

ENERGY AND MINERALS

ENERGY

Introduction

There are adequate resources of brown coal and natural gas for Victoria to be completely self sufficient in these particular fuels. About 90 per cent of Victoria's petroleum refinery input comes from the State's indigenous oil fields offshore in east Gippsland and more than 80 per cent of Victoria's electricity supply is produced by brown coal fired generating stations situated on the coal fields in the La Trobe valley. A further 5 per cent of Victoria's electricity requirements are produced by hydro power stations in the north-eastern ranges of the State.

About 10 per cent of Victoria's petroleum requirements are derived from crude oil imported from the Middle East and approximately 10 per cent of electricity is obtained from the Snowy Mountains Hydro-Electric Scheme in south-eastern New South Wales.

Natural gas is assuming an increasingly important role in the supply of energy in Victoria. Before 1969 there was a small but steady increase each year in the supply of towns gas comprising a blend of Lurgi gas from brown coal, refinery gas, tempered or reformed LPG, water gas, oil gas, and gas from black coal and coke. The blends varied in different parts of Victoria according to supply of feedstocks and type of gas making plant installed. Since 1969, however, the advent of natural gas has caused sales to increase rapidly.

Ministry of Fuel and Power

The Ministry of Fuel and Power was formed in December 1965 following the passing of the *Fuel and Power Act* 1965. This Act made the Minister for Fuel and Power responsible for determining the means by which the present and future supplies and sources of fuel and power in Victoria can best be developed and utilised. The Act also established the administrative machinery of the Ministry and made the Minister responsible for the State Electricity Commission of Victoria and the Gas and Fuel Corporation of Victoria. The broad terms of the Act also enable the Minister to deal with legislative and other problems concerned with the production and marketing of energy which may be referred to him by private oil and gas companies. In accordance with the provisions of the *Pipelines Act* 1967 the Ministry is also responsible for determining the routes of major pipelines conveying hydrocarbons throughout Victoria.

On 24 July 1975 the Premier announced the formation of a brown coal research and development committee, under the Ministry, to study all aspects of the development of Victoria's brown coal resources other than for the generation of electricity and with particular emphasis on the production of liquid hydrocarbons. The committee, comprising a chairman, ten members, and later an executive secretary (who is also chief engineer) held its first meeting on 5 August 1975.

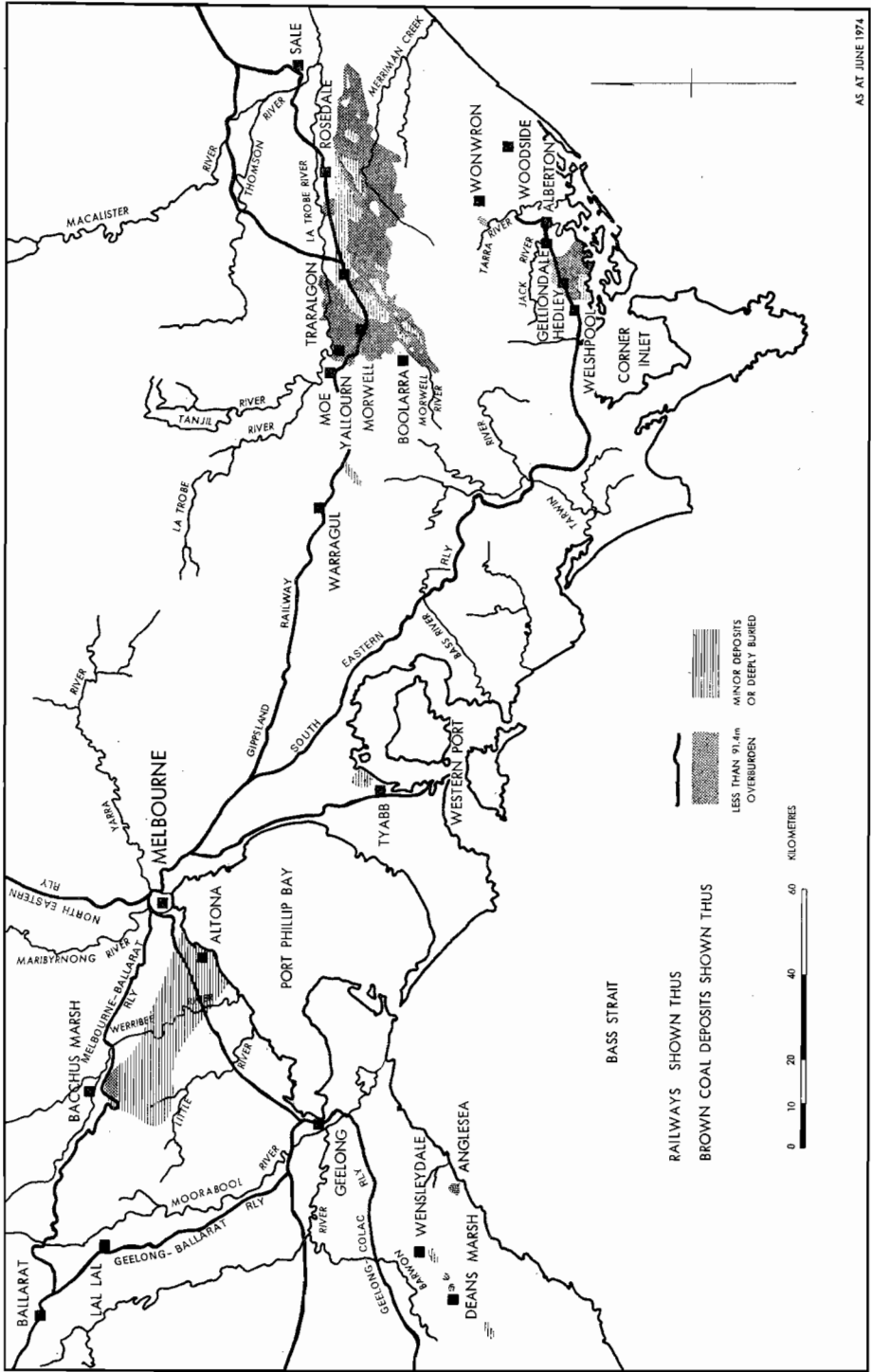


FIGURE 13. Brown Coal Areas of Victoria, June 1974.

Brown coal*Location*

Victoria's largest resources of fossil fuels, which form the bulk of energy available in the State, are huge deposits of brown coal. Among the largest in the world, they are located in the La Trobe valley about 130 to 180 kilometres east of Melbourne in central Gippsland. Smaller deposits also exist in other areas, in the south of Victoria at Gelliondale, Anglesea, Bacchus Marsh, and Altona, and although extensive they do not compare in magnitude and importance with those in the La Trobe valley.

The brown coal seams in the La Trobe valley range from Eocene to Early Miocene in geological age, that is, between 20,000,000 and 50,000,000 years old.

Reserves

The reserves of brown coal in Victoria, re-assessed during 1974, and unchanged since then, are shown in the following table :

VICTORIA—RESERVES OF BROWN COAL, 1974
(megatonnes)

Major coalfields	Proven geological reserves	Readily recoverable reserves		
		Main areas	Marginal areas	Total
La Trobe valley—				
Yallourn—Maryvale	12,400	2,500	300	2,800
Morwell—Narracan	6,800	2,200	1,100	3,300
Loy Yang Flynn	21,300	3,400	1,300	4,700
Sub-total—main fields	40,500	8,100	2,700	10,800
Gormandale	4,000	400	200	600
Holey Plains—Coolungoolun	2,500	100	100	200
Other areas	17,900	30	..	30
Total La Trobe valley	64,900	8,630	3,000	11,630
South Gippsland—				
Gelliondale	1,300	200	200	400
Won Wron	2	..	..	..
Total South Gippsland	1,302	200	200	400
Total Central Gippsland	66,202	8,830	3,200	12,030
Other (Bacchus Marsh, Altona, and Anglesea)				
	500	100	100	200
Grand total	66,702	8,930	3,300	12,230

In addition to the 66,702 megatonnes of proven geological reserves in Victoria, there are further inferred geological reserves of 47,000 megatonnes making an overall total of proven plus inferred reserves of 113,700 megatonnes. Of this total, 113,000 megatonnes are in central Gippsland with 108,000 megatonnes being situated in the La Trobe valley.

Recoverable reserves

About 35,000 megatonnes, or 54 per cent of the proven deposits, occur in areas where the overburden over the uppermost seam is less than 30.5 metres, while 62,000 megatonnes, or 95 per cent, is in areas with less than 91.4 metres of overburden. The inferred reserves of 43,000 megatonnes in the La Trobe

valley are mostly deeper and less accessible with about 75 per cent occurring in areas with more than 30.5 metres of overburden. Thick coal seams occur close to the surface in two large areas. One of these is the Yallourn/Morwell coal field where the large, base load power stations are located and the other is the Loy Yang coal field which will be developed during the 1980s for power generation.

