

2. **The Electricity Trust of South Australia.**—Early in 1946, a Bill was passed transferring the assets of the Adelaide Electric Supply Co. Ltd. to the newly formed Electricity Trust of South Australia, which became responsible for unification and co-ordination of the major portion of the State's electricity supplies. This legislation provided that the Trust should take over the powers vested in the South Australian Electricity Commission under the 1943 Act, which, after establishment of the Trust, would cease to exist. In addition to the powers specified in the Adelaide Electric Supply Company's Acts 1897–1931, the Trust may, *inter alia*, supply electricity direct to consumers within a district or municipality with the approval of the local authority, and by agreement with other persons who generate or supply electricity, arrange to interconnect the mains of the Trust with those of other persons, and give or receive supplies of electricity in bulk.

3. **Capacity and Production.**—There are three main categories of organizations generating electric power in South Australia, namely :—(*a*) Governmental, which include the Electricity Trust ; (*b*) Local Authorities, e.g., municipal and district councils, Renmark Irrigation Trust, Municipal Tramways Trust ; and (*c*) Other, including individuals and firms primarily engaged in generating power for sale, firms generating power primarily for their own use but supplying outside consumers, and firms generating power for their own use.

In 1953-54 total installed capacity in South Australia was 269,992 kW, an increase of 1,858 kW on the year before. The units generated totalled 955 million kWh compared with 822 million kWh in the previous year.

Of the total installed capacity, the Electricity Trust of South Australia operated plant with a capacity of 219,700 kW. It is thus the most important authority supplying electricity in the State. There were approximately 216,289 ultimate consumers of electricity, of whom 188,936 were supplied by the Trust. Its major steam stations were Osborne " A " (79,000 kW), Osborne " B " (120,000 kW) and Port Augusta " A " (15,000 kW) while the balance of the capacity controlled consists of a limited number of small internal combustion plants located in rural districts.

No hydro-electric potential exists in South Australia. Steam generating units comprise 94 per cent. of installed capacity and the balance, 6 per cent., is internal combustion equipment. Until recently, all fuel consumed in the thermal stations was obtained from sources outside the State, and at times power restrictions were necessary owing to the inadequacy of supplies.

4. **Leigh Creek and other new Capacity.**—With a view to reducing the dependence on external sources of fuel, steps have been taken to produce local coal and to install plant to use it. Fairly extensive deposits of low-grade sub-bituminous coal are obtainable at Leigh Creek, about 360 miles north of Adelaide. Under the Electricity Trust of South Australia Act Amendment Act 1946, the Trust was given authority to develop Leigh Creek coal for use in its own undertakings and also for sale to other consumers. Production from the Leigh Creek field commenced in 1944 and in the year ended 30th June, 1954, 455,510 tons of coal were sold. Of this amount the Electricity Undertaking used 332,365 tons.

In order to cope with the rapidly increasing demand for power, the Electricity Trust is installing two additional 30,000 kW units at Osborne " B " Power Station. These will complete the " B " station which will then have a total capacity of 180,000 kW. Another major work under construction is the power station at Port Augusta with an ultimate capacity of 90,000 kW. The first 15,000 kW boiler and 30,000 kW turbo-alternator were commissioned in June, 1954. This power station is located at Port Augusta because of its proximity to the Leigh Creek coalfield and the station will use Leigh Creek coal exclusively. A new standard gauge railway line to connect Leigh Creek with Port Augusta is being constructed by the Commonwealth Railways Department. The power station is inter-connected with the Metropolitan Area by two transmission lines which will also supply power at intermediate points. The Trust has now decided to construct a second power station at Port Augusta to be known as Port Augusta " B ". This station will have a capacity of 180,000 kW making the combined capacity at Port Augusta 270,000 kW. With the two Port Augusta power stations and the extensions to Osborne " B " station the planned increase in generating capacity is 315,000 kW.

5. **The Municipal Tramways Trust.**—In addition to the instrumentalities mentioned above which are engaged in the generation and distribution of electric power in South Australia, the Municipal Tramways Trust operates a power station of 19,100 kW at Port Adelaide, which supplies energy for traction purposes. In 1943 a 5,500 kW frequency changer was installed to form a link between the power stations of the Trust and the Electricity Trust of South Australia to permit interchange of power when necessary. In 1954 the service consumed approximately 19 million kWh of electricity.

§ 5. Western Australia.

