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ENERGY AND MINERALS

INTRODUCTION

This Chapter examines the utilisation of Victoria's energy and mineral resources. Both are fundamental to the needs of the community and the production of its economic wealth. Both have been major influences on the development of the State.

It was gold in 1851 that made Victoria a magnet for immigrants hoping to find quick wealth. The fact that the wealth was less easily found than expected produced a series of consequences which shaped the future of the State. After the First World War the decision to win brown coal from the La Trobe Valley for electricity (and later gas) generation helped make possible the growth of industry. The discovery of natural gas and oil in Bass Strait in the 1960s was the next major event.

The development of electricity, gas, liquid fuels, and minerals form the major sections of the Chapter. Their basic impact on agricultural and manufacturing industries, other sectors of the economy, and the lifestyle of the community are self-evident. In the 1930s agriculture was not yet fully mechanised and industry was modest in scale. During the 1950s and 1960s the growing use of energy enabled an increase in productivity per person in agriculture as well as the expansion of industry and the growth of suburbia based on the motor car. By the mid-1970s economic activities were affected by oil price rises and it became important to conserve rather than encourage the use of energy.

ENERGY

Background

Although black coal was first observed by William Hovell at Cape Patterson in 1826, the first recorded discovery of brown coal—destined to become Victoria's prime energy resource—was in 1857 at Lal Lal, south of Ballarat, and in various areas, including Morwell, by 1876. The Victorian Government, sensing the importance of the finds, sent officers to Germany in 1891 and 1901 to study the use of brown coal, interest in which again revived sharply during the 1916 coal strike at Newcastle in New South Wales, which was then supplying Victoria's black coal.

The proving programme of the Morwell deposits after 1916 led directly to the establishment of the State Electricity Commission (SEC) under the leadership of Sir John Monash in 1919. Two years later the SEC began construction at Yallourn, and Melbourne received its first transmitted electricity in 1924. From then the enterprise gathered momentum.

The use of brown coal for gas manufacture, however, did not eventuate until the 1950s. By 1934 there were several privately owned gas companies supplying Victoria's requirements by processing black coal on a more or less regional basis. Technical advances were made, but the development of the industry was hampered by the State's complete dependence on New South Wales for black coal.

Technological advances helped supply the growing demand for petroleum products after the 1880s. At first these were imported from USA, but after 1891, the major companies began to set up facilities in Victoria. Kerosene was at first required for steam engined motor cars, but the emergence of spark ignition engines needed motor spirit (petrol). Imports gradually yielded to the locally refined product, the first being produced at Laverton in 1924. Overall demand grew as agricultural, aeronautical, and various industrial

engines came into use and as bunkering oil replaced coal in ships. The cumulative growth in demand for petroleum products eventually encouraged the first bulk shipment of motor spirit from Holden Dock to Spotswood bulk terminal after the First World War. The following table shows the end usage of fuels in 1980-81:

END USAGE OF FUELS BY SECTOR: VICTORIA, 1980-81
(petajoules)*(a)*

Fuel	Transport		Industrial		Domestic		Commercial		Total	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Oil	214.6	99.5	24.8	15.6	9.4	11.2	2.6	9.5	251.4	51.8
Electricity	1.0	0.5	45.6	28.7	29.0	34.7	14.4	52.8	90.0	18.5
Natural gas	—	—	86.0	54.1	40.5	48.4	10.3	37.7	136.8	28.2
Solar	—	—	2.5	1.6	4.8	5.7	—	—	7.3	1.5
Total	215.6	100.0	158.9	100.0	83.7	100.0	27.3	100.0	485.5	100.0

(a) One petajoule (PJ) is approximately equivalent to 100,000 tonnes of Loy Yang or Morwell brown coal, or 160,000 barrels of crude oil. Victoria as a whole uses 1.3 PJ of secondary energy (electricity, gas, and petroleum products) each day. 1 petajoule = 10^{15} joules.
Source: Department of Minerals and Energy.

Electricity

From 1934 to 1939

By 1934 the State Electricity Commission of Victoria was providing power, which had become the corner stone of Victorian industrial growth, and it took over the Ballarat and Bendigo undertakings of the Electric Supply Company of Victoria in July 1934.

In late November 1934, Victoria experienced record rains and by Saturday 1 December the Yallourn open cut was flooded by the La Trobe River, which had risen to a level 3.3 metres higher than any previously recorded—just 30 centimetres over the levee banks protecting the open cut. The coal supply from the open cut came to a halt, although part power production continued with the use of stock coal until the old north open cut was put into action again. Richmond power station was also flooded by the rains swelling the Yarra River and Newport B was shut down for overhaul. These stations were later restored to production and the Sugarloaf power station produced a record output in the meantime. Pumps were obtained from all possible sources and mounted on pontoons in the Yallourn open cut. By mid-April 1935, a coal dredger was back in operation and full production was restored in time to meet winter peak demands.

In order to increase capacity, the Commission recommended for consideration by the Victorian Government in 1937 a 104,000 kilowatt hydro-electric installation at Kiewa—a project that had many supporters even before the Yallourn operation commenced. It also planned to add 18,000 kilowatt and 30,000 kilowatt units to Newport B, bringing its capacity to 63,000 kilowatts and Newport C was to be constructed with two 30,000 kilowatt units. By 1938 Yallourn B was fully operative, site work had commenced at Kiewa and in the following year the Commission was serving 417 country centres and 4,376 farms, the rate of farm connections having reached 1,000 per year. Power had at last been brought to country industry and street lighting to country towns.

War years, 1939 to 1945

During the years of the Second World War, the Commission's resources were greatly strained because of manpower shortages and the diversion of Commission fuel to industry by Commonwealth Government fuel controls. Despite this, greatly increased power was supplied to industry, an achievement made possible by the purchase of equipment in the immediate pre-war years. Two wartime developments which were important to the post-war years were the introduction in 1940 of uniform tariffs throughout the State for industrial users, and the connection of power to 2,500 farms when agriculture was declared essential to the war effort.

After a committee appointed by the Premier in 1940 had recommended increases in output, the Commission, in the following year, reported that a new open cut mine would

be necessary for further extension of its electricity and briquette undertakings and that it had begun investigations for the selection of a site. The Commission had continued the Mines Department's brown coal drilling campaign in 1922, but by 1938, when drilling once more ceased, investigations had been concerned only with the immediate vicinity of the Yallourn open cut. In 1941, the area of drilling was systematically extended and the main areas of shallow coals in the La Trobe Valley were defined.

A site south of the town of Morwell was subsequently recommended and planning for briquette manufacture at this site began in 1943. The Commission intended that increased briquette production would relieve the shortage of black coal at its metropolitan power stations, which were subsequently converted to burn briquettes by the installation of grates manufactured from a special high temperature cast iron developed by the Commission. In 1941, the Yallourn North open cut was opened again to augment fuel supply, and the Melbourne City Council's Spencer Street power station was integrated with the Commission's system, but remained under the ownership of the Council.

In 1943 the use of Snowy Mountains waters for power generation, first proposed in 1928, was again being considered, this being in fact the first public reference to this topic by the Commission. Plans to use the discharge of the Hume Reservoir for power generation were already under way and Victoria intended to install two or three 21,000 kilowatt generators.

The first power to be delivered from the Kiewa hydro-electric scheme became available in 1944 at the same time as the Newport extensions commenced operation; both had, in fact, been delayed by late delivery of generation equipment. The Yallourn C briquette factory also came into operation at that time.

A disastrous bushfire commenced outside the Commission controlled area at Yallourn in February 1944 and caused the deaths of nine people, as well as the destruction of over 100 houses. Wind blown embers started a fire in the Yallourn open cut and, as a result of strong winds, the fire took four days to put out. Some equipment was damaged; coal supplies to the power stations were restricted; and the only electricity restrictions during the war had to be imposed. However, they lasted only 11 days. As a result of the fire, the Commission was given fire protection control over a wider territory and grazing licences in these areas were restricted.

During the first three years of the war, the demand for power had increased by 10 per cent and at a somewhat lower rate over the following two years. Despite flood and fire, wartime demands for both fuel and power had been met and, although domestic briquette supplies had been restricted, electricity was not, except for the brief period after the open cut fire.

Early post-war years, 1946 to 1950

The Commission had not expected the wartime power demand to be maintained in the immediate post-war period. However, after a brief decline in demand at the end of the war, an amazingly quick recovery, which was well beyond estimates, took place. This sudden rise was apparently due, in part, to the lifting of wartime controls and the permitted use of radiators and many other appliances which had previously been prohibited.

The effect of the increased demand was greatly exacerbated by the fact that wartime fuel controls had almost completely exhausted fuel stocks, because State fuel controls, continuing after the war, did not allow summer fuel stock build-ups to meet winter demands. The increased fuel demands of this period were aggravated by severe industrial troubles in the NSW coal fields. Metropolitan power stations, which in the winter of 1946 required 9,100 tonnes of briquettes a week, were getting only 6,900 tonnes. Delays in the completion of the Kiewa scheme due to wartime labour shortages, and plant delays had also contributed to the problem. Furthermore, equipment to alleviate the power generation shortage was not available and winter rationing became a regular feature for several years.

In May 1946, the existing power restrictions turned into severe rationing when a Yallourn dredger broke down. Two months later, the Premier asked the Commission to plan to achieve complete independence from imported fuels within 15 years and to maintain it thereafter; within a month the Commission submitted proposals for a 75 per cent increase in generating capacity by 1956. It was hoped that Snowy scheme power would also be

available within that time. In fact, the construction of the Snowy scheme commenced in 1949 under wartime emergency powers still in force, as agreement between the Governments concerned had not yet been reached.

