CHAPTER XXV.

ELECTRIC POWER GENERATION AND DISTRIBUTION.

The following article, which is designed to remedy a serious deficiency in the range of subjects dealt with in the Official Year Book, has been contributed by the Division of Industrial Development of the Commonwealth Ministry of National Development. The article is divided into four major parts, viz. :—A.—Introduction, which deals generally with the resources, generation and distribution, and future developments, of electric power in Australia; B.—a part describing the Snowy Mountains Hydro-electric Scheme; C.—a part dealing with the origins, development, present situation and new projects of electrical systems in each Australian State and Territory (internal and external); and D.—the Conclusion, which refers briefly and generally to plans for increased generating capacity in Australia and the tariff policies of electricity supply authorities. A Statistical Summary (E) and a Bibliography (F) are appended. The Synopsis at the beginning of this volume provides an outline in detail of the contents of the article.

A great deal of research was required in the preparation of this article, as sources of historical material were scanty. Information presented herein has been checked, wherever possible, by the organization concerned, but in spite of the care exercised in the preparation and checking of data, it is possible that errors may have occurred, and advice of any discovered would be appreciated. It should be remembered, however, that the information relates to situations existing and projects contemplated early in 1952 and may be considerably affected by changes in policy or plans, or by developments in the projects themselves.

It is intended to advance the statistical matter in this article in future issues of the Year Book, also to keep the descriptive matter up-to-date by including information on developments in works in progress and in new projects.

A. INTRODUCTION.

1. **General.**—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 growth of population, especially in country areas, has, of course, been itself much influenced by the availability of water and fuel.

On the other hand, the extent of power development in a country depends in general on the size of the population, the degree of industrialization and the magnitude of the resources available for power production.

2. **Population.**—Between 1939 and 1949, the Australian population increased by approximately one million, to reach a total of eight million. For the latter year, the rate of growth was estimated at 3.3 per cent., of which natural growth contributed 1.4 per cent. and net migration 1.9 per cent. By far the greater portion of this increase occurred between 1945 and 1949, when both natural increase and immigration were accelerated—particularly the latter.

Australia, including Tasmania, has an area of 2,974,581 square miles. The average population density in 1949 was therefore roughly 2.7 persons per square mile. This measure, however, can be misleading in view of the very sparse population in wide areas and the great concentration in capital cities. In fact, some 89 per cent. of the total population lies to the south-east of an area enclosed by an arc drawn from a point west of Whyalla in South Australia and curving north-easterly to the Queensland coast a little

north of Brisbane. Outside this area, the only significant concentrations of population are in the south-west of Western Australia and along the more northerly Queensland coast. Within it (about one-sixth of the total area of Australia) lie all the Australian capitals except Perth, and practically the whole of Australia's manufacturing activities. The density per square mile in this sector of the continent is about fifteen persons, but, again, this figure would be considerably less if the populations of the five State capital cities included in it (totalling almost four million) were excluded from the calculation.

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 in relatively close proximity 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, is of paramount significance in influencing the distribution of industrial population and the location of major electric power stations.

3. **Power Resources.**—The principal sources of energy utilized in the production of electric power in Australia are coal, water and petroleum products. This last is of least importance, being chiefly used in local stations in small country towns in which power is generated by internal combustion engines, large in number, but small in total capacity. It is also employed for stand-by and peak load plant by some central authorities. As there are no known significant oil deposits in Australia, practically all supplies of liquid fuel must be imported from external sources.

By far the most important source of energy used in the production of electric power in Australia is coal. In 1949, thermal power stations represented 82.4 per cent. of the total installed generating capacity. The balance, 17.6 per cent., was distributed between hydro and internal combustion equipment in the proportions of 13.2 per cent. and 4.4 per cent., respectively.

It has been estimated that Australia's probable coal reserves are of the order of 53,000 million tons, of which 14,000 million tons are black coal and 39,000 million tons brown or sub-bituminous coals. Whilst these reserves may appear small by comparison with those of many other countries, they are, at present, high per head of population. The known deposits are unevenly distributed throughout the continent, about 85 per cent. of the black coal reserves being in New South Wales and 95 per cent. of the brown in Victoria. However, the potential reserves in Queensland may prove as great, if not greater, than those of New South Wales, but owing to the lack of precise data it is difficult to obtain a reasonably accurate estimate of their extent.

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

The deficiency of water resources is even more significant in relation to the generation of hydro-electric power, which is thereby restricted to a very small proportion of the continent's total area. Furthermore, because of the large fluctuations which occur in rainfall, no hydro-electric plant can be depended on for a firm output, unless considerable provision is made for storage. Even in Tasmania, where the rainfall is on the whole much more uniform than on the mainland, deficient rainfall has at times caused a considerable reduction in the available water from natural storages. There are two alternatives for improving the degree of utilization, namely, additional use of unregulated stream flow or artificial storage.

Furthermore, this paucity of water necessarily causes the quantity available to be divided so that the various uses for which it is required—domestic, stock, irrigation, power generation, etc.—shall receive their due proportion. In a project which combines irrigation and power generation as its objective, therefore, power can only be produced when water is released from the storage for irrigation—unless the scheme provides for additional storage below the power station, or the flow is sufficient to permit continuous

generation of power and the water not used for irrigation can therefore be allowed to run to waste. Furthermore, where a scheme is designed primarily for irrigation, power production is normally limited to the period (of, say, six months in a year) when water is released for this purpose, which is often the time when the demand for electric power is at a minimum.

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 approximately 3,289,000 kW. within the next 25 years, of which 789,000 kW. should be available by 1960. 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. However, because of its insular position, that State's electric power potentialities must at present be considered apart from those of the mainland, although their indirect contribution to the Australian economy as a source of power for basic industries is quite substantial. Improvements in transmission techniques may some day make possible a direct contribution.

A study of the map on page 1171 reveals a significant distribution of the resources required for the generation of electric power. When the resources of Tasmania are excluded, the pattern is broadly symmetrical. In close proximity to Sydney lie great black coal deposits, while the most extensive brown coal deposits are located near Melbourne; roughly equidistant from these two large centres of population and industry is found the mountainous region which contains most of the available hydro-electric potential.

From a geographical point of view, this concentration of energy resources is disproportionate; from an economic point of view, however, when considered in relation to the distribution of other resources and to other factors, it has a direct bearing on the general pattern of Australia's development.

4. **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 production of electric power for sale. As the demand for power increased, particularly from manufacturing industries, supply facilities were expanded and the industry grew rapidly. A trend towards public ownership commenced during the 1914–18 War and became more pronounced after the 1939–45 War. By 1952, 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 in 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 firms engaged in mining pursuits remote from the main centres of population. As this article is intended primarily to

cover the activities of central electric stations, and as power regularly produced for such internal consumption is a relatively small proportion of total power produced, only incidental reference is made to firms generating electricity for consumption within their establishments.

(ii) *Power Production.* In the twenty year period 1928–29 to 1948–49, production of electric power in Australia increased by nearly 300 per cent., from 2,286 to 9,053 million kilowatt hours. A comparison of the relative amounts produced in each State is shown in the following table :—

PROPORTION OF ELECTRIC POWER PRODUCED IN EACH STATE.

(Per Cent.)

Year.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Total.
1928–29	42	29	4	7	5	13	100
1948–49	41	28	10	6	4	11	100

During the 1920's, demand increased very rapidly as supply was extended to new areas and electricity usage considerably diversified. In that period, consumption increased at a rate of 15 per cent. per annum compound, which amounted to a doubling of the load each five years. As the net population increase averaged a little less than 2 per cent. per annum, this was not a significant contribution to the comparatively rapid increase in consumption.

During the depression of the early '30's, demand remained fairly constant, but from 1934 to 1939, as industrial activity regained momentum, consumption increased rapidly each year at a rate of from 8 to 10 per cent. per annum compound. During the 1939–45 War, power restrictions were imposed on commerce and industry, very few houses were built and, in general, new domestic electric appliances were either in short supply or not available. Despite these conditions, consumption continued to increase, but this was due mainly to rising demand caused by war production.

Since the 1939–45 War industry and commerce have expanded rapidly, many new houses have been built and the population has increased by approximately 8 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 inflated demand for power cannot be satisfied by the existing installed capacity of central generating stations. For example, average consumption per head per annum in 1950 exceeded 1,000 kWh., compared with approximately 500 kWh. before the war. During the period 1939–40 to 1949–50, the capacity of electrical machinery installed by secondary industries and utilizing purchased electricity, increased by 118 per cent., namely, from 1.1 million horse-power to 2.4 million horse-power.

Notwithstanding the fact that production of electric power nearly doubled in the decade between 1938–39 and 1948–49, all States have found it necessary to introduce some form of power rationing, particularly during the winter peak period. The main cause of the inadequate supply was, and continues to be, the lack of sufficient generating capacity, a situation which originated in the restriction of development programmes during the 1939–45 War. Rationing has in some States also been partly due to inadequate coal supplies, particularly in those dependent on New South Wales coal.

(iii) *Generating Capacity.* In 1949, installed generating capacity in Australia totalled approximately 2.1 million kW. compared with 1.7 million kW. in 1939, an increase of about 24 per cent. This represents 0.28 kW. and 0.24 kW. per head of population in 1949 and 1939 respectively, while the total population increased by 14 per cent. in this period. Had demand per head remained constant, the increase in installed capacity would have been adequate to cater for the additional consumption by the larger population. However, the factors already mentioned have caused demand to be considerably in excess of supply or potential supply, especially during the winter.

This situation has been met in part by the increased use of available plant. In 1939 each kW. of installed capacity produced an average of 3,000 kWh. per annum, compared with an average of 4,400 kWh. in 1949. 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 outputs per kW. installed were 5,000 and 5,400 kWh. in 1939 and 1949 respectively, compared with 2,300 and 3,600 kWh. in South Australia.

With a view to further decreasing the gap between demand and supply and reducing peak loads, electricity authorities have introduced differential tariffs, zoning in some areas, and restrictions on the use of certain electrical appliances. However, particularly in New South Wales and Victoria, the absence of reserve plant has led to frequent "black-outs" in recent years because of the inability to handle winter or abnormal peak loads.

5. **Future Developments.**—(i) *Power Supply and Demand.* 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 be taken into account.

Increases in population, even if unaccompanied by increases in consumption of power per head, would result in overall increases in consumption. The rise in industrial demand, which was very great during the period 1930–1950, may be expected to continue, even though the rate of increase slows down; this will further add to the demand for power.

(ii) *Thermal-Hydro Comparison.* The increasing relative importance of the generation of electric power from water resources is illustrated by the following expected changes in proportion between steam, hydro and internal combustion installed generating capacity over the period 1949 to 1960, viz.:—Steam, from 82 per cent. to 71 per cent.; hydro, from 13 per cent. to 26 per cent.; internal combustion, from 5 per cent. to 3 per cent. Although it is evident that, unless there is revolutionary change in the ways of using resources for producing electric power, hydro generated electricity will remain of lesser importance than that generated by steam, its contribution will become more significant as existing potential is developed and problems connected with the transmission of power over relatively great distances are overcome. Furthermore, in comparison with thermal generated power, the cost of generation per unit is substantially lower, although increases in capital costs of large hydro-electric projects may raise the overall costs of production to a level not much lower than that prevailing for thermal generated power.

6. **Summary.**—The major portion of Australia's power resources, namely, her coal deposits and hydro-electric potential, are concentrated in the south-eastern section of the continent, an area comprising approximately one-sixth of the total. Closely related to this distribution of basic resources is the location of population and industry. In this area are contained 89 per cent. of the population and more than 90 per cent. of Australia's secondary industries.

In the years between 1929 and 1949, production of electric power increased by nearly 300 per cent. This increase followed the rapid growth of industrial activity, usage of electric power in new fields, and a greatly increased consumption per consumer. To-day, owing mainly to the retarding of constructional programmes during the 1939–45 War, production of electric power is insufficient to cater for demand, compelling most States to impose power rationing on industrial and domestic consumers with varying degrees of severity. In an endeavour to overcome the present unsatisfactory supply position, State electricity supply authorities have projects under construction which, if carried out according to programme, will double generating capacity in the Commonwealth by 1956.

Since 1914 there has been a consistent movement towards nationalization of the electricity supply industry, which in the post 1939–45 War period has accelerated. At present, all major power stations producing electricity for sale are, in varying degrees, under the control of statutory State commissions. Where practicable, supply is being extended in rural areas, and small private and municipal organizations generating power in country towns are being absorbed into the system of the States' central electricity supply authorities. Many municipalities, however, buy in bulk and undertake local reticulation.

Each State has problems peculiar to its own territory relative to the generation and distribution of electric power, and these will be discussed in the respective sections.

B. SNOWY MOUNTAINS HYDRO-ELECTRIC SCHEME.

1. **Geography of Area.**—The main features of the Snowy country in south-eastern New South Wales have been described earlier in this survey. It 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 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.

2. **Historical.**—(i) *Early Suggestions for Utilization of Snowy River.* 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 uninhabitated 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 very 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 very large proportion of the waters from the south-eastern New South Wales snowfields.

As early as 1884, the possibility of diverting its waters to the parched inland plains had been suggested by the Surveyor-General, Mr. P. F. Adams, in evidence before a Royal Commission on water conservation. Subsequently, the increasing use of electricity led to investigations of its possibilities as a source of hydro-electric power. Interest shifted sporadically between these two objectives, and the Snowy was 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.

In 1918, a Parliamentary survey was carried out by the New South Wales Public Works Department of a project to utilize the waters of the river for generation of electric power, and a report in this regard was presented to the Under Secretary of the Department on 16th January, 1920. Nothing, however, resulted from this proposition. In 1937 the British firm of Consulting Engineers, Messrs. Rendel, Palmer and Tritton, in the course of a report to the New South Wales Government, suggested a new scheme for the utilization of Snowy waters, based on building a storage dam at Jindabyne and expected to produce 220,000 kVA. of power.

The 1939–45 War, however, 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.

(ii) *Committee of Commonwealth and State Representatives*, 1946–1949. 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.

(iii) *Constitution of Snowy Mountains Hydro-electric Authority*, 1950. 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.**—The proposals at present being implemented fall into two groups—(i) Tumut Development and (ii) 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 1178. 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.

(i) *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 head waters 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 to be 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 15-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 racelines 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.

To the Lob's Hole Reservoir will also be brought the waters of the Upper Murrumbidgee from another major storage at Tantangara, holding over 350,000 acre feet. From it, waters will be led by tunnel to power station T.3 with an installed capacity of 140,000 kW., which will discharge 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 160,000 kW. which, in turn, will discharge into the Lob's Hole Reservoir.

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 will have a capacity of about 800,000 acre feet and at the foot of the dam will be the last of the Tumut power stations, T.7, with a capacity of some 500,000 kW., but this station will operate only when water is released for irrigation.

The total extra new water which will reach the Murrumbidgee is expected to average 565,000 acre feet per annum and the total installed capacity of the various power stations is estimated at 1,310,000 kW. (excluding T.7).

(ii) *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 1,200,000 acre feet, and from it will run right through the Great Dividing Range a tunnel approximately 32 miles in length, 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 will lead to station M.1.B. with a capacity of 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 already commenced. Munyang Pond will discharge into a tunnel leading to station M.2 H and L with installed capacity of 85,000 kW., thence into a reservoir at Island Bend on the main stream of the Snowy.

From the Island Bend reservoir, a vertical shaft, 1,000 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 250,000 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 racelines and tunnel to station M.5.H. with an installed capacity of 40,000 kW., discharging into Geehi River pond.

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 730,000 acre feet per annum, but as 330,000 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, 400,000 acre feet per annum; the total installed capacity of the power stations, 1,700,000 kW.

(iii) *Race Lines.* An integral part of each development is the construction of hundreds of miles of racelines, 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 greater 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.