Use for electricity generation

The brown coal mined from the La Trobe valley deposits in central Gippsland is used to fuel the base load power stations providing more than 85 per cent of Victoria's electricity. It is also the feedstock for the production of briquettes, a solid fuel made from brown coal by the removal of most of the moisture and subsequent compression into different sizes of rectangular pellets for use as a fuel in industry and homes and to generate electricity principally at the peak load power station at Newport, near Melbourne.

With its high moisture content and difficult burning characteristics brown coal is less suitable than black coal for power generation but there are ample supplies of it. Brown coal is also located conveniently and cheap to mine.

Following the study by The Electricity Commissioners between 1918 and 1920, the practicability of using brown coal for the generation of electricity was confirmed. The State Electricity Commission of Victoria was formed in 1921, and soon after work began on the excavation of an open cut at Yallourn for the mining of brown coal for use in a power station to be built nearby.

Yallourn open cut now covers more than 890 hectares in area, is currently producing coal at the rate of about 12 megatonnes a year, and since 1926 has yielded a total of about 358 megatonnes. The highest grade seams remaining lie under the township of Yallourn which will gradually be dismantled early in the 1980s as the demand for fuel for the new Yallourn "W" power station, now under construction, increases.

During the late 1950s full scale production of brown coal began from a new open cut at Morwell, about 6 kilometres south-east of Yallourn, for use in the then recently erected combined power station and briquetting factory complex. Working at several levels large dredgers, the latest capable of mining up to 1,990 tonnes an hour, have produced about 153 megatonnes from this open cut to date. Currently the rate of production is 15 megatonnes a year. The coal is taken by conveyor belts to the Morwell and Hazelwood power stations. Up to 30 June 1976 a total of about 535 megatonnes of brown coal had been produced from open cuts in the La Trobe valley.

Other areas

In addition to being used as a fuel in power stations in the La Trobe valley, brown coal is mined by open cut methods at two other localities in Victoria. The more important of these is at Anglesea, about 130 kilometres south-west of Melbourne, where Alcoa of Australia Ltd excavates the coal for fuel in a 150 MW power station built by the company and commissioned in 1969. This station produces electricity for use at Alcoa's alumina smelter at Point Henry, about 56 kilometres east of Geelong. The Anglesea field contains reserves estimated at 117 megatonnes and production is about 1 megatonne a year. About 0.2 megatonnes a year is also produced at Bacchus Marsh for industrial use by two private companies.

A table showing the production of brown coal in Victoria from 1926 to 1974-75 can be found on page 324 of the *Victorian Year Book* 1976. Total production of brown coal from the Yallourn, Yallourn North, and Morwell open cuts in 1975-76 was 28.082 megatonnes.

Briquettes

Briquettes are pellets of brown coal which have been compressed into various sizes capable of being transported and stored economically for industrial and domestic use. During the processing, the moisture in the brown coal is reduced from about 66 per cent to about 15 per cent, according to the source of the coal used. Coal from the Yallourn open cut can be made into briquettes relatively easily by drying and pressing finely crushed raw coal without any need for a binding agent. Coal from the Morwell open cut is unsuitable for briquetting because it contains boiler fouling constituents and has poor weathering characteristics. The Yallourn briquette factory commenced production in 1924 and closed in 1971. Manufacture of briquettes from Yallourn coal continues, however, at the Morwell factory. Annual production reached a peak of 1.92 megatonnes during the mid-1960s but declined to 0.95 megatonnes in 1975-76.

Briquettes are also used as a feedstock in the production of char and could be used to produce oil from brown coal.

Electricity

In Victoria the most widely used and extensively distributed form of energy is electricity. This is supplied by the State Electricity Commission of Victoria, a public utility formed by an Act of the Victorian Parliament in 1921. At 30 June 1976 the Commission, with 18,572 personnel and capital assets of \$1,870m, distributed electricity to 1,187,000 customers throughout Victoria and to a further 265,000 customers through eleven metropolitan councils which purchase electricity in bulk for retail distribution. The State Electricity Commission and municipal networks comprise more than 115,000 kilometres of power lines.

Existing system of electricity generation

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 produces all of the electricity generated in Victoria available for public supply.

The development of Victoria's electricity system is based on the utilisation for both power and fuel of Victoria's extensive brown coal resources in the La Trobe valley in central Gippsland, about 130 kilometres east of Melbourne, with supplementary development of the hydro-electric potential in north-eastern Victoria. Victoria is entitled to one third (New South Wales receives two thirds) of the electricity from the Snowy Mountains Hydro-Electric Scheme after the Commonwealth Government's requirements for the Australian Capital Territory have been met. Victoria also shares with New South Wales the electricity generated at the Hume hydro station near Albury on the Murray River.

By far the largest proportion of Victoria's electricity is generated from brown coal, used mainly in its raw state. The coal is also manufactured into a high quality fuel in the form of briquettes, some of which are consumed in power stations.

Electricity generated in the State system or purchased by it totalled 18,347 million kWh in 1975-76. 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 1976 was 4,745 MW. The power stations are interconnected and feed electricity into a common pool for general supply.

The major station in this interconnected system is the 1,600 MW brown coal fuelled power station at Hazelwood, which alone generates about 50 per cent of Victoria's electricity. Other power stations in the interconnected system comprise the other three base load power stations—Yallourn (which contributes 15 per

cent), Morwell, and the first two sets of a new base load power station, Yallourn "W", steam stations in Melbourne (Newport, Richmond, and Spencer Street); and hydro-electric stations at Kiewa, Eildon, on the Rubicon and Royston Rivers near Eildon, and at Cairn Curran on the Eppalock Reservoir on the Campaspe River near Bendigo.

New and proposed generating projects

Yallourn "W"

Designed as a base load power station of 1,450 MW capacity, this station is being built in two stages at Yallourn West in the La Trobe valley. The station was originally planned to comprise only 2×350 MW units when approved by the Victorian Government in 1965. The first unit was commissioned during the winter of 1973 and the second during the winter of 1975.

In 1972 the Victorian Parliament approved a proposal to extend the Yallourn "W" power station by the addition of two generating units. Each will have a capacity of 375 MW. The two new generators are expected to be in service in the early 1980s. Site works commenced in 1975. The total cost of the station is estimated to exceed \$400m.

The Yallourn "W" boilers are among the largest in the world designed for the combustion of raw brown coal. Each boiler is more than 80 metres high and contains 200 kilometres of steam tubing and 137 kilometres of water tubing. At full load each boiler can consume 600 tonnes of coal an hour.

Newport

The State Electricity Commission plans to build a 1,000 MW regulating power station at Newport at the mouth of the Yarra River at an estimated cost of about \$250m. It will be fuelled primarily by natural gas. Following an exhaustive inquiry, the Environment Protection Authority issued licences for the operation of the station. Appeals to the Environment Protection Authority Third Party Appeal Tribunal in 1974 and to the Environment Protection Appeal Board in 1974 were disallowed and the granting of the licences was upheld. Conditions of the licences impose stringent controls on the operation of the station, and the Commission must observe all the conditions imposed. As the building of the station became a matter of intense public debate, the Victorian Government appointed an independent panel of four members to review the decision in 1976.

Dartmouth

The State Electricity Commission plans to construct a new hydro-electric power station of one 150 MW generator at Dartmouth in north-eastern Victoria. It will be operated in association with the irrigation storage now being built on the Mitta Mitta River (see pages 379-81). The station is scheduled to commence operating in 1979.

Loy Yang

In 1973 the State Electricity Commission announced its intention to carry out an extensive investigation into the possible development of a new major base load generating project of about 4,000 MW capacity at Loy Yang in the La Trobe valley, to begin operating in the early 1980s.

The Parliamentary Public Works Committee was given the task of inquiring into the Commission's proposals, and began hearing evidence late in 1974. In December 1975 the Committee issued a progress report endorsing the Commission's plans. It announced that it would make a comprehensive final report later, containing recommendations on ancillary issues involved in the inquiry.