The Commission in December 1946 expressed doubts in a public report about the economic soundness of enlarging the briquette enterprise to the independence level, pointing out that industrial users would buy fuel in the cheapest market. As it was, industrial trouble in the metal and building trades in the following year affected the Commission's construction work.

Parliament authorised the Morwell open cut and associated works in 1948. The Act also provided for the extension of the Kiewa capacity to 289,000 kilowatts. By 1950, the first bucket wheel dredger, capable of winning about 500 tonnes of coal per hour, was working at Yallourn and Newport C power station commenced operation. The Commission took over Newport A from the Victorian Railways in 1951.

Due to industrial disputes in the NSW coal mines, Australia had been forced to import coal from overseas. However, as a result of imports, 1952 was the first year since the end of the war for which sufficient coal was available to the Commission for full power generation. Rationing of electricity ceased.

At this time, also, a uniform tariff for farms throughout the State was introduced. In the seven years after the war, farms connected to the State system rose from less than 9,000 to over 20,000. In the same period, tariff increases occurred—the first since the Commission commenced operations. These occurred against a background of inflation. Trading deficits also occurred in this period, although a surplus was again achieved after 1951.

From 1950 to 1963

Uncertainties

In September 1950, the Commonwealth Government believed that it was necessary to make defence preparations, including expansion of fuel production and electric power generation capacity. A Commonwealth-State Consultative Committee on Electric Power was appointed which established priorities for loan support for power developments. But the investment risk remained with the States, which, in the case of Victoria, meant the Commission. Measures taken by the Commission included ordering from USA of packaged power stations for Geelong, Ballarat, and Mildura, enlarging the Kiewa scheme, and proceeding with the Morwell open cut and briquette project. In order not to be caught short of equipment again by war, the Commission also purchased a great deal of generation and transmission equipment and material.

Suddenly in 1951 export prices fell and the economy declined. Loan funds were cut. The effect of this was reduced by slowing down some contracts and arranging for others to be completed on a deferred payment basis. Nevertheless, the Commission was forced to dismiss thousands of men engaged in development. It was left with a large investment of materials and equipment on which it was obliged to pay interest, and, in fact, was compelled to dispose of some briquetting equipment at a loss. The Kiewa development was reduced by two thirds and the Morwell project stopped. To assist finances, tariffs were increased in 1952, but, in spite of this, only Tasmania with its hydro-electric power still had cheaper rates than Victoria. Even so, costs had been increased by the imports of fuel from overseas.

Self help

Many communities and industries that had anticipated that increased power would be available from the new developments were left disappointed by the 1951 cut back in construction. Yet out of this situation was born one of the most significant episodes of Victorian Government works financing. Material and labour costs to connect power to these communities were approximately equal. The Commission had the materials, but not the money to pay labour to use them. In 1951, the Commission conceived a scheme by which prospective customers—communities, industries, or individuals—put up an "extension deposit" to pay labour costs and the power connections were then made. Repayment of the deposits was by supplying electricity without payment until the deposits had been

repaid. Any balance at the end of five years could be repaid in cash, if desired, or the supply without payment method continued. It was a "pay now—use later" scheme and was most successful.

When the Commission's material surplus was used up, the scheme had to be suspended. But many communities, industries, and housing developments were willing to advance the whole cost of connections, so in 1953 self-help on this basis was effected. Self-help on a 50/50 basis or 100 per cent basis has continued, the demand being so great at times that waiting lists became a common feature.

Additional investigations of the brown coal resources were indicated in 1952, after it had been found that the continuous sampling and detailed analysis undertaken in 1941 had not been sufficiently extensive to define adequately the extent and quality of the coal.

Service extension

Despite the recession after the Korean War boom there was a 13 per cent rise in sales by 1953 and by the following year the recession had faded and consumption rose sharply. In that year, the Commission embarked on a 10 year programme to connect 178,000 houses, acquire 48 local undertakings and extend supply to 650 centres that did not have a public mains supply. It was estimated that on the completion of this programme only 15,000 houses in remote areas would not have supply.

The Commission acquired the Mildura undertaking in 1953 and installed the packaged power plant already referred to. This development was matched by others. New oil engine powered plants at Shepparton and Warrnambool commenced service, and those at Ballarat and Geelong did likewise in the following year, as did the first of two Yallourn C units, each of 50,000 kilowatts. The second unit commenced operation in 1955.

Because of the changed outlook for briquette production resulting from the 1951 recession, the emphasis of the Morwell project, recommenced in 1954, was changed in the direction of power production. Kiewa began to deliver power through a 220 kilovolt transmission line in June 1955, and two years later the Commission announced that the scheme would be completed at 183,600 kilowatts instead of 289,000 kilowatts. The power station at Hume Reservoir shared its 50,000 kilowatt capacity equally between New South Wales and Victoria after it was completed in 1957. In the following year the Snowy Mountains Hydro-electric Agreement was signed. This was to give Victoria 200,000 kilowatts of power within six years. Snowy Mountains power began to arrive in 1959 over a 330 kilovolt transmission line. The completion of the transmission line through the Snowy scheme enabled Victoria and New South Wales to help each other in meeting peak demands, assisted by the fact that the incidence of peak demands were slightly different in the two States.

In 1956 the first of two 60,000 kilowatt units at the reconstructed Eildon hydro-electric scheme commenced operation, and in the following year the first of two 50,000 kilowatt units at Yallourn D was commissioned, while the proposal was announced to construct the 1,200,000 kilowatt (6 x 200,000 kilowatt units) Hazelwood power station based on the Morwell open cut.

By 1959 the Morwell open cut had commenced coal production and briquette production, and the metropolitan peak load stations returned to the use of briquettes which eased their fuel problems.

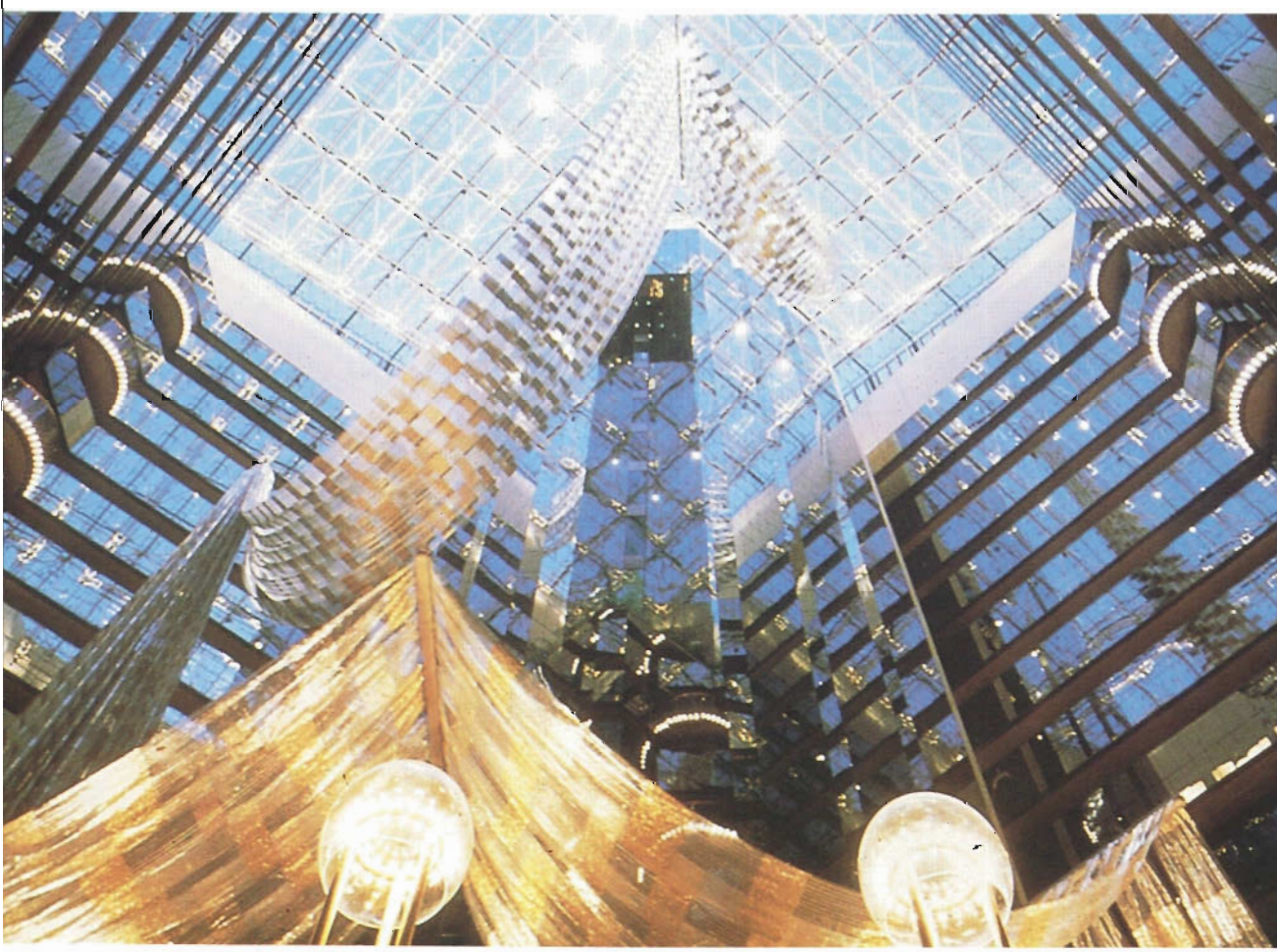
In the following year, the last of the Kiewa programme was completed with the commencement of the McKay Creek power station (96,000 kilowatts) and the second Morwell briquette factory came into operation.