For the purposes of general comparison, the ratio of 38 per cent. for effective capacity of hydro power to 62 per cent. thermal has been adopted. This, however, is only tentative and may be departed from as the scheme proceeds. It has, however, 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 project has not yet proceeded so far that plans can be formulated for the actual scheme of power distribution, but transmission lines from the Australian Capital Territory via Cooma are under construction and, whereas this is primarily to supply power from the existing New South Wales network to the operational sites for construction purposes, it is anticipated that, when station M.I.B. comes into operation, power will then be fed from that station back to the interconnected network. The original estimates for transmission costs in the proposal were based on transmission to load centres at 220,000 volts, but it is probable that much higher voltages will be used.

C. STATES AND TERRITORIES.

§ 1. New South Wales.

1. **General Historical.**—Experiments first took place with electricity in Sydney during 1860, and it was first commercially used in 1878; since then the generation and distribution of power and the responsibility for these functions have undergone considerable changes.

Initially, the supply of electricity was a purely local problem, and it was not until satisfactory techniques had been developed for transmitting electricity over longer distances that the need arose for co-ordination on a State-wide basis. Consequently, in the early stages numerous organizations, both large and small, private and public, entered the field.

A pioneer in electricity generation and supply was the Tamworth Municipal Council, which reticulated power for street lighting in 1888; during the same year the town of Young was supplied with electricity, followed by Penrith and Moss Vale (1889), Broken Hill (1890) and Redfern (by the Redfern Municipal Council), during 1891. In the city of Sydney, King-street was lighted between Elizabeth and Pitt streets during 1892. Prior to 1904, electricity was supplied in the City of Sydney by five small companies:— the Empire Electric Light Co., the Strand Electric Light Co., the Imperial Arcade Electric Light Co., the Oxford Street Electric Light Co., and the Palace Electric Light Co. These concerns and the undertakings of the Redfern Municipal Council were subsequently purchased by the Municipal Council of Sydney.

In the early days of power production, both generation and distribution were the responsibility of each authority. However, with the growth and diversification of electric power usage, two factors, interconnexion of power stations and bulk supplying, have tended to separate the function of generation of electricity from its reticulation. The first interconnexions took place in the Sydney area, when Ultimo power station,

operated by the Department of Railways, was linked with Pyrmont, a station owned by the Sydney Municipal Council. In Newcastle, the Department of Railways power station at Zarra-street was connected to the Newcastle Municipal Council's electrical undertaking in Sydney-street. As a result of these power links a large proportion of the electricity supplied to domestic and industrial consumers in Sydney and Newcastle was generated by the Department of Railways.

At the same time, the practice of bulk supplying was increasing. A number of Sydney municipalities were distributing power purchased in bulk from the Department of Railways and the Electricity Supply Undertaking of the Sydney Municipal Council. The further development of this trend toward separation of generation from distribution is illustrated by the fact that in 1949 there were 67 organizations generating power, compared with 161 supplying it. It may be noted that, of these 67 generating organizations, four produced approximately 95 per cent. of the total electricity production in New South Wales.

Before establishment of the State Electricity Commission of New South Wales which was constituted under the Electricity Commission Act 1950, the major organizations responsible for the generation of electric power were the Sydney County Council, the Department of Railways, the Electric Light and Power Supply Corporation, the Southern Electricity Supply, and the Clarence River County Council. A discussion of the early history and the growth of these organizations up to 1950, and of the general pattern of electric power development in New South Wales follows. (Details of the projects under control of the Snowy Mountains Hydro-electric Authority are dealt with separately in Part B, commencing on page 1154.)

The areas of supply of the major generating authorities and the location of small generating undertakings are shown on the map on page 1172.

2. **The Sydney County Council.**—Under the Municipal Council of Sydney Electric Lighting Act 1896, the Electricity Supply Undertaking was established in 1902 and by 1904 was reticulating electricity for domestic and industrial purposes and for street illumination. As the Act provided for construction of generating and transmission equipment to cater for an increasing load and extension of the area of supply, steps were taken to erect a power station at Pyrmont on Sydney Harbour. The initial installation consisted of three vertical engines direct coupled to alternators generating at 5,000 volts, 3-phase, 50 cycles, having a total capacity of 1,500 kW. The demand for power in the area supplied was continually increasing, necessitating frequent extensions of capacity, and by 1924 installed capacity totalled 73,500 kW. This was considered the maximum economic size for the station.

In 1925 construction was commenced on a steam station at Bunnerong on Botany Bay designed for a capacity of 150,000 kW. consisting of six 25,000 kW. units; it was completed during 1930. Boiler plant comprised eighteen boilers, each complete with stokers and mechanical draught plant. In August, 1937, a further 25,000 kW. unit was installed making the station's total capacity 175,000 kW. During 1939, Bunnerong "B" was placed in service with one 50,000 kW. unit—another 50,000 kW. unit being installed in 1941. By 1947, one more similar unit had been added, giving Bunnerong "A" and "B" an aggregate of 325,000 kW. Between 1929 and 1940, some of the older units at Pyrmont were withdrawn from service, reducing generating capacity to 49,500 kW.

On 1st January, 1936, the ownership and control of the Electricity Supply Undertaking were vested in the Sydney County Council, an organization created by the Gas and Electricity Act 1935-1941. From its two major power stations, namely Bunnerong and Pyrmont, the Council supplies electricity direct to industrial and domestic consumers and provides power for street lighting in the city and 33 suburbs. Bulk supplies are sold to a number of municipalities and to the Hawkesbury Development Company, an organization having a franchise to reticulate electricity in parts of Penrith Municipality and Colo Shire.

Originally, an area of about one square mile in the centre of the city was supplied by power converted to direct current operation. During 1930, work was commenced to

change the supply to alternating current. Numerous interruptions caused the conversion programme to be retarded, but much of the rewiring has now been done, an alternating supply system has been established throughout the area, and the changeover of installations in premises is proceeding.

Power generated at Bunnerong is stepped up from 11 kV. to 33 kV. for transmission to a number of substations, where the voltage is reduced to 5 or 11 kV. for reticulation to distribution centres. Electricity from the Pyrmont station, used normally for peak load requirements during the winter months, is transmitted at 5 kV. direct to distributing centres. Bunnerong and Pyrmont are connected by cables, having a capacity of 75,000 kVA.—the system further provides for interchange of power between Pyrmont and the Railway Department's White Bay power station, and Bunnerong and the Department of Public Works' station at Port Kembla. Capacities of the interconnecting equipment of these two systems are 36,000 kVA. and 15,000 kVA. respectively. Further interconnexions exist between the systems of the Sydney County Council and the Electric Light and Power Supply Corporation.

The growth of the undertaking of the Sydney County Council between 1904 and 1949 is indicated by the following comparisons:—Installed capacity, from 500 kW. (estimated) to 375,000 kW.; units sold, from 0.258 million kWh. to 1,112 million kWh.; consumers, from 86 to about 300,000. The Council also supplies electricity in bulk to the municipalities of Holroyd, Ryde, Windsor, Penrith and Fairfield, the Blacktown, Baulkham Hills and Hornsby Shires, and the McKellar County District. Consumers in these areas number approximately 68,000.

The proportions of electricity usage by the various classes of consumers supplied by the Sydney County Council during the years 1944 and 1949 respectively are as follows:—Domestic, 30 per cent., 33 per cent.; industrial, 48 per cent., 43 per cent.; commercial, 11 per cent., 9 per cent.; bulk, 9 per cent., 13 per cent.; street lighting, 2 per cent. each year. Rationing of power was more severe in 1949 than in 1944, particularly for industry and commerce.

3. **The Department of Railways.**—The Department of Railways commenced the generation of electricity in 1899 with a steam power station located at Ultimo, a suburb of Sydney. It now operates four major stations, namely, Ultimo and White Bay in the metropolitan area, and at Newcastle and Lithgow. Installed capacity and units generated in 1935-36 and 1948-49 were as follows:—

NEW SOUTH WALES: DEPARTMENT OF RAILWAYS SYSTEM.

Power Station.	1935-36.		1948-49.	
	Installed Capacity.	Units Generated.	Installed Capacity.	Units Generated.
	kW.	m.kWh.	kW.	m.kWh.
Twenty-five cycle—				
Ultimo	50,000	165	60,000	300
White Bay	63,750	38	27,500	43
Fifty cycle—				
White Bay	86,000	220	86,000	398
Zarra-street(a)	35,000	105	77,500	358
Lithgow	7,500	14	12,500	54
Total	242,250	542	263,500	1,153

(a) Includes some 25-cycle generating equipment.

Initially, the Ultimo undertaking was designed to supply a 600 volt direct current service for the city trams; this was increased to 6,600 volts operating at a frequency of 25 cycles, with radial feeders to sub-stations. At a later stage, the direct current generating plant was replaced by rotary convertors for the inner city 600 volt services. The convertors were supplied from either the Ultimo alternating current plant, or, if desired, from the original section of the Department's power station at White Bay, both of which operated at a frequency of 25 cycles; the more recently constructed section of White Bay operates at 50 cycles.

The Department of Railways steam station located at Zarra-street, Newcastle was placed in service during 1917. In addition to providing power for the Newcastle electric tramways, a service inaugurated in 1923, the Department sells bulk supplies to the Greater Newcastle and Maitland City Councils, municipalities of Dungog and Singleton, shire councils of Stroud and Gloucester and the Clarence River, Macleay River, Manning River, Brisbane Water, and Oxley County Councils. The Newcastle trams were replaced by buses during 1950. At Lithgow, situated 96 miles west of Sydney, the Department operates another steam station which was placed in service during January, 1928. Power is supplied in bulk to the State Coal Mine at Lithgow and to a number of local authorities between Lawson and Dubbo. These include the Lithgow, Orange and Bathurst City Councils, Lyndhurst and Wellington Shire Councils and Dubbo Municipal Council, the Blue Mountains City Council at Katoomba, and the Blaxland Shire Council at Wallerawang near Lithgow.

4. **The Electric Light and Power Supply Corporation Ltd.**—In 1909 the Electric Light and Power Supply Corporation Ltd. commenced production of electricity from its power station at Balmain—a suburb of Sydney. The Corporation was permitted to reticulate electricity to five suburban municipalities, Ashfield, Balmain, Leichhardt, Newtown and Petersham. Present installed generator capacity of the Balmain station is 48,000 kW. During 1949 the Corporation expanded its activities by the acquisition of two other private electricity supply organizations—Parramatta and Granville Electric Supply Co. Ltd. and the Dundas Electricity Undertaking. The first mentioned organization was formed in 1913, and with purchased power served certain areas of the municipalities of Parramatta and Granville. These undertakings are to be acquired by the Electricity Commission at a price to be determined by the Land and Valuation Court.

5. **The Southern Electricity Supply.**—In the eastern central area of New South Wales (*see* map on page 1172) the Southern Electricity Supply, which was formed in 1942 under the Southern Electricity (Administration) Act, No. 3 and which was administered by the Department of Public Works, operated five power stations located at Yanco, Port Kembla, Cowra, Burrinjuck and Wyangala near Cowra. These five stations, the first three steam and the latter two hydro, are interconnected to form the Southern Electricity Supply system. In addition, the Canberra power station, which is owned by the Commonwealth Department of Works, is part of the system. The Electricity Commission pays an annual rental for the station, and also owns some of the plant there. Power is transmitted by a 132 kV. line 145 miles long connecting Burrinjuck and Port Kembla, while Yanco, Burrinjuck, Wyangala and Canberra are connected by transmission lines of 66 kV. To permit an interchange of power, the system has been interconnected by 66 kV. lines with the metropolitan systems and the Department of Railway's western system at Orange. The assets, liabilities and staff of the Southern Electricity Supply were transferred to the Electricity Commission on 1st November, 1950, and the Southern system became the first part of the State's interconnected system to be owned and operated by the Electricity Commission.

The Southern system provides power in bulk to the Commonwealth Department of the Interior at Canberra and a number of local government authorities, who in turn supply electricity for domestic, industrial and street lighting purposes in their shires or municipalities. Bulk supplies are also made to the Water Conservation Irrigation Commission at Yanco, which reticulates power to towns in the Murrumbidgee Irrigation Area, including Griffith, Leeton and Yenda. In 1948–49 it purchased 16 million kWh. of energy.

Growth of the Southern Electricity Supply's system in the decade 1939 to 1949 is shown in the following table :—

NEW SOUTH WALES : SOUTHERN ELECTRICITY SUPPLY SYSTEM.

Power Station.	1939.		1949.	
	Installed Capacity.	Units Generated.	Installed Capacity.	Units Generated.
	kW.	m.kWh.	kW.	m.kWh.
Yanco	4,750	9	4,750	7
Port Kembla	14,500	37	28,000	114
Burrinjuck	20,000	(a) 30	25,800	111
Wyangala	..	..	7,500	31
Canberra	(b) 5,100	(b) 13	5,100	6
Cowra	..	..	5,000	7

(a) Restrictions were imposed during 1939 owing to drought conditions in the catchment area. (b) Year 1938–39. Part of the plant was installed prior to linkage with the interconnected system; immediately thereafter Canberra became a stand-by station.

Proportions of units sold within the Southern Electricity Supply system to the various consumers of power are : bulk, 64 per cent. ; industrial, 32 per cent. ; retail, 3 per cent. ; and miscellaneous, 1 per cent. Organizations receiving bulk supplies reticulate electricity to domestic and industrial consumers and use some power for street lighting.

6. **The Clarence River County Council.**—On the north coast of New South Wales, the Clarence River County Council is responsible for the generation of electricity in an area stretching from Kempsey in the south to near the Queensland border (*see* map on page 1172). Richmond River (Electricity) County Council and Mullumbimby Municipal Council obtain marginal supplies from the Clarence River County Council to supplement the electricity generated in their own power stations.

The Clarence River County Council was set up in 1923, pursuant to the Local Government Act 1919, with the object of developing some of the hydro-electric potential of the Nymboida catchment. On 25th November, 1924, the station was placed in service with an installed generator capacity of 800 kW. The area of supply included the city of Grafton, the municipalities of South Grafton and Ulmarra, and the surrounding district. As the system was extended to new localities and consumption per head rose, the station's installed capacity was increased and by 1939 amounted to 4,800 kW.—the project's designed maximum output. The Council also operates a diesel stand-by station of 0,800 kW. at Lismore and a small hydro station of 300 kW. at Dorrigo, west of Coff's Harbour. Capacity at Lismore is being increased by the installation of an additional 1,000 kW. diesel unit.

Nymboida and Lismore stations are connected by a 66 kV. transmission line approximately 90 miles long, with two step-down substations en route at Grafton and Casino. From Nymboida the line runs south to Kempsey, where it interconnects with the Department of Railways 66 kV. system. A secondary transmission system supplies power in the County Council's area and to a number of shires and municipalities at 33 kV. (*see* map on page 1172). The municipalities of Lismore and Casino obtain power in bulk, while the Mullumbimby Municipal Council and the Richmond River (Electricity) County Council receive some of their requirements from this source. The three stations generated 49 million kWh. of energy in 1949, of which Nymboida contributed 36 million, Lismore 12 million and Dorrigo one million. A total of 13,932 consumers were connected in that year to the system, compared with 9,698 in 1940, when 25 million kWh. were generated. The total area supplied by the Council is about 10,000 square miles.

7. **Other Organizations.**—At Tamworth, approximately 190 miles north of Sydney, the Tamworth Municipal Council supplies electricity in bulk or retail to the municipalities of Manilla and Quirindi, the Shires of Cockburn, Peel, Liverpool Plains and Mardowa, and to the Namoi Valley, New England and North-west County Councils. The Council has the distinction of being the first organization in Australia to supply electric power for street lighting, a service which was inaugurated in November, 1888. During 1907 it commenced to reticulate supplies to domestic and industrial consumers. A steam station located at Tamworth has an installed generator capacity of 16,300 kW. Energy is generated at 3.3 kV. and stepped up to 66 kV. for transmission. Power lines run north to Inverell, north-west to Narrabri, and south to Murrurundi (*see* map on page 1172). During 1950 a total of 28 million kWh. of power were generated compared with 14 million in 1945 and 12 million in 1943.