The plans include the development of a new open cut on the Loy Yang coal field about 5 kilometres south of Traralgon. The field has total estimated commercially recoverable reserves of 4,700 megatonnes. Two power stations, each

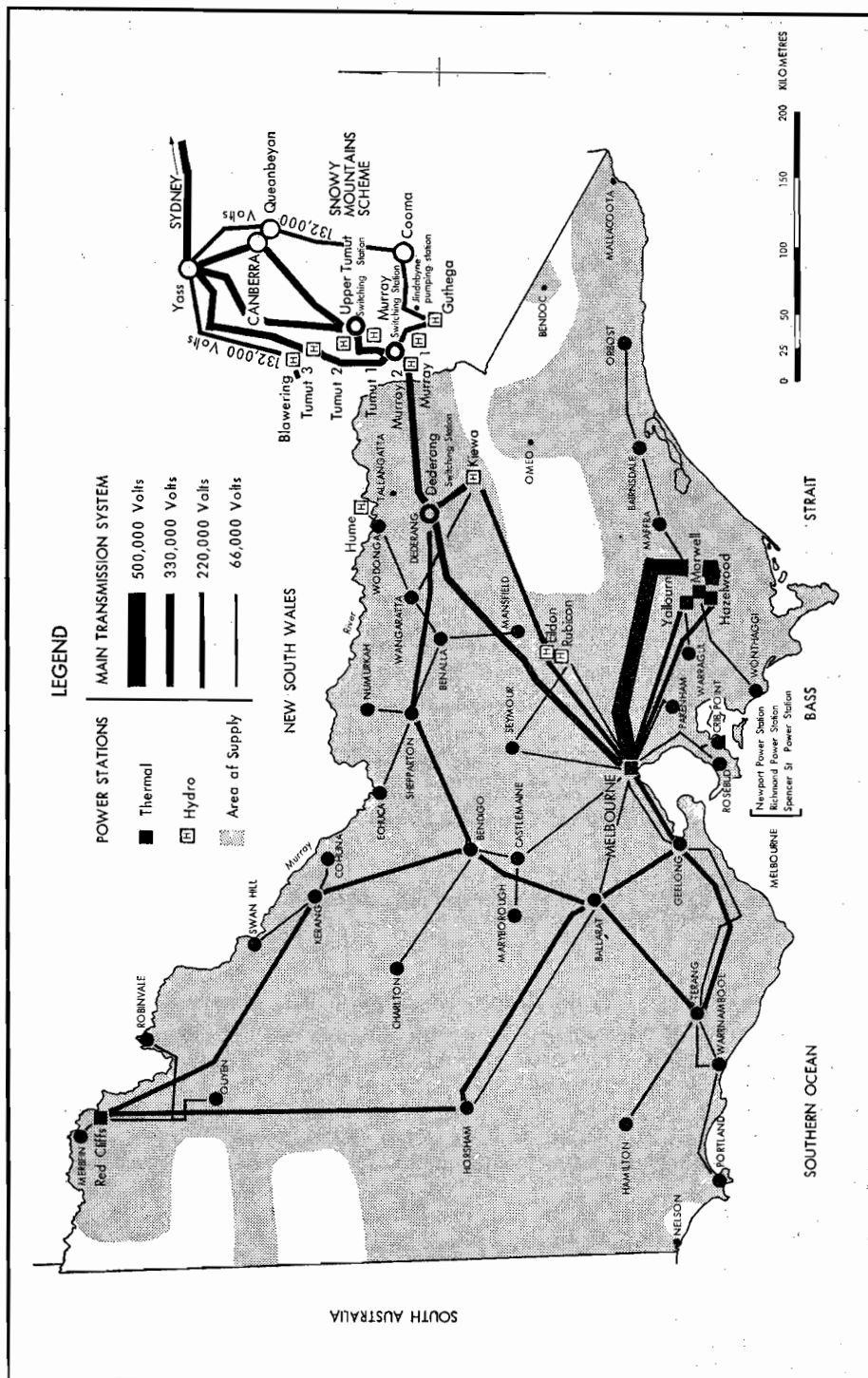


FIGURE 14. Victoria's main power transmission system, 30 June 1975.

of 2,000 MW, will be erected and the entire project is expected to cost \$1,635m at January 1976 price levels. Excavation of the overburden is expected to commence in 1979 on the southern side of the coal deposits to establish a coal face advancing in a northerly direction. Construction of the first station is expected to begin late in 1976 or in 1977, with operations commencing in 1983. The Loy Yang project is expected to meet Victoria's base load requirements during the 1980s and the early 1990s. It will have a larger generating capacity than the Snowy Mountains Hydro-Electric Scheme and will produce six times as much electricity.

VICTORIA—POWER STATIONS : LOCATION, RATING, AND PRODUCTION

Station	Maximum continuous rating (a)	Electricity production							
		1972-73		1973-74		1974-75		1975-76	
		Quantity	Percentage of production	Quantity	Percentage of production	Quantity	Percentage of production	Quantity	Percentage of production
MW	Mill kWh	Mill kWh	Mill kWh	Mill kWh	Mill kWh	Mill kWh	Mill kWh	Mill kWh	
Thermal stations—									
Hazelwood	1,600	8,550.4	57.2	8,510.6	52.7	8,238.0	48.1	9,132.2	49.8
Yallourn	546	2,659.2	17.8	2,480.1	15.4	2,545.1	14.8	2,360.7	12.9
Yallourn " W "	700	4.8	..	1,475.1	9.1	2,409.0	14.1	3,538.9	19.3
Morwell	170	1,134.5	7.6	1,196.9	7.4	1,263.7	7.4	1,165.3	6.3
Newport	198	140.5	0.9	181.6	1.1	136.6	0.8	133.4	0.7
Spencer Street (b)	90	15.2	0.1	12.7	0.1	1.0	..	1.2	..
Richmond	38	5.2	..	7.2	..	0.1	..	0.2	..
Red Cliffs (c)	..	0.6	..	0.5	..	0.1	..	..	..
Total—S.E.C. thermal	3,342	12,510.4	83.6	13,864.7	85.8	14,593.6	85.2	16,331.9	89.0
Hydro stations—									
Kiewa (d)	184	286.1	1.9	452.0	2.8	451.9	2.6	394.3	2.1
Eildon (e)	135	306.4	2.1	320.7	2.0	539.1	3.2	415.5	2.3
Total—S.E.C. hydro	319	592.5	4.0	772.7	4.8	991.0	5.8	809.8	4.4
Total—S.E.C. Net purchases	3,661	13,102.9	87.6	14,637.4	90.6	15,584.6	90.9	17,141.7	93.4
	..	1,853.8	12.4	1,510.6	9.4	1,554.7	9.1	1,204.8	6.6
Total	3,661	14,956.7	100.0	16,148.0	100.0	17,139.3	100.0	18,346.5	100.0

(a) At 30 June 1976.

(b) Melbourne City Council station.

(c) Retired April 1975.

(d) McKay Creek, West Kiewa, and Clover.

(e) Eildon, Rubicon, Lower Rubicon, Royston, Rubicon Falls, and Cairn Curran.

Source : State Electricity Commission of Victoria.

Transmission and distribution

Electrification of Victoria has been virtually completed. Only some isolated properties in remote parts of Victoria are without a supply from the Commission's system. The Commission supplies electricity in bulk to the eleven municipal undertakings which operate as 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 Murray River.

The electrical transmission and distribution system in the State supply network at 30 June 1976 comprised more than 115,000 kilometres of power lines, 4 auto-transformation stations, 26 terminal receiving stations, 169 zone sub-stations, and more than 70,000 distribution sub-stations. Main transmission is by 500 kV, 330 kV, 220 kV, and 66 kV power lines (8,000 route kilometres), which supply the principal distribution centres and also provide interconnection between the power stations.

Electricity from the Hazelwood power station is transmitted at 500 kV.

Petroleum

Petroleum products were first imported into Victoria in drums mainly from the United States of America, during the last few years of the nineteenth century. Initially the principal product was kerosene. However, with the advent of the motor car during the early years of the twentieth century, the demand for petrol gradually replaced kerosene and it became necessary to construct bulk storage facilities (now known as tank farms). The first of these storages was erected near the mouth of the Yarra River at Newport.

Victoria's first refinery was built at Laverton during the 1920s and closed in 1955. In order to cope with an ever increasing market demand after the Second World War, two major refineries were erected during the early 1950s. The Shell Co. of Australia refinery at Corio, near Geelong, was commissioned in 1954 and the Standard Vacuum refinery—now Petroleum Refineries (Australia) Pty Ltd—commenced full scale operation at Altona in 1955. A third major refinery was built by BP Refinery (Westernport) Pty Ltd at Crib Point in 1965. These three refineries currently satisfy almost the whole of Victoria's market for refined petroleum products.

Exploration in the Gippsland Basin, 1960 to 1975

After an extensive geological and geophysical exploration programme had been carried out in the offshore waters of Victoria between 1960 and 1963, drilling commenced in eastern Bass Strait late in 1964. After discovering two gas fields, drilling operations moved further out into the deeper waters of Bass Strait and, in 1967, two important oil fields—Halibut and Kingfish—were discovered. The latter field, in about 83 metres of water and 80 kilometres offshore, was subsequently declared to be a major offshore field by world standards.

