

CHAPTER 6

ELECTRIC POWER GENERATION AND DISTRIBUTION

This chapter is divided into three major parts: the Introduction, which deals briefly with the resources, generation and distribution, and future development of electric power in Australia; the Snowy Mountains Hydro-electric Scheme; and the origins, development, present situation and new projects of electrical systems in each Australian State and Territory.

The information contained in the chapter relates to situations existing and projects contemplated in December 1965, and may be considerably affected by changes in policy or plans, or by developments in the projects themselves.

INTRODUCTION

Distribution of population and location of power resources in Australia

The two principal centres of population and industry in Australia, the metropolitan areas of Sydney and Melbourne, make the greatest demands for electric power, and their growth has been associated with the development of large deposits of coal located relatively close to the source of demand. This, together with the fact that the major water resources are also located in the south-eastern portion of Australia, materially influences the distribution of industrial population and the location of major electric power stations. By far the most important source of energy used in the production of electric power in Australia is coal. At 30 June 1964 thermal power equipment represented 71 per cent, hydro plant 26 per cent, and internal combustion equipment 3 per cent of the total installed generating capacity.

Most of Australia is poorly supplied with water, only about 13 per cent receiving an annual rainfall of 30 inches or over, and these areas are confined largely to Tasmania and to the narrow coastal strip along the east coast of the mainland. The only region on the mainland of Australia high enough to receive reliable winter snowfall, and from which, therefore, reasonably constant water supplies throughout the year can be expected, is the mountain chain which stretches from the high plateaux of south-eastern New South Wales to the north-eastern highlands of Victoria. The hydro-electric potential of this area is considerable, and plans have been formulated to develop more than 4,000,000 kW by 1975. The two major construction projects in this area are the Snowy Mountains and Kiewa schemes. 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 available is smaller than 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. On the mainland the chief source of energy is coal; in Tasmania it is water.

Electric power generation and distribution

At the beginning of this century Australia's electrical undertakings were carried on mainly by private enterprise, but with some measure of governmental control designed to provide standards of safety and to define the scope and obligations of the private organizations. A trend towards public ownership commenced during the 1914-18 War and became more pronounced after the 1939-45 War. By 1961 all major generating stations supplying the public were, in varying degrees, under the control of statutory organizations constituted with the object of unifying and co-ordinating the generation and distribution of electricity supplies. There are still a large number of small private and municipal enterprises generating power for supply to country towns, although central authorities are extending supply to these places wherever practicable. In many areas it has been, and remains, the practice for central authorities to sell power in bulk to local distributing organizations which undertake reticulation.

In addition to the private, local government and statutory organizations which generate and/or distribute electricity for sale, numerous firms generate power for use in their own establishments, particularly those engaged in mining pursuits remote from the main centres of population. This chapter, however, is concerned mainly with the activities of central electric stations, as the power regularly produced for such internal consumption is, in any case, a relatively small proportion of the total power produced. The measures taken by authorities to satisfy the demand created by the post-war growth in population and building and by developments in industry and commerce are described in the following pages.

SNOWY MOUNTAINS HYDRO-ELECTRIC SCHEME*

Snowy Mountains Hydro-electric Power Act 1949

In July 1949 the Commonwealth Government established the Snowy Mountains Hydro-electric Authority, and empowered it to generate electricity by means of hydro-electric works in the Snowy Mountains Area; supply electricity to the Commonwealth (i) for defence purposes, (ii) for consumption in the Australian Capital Territory; and supply to a State, or to a State Authority, electricity not required for defence purposes or for consumption in the Australian Capital Territory.

The Authority is constituted by a Commissioner and two Associate Commissioners, the three appointments being made by the Governor-General. It is empowered to construct, maintain, operate, protect, manage and control works:

- (a) for the collection, diversion and storage of water in the Snowy Mountains Area;
- (b) for the generation of electricity in that area;
- (c) for the transmission of the electricity generated;
- (d) incidental or related to the construction, maintenance, operation, protection, management or control of any works otherwise specified in the Act.

The Snowy Mountains Act is supported by a detailed agreement between the States of New South Wales and Victoria and the Commonwealth with regard to the construction and operation of the Scheme, the distribution of power and water, charges to be made for electricity, and other such matters. The Snowy Mountains Council, established under the terms of the Agreement and consisting of representatives of the Commonwealth, the Authority and the two States, directs and controls the operation and maintenance of the permanent works of the Authority and the allocation of loads to generating stations.

Snowy Mountains Hydro-electric Scheme

The Snowy Mountains area in south-eastern New South Wales is the only part of the continent in which 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 150 inches a year in the vicinity of Mt. Kosciusko, the highest point in Australia. The drainage from the snowfields is practically all to three systems—those of the Murray and Murrumbidgee Rivers, which flow inland, and that of the Snowy River, which flows southward to Bass Strait.

The broad basis of the Snowy scheme is to transfer waters, which would otherwise flow to the sea unharnessed, from the Snowy River and its tributaries to the inland system, so that the water may be used for irrigation and to provide power. It involves two main diversions, the diversion of the Eucumbene, a tributary of the Snowy, to the Upper Tumut River, and the diversion of the main stream of the Snowy River at Island Bend and Jindabyne to the Swampy Plain River. These two diversions divide the scheme geographically into two sections, the Snowy-Tumut Development and the Snowy-Murray Development (*see* plate 18). For purposes of both power production and irrigation it is necessary to regulate run-off, and this will be achieved by the use of Lake Eucumbene (formed by the construction of Eucumbene Dam) and other smaller storages to control the waters of the Eucumbene, Murrumbidgee, Tooma and Tumut Rivers of the Snowy-Tumut Development and of the Snowy and Geehi Rivers for the Snowy-Murray Development. A sectional diagram of the scheme appears on plate 19.

Snowy-Tumut Development. This development comprises works for the diversion and regulation of the waters of the Eucumbene, Upper Tooma, Upper Murrumbidgee and Upper Tumut Rivers and their combined development through a series of power stations down the Tumut River. A major dam has been constructed on the Eucumbene River to create Lake Eucumbene, which has an ultimate usable storage of 3.5 million acre feet. The waters of the Upper Murrumbidgee River are diverted into Lake Eucumbene by a dam at Tantangara and a 10½-mile tunnel from Tantangara Reservoir. From Lake Eucumbene, the water flows through a 14-mile tunnel to Tumut Pond Reservoir on the upper reaches of the Tumut River, where it joins the waters of the Tumut River itself and the waters of the Tooma River diverted to Tumut Pond Reservoir by a diversion dam and a 9-mile tunnel. The 14-mile Eucumbene-Tumut Tunnel is used during periods of high flow to divert waters of the Tumut River from Happy Jacks Shaft or the combined waters of the Tumut and Tooma Rivers from Tumut Pond Reservoir back to Lake Eucumbene for storage.

From Tumut Pond Reservoir water is conveyed by pressure tunnel to Tumut 1 underground Power Station (capacity 320,000 kW), returned to the Tumut River and then by another pressure tunnel to Tumut 2 underground Power Station (capacity 280,000 kW), thence discharging into Talbingo Reservoir, also on the Tumut River.

* *See also* the chapter Water Conservation and Irrigation of this issue and special detailed article in Year Book No. 42, pp. 1103-1130.

Tumut 3 Power Station, the largest station of the scheme (capacity 1,500,000 kW of which 500,000 kW will be provided by pump turbines) will be constructed below Talbingo Reservoir and will discharge into Jounama Pondage on the Tumut River. This pondage will provide a downstream pumping pool and also re-regulate discharges from Tumut 3 Power Station as required. Releases from Jounama Pondage will then enter Blowering Reservoir formed by Blowering Dam. This dam is under construction by the Snowy Mountains Authority as an agent for the State of New South Wales and will provide for the regulation of power station discharges for irrigation use in the Murrumbidgee Valley. The Authority will construct a power station at the foot of the dam to generate power from releases of water for irrigation purposes.