Retail supply of electricity in the Newcastle area is in the hands of the City of Newcastle Electric Supply Department. The service was inaugurated in 1894 by the Newcastle City Council and became the responsibility of the Electric Supply Department in 1897. At that time, 290 consumers used 750,000 kWh. of energy, compared with 48,000 consumers in 1947 who purchased about 192 million kWh. The Department maintains a steam stand-by station of 2,500 kW., but purchases in bulk the major portion of its power requirements from the Railways Department station at Zarra-street.

The Electric Supply Department's area of supply covers 1,270 square miles, having a population in 1947 of 209,800 persons. In addition to Greater Newcastle, territory served comprises the Shire of Lake Macquarie, and parts of the Shires of Lower Hunter, Port Stephens, Wallarobba and Kearsley. Proportions of electricity usage amongst the various classes of consumers in 1943, 1947 and 1950, respectively, were as follows:—Domestic, 18 per cent., 22.5 per cent., 30 per cent.; commercial, 7 per cent., 8 per cent., 8 per cent.; industrial, 73 per cent., 68 per cent., 61 per cent.; street lighting, 2 per cent., 1.5 per cent., 1 per cent.

Numerous other authorities and private firms are active in New South Wales generating or distributing power, or both, but in general to rural districts and country towns. Some of the larger undertakings include the Oxley, Bega Valley, St. George, Northern Riverina, Southern Riverina, North-west and Brisbane Water (Gosford) County Councils, and the Broken Hill and Blue Mountains City Councils. A number of these organizations purchase their supplies in bulk from the principal supply authorities, e.g., Department of Railways and Electricity Commission. In addition, a number of large industrial organizations generate power for their own use and in some cases supply electricity to surrounding districts or contribute to the interconnected system during peak load periods.

8. **State Organization.**—(i) *Gas and Electricity Act* 1935. Prior to 1935, apart from certain provisions under the Local Government Act, there was virtually no legislation enabling supervision to be exercised over the development and co-ordination of electricity supplies in New South Wales. In 1935, however, the Gas and Electricity Act, which made some important amendments in respect of electricity supply to the Local Government Act, became law. Under its provisions, an Advisory Committee was convened for the purposes of investigating proposals involving the construction of power stations, major increases in generator capacity, erection or extension of main transmission lines and associated works. The Committee was required to report on any such proposals to the Minister for Local Government.

(ii) *The Electricity Authority of New South Wales.* Under the Electricity Development Act of 1945 the Electricity Authority of New South Wales was constituted for the stated purpose of promoting and regulating the co-ordination, development, expansion, extension and improvement of electricity supply throughout the State.

The Authority assumed the duties formerly carried out by the Electricity Advisory Committee together with certain further powers, and became responsible for the overall planning and co-ordination of electrical development throughout the State. Of major concern was the rationalization of supply areas, and, in particular, the consolidation of

town and rural areas under one electricity organization. The main approach to this problem has been through the avenue of County Councils established for the purpose of distributing electricity throughout the County Districts. There are now 21 electricity County Councils in the State, ten of which have been constituted since 1947.

The Authority also administers the Rural Electricity Subsidy Scheme, introduced by the Government in 1946, under which are provided subsidies amounting in some cases to nearly 50 per cent. of the cost of rural extensions. The initial programme under the Scheme aimed at the extension of electricity supply to 24,000 farms and 9,500 other rural consumers within a period of ten years. By 1951 a total of 12,800 farms and 11,000 other rural consumers had actually been connected. The total number of farms in New South Wales is more than 70,000 and of these, some 16,000 were connected when the Scheme began. Thus about 40 per cent. of the farms in the State are now served by electricity.

The Authority also exercises control over safety standards—its functions in this sphere including the approval of prescribed electrical appliances and the licensing of electricians and electrical contractors.

The functions of the Authority are not affected by the Electricity Commission Act 1950, except in so far as the work of the Commission is not subject to the approval of the Authority.

(iii) *Electricity Commission of New South Wales.* The legislation constituting the Electricity Commission was contained in the Electricity Commission Act 1950, which also amended certain provisions of the Gas and Electricity Act 1935-1949, and repealed the Southern Electricity (Administration) Act 1942. The Electricity Commission Act empowers the Commission to acquire electricity undertakings and mentions specifically the undertakings of the Electric Light and Power Supply Corporation Ltd., and the Parramatta and Granville Electric Supply Co. Ltd., Sydney County Council, Commissioner for Railways and the Southern Electricity Supply of New South Wales. When these acquisitions are effected, it becomes the responsibility of the Commission to generate and transmit to bulk consumers. The Commission will then produce approximately 96 per cent. of the electricity for public supply and traction. However, local reticulation will remain the responsibility of separate distributing authorities, mostly controlled by local government bodies. The Southern Electricity Supply was taken over in November, 1950, and the Sydney County Council's electricity generating assets on 1st January, 1952. Arrangements have been made to acquire the other two major undertakings, which are already subject to the Commission's control in respect of the amount of electricity they are required to feed into the interconnected system. When acquisition is completed, the 79 bulk consumers of the four major organizations specified will purchase electricity in bulk from the Commission. In general, therefore, local government bodies, including the Sydney County Council, will continue to distribute electricity to consumers throughout the State, but the Commission will be responsible for the generation and transmission to these distributors and for providing the major portion of the State's requirements of electricity.

9. **Electricity Generation.**—(i) *General Position.* The following statistics show the growth of electricity generation in New South Wales between 1939-40 and 1949-50 :— Installed capacity, 790,103 kW. to 980,871 kW. ; units generated, 2,145 million kWh. to 3,758 million kWh. ; consumers, 520,000 to 784,000.

Despite the significant increase in the amount of power generated, supply has been unable to keep pace with the growth of demand—particularly since 1945. Severe restrictions have been imposed in the metropolitan area on the use of power by all classes of consumers during the winter months and to a lesser extent during other periods of the year. It has been estimated that, provided the installation of new generating capacity is maintained at present schedules, supply will be adequate to meet unrestricted demand by 1954.

(ii) *New Generating Capacity.* There are a number of works under construction in the metropolitan area and elsewhere in New South Wales which are designed to increase installed capacity. The more important projects, involving construction of new stations or extension of existing stations, and their location, are as follows :—

(*a*) *Thermal Capacity* (kW.).

Sydney Metropolitan Area.—Pyrmont "B", 200,000; Bunnerong "B", 50,000; Balmain, 50,000; White Bay, 100,000; Liverpool, 20,000; Penrith, 20,000.

Port Kembla Area.—Tallawarra (Lake Illawarra), 240,000; Port Kembla, 20,000.

Newcastle Area.—Lake Macquarie, 300,000; Maitland, 20,000.

Lithgow Area.—Wallerawang, 120,000; Lithgow, 22,500.

Other.—Koolkhan (near Grafton), 17,500; Gunnedah, 50,000.

(*b*) *Hydro-electric Capacity.*

Hume Weir—hydro-electric, 50,000 kW.—initially the New South Wales system will benefit by 25,000 kW. from this project.

By far the greater proportion of generating capacity in New South Wales, 92 per cent. of the total, is steam-operated, the balance of 8 per cent. being equally divided between hydro-electric and internal combustion plant. Considerable hydro potential does exist, however, in the Snowy Mountains area and in the rivers flowing into the Pacific Ocean along the northern coast. Surveys undertaken in the Clarence River (a northern coastal river) area have indicated that a potential of between 300,000 and 400,000 kW. exists. Plans are being formulated by which 35,000 kW. will initially be developed. Details of projected works in the Snowy region, where it is estimated that more than 3 million kW. of generating equipment can be installed, are dealt with on pages 1155-6. After Commonwealth requirements from the Snowy scheme have been met, the remaining output will be shared between New South Wales and Victoria in the proportions of two-thirds and one-third, respectively.

§ 2. Victoria.

1. **General Historical.**—Since 1919, control of the generation and distribution of electric power in Victoria has been vested in the State Electricity Commission of Victoria (known until 1921 as the Electricity Commissioners). Prior to 1919, there was no legislation to co-ordinate and unify electricity supplies throughout the State—development of electric power production being in the hands of local government authorities and private organizations. After 1896, however, authority to operate electrical undertakings and private organizations was granted pursuant to the Electric Light and Power Act or by Orders-in-Council.

Records of early achievements in the production of electricity indicate that it was first employed in 1863 at a display to celebrate the marriage of the Prince of Wales. Current was generated by Cullen chemical batteries and burnt in three arc lamps erected in the City of Melbourne. In 1878 and 1879 two firms, Sands and McDougall and the Apollo Candle Co., each imported an arc lamp and generating equipment—the power produced was used for commercial lighting.

During 1880 the Victorian Electric Light Co. was formed with a nominal capital of £2,500. A small power station, established by the Company in Russell-place, off Bourke-street, later supplied power for lighting the Eastern Market and Athenaeum Hall. In 1881, the company's assets were acquired by the Australian Electric Light Co. Two new firms commenced operations in 1883, the Australian Electric Light, Power and Storage Co. and the Indian and Colonial Edison Co. The first-mentioned firm later merged with the Australian Electric Light Co., while the latter went out of existence.

In 1886 the Australian Electric Light Co. (later reconstituted under the name of the New Australian Electric Lighting Co., with a capital of £250,000) acquired a piece of land at Richmond—present site of the State Electricity Commission's power station in that suburb—and commenced work on a station designed for an ultimate capacity of 9,000 kW. During 1891 the company secured contracts for street lighting in the suburbs of Richmond and Prahran.

In 1899, the assets of the New Australian Electric Lighting Co. were purchased by the Electric Lighting and Traction Co. of Australia Ltd. (later the Melbourne Electric Supply Co.), an organization formed specifically for the purpose of acquiring the undertakings of the foregoing company and another smaller firm, the A. U. Alcock Electric Light and Motive Power Company. The company obtained a franchise under the Electric Light and Power Act 1896 to supply electricity in certain areas of Melbourne and Geelong and for tramway traction purposes.

In 1908, the Electric Lighting and Traction Co. of Australia Ltd. changed its name to the Melbourne Electric Supply Company. From its power station at Richmond it supplied power to a large portion of the metropolitan area and to two tramway trusts, while in Geelong the company reticulated power in the city and also operated the tramway service. These undertakings continued to function after the Commission was established, but in 1924 an agreement was made which, in effect, transferred control of the stations to the Commission. In that year the company's franchises were extended by Parliament for five years. Under the terms of the agreement the company was to manage the undertakings pending acquisition by the Commission of its assets at the end of five or seven and one-half years. As part of the agreement, the Richmond station's generator capacity was increased by the installation of a 15,000 kW. unit during May, 1929. In 1930 the Commission exercised its right of purchase, and the company's Melbourne and Geelong undertakings passed to the direct control of the Commission.

During 1894, the Melbourne City Council, which had set up a department to administer its electrical undertakings, started to generate electricity at a power station at Spencer-street, City for domestic and industrial consumption and street lighting. The Council arranged to purchase the undertakings operated by various small companies located near the city's boundaries, but in the final event the purchase was effected from the Electric Lighting and Traction Co. of Australia Ltd., which, before completion of the negotiations for the sale, had taken over the smaller organizations. To cater for an increasing consumption of electric power in its area of supply, the Council at various times took steps to develop the Spencer-street power station, which, by 1951, had an installed capacity of about 44,000 kW. In January, 1941, by agreement between the Council and the Commission, this station became part of the Commission's system, operating under its control although remaining in the Council's ownership.

A third major generating and supply authority in the metropolitan area, the North Melbourne Electric Tramways and Lighting Co. Ltd., was formed during 1905 to supply electric power to Essendon, Kensington and Flemington. This organization, which also supplied energy for tramway traction purposes, was acquired by the Electricity Commission on 1st August, 1922—the tramways portion of the undertaking being passed to the Tramways Board.

Moves had been made before the turn of the century to develop electricity supply in Geelong. In 1899 an Order-in-Council covering the municipal areas of Geelong, Newtown, Geelong West and Chilwell was granted to Messrs. F. J. Leary and J. A. Dawson. This authority was later in the year transferred to the Electric Lighting and Traction Co. of Australia, the term of the order being for 30 years and due to expire during 1929. As mentioned previously, the company's Geelong undertakings were acquired by the Commission in 1930. A tramway service was inaugurated in 1912 and by 1919 the power station had an installed capacity of 1,000 kW. In that year the company changed its supply from direct current to three-phase alternating current.

At Bendigo and Ballarat, the Electric Supply Co. of Victoria was granted a franchise to generate and distribute electric power for domestic, industrial and tramway traction purposes. The company purchased the assets of existing undertakings and commenced operations at Bendigo in 1903 and at Ballarat in 1905. Tramway services were established in both cities. On 30th June, 1931, the company's undertakings were acquired by the State Electricity Commission, but the company's franchises were extended for three years under Commission financial control, full operational control being assumed by the Commission on 1st July, 1934.

2. **The State Electricity Commission of Victoria.**—(i) *Extent of System.* The foregoing outlines the picture of the development of the generation and distribution of electric power in Victoria from early times, and the gradual process of acquisition of electrical undertakings by the State Electricity Commission after its establishment in 1919. Since that date the Commission has developed a State-wide system supplying two-thirds of the State in which four-fifths of the population reside.

Included in the State generating system there were at 30th June, 1951, thirteen steam-electric, hydro-electric and diesel-electric power stations located at different centres in the State, and all interconnected in one State-wide system. The distribution system comprised 15,200 miles of high and low voltage power lines, eight terminal receiving stations and over 6,700 distribution sub-stations.

(ii) *Origin and Development.* First moves towards establishment of a State statutory authority to develop Victoria's electric power resources were taken in 1917 with the appointment by the Victorian Government of an Advisory Committee, whose objects were to "make certain investigations and report in regard to the commercial utilization of brown coal, and particularly for the purpose of generating electrical energy". In its Report dated 25th September, 1917, the Committee, amongst other things, recommended the erection of a power station at Morwell with transmission facilities, and the creation of an appropriate authority to initiate and control the project.

As a result of the Committee's Report, a Bill was drafted and presented to Parliament on 10th December, 1918, and received royal assent on 7th January, 1919. Under the terms of this Act, three Commissioners were appointed, who took up duty on 4th March, 1919. 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; 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.

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 Morwell brown coal field 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 Morwell station (its name was changed to Yallourn in 1920) and any other power house to be erected in connexion with the proposed State electric supply scheme should be interconnected with the Railways Department power station at Newport and operated under the control of a single authority.

However, no action was taken until 1948 to transfer the Railways Department's section of Newport to the State Electricity Commission—the actual transfer being effected on 21st January, 1951. Newport "A", which operates at 25 cycles frequency, was established by the Department of Railways during 1918, providing power for the suburban electric trains—a service inaugurated in July, 1919 with the electrification of the Sandringham–Essendon line. Several additions to generating equipment were made in subsequent years and by 1948 Newport "A" had an installed capacity of 95,500 kW. At the date of its transfer to the Commission, the station's capacity was 113,000 kW.

As an alternative to early control of Newport " A " by the Commission, arrangements were made whereby the Commission would establish its own station on a site immediately adjacent to Newport " A ", thus securing economy in handling the two authorities' fuel requirements. Work on the new station, known as Newport " B ", commenced during April, 1921. Supplementing the power output of this new project, which was designed for an initial capacity of 30,000 kW. operating at a frequency of 50 cycles, Newport " A " supplied the Commission with 12,500 kW. of 25-cycle energy to assist it in catering for the increasing consumption in the metropolitan area. To convert the power from 25 to 50 cycles, a frequency changer of 12,500 kW. capacity was installed.

The Railways were already under contract to supply electricity to the Melbourne City Council and the Melbourne Electric Supply Co., both of which had installed 5,000 kW. frequency changers which came into operation during 1921. The capacity of the frequency changers in operation at 30th June, 1951, was 22,000 kW. An additional frequency changer of 30,000 kW. capacity is scheduled to be in service during 1952.

By agreement with the Railways Department, the new station, after being placed in service on 12th October, 1923, was operated in conjunction with Newport " A " station by that Department.