Yallourn E (240,000 kilowatts) was completed by 1962 and the 220 kilovolt ring main (Melbourne-Kiewa-Shepparton-Bendigo-Ballarat-Geelong-Melbourne) was put into service, as was the 220 kilovolt Murray Valley transmission line, connecting Mildura to the State system. It was thus possible to phase out the rural thermal stations and have the La Trobe Valley system take up the load more economically. There was a recession in 1961 which reduced power sales, but these resumed in the following year with a 13.4 per cent increase.

Alcoa of Australia Ltd commenced to develop its brown coal open cut at Anglesea for power generation for its Point Henry (Geelong) aluminium smelter in 1962. As the smelter was ready to operate before the Anglesea power station, the Commission provided power

A view of the modern Melbourne skyline looking west over the Central Business District.

State Electricity Commission of Victoria



The Regent Hotel design incorporates an open cylindrical core (or atrium) which extends through all guest floors to a transparent skylit roof.

Regent Hotel, Melbourne

The Mining Museum at Sovereign Hill in Ballarat consists of surface installations and an underground display area that traces the development of gold mining techniques.

Ballarat Development Corporation

(Below right) Visitors to the Sovereign Hill gold mining township in Ballarat are shown traditional gold panning methods.

Ballarat Historical Park Association

(Below left) Prospectors using a metal detector discovered this 27.2 kilogram nugget at Kingower, near Bendigo in 1980. The nugget, known as the "Hand of Faith", was eventually sold for $1m.

Peter Rummel

The West Kingfish oil platform in Bass Strait with the workboat *Atlas Dampier*. West Kingfish is the third platform to produce oil (in 1982) from the Kingfish field, which was discovered in 1968.

Esso Australia Ltd

The semi-submersible drilling rig *Southern Cross* operating in Bass Strait.

Esso Australia Ltd

The Morwell open cut mine in 1970. The Hazelwood Power Station is in the background.

State Electricity Commission of Victoria

Yallourn "W" Power Station with the old power stations in the foreground.

State Electricity Commission of Victoria

The Dartmouth Dam which was completed in 1979 dwarfs the SEC's hydro-electric power station.

State Electricity Commission of Victoria

Three 500 kilovolt transmission lines link the La Trobe Valley power stations with Melbourne and the State grid.

State Electricity Commission of Victoria

The solar powered vehicle *The Quiet Achiever* which crossed Australia during December 1982 and January 1983 undergoing trials at the Esplanade, St Kilda. It was constructed at Mordialloc, Victoria.

BP Australia Ltd

Box Hill Indoor Recreation Centre has 185 square metres of PVC solar collectors installed on the roof. This is expected to provide about 22 per cent of the heating for the swimming pools.

Victorian Solar Energy Council

in the interim—a benefit to it as it earned revenue during this period from some of its reserve capacity that would not otherwise have been used. Subsequently the Anglesea output was integrated into the SEC system.

Since 1963

Hazelwood

Electricity sales rose by 94 per cent between 1961 and 1969 and generating capacity rose by 101 per cent. This was the era of the Hazelwood development close to Morwell township. Although Commission development has been virtually continuous since its establishment, the Hazelwood project working from the Morwell open cut, was a new phase, being the first major La Trobe Valley generating station to be established away from Yallourn and the first to have what were then described as the "giant" generating sets. Failure to deliver Hazelwood equipment on time meant that extra power had to be purchased from New South Wales for the 1964 winter; however, the first Hazelwood generation of 200,000 kilowatts commenced operation later in the year. This and more power from the Snowy scheme enabled the heavy demand of the 1965 winter to be met. That year also saw approval given for the Yallourn W station of 700,000 kilowatts (2 x 350,000 kilowatt units) planned for completion in 1973, which was designed to have Australia's first large natural draft cooling towers, as well as the introduction of uniform tariffs throughout the State of Victoria.

ELECTRICITY DEVELOPMENT: PRODUCTION AND GENERATION, VICTORIA, 1934-35 TO 1981-82

Year	Total installed plant capacity	Electricity gained through State Electricity Commision power stations	Electricity available for distribution in Victoria	Brown coal produced by the State Electricity Commision	Briquette production	Number of customers (excluding bulk supplies)
	MW	GWh	GWh	'000 tonnes	'000 tonnes	'000
1934-35	133	632	867	2,258	232	213
1939-40	229	1,024	1,273	4,347	435	272
1944-45	370	1,502	1,731	5,532	438	311
1949-50	508	2,363	2,656	7,445	598	391
1954-55	926	3,970	4,049	10,274	641	532
1959-60	1,460	6,040	6,112	15,223	990	680
1964-65	2,288	8,253	9,636	20,990	1,923	842
1969-70	3,546	12,630	13,455	23,155	1,565	1,015
1974-75	4,395	15,585	17,003	26,320	1,092	1,160
1979-80	5,210	19,490	21,374	31,597	1,253	1,295
1980-81	5,792	21,457	23,255	30,847	1,081	1,321
1981-82	6,344	25,008	24,481	36,256	993	1,343

Source: State Electricity Commission Annual Reports.

A degree of integration of the Victorian and New South Wales systems had by now been achieved so that power was exchanged between the two systems at times favourable to both (under computer control)—a trend which has continued. The South Australian system supplied Nelson near the western border, Wentworth in New South Wales was supplied from Victoria, and Bendoc from Tumut, in New South Wales.

All of the original six Hazelwood generating sets were in operation by 1969, but, in the meantime, it had been decided to increase the station to eight 200,000 kilowatt sets. Thus, more power would be generated in one station on the Morwell open cut than on all the six stations established and, at this time, planned on the Yallourn open cut. The new bucket wheel dredgers being commissioned at Morwell in 1969 had a capacity of 30,000 tonnes per day, as compared with the original bucket chain dredgers at Yallourn with capacity of 15,000 tonnes per day. The installation of successively higher capacity equipment for coal winning and power generation, in addition to higher voltage and higher capacity transmission lines, was continually improving the efficiency of generation and distribution. By 1970 the seventh Hazelwood 200,000 kilowatt unit had come into operation and the eighth set was completed in the following year.

A review made by the Commission in 1968 of future coal requirements confirmed the earlier statement in 1961 that coal under the Yallourn township would be needed, and in April 1969 the Yallourn Town Advisory Council was informed of the Commission's plans for the gradual removal of the township.

Long-range planning again came under discussion in 1969 when the Prime Minister announced the formation of a National Consultative Committee on Nuclear Energy on which the States were invited to join the Commonwealth for the purpose of examining the administrative and legal framework which must be set up before nuclear generation of electricity could be introduced into the State power systems.

Another new dimension to energy production in 1969 was the provision of natural gas to the domestic and industrial markets, with intense competition ensuing between the Commission and the Gas and Fuel Corporation. Also, the first of two 500 kilovolt transmission lines from Hazelwood to Keilor was commissioned in 1970 and was the first at this voltage in the southern hemisphere. The second line was commissioned the following year.

In the rural areas, nearly 76,000 farms were served by 1970 and only one-third of one per cent of homes were not connected to the State system. The Commission was serving 2,330 centres outside the metropolitan area. Only one country centre in the far east of the State (Mallacoota) was still running its own electric supply. However, with the transfer to the Commission by 1972 of the independent undertaking at Mallacoota the electrification of the State was complete, except for some isolated properties in remote areas. In Melbourne, there were still 11 municipal councils supplying power purchased "in bulk" from the Commission. These franchises were acquired only at the request of the councils concerned unless Parliament legislated otherwise.

Construction at Newport

In November 1971, the Victorian Parliament authorised the construction of a 1,000,000 kilowatt natural gas fired steam power station at Newport—to consist of two 500,000 kilowatt units—planned for service in 1976 and 1978. This plant was to be flexible in operation and capable of handling peak loads or base loads, as may be programmed from time to time. The Minister for Fuel and Power authorised the dedication of 22,600 billion cubic metres of gas for this purpose, plus a probable further 11,300 billion cubic metres to be confirmed at a later time.

Site works commenced on the Newport project early in 1972, but union work bans on environmental grounds caused suspension soon afterwards. An Environment Protection Authority inquiry was followed by the issue of waste discharge licences containing stringent conditions, but work bans continued. Appeals against the EPA licences were heard and resolved, but still work bans continued. In a compromise plan to break the deadlock, the Victorian Government and the Trades Hall Council agreed to accept the decision of an inquiry by a Newport review panel—a four man committee acceptable to both. By a majority of three to one, the panel concluded that a 500,000 kilowatt station should be built, in lieu of the 1,000,000 kilowatt station originally approved. The Trades Hall Council did not accept this decision and union work bans continued.

In 1977 the Victorian Parliament amended its original authorisation for a 1,000,000 kilowatt station to permit a 500,000 kilowatt station, and the project was declared to be a vital project under the *Vital State Projects Act* 1976. Because of the continuing bans, the Victorian Government decided that the Public Works Department should commence construction using day labour. Contractors subsequently commenced work after a six-year delay in commencement of construction. The subsequent completion of construction was achieved during 1979.

POWER STATIONS: VICTORIA, AT 30 JUNE 1982

Station	Capacity (a)	Date fully commissioned
	MW	
Steam —		
Hazelwood	1,600	1971
Yallourn W	1,450	1982
Yallourn	521	1961
Newport D	500	1979
Morwell	170	1962
Spencer Street	60	1959
Total steam	4,301	
Gas turbine —		
Jeeralang	465	1980
Total gas turbine	465	
Hydro —		
Kiewa	184	1960
Dartmouth	150	1980
Eildon (b)	135	1960
Total hydro	469	
Total capacity	5,235	

(a) Manufacturers' maximum continuous rating.
(b) Includes Eildon, Rubicon, Lower Rubicon, Royston, Rubicon Falls, and Cairn Curran.
Source: State Electricity Commission Annual Reports.