During the entire exploration programme, seven commercial gas and/or oil fields were found: Barracouta (1965—gas and 1968—oil), Marlin (1966—oil), Halibut (1967—oil), Kingfish (1967—oil), Tuna (1968—oil and gas), Snapper (1968—gas), and Mackerel (1969—oil). The following table shows the commercial exploration wells drilled in the Gippsland Basin during the period from December 1964 to September 1975 when drilling ceased to allow the reassessment of targets:

VICTORIA—COMMERCIAL EXPLORATION WELLS DRILLED BY ESSO
AND B.H.P.: GIPPSLAND BASIN, 1964–1975 (a)

Well	Date exploration well spudded-in	W, A, or D (b)	Classification
Barracouta 1	27.12.64	W	Gas discovery
Barracouta 2	8.6.65	A	Gas discovery confirmation
Barracouta 3	3.8.69	A	Gas discovery confirmation
Barracouta A-3 (c)	20.4.68	D	Oil discovery
Marlin 1	5.12.65	W	Gas discovery and oil show
Marlin 2	31.5.66	A	Gas discovery confirmation
Marlin 3	16.12.66	A	Gas discovery and oil show confirmation
Marlin A-6 (d)	11.8.68	D	Gas discovery confirmation
Marlin A-24 (e)	16.5.73	D	Gas discovery confirmation
Halibut 1	20.6.67	W	Oil discovery
Kingfish 1	6.4.67	W	Oil discovery
Kingfish 2	28.11.67	A	Oil discovery confirmation
Kingfish 3	2.2.68	A	Oil discovery confirmation
Kingfish 4	15.11.73	A	Oil discovery confirmation
Tuna 1	7.5.68	W	Gas and oil discovery
Tuna 2	30.10.68	A	Gas and oil discovery confirmation
Tuna 3	18.2.70	A	Gas and oil discovery confirmation

VICTORIA—COMMERCIAL EXPLORATION WELLS DRILLED BY ESSO AND B.H.P.:
GIPPSLAND BASIN, 1964-1975 (a)—continued

Well	Date exploration well spudded-in	W, A, or D (b)	Classification
Snapper 1	8.5.68	W	Gas discovery and oil show
Snapper 2	16.6.69	A	Gas discovery confirmation
Snapper 3	24.11.69	A	Gas discovery confirmation
Mackerel 1	27.3.69	W	Oil discovery
Mackerel 2	14.2.72	A	Oil discovery confirmation
Mackerel 3	1.4.72	A	Oil discovery confirmation
Mackerel 4	11.2.73	A	Oil discovery confirmation

(a) Drilling by Esso/B.H.P. in Gippsland Basin ceased temporarily on 11 September 1975.

(b) W : wildcat, A : appraisal well, D : development well.

(c) Drilled during development drilling on Barracouta platform in 1968—deep well probe.

(d) Drilled during development drilling (first stage) on Marlin platform in 1968—deep well probe.

(e) Drilled during development drilling (second stage) on Marlin platform in 1973—deep well probe.

Sources : Esso Australia Ltd and the Oil and Gas Division of B.H.P., 1965-1975.

Development of Gippsland oil fields

During the period from 1967 to 1971 four of the commercial fields discovered offshore in the Gippsland Basin in eastern Victoria were developed as an integral operation. These were the Barracouta, Marlin, Halibut, and Kingfish fields. During 1972 and 1973 further development was carried out on the Marlin field and in 1975 development began on the Mackerel and Tuna fields.

The Barracouta oil reservoir, discovered during gas development drilling programmes in 1968 came on stream in October 1969, the Halibut field in April 1970, and the Kingfish field in March 1971. The crude oil from these three fields is stabilised at the Gippsland Gas Processing and Crude Oil Stabilisation Plant at Longford through the extraction of the higher fractions—methane, ethane, propane, and butane. To the resulting stream of stabilised crude oil are added the pentanes extracted during the treatment of natural gas. The stabilised crude oil is then conveyed through a pipeline 188 kilometres long and 700 mm nominal diameter to Long Island Point where it is stored in eight 268,000 barrel capacity tanks. From the tank farm at Long Island Point the crude oil is then taken by tanker to refineries in Sydney and Brisbane and by pipeline to Victoria's three refineries. The following table shows the production of stabilised crude oil for the years 1971 to 1975 :

VICTORIA—PRODUCTION OF STABILISED CRUDE OIL

Year	Barrels			Kilolitres		
	During year	Progressive production at 30 June	Average barrels/day for year	During year	Progressive production at 30 June	Average kilolitres/day for year
1971	95,668,066	143,028,336	262,104	15,207,132	22,735,390	41,663
1972	103,262,110	246,290,446	282,137	16,414,260	39,149,650	44,848
1973	127,089,311	373,379,757	348,190	20,201,766	59,351,416	55,347
1974	126,656,461	500,036,218	347,004	20,132,962	79,484,378	55,159
1975	136,434,598	636,470,816	373,793	21,687,267	101,171,645	59,417

The first shipment of Gippsland crude oil was made from the Long Island Point jetty late in March 1970.

Victoria's three refineries are now connected by pipeline to the Long Island Point Tank Farm and during the twelve months ending 31 December 1975 absorbed Gippsland crude oil at an average rate of 31,490 kilolitres a day, or about 52 per cent of the total available from the Gippsland fields.

VICTORIA—GIPPSLAND BASIN: COMMERCIAL HYDROCARBON RESERVES
AND FIELD PRODUCTION TO 31 DECEMBER 1975

NATURAL GAS						
Field	Trillions of cubic feet			Millions of cubic metres		
	Initial	Produced	Remaining	Initial	Produced	Remaining
Barracouta	1.857	0.142	1.715	52.607	4.023	48.584
Marlin	2.763	0.125	2.638	78.272	3.541	74.731
Halibut	0.028	0.016	0.012	0.794	0.454	0.340
Kingfish	0.206	0.084	0.122	5.836	2.380	3.456
Mackerel	0.092	..	0.092	2.607	..	2.607
Tuna	0.484	..	0.484	13.711	..	13.711
Snapper	2.464	..	2.464	69.802	..	69.802
Total	7.894	0.367	7.527	223.629	10.398	213.231

CRUDE OIL						
Field	Millions of barrels			Kilolitres		
	Initial	Produced	Remaining	Initial	Produced	Remaining
Barracouta	25	11	14	3,974,750	1,748,890	2,225,860
Marlin	2	..	2	317,980	..	317,980
Halibut	653	304	349	103,820,470	48,332,960	55,487,510
Kingfish	952	314	638	151,358,480	49,922,860	101,435,620
Mackerel	256	..	256	40,701,440	..	40,701,440
Tuna	84	..	84	13,355,160	..	13,355,160
Total	1,972	629	1,343	313,528,280	100,004,710	213,523,570

CONDENSATE						
Field	Millions of barrels			Kilolitres		
	Initial	Produced	Remaining	Initial	Produced	Remaining
Barracouta	28	..	28	4,451,720	..	4,451,720
Marlin	73	..	73	11,606,270	..	11,606,270
Tuna	10	..	10	1,589,900	..	1,589,900
Snapper	65	..	65	10,334,350	..	10,334,350
Total	176	..	176	27,982,240	..	27,982,240

LPG						
Field	Millions of barrels			Kilolitres		
	Initial	Produced	Remaining	Initial	Produced	Remaining
Barracouta	67	5	62	10,652,330	794,950	9,857,380
Marlin	129	5	124	20,509,710	794,950	19,714,760
Halibut	33	16	17	5,246,670	2,543,840	2,702,830
Kingfish	100	32	68	15,899,000	5,087,680	10,811,320
Mackerel	31	..	31	4,928,690	..	4,928,690
Tuna	20	..	20	3,179,800	..	3,179,800
Snapper	89	..	89	14,150,110	..	14,150,110
Total	469	58	411	74,566,310	9,221,420	65,344,890

NOTE. All figures are for products after processing.
Source: Victorian Mines Department.

Refining

About 70 per cent of Australia's refined petroleum products are derived from Australian crude oils. The ratio of gasolene produced is higher than from Middle East crudes while that of bitumen, asphalt, and other "heavy ends" is much

lower. The three refineries in Victoria obtain crude oil feedstocks from both the Gippsland fields and from the Persian Gulf. They import wholly or partially refined products either from overseas or other States and export considerable volumes of wholly or partially refined products either to other States or to overseas countries.