This arrangement remained in force until 1939, when the Commission assumed control of the operation of Newport " B ". Also in that year, the station's capacity was increased by the installation of a new 30,000 kW. unit. During the 1939-45 War, a further 48,000 kW. were installed—18,000 kW. at Newport " B " and 30,000 kW. in a new extension known as Newport " C ". Three additional 30,000 kW. units were added to Newport " C ", one each in 1946, 1948 and 1950. By 1951, the total installed generating capacity at Newport " A ", " B ", and " C " was 311,000 kW., which, added to Spencer-street (44,000 kW.) and Richmond (15,000 kW.), made a total of 370,000 kW. installed in the Melbourne metropolitan area, of which all but the 113,000 kW. in Newport " A " power station were included in the 50-cycle interconnected State generating system.

(iii) *Yallourn Power Station.* To implement one of the main purposes for 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. By 1923, power was being supplied to nearby Gippsland areas from a temporary station erected for constructional activities at Yallourn itself—installation of five machines with a total capacity of 62,500 kW. was completed in 1925. Work also commenced on a double circuit transmission line of 132,000 volts (later duplicated) designed to carry the power to Melbourne, a distance of approximately 90 miles. On 24th June, 1924, power was first transmitted on a commercial basis from Yallourn to Melbourne. Main terminal stations were constructed at Yarraville and later at Richmond.

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, whilst, most important of all considerations, an area of one square mile, adjacent to the proposed 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 mechanical 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.

Estimated to contain about 6,000 million tons of brown coal, all capable of being won by mechanized open-cut methods, the Yallourn-Morwell brown coal field forms part of the very large brown coal deposits in the Latrobe Valley, where boring has revealed approximately 18,000 million tons of brown coal capable of being won by open-cut methods of extraction.

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. By 1928, a sixth 12,500 kW. unit had been installed, giving the station a total capacity of 75,000 kW. In the early 1930's construction was commenced on Yallourn "B" with a planned ultimate capacity of 100,000 kW., in four units—this project was completed during 1938, Yallourn "A" and "B" then having a total capacity of 175,000 kW. (In addition, an average of 8,000 kW. of by-product electricity is fed into the system from the Yallourn briquette factory.)

(iv) *Hydro-electric Development.* (*a*) *General.* 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 Weir, 13,500 kW.), Rubicon (9,100 kW.), Lower Rubicon (2,700 kW.), Royston (840 kW.), and Rubicon Falls (275 kW.), were installed, totalling approximately 26,400 kW. The complete project was in service by 1929. When the new Eildon Dam has been constructed, the Sugarloaf station will be replaced by one having a total installed capacity of 135,000 kW. It will comprise two new generators, totalling 120,000 kW. capacity, while the two 6,750 kW. machines in the existing Sugarloaf power station will be re-built and re-installed at the revised rating of 7,500 kW. each.

(*b*) *Kiewa Project.* 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 Mt. Bogong 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 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 placed in service in April, 1945.

The 1937 Kiewa project, prior to its submission to the Government, was critically reviewed by a group of oversea consulting engineers, and their report indicated 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. with an annual output, averaged over a typical period of wet and dry years, of about 986 million kWh. The greater capacity, which required provision of increased water storage and construction of two additional power stations, was planned for completion by 1956. Approval for the amended scheme was contained in the State Electricity Commission Act 1948. Work is proceeding on the project.

(v) *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 the greater part of the Victorian population and certain towns in New South Wales, including

Albury (*see* map on page 1173). By 1929, installed capacity totalled 148,000 kW. and approximately 423 million units of power were generated in that year. Supplies of electricity were being reticulated to practically the whole of the metropolitan area, 140 country towns, and 700 farms. The Commission had erected about 1,500 miles of high voltage transmission lines, extending to Echuca, Corowa and Albury in the north to Port Fairy in the west, and to Lakes Entrance in the east. The following comparative table indicates the growth of the Commission's State system between 1929 and 1951.

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

Particulars.	Year ended 30th June—			
	1929.	1939.	1949.	1951.
Installed Capacity .. .. kW.	148,000	(*b*) 281,400	478,500	510,000 (50 cycle) 113,000 (25 cycle)
Units Generated .. .. m.kWh.	423	898	2,148	2,518 (50 cycle) 193 (25 cycle)
No. of consumers (approx.) (including bulk supply areas)	230,000	368,000	500,000	553,000
Country Centres Served	140	440	720	780
Farms Served	700	4,985	14,419	17,572

(*a*) About 98 per cent. of electricity produced in Victoria is generated by the State Electricity Commission, which also supplies 95 per cent. of consumers. (*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.

During 1950–51, electricity was reticulated to the various classes of consumers in the following proportions—domestic, 35 per cent.; commercial, 15 per cent.; industrial, 44 per cent.; public lighting, 2 per cent.; and traction (excluding railways), 4 per cent.

As stated previously, the State Electricity Commission (as it was styled from 1921 onwards) was established by legislation passed in 1918. This Act and subsequent amending legislation were consolidated in the State Electricity Commission Act of 1928, which (with later amendments) is the Act now governing the operations of the Commission. Operations of independent undertakings are governed by the Electric Light and Power Act 1928, which the Commissioner administers. Statutory powers conferred upon the Commission authorize it, *inter alia*, to own and operate equipment for the generation and transmission of electricity; to co-ordinate and unify the distribution and supply of electricity to all consumers in the State; and control the regulatory functions of the electric supply industry.

Since its inception, the Commission has acquired 78 country undertakings in addition to those acquired in the metropolitan area and in provincial cities, and carries out retail distribution throughout its area of supply, except for part of the metropolitan area where 11 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 also given to five New South Wales border municipalities and shires, Albury, Berrigan, Coreen, Corowa and Moama. There remained in 1951, 55 independent undertakings in various country towns in Victoria generating and distributing their own supplies.

(*b*) *Composition and Control of Inter-connected Generating System.* The Commission's interconnected generating system comprises three principal groups of power stations, namely :—

Steam stations.

Yallourn—burning raw brown coal; Metropolitan and provincial stations—burning briquettes and brown coal. (Newport power station also burns black coal and oil fuel.)

Hydro stations.

Sugarloaf-Rubicon; Kiewa.

Diesel stations.

Shepparton (partly in service in 1951); Warrnambool (partly in service in 1952).

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.

This procedure results in an arrangement of the system on the following general lines :—

1. Yallourn power station, owing to the very low cost of extraction and ample supply of raw brown coal, is a base load station, and is operated continuously at its maximum economic capacity.
2. Metropolitan and provincial steam and internal combustion (diesel) stations—Newport (excluding Newport "A", which supplies power for the Victorian Railways), Richmond, Spencer-street, Geelong, Ballarat, Shepparton and Warrnambool—situated close to load centres, are designed to operate as peak load stations to assist in meeting the heavy, short period load. Pending the completion of extensions to Yallourn power station, a substantial proportion of the total load on the system is carried by Newport "B" and "C".
3. Sugarloaf-Rubicon and Kiewa hydro stations are operated at all times in accordance with the availability of water. They are designed to effect, where possible, a saving of the more expensive fuels used in the metropolitan and provincial thermal stations.

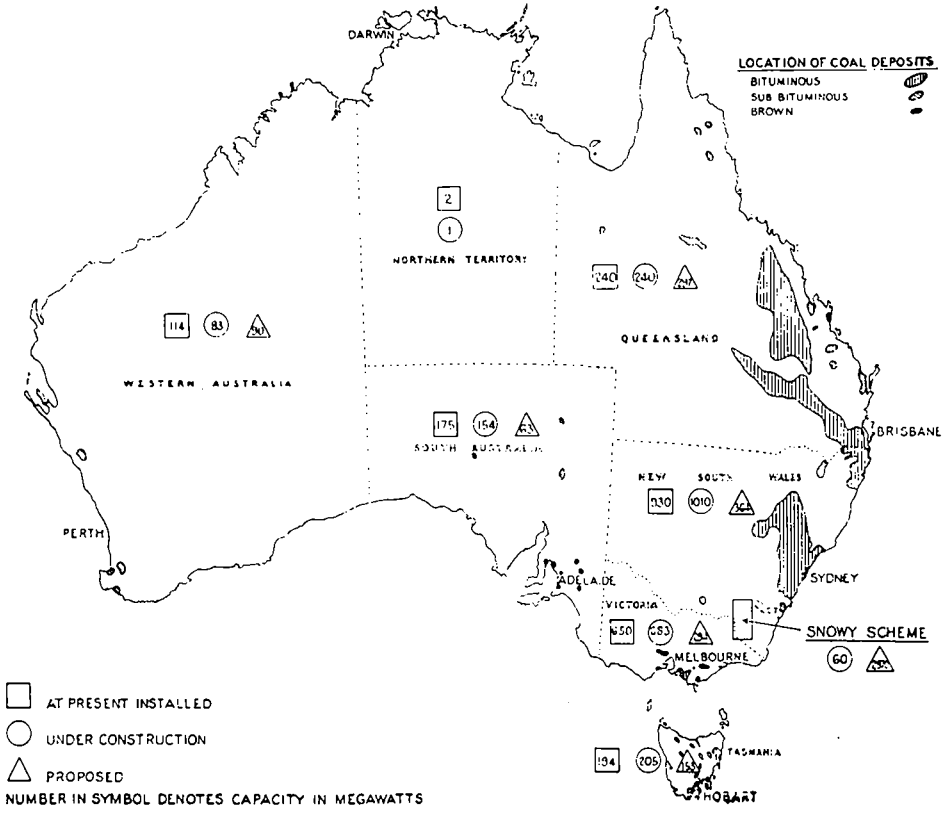
(*c*) *Organization.* In the Commission's organization, the functions of generating and distributing electrical energy are under the control of two separate departments—the Production Department in charge of power stations, brown coal winning, briquette manufacture, terminal stations and main substations, and the Electricity Supply Department, responsible for reticulation to consumers. The territory covered by the latter Department is divided into nine areas, each constituting a supply branch. 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 the metropolitan municipal supply authorities purchasing electricity in bulk at metropolitan terminal stations and a number of main transmission substations. 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 Ballarat, Bendigo, Geelong, Dandenong (Eastern Metropolitan), Traralgon (Gippsland), Castlemaine (Midland), Benalla (North Eastern) and Colac (South Western).

Supply to the Gippsland Branch is obtained from Yallourn power station. From Yallourn 66,000 volt transmission lines extend within the branch to Maffra in the east and Leongatha in southern Gippsland, while another—from Yallourn to Warragul—is due for completion in 1952.

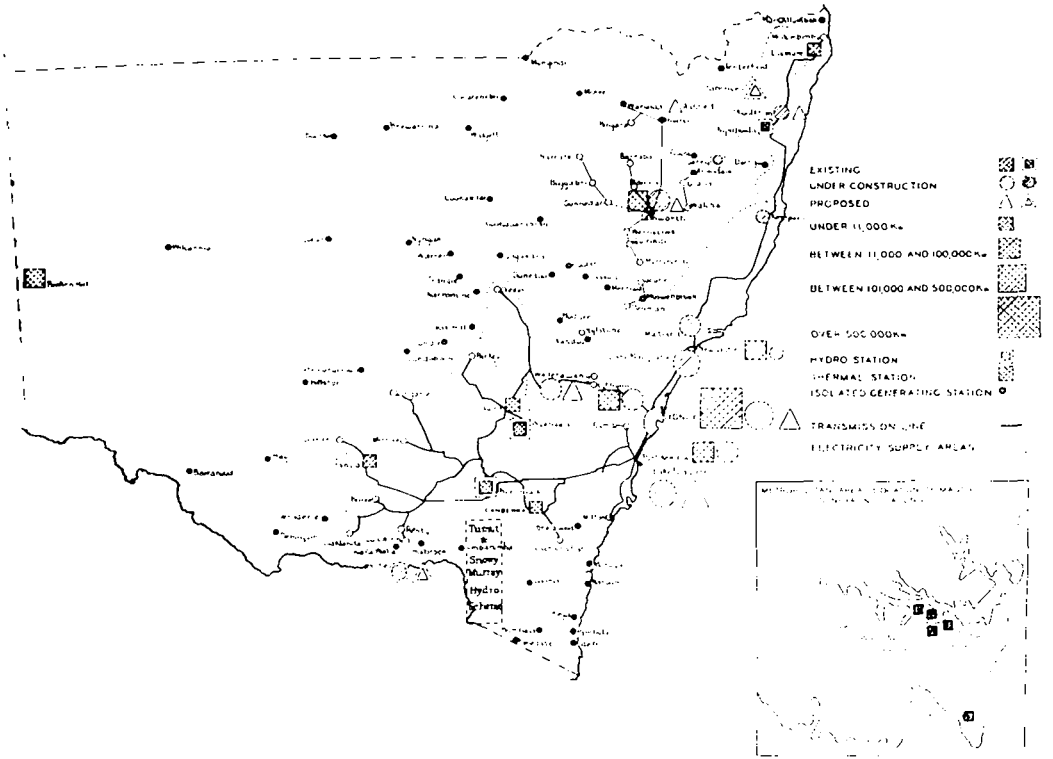
Supply to the Geelong Branch is obtained through Geelong power station and Geelong terminal station, the latter being connected with the rest of the system by a 66,000 volt transmission line to Newport power station.