Other projects

Meanwhile, other works were progressing. The first 350,000 kilowatt unit of Yallourn W commenced operation in August 1973 and the Victorian Parliament authorised the doubling of the capacity of the station. Two more units were to be constructed and were to be increased to 375,000 kilowatts capacity by increasing the operating steam pressure. The second unit of Yallourn W Stage 1 (350,000 kilowatts) came into operation in July 1975, and the two units of Stage 2 came into service in 1981 and 1982. The Victorian Parliament also authorised the construction at Dartmouth Dam of a 150,000 kilowatt hydro-electric plant. Works on the project were put in hand with the dam construction contracts and the power station came into service in January 1980.

A 220 kilovolt transmission line from Horsham to Redcliffs was brought into service in 1973 to provide an alternative supply to north-west Victoria. The 220 kilovolt line from Keilor to Brooklyn was rebuilt to meet increased load growth and to transmit the output from the future Newport power station. A double circuit 220 kilovolt line between Brooklyn and Newport power station was commissioned in 1979 and 1980 to connect the completed Newport power station to the metropolitan system.

In 1975-76 planning and design commenced on a 330 kilovolt transmission line from Dederang to Wagga (NSW), in conjunction with the Electricity Commission of New South Wales, to improve the supply capacity to the Albury/Wodonga Region and to reinforce the interconnection of the New South Wales and Victorian supply systems through the Snowy Mountains. This line came into operation in 1979.

Because of the continued delays on Newport D construction and in order to avoid consequent power shortages, the Commission proposed the installation of 200,000 kilowatts of gas turbine generating equipment at Jeeralang for operation in 1979. Jeeralang A (4 x 56,500 kilowatts maximum continuous rating), with a used output of 225,000 kilowatts, came into service during 1978-79 and a further three units, each of 80,000 kilowatts, were constructed to compensate for the reduced capacity of Newport and came into service in 1980.

Loy Yang project

In 1976-77, after an inquiry by the State Parliamentary Public Works Committee, the Victorian Parliament authorised the construction of a 4,000,000 kilowatt power project at Loy Yang. This would consist of two 2,000,000 kilowatt stations based on a new open cut to be developed in an area with 6,000 million tonnes of coal reserves. Later in the year, it was decided that power supply from Loy Yang would be accelerated by the installation there of the 500,000 kilowatt unit which was to have been the second installed at Newport.

In February 1979, Governor in Council approval was given for three 500 kilovolt transmission lines between Hazelwood and Cranbourne, one of them to be ready for service in 1982 and another in 1985 to transport power from the initial stage of Loy Yang via Cranbourne and to connect into the metropolitan network at South Morang. A 220 kilovolt line from Dartmouth was planned for service in 1981 to bring output from the power station into the transmission system at Mt Beauty.

Thus, in 1980 the Commission was engaged on a capital works programme of unprecedented proportions—including the huge Loy Yang project, Stage 2 of Yallourn W, the Newport D station, the Jeeralang gas turbine installations and the Dartmouth hydro-electric power station—together with associated coal winning developments and transmission lines. The programme however was affected by strikes and work bans on construction which occasioned significant delays and increases in costs.

In July 1980 the Commission announced its Driffield power project proposal to duplicate Loy Yang with a 4,000,000 kilowatt complex on a new open cut on the Narracan coal field. The Commission made its report to the Victorian Government in November and the Parliamentary Public Works Committee began its public inquiry into the project in April 1981. Since that time the Committee has submitted progressive reports.

The SEC's other significant transmission line projects have been developed to augment supply to Geelong by the erection of two 500 kilovolt lines between Sydenham and Moorabool in 1983, and a complementary project to build a double circuit 500 kilovolt transmission line from Moorabool to supply power to an aluminium smelter planned for Portland. The 173km Moorabool-Portland line will be the longest 500 kilovolt transmission line in Australia. Three more 500 kilovolt lines are planned for construction between Loy Yang power station and Hazelwood power station to connect Loy Yang to the 500 kilovolt system.

Finance

The Commission was originally entirely dependent for finance on loan funds voted to it by the Victorian Government. In 1934 it was given power to raise its own loans—within limits determined from time to time by the Victorian Government. From that year to 1950 it financed its works by a blend of Commission loans and internal finance, i.e. funds from its own reserves. Between 1951 and 1970, State loans supplied about 16 per cent, Commission loans about 55 per cent, internal funds about 23 per cent and "self help" about 6 per cent of its financial requirements, including finance for new works and the redemption of maturing loans. By 1970 internal funds were supplying over 50 per cent of financial needs. However, by June 1982 the revenue derived from internal funding had progressively diminished to 15 per cent of total finances.

Gas and fuel

Brown coal gasification

By 1934, Victoria had a well established towns gas industry which was entirely dependent on New South Wales for coal supplies; however, research into brown coal gasification had commenced. The uncertainties of shipping, together with industrial disruption in the New South Wales coal fields in the late 1930s, stimulated interest in the possibility of brown coal gasification and in 1941 the then Premier of Victoria appointed a committee to inquire into the greater use of brown coal.

Following intensive investigation, both in Australia and overseas, the Lurgi high pressure gasification process was selected as the most suitable method of producing towns gas from brown coal. However, the erection of the necessary works required a large capital outlay which, in the financial climate of the immediate post-war years, was beyond the resources of the Metropolitan Gas Company acting alone.

After consideration by an all-party committee, Parliament enacted the *Gas and Fuel Corporation Act* 1950, which provided for the merging of the interests of the Metropolitan Gas Company, the Brighton Gas Company Limited, and the State. The Colonial Gas Association Limited elected not to participate in the merger.

The Gas and Fuel Corporation of Victoria was established as a public authority of the State owned jointly by the Government and the former shareholders of the Metropolitan and Brighton Gas Companies. It began commercial operations on 1 July 1951. One of its first tasks was to undertake the construction of a Lurgi high pressure gasification plant on a site at Morwell with adequate room for expansion. The plant was designed to produce towns gas from brown coal briquettes. In the initial planning it was envisaged that the Morwell plant would be progressively expanded and would eventually produce oil from coal using the Fischer-Tropsch system. As matters turned out, however, this phase of development never took place for economic reasons.

The plant, the first of its kind outside Europe, was commissioned in 1956 using briquettes supplied by the State Electricity Commission. It had an initial capacity of 425,000 cubic metres per day of towns gas with a heating value of 17 megajoules per cubic metre—approximately one-third of Melbourne's gas requirements at that time. Progressive increases brought the capacity up to 630,000 cubic metres per day by 1968-69.

A necessary adjunct to the Morwell plant development was the construction by the Corporation of Australia's first long distance gas transmission pipeline—a 127 kilometre long 450 mm diameter welded steel pipeline from Morwell to the Corporation's City Gate Station at Dandenong designed to operate at pressures up to 2,800 kilopascals.

The balance of the Corporation's gas requirements were still being supplied from the West Melbourne and the Highett works, both of which in 1955 had commenced blending refinery tail gases from Petroleum Refineries (Aust.) Pty Ltd's oil refinery at Altona with coal gas, pipelines having been constructed to convey the refinery gas from Altona to these works. The Corporation was the first undertaking in Australia to make such use of refinery gases.

A subsequent development was the decision by the Gas and Fuel Corporation to begin a $10m programme to convert its West Melbourne works from one based on black coal to one based primarily on petroleum products. This programme included the construction of an Onia-Gegi catalytic gasification plant in 1962 to produce towns gas from either heavy residual oil or refinery tail gases from the Altona refinery. The previous year the Geelong Gas Company had undertaken construction of a similar plant to produce towns gas by reforming refinery tail gases from the Shell Company's Geelong refinery. Part of this programme was the construction in 1962 at Derrimut of the second liquefied petroleum gas (LPG) refrigerated storage plant in the world for the purpose of supplying LPG and for blending for the West Melbourne Onia-Gegi plant.

In 1965 the Corporation constructed an LPG storage and blending plant at Dandenong. At this plant supplies of brown coal gas were supplemented with LPG and other refinery gases from the BP refinery at Crib Point. The Dandenong plant was later linked by pipeline to Highett and West Melbourne.

Black coal carbonisation continued at West Melbourne on a reduced scale until 1969, one hundred and thirteen years after the commissioning of the first hand-stoked horizontal retorts on that site.

The brown coal gas, Onia-Gegi gas, black coal gas, and refinery gases used in this period were blended as necessary to produce a gas of heating value and other combustion characteristics similar to those of towns gas manufactured from black coal.

While the Gas and Fuel Corporation was producing gas from brown coal at Morwell, the Colonial Gas Association had continued to supply its metropolitan franchise areas with gas manufactured from black coal and LPG at Box Hill and Footscray.

GAS PRODUCED AND PURCHASED BY THE GAS AND FUEL CORPORATION: VICTORIA, 1950-51 TO 1970-71
(megajoules)

Year	Black coal	Water	Oil	Lurgi	Refinery and LPG	Natural gas	Total
1950-51	3,575	1,142	—	—	—	—	4,717
1954-55	3,827	1,867	23	—	81	—	5,798
1959-60	2,632	848	—	2,160	2,215	—	7,855
1964-65	1,118	327	2,838	2,838	2,648	—	9,769
1969-70	345	45	2,233	1,499	3,432	7,434	14,988
1970-71	72	187	560	—	1,155	18,760	20,734

Source: Department of Minerals and Energy. Gas and Fuel Corporation.