1. **General.**—Electrical undertakings in Perth and Fremantle formerly owned by the Perth City Council, the Western Australian Government Electricity Supply, the Fremantle Municipal Tramways and Electric Lighting Board and other metropolitan municipal and road board supply authorities have now been taken over by the State Electricity Commission of Western Australia. For information on the early history of electricity supply in the metropolitan area *see* Official Year Book No. 39, p. 1189.

2. **Metropolitan Undertaking.**—Statistics relating to activities at the Metropolitan undertaking are shown in the following comparative table.

WESTERN AUSTRALIA: METROPOLITAN UNDERTAKING.

Particulars.	1928–29.	1938–39.	1953–54.
Plant capacity .. .. .. kW	32,000	57,000	124,000
Maximum load .. .. .. kW	21,500	33,000	89,000
Units generated .. .. Million kWh	80	137	401
Coal used per unit generated .. .. lb.	3.1	2.77	1.75
Coal used—			
Collie small.. .. .. .. tons	110,460	165,355	312,903
Imported .. .. „	427	3,367	..

As a result of a separate inquiry conducted at the same time as the early investigations into the proposed new station at South Fremantle, a recommendation was made favouring conversion of the East Perth 40 cycle system to the British and Australian Standard Frequency of 50 cycles per second. The recommendation was adopted and implemented by making the frequency of generation at South Fremantle 50 cycles and installing at East Perth a frequency changer able to convert 25,000 kW of energy from one frequency to the other. Change-over of consumers' plant is proceeding and a large number of important loads are now supplied at 50 cycles.

3. **Kalgoorlie.**—In Kalgoorlie, the Municipal Council in 1895 first established electricity supply and by 1945 it was supplying 3,350 consumers with direct current from a diesel station of 1,350 kW generating capacity. Primarily established to supply power for the gold mines and for traction, the Kalgoorlie Electric Power and Lighting Corporation operates a steam station of 18,750 kW and maintains a 22 kV line of 21 miles to the Celebration mine. Alternating current is also supplied to about 1,000 consumers. The Corporation's undertaking generates approximately 42 million kWh and new boilers have been installed to permit steam-raising from Collie coal, since depletion of timber in neighbouring areas has proceeded to the point where firing on wood fuel is no longer economic.

4. **General Pattern of Electricity Supply.**—The pattern of the generation and distribution of electric power in Western Australia consisted until recently of a number of isolated systems each supplying a particular area. Except in the metropolitan area and in the area embraced by the South-West Power Scheme (*See* para. 6 below), where in both cases electricity supply is in the hands of the State Electricity Commission of Western Australia, local authorities are generally responsible for the supply of electricity for domestic, industrial and traction purposes. In the area between the Great Southern Railway from Northam to Albany and the west coast, however, the State Electricity Commission has now constructed transmission lines to give central station supply to the towns and their surrounding rural areas. In addition, there are

several mining companies which generate electricity for use in their mines. In order to cater for the expected growth in demand, capacity of the State's major generating stations is being increased and designs are proceeding for the inter-connexion of the Perth-Fremantle system with the south-western area.

The main load centre of the State is, of course, the Perth-Fremantle area into which is concentrated the major portion of the State's population and industry. The pending inter-connexion between the Metropolitan and Country systems is, however, expected to lead to a gradual decentralization of load.

5. **The State Electricity Commission of Western Australia.**—(i) *Origin and Aims.* In order to ensure an organized and co-ordinated future growth of electricity generation and distribution throughout the State, the Government introduced a Bill in 1945 to establish the State Electricity Commission, which, together with an Electricity Bill, became law early in 1946. Under these Acts, the Commission was given power, *inter alia*, to secure the ultimate co-ordination of all State or other electrical undertakings in the State, to construct and operate power stations and transmission lines and purchase as a going concern and carry on the undertaking of any supply authority. Under the Electricity Act, which should be read in conjunction with, and is subject to, the State Electricity Commission Act, no person or organization is permitted to construct or extend an electricity supply undertaking without consent from the Commission. Local authorities are empowered to operate and construct power stations and other works associated with the supply of electricity, provided that authority is first obtained from the Commission and any proposals are not inconsistent with the Commission's plans.