AUSTRALIA - PRESENT AND FUTURE ELECTRICITY GENERATING CAPACITY



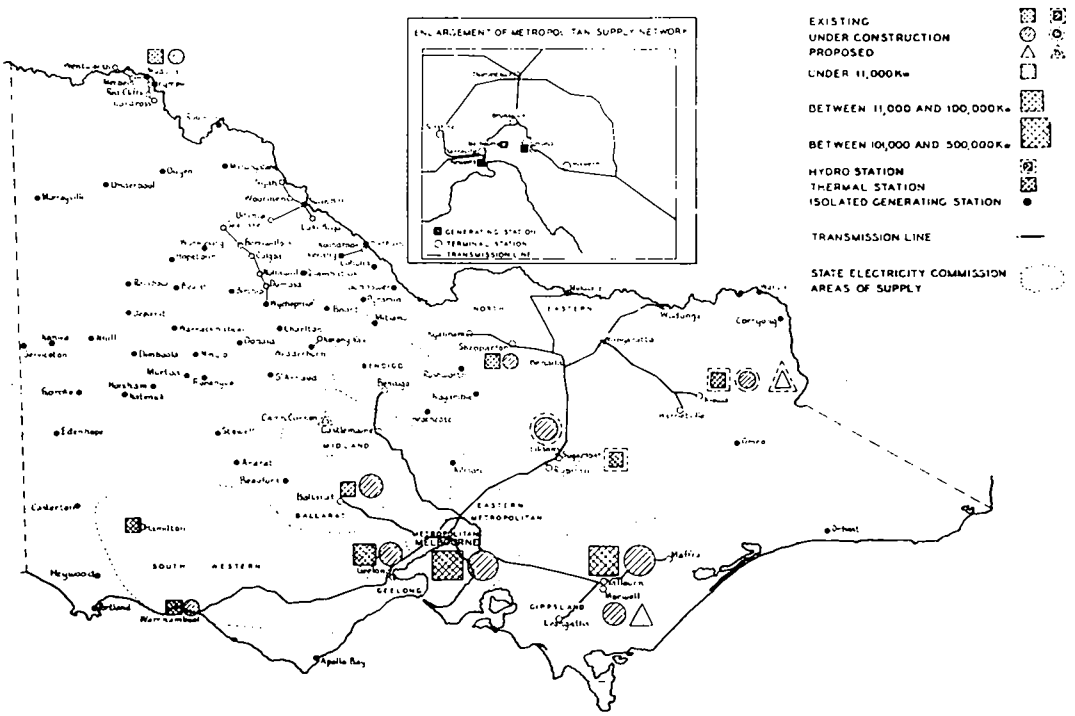
NEW SOUTH WALES

LOCATION OF ELECTRICITY GENERATING STATIONS AND MAIN TRANSMISSION LINES



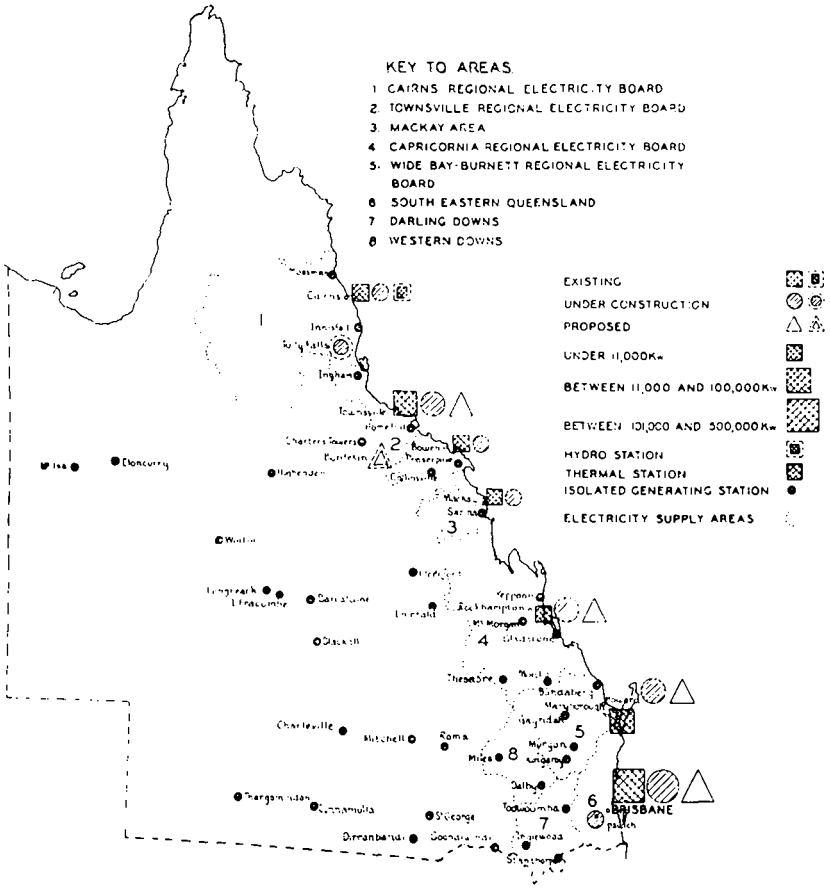
VICTORIA

LOCATION OF ELECTRICITY GENERATING STATIONS AND MAIN TRANSMISSION LINES

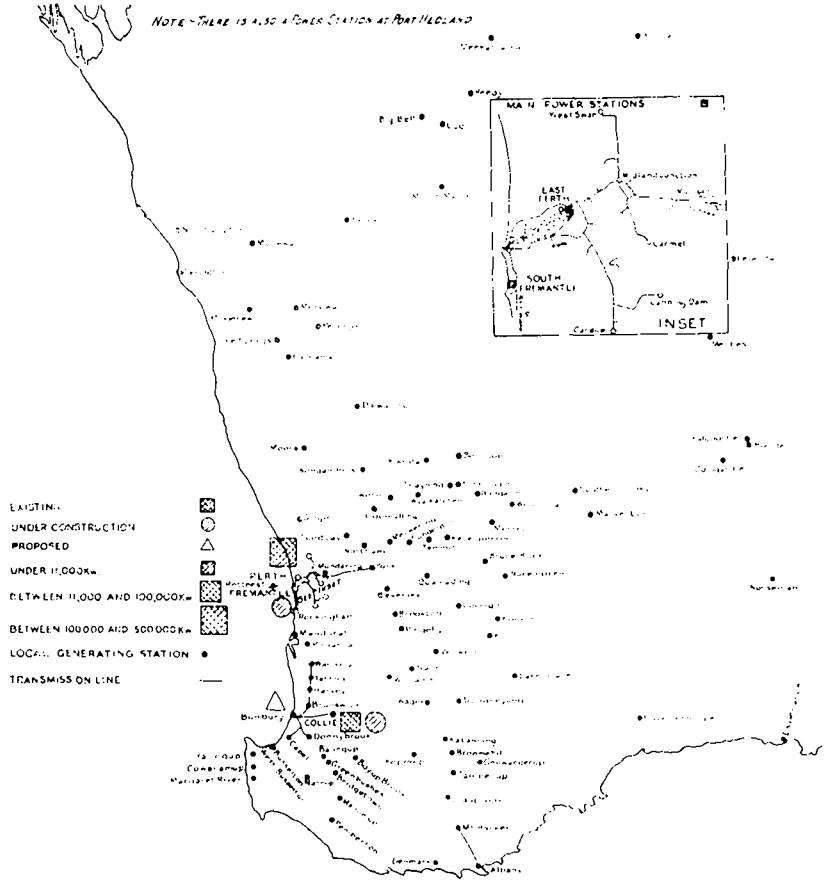


QUEENSLAND

LOCATION OF ELECTRICITY GENERATING STATIONS AND ELECTRICITY SUPPLY AREAS



LOCATION OF ELECTRICITY GENERATING STATIONS
AND
MAIN TRANSMISSION LINES

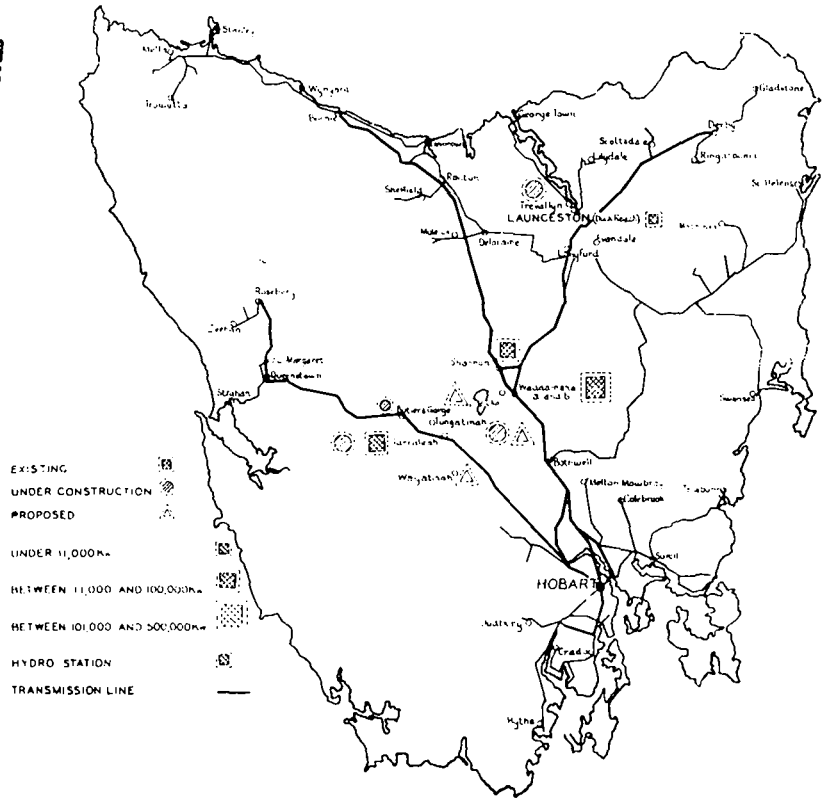


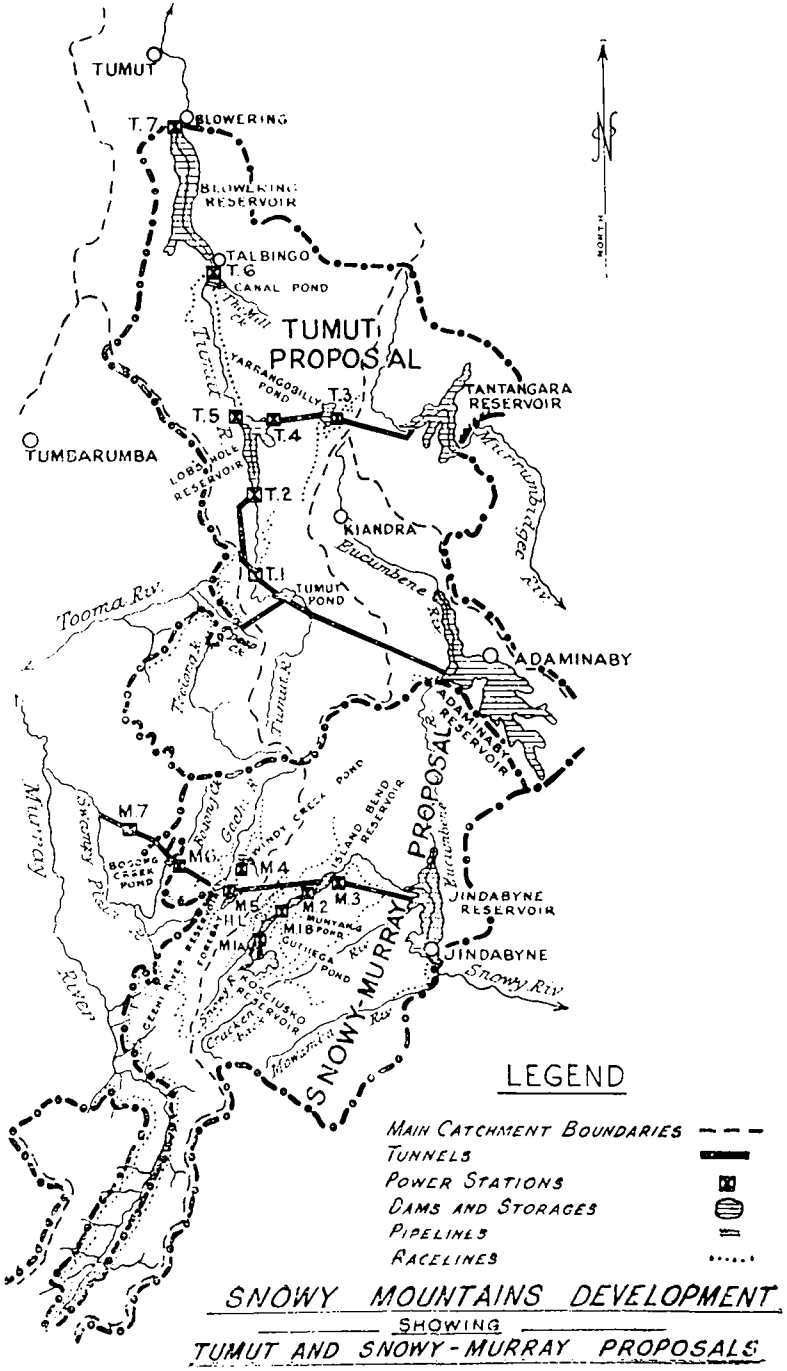
WESTERN AUSTRALIA

LOCATION OF ELECTRICITY GENERATING STATIONS AND MAIN TRANSMISSION LINES

TASMANIA

LOCATION OF ELECTRICITY GENERATING STATIONS
AND MAIN TRANSMISSION LINES




TUMUT
T.7
BLOWERING
BLOWERING RESERVOIR
TALBINGO
T.6
CANAL POND
TUMUT PROPOSAL
YARRANGOBILLY POND
T.3
TANTANGARA RESERVOIR
T.5
T.4
TUMBARUMBA
LOBS HOLE RESERVOIR
T.2
KIANDRA
Eucumbene R.
T.1
TUMUT POND
Tooma Riv.
ADAMINABY
ADAMINABY RESERVOIR
M.7
M6
M4
M5
M2
M3
M1B
M1A
JINDABYNE RESERVOIR
JINDABYNE
Snowy Riv.
SNOWY-MURRAY PROPOSAL
LEGEND
MAIN CATCHMENT BOUNDARIES
TUNNELS
POWER STATIONS
DAMS AND STORAGES
PIPELINES
RACELINES
SNOWY MOUNTAINS DEVELOPMENT
SHOWING
TUMUT AND SNOWY-MURRAY PROPOSALS

Supply to the South Western Branch is obtained through Geelong terminal station by a 66,000 volt transmission line extending through Colac to Warrnambool, where the new peak load power station to reinforce supply is due to begin operating during 1952.

Ballarat Branch obtains its supply from Ballarat power station and Ballarat terminal station, the latter being connected with the rest of the system by a 66,000-volt transmission line to Newport power station.

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" terminal station, Sugarloaf power 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", Sugarloaf and Benalla, with branches to Shepparton and Kyabram, Yarrawonga and Mulwala (New South Wales), and via Wangaratta to Wodonga for supply to Albury.

The Commission also operates a diesel station at Hamilton of 2,757 kW., which is not at present part of the interconnected system.

(vi) *New Capacity.* Despite a very great increase in the production of electrical energy in Victoria between 1919 and 1951 (and 180 per cent. increase between 1939 and 1951), supply since the 1939-45 War has been inadequate to cater for the increase in demand. In recent years, particularly during the winter months, the Commission has found it necessary to impose restrictions on the use of certain electrical appliances and on commercial and industrial consumers. At times, "load shedding" has caused temporary cessation of supply. The main reasons for the deficiency of electric power are the effect of retarded constructional programmes during the war, fuel shortage at Newport power station, and an accelerated increase in demand since the war.

With a view to stabilizing the supply demand relationship, the Commission has electric-power projects under construction which, provided constructional programmes can be maintained, are expected to increase the installed capacity of the State generating system to approximately 1,300,000 kW. by 1957, inclusive of by-product electricity obtained from the power station to be constructed as part of the Commission's Morwell briquette project.

Major approved works include :—

(a) *Thermal stations.*

Yallourn extensions—200,000 kW.

Morwell—90,000 kW. for the new power station in conjunction with the Morwell briquette project. Of this, approximately 35,000 kW. of by-product electricity will be available to the State system in the first stage (on completion of the first and second factories). A further 35,000 kW. will be available in the second stage (on completion of the third and fourth factories), when an additional 60,000 kW. will be installed.

Metropolitan—153,000 kW. This includes a 30,000 kW. 25-cycle generator, due to be in full service with its two associated boilers during 1952, at Newport "A" power station. In addition to 153,000 kW. of generating plant, the system is being reinforced by the installation at Newport power station of a new 30,000 kW. frequency changer, also due for completion in 1952.

Geelong—30,000 kW. "packaged" units.

Ballarat—20,000 kW. " "

Shepparton—10,000 kW. Portion of this station is in service.
Warrnambool—10,000 kW. ,, ,, ,, ,,

(*b*) *Hydro stations.*

Kiewa—124,000 kW. (with further power stations projected at a later date).
Hume—25,000 kW. representing Victoria's share of a 50,000 kW. power station shared equally by Victoria and New South Wales.
Eildon Dam—135,000 kW.

(*c*) *Thermal regional stations.*

Mildura—10,000 kW. This will be a " packaged " power station.

A 220 kV. transmission line is under construction from the Kiewa project to Thomastown terminal station.

As portion of a plan to provide electricity to the major part of the Murray Valley area, the Commission will construct a 220 kV. transmission line from Kiewa to Mildura by way of Shepparton—a distance of approximately 350 miles. Regional stations at Shepparton and Mildura will function primarily as peak-load stations when the plan is implemented.

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 178,000 additional country consumers, bringing electricity to every home in Victoria except for a residue of about 15,000 homes located in the most isolated parts of the State.

§ 3. Queensland.

1. **General Historical.**—(i) *Prior to establishment of State Electricity Commission.* 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. In 1936, there were 62 electrical undertakings in Queensland, of which 51 operated their own generating equipment and eleven purchased energy in bulk. Of the 62 undertakings, 41 were owned by local authorities and 21 by private organizations. No attempt had been made to interconnect any of the power stations then operating.

The early history of the industry in Queensland records that electricity was first used in the Government Printing Office, Brisbane, on 9th April, 1883, when some 50 incandescent lamps were put into service. These lamps were supplied with power from an 8.5 h.p. generator, coupled to the engine used for driving the printing machinery. The following year a local newspaper, the *Brisbane Courier*, had electric lighting installed in its composing room, and during the same year the Brisbane railway station was permanently lit with arc lamps. In 1886, transmission lines were constructed from the Government Printing Office along William-street to Parliament House.