Snowy-Murray Development. The principal features of the Snowy-Murray Development are the diversion of the main stream of the Snowy River by tunnels, shafts, and pipelines westwards through the Great Dividing Range into the Swampy Plain River in the catchment of the Upper Murray, and the development of power on the western slopes of the Alps. The main works of the development will be as follows.

- (a) A tunnel from the Snowy River near Island Bend through the Great Dividing Range to Geehi Reservoir on the Geehi River, and two power projects between Geehi Reservoir and the Swampy Plain River near Khancoban. The power stations associated with these two power projects, Murray 1 and Murray 2, will have a combined capacity of 1,500,000 kW.
- (b) A tunnel from a small dam on the Snowy River near Island Bend to Eucumbene Dam to carry Snowy water to Lake Eucumbene for storage at times of high river flows. When river flows are lower than average, this stored water will be returned towards Island Bend and thence through the Snowy-Geehi Tunnel to Geehi Reservoir and Murray 1 and Murray 2 Power Stations.
- (c) A dam on the Snowy River near Jindabyne to store the residual flow of the Snowy and Eucumbene Rivers downstream from Island Bend and Eucumbene Dams, including the flows of major tributaries, the Crackenback and Mowamba Rivers; and the construction of a pumping plant, pipeline and tunnel to lift this water from Jindabyne Reservoir to the Snowy-Geehi Tunnel near Island Bend, where it will join the flow to the Geehi Reservoir for use through Murray 1 and Murray 2 Power Stations.

The power output of this section of the Scheme will be increased by the construction of subsidiary hydro-electric projects on the Upper Snowy River above Island Bend and on Windy Creek, a tributary of the Upper Geehi.

Utilization of power from scheme

The future electric power plants on the mainland of Australia will be predominantly thermal or thermo-nuclear installations, and in an electrical system in which the greater part of the energy is generated in thermal plants it is usually found that the hydro installations operate to the best advantage on peak load. However, the existing New South Wales and Victorian systems include a proportion of relatively old and less efficient installations which, for reasons of fuel economy, are also best used for the production of peak load power. Therefore, in order to utilize the potential of the Snowy Mountains Scheme most effectively, the order of development is being arranged so that the early stations operate, initially, somewhat below the peak of the system load, with a progressive change to predominantly peak load operation as construction proceeds and as the load increases in magnitude.

The Snowy Mountains Scheme is situated about midway between the principal load centres of Sydney and Melbourne and is connected to those cities by 330 kV transmission lines. It is, consequently, in a position to take advantage of the diversity in the power requirements of these two load systems, a most important factor in so far as it affects the economy of operation of the supply systems of the two States. Although most of the output from the scheme will go to the States of New South Wales and Victoria, the Commonwealth Government has the right to draw from the scheme its requirements of power and energy for the Australian Capital Territory and for defence purposes. For convenience, the Commonwealth's requirements are drawn from the New South Wales transmission network by an exchange arrangement between the Commonwealth and the Electricity Commission of New South Wales. Electricity over and above that required by the Commonwealth Government is divided between the States of New South Wales and Victoria in the ratio 2 : 1.

Progress of scheme and future programme

The scheme's first power station, Guthega, of 60,000 kW initial capacity, came into operation in February 1955. It was followed by Tumut 1, an underground power station with a capacity of 320,000 kW, in 1959, and by the 280,000 kW Tumut 2 underground Power Station in 1962. The total installed capacity of the scheme at present is 660,000 kW. Eucumbene Dam, which provides the major regulating storage for the scheme, was completed in May 1958. Tumut Pond

Dam, completed in September 1958, provides the balancing storage for the power stations of the Upper Tumut Works. The first trans-mountain diversion of water from Lake Eucumbene to the Tumut River at Tumut Pond was made possible when the 14-mile Eucumbene-Tumut Tunnel was completed in June 1959. The 10½-mile Murrumbidgee-Eucumbene Tunnel and the 9-mile Tooma-Tumut Tunnel came into operation early in 1961. Following the completion of the Upper Tumut Works, construction activity has been concentrated on the Snowy-Murray development. The first unit of this development, the Eucumbene-Snowy project which comprises Island Bend Dam and the 15-mile Eucumbene-Snowy Tunnel, commenced diverting Snowy River water to storage in Lake Eucumbene in August 1965. Construction is well advanced on the 9-mile trans-mountain Snowy-Geehi Tunnel, the 7½-mile Murray 1 Pressure Tunnel, the 1-mile Pressure Pipeline and the 950,000 kW Murray 1 Power Station. These works, together with the Khancoban Dam, which will regulate power station releases before discharge into the Murray River, are to be substantially completed in 1966. At this time, the first trans-mountain diversion of water from the Snowy River to the Murray River and the first generation of electricity from the Murray 1 Power Station will occur.

STATES AND TERRITORIES

New South Wales

In Year Book No. 39, an account was given in some detail of the origin and development of electricity generation and distribution in New South Wales. At present, the following three main Acts govern electricity supply in New South Wales.

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

The Electricity Development Act, 1945-1964, which established the Electricity Authority of New South Wales as the body responsible for the co-ordination of electricity supply throughout the State.

The Electricity Commission Act, 1950-1961, which constituted the Electricity Commission of New South Wales as the major generating authority and not subject to the provisions of the Electricity Development Act.

Electricity Commission of New South Wales and other electricity supply authorities

The Commission, which is directly responsible to the Minister for Local Government, consists of five members, of whom one is full-time Chairman and one is full-time Vice-Chairman. The main function of the Commission is the generation and transmission of electricity, which it sells in bulk to distributing authorities (mainly local government bodies) throughout a large part of the State, to the Government railways, and to certain large industrial consumers. As the major generating authority, it is also responsible for the development of new power sources except in the Snowy Mountains region.

The retail sale of electricity to the public is, in general, carried out by separate electricity supply authorities—municipal and shire councils, electricity county councils (consisting of groups of shire and/or municipal councils), or private franchise holders. At 30 June 1965 there were fifty supply authorities throughout the State, of which thirteen also generated part or all of their power requirements. Most of the small power stations which had operated in many country centres have closed down as the main transmission network has been extended.

Over recent years there has been a distinct trend towards the consolidation of supply areas on a district basis for electricity distribution purposes. Generally, these consolidations have taken the form of a county district consisting of a number of neighbouring shire and municipal and city areas grouped only for electricity supply purposes, and administered by a county council of representatives elected by the constituent councils. Of the 224 cities, municipalities and shires in New South Wales, 214 are included in one or other of the thirty-four electricity county districts. The majority of these county districts have been constituted since 1945. The largest of the county councils is the Sydney County Council, which at 30 June 1965 was supplying 530,219 consumers in the Sydney metropolitan area.

Electricity Authority of New South Wales

The Electricity Authority was constituted for the purpose of promoting and regulating the co-ordination, development, expansion, extension and improvement of electricity supply throughout the State. A regulatory body, it consists of seven members of whom one is a full-time Chairman. Like the Electricity Commission, it is responsible to the Minister for Local Government. The following are the main functions of the Authority.

Distribution. The approval of the Authority is required for the establishment or acquisition of an electricity trading undertaking by a local government council, for the granting or renewing by such a council of electricity franchise agreements or corresponding agreements with other councils, and for the giving or taking of bulk supplies of electricity. It also has power to formulate proposals for the establishment of county councils. In exercising these powers, the Authority is concerned mainly with seeing that distributing authorities are sufficiently strong to provide an economical, efficient and satisfactory service. Its most important activities in this regard are in investigating supply areas and in making recommendations to the Minister for the consolidation of such areas into county districts.

Rural electrification. The Authority administers the rural electricity subsidy scheme under which rural electrification throughout the State is progressing very rapidly (see pp. 148-9).