Towns gas in the country areas

Meanwhile changes were taking place in the country areas. Concurrently with the initiation of the supply of Lurgi gas to Melbourne, a pipeline from Morwell was laid to supply Traralgon in 1957 and the local gas works ceased operation. The Warragul undertaking was purchased by the Gas and Fuel Corporation from the Colonial Gas Association. In 1959, gas was supplied to Warragul from the Morwell-Dandenong pipeline and the local gas works closed. New reticulation systems were commissioned in Morwell in 1959 and Trafalgar in 1960.

The availability of LPG from local refineries also had an impact in country areas where several reticulation systems were supplied with tempered LPG (LPG blended with air to produce a gas with heating value similar to black coal gas), and local coal gas manufacture was discontinued. LPG was provided by the Gas and Fuel Corporation, Colonial Gas Association, and Gas Supply Company using local high pressure LPG storage vessels replenished by road tankers. In addition, LPG supplied in portable high pressure cylinders ("bottled gas") and from on-site pressure storage vessels was used to meet the demand for gaseous fuel in areas where no reticulation systems existed.

Natural gas

The first commercial natural gas discoveries in Bass Strait were made in 1965. Commercial fields established were the Barracouta and Marlin gas fields. In addition some gas was associated with subsequently discovered oil and some found in lower geological horizons was regarded as non-commercial at the time.

The Victorian gas utilities, the Gas and Fuel Corporation of Victoria, Colonial Gas Association, Gas Supply Company, and Geelong Gas Company entered into negotiations with the discoverers, Esso-Hematite, and in March 1967 a letter of intent was signed relating to the supply of gas to meet the State's future needs for gaseous fuel.

The discoverers then put in hand the construction of production platforms on the Barracouta and Marlin fields, pipelines from these platforms to Longford, and a large gas processing plant at Longford.

The Victorian Pipelines Commission established by the Victorian Government in 1967 commenced planning of a gas transmission pipeline from the Longford metering station near the gas plant to the Gas and Fuel Corporation's City Gate station at Dandenong. This 174 kilometres long, 750 mm diameter pipeline, was designed and constructed by the Corporation as consultants for the Commission. The pipeline was completed in March 1968 (the Commission was subsequently dissolved in June 1971 and its powers, functions and responsibilities were vested in the Gas and Fuel Corporation).

At the same time the gas utilities put in hand the planning and execution programme which involved modifying every piece of towns gas burning equipment in their supply areas to suit the new gas. This course, necessitated by the higher heat value of natural gas (approximately double that of coal gas), was chosen by the companies in preference to the alternative of reforming natural gas to towns gas standards and had the great economic advantage of virtually giving an immediate doubling of the capacity of their distribution systems.

The Corporation's pre-conversion programme began on 8 April 1968. Natural gas was turned over at Carrum, the first section on 14 April 1969, and the mammoth task of conversion was completed on 23 December 1970. Colonial Gas had meanwhile completed a similar conversion programme in its franchise areas, thereby making Melbourne the first capital city in Australia to be supplied entirely with natural gas. The programme had involved the modification of 1.3 million appliances owned by 526,000 consumers at a total cost of $35m.

As the changeover to natural gas progressed, gas manufacturing activities were phased out. The Corporation's Highett works were closed on 12 July 1969, the Morwell brown coal gasification plant on 26 November 1969, and its West Melbourne works in December 1970, while the Colonial Gas Association's Box Hill works were closed in November 1969 and the Footscray works in March 1970. The large gas holders were progressively taken out of service and later dismantled.

The purchase of Colonial Gas Holdings by the Gas and Fuel Corporation in 1973 completed the unification of the gas industry in Victoria envisaged when the Corporation was formed, and made the Corporation the sole reticulated gas supplier in the State.

The Corporation's gas supply system has been subsequently boosted by the construction of a compressor station at Gooding, midway between Longford and Dandenong and by progressive looping of the main Longford-Dandenong gas transmission pipeline. In addition, the Morwell-Dandenong former brown coal gas pipeline was made into an effective loop for Melbourne supply by constructing a 16 kilometre branch from the main line at Tyers to the brown coal line at Morwell.

The Gas and Fuel Corporation also undertook the construction of the first liquefied natural gas (LNG) plant in Australia. This plant, which has a capacity to store 12,000 tonnes of LNG, was commissioned in 1980. Primarily intended to supplement the Melbourne supply at times of peak demand and to give additional security to the system, it was designed to operate in conjunction with an air liquefaction and separation plant constructed on an adjoining site by Commonwealth Industrial Gases Ltd.

Natural gas supply to country centres

In 1969, in an operation integrated with its metropolitan conversion programme, the Gas and Fuel Corporation supplied natural gas to the Gippsland towns of Warragul, Trafalgar, Traralgon, Morwell, and Sale. Subsequently supply was extended to Maffra, Rosedale, Drouin, Churchill, and Moe.

A pipeline to Geelong was constructed in 1970 and gas manufacture there ceased in 1971. Supply has subsequently been extended to Queenscliff, Point Lonsdale, and Ocean Grove.

In 1973 the Corporation constructed a transmission pipeline to supply natural gas to Bacchus Marsh, Ballarat, Castlemaine, and Bendigo. This system has subsequently been extended to supply Maryborough and Kyneton.

The following year the Corporation purchased the Albury Gas Company in New South Wales and commenced planning a transmission pipeline to supply natural gas to the Albury-Wodonga growth centre. This pipeline was commissioned in 1977, thus adding Albury-Wodonga, Seymour, Benalla, Wangaratta, and Shepparton to the natural gas supply system. Supply has subsequently been extended to Broadford, Euroa, and the Goulburn Valley towns of Mooroopna, Tatura, Kyabram, Stanhope, and Girgarre.

In accordance with government policy of supplying energy to country areas at Melbourne prices, the Gas and Fuel Corporation tariffs in country areas are the same as those in Melbourne.

Gas marketing

One of the vital aspects of the supply agreement between Esso-Hematite and the marketing companies was the need to expand greatly the use of natural gas in Victoria by comparison with the previous use of towns gas in order to render economic the very large capital expenditure required by both producers and marketers.

To ensure the viability of the whole project, therefore, the marketers, principally the Gas and Fuel Corporation, planned to sell more gas, particularly to the industrial sector,

but also to the commercial and domestic sectors. Public acceptance was shown by the fact that in 1969 gas supplied less than 8 per cent of the non-transport energy requirements in Victoria. Ten years later it was providing 48 per cent of non-transport energy, while electricity supplied 26 per cent, oil 18 per cent, and other fuels 8 per cent.

While the domestic market showed a dramatic increase, particularly in space heating, the most spectacular increase has been in the industrial sector, sales in 1981-82 amounting to 78,986 megajoules.

At 30 June 1982, approximately 80 per cent of the population of Victoria was within reach of natural gas supply and natural gas was providing 55 per cent of the State's non-transport secondary energy requirements.

GAS SALES AND CUSTOMERS OF THE GAS AND FUEL CORPORATION: VICTORIA, 1970 TO 1982

Year	Sales (megajoules)			Customers		
	Domestic	Commercial	Industrial	Domestic	Commercial	Industrial
1969-70	9,124	1,369	3,218	431,658	12,054	3,940
1970-71	11,116	1,810	5,923	477,921	14,177	4,124
1971-72	13,065	2,400	10,596	488,997	14,406	4,040
1972-73	16,609	3,315	22,544	596,014	15,852	4,650
1973-74	18,469	3,784	37,421	612,950	16,068	4,579
1974-75	22,721	5,561	43,971	637,511	16,107	4,451
1975-76	24,236	6,065	53,327	664,713	17,218	4,734
1976-77	29,669	6,428	59,374	689,451	17,551	4,855
1977-78	31,850	7,327	62,886	716,332	18,218	4,944
1978-79	35,056	8,675	65,407	746,617	19,775	4,811
1979-80	36,979	9,425	70,286	795,389	20,895	5,013
1980-81	40,495	10,276	75,627	845,343	22,189	5,254
1981-82	46,037	11,603	78,986	880,980	23,291	5,300

Source: Gas and Fuel Corporation, Annual Reports.

Reserves

The reserves of natural gas in the Gippsland Shelf contractually committed to the Gas and Fuel Corporation are considered adequate to meet Victorian needs to beyond the turn of the century. However, recognising the need to ensure adequate supplies of gas in the long term, the Corporation has, in accordance with its charter, entered into joint ventures to explore for gas and oil in both the Gippsland and Otway Shelf areas. At the same time further exploration is being carried out by other organisations.

The Corporation has also maintained a continuing involvement with developments in coal gasification and has taken steps to ensure that brown coal resources are available to enable it to meet the demand for gaseous fuel when the supplies of natural gas available to Victoria are ultimately depleted.

Liquid fuels

Introduction

Prior to 1939 Victoria's petroleum needs were being met through imports, supplemented by local production at the Commonwealth Oil Refineries' (COR) Laverton refinery, established in 1924. With the outbreak of the Second World War the oil industry managed to maintain supplies of motor spirit and other fuels and lubricants, albeit at reduced levels, to the civilian population. However, in 1940 petrol rationing was introduced in Australia and in 1942 Pool Petroleum Pty Ltd was established jointly by the importing companies to handle the co-ordinated distribution of petroleum products. Essential services were maintained throughout the period, although with some inconvenience, and the private motorist was left with a small ration to provide occasional recreation or to deal with emergencies. Gas producers burning charcoal were also available. Pool Petroleum was dissolved soon after the war but rationing was not finally abolished until February 1950.