In the following year a private firm, Barton and White, set up as electrical engineers, and not long after established a supply of electricity in Brisbane. A few years later the firm's assets were purchased by the City Electric Light Co. Ltd., which now supplies a large part of Brisbane's electric power requirements and a considerable rural area south-east of the city. 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 at Bulimba " A " is now 95,000 kW.; with this, 401 million units were generated in 1950, while the number of its consumers at 31st January, 1951 totalled 65,704.

The first country town in Queensland to receive supplies of electric power was Thargomindah, 730 miles west of Brisbane, in 1893—electricity being generated by utilizing the water flow from an artesian bore. This station operated until 1951, when reduced flow from the bore necessitated replacement of the hydro unit by diesel equipment. During 1905, the Toowoomba Electric Light and Power Co. Ltd. established supply in Toowoomba, and now supplies a considerable area including portion of the Darling Downs. Power is generated at the Company's diesel stations of 3,520 kW. supplemented with bulk supplies purchased from the City Electric Light Co. Ltd. In 1940 the company purchased the power undertakings at Warwick—a service inaugurated in that town during 1912 by the Electric Energy Supply Co. Ltd., and in 1946 the Killarney undertaking from the Killarney Electric Light Co., which established supply in 1931.

After the 1914–18 War, a number of suburban municipalities made plans to reticulate in their areas electricity purchased in bulk from the City Electric Light Co. Ltd. With a view to co-ordinating these developments, the Brisbane City Council established an electricity supply service. The first bulk supplies were provided in 1920 and supply was commenced to a number of other municipalities during the next three years. In 1923, all municipalities receiving bulk supplies were amalgamated under the Metropolitan Electricity Board to facilitate administration of the service. When the Greater Brisbane Council was constituted, the functions of the Board were vested in the Brisbane City Council Electricity Supply Department (now known as the Department of Electricity) which commenced operations on 1st October, 1925. By 1938, the Council was supplying an area of about 365 square miles, including the suburbs of Balmoral, Coorparoo, Enoggera, Hamilton, Ithaca, Kedron, Sandgate, Stephens, Sherwood, Taringa, Toombul, Toowong, Windsor and Wynnum—its consumers in the area numbered 56,928. Energy was purchased 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.

An electric tramway system, operated by the City Council, serves the City of Brisbane and a large part of the suburbs. The service was inaugurated during August, 1885, and, until 1897, the trams were drawn by horses. During 1896, however, interests in the service were acquired by the Brisbane Electric Tramway Co.—a private organization, with its head office in London. Conversion was commenced immediately and the first electric tram was placed in service during 1897. In that year track mileage totalled fifteen, compared with 106 in 1938, and 120 in 1950. Power is obtained from a station at New Farm and converted to direct current for traction purposes. The initial installation at New Farm comprised two generating units of 9,375 kW. each—the station's capacity now totals 75,000 kW.

On 31st December 1922, the tramway service was purchased by the Government, and the Brisbane Tramway Trust was set up to control and operate it. In November, 1925, after adoption of the Greater Brisbane Scheme which amalgamated all suburban and city municipalities of Brisbane, control of the tramways passed to the City Council. Growth of the Council's electrical undertaking and power production is indicated by the following comparisons between 1937–38 and 1950–51 figures, respectively :—Installed capacity, 56,250 kW. and 75,000 kW.; units purchased and generated, 71 million kWh. and 331 million kWh.; consumers, 57,000 and 93,000. In 1950–51 New Farm power house generated 328 million units and three million were purchased from City Electric Light Co. Ltd. The Department of Transport (Tramways) consumed 37 million units.

Prior to the establishment of the State Electricity Commission of Queensland in 1938, the generation and distribution of electric power was administered under the Electric Light and Power Acts 1896–1934, Local Authorities Acts 1902–1935, City of Brisbane Acts 1924–1936, and Electrical Workers Act 1927–1931. This legislation gave authority for the issue of Orders-in-Council to local governing bodies and private organizations for supplying electricity within specified areas and other associated matters. An amendment to the 1896 Act, promulgated in 1933, approved the reticulation of power to a small number of consumers by firms generating electricity for use primarily in their own factories. In 1936, there were eight such establishments in Queensland, as well

as a large number generating power for their own use exclusively. Before establishment of the Regional Electricity Boards, no attempts had been made to unify or co-ordinate electricity supplies, and rural electrification, apart from reticulation within certain townships, was practically unknown. Further amendments effected during 1933 set up an Electricity Board to review tariffs and provided for the appointment of government electrical inspectors.

(ii) *Royal Commission on Generation and Distribution of Electric Power in Queensland, 1936.* On 5th December, 1935, the Queensland Government, being concerned with the need to develop the State's power resources in the public interest, appointed a Royal Commission to inquire into and make recommendations on matters relating to the generation and distribution of electric power in Queensland. The Royal Commission's terms of reference were wide and included inquiry into the general operation and effect of the legislation then in force relating to the electricity industry and whether amendments to this legislation or new provisions were necessary, desirability of centralized control, and the need for co-ordination of the generation and supply of electric power.

The Commission commenced its task on 10th March 1936, and throughout the inquiry tended to concentrate mainly on proposals for electrification of south-eastern Queensland and establishment of a suitable statutory authority to control and unify the development of electrical undertakings in the State. South-eastern Queensland, as designated in the Commission's Report, represented only 2.86 per cent. of the total area of Queensland, but contained more than 57 per cent. of the State's population. At 31st December, 1935 its area was 19,192 square miles with a population of 554,871 persons. In 1935, 152 million units were generated in Queensland, of which the south-eastern portion of the State contributed 122 million.

Investigations revealed that the lack of rural electrification was attributable mainly to two main associated factors, namely the absence of load centres of sufficient size to make the establishment of electrical undertakings economical and the inability of local authorities to finance the expenditure necessary for their establishment. It was found that rural extensions had been made chiefly in the south-eastern area and then only in isolated localities. Furthermore, some of these organizations were unable to show a profit unless they charged high tariffs, which made the extensive use of electricity economically unsound.

Two proposals were submitted to the Commission for electrification of the south-eastern area—one from the Brisbane City Council and another from the City Electric Light Co. Ltd. The former included compulsory acquisition by the Council of the City Electric Light Company's undertakings—a power which it was held existed under the City of Brisbane Act 1924. The Council, which desired sole rights to supply electricity within a radius of 100 miles of Brisbane, had evolved a plan whereby power would be supplied in bulk to four proposed Joint Boards appropriately situated in the area. The four Joint Boards were to be formed by contiguous cities, towns and shires for the purpose of initiating and controlling electricity supply in the Boards' areas. Energy would be supplied in bulk at 33,000 volts at appropriate points from main transmission lines owned and controlled by the Council.

The alternative proposal submitted by the City Electric Light Co. Ltd. provided for complete electrification of an area that it considered could be supplied economically and efficiently from Brisbane. The company's plan included the construction of main transmission lines southward to the Queensland—New South Wales border so that the two States' systems could be interconnected. The main transmission system within the area was designed to provide a number of interconnecting lines, giving duplicate supply to all main sub-stations at 66,000 volts. Under its scheme, the company would carry out complete reticulation, meter readings, collections of monies, etc., and supply power to the area at a price ten per cent. higher than its Brisbane tariff.

In the course of the investigations, the Commission indicated that, in its opinion, ultimate public ownership of electricity supply was desirable, and recommended that in order to achieve a properly planned scheme for the electrification of the south-eastern area, control of the generation and distribution of electric power be vested in the State—a commission, similar to the State Electricity Commission of Victoria, could give effect to the Government's policy on electric power.

Alternatively, the Royal Commission recommended that, if establishment of an operating Commission was not found practicable, electrification under public control with ultimate public ownership be implemented. This could best be effected by a controlling Commission capable of being converted at any time into an operating Commission. The alternative plan envisaged the negotiation of an agreement with the City Electric Light Co. Ltd., under which the Company would proceed with its project to electrify the south-eastern area of the State.

With regard to electricity supplies in areas of Queensland outside the south-eastern portion of the State, the Commission concluded that, with the exception of a section of the country from Townsville north to Mossman and west to Herberton, such electricity problems as existed were purely local ones of generation and distribution, not justifying further consideration at that time. It was suggested that the Barron Falls hydro-electric scheme, the potentialities of Tully Falls and the development of the Cairns area in general be the subject of immediate and detailed investigations.

2. **The State Electricity Commission of Queensland.**—In 1937, the State Government legislated to constitute a State Electricity Commission, 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 1951, the number of private companies was reduced by absorption and acquisition from twenty-one to seven, and publicly owned undertakings, by amalgamation into Regional Authorities, from forty-seven to thirty.

By agreement with the Commission in 1939, the City Electric Light Co. Ltd. became co-ordinating authority for 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 Government has the right to acquire both these companies in 1954, or later.

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.

3. **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. (Regional Boundaries and the location of generating stations throughout Queensland are shown on the map facing page 1174.)

Activities of the five Regional Boards in 1950-51, 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.		1950-51.	
	Units Generated.	No. of Consumers.	Units Generated.	No. of Consumers.
	m.kWh.		m.kWh.	
South Burnett(*a*)	2.3	2,165	4.1	2,892
Wide Bay	11.4	9,302	23.6	13,959
Capricornia	19.5	11,196	36.5	15,175
Townsville	25.8	11,612	53.7	16,050
Cairns	22.7	9,722	47.6	13,631
Total	81.7	43,997	165.5	61,707
Queensland	487.0	194,429	(*b*) 972.0	(*b*)243,161

(*a*) *See* previous paragraph. (*b*) Year 1949-50.

Generator capacity installed at 31st December, 1951 of the four existing Regional Boards was :—Wide Bay-Burnett, 22,700 kW.; Capricornia, 7,109 kW.; Townsville, 15,332 kW.; Cairns, 12,020 kW.; total, 57,161 kW.

4. **New Capacity.**—(i) *Regions.* To provide for development of the electric power resources in the regions, the 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 proceeding. 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 interconnexion between the regions.

Work has commenced on a number of new generating stations, including Howard (Wide Bay Region), of which 15,000 kW. was placed in service during September, 1951, Rockhampton (Capricornia Region), and Townsville (Townsville Region). Each of these stations will have an ultimate capacity of 52,500 kW. and be steam-operated. In the Cairns Region, construction has commenced on the Tully Falls hydro-electric scheme, which is designed for an ultimate installed capacity of 92,400 kW. To augment existing capacity, pending operation of Tully Falls, the Cairns Regional Board has installed eleven diesel units with a total capacity of 7,860 kW. In addition, five 750 kW. sets are on order. It will be necessary, however, to obtain further plant, as it is anticipated that the demand will equal present plant facilities by the end of 1953.

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 5,000 kW. and 1,000 kW., respectively. The Mackay City Council is embarking on a scheme for rural development under an arrangement with the State Electricity Commission. To cater for the anticipated growth in demand, the capacity of its station will be increased to 10,000 kW. by 1954. 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, 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 in the first instance will provide the amenities of electricity to ten townships in the west of Queensland. The power will be supplied by small oil driven generating sets with automatic controls, which can be run with a minimum of operating attendance.

(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 203,200 kW. The City Electric Light Co. Ltd. is building a station known as Bulimba "B" on a site adjacent to Bulimba "A"—the initial installation comprises 60,000 kW. but the ultimate capacity may reach 180,000 kW. A 3,200 kW. unit at Somerset Dam near Brisbane is expected to be in service during 1952. At Tennyson in the Brisbane area, the City Council is constructing a new power station—initial capacity 60,000 kW. which may ultimately be increased to 180,000 kW. To supplement capacity pending operation of these projects, "packaged" generating units totalling 20,000 kW. have been ordered from overseas; of these 10,000 kW. will be installed at Tennyson and 10,000 kW. at Ipswich. In addition to catering for the anticipated increase in demand from industrial and domestic sources, this new capacity will be called on to supply energy for the electrified suburban railways—a project upon which preliminary work has commenced.

(iv) *The Burdekin River Hydro-electric Project.* In the vicinity of Townsville, the Commission, acting on behalf of the Burdekin River Authority, is continuing investigations of the proposed hydro-electric development of the Burdekin River. This project is linked with the plan to conserve the waters of the River for irrigation, and surveys undertaken indicate that approximately 80,000 kW. could be generated. It has been estimated that a station approaching this size should meet the requirements of Townsville and the adjacent areas, including the coal mines in the region of Collinsville, for at least 20 years, and by obviating the continuous operation of thermal plant, achieve significant savings in fuel. In addition, construction of this hydro station will obviate the need to install new thermal capacity at Townsville within a relatively short time.

§ 4. South Australia.

1. **General Historical.**—In 1895, the South Australian Electric Light and Motive Power Co. Ltd., with nominal capital of £20,000, was formed under the South Australian Companies Act with the object of supplying electricity for public and private purposes. A private Act, passed in 1897, conferred certain powers which enabled the company to generate and transmit electric power for sale.

Just prior to the close of the 19th century, the Electric Lighting and Traction Co. of Australia Ltd., a company registered in London, acquired the assets of the South Australian Electric Light and Motive Power Co. Ltd. These included a small power station at Port Adelaide of 150 kW. capacity, as well as the franchise of that company to supply power in Port Adelaide and the City of Adelaide. A station of 400 kW. capacity was built which supplied direct current to the City of Adelaide; by 1917, this had an installed capacity of 12,000 kW.

In 1905, the Adelaide Electric Supply Co. Ltd., incorporated in Great Britain with a paid-up capital of £180,000, took over the South Australian section of the Electric Lighting and Traction Co. of Australia Ltd., including the franchise under the 1897 Act. Certain limitations had been imposed under that legislation in respect of the area within which electricity might be supplied. However, in 1922, shortly after the management of the company had been transferred from England to South Australia, a further private Act was passed which amended the 1897 Act and, subject to certain provisions, gave the company authority to operate in any part of the State.

Although the Act of 1922 conferred additional powers on the Company, it nevertheless maintained a principle laid down in the 1897 legislation, namely, that the Company could not extend its area of supply to a district without the sanction of a resolution of the ratepayers. This provision did not, however, prevent the Company from taking its instrument of supply into and through intermediate districts.

The Adelaide Electric Supply Co. Ltd. gradually expanded its activities, and in August, 1923 a new station of 20,000 kW., in three units, was commissioned at Osborne on the Port River. By 1937 this station had a capacity of 55,000 kW. and the company was supplying an area of about 3,500 square miles. Its distribution system included three 33 kV. double circuit overhead transmission lines from the Osborne power house to the Croydon and Richmond substations, and a 33 kV. ring about 20 miles in length linking these two substations to the three main suburban substations. These in turn were linked to the four main city substations by an inner 33 kV. ring.

A measure of State control over matters relating to the service provided to consumers of electric power was envisaged by the 1897 legislation. Under Section 27, power existed to make regulations for securing a regular and sufficient supply of electricity and fixing a maximum price to be charged. Section 26 provided that any local authority within whose municipality the company was operating might lawfully purchase, after the expiration of specified periods from the passing of the Act, all or portion of the company's assets located in the area under the local authority's control.

However, no regulations were made under Section 27, and no Council attempted to exercise its right of purchase under Section 26. Provision is made in Part XXIV., Division II., of the Local Government Act 1934-1941, giving local authorities autonomy to generate and supply electricity within their areas, and a number of councils have availed themselves of this power.

Prior to 1932, no attempts had apparently been made to exercise any of the powers available to control the company, or to institute any inquiry regarding it. In that year, however, a Committee was appointed to inquire into and report upon certain activities of the company, namely:—

1. The charges made for the supply of electricity to consumers, including minimum charges;
2. The payments for the rent of meters registering the amount of electricity used by consumers;
3. The payments of any deposits before installation of electrical apparatus.