Safety. The Electricity Development Act, 1945-1964 contains provisions for the making of regulations relating to most aspects of safety, and these powers are being used more and more extensively. Safety regulations now in force cover such matters as inspection of consumers' installations, licensing of electricians and electrical contractors, approval of electrical appliances, safety of linesmen and overhead line construction.

Generation and transmission. The approval of the Authority is required for the establishment or extension of power stations and main transmission lines (with the exception of those of the Electricity Commission).

Generation and transmission

Except in the Snowy Mountains district and in one or two other areas New South Wales is lacking in major water power potential, and for the generation of electricity the State is dependent mainly on steam power stations. During the year ended 30 June 1965, coal-fired power stations generated 82.8 per cent of the State's energy requirements, hydro-electric stations 16.7 per cent and internal combustion plants 0.5 per cent. Of the 16.7 per cent generated from hydro-electric stations, approximately 70 per cent was from the Snowy Mountains Scheme. This proportion will increase with the expansion of that scheme, but it is not expected that more than 15 per cent to 20 per cent of the State's power needs will be supplied from this source. The coal-fired steam power stations (and possibly atomic power stations in the future) will therefore continue to supply the greater part of requirements.

Major generating stations. In New South Wales the generation of electricity has followed the general world trend towards large centralized power stations supplying large areas through interconnected transmission networks. Whereas until a few years ago the greater part of the coal-fired generating plant was located in the industrial areas of Sydney, Newcastle and Wollongong, where most of the population is also located, major power stations are now being located on the coalfields to the north, south and west of Sydney, and power is transmitted to the load centres through high voltage transmission lines.

At 30 June 1965 the major power stations of the State system of the Electricity Commission of New South Wales and their installed capacities were as follows: *Steam*—Vales Point (Lake Macquarie), 600,000 kW; Bunnerong (Sydney), 375,000 kW; Wangi (Lake Macquarie), 330,000 kW; Tallawarra (Lake Illawarra), 320,000 kW; Wallerawang (near Lithgow), 240,000 kW; Pyrmont (Sydney), 200,000 kW; White Bay (Sydney), 172,000 kW; Balmain (Sydney), 107,000 kW; Port Kembla, 60,500 kW; Zarra Street (Newcastle), 42,500 kW; Muswellbrook, 30,000 kW; Lithgow, 27,000 kW; Tamworth, 27,000 kW; Maitland, 20,000 kW; Penrith, 20,000 kW; Liverpool, 20,000 kW; *Hydro*—Hume—(near Albury), 50,000 kW; Warragamba (near Penrith), 50,000 kW; Burrinjuck (near Yass), 20,000 kW. There were also various other steam, hydro and internal combustion stations aggregating 33,150 kW. The total installed capacity of the Electricity Commission's system was 2,744,150 kW. The greater part of the Commission's generating plant is concentrated within a hundred mile radius of Sydney—the largest stations outside this area being located at Hume, Muswellbrook and Tamworth.

Major transmission network. The retailing of electricity to 97 per cent of the population of New South Wales is in the hands of local distributing authorities, which obtain electricity in bulk from the Commission's major State network. This network of 330 kV, 132 kV, 66 kV and some 33 kV and 22 kV transmission lines links the Commission's power stations with the load centres throughout the eastern portions of the State, extending geographically up to 400 miles inland.

At 30 June 1965 there were in service 859 route miles of 330 kV (including 143 miles operating for the time being at 132 kV) and 2,073 miles of 132 kV transmission lines (including 153 miles operating for the time being at 66 kV or lower). There were also in service 2,445 miles of transmission line of 66 kV and lower voltages. The installed transformer capacity at the Commission's 112 sub-stations was 9,350,300 kVA.

Separate systems and total State installed capacity. A number of small plants which supply isolated towns and villages have not yet been interconnected with the main network. Some local government bodies have undertaken the development of independent power stations. Of these, the more important are:—the Northern Rivers County Council, which has constructed a steam power station at Koolkhan (near Grafton) with an installed capacity of 28,750 kW, and the North-West County Council, which has established a 15,000 kW steam power station on the Ashford coalfield. The aggregate installed capacity for the whole of the New South Wales systems and isolated plants was 2,858,480 kW at 30 June 1965 and the number of ultimate consumers at this date was 1,339,499.

Future development

The major new thermal stations already built and those now being developed on the coal-fields will become the main base load centres for the northern, southern and western regions. Wangi, on Lake Macquarie, Wallerawang, near Lithgow, and Tallawarra, on Lake Illawarra, have been completed.

At Vales Point, on Lake Macquarie, work is in progress on a large thermal station with a designed capacity of 875,000 kW. The plant will consist of three 200,000 kW units and one 275,000 kW unit. The three 200,000 kW units have been commissioned. The 275,000 kW unit is programmed for completion in 1966. Construction of the Munmorah Power Station, located between Lakes Munmorah and Budgewoi (on the central coast), has commenced. The plant at Munmorah will comprise four 350,000 kW generating units, the first of which is programmed for commissioning in 1967, and the second, third and fourth units will follow at yearly intervals thereafter.

During the first half of 1965 work commenced on the Liddell Power Station project in the Hunter Valley, between Singleton and Muswellbrook. The designed capacity of Liddell is 2,000,000 kW, consisting of four 500,000 kW generating units and is the biggest thermal power station yet planned in Australia. The first unit is scheduled for commissioning in 1971, and the second, third and fourth units in 1972, 1973 and 1974 respectively. The development of the 330 kV main system is continuing. With duplicate transmission completed over the whole distance from the Snowy Mountains to the northern coalfields, the main work now is the construction of a third circuit between the Vales Point-Munmorah area and Sydney and between the Snowy area and Yass. The latter transmission line is being constructed between Talbingo and Yass (74 miles) and will connect at Talbingo to a new 330 kV line being constructed by the Snowy Mountain Authority between Talbingo and the Authority's Murray switching station transmitting power to the New South Wales net work from the Murray power stations.

The development of the 330 kV network around the Sydney metropolitan area is proceeding. Further progress in the work of bringing additional power into the Sydney metropolitan area from southern and northern power stations was achieved when the new 330 kV transmission centre was commissioned at Sydney West, near Wallgrove, with a transformer capacity of 870 MVA. This major 330 kV substation, the third to be established in the metropolitan area, is linked at 330 kV with Sydney North and Sydney South and also with Dapto in the south. Plans to augment the transmission system during the next five years provide for the construction of 379 route miles of 330 kV lines and three associated substations, over 930 route miles of 132kV line and eighteen substations, as well as additions to existing substations and a number of lower voltage works.

Hydro-electricity

The greater part of the hydro-electric potential of New South Wales is concentrated in the Snowy Mountains area (*see* Snowy Mountains Hydro-electric Scheme, p. 144). Apart from this area, major hydro-electric stations are in operation at the Warragamba Dam (50,000 kW), Hume Dam (50,000 kW), Burrinjuck Dam (20,000 kW), and Keepit Dam (6,000 kW). The output of Warragamba Power Station depends upon the availability of water surplus to the requirements of the Sydney metropolitan area, and the output of the other stations on the release of water for irrigation. Of the remaining hydro installations, the largest is that of the New England County Council on the Oakey River, a tributary of the Macleay River, which has a capacity of 5,250 kW. The Northern Rivers County Council operates a hydro-electric power station on the Nymboida River, a tributary of the Clarence River. This station has a capacity of 4,500 kW. The Bega Valley County Council has constructed a hydro-electric scheme at Brown Mountain utilizing the headwaters of the Bemboka River. This installation has a capacity of 3,950 kW. The Mullumbimby Municipal Council has in operation two hydro units with an effective rating of 140 kW each, on Wilson's Creek, a tributary of the Richmond River.