Because the characteristics of Gippsland crude oil were different from those imported from the Middle East, the three Victorian refineries modified their refining processes and in some instances installed new plant. When the modification and expansion programmes were completed in 1971, the three refineries had the following respective production capacities, namely, Shell refinery at Corio—between 104,100 barrels (16,500 kilolitres) and 110,000 barrels (17,500 kilolitres) a stream day, P.R.A. refinery at Altona—96,000 barrels (15,000 kilolitres) a stream day, and BP refinery at Crib Point—50,000 barrels (8,000 kilolitres) a stream day. In October 1973 the BP refinery at Crib Point further modified its plant to increase production capacity to 60,000 barrels (9,500 kilolitres) a stream day. Shell Refining (Aust.) Pty Ltd also operates a lubricating oil plant at Corio which has a capacity of 2,200 barrels (350 kilolitres) a stream day.

Each refinery also imports crude oils from the Middle East for the production of special oils, bitumen, asphalt, and certain other "heavy ends" products. The total refinery capacity in Victoria is approximately 263,000 barrels (42,000 kilolitres) a stream day, or about 30 per cent of Australia's total refining capacity.

Transportation

Indigenous crude oil is shipped from the Long Island Point and Crib Point jetties at Western Port by tanker to refineries in Sydney and Brisbane. The total volume shipped by tanker during the twelve months ending 30 June 1976 was 62,176,235 barrels (9,885,248 kilolitres), and 159 tanker movements were involved.

Each refinery has its own tanker loading and discharging facilities and jetties. These are located at Crib Point for the BP refinery, at Williamstown and Newport for the P.R.A. refinery at Altona, and at Corio for the Geelong refinery. There is also a tank farm at Portland in the far west of Victoria for the storage of refined products.

During the twelve months ending 30 June 1976, the three refineries obtained by pipeline 74,834,179 barrels (11,897,704 kilolitres) of Gippsland crude oil and imported 6,545,000 barrels (1,040,574 kilolitres) of crude oil from the Persian Gulf, making a total supply of 81,379,179 barrels (12,938,278 kilolitres) of crude oil feedstocks. During the calendar year 1975 the refineries imported by ship 3,452,000 barrels (549,200 kilolitres) of wholly or partially refined products from overseas or other States in Australia and exported by ship 30,034,000 barrels (4,774,000 kilolitres) of wholly or partially refined products to overseas destinations such as New Zealand or the Pacific Islands and to other States in Australia.

Marketing

Motor spirit in two grades—98 octane (super grade) and 89 octane (standard grade)—and a wide range of other petroleum products are marketed in Victoria through a number of industry terminals and depots and 4,192 retail outlets (31 December 1975), the majority of which are operated by the nine major oil companies. Victoria had a capacity to store in bulk (30 June 1975) 3,128,933 kilolitres of crude oil and petroleum products at 21 installations in Melbourne (14), Geelong (1), Crib Point (1), Long Island Point (1), and Portland (4), including refineries.

In 1975 a total of 9,413.62 thousand kilolitres or 26 per cent of the Australian total of the main petroleum fuels were marketed in Victoria's marketing area. The principal petroleum products marketed in 1975 are shown in the following table :

VICTORIA—PRINCIPAL PETROLEUM PRODUCTS MARKETED, 1975
(‘000 kilolitres)

Item	Quantity	Item	Quantity
Aviation gasolene	16.51	Industrial diesel fuel—	
Motor spirit—		Inland	325.69
Super	3,175.24	Bunkers	87.12
Standard	523.52		
Total	3,698.76	Total	412.81
Power kerosene	13.23	Fuel oil—	
Aviation turbine fuel	379.78	Inland (a)	409.58
Lighting kerosene	56.62	Bunkers	546.02
Heating oil	464.90	Total	955.60
Automotive distillate—		Other petroleum fuels (b)	2,493.81
Inland	890.72		
Bunkers	30.88	Grand total	9,413.62
Total	921.60		

(a) Excluding refinery fuel.

(b) Including refinery fuel.

Source : Petroleum Branch—Commonwealth Department of National Resources.

Propane, butane (LPG), and ethane

While the three refineries in Victoria each produce LPG in varying quantities, such production is only a fraction of the total produced. The largest LPG plant in Australia is operated by Esso and B.H.P. at Long Island Point, approximately 65 kilometres south-east of Melbourne.

Gas liquids comprising untreated propane, butane, and ethane are extracted from natural gas and crude oil produced from the Gippsland fields at the Gippsland Gas Processing and Crude Oil Stabilisation Plant at Longford. These products, in a mixed stream, are then conveyed to Long Island Point through a pipeline 190 kilometres long and 250 mm in diameter. The Long Island Point Fractionation Plant was erected between 1968 and 1970 and commissioned in April 1970. Since that time it has been expanded by doubling the production capacity and more than tripling the storage capacity. In December 1975 a third processing train to further increase capacity was commissioned. With the completion of this expansion programme the plant can produce approximately 1,200,000 tonnes of LPG a year, together with sufficient volumes of ethane gas to supply two major petrochemical plants.

Almost all of the propane and butane are exported to overseas markets, principally Japan. Since the first loading was made at the Long Island Point jetty in July 1970, LPG carriers have been loaded continuously for destinations outside Victoria. About two thirds of the overseas shipments have been made to markets in Japan. Some has also been shipped to Argentina, Spain, and the Pacific Islands. The balance of the shipments has been made in small pressure carriers to ports around Australia. To 31 December 1975, 2,093,422 tonnes of propane and 2,772,967 tonnes of butane had been produced, making a total of 4,866,389 tonnes.

Ethane gas has, since 31 December 1972, been conveyed through a pipeline 79 kilometres in length and 250 mm in diameter to the Altona Petrochemical Co. Ltd at Altona. Supply of this gas to Hydrocarbons Products Pty Ltd at West Footscray is expected to commence early in 1977, through a pipeline 6.13 kilometres in length and 250 mm in diameter from Altona to the new \$60m plant as a feedstock for the production of styrene-monomer.

Gas industry

The gas industry, one of Victoria's oldest energy industries, has been revitalised during the last six years as a result of the introduction of natural gas.

It has changed from being operated by a large number of privately owned companies and small municipal undertakings to being controlled by a single public utility—the Gas and Fuel Corporation of Victoria, a State instrumentality with a percentage of private shareholdings.

Gas and Fuel Corporation of Victoria

The Gas and Fuel Corporation was created by the *Gas and Fuel Corporation Act* 1950 which established it as a joint enterprise combining the State of Victoria with the shareholders of the Metropolitan Gas Company and the Brighton Gas Company. The purpose of the legislation was to provide the means for developing Victoria's brown coal resources instead of using New South Wales black coal for the production of gas, and to consolidate and rationalise the gas industry by providing for the takeover or absorption of other gas utilities. The Corporation commenced operating on 1 January 1951 and by 1974 it had, through subsequent enabling legislation, become the sole authority responsible for the distribution of reticulated gas throughout Victoria.

At 30 June 1976, reticulated gas was being supplied to 682,251 customers in Victoria through a network of approximately 14,000 kilometres of transmission pipelines and reticulation mains. About 98 per cent of the total supplied is natural gas.

Development of natural gas, 1965 to 1976

In February 1965, natural gas in commercially recoverable quantities was discovered in eastern Bass Strait in the Gippsland Basin about 20 kilometres offshore. The well, Barracouta, was the first offshore well drilled in Australian waters and Australia's largest gas discovery to that time. A second and even larger field, Marlin, was found a year later. These two events enabled natural gas to be commercially developed in Victoria. The partnership of Esso Exploration and Production Australia Inc. and Hematite Petroleum Pty Ltd (a wholly owned subsidiary of The Broken Hill Proprietary Co. Ltd), which discovered the fields, commenced a development programme immediately.

The initial step was the establishment of a marine terminal at Barry Beach in southern Gippsland, about 193 kilometres south-east of Melbourne and 145 kilometres west of the fields. This terminal, built between 1966 and 1968, became a general operational base for both exploration activities and the development projects, the most immediate of which was the fabrication of jackets and decks for the platforms from which the natural gas development wells, and later the crude oil wells, would be drilled.

Negotiations with the Gas and Fuel Corporation of Victoria for the sale of the natural gas to the State's gas utilities were virtually completed early in 1967 when agreement was reached on terms involving the payment, over a contract period of twenty years, of a fixed maximum price of 3.2 cents a therm and a minimum of 2.58 cents. A market for the gas was now assured. Further contractual arrangements were entered into during 1975 to provide for additional volumes of gas being supplied and to obtain an option over future discoveries.

Certain legislative measures were also necessary to implement the development programme. First, the Victorian Government established the Victorian Pipelines Commission to lay a natural gas trunkline to the Melbourne City Gate at Dandenong from Longford where the partnership was establishing a gas processing plant. The Commission later built the natural gas pipeline from Brooklyn to Geelong, but was dissolved and incorporated into the Gas and Fuel Corporation of Victoria on 1 July 1971.