The Committee's report of 16th July, 1932 indicated that in their opinion the organization was efficiently managed and conducted with due regard to its obligations to deal fairly and equitably with the public, and that it provided the standard of service to which the latter was entitled. No further action was taken until 1935, when the Government instituted inquiries into the capitalization of a sum, representing nearly the whole of an amount paid in premiums on the issue of ordinary shares in 1912, 1913, 1915 and 1921, and also the rate of dividends being paid to holders of ordinary shares in the Company.

It was evident that the Government was becoming concerned with the need to provide an adequate supply of electricity at reasonable rates to the public, particularly with a view to encouraging the development of industry. In March, 1943, a Committee was appointed to investigate the following questions:—

1. The desirability of establishing a power station at Port Augusta or elsewhere outside the metropolitan area for the generation and transmission of electricity to the metropolitan area and country districts.
2. What additional sets, if any, should be installed at Osborne "B" power station, in addition to the 30,000 kW. set then under construction. (At this time the Company's programme for increasing capacity included two 30,000 kW. turbo-alternators and three 15,000 kW. boilers.)
3. What measures might be taken to meet the necessity for an immediate increased electricity supply in the metropolitan area.

Following upon this inquiry, 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, which included alternative recommendations, the main substance of which was subject to certain considerations and assumptions, that

(*a*) 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, if acquisition was not considered desirable,

(*b*) 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. **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 27,500 kW. at Port Adelaide, which supplies energy for traction purposes. This organization was formed in February, 1907 and acquired the assets of the horse tramway companies then operating. An electric service was commenced in March, 1909. The system was gradually extended, and in 1929 the Trust purchased the South and North Terrace railway lines, which connected Adelaide and Glenelg, from the South Australian Railways Commissioner. By December, 1929, the Trust had completed the electrification of the South Terrace section and opened it for traffic. Trolley buses were introduced during 1938, providing a service between Tusmore and Largs—a distance of approximately 15 miles. In 1946 the Trust's route mileages were:—tramway, 80; trolley bus, 16. It also operates a number of motor buses. In 1946 the service consumed approximately 28 million kWh. of electricity.

4. **Capacity and Production.**—(i) *Categories.* 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; (*c*) Other, including:—(i) Individuals and firms primarily engaged in generating power for sale; (ii) Firms generating power primarily for their own use but supplying outside consumers; (iii) Firms generating power for their own use.

(ii) *Installed Capacity.* In 1949–50 total installed capacity in South Australia was 206,743 kW. compared with 120,081 kW. in 1939–40. Units generated totalled 594 and 270 million kWh. in 1949–50 and 1939–40, respectively.

Of the total installed capacity, the Electricity Trust of South Australia operates plant with a capacity of 145,000 kW. It is thus the most important single authority supplying electricity in the State. There are approximately 169,000 consumers of electricity, of whom about 145,000 are supplied by the Trust. Its major steam stations are Osborne "A" (79,000 kW.) and Osborne "B" (60,000 kW.), while the balance of the capacity controlled consists of a number of small internal combustion plants located in rural districts.

No hydro-electric potential exists in South Australia. Steam generating units comprise 92 per cent. of installed capacity and the balance, 8 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.

5. **Leigh Creek and other new Capacity.**—With a view to achieving independence from external sources, steps are being taken to install boilers designed to burn locally mined fuel. Fairly extensive deposits of low-grade sub-bituminous coal are obtainable at Leigh Creek, about 370 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 to sell or otherwise dispose of any surplus production.

In order to cope with the rapidly increasing demand for power, the Electricity Trust is installing four additional 30,000 kW. units at Osborne "B", one of which is planned to be in service by June, 1952. Ultimate capacity of this station will be 180,000 kW. Another major work under construction is the regional power station at Port Augusta, where three 30,000 kW. units will be installed, one each by 1954, 1955 and 1956. One of the principal reasons for locating the station at Port Augusta is its proximity to the Leigh Creek coal, thus eliminating a considerable part of the long and costly haul to Adelaide. A new standard gauge line is to connect Leigh Creek with Port Augusta. A system of power transmission lines is to interconnect the metropolitan

stations with Port Augusta by way of Port Pirie; supply to country areas will also be facilitated or increased. The Trust recently purchased a small power station at Port Lincoln from the Government Produce Department for reconstruction at a new site, and with an ultimate capacity of 3,000 kW. Extensions are planned to the existing steam station at Leigh Creek, which include the installation of two steam units each of 1,500 kW. The locations of generating stations and main transmission lines in South Australia are shown on the map on page 1175.

Present works are expected to increase installed capacity by 154,000 kW. by 1956, providing a total installed capacity of approximately 361,000 kW. From 1952 to 1956, it is expected that at least one 30,000 kW. unit will be installed each year. These increases should more than cater for the increase in demand up to 1956, but further additions to plant will be necessary before 1960 to maintain reserves and provide replacements for retired equipment.

§ 5. Western Australia.

1. **General Historical.**—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. Excepting in the metropolitan area and in the area embraced by the South West Power Scheme, 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 order to cater for the expected growth in demand, capacity of the State's major generating stations is being increased and plans have been formulated for the interconnexion of the Perth-Fremantle system with the south-western area. In 1945, the State Electricity Commission was set up with the object of co-ordinating the supply of electricity throughout the State.

The first supplies of electric power in Perth were reticulated to consumers by a private organization—the Perth Gas Company Ltd.—in 1894. This firm continued to supply until 1912, when its undertakings were purchased by the Perth City Council. At that time, responsibility for the generation of electric power was assumed by a Governmental authority administered by the Commissioner for Railways, namely the Western Australian Government Electricity Supply, distribution remaining mainly in the hands of the Perth City Council. Pursuant to the Electric Light and Power Agreement Act 1913, the Government Electricity Supply contracted with the Perth City Council to supply the Council's power requirements in bulk at a price not exceeding 0.75d. per unit for a period of 50 years. However, in 1948, fifteen years before expiration of the agreement, the State Electricity Commission purchased the Council's electricity and gas undertakings, thus releasing it from the contract. Under a similar agreement the Government organization also sells bulk supplies of power for traction and other purposes to the Fremantle Municipal Tramways and Electric Lighting Board, which reticulates power to industrial and domestic consumers in Fremantle and East Fremantle municipalities, and Melville and Rockingham Road Board districts.

2. **Perth.**—Under the Government Electric Works Act 1914, the Western Australian Government Electricity Supply was given power to construct works for the supply of electricity in the metropolitan area. By 1916, the authority had established a generating station at East Perth with an installed capacity of 12,500 kW. As the demand for electric power became more widespread, both the generation and distribution facilities were increased. In 1930, installed capacity stood at 32,000 kW. and the distribution system extended for a radius of 24 miles from the stations; altogether, 105 miles of high tension lines were in use, including 92 miles of 20,000 volt and the balance 6,000 volt. Capacity was further increased in December, 1938, when a 25,000 kW. unit was placed in service. At the same time, three new boilers were installed which were designed to use pulverized Collie coal. In 1946, control of this station was passed to the State Electricity Commission.

Statistics relating to activities at the East Perth undertaking are shown in the following comparative table :—

WESTERN AUSTRALIA : EAST PERTH UNDERTAKING.

Particulars.		1928–29.	1938–39.	1949–50.
Plant capacity	kW.	32,000	57,000	53,000
Maximum load	kW.	21,500	33,000	52,500
Units generated	m.kWh.	80	137	237
Units used on works	,,	5	13	20
Units sold	,,	69	117	192
Coal used per unit generated	lb.	3.1	2.77	2.55
Coal used—				
Collie small	tons	110,460	165,355	267,448
Imported	,,	427	3,367	..

3. **Kalgoorlie.**—In Kalgoorlie, on the goldfields, electricity supply was first established by the Municipal Council in 1895. By 1945, this authority was supplying 3,350 consumers with direct current from a diesel station of 1,350 kW. generating capacity. In 1902, the Kalgoorlie Electric Power and Lighting Corporation commenced operations with the primary objectives of supplying power for the gold mines and for traction. This organization 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, and bulk supplies are provided to the Kalgoorlie Electric Tramways Limited. The Corporation's undertaking generates approximately 45 million kWh. per annum and consumes about 100,000 tons of wood fuel.

4. **General Pattern of Electricity Supply.**—The pattern of electricity supply in rural areas of Western Australia has hitherto consisted of a large number of small organizations, both private and local government, generating power for sale to consumers in a particular town or municipality, but in the area between the Great Southern Railway from Northam to Albany and the west coast, the State Electricity Commission is now constructing 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.

The main load centre is, of course, the Perth-Fremantle area into which is concentrated the major portion of the State's population and industry. In 1949, the East Perth power station generated 39 per cent. of the electricity produced in the State from all sources, excluding those firms which generate power for their own use. No interconnections between the various power stations established in rural localities and those in the metropolitan area have yet been effected.

Some statistics relative to the generation and supply of electric power in Western Australia are provided by the following comparisons between 1939–40 and 1949–50, respectively :—total installed capacity, 111,641 kW. and 119,396 kW. ; units generated, 337 million kWh. and 417 million kWh. ; consumers, 95,000 and 109,000.

The location of power stations and distribution systems, including projects under construction or proposed, are shown on the map on page 1176.

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 interconnect 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 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. By 1951, two units had been placed in service and the output was being fed into the metropolitan system. The Commission plans to have all units in operation during 1952 and 1953.

Most of the plant at the East Perth power station, which passed to the Commission's control in 1946, is due for retirement or requires extensive overhaul. During and since the War, the demand for power has necessitated its almost continuous operation, all maintenance work being undertaken during week-ends or holidays. At times, when the load has become too great or break-downs have occurred, it has been necessary to "black out" certain districts or reduce the load by other means. In addition, certain restrictions were imposed on consumers between 1946 and 1950, but were lifted when the new station came into service just prior to the winter of 1951. In an endeavour to improve the position pending operation of the South Fremantle station, three diesel units, each of 1,000 kW., were installed in 1950. The Commission now plans to install a 30,000 kW. unit at East Perth, and tenders have been called for supply of the turbo-alternator, boiler plant and ancillary equipment.

6. **Frequency Conversion.**—The earliest sets installed at East Perth were designed for operation at 40 cycles and this frequency was adhered to throughout the growth of the plant on this site, until the 1938 additions brought total capacity at this frequency to 57,000 kW. During 1947 the station's size was reduced by 4,000 kW.

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 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.

7. **South-west Development.**—Under the Electricity Act of 1937, which was superseded by the 1946 Acts, a Committee was appointed to inquire into and report upon a proposed scheme for the electrification of the south-western portion of the State. The Committee commenced its activities in 1939, but owing to the conditions prevailing at that time no action was taken to implement any of its recommendations. On 30th

August, 1943, the Electricity Advisory Committee was requested by the Government to report on the question of establishing a central power station in the south-west, taking into consideration current policy regarding decentralization of industry, and also the increased development which might reasonably be anticipated in the south-west after the War.

The Committee submitted its report in 1945, recommending, amongst other things, that a National Power Scheme for the south-west be proceeded with. 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 interconnexion 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 will be increased to 12,500 kW. by the end of 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. When completed, a system of power lines will reticulate electricity over an area of approximately 1,800 square miles. Tenders have been called for the first two 30,000 kW. units for a new power station at Bunbury, which will be interconnected by transmission lines to the Collie and South Fremantle stations, permitting an interchange of power between the metropolitan and south-west systems.

§ 6. Tasmania.

1. **Hydro-electric Potential.**—With its mountainous terrain and relatively high rainfall, Tasmania is well endowed with hydro-electrical resources. It has been estimated that its lakes and rivers possess a potential which, with appropriate conservation measures, would permit the installation of generating equipment totalling at least 1,750,000 kW. Present installed capacity is only a fraction of this amount, namely, about 218,000 kW.

The major portion of Tasmania's hydro potential is situated on the Central Plateau, covering an area of about 1,500 square miles at an altitude varying from 2,000 to 4,000 feet. Annual rainfall ranges from 80 inches in the western section to 30 inches in the east. Natural storages are provided by a number of lakes and marshes, the largest of which is the Great Lake, covering an area of 58 square miles with a present capacity of 1,150,000 acre feet. Numerous rivers, having their source on the Central Plateau, flow into the sea at intervals around the coast, but by far the greatest proportion of the run-off is carried southwards by the Derwent River and its tributaries. This river system is thus the most important source of hydro-electric power on the island.

In addition to the rivers having their source on the Central Plateau catchment, there are two other major potential areas of hydro-electric power, namely, those of the Esk River in the north near Launceston and the Huon in the south near Hobart. Both these areas are important in that relatively large stations could be operated at low cost in close proximity to large load centres. A station of approximately 80,000 kW. which will utilize the waters of the South Esk is at present under construction near Launceston.

2. **Historical.**—Development of the island's hydro-electric potential was first commenced in 1892, when the Launceston City Council constructed a small station of 450 kW. at Duck Reach on the South Esk River. Power was made available in 1895. This station, which is still operating and was acquired by the Hydro-Electric Commission in 1944, now has an installed capacity of 2,000 kW. Although this was the first hydro-electric station, a steam station operated by a private concern supplied some power to Hobart in 1893.

With a view to obtaining cheap supplies of electric power, the Mount Lyell Mining and Railway Co. in 1911 decided to develop the potential of Lake Margaret near the western coast; the Lake's catchment has an area of 8 square miles with an annual rainfall of 147 inches. By 1914, the Company was generating about 8,400 kW., later increased by the installation of another unit. In 1951 the station had an installed capacity of 9,900 kW. Originally it was arranged that any power not required for the Company's activities should be fed into the Tasmanian system. However, in recent years the amount generated has been insufficient, necessitating purchase of additional supplies from the Hydro-Electric Commission. In 1911 also, another private firm obtained authority to generate electricity. This organization, the Hydro-Electric Power and Metallurgical Company, was formed to exploit the potential of the Great Lake, where it was intended to develop 7,000 kW. for the electrolytic treatment of complex ores. However, the Company experienced considerable difficulty in raising capital, and in 1914 the Government, being concerned about the progress of the scheme, took over that part of the Company responsible for the development of the power project.

As a result of this move, the Hydro-Electric Department of Tasmania was set up and immediate action taken to develop the Great Lake scheme. By May, 1916, two 3,500 kW. units had been installed at a station named Waddamana. The power produced was utilized for domestic lighting and tramway traction in Hobart and also for the treatment of ores. In 1919 the Department accepted a contract to supply 23,000 kW. of power to the Electrolytic Zinc Co. of Australasia Ltd., which necessitated the enlargement of the Great Lake scheme. It was decided at this time that the constructional programme should be designed to cater for the anticipated future load-growth, and by 1922 the Great Lake–Waddamana project had an installed capacity of 49,000 kW. Works associated with the project required construction of a multiple arch dam at Miena, where the natural flow from the southern end of the Lake forms the River Shannon. Additional catchment area has been obtained by diverting water from the Ouse River to the Lake. Transmission lines of 88 kV. capacity run northward to Burnie and the north-east coast, and southwards to Hobart.

Before the waters which drive the generators at Waddamana pass through that station, they are first used to generate power in the Shannon project. This scheme utilizes the controlled flow of water between Miena Dam and the Waddamana Canal. Construction of an earthen dam to divert water from the Shannon River into a canal, before falling through steel pipe-lines to the power station 258 feet below, was commenced in the late 1920's and by 1934 the Shannon station had an installed capacity of 10,500 kW.

In 1929, the Government passed the Hydro-Electric Commission Act, under which was established the Hydro-Electric Commission. In 1930 this corporate body took over the State hydro-electric undertakings and the business of the Hydro-Electric Department.

3. **The Hydro-Electric Commission.**—(i) *Extent of Operations.* After the economic depression of the early 1930's, industrial activity, particularly in those industries requiring large blocks of electric power, increased rapidly. It became evident to the Commission that this demand for power, together with the increasing domestic demand, would soon reach a stage when it could only be satisfied by the installation of additional generating capacity. Accordingly, towards the end of 1934, the Tarraleah project was commenced and by 1938 three 15,000 kW. units had been installed. Since then three more units have been placed in service, giving the station a total installed capacity of 94,500 kW. The Tarraleah scheme involved construction of a power station on the Nive River near its junction with the Derwent, conservation of waters in the River Derwent at Lake St. Clair and Butler's Gorge and their diversion by flume and pipeline to the power station. Power is generated at 11,000 volts and stepped up to 110,000 volts for transmission to Rosebery on the west coast and to Hobart.