Rural electrification

When the Electricity Authority of New South Wales was constituted in 1946 less than one-quarter of New South Wales farms within reasonable reach of public electricity supply systems were being served with electricity. Under a subsidy scheme approved in August 1946, local

electricity suppliers receive subsidies from the Electricity Authority towards the cost of new rural lines. The amount of subsidy is based on the estimated cost of the proposed extension and the number of consumers able to be served by the new lines. The scheme was designed to encourage local electricity supply authorities to construct the more economic extensions first by fixing a limit to the cost for which suppliers could be subsidized. Originally this limit was £250 (\$500) per consumer when averaged over the cost of the whole extension, but the limit was raised to £400 (\$800) in December 1953. Some subsidy was paid on higher cost extensions, but the excess over an average of £400 (\$800) was not subsidized.

To assist supply authorities in extending supply to less populated, and thus high-cost, areas of the State the subsidy scheme was extended from May 1959 to provide for payment of increased subsidy in respect of extensions where the average capital cost per consumer lies within the range of £600-£800 (\$1,200-\$1,600).

Between August 1946 and June 1965, applications for subsidy had been made by electricity suppliers to the Authority covering rural extensions costing \$75 million to give supply to some 57,250 farming properties and 34,700 other rural consumers and involving 54,300 miles of line. The greater part of this work had been completed at 30 June 1965. At this date the Authority was committed to the payment of \$30,924,486 in subsidies, of which \$16,455,470 had been paid.

Victoria

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

Constituted by the *Electricity Commissioners Act 1918*, the State Electricity Commission is a semi-governmental authority administered since 1921 by a full-time Chairman and three part-time Commissioners. The principal duty of the Commission is to co-ordinate and extend on an economic basis the supply of electricity throughout Victoria. For this purpose it is vested with power to erect, own, and operate power stations and other electrical plant and installations, supply electricity retail to individual consumers or in bulk to any corporation or public institution, acquire and operate electricity undertakings, develop, own, and operate brown coal open cuts and briquetting works, and develop the State's hydro-electric resources. From its own revenues, which it controls, the Commission must meet all expenditure in the operation of its power, fuel and subsidiary undertakings, and all interest and other charges incurred in the service of its loans and other capital commitments.

The Commission is the controlling authority for all electrical undertakings in Victoria. It is responsible for the registration of electrical contractors, the licensing of electrical mechanics, the control of installation methods and material, and the testing and approval of electrical equipment and appliances. Incidental to its main operations, the Commission owns and operates the tramway systems in Ballarat and Bendigo. For the accommodation of its employees at Yallourn, the Commission owns and administers the town of Yallourn. It also owns large housing estates in the surrounding area, but is progressively selling houses in these estates to Commission employees. In the Kiewa hydro-electric works area it has built the two townships of Mount Beauty and Bogong, municipal administration of the former now being vested in the Shire of Bright. With construction at Kiewa now complete, many houses at Mount Beauty have been sold for holiday homes.

State Electricity Commission of Victoria

Since it began operating in 1919 the State Electricity Commission has expanded and co-ordinated the production and supply of electricity on a State-wide basis to the point where its system now generates almost all the electricity produced in Victoria and serves nearly 98 per cent of the population. Development of Victoria's electricity system is based on the utilization for both power and fuel of Victoria's extensive brown coal resources in the Latrobe Valley in eastern Gippsland, with supplementary development of the hydro-electric potential of north-eastern Victoria. Victoria is entitled to one-third of the electricity from the Snowy Mountains Hydro-electric Scheme, after the Commonwealth has taken the power it needs for its purposes. Victoria also shares with New South Wales in the electricity generated at Hume Hydro Station on the River Murray. About 75 per cent of the State's electricity is generated from brown coal, either used in its raw state or manufactured into higher quality fuel in the form of brown coal briquettes. All the brown coal and briquette fuel is supplied by undertakings which the Commission itself owns and operates. Output of brown coal in 1964-65 from the three open cuts at Yallourn, Yallourn North and Morwell totalled 19,001,796 tons, of which 13,322,670 tons were used in the Commission's own power stations, and 5,250,518 tons were manufactured into 1,892,759 tons of brown coal briquettes, 33 per cent of the briquette output then being used for electricity production

in metropolitan and provincial steam power stations. The two functions, generation of electricity and production of fuel, are closely integrated. Apart from the large proportion of brown coal and briquette fuel consumed in the power stations, the process of briquette manufacture results also in the generation of electricity, since the steam needed for processing the raw coal for briquetting is first used to operate turbo-generators.

Electricity supply

At 30 June 1965 the number of ultimate consumers in Victoria was 1,057,314. Of these, 1,048,554 were served by the State system and 8,760 by local country undertakings. The State system supplies all the Melbourne metropolitan area and over 2,000 other centres of population.

Complete electrification of the State is now within sight. By 30 June 1965 about 890,000 of the 917,000 homes in the State and 61,200 of Victoria's 72,000 farms were supplied with electricity. By 1970-71, allowing for extensions then in progress, only about 6,000 homes and fewer than 1,250 farms in remote areas will be out of reach of public electricity supply, but efforts will be continued to supply as many of these as possible.

The Commission sells electricity retail in all areas except part of the metropolitan area, where it sells in bulk to eleven municipal undertakings which operate as local retail supply authorities under franchises granted before the Commission was established. Bulk supply is also being provided at present to several New South Wales municipalities and irrigation settlements bordering the River Murray. The number of consumers served by the State system outside the Melbourne metropolitan area is 481,616. Of the new consumers connected to supply each year, more than two-thirds are outside the metropolitan area. New farm connections average over 3,000 a year.

The Commission's retail consumers numbered 842,168 at 30 June 1965. Retail supply is administered through the metropolitan branch and ten extra-metropolitan branches (Ballarat, Eastern Metropolitan, Geelong, Gippsland, Midland, Mildura, Northern, North-Eastern, South-Western and Wimmera). At 30 June 1965 there were branch and district supply offices in Melbourne and 90 other cities and towns in Victoria.

Electricity production, transmission and distribution

Electricity generated in the State system or purchased by it totalled 9,636 million kWh in 1964-65, or more than 99 per cent of all Victoria's electricity for public supply. The system comprises a series of thermal and hydro-electric power stations. Inclusive of generator capacity both within the State and available to the Victorian system from outside the State, the total installed generator capacity at 30 June 1965 was 2,288,000 kW. Power stations are interconnected and feed electricity into a common pool for general supply. The major power station in this interconnected system is the brown coal burning power station at Yallourn, which alone generates nearly half of Victoria's electricity. Other power stations in the interconnected system comprise two further base load brown coal burning power stations, Morwell and Hazelwood (which has two of its planned eight 200,000 kW generating sets in service); steam stations in Melbourne (Newport, Richmond and Spencer Street), Geelong and Ballarat, and also at Red Cliffs, which has, in addition, some internal combustion plant; hydro-electric stations at Kiewa, at Eildon, on the Rubicon and Royston rivers near Eildon, and at Cairn Curran; and an internal combustion station at Warrnambool. All within Victoria are Commission-owned, except Spencer Street Power Station, which remains the property of the Melbourne City Council, although operated as a unit in the interconnected system. A 330 kV transmission line links the Victorian system with the Snowy Mountains undertaking, and also provides facilities for interconnection between the Victorian and New South Wales State generating systems. Also linked with the Victorian interconnected system is the hydro station at Hume Dam on the River Murray. This power station is operated by the Electricity Commission of New South Wales. Output and operating costs are shared by Victoria and New South Wales. In meeting the total demand on the system, which fluctuates throughout the day and from month to month, each group of stations in the interconnected system is assigned a predetermined function dependent upon the availability of power from each group and the economics of generation. The various stations are utilized in the combination that will meet the system load most economically at a given time.