Drafting of legislation to regulate offshore exploration for, and exploitation of, oil and gas was expedited. After several years of discussions between the

Commonwealth Government and all the States, the various enabling enactments applicable to each State and Australia were passed by the respective Parliaments in October 1967 and came into operation on 1 April 1968. Entitled the *Petroleum (Submerged Lands) Act 1967*, this legislation provided for uniformity in granting offshore petroleum exploration permits and production licences, the imposition of royalties, and the laying of submarine pipelines. The Victorian Government also introduced the *Pipelines Act 1967*, Australia's first major attempt to regulate pipelines to convey oil and gas onshore.

During 1968 and 1969, Esso Australia Ltd as the operator for the Esso/B.H.P. partnership, erected two platforms in Bass Strait (one each over the Barracouta and Marlin gas fields), carried out a development drilling programme, and laid submarine and onshore pipelines to Longford where it built a gas treatment plant. The facilities at the plant comprise a twin-train, refrigerated absorption plant designed to process 11,000,000 cubic metres a day of wet gas. It is capable of removing about 35 per cent of ethane and all of the heavier hydrocarbons.

In February 1976, Esso/B.H.P. commissioned new gas treatment facilities at Longford. The new plant, known as the Gippsland Gas Processing Plant No. 2, cost \$30m to build and is capable of treating 9,600,000 cubic metres a day. The new facilities will meet the expected peak demands of the Gas and Fuel Corporation during the latter part of the 1970s.

The Tuna field, which contains both natural gas and crude oil, is currently being developed and is expected to become operational near the end of the 1970s. A table outlining reserves and production can be found on page 359.

Distribution and conversion

Treated natural gas is conveyed from the Longford plant to the Dandenong City Gate through the Gas and Fuel Corporation's main transmission pipeline, 174 kilometres long and 750 mm in diameter. Natural gas first reached the metering and regulating station at Dandenong, known as the City Gate, on 31 March 1969, and the Corporation commenced distributing natural gas to its customers during the following month.

During the late 1960s the Gas and Fuel Corporation commenced the construction of a ring main around Melbourne initially to cope with normal expansion of gas supply to the rapidly developing suburban areas, and subsequently for the distribution of natural gas to its customers. The northern section of the ring main—82 kilometres long and 450 mm in diameter—passing through the eastern and northern suburbs, was completed late in 1969 and the 35 kilometres long and 750 mm in diameter southern section direct from the Dandenong City Gate to West Melbourne came fully into operation in May 1970. Built at a cost of \$11m, this 118 kilometres long pipeline now forms an essential part of the Corporation's entire metropolitan distribution system and supplies gas to Geelong, Ballarat, and Bendigo and is to provide supplies to Seymour, Wangaratta, Benalla, Wodonga, Albury, and Shepparton by the end of 1976.

The conversion of existing gas appliances in the Melbourne metropolitan area was completed in December 1970. In Geelong, conversion finished near the end of 1971, about five months after commencement. By the time conversion had been completed, the Lurgi plant at Morwell and the gas making plants at West Melbourne, Highett, Footscray, and Box Hill in the Melbourne metropolitan area had closed down.

Following the laying of a 196 kilometres long system to Ballarat and Bendigo during 1972 and 1973, the former city first received natural gas on 14 April 1973. The conversion programme, involving more than 36,000 appliances used by about 17,000 customers, was carried out in these two cities and at Castlemaine

and Bacchus Marsh by the Corporation's own staff during 1973 at a cost of about \$1.6m.

Early in 1974 the *Gas and Fuel Corporation (Powers) Act 1974* was passed, enabling the Corporation to acquire the Albury Gas Company Ltd at a cost of approximately \$800,000. This legislation facilitated arrangements for laying a pipeline to north-central Victoria.

At the present time a system of pipelines 355 kilometres long is being laid from Melbourne to supply towns along the Hume Highway and at Albury/Wodonga and Shepparton, and a conversion programme will be carried out during the second half of 1976 and the first part of 1977. A new 750 mm diameter pipeline will also be laid from South Melbourne to Brooklyn to reinforce supply in the western region of Victoria.

At 30 June 1976 a total of 1,370,000 appliances owned by 564,667 customers had been converted to natural gas in Victoria.

Gas supply areas

At 30 June 1976 there was a total of 664,643 customers receiving natural gas in Victoria. A further 17,608 customers were using other reticulated gases, mainly reformed LPG, making a total of 682,251 customers. The areas supplied with reticulated gas and the suppliers concerned are shown in the following table :

VICTORIA—AREAS SUPPLIED WITH GAS AT 30 JUNE 1976 (a)

Supplier	Areas supplied with—	
	Natural gas	Other gases (b)
Public utilities—		
Gas and Fuel Corporation of Victoria	Bacchus Marsh Ballarat Bendigo Castlemaine Geelong Lara Maffra Melbourne Morwell Sale Trafalgar Traralgon Warragul	Ararat Benalla Colac Hamilton Horsham Kyneton Portland Queenscliffe Seymour Shepparton Stawell Wangaratta Warrnambool Wodonga
Private suppliers—		
Esso Exploration and Production Australia Inc. and Hematite Petroleum Pty Ltd (B.H.P.)	Western Port North Geelong	

(a) Excludes Esso/B.H.P. plant use at Longford and Long Island Point.

(b) In addition the Gas and Fuel Corporation supplies Maryborough and Warracknabeal with bottled LPG.

Source: Victorian Ministry of Fuel and Power.

Liquefied petroleum gas is also supplied to more than 100,000 customers from reticulation and cylinder by the Gas and Fuel Corporation and from cylinder by oil companies or subsidiary LPG marketing companies in accordance with the provisions of the *Gas Franchises Act 1970*.

Production and sales

Since the Gippsland fields first came on stream in March 1969 the production of treated natural gas has increased markedly as the following table shows :

**VICTORIA—PRODUCTION OF TREATED
NATURAL GAS (a)**

Year	Quantity	
	MMcm	MMcf
1971	1,012.508	35,756.710
1972	1,202.882	42,479.756
1973	1,793.526	63,338.363
1974	2,241.743	79,167.139
1975	2,565.355	90,557.032
Total	8,816.014	311,299.000

(a) Includes sales, field, and plant usage.

MMcm : million cubic metres.

MMcf : million cubic feet.

Source : Commonwealth Department of National Resources.

Sales increased rapidly following the introduction of natural gas in April 1969. During the twelve months period ending 30 June 1968, the last full year before the introduction of natural gas, sales showed an increase of only 5.5 per cent over the previous year. Sales during the twelve months period ending 30 June 1976 increased by 15.8 per cent.

VICTORIA—SALES OF GAS

Year	Gas and Fuel Corporation of Victoria
	Sales in gigajoules
1974-75 (a)	72,253,000
1975-76 (a)	83,671,136

(a) Includes Mt Gambier Gas Co. Ltd in South Australia.

1 gigajoule = 9.479 therms.

NOTE. For sales of gas in Victoria for the years 1970-71 to 1973-74, see table on page 335 of *Victorian Year Book 1976*.

Source : Gas and Fuel Corporation of Victoria.

Further reference, 1976 ; Natural gas and crude oil development, 1961-1972 ; Brown coal, 1971 ; Discovery and development of crude oil in Victoria, 1974

MINERALS

Economic natural resources

Introduction

Victoria lacks the diversity of mineralisation present in other Australian States. However, mineral discoveries in Victoria in the past have had an important effect both on the State and Australia as a whole. The first major mineral development occurred in the 1850s with the gold discoveries and the subsequent gold rushes. A less spectacular development, but nevertheless one vitally important for Victoria's economy, was the utilisation of the La Trobe valley brown coal deposits for power generation in the 1920s. Of equal, or perhaps greater, significance were the oil and gas discoveries in Bass Strait during the 1960s from which Victoria now supplies about 80 per cent of Australia's crude oil requirements.

The recent world energy crisis has emphasised that liquid fuel deposits are not infinite and that in the future liquid hydrocarbons may have to be manufactured from coal. Victoria, with its vast reserves of brown coal, may be in an excellent position to continue to supply a substantial part of Australia's liquid fuel requirements in the future.

Construction materials

Apart from crude oil and natural gas, construction materials exceed other mineral production, including brown coal, in terms of quantity and value. In

1974-75, the production of construction materials, including clay and limestone for lime and cement, was approximately 35,000,000 tonnes, valued at \$66.7m. The larger portion of this quantity, and estimated to be as much as 60 per cent, is both produced and used within the Melbourne Statistical Division.

Basalts from the Newer Volcanic series remain the most important source of crushed and broken stone, although the proportion of the total production is gradually declining. The reason for this decline probably lies in the difficulties in meeting specifications and the recognition by the industry that granitic rocks and acid lavas are more uniform in quality both laterally and vertically and that the quantity of stone obtainable from a particular site is limited largely by geometrical considerations.