There was substantial expansion of refinery capacity in the 1950s. In 1949 the Vacuum Oil Company refinery at Altona came on stream producing lubricating oil and bitumen. In 1954 the Standard-Vacuum Oil Company's crude oil refinery commenced operations at

a nominal capacity of 40,000 barrels per day (2.03 million tonnes per year) and incorporated the previous Vacuum refinery. In 1962 the company became Petroleum Refineries Australia (PRA). Successive increases brought the nominal capacity up to 100,000 barrels per day (5.08 million tonnes per year) by 1982.

In 1954 the Shell refinery at Geelong came on stream with a nominal capacity of 50,000 barrels per day (2.4 million tonnes per year) which was increased by several steps to 130,000 barrels per day (5.0 million tonnes per year) by 1982.

The COR refinery at Laverton, jointly owned by Anglo Iranian (named British Petroleum [BP] after 1957) and the Commonwealth Government, was closed in 1955. The Commonwealth Government sold its half share to the other partner and the COR company became BP Australia Ltd in 1957. The BP refinery at Western Port came on stream in 1965, having a nominal capacity of 50,000 barrels per day (2.2 million tonnes per year) which was increased by 1982 to 60,000 barrels per day (2.5 million tonnes per year).

The actual capacities of the refineries depend on the kind of crude oil being treated as also does the relationship between barrels per day and tonnes per year. The total refining capacity in Victoria in 1982 was 290,000 barrels per day, more than sufficient for local requirements and some of the production was marketed interstate.

After the Second World War the requirements of aircraft engines became increasingly sophisticated and by 1960 aviation gasoline *(Avgas)* was supplied in 100/130 octane and 115/145 octane grades. The introduction of prop jet and jet engines brought the need for further new fuels and led to the production of kerosene base aviation turbine fuels *(Avtur)* with low freezing point, high smoke point, and low vapour pressure. Melbourne Airport at Tullamarine was completed in 1971, supplied with fuel by underground pipeline from Spotswood terminals.

REFINERY CAPACITY: VICTORIA, 1960 TO 1981
('000)

Year	Petroleum Refineries Australia *(a)*		Shell Refining (Aust.) Pty Ltd *(b)*		Shell Refining (Aust.) Pty Ltd —Lubricating Oil Plant *(c)*		British Petroleum *(d)*		Total	
	tonnes/year	BSD	tonnes/year	BSD	tonnes/ year	BSD	tonnes/year	BSD	tonnes/year	BSD
1960	2,130	43	2,440	50	..	..	..	..	4,570	93
1965	2,570	55	2,540	60	80	2	2,240	50	7,430	167
1970	3,980	85	5,690	118	100	2	2,240	50	12,010	255
1975	4,670	100	5,390	104-110	100	2	2,540	60	12,700	272
1980	4,670	100	5,000	110-132	145	3	2,540	60	12,355	295
1981	4,670	100	5,000	110-132	145	3	2,540	60	12,355	295

(a) The Vacuum Oil Refinery came on stream in 1949. This company became the Standard Vacuum Oil Company (Aust.) in 1954 and Petroleum Refineries (Aust.) in 1964. The refinery is located at Altona.
(b) The Shell Refinery at Geelong came on stream in 1954.
(c) The Shell Lubricating Oil Plant at Geelong came on stream in 1965.
(d) The BP Refinery at Western Port came on stream in 1965.
NOTE. BSD = Barrels per stream day.
Source: *Oil and Australia*—Australian Institute of Petroleum (final publication December 1981).

Petroleum and gas exploration

Between 1934 and 1939 no new oil exploration drilling was carried out in Victoria. The Nelson bore, planned late during the war, reached total depth at 2,225 metres in 1945. This stratigraphic well was drilled jointly by the Victorian Mines Department and the Bureau of Mineral Resources. It showed no trace of petroleum.

The discovery of oil in Rough Range in W.A. in 1953, though non-commercial, gave new impetus to oil exploration in Australia and a number of wells were drilled between then and 1974 in the Gippsland, Otway, and Murray Basins. The discovery of natural gas and oil in the Gippsland Basin in 1965 and 1967, respectively, resulted from the utilisation for the first time in Victoria of modern exploration techniques including seismic surveys and geophysical well logging. Where earlier attention had been confined to Tertiary formations, in this second exploration phase many wells were drilled into Mesozoic rocks. This discovery of natural gas and oil in the offshore Gippsland Basin was the most notable event in the history of petroleum exploration in Australia. This discovery altered Victoria's and Australia's energy position from one of complete dependence on overseas supplies to one of partial dependence only. Although further oil and gas discoveries were made, the

full implication of the successful exploration decade from 1964 to 1974 became clearly evident late in 1973 when world oil prices began their climb, a major factor in altering the world's economic parameters during that decade. Victoria was able to supply Australia with some 60 per cent of its oil requirements.

An offshore aeromagnetic survey, carried out in 1956 by the Bureau of Mineral Resources, was the first major attempt to explore the sedimentary basins of the continental shelf of south-eastern Australia. The survey defined the offshore limits of the basin and revealed the presence of sediments up to 4,268 metres thick.

On 21 March 1960 the Broken Hill Proprietary Company Ltd, acting on the advice of Lewis G. Weeks, a noted American petroleum geologist, applied to the Victorian Mines Department for petroleum exploration licences in Victorian waters. The Minister for Mines granted three permits to the company on 1 April 1960 to search for oil in the offshore areas of Gippsland and western Victoria.

After carrying out geophysical surveys in three basins from 1960 to 1963, Hematite Exploration Pty Ltd, a wholly owned subsidiary of BHP, entered into a joint venture agreement with Esso Exploration and Production Australia Inc. in April 1964, whereby Esso would carry out further seismic surveys, and drill a number of promising structures in the Gippsland Basin. Similar agreements were later made in respect of operations in the Otway and Bass Basins.

Exploration drilling by Esso commenced on 27 December 1964, about 26 kilometres offshore from Seaspray in the waters of eastern Bass Strait and the discovery of natural gas quickly followed in the first well drilled, known as Barracouta 1. Natural gas was also discovered early the following year in the Marlin well, about 40 kilometres east of Barracouta 1.

In 1967 commercial discoveries of crude oil were made in the large Halibut field and the even larger Kingfish field. During development drilling over the Barracouta structure in 1968 a small reservoir of high-grade crude oil was located. Gas and oil were discovered in the Tuna field in 1968 and confirmed as commercial in 1970. Oil shows were located in the Mackerel 1 wildcat well in early 1969 and, after further drilling in this area, BHP announced on 1 June 1973 that Mackerel was a commercial field.

The following table indicates the number of wells drilled in the various basins—onshore and offshore—in each decade of the period under review. A brief account of the exploration in these various basins follows.

EXPLORATION WELLS DRILLED *(a)*: VICTORIA, 1934 to 1982

Period	Onshore		Offshore	
	Gippsland	Otway	Gippsland	Otway
1934 to 1943	23	2	—	—
1944 to 1953	—	1	—	—
1954 to 1963	30	9	—	—
1964 to 1973	21	9	57	6
1974 to 1982	1	20	41	2

(a) Excludes Murray Basin
Source: Department of Minerals and Energy.

Murray Basin

Only four significant oil exploration wells have been drilled in this area but the results were disappointing, as no trace of petroleum was encountered. These wells were drilled into Tertiary and Lower Cretaceous rocks and in some cases bottomed in Permian glacial beds on Palaeozoic basement. Depths ranged from 276 metres to 1,001 metres.

Otway Basin

Onshore

Onshore wells in the Otway Basin were aimed at both the Waarre Sandstone at the base of the Upper Cretaceous, and the Pretty Hill Sandstone at the base of the Lower Cretaceous (Otway Group). Offshore, however, because Tertiary and Upper Cretaceous rocks thicken

towards the south, sands at the base of the Otway Group were considered to be too deep a target and the top of the Otway Group was therefore considered to be economic basement. The North Paaratte No. 1, drilled in 1979, yielded a significant flow of gas. Further evaluation is necessary to determine whether an economic accumulation is present. In 1980 further exploration permits were granted in the Otway Basin, including the Otway Ranges area, where no previous seismic surveys or drilling had been carried out.

Between 1934 and 1943 two onshore wells were drilled, but little is known of these. In the following decade one well, drilled to 625 metres by Geelong Flow Oil near Torquay was reported to have encountered gas and water, the gas being analysed as containing 63 per cent hydrogen.

Between 1954 and 1963 nine wells were drilled to depths ranging from 1,818 metres to 3,546 metres. Six of these reported shows of gas and/or oil. In the 1964 to 1973 decade a further nine wells were drilled ranging from 1,235 to 2,597 metres in depth. Five of these reported shows of oil or gas. Between 1974 and 1982 twenty wells were drilled, seven of which reported shows of oil or gas.

All of the wells drilled before 1954—except the Nelson stratigraphic bore—were believed to have aimed at Tertiary targets and did not enter Mesozoic rocks. All of the wells drilled since 1954 had Mesozoic objectives.

Offshore

Between 1964 and 1973 six wells were drilled in the offshore section of the Otway Basin, three by Shell in 1967, two by Esso-Hematite in 1968-69, and one by Hematite in 1972. In the Shell wells the principal objective was the Waarre Sandstone, but they yielded only minor or non-commercial gas.

Gippsland Basin

Onshore

Between 1934 and 1943, 23 wells were drilled—all prior to 1940—ranging in depth from 337 metres to 536 metres. In the following decade no wells were drilled—reflecting the interruption to exploration during the Second World War and the general lack of interest in oil exploration in Victoria.