The electrical transmission and distribution system in the State supply network at 30 June 1965 comprised 46,011 miles of power-lines, 19 terminal receiving stations, 94 main transmission sub-stations, and over 42,000 distribution sub-stations. Main transmission is by 330 kV, 220 kV, 132 kV and 66 kV power lines which supply the principal distribution centres and also provide interconnection between the power stations. The 330 kV and 220 kV systems total 1,154 miles.

Future development

Major new construction is concentrated on the erection on the brown coal fields of the Latrobe Valley, of a large new brown coal burning power station (Hazelwood), which is designed to operate on raw brown coal fuel supplied by belt conveyor direct from the Morwell open cut. Hazelwood Power Station is the largest project yet undertaken by the Commission and is designed

to have a capacity of 1,600,000 kW in 1971. By that year the State's power resources, including Victoria's share of the output of the Snowy scheme, will have increased by 81 per cent to 3,616,000 kW. The first of Hazelwood's eight 200,000 kW turbo-generators was commissioned in October 1964. A second generating set of the same capacity went into service in 1965, and six other 200,000 kW sets will follow at yearly intervals. Power generated at Hazelwood Power Station is transmitted at high voltage to Melbourne metropolitan terminal stations for distribution through the State supply network.

Local country electricity undertakings

At 30 June 1965 there were eleven independent electricity undertakings in country centres in Victoria generating and distributing their own local supply. All except three of these undertakings were in the west and north-west of the State. Under the State Electricity Commission's rural electrification programme almost all the independent local country undertakings will ultimately be acquired and absorbed into the State system. For the year 1964-65 the total production of the independent undertakings was 32 million kWh. The number of consumers at 30 June 1965 was 8,760. With the exception of the Wonthaggi undertaking (which is operated by the State Coal Mine), the operation of the independent undertakings is governed by the *Electric Light and Power Act 1958*, which is administered by the State Electricity Commission.

Queensland

In Year Book No. 39 an account is given of the growth of electricity generation in Queensland, with particular reference to south-eastern Queensland, and of the events leading up to the establishment in 1937 of the State Electricity Commission of Queensland.

Electricity supply in Queensland is governed by the following Acts which are administered by the Commission:

- '*The State Electricity Commission Acts, 1937 to 1965.*' These Acts constituted the Commission and define its powers, duties and responsibilities.
- '*The Electric Light and Power Acts, 1896 to 1965.*' These Acts relate to the constitution of electric authorities, and define their powers, duties and responsibilities, and the conditions under which electricity is to be supplied and used, and also provide for the making of regulations governing safety and other matters.
- '*The Regional Electric Authorities Acts, 1945 to 1964.*' These Acts provide for the constitution of Regional Electricity Boards representative of the Commission and the Local Authorities within each region, and define their powers and responsibilities.
- '*The Southern Electric Authority of Queensland Acts, 1952 to 1964.*' These Acts established the Southern Electric Authority as a public authority and successor to the City Electric Light Co. Ltd., and define the powers and responsibilities of the Authority.
- '*The Northern Electric Authority Acts, 1963 to 1964.*' These Acts established the Northern Electric Authority with responsibility for the generation and main transmission of electricity in north Queensland and for its sale in bulk to regional distributing authorities. They also define its powers and responsibilities.
- '*The Electrical Workers and Contractors Acts, 1962 to 1964.*' These Acts deal with the execution of electrical works, the competency of electrical workers, and the licensing of electrical contractors.

State Electricity Commission of Queensland

The Commission commenced to function in January 1938. Generally, the Commission is the statutory authority concerned, *inter alia*, with the administration of electricity supply legislation, the general control, organization and efficient development of the electricity supply industry in Queensland, the forward planning of such development, the control of electricity charges, the administration of regulations and rules relating to safety, the raising of capital, the provision of engineering and consulting services, the promotion of the use of electricity, particularly in manufacturing and rural industries, and the fixing of standards. In addition, it is an authority to which consumers may appeal on matters in dispute between them and their electric authorities. The Commission is also empowered to own directly and operate generating stations and transmission lines and to sell electricity in bulk, but up to the present it has not been found necessary or desirable to implement this power.

Development and organization

Following the 1939-1945 War, regional systems of electricity supply were established in and adjacent to the eastern coastal area, which is over 1,300 miles long. Five Regional Electricity Boards were established to replace the numerous individual electricity undertakings which had supplied only the larger centres of population. Under this system supply was delivered from

central generating stations at or near the principal load centres. Each region comprised a homogeneous area, possessing relatively common interests, within which integrated transmission and distribution systems were established. Transmitted supply was taken to load centres previously served by relatively costly local generating stations and a vigorous policy of rural electrification was pursued. In south-eastern Queensland regional electrification was undertaken by the Southern Electric Authority and the Dalby Town Council. The Brisbane City Council supplies the metropolitan area.

In the pastoral areas west of the Great Dividing Range supply had been provided by means of small diesel-operated generating stations run by local authorities. These independent units are fairly uniformly scattered throughout western Queensland and no town or village with more than fifty potential consumers is without electricity. With increasing consumption there has been a trend in this area for local generating stations to be superseded by transmitted supply from larger centres. From such transmission lines it has been possible to provide electricity to many otherwise isolated rural properties.

Continued load growth led naturally to the interconnection of regional systems and by this means the production of electricity was concentrated on the cheapest sources of power. The three northern Regional Electricity Boards (Cairns, Townsville and Mackay) were consolidated into one interconnected grid. In the south, the supply systems of the Southern Electric Authority, the Brisbane City Council, the Wide Bay-Burnett Regional Electricity Board and the Dalby Town Council also form an interconnected grid. The central Queensland network, which is operated by the Capricornia Regional Electricity Board, is not yet connected with either the northern or southern grids.

The natural sequel to the interconnection of regional supply systems has been the severance of the production and distribution functions. For the northern grid, the Northern Electric Authority is responsible for the operation of generation and main transmission facilities, with the Cairns, Townsville and Mackay Regional Electricity Boards buying in bulk and acting as distributing authorities. In the south, the Southern Electric Authority is responsible for generation and transmission, with the other authorities purchasing in bulk and performing the distribution function. However, the Southern Electric Authority also distributes over a large rural area surrounding Brisbane, and the Wide Bay-Burnett Board generates on a small scale. The Capricornia, Townsville and Cairns Boards operate a number of small isolated diesel generating stations.

All electricity undertakings in Queensland are now publicly owned, and with the exception of the Southern Electric Authority are controlled by representatives of local authorities within the areas concerned. Further interconnections and amalgamations within the electricity supply industry will be effected as soon as they will produce greater efficiency and lower costs to consumers. A major co-ordinating factor has been the inclusion of the Commissioner for Electricity Supply on the Boards of the Southern Electric Authority, the Northern Electric Authority and the five Regional Electricity Boards since their inception.

Electricity generation, transmission and distribution

Electricity generated in the State is based primarily on black coal, 83.3 per cent of the total production during 1964-65 being derived from this fuel. Hydro-electric stations, located mainly in north Queensland, provided 15.1 per cent, and the balance of the production, 1.6 per cent, was from internal combustion plants located mainly in western Queensland, utilizing oil, wood, coal or natural gas as fuel. Natural gas is the principal fuel used at the Roma power station. Electricity generated in Queensland in power stations in 1964-65 totalled 3,518 million kWh. At 30 June 1965, the major power stations within the State were as follows:—*Steam*—Bulimba A (Brisbane), 92,500 kW; Bulimba B (Brisbane), 180,000 kW; New Farm (Brisbane), 75,000 kW; Tennyson A (Brisbane), 120,000 kW; Tennyson B (Brisbane), 120,000 kW; Howard (near Maryborough), 37,500 kW; Rockhampton, 52,500 kW; Callide, 30,000 kW; Mackay, 12,250 kW; Townsville, 37,500 kW; *Hydro*—Kareeya (Tully Falls), 72,000 kW; Barron Gorge (near Cairns), 60,000 kW. The Mackay station also contains 3,000 kW of internal combustion plant. The Southern Electric Authority also operates two packaged plants each of 10,000 kW capacity. The total installed capacity of all Queensland generating stations was 995,975 kW, which comprised 833,750 kW of steam plant, 135,205 kW of hydro-electric plant and 27,020 kW of internal combustion plant.