(ii) *New Projects.* Since its inception in 1946, the Commission has proceeded with the task of increasing generating capacity in an endeavour to cater for a greatly increased demand for power. Long-range plans have been formulated to inter-connect the south-western portion of the State with the Perth-Fremantle system. One of its most important and immediate problems was to increase the capacity of the generating equipment serving Perth and Fremantle. During the 1939-45 War years, it became evident that the growth of demand for electric power would necessitate provision of additional generating equipment in the metropolitan area as soon as possible. Accordingly, the Government Electricity Supply authority commenced design work for a new station of 50,000 kW capacity. Contracts were let in 1945 and construction commenced on a site selected at South Fremantle, on the coast south of Fremantle proper. Responsibility for completion of this project was given to the Commission under the Act of 1946. As it was considered that an even larger station would be required, provision was made for the installation of two additional units giving an ultimate capacity of 100,000 kW. Steam is furnished by eight boilers designed to use pulverized coal from Collie, which is located about 120 miles from the station. At the end of 1954 four units had been placed in service and the output was being fed into the metropolitan system.

Most of the plant at the East Perth power station, which passed to the Commission's control in 1946, is due for retirement. Work is now proceeding upon dismantling the oldest boilers and generators in order to make room within the existing buildings for new and modern plant which will possess the merit of high efficiency, yet may be cheaply installed by requiring a minimum of site preparation, building and distribution expenditure. Current contracts provide for the installation of 30,000 kW of new plant in this station.

6. **South-west Development.**—At the request of the Government, the Electricity Advisory Committee in 1945 submitted a report recommending, amongst other things, that a National Power Scheme for the south-west be proceeded with (implementation of the recommendation of a previous Committee in 1939 had been prevented by the conditions then prevailing). The plan provided for acquisition of the existing Collie

power station and installation of additional generating capacity, construction of a power station at Bunbury and inter-connexion of the south-west scheme with the metropolitan system. On 12th October, 1946, the State Electricity Commission acquired the Collie power station, which prior to 1946 was owned and operated by the Collie Power Company Limited. At the date of acquisition, the station's installed capacity was 5,000 kW, comprising two steam units. The capacity of the station was increased to 12,500 kW in 1952.

Since 1950, the Commission has acquired a number of electrical undertakings from municipal bodies and private organizations in the south-west area and is proceeding with arrangements for the purchase of others. In August, 1951, the first portion of the South-West Power Scheme was officially opened at Collie and many of the south-west towns have now been connected by transmission line to the Collie Power Station. When completed, a system of power lines will reticulate electricity over an area of approximately 1,800 square miles. Contracts have been let for the first three 30,000 kW units for a new power station at Bunbury, which will be inter-connected by transmission lines to the Collie and the metropolitan stations, permitting an interchange of power between the metropolitan and south-west systems.

§ 6. Tasmania.

1. **General.**—A considerable part of the water catchment in Tasmania is at high level, with a substantial natural storage available, and this has made it possible to produce energy at lower cost than elsewhere in Australia, or in most other countries. Other contributing factors to the low costs are that rainfall is distributed fairly evenly throughout the year, with comparatively small yearly variations. The cheap power has led to the establishment in Tasmania of several large electro-chemical works with high load factor, and as a consequence the system load factor is also very high and at present is 61 per cent.

For information on hydro-electric development in Tasmania prior to the establishment of the Hydro-Electric Commission in 1930 *see* Official Year Book No. 39, pp. 1192–3.

2. **The Hydro-Electric Commission.**—(i) *Present System.* In 1929 the Government passed the Hydro-Electric Commission Act, under which was established the Hydro-Electric Commission and which vests in the Commission, with some minor exceptions, the right to use the waters of the State of Tasmania and authorizes it to develop and reticulate electric power for all purposes. In 1930 this corporate body took over the State hydro-electric undertaking and the business of the Hydro-Electric Department.

The first project undertaken by the Commission was the Shannon Power Development which utilizes 258 feet of the difference in level between the Great Lake (Miena Dam) and Waddamana forebay. A small earthen dam diverts the outflow from the Great Lake through 2½ miles of canal and then by two pipelines to the Shannon Power Station, where 10,500 kW was added to the system in 1934. After passing through Shannon Power Station the water discharges into the Waddamana canals to be used again at the Waddamana Power Stations.

In 1933 it was decided to proceed with the Tarraleah Power Development. In this scheme the waters of the River Derwent are picked up near Butler's Gorge by a canal and conveyed 14 miles to the pipeline forebay 982 feet above the power station on the Nive River where three 15,000 kW generators were placed in service in 1938. Shortly afterwards two more 15,000 kW units were added and a sixth machine installed in 1951 brought the total installed capacity at Tarraleah Power Station to 90,000 kW. Storage is provided at Lake St. Clair and at Lake King William, an artificial lake created by the 200-ft. high Clark Dam across the Derwent at Butler's Gorge. In the Butler's Gorge Power Station at the foot of the dam a single 12,200 kW generator was installed in 1951. To increase the security of the system and to permit variable seasonal loading of Tarraleah station a second canal from Clark Dam to Tarraleah was completed in 1955.