Production of crushed and broken stone has shown a steady increase of about 5 to 6 per cent per annum. At the same time, however, there has been a gradual decrease in the number of quarries, the higher total production being achieved by increased productivity of individual quarries. Production of sand has shown a similar increase together with a gradual decrease in the number of sand pits.

Fossil fuels

Victoria has proven resources of brown coal and producing offshore oil and natural gas fields. The State's proven geological reserves of brown coal (lignite) amount to 66,702 million tonnes, of which 64,900 million tonnes occur in the extensive coal fields of the La Trobe valley. The total inferred geological reserves down to depths at present uneconomic to mine amount to 113,700 million tonnes, but the State Electricity Commission estimates that the present economically extractable quantity is 12,200 million tonnes. This would contain an energy content of 120,000,000 terajoules.

The Bass Strait oil and natural gas fields will supply Victoria with natural gas for thirty years at the anticipated rate of consumption. It is estimated that an energy equivalent of 7,800,000 terajoules will be available if new gas fields are not discovered. The crude oil reserves, equivalent to 9,000,000 terajoules, will be seriously depleted by the late 1980s unless new discoveries are made in Victoria and Australia in the next ten years.

VICTORIA—ENERGY EQUIVALENT OF RECOVERABLE FOSSIL FUEL
(million terajoules)

Crude oil	Natural gas	Gas liquids	Brown coal	Total
9.0	7.8	2.1	120.0	138.9

The crude oil from the Bass Strait oil fields is deficient in the heavier lubricating fractions and the main commercial derivatives are light petroleum liquids ranging from heating oil to motor spirit. Victoria and Australia still depend on overseas crude oil for production of medium to heavy lubricating oils.

The black coal deposits of the south Gippsland coal fields such as Wonthaggi, Kilcunda, Korumburra, and Outtrim were mined during the first half of the twentieth century. The coals were of average grade, but because of thin seams and complex block faulting, mining was expensive and the final production ceased from Wonthaggi in 1968. Reserves are estimated to total 8,000,000 tonnes.

Metallic minerals

Only minor amounts of metallic minerals are produced in Victoria. The most valuable of these is gold. These minerals contribute only about 0.5 per cent of the value of mineral products.

History of mining in Victoria

Victoria owes its rapid settlement and economic growth to the rich alluvial gold discoveries of the early 1850s. Although the early settlers were pastoralists,

the rapid development of mining promoted the growth of industries and financial institutions. Gold mining reached a peak in 1856 with a total production of 86,000 kilograms of gold. From 1851 to 1857 the population of Victoria increased from 97,489 persons to 456,522 persons and had reached 1,000,000 persons by 1887.

One major consequence of the gold rushes was that Melbourne became an important centre of finance and maintains this role in Australia to the present day. Exploitation of the goldfields resulted in improved transportation facilities and improved access to large areas of fertile land which in itself supported the expansion of farming and pastoral industries.

Although for a long time gold production dominated the mining industry, other minerals were mined such as tin, antimony, copper, molybdenum, and wolfram. Production of some of these metals was as a by-product of gold mining. The mining activities of Victoria in the twentieth century have been characterised by marked progress in open cut mining, particularly of brown coal, limestone, and construction materials.

Discoveries of black coal in the south Gippsland area during the late nineteenth century and the early twentieth century resulted in underground mines at Coalville, Korumburra, Jumbunna, Outtrim, Kilcunda, and Wonthaggi. The black coal deposits at Wonthaggi were discovered in 1909 and the State Coal Mine operated in this area until 1968.

Brown coal mining in the Lal Lal, Bacchus Marsh, Altona, Wensleydale, Dean's Marsh, Benwerrin, Anglesea, Gelliondale, and La Trobe valley areas has operated for many years and the operations in the La Trobe valley rank among the world's largest open cut mining projects. Coal has been extracted from Yallourn North since 1889, but the major developments have taken place since 1920 when the State Electricity Commission took over the work begun by the Mines Department in 1916. Since 1924, when large-scale production began, more than 500,000,000 tonnes of brown coal have been mined from the Yallourn and Morwell open cuts.

Since the Second World War the rapid industrial development and recurrent building growth periods have made the production of construction materials the most extensive and valuable (apart from crude oil and natural gas) mining operation in Victoria. Limestones have been mined in large open cuts at Batesford and Waurn Ponds near Geelong, and at Merrimans Creek near Rosedale in Gippsland, for the manufacture of cement. Hard rock quarries supply aggregate and crushed rock for road construction and ferro-concrete buildings. Construction sands for concrete, plaster, and moulding are an important commodity and clays are mined by open cut methods for brick, tile, and pipe manufacture.

Victoria's economy was given another major impetus by the discovery in 1965 of the first of the large oil and gas deposits in the offshore fields of Bass Strait. Oil from Bass Strait now supplies approximately 80 per cent of total Australian requirements. Sufficient reserves of natural gas have been proved to supply Victoria's needs for more than twenty years, as well as other markets.

Mines Department

The role of the Mines Department is to promote the exploration of the mineral, "stone", petroleum, and groundwater resources of the State; to administer a system of leases, licences, and permits to enable the exploitation of those resources; and to regulate their extraction to ensure that it is carried out in an efficient and safe manner. The Department also carries out geological research and surveys and publishes the results in geological maps and reports. In addition to assisting in exploration, these maps and reports provide basic information for soil surveys, land-use, environmental surveys, and engineering undertakings. They are also of assistance to educational institutions and the general public.

The legislation administered by the Department includes the *Mines Act* 1958, *Petroleum Act* 1958, *Extractive Industries Act* 1966, *Petroleum (Submerged Lands) Act* 1967, and *Groundwater Act* 1969; the Department also plays an important role in the functioning of the *Environment Protection Act* 1970 and the *Land Conservation Act* 1970.

The *Extractive Industries Act* 1966, which provides for the regulation of quarries by leases and licences, also involves the Department in town and country planning schemes where the location and protection of deposits of "stone" are involved. "Stone" as defined in the Act includes basic construction materials such as hard rock for aggregates, sand, gravel, clay, limestone, etc. The Department's responsibility is to assist with the discovery of deposits of "stone" and to recommend to the various planning authorities an adequate form of zoning to protect the deposits. Sources of construction materials are an essential requirement in maintaining the development of housing, schools, factories, roads, dams, and sewerage systems, but with increasing public awareness about environmental issues, there often appears to be conflict between the various public interests. The planning authorities and the Department have a responsibility to plan for the future to ensure that valuable deposits of "stone" are not sterilised by other land-use, particularly if the resource is in short supply. The siting of extractive operations can generally be planned, with due regard to the aesthetic interests and the material needs of the community.

The *Land Conservation Act* 1970 set up a Land Conservation Council to publish reports in relation to the future use of Crown lands. The Council instigates studies of areas through study groups comprised of professional officers from Victorian Government departments and authorities. Mines Department geologists work on the study groups to prepare reports on the physiography, geology, hydrogeology, and mineral resources of the study areas. Because important mineralised areas, deposits of "stone", and important aquifer systems often occur on Crown lands, the Department's contribution to the study groups is to point out where aquifer systems occur, where proven mineral deposits exist, or where potentially important minerals may be found. In such cases, the Department then requests the Council to recommend that the land be available for exploration and mining should the need arise in the future. Some particular mineral may become of strategic significance at a later date and access to mineralised areas may be of vital importance.

Through the *Petroleum Act* 1958 and the *Petroleum (Submerged Lands) Act* 1967, the Department regulates the exploration by companies for oil and gas deposits in onshore and offshore areas. Leases and permits are issued and through a regular system of inspection of operations and of reporting from the companies, a high standard of professional efficiency and safety is maintained. On the development side, the installation of production facilities and the production and transmission of the oil and gas by pipeline are rigidly controlled. Through the 1970s the exploration for petroleum and gas and the community's increasing dependence on a local source will place major emphasis on exploration and development. The Department's task will be to encourage and stimulate continuing exploration and to assist as much as possible with expert technical advice and publications on geological and engineering matters. The Department, in collaboration with the South Australian Mines Department, carried out a major sedimentary basin study on the onshore Otway Basin during the 1960s, and a comparable study is in progress on the onshore Gippsland Basin and the Port Phillip area.

The *Groundwater Act* 1969 confirmed the Department's long-standing role in the investigation and assessment of Victoria's groundwater resources and provided for the control, construction, and maintenance of water bores. The Act made explicit provisions for the protection of groundwater from

pollution from the surface or by material injected underground. To carry out this part of the Act, the Department is required to report on any existing or proposed disposal sites for soluble solid or liquid domestic or industrial wastes, which may overlie unconfined aquifer systems or be sited in important aquifer intake areas. Under the Act, "bore" is defined in such a way that any quarries, sandpits, or comparable excavations are included. Several geologists are now working continuously on problems related to groundwater pollution and are also investigating sites where disposal dumps and depots are established.