The electrical transmission and distribution systems within the State comprised 34,180 circuit miles of electric lines at 30 June 1965. The main transmission voltages are 132 kV, 110 kV, 66 kV and in certain areas 33 kV. Extensive rural electrification has been undertaken by means of the single wire earth return system. At 30 June 1965 the total number of electricity consumers was 476,000, of whom 191,691 were in metropolitan Brisbane. The total number of farming properties supplied with electricity was 25,876.

Future development

Major new construction is concentrated on the development of three new power stations sited on coalfields. These are at Swanbank (396,000 kW) on the West Moreton coalfield near Ipswich, Callide (120,000 kW) on the Callide open-cut coalfield near Biloela, and at Collinsville

(180,000 kW) on the Collinsville coalfield. These stations will supply the southern, central and northern network, respectively. Cooling water for the Callide station will be provided from a multipurpose dam on Callide Creek which will also satisfy irrigation needs. A similar multipurpose dam on the Broken River will serve the Collinsville station. The water requirements of the Swanbank power station will be supplied from the Moogerah Dam. The Swanbank station will consist of six 66,000 kW generating sets, the first of which will be commissioned in 1966, two more in 1967 and one in 1968 and 1969. The first stage of the Callide station consists of two 30,000 kW sets, the first of which was commissioned in June 1965. The second and third sets are scheduled for commissioning in 1966 and 1967 respectively. At Collinsville the first stage of two 30,000 kW sets is planned for commissioning in 1968. In November 1965 Government approval was secured for the construction of a second thermal power station at Swanbank. This station has a planned capacity of 480,000 kW, and one 100,000 kW generating set will be commissioned annually from 1970 to 1973. In North Queensland, developments being considered include the further expansion of thermal generation at Collinsville and the further utilization of the area's hydro-electric potential.

The electrical development in the west of Queensland is being assisted by the progressive extension westwards of the boundaries of the major regional electricity undertakings to include smaller western undertakings, bringing with it the advantages of incorporation within larger authorities, lower tariffs and greater financial and technical resources. Organizational changes involving amalgamation of isolated undertakings and their interconnection by transmission lines are being implemented as and when economic benefits to the consumers will result. In the extreme far west the isolated undertakings must inevitably continue to remain as such for the foreseeable future. New measures now proposed include the further westward extension of the areas of supply of the Townsville and Capricornia Regional Electricity Boards, and the establishment of a small electricity supply region to cater for the development of the central Western area of the State based upon Longreach and Barcaldine.

South Australia

An account of the companies generating electric power in South Australia prior to the establishment of the Adelaide Electric Supply Co. Ltd., and describing the development of that company's activities, was given in Year Book No. 39. Also included in the account was some reference to the early measures of public control over electricity supply in South Australia and the extent to which they were applied, and also to the inquiries into the activities of the Adelaide Electric Supply Co. Ltd., in 1932 and 1935. Following an inquiry instituted by the Government in 1943, relative to measures for increasing electricity supply to the metropolitan area and country districts, the Electricity Act, 1943 was passed, which, *inter alia*, established the South Australian Electricity Commission.

Electricity Trust of South Australia

In 1946 the assets of the Adelaide Electric Supply Co. Ltd. were transferred to a newly formed public authority, the Electricity Trust of South Australia, which became responsible for unification and co-ordination of the major portion of the State's electricity supply and which took over the powers previously vested in the South Australian Electricity Commission. In addition to the powers specified in the Adelaide Electric Supply Company's Acts, 1897-1931, the Trust may supply electricity direct to consumers within a district or municipality with the approval of the local authority, and by agreement with other organizations which generate or supply electricity, arrange to inter-connect the mains of the Trust with those of other organizations, and give or receive supplies of electricity in bulk.

Capacity and production

Three main categories of organizations generate electric power in South Australia, namely: (a) governmental, which include the Electricity Trust; (b) local authorities, e.g. municipal and district councils, and the Renmark Irrigation Trust; and (c) other, including individuals and firms engaged primarily in generating power for sale, firms generating power primarily for their own use but supplying outside consumers, and firms generating power solely for their own use.

Of the total installed capacity in South Australia at 30 June 1965, the Electricity Trust operated plant with a capacity of 666,000 kW, and is the most important authority supplying electricity in the State. There were approximately 368,000 ultimate consumers of electricity in the State, of whom 349,600 were supplied directly and approximately 11,000 indirectly (i.e. through bulk supply) by the Trust. Its major steam stations are Osborne 'A' (60,000 kW), Osborne 'B' (240,000 kW), and Port Augusta Playford 'A' (90,000 kW) and Playford 'B' (240,000 kW), the balance of the capacity controlled consisting of house sets and regional stations at Port Lincoln and Mount Gambier, where the Trust operates steam power stations of 5,000 kW and 21,800 kW capacity respectively, the former burning fuel oil and the latter either wood waste or fuel oil. Mt. Gambier is connected with the Metropolitan system by a 132 kV line. No hydro-electric potential exists in South Australia. Steam generating units comprise 98 per cent of installed capacity and the balance is internal combustion equipment.

Leigh Creek and other new capacity

Fairly extensive deposits of low grade sub-bituminous coal are obtainable at Leigh Creek, about 360 miles north of Adelaide. Under the Electricity Trust of South Australia Act, 1946, the Trust was given authority to develop Leigh Creek coal for use in its own undertakings and also for sale to other consumers. Production from the Leigh Creek field commenced in 1944, and in the year ended 30 June 1965, 1,919,483 tons of coal were produced, practically all of which was used by the electricity undertaking at the Port Augusta Playford Power Stations which use Leigh Creek coal exclusively.

A large power station is to be constructed on Torrens Island near Adelaide and four 120,000kW turbo-alternators and associated oil fired boilers have been ordered, the first to be commissioned early in 1967.

Western Australia

Since 1952 the State Electricity Commission of Western Australia has generated and distributed all electric current in the Perth metropolitan area, including Fremantle. Previously the Fremantle Municipal Tramways and Electric Lighting Board and other metropolitan municipal and road board supply authorities had purchased current in bulk from the Commission for distribution through their own system. For information on the early history of electricity supply in the metropolitan area, see Year Book No. 39, page 1189.

State Electricity Commission of Western Australia

The State Electricity Commission of Western Australia was established by the *State Electricity Commission Act, 1945*, and, as at present constituted, consists of nine members, including the Chairman, appointed by the Governor. Four of the Commissioners are representatives of consumers, one for the metropolitan area, two for the rest of the State and one representing commercial consumers. Of the remaining five, one is the Under Treasurer of the State or his deputy, one represents employees of the Commission and three are required to be qualified engineers.

The Commission is empowered to co-ordinate all State and other power undertakings in the State; to encourage and promote the use of electricity and other power, especially for industrial, manufacturing and rural purposes; and to carry out investigations to determine the safest, most economical and effective means for promoting, establishing, extending and improving works for the generation, transmission, distribution, supply and use of electricity or other power throughout the State. 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 that their proposals are not inconsistent with the Commission's plans.

General pattern of electricity supply

The State Electricity Commission gives central power station supply to the metropolitan area and an area of approximately 25,000 square miles defined in the report which formed a basis for the *South West State Power Scheme Act, 1945*, and an area extending eastward from Perth to Merredin. These areas include the more highly developed rural districts with a greater population density, which can more readily be connected to a central power station system. The policy of extending power supplies to rural consumers is continuing and at 30 September 1965 some 5,673 rural consumers were connected. A similar scheme known as the Northern Areas State Power Scheme will be developed and a depot has been established in the Geraldton area. The Commission purchases power in bulk from the Geraldton Town Council to supply surrounding districts as far north as Northampton.