Early in 1939 it was decided to make full use of the Great Lake storage by increasing the peak capacity at Waddamana. War conditions impeded progress, but by the end of the war two 12,000 kW generators had been installed in a new power station, Waddamana " B ", adjacent to the original station Waddamana " A ". A third unit installed in 1946 and a fourth in 1949 brought the total to 48,000 kW. To enable a full peak capacity to be maintained at both Waddamana stations a duplicate of the original Waddamana canal was constructed during 1947–48.

Between 1930 and 1948 the generating capacity of the system was increased by 121,500 kW but the demand for power continued to increase rapidly and it was obvious that a greatly accelerated construction programme would have to be undertaken. Construction of the Tungatinah Power Development was started in 1948 and the Trevallyn Power Development in 1949.

The Tungatinah scheme draws water from three separate catchment areas located on the Central Plateau between the Great Lake (Shannon–Waddamana) and the Lake St. Clair (Butler's Gorge-Tarraleah) catchments and control of practically the whole run-off from the Central Plateau has now been effected.

The principal catchment utilized by the Tungatinah scheme is drained by the Nive River. A 120-ft. high dam at Pine Tier diverts the waters of the Nive through 6½ miles of canal system to the first of a chain of four artificial lakes, created by dams constructed across the outlets from natural marshes and linked by large open cuts. From the southernmost lake a tunnel and then five steel pipelines lead to the six 25,000 kW generators in Tungatinah Power Station, 1,005 feet below on the Nive River just upstream from Tarraleah station on the opposite bank of the river. Power was first generated at Tungatinah in mid-1953 and with a capacity of 150,000 kW it is the largest hydro-electric power station in Australia. Water from the smaller Clarence River catchment is brought into one of the lakes in the Tungatinah system by means of a woodstave pipeline 5½ miles in length and the third catchment area utilized is the Lake Echo-Dee River catchment. Regulation of this catchment has been achieved by construction of a dam at Lake Echo to provide the main storage reservoir for the Tungatinah scheme, construction of the Lake Echo Power Station (one 32,400 kW generator) to utilize 568 feet of the difference in level between Lake Echo and Dee Lagoon and the diversion of water from Dee Lagoon through 2 miles of tunnel to the main Tungatinah system.

The Trevallyn Power Development, the first constructed by the Commission outside the Central Plateau region, was undertaken primarily to meet the requirements of the aluminium industry. The waters of the South Esk River are diverted through 2 miles of tunnel and pipeline to a power station on the Tamar River near Launceston. Three 20,000 kW generators were installed in mid-1955 and a fourth unit has since brought the total capacity of Trevallyn Power Station to 80,000 kW.

(ii) *New Capacity.* The Hydro-Electric Commission is still engaged in the most progressive construction programme in its history. Since 1948 the generating capacity of the system has been increased by 276,600 kW to a total of 447,100 kW and present construction is planned to bring this total to 569,000 kW by 1960. There will still remain very considerable resources for future development as it is considered that at least 2,400,000 kW can be economically developed.

The Wayatinah Power Development, now under construction, will comprise two power stations and headworks to utilize water which is in the main already regulated and which has been used several times. The volume of water available is much larger and the head smaller than in the case of other major stations. All the water which has passed through Tarraleah or Tungatinah stations will be diverted, by a weir across the Nive River below Tarraleah, through 4 miles of tunnel and then steel pipes to Wayatinah " A " Power Station lower down on the Nive River where 83,700 kW will be installed by 1960.

A dam across the River Derwent, just below its junction with the Nive, will create a small lake into which will flow all the water from Wayatinah "A" plus water collected by the Derwent below Clark Dam. One mile of tunnel and one mile of pipeline will lead the water to Wayatinah "B" Power Station on the Derwent three-quarters of a mile below its junction with the Florentine River. The lower station, Wayatinah "B", is being constructed first for completion by 1958. Installed capacity will be 38,250 kW.

There is every indication that the demand for power in Tasmania will continue to increase. The Commission is conducting extensive surveys and investigation of other schemes with a view to further construction after the completion of the present programme.