Between 1954 and 1963 a great increase in drilling took place due to the stimulus from the Rough Range discovery in Western Australia and a total of 30 wells were drilled to depths ranging from 170 metres to 3,661 metres. As previously mentioned, modern geophysical techniques were introduced during this period, although these were not applied to all wells drilled during this time. In the decade from 1964, 21 wells were drilled ranging from 361 metres to 3,795 metres in depth. The following decade saw a lull in drilling until 1980 when one well (East Seacombe No. 1) was drilled to 1,361 metres depth.

Most of the shallower wells were directed at Tertiary targets and a number of wells penetrated the prospective zone at the top of the La Trobe group (described more fully in connection with offshore exploration below). No significant hydrocarbon shows were encountered and the results indicated that this may be accounted for by fresh ground waters flushing the reservoir sands. Small gas shows were reported in this formation.

Only one well, Duckbay No. 1, fully penetrated the Strzelecki Group (Lower Cretaceous) passing through Permian volcanics and Permian sandstones and ending in Ordovician slates at total depth (1,292 metres). The 150 metres of the Strzelecki Group penetrated consisted of shales, mudstones, and claystones. The relatively thin Strzelecki section is due to the fact that the well is located near the northern margin of the basin. No hydrocarbons were reported. Other wells to enter the Strzelecki Group only encountered small oil and gas shows.

Offshore

The main offshore exploration did not commence until the period 1964 to 1973, although a limited number of geophysical surveys had been carried out earlier. Of the 57 wells drilled in this decade and the 41 in the following decade, 52 were wildcat wells (the industry term for new field exploration wells) and 33 were step-out (or appraisal wells in fields

discovered by wildcat drilling). These figures do not include wells which had to be abandoned at shallow depth for technical reasons and duplicated by new wells drilled close to the original site. Also included are two wells drilled from the Marlin platform which served the dual purpose of development and exploration wells.

All of the fields which are being produced or are planned to be produced were discovered by Esso-Hematite drilling. These include the Barracouta, Marlin, and Snapper fields which are principally gas (though Barracouta produced a small oil reservoir) and Halibut, Kingfish, Mackerel, Cobia, Tuna, Flounder, and Fortescue which are principally oil fields with minor gas reserves. The Seahorse, Bream, and Turrum fields, for which there are no current plans for production, contain oil and gas reserves and may later become productive. Several wells had shows of oil or gas; some of these shows cannot be counted as reserves; others can be regarded as sub-economic which could conceivably become economic at a future time.

COMMERCIAL HYDROCARBON RESERVES AND PRODUCTION, GIPPSLAND BASIN: VICTORIA, AT 30 SEPTEMBER 1982

Item	Unit	Initial	Produced	Remaining
Natural gas	giga cu.m.	220.4	40.7	179.7
Crude oil	giga litres	466.2	243.9	222.3
Condensate	giga litres	34.4	6.3	28.1
Liquefied petroleum gas	giga litres	88.7	28.9	59.8

Petroleum production

Production platforms have been erected at Barracouta (10 development wells), Marlin (23 development wells), Halibut (20 development wells), Kingfish A (21 development wells), Kingfish B (21 development wells), Tuna (9 development wells), Mackerel (17 development wells), Snapper (5 development wells), and West Kingfish (1 development well). Further platforms proposed are Fortescue, Flounder, and Cobia. An underwater production well has been completed at Cobia. The development of these offshore fields from platforms requires that most of the wells be deviated to give a sufficient areal coverage to provide effective drainage.

COMMERCIAL HYDROCARBON PRODUCTION: VICTORIA, 1935 TO 1982

Year	Crude oil *(a)*	Natural gas *(b)*	Ethane *(c)*	Propane *(d)*	Butane *(d)*
	cu.m.	'000 cu.m.	'000 cu.m.	cu.m.	cu.m.
1935	20	..	..	..	..
1940	18	..	..	..	..
1970	7,568,960	538,659.0	..	156,976	155,402
1975	21,691,496	2,424,848.4	68,139.8	1,064,941	1,203,374
1980	20,508,424	4,547,772.9	137,036.7	1,457,557	1,433,639
1981	21,349,102	5,701,778.8	148,549.0	1,539,434	1,498,854
1982	20,202,530	5,686,452.7	163,955.1	1,492,787	1,410,278

(a) Commercial production of crude oil was not undertaken between 1941 and February 1970.
(b) Commercial production of natural gas commenced in March 1969.
(c) Commercial production of ethane commenced in December 1972.
(d) Commercial production of propane and butane commenced in March 1970. Separate production data for each of these items was not available until July 1970. During this period 42,177 cubic metres of propane and butane was produced.
Source: Department of Minerals and Energy, Oil and Gas Division.

Prices

The considerable increase in oil prices since 1973 and the decision of the Commonwealth Government to permit local producers to obtain import parity prices for newly discovered

oil, stimulated interest in oil exploration and an increase in drilling in Victoria—both onshore and offshore. Refiners pay the import parity price for all Australian produced crude oil. The revenues from the sale of crude oil are shared between the producers and Governments, with State Governments collecting royalties, and the Commonwealth Government receiving excise on "old" oil (discovered before 18 August 1976) and a share of royalty for offshore production. "New" oil is excise free and this provided the major incentive to exploration and development.

Liquefied petroleum gas (LPG) is produced in conjunction with crude oil and natural gas as well as being a product of refining crude oil. A high proportion of the production of "naturally occurring" LPG is being exported. The Commonwealth Government's policy was to reverse this trend by encouraging the local use of LPG, particularly in those areas such as automotive uses, where LPG had a premium value. By this means Australia would reduce its dependence on imported oil, and increase its security of supply.

To achieve this policy objective, the Commonwealth Government sets the price that the producers receive for LPG sold for automotive, domestic, and traditional commercial/industrial uses at a level that provides incentives for its use. Other LPG sales such as to the petrochemical industry, major non-traditional LPG users in industry and for export, are set by commercial negotiation.

Legislation

The legislation governing onshore petroleum exploration and production in Victoria is the *Petroleum Act* 1958 whilst the *Pipelines Act* 1967 controls the construction of transmission pipelines for oil and gas as well as other substances. Exploration, production, and pipeline construction in the offshore area was, prior to 1967, controlled in the Victorian area under the *Petroleum Act* 1958. It is controlled under the so called "mirror" legislation —i.e., the *Petroleum (Submerged Lands) Act* 1967 of the Commonwealth and a similar Act of the State. The legislative scheme was devised because of the absence of clear knowledge of whether Commonwealth or State had the offshore jurisdiction. In the Victorian "adjacent area" both Acts are administered by the Minister of Mines as the "Designated Authority". The theory of the Designated Authority is that an administrative action of the Designated Authority is always taken simultaneously under both Acts and must be valid under one of them.

Standing behind the offshore "mirror" legislation was an agreement between the Commonwealth and the States. One clause of the agreement was that no Government would, without consultation, present to its Parliament any legislation which would affect the scheme of the "mirror" legislation. Nevertheless the Commonwealth Parliament in 1973 passed the *Seas And Submerged Lands Act* 1973 which asserted Commonwealth jurisdiction over the whole offshore area, including the territorial seas which had been accepted as an area of State jurisdiction since Federation. A challenge by the States in the High Court in 1975 against this legislation was decided in favour of the Commonwealth. As a result of the legal uncertainty which resulted from this decision with respect to many aspects of law such as ports, beaches, and the fishing industry the Commonwealth and States agreed, at various Premiers' Conferences, that the problems should be remedied.

A parcel of legislation to be presented to all Australian Parliaments was agreed upon. This parcel included the *Petroleum (Submerged Lands) Amendment Act* 1980 which was passed by Commonwealth Parliament and proclaimed on 14 February 1983. Complementary legislation was planned to be submitted to State Parliaments.

The effect of the amending legislation has been that the authority in relation to "important matters of title" will reside with a "Joint Authority" consisting of the Commonwealth Minister for National Development and Energy and, in the case of Victoria, of the State Minister for Minerals and Energy. In the event of a disagreement between the Ministers the view of the Commonwealth Minister prevails. In all other matters decision rests with the State Minister as Designated Authority and the general administration of the whole of the legislation is carried out by the State.

Developments in energy since 1970

Victorian Brown Coal Council

The Victorian Brown Coal Council was established as a statutory body in December 1978 to succeed the Victorian Brown Coal Research and Development Committee. The enacting legislation is known as the *Victorian Brown Coal Council Act* 1978.

The Council, which commenced operation in January 1979, is subject to the direction and control of the Minister for Minerals and Energy and its Board comprises the principal officers of the State's energy agencies, with the addition of a representative from industry.

The Council's principal objectives are to examine and report on the quantity, quality, and location of brown coal in Victoria; to identify possible uses and develop markets for brown coal; to develop strategies for brown coal extraction and processing; to encourage brown coal conversion for production of fuels for transport and industry and other commercial uses; to co-ordinate brown coal development proposals; and to manage the brown coal resource (excluding areas provisionally allocated for electricity and substitute gas production).

Other activities of the Council include the supervision for the Victorian Government of the construction and operation of a coal-to-oil pilot plant, funding of which is being provided by the Japanese Government.

The Council, through consultants, has conducted a study designed to recommend a strategy which will achieve the best use of the Victorian brown coal resource taking into account all aspects including labour, infrastructure, and social and community needs, which was released for public comment in February 1983.

Victorian Solar Energy Council

The Victorian Solar Energy Council, established in December 1980, took over the role of the Victorian Solar Energy Research Committee, with terms of reference expanded beyond advising the Victorian Government on solar energy matters.