In the other areas of the State, towns are supplied by the local authority or by a concessionaire operating under an agreement with the local authority and the Commission. Power stations operated under these conditions are exclusively diesel of varying sizes. The number of consumers at 30 June 1965 was 189,844.

At the request of the Government, the Electricity Advisory Committee, in 1945, submitted a report which recommended, among other things, a national power scheme for the south-west. The plan provided for acquisition of the existing Collie Power Station and installation of additional generating capacity, construction of a power station at Bunbury and inter-connection of the south-west scheme with the metropolitan system. In 1946 the State Electricity Commission acquired the Collie Power Station, and since then it has acquired a number of electrical undertakings from municipal bodies and private organizations in the south-west area and is proceeding with arrangements for the purchase of others. In August 1951 the first portion of the South-West Power

Scheme was officially opened at Collie, and most of the south-west towns as well as towns in the eastern wheat belt area as far east as Merredin have now been connected by transmission line to the interconnected system. Statistics relating to activities of the interconnected system for the years 1963-64 and 1964-65 are shown in the following table.

	1963-64	1964-65
Plant capacity kW	289 500	349,500
Maximum load kW	263,000	320,000
Units generated million kWh	1,094	1,215
Fuel used per unit (kWh) generated lb.	1.49	1.47
Coal used tons	617,150	686,928

In Kalgoorlie the large gold mines generate their own power requirements. The Power Corporation has ceased operations, and the Kalgoorlie Town Council operates a new 50 cycle diesel station to supply A.C. consumers in Kalgoorlie and Boulder. The D.C. stations of the Kalgoorlie and Boulder Town Council will continue to operate for some time at least.

New projects

Since its inception in 1946 the State Electricity Commission has made the provision of an adequate reserve of generating plant its primary object. With the commissioning of the first unit at South Fremantle Power Station in May 1951, the lag caused by shortages during the war and early post-war years was overcome. The system then developed rapidly to keep pace with the expansion of industry and housing. Generating plant has increased five-fold in the past eighteen years. The three major power stations have been interconnected with the South West Power Station at Collie enabling the most economical units to be used as a base load station. Continuous development of the transmission and distribution system is being undertaken to keep pace with the growth in consumer demand which is being maintained at a high level.

The first of the four turbo alternators to be installed at Muja Power Station (near Collie) was commissioned on 10 July 1965, and work on the other units is proceeding to schedule. One of these will be ready for service in September 1966, another in 1967 and the fourth in 1968. Tenders have also been called for two 120,000 kW oil fired units for a new station to be built at Kwinana. It is expected that these units will be commissioned in 1970 and 1971.

Tasmania

A considerable part of the water catchment in Tasmania is at high level, with a substantial natural storage available, and this has made it possible to produce energy at lower cost than elsewhere in Australia, or in most other countries. Another factor contributing to the low cost is that rainfall is distributed fairly evenly throughout the year with comparatively small yearly variations. The abundant and comparatively cheap supplies of electricity and other natural resources have attracted to Tasmania a number of important secondary industries, including large electro-chemical and metallurgical works with high load factor (in consequence of which the system load factor is also very high—72 per cent), for which energy costs constitute a large proportion of the total cost of production. The continuous power demands of these organizations when plant is in full operation aggregates 278,000 kW. For information on hydro-electric development in Tasmania prior to the establishment of the Hydro-Electric Commission in 1930, see Year Book No. 39, pages 1192-3.

Hydro-Electric Commission

In 1929 the Government passed the *Hydro-Electric Commission Act 1929*, which established the Hydro-Electric Commission and vests in the Commission, with some minor exceptions, the right to use the waters of the State of Tasmania, and authorizes it to develop and reticulate electric power for all purposes. In 1930 this corporate body took over the State hydro-electric undertaking and the business of the Hydro-Electric Department. For details of projects undertaken by the Commission prior to 1957 see Year Book No. 48, pp. 243-4, and earlier issues. Particulars of the Catagunya Power Development Scheme, begun in 1957 and completed in 1962, are contained in subsequent issues up to No. 51.

In the Great Lake Power Development the water of the Great Lake, by its diversion to the north-east in the direction of the most precipitous fall, is used to much greater advantage than previously through Shannon and Waddamana. Eventually reaching the South Esk River, it is used again through the machines of the Trevallyn Power Station. The works consist of an intake at the Great Lake, a four-mile headrace tunnel through the Western Tiers, one mile of high pressure pipeline on the face of the Tiers, a vertical shaft leading to the Poatina Power Station some 500 feet underground, a two-mile trailrace tunnel discharging into a canal, and then a

channel to the Lake River, a tributary of the South Esk. In this development the power is generated by the fall of water through a vertical distance of 2,730 feet to the underground Poatina Power Station. Three 50,000 kW generators were in operation by mid-1964, a fourth in September, 1964, and a fifth in February 1965. A sixth generator, to be installed at a later date, will bring the station's installed capacity to 300,000 kW. A further section of the scheme, now nearing completion, includes a dam at Arthur Lakes from which water will be pumped via conduit into the Great Lake, thus increasing the storage for use through the Poatina Power Station. With the commissioning of Poatina Power Station, Shannon Power Station was taken out of service in June 1964, and the original Waddamana 'A' Power Station was taken out of service in June 1965. Waddamana 'B' Station is being retained to provide peak load capacity and spare plant.

The total installed capacity of alternators in the various power stations throughout Tasmania in June 1965 was as follows:

	kW
Waddamana 'B'	48,000
Tarraleah	90,000
Butler's Gorge	12,200
Trevallyn	80,000
Tungatinah	125,000
Lake Echo	32,400
Liapootah	83,700
Wayatinah	38,250
Catagunya	48,000
Poatina	250,000
Total	807,550
King Island (diesel plant)	390

Approved construction will bring this total to approximately 1,240,000 kW by 1974. The number of ultimate consumers at 30 June 1965 was 131,593.

New capacity

The Hydro-Electric Commission is engaged on a construction programme which comprises the Lower Derwent Power Development and the Mersey-Forth Power Development. In the first-named a three-stage development is under construction below Catagunya on the River Derwent. With dams and associated power stations Repulse, Cluny and Meadowbank, completion of this project by 1967 will add a further 85,000 kW to the system, and it will also bring to an end the exploitation of the power potential of the River Derwent and its tributaries.

The Mersey-Forth Power Development is also under construction and is scheduled to be completed by 1974. In this development the Mersey River will be diverted westward to the Forth River by the construction of the Parangana Dam about half a mile below the junction of the Mersey and Fisher Rivers. Thence the flow will be conducted by a tunnel and penstock to Lemonthyme Power Station on the Forth River. The combined flow will be used for power generation at three power stations on the Forth River, situated at the foot of dams at Cethana, Devil's Gate, and Paloona. The Wilmot River will be diverted to the east by a dam through a tunnel to a power station on the Forth River upstream from Cethana Dam. The diverted flow of the Wilmot River will also be used to produce power at Cethana, Devil's Gate, and Paloona. A sixth power station will result from the development of the Fisher River, where a rapid fall from Lake Mackenzie on the plateau to the Mersey River enables a head of some 2,100 feet to be exploited. The principal storage in the development, Lake Rowallan, will be situated on the upper Mersey River at Walters Marsh, and Rowallan Power Station will exploit the water released from this storage. Smaller storages will be provided by Lake Mackenzie and by Parangana, Wilmot, Cethana and Devil's Gate Dams. The six stages of the development are to be completed progressively between 1969 and 1974 and will add a total of 298,500 kW to the system.