3. **Power Usage by Secondary Industry.**—After 1930, every effort was made to keep pace with anticipated increases in demand by means of a progressive construction policy. The abundant and comparatively cheap supplies of electricity and other natural resources attracted to Tasmania a number of important secondary industries for which energy costs constitute a significant proportion of the total cost of production. Some of the more important organizations and their continuous power demands when plant is operating are as follows:—Electrolytic Zinc Company of Australasia Ltd., 51,000 kW; Australian Commonwealth Carbide Company Ltd., 6,500 kW; Goliath Portland Cement Company Ltd., 1,800 kW; Associated Pulp and Paper Mills Ltd, 8,600 kW; Australian Newsprint Mills Ltd., 24,000 kW; and Australian Aluminium Production Commission, 30,000 kW.

§ 7. Commonwealth Territories.

1. **Internal Territories.**—(i) *General.* The electricity supply undertakings at Canberra in the Australian Capital Territory and at Darwin, Katherine, Tennant Creek and Alice Springs in the Northern Territory are operated by the Commonwealth Government. Administration and control of these undertakings is vested in the Commonwealth Department of Works.

(ii) *Australian Capital Territory.* Supply was first established at Canberra during 1915. The Department owns steam stand-by plant of 2,100 kW capacity which is operated in conjunction with the New South Wales Electricity Commission's generating equipment. The major portion of Canberra's power requirements are supplied in bulk from the New South Wales inter-connected system. Within the next few years, defence projects at present under construction in Canberra will greatly increase the demand for electrical energy. These requirements will be met from the Snowy Scheme, the first section of which came into operation early in 1955, the power produced being fed into the New South Wales inter-connected system at Cooma.

(iii) *Northern Territory.* At Darwin, supply was established by the Town Council in October, 1934, but later, during April, 1937, responsibility for generation and supply was placed in the hands of the Northern Territory Administration. The power station is equipped with diesel generating plant of 3,925 kW capacity. Two 970 kW diesel sets will be installed in 1955–56. Small diesel generating units supply the requirements of Katherine (297 kW), Tennant Creek (165 kW) and Alice Springs (1,042 kW).

In 1948 it was announced that the Department of Works and Housing (now the Department of Works) had selected a site for a hydro-electric station on the Adelaide River, 72 miles from Darwin. The scheme is designed to augment supply to Darwin and suburbs when the diesel equipment at present installed is unable to cope with the demand for power. No constructional work has yet been undertaken on the project.

2. **External Territories—Papua and New Guinea.**—Responsibility for the operation and establishment of electrical undertakings in Papua and New Guinea is vested in the Administration of the Territory of Papua and New Guinea, whose headquarters are

located at Port Moresby. The total generating capacity of the diesel engine-driven generating sets amounts to 4,708 kW. The generating capacity of the power plants at the main centres is—Port Moresby, 2,569 kW; Rabaul, 561 kW; Lae, 598 kW; Madang, 280 kW; Samarai, 200 kW; Kavieng, 67 kW; Wewak, 110 kW; Lorengau, 100 kW; and 223 kW distributed among eleven outstations where generating capacity is between 5 kW and 60 kW. New power plant is under construction at Lae (874 kW) and Rabaul (1,451 kW). The townships of Wau and Bulolo are supplied by the Bulolo Gold Dredging Co., which operates a hydro-electric plant of 5,500 kW. This power is produced mainly to supply the alluvial dredges and, in addition, now supplies the recently constructed plywood mill at Bulolo.

Vast hydro-electric potential exists in New Guinea—it has been estimated at 15,000,000 kW, but because of the island's location, absence of large load centres and lack of industrialization, only a very small proportion could, at present, be economically developed.

In 1950 it was announced that the Commonwealth Government had joined with British Aluminium Co. Ltd. of London to locate and develop large capacity hydro-electric schemes in New Guinea. A new company was formed, known as New Guinea Resources Prospecting Co. Ltd., with a capital of £100,000. The Commonwealth holds 51 per cent. of the shares and has a controlling interest on a board of five members. The agreement for formation and operation of the Company is administered by the Commonwealth Department of Supply, except in matters requiring compliance with the law of New Guinea, when responsibility for administration rests with the Department of Territories. Surveys and comprehensive investigations are in progress.