With a view to ensuring that peak loads could be met, the Commission, during the 1939–1945 War, commenced construction of a new station known as Waddamana "B". An ideal source of peak load power exists in the Great Lake storage, which has a capacity

of 1,150,000 acre feet at an altitude of 3,380 feet. The project, with a total installed capacity of 50,000 kW. comprising four units, was completed in 1949. Sufficient water to operate the station is provided by a canal similar to the one supplying Waddamana "A". Power is generated at 11,000 volts and transmitted by 110,000-volt lines to Boyer substation near Hobart.

Since the first year of operation, namely 1916, when Waddamana "A" was placed in service, output of the Hydro-Electric Commission's system grew from about four million kWh. to a total of 920 million kWh. in 1949. Between 1939 and 1949 the number of consumers of electric power in Tasmania increased by 20,924 to 70,924. During the same period the peak load on the system rose from about 70,000 kW. in 1939 to 171,940 kW. in 1949. The Commission's total installed generating capacity was 172,500 kW. at 30th June, 1949, which, when compared with the 1949 peak load of 171,940 kW., indicates that very little reserve capacity was available. A number of factors contributing to an increase in demand, combined with a series of rainfalls below average, have in recent years necessitated the imposition of power rationing. These restrictions on the use of electricity are expected to continue until 1953.

The following comparative statistical material indicates the growth of the Hydro-Electric Commission's system between 1938 and 1949:—

TASMANIA: HYDRO-ELECTRIC COMMISSION SYSTEM.

Power Station.	1938.			1949.		
	Installed Capacity.	Units Generated.	Peak Loads.	Installed Capacity.	Units Generated.	Peak Loads.
	kW.	m.kWh.	kW.	kW.	m.kWh.	kW.
Waddamana "A" ..	47,200	376	51,000	49,000	242	52,000
Waddamana "B" ..	..	..	..	36,000	140	40,000
Shannon	10,200	84	10,000	10,500	72	9,600
Tarraleah	(a) 47,250	(a) 15	(a) 10,700	75,000	463	73,700
Duck Reach ..	(b)	(b)	(b)	2,000	3	1,620
Devonport (Steam) ..	750	.013	(c)	(d)	(d)	(d)
Total ..	105,400	475.013	..	172,500	920	..
System ..	67,100 kW.			171,940 kW.		
Number of substations	9			15		

(a) Not in full operation. (b) Not taken over by Hydro-Electric Commission until 1944.
(c) Not available. (d) Withdrawn from service.

Since 1949 installed generator capacity at Waddamana "B" has been increased to 50,000 kW. and Tarraleah to 94,500 kW., while the new Butler's Gorge station is now in service, making total installed capacity of the system approximately 218,000 kW.

(ii) *New Capacity.* In order to cater for increasing demands for power from domestic and industrial sources, the Commission has projects under construction which, by 1954, are expected to more than double present installed capacity. Major works include the Tungatinah scheme on the Nive River, where a new station with an initial capacity of 100,000 kW. is scheduled for completion in 1953. This project will be extended at a later date by the installation of an additional 25,000 kW. unit. At a site near Launceston work is in progress on the Trevallyn scheme, involving construction of a tunnel from the South Esk to the River Tamar. The power station is to be located on the left-hand bank of the Tamar facing downstream. The ultimate capacity of the

station is planned as 80,000 kW. in four units, all of which should be in service by 1954. This project is designed primarily to supply power to the Aluminium Production Commission's works at Bell Bay, but any surplus energy will be fed into the Tasmanian system.

Further development of Tasmania's hydro potential is proposed, involving the construction of two major stations and associated works. The larger, known as the Wayatinah scheme, will have an installed capacity of approximately 100,000 kW. The plan includes construction of diversion dams on the Nive River below the present Tarraleah station, with a tunnel and a canal from the Nive to the Derwent. The power station will be located near the junction of the Florentine and Derwent Rivers. A station of about 28,000 kW. is planned on the Dee River below Lake Echo. The water to be utilized in this project later passes through both the Tarraleah and Tungatinah stations.

Details of the Hydro-Electric Commission's power stations, distribution system and proposed works are shown on the map on page 1177.

(iii) *Special Features.* 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 Australia Ltd., 51,000 kW.; Australian Commonwealth Carbide, 6,500 kW.; Goliath Portland Cement, 1,800 kW.; Associated Pulp and Paper Mills Ltd., 8,600 kW.; Australian Newsprint Mills Pty. Ltd., 24,000 kW.; and Australian Aluminium Production Commission, 30,000 kW. (when in production). These quantities shown relate to demand on an unrestricted basis—namely during 1950—and they are not necessarily the actual amounts consumed by these organizations.

Given normal weather conditions, it was not found necessary, until recently, to impose restrictions on consumers in regard to either load or usage. With the extension of the use of electricity into new fields, however, demand for power steadily increased, and this, combined with a series of below average rainfalls, necessitated the introduction, of a power rationing scheme in March, 1951.

With the object of offsetting to some degree the trend towards centralization of the population in the larger cities, it is the policy of the Commission to extend its service to all districts. Where the costs of the extension cannot be covered by the anticipated revenue, the State Government subsidizes the extension. This has caused a substantial increase in consumption in rural districts where the electrification of farm machinery and other labour saving devices has in recent years become widespread. Also of considerable importance is the fact that the standard of living on farms has been raised, thereby tending to attract families to the country and retain those already established in rural areas.

In general, exploitation of Tasmania's hydro potential has led to a comparatively high standard of domestic life and no less than 90 per cent. of the island's population is served with electricity.

§ 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 and diesel stand-by plant of 2,100 kW. capacity which is operated in conjunction with the New South Wales Electricity Commission's

generating equipment (for further details *refer* to page 1160 of this article). The major portion of the Capital City's power requirements are supplied in bulk from the New South Wales interconnected 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 is scheduled for operation in June, 1954, and the power produced is to be fed into the New South Wales interconnected 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 2,010 kW. capacity. During 1951, the first of two new 850 kW. diesel sets was placed in service—it is expected that the second set will be operating in 1952. Small diesel generating units supply the requirements of Katherine, Tennant Creek and Alice Springs.

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-New Guinea, whose headquarters are located at Port Moresby. Diesel equipment totalling 1,372 kW. is in operation at Port Moresby (750 kW.), Samarai (52 kW.), Lae (360 kW.), Madang (50 kW.) and Rabaul (160 kW.). At Wau, New Guinea, supply is provided to a small number of residents in the town by the New Guinea Goldfields Ltd., operating under franchise from the New Guinea Administration. At Bulolo, near Wau, the Bulolo Gold Dredging Ltd. operates a hydro station of 5,500 kW. Power produced is used to operate the Company's dredges and bulk supplies are provided to the New Guinea Goldfields Ltd.

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. However, there are indications that some industrial expansion will be effected in the main centres of population within the next few years.

In 1950 it was announced that the Commonwealth Government had joined with the British Aluminium Co. Ltd. of London to locate and develop large capacity hydro-electric schemes in New Guinea. A new company has been formed, known as the 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.

With a view to providing cheap power in the near future for domestic purposes and also to industry in the Port Moresby, Lae and Rapopo areas, the Department of Territories has drawn up a plan to construct a number of small hydro-electric schemes in Papua and New Guinea. These projects involve expenditure of more than £1,000,000 over the next three years.

The more important projects and estimated costs are as follows :—Port Moresby (Papua), £192,000 ; Lae (New Guinea), £200,000 ; Rapopo (New Guinea), £440,000 ; Madang (New Guinea), £200,000.

Work has commenced on the Port Moresby project which will have a capacity of approximately 10,000 kW. The estimated cost of smaller schemes is £186,000.

D. CONCLUSION.

During the next four to five years, electricity supply authorities plan to increase installed generating capacity in Australia by 2,350,000 kW. The overall cost of these works is estimated at approximately £300,000,000, based on an average of £80 per kW. for generation and £50 per kW. for transmission. This means, in effect, that each year for the next five years Australia will need to invest £60,000,000 on electric power projects alone. Imports of equipment for use in the generation of electricity were valued at about two and a half million pounds (£A.f.o.b.) in 1949-50 and at about four and a half million pounds (£A.f.o.b.) in 1950-51. The corresponding value of imports during 1939-40 was less than half a million pounds (£A.f.o.b.). By 1956, installed capacity is expected to be sufficient to satisfy unrestricted demand for electrical energy and have adequate reserve generating capacity available to provide for emergencies.

In determining the cost of electrical energy reticulated to the consumer, the main factors entering into such calculations include the geographical location of power stations in relation to the cost of fuel delivered (in the case of thermal stations) and the cost of transmission. Other elements in costs include labour, interest on capital invested and, to a certain extent, profits.

In general, the electricity supply authorities of Australia have adopted a tariff policy based on the cost of production at the power station or for the system as a whole, the class of consumer and amount consumed, the time of the day or night that consumption takes place, and the distance of the consumer from the source of supply. The only significant departure from the differential tariff policy is in Tasmania, where the Hydro-electric Commission charges a uniform tariff to all consumers of a certain class throughout the State—rates vary, of course, between the different classes of consumer, e.g. domestic or industrial. If the reticulation of electric power to new rural consumers is uneconomic, the State Government subsidizes the extension. Similar policies are in force in New South Wales and Queensland, but tariffs are not uniform in these States, i.e. they differ between metropolitan and rural localities.

Actual tariffs vary from State to State, being determined by the incidence of generation and distribution costs. Since the 1939-45 War, the price of electric power to the consumer has risen and it appears likely that this trend will continue for a number of years. With a view to encouraging the decentralization of industry to rural areas, most electricity supply authorities offer tariffs on a par with, or only slightly in excess of, those current in metropolitan areas. In both metropolitan and rural areas the average cost per unit to the consumer moves in an inverse ratio to the amount of power consumed.

The provision of adequate supplies of electric power is of such vital importance to Australia that, while its overall cost to the community and its cost to the consumer must be studied, the task of bringing supply and demand into equilibrium requires the constant attention of the authorities responsible, Commonwealth and State.

E. STATISTICAL SUMMARY, 1939-40 AND 1949-50.

The tables in this part present summaries, for the years 1939-40 and 1949-50, for each State separately and combined, relating to :—(i) the numbers and capacity of central electric generating stations, (ii) the amount of electricity generated and the number of consumers, and (iii) the values of production and output and the numbers of persons employed in the electricity supply industry.

CENTRAL ELECTRIC STATIONS.

1. NUMBER ACCORDING TO OWNERSHIP.

State.	Government.		Local Authority.		Other.		Total.	
	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.
New South Wales ..	6	10	39	45	54	37	99	92
Victoria ..	8	10	38	32	32	25	78	67
Queensland ..	1	..	36	36	16	9	53	45
South Australia ..	1	2	14	14	28	20	43	36
Western Australia ..	2	12	29	42	79	61	110	115
Tasmania	1	2	1	..	2	1	4	3
Total	19	36	157	169	211	153	387	358

2. INSTALLED CAPACITY ACCORDING TO OWNERSHIP.

(Kilowatts.)

State.	Government.		Local Authority.		Other.		Total.	
	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.
New South Wales ..	298,250	346,850	308,356	430,478	183,497	203,543	790,103	980,871
Victoria ..	360,540	553,047	(a)	(a)	(a)	(a)	414,686	619,889
Queensland ..	(a)	..	84,098	127,516	(a)	119,458	156,436	246,974
South Australia ..	(a)	(a)	(a)	33,370	85,771	(a)	120,081	206,743
Western Australia ..	(a)	65,001	(a)	(a)	48,578	(a)	111,640	119,396
Tasmania	(a)	(a)	(a)	..	(a)	(a)	125,980	194,950
Total	833,504	1,295,287	484,335	663,005	401,083	410,531	1,718,926	2,368,823

(a) Not available for publication.

3. INSTALLED CAPACITY ACCORDING TO SOURCE OF ENERGY.

(Kilowatts.)

State.	Steam.		Hydro.		Internal Combustion.		Total.	
	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.	1939–40.	1949–50.
New South Wales ..	720,471	889,434	25,661	32,655	43,971	58,782	790,103	980,871
Victoria ..	375,530	548,500	26,495	52,419	12,661	18,970	414,686	619,889
Queensland ..	134,331	211,274	4,666	4,141	17,439	31,559	156,436	246,974
South Australia ..	112,041	195,336	..	..	8,040	11,407	120,081	206,743
Western Australia ..	81,562	78,225	50	68	30,028	41,103	111,640	119,396
Tasmania	750	..	125,180	194,950	50	..	125,980	194,950
Total	1,424,685	1,922,769	182,052	284,233	112,189	161,821	1,718,926	2,368,823

4. INSTALLED CAPACITY PER HEAD OF POPULATION AND PER ULTIMATE CONSUMER.

(Kilowatts.)

State.	Per Head of Population.		Per Ultimate Consumer. (a)	
	1939–40.	1949–50.	1939–40.	1949–50.
New South Wales	0.29	0.31	1.5	1.3
Victoria	0.22	0.29	1.0	1.1
Queensland	0.15	0.21	1.0	1.0
South Australia	0.20	0.30	1.0	1.3
Western Australia	0.24	0.22	1.2	1.1
Tasmania	0.52	0.70	2.5	2.6
Total	0.25	0.29	1.3	1.2

(a) *See* note (a) on following page.

ELECTRICITY GENERATION AND CONSUMPTION.

1. ELECTRICITY GENERATED.

(Million kWh.)

State.	1939-40.	1949-50.
New South Wales	2,145	3,758
Victoria	1,391	2,706
Queensland..	422	972
South Australia	270	594
Western Australia	337	417
Tasmania	615	1,062
Total	5,180	9,509

2. NUMBER OF ULTIMATE CONSUMERS.(a)

State.	1939-40.		1949-50.	
	Ultimate Consumers.	Proportion of Population.	Ultimate Consumers.	Proportion of Population.
		%		%
New South Wales	520,000	19	784,000	25
Victoria	398,000	21	557,000	26
Queensland..	149,000	15	243,000	21
South Australia	120,000	20	161,000	23
Western Australia	95,000	20	109,000	20
Tasmania	50,000	21	76,000	27
Total	1,332,000	19	1,930,000	24

(a) Approximate figures. 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.

3. POWER USED PER HEAD OF POPULATION AND PER ULTIMATE CONSUMER.

(Kilowatt-hours.)

State.	Per Head of Population.		Per Ultimate Consumer.	
	1939-40.	1949-50.	1939-40.	1949-50.
New South Wales	766	1,174	4,290	4,698
Victoria	712	1,460	3,383	4,510.
Queensland	422	810	2,110	4,050
South Australia	450	850	2,700	2,970
Western Australia	674	700	3,370	4,170
Tasmania	3,075	3,540	12,300	10,620
Total	734	1,174	3,955	5,005

ELECTRICITY SUPPLY INDUSTRY.

VALUE OF PRODUCTION AND OUTPUT; NUMBER OF PERSONS EMPLOYED.

State.	Value of Production.(a)		Value of Output.		Persons Employed.	
	1939-40.	1949-50.	1939-40.	1949-50.	1939-40.	1949-50.
	£	£	£	£	No.	No.
New South Wales	4,466,264	7,196,816	6,196,385	15,017,542	2,148	3,968
Victoria	1,955,657	2,522,187	2,673,351	6,214,850	1,445	2,294
Queensland	578,575	856,920	1,061,158	3,476,503	587	967
South Australia	1,157,640	950,285	1,488,071	2,788,136	1,790	1,209
Western Australia	670,935	754,312	1,396,733	2,430,501	702	1,029
Tasmania	700,066	559,728	761,711	584,112	129	128
Total	9,529,137	12,840,248	13,577,409	30,511,644	6,801	9,595

(a) Value of production is the value added in the process of generation.

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