The Commission is conducting extensive surveys and investigation of other schemes with a view to further construction after the completion of the present programme. Investigations are continuing into the very considerable resources as yet untouched, principally in the west and north-west of the State, and it is estimated that the potential which can be developed economically should ultimately harness 2,400,000 kW to the system.

Statistical Summary

The following table shows statistics for each State separately and for the six States combined for the year 1963-64. Statistics of the electricity supply industry for the years 1959-60 to 1963-64 are given in the chapter Manufacturing Industry. Particulars of the Snowy Mountains scheme are included under New South Wales in the following table.

CENTRAL ELECTRIC STATIONS, STATES, 1963-64

Particulars	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	Total
Generating stations—							
Government . . . no.	26	11		10	13	12	72
Local authority . . . "	10	8	51	8	38		115
Companies . . . "	14	10	1	11	43	3	82
<i>Total stations</i> . . .	50	29	52	29	94	15	269
Installed capacity of generators—							
Steam . . . '000 kW	2,615	1,303	834	657	300		5,709
Hydro . . . "	809	333	139		2	767	2,050
Internal combustion . . . "	71	26	34	12	80	1	224
<i>Total capacity</i> . . .	3,495	1,661	1,008	669	382	768	7,983
Persons employed(b) . . . no.	4,230	3,356	1,682	1,542	(a)	(a)	12,162
Value of output(c) . . . \$'000	128,051	71,095	37,851	21,697	(a)	(a)	291,220
Value of production(d) . . . "	54,774	44,905	18,888	12,452	(a)	(a)	194,020
Electricity generated(e) million kWh	13,859	7,888	3,493	2,547	1,318	3,414	32,519
Ultimate consumers(f) . . . no.	1,295,353	1,017,355	457,600	352,000	182,094	128,642	3,433,044

(a) Not available for publication; included in the total for Australia. (b) Average employment in generating station, over whole year, including working proprietors. (c) Value, at generating station, of electricity produced plus certain earnings. (d) Value added in the process of generation. (e) Total generated including that generated by factories for their own use. (f) Approximate figures supplied by the electricity authority in each State. 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 identical with the number of persons served with electricity because one ultimate consumer may represent three or four persons, e.g. in a household.

Commonwealth Territories

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.

Australian Capital Territory

The supply authority is the A.C.T. Electricity Authority, which took over the functions of the Canberra Electric Supply Branch, Department of the Interior, on 1 July 1963. Supply was first made available in Canberra during 1915 and was met from local steam plant. Connection to the New South Wales interconnected system was effected in 1929, and all requirements are now taken from this system. Locally owned plant consists of 4,000 kW of diesel alternators which are retained as a standby for essential supplies. The total number of ultimate consumers at 30 June 1965 was 25,090. During the year 1964-65 the bulk electricity purchased was 287,347,316 kWh and the system maximum demand was 77,900 kW.

Northern Territory

At Darwin, supply was established by the Town Council in October 1934, but during April 1937 responsibility for generation and supply was transferred to the Northern Territory Administration. The power station is now equipped with turbo alternators with a total capacity of 15,000 kW. Tenders were let during 1964 and 1965 for two additional 1,500 kW turbo alternators and boilers for installation at Stokes Hill, Darwin, power station. In addition, diesel generating plant of approximately 6,500 kW is available. A 66 kV transmission system is used. At Alice Springs the power station is equipped with a diesel generating plant of 3,600 kW capacity. Additional plant of 2,000 kW capacity is installed and a contract for another 2,000 kW set will be let early in 1966. At Katherine the power station is equipped with a diesel generating plant of 960 kW capacity with an additional 1,100 kW planned. The total number of ultimate consumers served in the Territory at 30 June 1965 was 6,641.

Papua and New Guinea

Papua and New Guinea Electricity Commission. Responsibility for the operation and establishment of the electrical undertakings in Papua and New Guinea is vested in the Papua and New Guinea Electricity Commission, whose headquarters are located at Port Moresby. The Commission came into operation on 1 July 1963, and assumed the functions and responsibilities previously vested in the Electrical Undertakings Branch of the Department of Public Works. The Commission, on its own behalf, operates the public supplies in the main centres of population and, on behalf of the Administration, operates the supply in the minor centres and patrol posts,

hospitals, agricultural establishments, etc., where the supply cannot be considered to be a fully commercial supply. It has also regulatory functions associated with the licensing of electricians and contractors, the control of franchise holders and the approval of appliances and electrical materials for use in the Territory. The Appliance Approval By-laws will be based upon complete reciprocity with the Australian approval authorities.

The generating capacity in the centres under the control of the Commission is as follows: Port Moresby—*diesel*, 3,720 kW, with an additional 480 kW under construction, *hydro*, 5,500 kW; Rabaul—*diesel*, 3,000 kW; Lae—*diesel*, 2,640 kW; Madang—*diesel*, 1,620 kW; Wewak—*diesel*, 870 kW, with an additional 520 kW under construction; Goroka—*diesel*, 500 kW under construction, *hydro*, 400 kW; Samarai—*diesel*, 300 kW, with an additional 150 kW under construction; Kavieng—*diesel*, 200 kW, with an additional 150 kW under construction; Kokopo—*diesel*, 80 kW. On behalf of the Administration, the Commission operates generating sets totalling some 4,200 kW distributed over 130 centres, with capacities between 5 and 150 kW. The townships of Wau and Bulolo are supplied by power generated by Bulolo Gold Dredging Limited, which operates hydro-electric plant of 5,500 kW capacity. Power produced by this plant is used mainly in the plywood mill and gold dredges at Bulolo. The number of consumers served by the Commission at 30 June 1965 was 9,000. The consumers in minor centres approximated 4,000.

Future development. The Commission has a policy to take increasing advantage of the hydro potential existing in the Territory. Stage 1 of the Sirinomu Dam on the Laloki River near Port Moresby is in operation ensuring a minimum river flow of 200 cusecs. Tenders have been let for the supply of three 6,000 kW generating sets, to be installed in an underground power station, which will take advantage of the fall in the Laloki River over the Rouna Falls. This station will have an ultimate capacity of 30,000 kW. It is planned to commission the station in January 1967.

Preliminary investigations have indicated the economics of developing the potential of the Upper Ramu River adjacent to Kainantu in New Guinea, to provide a regional supply to Lae, Madang, Kainantu, Goroka and Mount Hagen. The present planning is to provide a station designed for ultimate capacity of 48,000 kW, and for the installation of two 8,000 kW generators in the first stage. Some 400 miles of 66kV and 132 kV transmission line will be constructed to bring power to the centres of consumption.

To meet the growing needs of the Territory, pending the commissioning of the hydro-electric power stations on the Laloki and Upper Ramu Rivers, the Commission is adopting the policy of installing skid-mounted diesel generating sets of a capacity which will permit their transfer at a later date to other growing centres. Trends indicate that a total of five 500 kW sets will be needed at Port Moresby. These will later be transferred to Lae and Madang.

Extensive investigations have been made to locate a suitable source of hydro-electric power to supply the township of Rabaul and the quickly developing area along the Gazelle Peninsula. However, the geological reports on those sites so far investigated have not been encouraging, and at present no firm proposal has been put forward. Several small hydro-electric installations are in service or are in process of construction to serve isolated centres. These are—Aiyura Agricultural Station—30kW; Mount Hagen—120 kW; Mendi (at tender stage)—200 kW; Tapini (under construction)—30 kW. The Commonwealth Department of Works has a Stream Gauging Section and maintains records of many of the main rivers in order to provide material for future investigations into some of the major hydro-electric potential which exists in the Territory.

In 1950 the Commonwealth Government joined with the British Aluminium Co. Ltd. of London to form a company, New Guinea Resources Prospecting Co. Ltd., to locate and develop large capacity hydro-electric schemes in New Guinea (the Commonwealth Government later sold its interest). The company carried out very extensive investigations into the rivers of the Gulf of Papua and, in particular, into the Purari River.