Its functions include promotion of solar energy, promotion of the manufacture of systems, review and evaluation of solar research, development and demonstration, provision of advice to industry, commerce and the public, and publication of ways in which solar energy can be used.

MINERALS

Gold

Although gold was the principal mineral produced in Victoria prior to 1934, the greatest part of this production took place prior to 1920. For the five years 1926 to 1930 inclusive, total production was the lowest for any similar period since discovery.

In 1930, following a rise in the price of gold, gold mining activity increased and reached its peak in 1940. Thus the period under review commenced with increased gold production and although this was quite small compared with the early years, it was a significant contribution to the economy of the State during the Depression years.

GOLD PRODUCTION:
VICTORIA, 1935 TO 1982

Period	Amount of gold produced	
	kilograms	fine ounces
1935 to 1944	37,144	1,194,199
1945 to 1954	21,391	687,746
1955 to 1964	10,197	327,855
1965 to 1974	3,005	96,603
1975 to 1979	322	10,347
1980	36	1,164
1981	76	2,441
1982	100	3,215

Source: From 1935 to 1971—Department of Minerals and Energy Annual Reports. From 1971 to 1982—Department of Minerals and Energy Quarterly Survey (results published by the Bureau of Mineral Resources).

A feature in recent years has been the number of gold nuggets found in the "nugget belt" north of Ballarat through the use of metal detectors—largely by relatively unskilled weekend prospectors. The largest of these was the "Hand of Faith" nugget found in the Wedderburn district in 1980 which weighed about 27.2 kilograms and was the seventeenth largest nugget ever found in the State. Because of the free marketing systems now operating for gold, the State does not have any records of gold won privately in recent years. It may form a significant amount of income to the small miner/prospector segment of the industry.

MAJOR GOLD PRODUCERS: VICTORIA, 1934 TO 1980

Mine	District	Production	Quartz or alluvial
		kilograms	
Wattle Gully Gold Mine	Chewton	10,985	Quartz
Morning Star Gold Mine	Woods Point	8,296	Quartz
A1 Consolidated Gold Mine	Woods Point	7,776	Quartz
North Deborah Gold Mine	Bendigo	4,015	Quartz
Victoria Gold Dredging	Newstead	3,646	Alluvial
Cook's Eldorado Gold Dredging	Eldorado	2,198	Alluvial
Central Victoria Gold Dredging	Amphitheatre	1,781	Alluvial
Tronoh Gold Dredging	Harrietville	1,706	Alluvial
Deborah Gold Mine	Bendigo	1,615	Quartz
Central Deborah Gold Mine	Bendigo	916	Quartz
Cook's Pioneer Gold Dredging	Eldorado	580	Alluvial

Source: Department of Minerals and Energy Annual Reports.

The Morning Star and A1 Consolidated Mines had operated almost continuously for over a century by the time they closed, the former during the 1960s and the latter in the 1970s.

The mines listed, accounting for just over half of the gold produced in the period, show only 23 per cent of production from alluvial sources as compared with some 60 per cent before 1934. This reflects the extraction in the early years of the rich shallow alluvial deposits and emphasises that the alluvial gold in the post-1934 period came principally from deep dredging operations.

Black coal

South Gippsland black coal production, principally from the State Coal Mine at Wonthaggi, continued at useful levels during the 1930s but thereafter steadily declined as the mining became uneconomic, because of thin seams and complex faulting. The State Coal Mine finally closed in 1968 after a series of heavy financial losses. By then it had long ceased its role of providing the railways with coal supplies during NSW strikes, as steam locomotives had been replaced by diesel locomotives.

BLACK COAL PRODUCTION: WONTHAGGI, 1934 TO 1971

Period	Amount
	tonnes
1934 to 1943	3,438,684
1944 to 1953	1,757,675
1954 to 1963	969,247
1964 to 1971	235,126

Brown coal

Brown coal has been by far the most significant mineral won in Victoria since 1934, its principal use for electricity generation having already been described.

Apart from the SEC's La Trobe Valley production, other brown coal production has come mainly from Bacchus Marsh and Anglesea. Production from the former area has been used mainly for industrial fuels, while the Anglesea deposit was developed by Alcoa of Australia Ltd for power generation to provide electricity for the aluminium smelting industry located at Point Henry near Geelong.

BROWN COAL PRODUCTION: VICTORIA, 1935 TO 1982

Year *(a)*	Quantity
	'000 tonnes
1935	2,257
1940	4,347
1945	5,533
1950	7,445
1955	10,275
1960	15,207
1965	20,990
1969-70	24,311
1974-75	27,541
1979-80	32,896
1980-81	32,103
1981-82	37,567

(a) Prior to 1969-70 quantity data are on a calendar year basis.

Active exploration for brown coal has taken place by the Department of Minerals and Energy in the La Trobe Valley area and in the Stradbroke area of Gippsland and in south-western and northern Victoria. In addition, private industry is carrying out detailed exploration under the exploration licence provisions of the *Mines Act* 1958 referred to later.

The quantity of brown coal occurring in Victoria is estimated to be of the order of 132,000 megatonnes. The percentage of this coal which can be put in the category of "reserves" depends entirely on the economic criteria set for the calculation.

Other minerals

The substances here referred to as "minerals" are essentially those of the kind listed in section 3 of the Mines Act.

Some 500,000 kilograms of silver has been produced, mainly as a by-product of the production of gold with which it is inevitably associated in amounts varying from 2 per cent up to 70 per cent of the weight of the accompanying gold.

Among other minerals produced since 1934 have been minor quantities of tin, antimony, and bauxite and their available production figures are given in the following table.

OTHER MINERALS PRODUCED: VICTORIA, 1935 TO 1982
(tonnes)

Period	Tin concentrate	Antimony concentrate	Antimony ore	Bauxite
1935 to 1944	1,274	1,690	—	14,666
1945 to 1954	525	611	17	26,822
1955 to 1964	50	—	14	35,317
1965 to 1974	217	294	1,576	23,722
1975 to 1979	4	—	5,157	13,189
1980	—	—	—	—
1981	—	—	—	7,104
1982	—	—	—	9,204

Source: From 1935 to 1971 Department of Minerals and Energy Annual Reports. From 1971 to 1982 Department of Minerals and Energy Quarterly Survey (results published by the Bureau of Mineral Resources).

The bauxite production was not used as a source of alumina but for the manufacture of aluminium chemicals. Very minor amounts of copper, lead, molybdenum, and tungsten were also produced.

Construction material

The regulation and production of aggregates and clays was, prior to 1966, controlled under the Mines Act. In 1966 the Extractive Industries Act was passed and took over the regulation of quarrying for crushed rock, sand, clay, and limestone. The Act and the

regulations provide for strict controls over operations from environmental and safety aspects.

CONSTRUCTION MATERIALS PRODUCED: VICTORIA, 1954 TO 1980-81

Period	Sand	Gravel	Crushed and broken stone	Dimension stone	Other quarry products
	'000 tonnes	'000 tonnes	'000 tonnes	tonnes	'000 tonnes
1954 to 1958	4,532	638	17,634	57,699	1,952
1959 to 1963	11,061	6,790	44,860	34,051	5,067
1964 to 1968	20,481	15,779	71,888	52,672	9,011
1968-69 to 1972-73	28,910	16,775	82,609	63,545	15,441
1973-74 to 1977-78	41,085	23,175	89,074	61,597	17,453
1979-80	8,400	5,131	18,001	25,640	3,354
1980-81	7,930	4,751	14,271	29,004	5,394

Source: From 1954 to 1968 Department of Minerals and Energy Annual Reports.

Mineral exploration

Modern prospecting techniques involve stream and soil geochemical work over large areas followed by geophysical work over areas of any geochemical anomaly and the drilling of geophysical anomalies. Certain prospecting methods involve the use of airborne geophysical techniques requiring substantial areas to search.

Before 1955, the Mines Act did not provide for such large area prospecting methods and this had an inhibiting effect on exploration. In 1955, an amendment to the Act provided for the granting of areas up to 25.9 square kilometres for uranium and thorium and in 1964, the Mines (Exploration Licences) Act amended the Mines Act to enable the granting of exploration licences for gold and a limited list of minerals up to an area of 2,590 square kilometres. Subsequent amendments have reduced the maximum area to 860 square kilometres and increased the range of minerals to include gold and all minerals listed in the definition of section 3 of the Act.

The initial period for which a licence is granted is two years and extensions not exceeding twelve months may be granted from time to time for "good reason". Licensees gain the right to explore for minerals within the provisions of the Act and obtain a prior right to the grant of a lease within the area of a licence during its currency. Licensees are required to lodge returns covering all operations under a licence. By these means a great deal of geological information is accumulated which, six months after the expiration of a licence, may be made available to other prospective explorers.

A great deal of exploration activity has been engendered by the provisions and an immense amount of geological, geochemical and geophysical data has been amassed.

Although Victoria has always been regarded as a gold producing State, the new exploration has revealed a previously unknown potential for base metals in certain of the Cambrian greenstone formations of the State and in the Silurian acid volcanic areas in the north-east of the State (at Benambra). Interest in the latter areas was stimulated when these volcanics, previously believed to be Devonian in age, were remapped by the Geological Survey of Victoria as Silurian in age and related to the Silurian Volcanic formations of the Captain's Flat and Woodlawn areas of New South Wales where significant base metal mining occurred in the past. Much activity was being directed to gold exploration and to coal exploration in the 1980s, the latter being particularly stimulated by the rise in world prices of liquid fuels.