The following hydro-electric schemes are under construction:—Port Moresby—at Rouna on the Laloki River providing 3,000 kW when complete, with provision for expansion to 5,000 kW. It is anticipated that the power station should be in operation during 1956. The present project utilizes only portion of the power available from the Laloki River and the economic ultimate development will be of the order of 50,000 kW; Goroka—with an initial capacity of 100 kW and Aiyura (for the Agricultural Experimental Station) with an initial capacity of 30 kW. Stream gauging and other preliminary investigations for hydro-electric schemes have been carried out at Lae, Rabaul and Madang.

There are possibilities for major hydro-electric development in the following localities:—Rouna Falls (near Port Moresby), Upper Snake and Busu-Erap-Leron (near Lae), Upper Ramu (near Markham–Ramu divide—80 miles from Lae) and Hathor Gorge (on Purari River) with an estimated average power of 100,000 kW, 150,000 kW, 2 million kW, 250,000 kW, and 3 million kW respectively. These have estimated run-offs of 1,400; 600; 12,000; 1,000; and 75,000 cusecs respectively.

In an area of 150,000 square miles of the Eastern New Guinea mainland, the power potential has been estimated at 150 kW per square mile which compares favourably with potentials of 170 kW per square mile for Switzerland and 95 kW per square mile for Norway.

D. STATISTICAL SUMMARY, 1948-49 AND 1953-54.

The following table shows statistics for each State separately and for the six States combined for 1948–49 and 1953–54 and relates to:—(i) the numbers and installed capacity of central electric generating stations, (ii) the values of production and output and the average numbers of persons employed in the generating side of the electricity supply industry and (iii) the amount of electricity generated in both years and the number of ultimate consumers of electricity in 1954–55.

For further statistics of the electricity supply industry (years 1938–39 and 1949–50 to 1953–54) *see* Chapter IX.—Manufacturing Industry.

CENTRAL ELECTRIC STATIONS.

Particulars.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Total.
1948–49.							
Generating Stations—							
Government .. No.	10	10	..	2	9	2	33
Local Authority ,,	41	33	36	13	42	..	165
Companies .. ,,	40	25	11	23	65	1	165
Total	91	68	47	38	116	3	363
Installed Capacity of Generators—							
Steam .. kW	869,109	518,950	206,334	(a)	78,225	(a)	1,869,769
Hydro .. ,,	33,155	52,419	4,141	(a)	..	(a)	272,763
Internal combustion ,,	51,581	17,237	25,506	(a)	37,476	(a)	143,476
Total .. ,,	953,845	588,606	235,981	(a)	115,701	(a)	2,286,008
Persons employed(b) No.	3,853	2,059	885	(a)	915	(a)	8,822
Value of output(c) £,000	13,368	5,512	2,893	(a)	2,172	(a)	26,938
Value of production(d) ,,	6,582	2,653	905	(a)	664	(a)	12,233
Electricity generated(e) Million kWh	3,717	2,504	890	567	399	976	9,053
1953–54.							
Generating Stations—							
Government .. No.	20	15	1	7	8	6	57
Local Authority ,,	34	28	45	14	38	..	159
Companies .. ,,	30	24	8	23	47	3	135
Total	84	67	54	44	93	9	351
Installed capacity of Generators—							
Steam .. kW	1,288,349	749,675	354,754	(a)	154,900	(a)	2,802,254
Hydro .. ,,	36,980	38,919	7,160	(a)	..	(a)	380,709
Internal combustion ,,	96,622	40,811	36,711	(a)	44,082	(a)	233,646
Total .. ,,	1,421,951	829,405	398,625	(a)	198,982	(a)	3,416,609
Persons employed(b) No.	5,140	2,690	1,289	(a)	961	(a)	11,395
Value of output(c) £,000	31,401	16,169	9,057	(a)	5,633	(a)	69,981
Value of production(d) ,,	13,996	6,862	3,154	(a)	2,309	(a)	30,098
Electricity generated (e) Million kWh	5,450	3,573	1,511	955	627	1,472	13,588
Ultimate consumers(f) No.	921,229	687,949	305,636	216,289	118,117	97,400	2,346,620

(a) Not available for publication; included in total for Australia. (b) Average employment over whole year including working proprietors. (c) Value of electricity produced plus certain earnings. (d) Value added to materials and fuel in the process of generation. (e) Total generated including that generated by factories for their own use. (f) Approximate figures supplied by the electricity authority in each State. This detail is not available for 1948–49. An "ultimate consumer" is a person, business, undertaking, etc., that has contracted to receive electric power from a public or private organization supplying this service. The number of ultimate consumers is not synonymous with the number of persons served with electricity because one ultimate consumer may embrace three or four persons, e.g., in a household.