The Department's responsibilities under the *Groundwater Act* 1969 in relation to pollution increased with the passing of the Environment Protection Act in 1970. The Department is now an investigating agent of the Environment Protection Authority in matters relating to groundwater and programmes of groundwater pollution monitoring are being jointly undertaken. The Department is concerned not only with pollutant seeping laterally or vertically into unconfined aquifers from disposal bores or waste disposal depots, but also with the quality of surface waters flowing in streams. In an unconfined aquifer system a percentage of recharge is from the surface drainage system. Unconfined aquifer systems around the shores of bays such as Western Port and Port Phillip also discharge eventually into the bays, and the investigations in the next few years will concentrate on methods of preventing polluted groundwaters eventually reaching the shallow bays or lakes.

As a result of the Department's work on groundwater and groundwater pollution, the studies will increasingly be integrated with environmental studies of areas such as Western Port Bay, Port Phillip Bay, and the Gippsland Lakes. No study of surface waters can be carried out effectively without a detailed study of the groundwater regime in relation to the geological and hydrological environment.

Victoria's major mineral resources are described on pages 335-42 of the *Victorian Year Book* 1976. A further special article on Victoria's minerals can be found on pages 1-29 of the *Victorian Year Book* 1970.

Geological Survey of Victoria

The Geological Survey of Victoria was formally established in 1852 following the first reported discovery of alluvial gold in the previous year. The establishment followed an appeal by Governor La Trobe to the Colonial Office in London for urgent expert geological assistance. A.R.C. Selwyn arrived in Melbourne in 1852 to become the founding Director of Geological Survey. Selwyn immediately initiated a programme of geological mapping and mineral resource surveys to assess the distribution and nature of the gold bearing formations. In 1867 the Geological Survey was brought under the control of the Minister of Mines and at the present time functions as a Branch of the Mines Department.

The early work of the Survey included detailed surface and subsurface mapping of the important goldfield areas, and in the 1890s studies were extended to the black coal deposits in south Gippsland. This work culminated in the discovery of the Wonthaggi coal field in the early 1900s.

In the period from 1910 to 1920, the Survey intensified the mapping programmes and undertook surveys of the brown coal deposits of the La Trobe valley. The Department initiated the re-opening of the Morwell open cut at Yallourn North and developed the brown coal fields as a source of fuel before this responsibility was transferred to the State Electricity Commission in 1920.

After the Second World War the activities of the Survey were diversified with the growing interest in petroleum exploration, groundwater investigation, engineering geology, and the extractive industries. The studies carried out by the Geological Survey on the Tertiary stratigraphy and micropalaeontology

of the onshore Gippsland Basin set a basis for the discovery of the oil and gas fields of Bass Strait during the middle 1960s.

In summary, the main activities of the Geological Survey are the investigation of Victoria's geological structure, mineral, petroleum, and groundwater resources; engineering geology; and the provision of basic information on these matters in the form of geological maps, reports, and advice to industry, the public, and Commonwealth and Victorian Government departments. The Survey also serves as geological consultant to government agencies when required, and provides scientific information for the appraisal, development, and conservation of Victoria's subsurface resources.

Mining and quarrying production

The mining and quarrying production of Victoria from lands occupied under the Mines Act and the Extractive Industries Act is recorded by the Victorian Mines Department, and from other lands by the Australian Bureau of Statistics. The production from both sources for the years 1971-72 to 1974-75 is shown in the following table:

VICTORIA—MINING AND QUARRYING PRODUCTION

Particulars	1971-72		1972-73		1973-74		1974-75	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	'000 gm	\$'000	'000 gm	\$'000	'000 gm	\$'000	'000 gm	\$'000
Metallic minerals (a)—								
Gold bullion	208	(b)223	148	(b)138	75	(b)81	249	225
	tonne		tonne		tonne		tonne	
Antimony concentrate	96	n.a.	..	..	..	..	..	..
Antimony ore	n.a.	n.a.	n.a.	n.a.	2,318	57	2,703	34
Bauxite	..	..	4,222	36	6,669	57	..	..
Iron ore	123	1	596	3	466	3	487	4
Tin concentrate	30	42	10	20	9	26	5	22
Wolfram ore	..	..	12	n.a.	..	..	..	..
Non-metallic minerals—								
Diatomite, refined	4	(c)	14	(c)	538	7	384	22
Fireclay	17,274	53	22,658	56	38,484	80	14,280	40
Fluorspar	380	22	1,700	79	874	49	..	..
Gypsum	42,063	128	43,694	154	49,825	149	54,139	161
Kaolin, refined	20,918	526	13,809	671	27,856	1,493	26,135	1,441
Kaolin, unrefined (d)	13,683	34	10,714	41	1,623	21	8,077	40
Limestone (e)	2,158,991	n.a.	2,162,770	n.a.	2,424,380	n.a.	2,139,529	n.a.
Other clays	2,106,382	1,754	2,186,698	1,858	2,736,979	2,524	2,222,221	2,343
Silica	98,791	316	109,019	339	141,832	460	142,550	445
Fuel minerals—								
Briquettes	1,328,630	11,280	1,228,005	9,173	1,163,922	11,011	1,092,134	11,391
Brown coal (f)	23,630,467	25,706	24,121,155	23,763	23,253,577	27,823	24,641,462	40,556
	'000 cub m		'000 cub m		'000 cub m		'000 cub m	
Crude oil	16,356		18,190		20,712		20,930	
Liquefied petroleum gases (g)—								
Commercial butane	662		988		929		1,147	
Commercial propane	576		798		1,123		1,025	
	MMcm	226,794	MM cm	263,984	MM cm	330,060	MM cm	395,311
	(j)	(j)	(i)	(j)	(i)	(j)	(i)	(j)
Natural gas (h)	1,097		1,473		1,998		2,284	
Other derivatives (g)—	'000 cub m		'000 cub m		'000 cub m		'000 cub m	
Commercial ethane	3,087		27,436		40,620		63,677	
Construction materials—								
	'000 tonnes		'000 tonnes		'000 tonnes		'000 tonnes	
Sand	5,619	8,004	6,659	8,945	7,788	11,068	7,541	11,726
Gravel	3,486	2,121	3,633	2,401	4,858	4,307	4,732	3,986
Crushed and broken stone	16,057	32,908	15,805	31,985	17,499	35,373	17,682	43,298
	tonne		tonne		tonne		tonne	
Dimension stone	13,066	200	14,515	284	10,937	217	12,283	262
	'000 tonnes		'000 tonnes		'000 tonnes		'000 tonnes	
Other quarry products	3,053	2,484	3,180	2,758	4,201	3,686	3,636	4,127

(a) See next table for assayed content.

(b) Includes gold subsidy of \$9,101 in 1971-72, \$36,361 in 1972-73, and \$18 in 1973-74. Gold subsidy payments ceased at 31 December 1973.

(c) Under \$1,000.

(d) Excludes unrefined kaolin used in producing refined kaolin at or near mine.

(e) Excludes limestone used as a construction material.

(f) Excludes brown coal used in production of briquettes: 1971-72: 3,632,000 tonnes; 1972-73: 3,199,000 tonnes; 1973-74: 3,101,000 tonnes; and 1974-75: 2,900,000 tonnes.

(g) Excludes manufactured liquefied petroleum gases and other derivatives from petroleum refining.

(h) Includes commercial gas and gas for field usage.

(i) Million cubic metres.

(j) Value shown is an estimate based on prices prescribed in legislation, quoted market prices, and information from government departments. Values of individual petroleum products are not available for publication.

Sources: Victorian Mines Department, Fuel Branch—Commonwealth Department of National Resources, and Australian Bureau of Statistics.

VICTORIA—ASSAYED CONTENT OF METALLIC MINERALS

Metal or element and mineral in which contained	1970-71	1971-72	1972-73	1973-74	1974-75
Alumina (tonne)—					
Contained in bauxite	3,373	..	1,977	2,819	..
Antimony (tonne)—					
Contained in antimony concentrate	93	n.a.	..	..	..
Contained in antimony ore	259	n.a.	n.a.	110	278
Total antimony	352	59	n.a.	110	278
Copper (tonne)—					
Contained in copper concentrate	18	..	..	..	..
Contained in copper ore	22	..	..	..	..
Total copper	40	..	..	..	..
Gold (gm)—					
Contained in antimony ore	..	..	..	158	..
Contained in antimony concentrate	19,035	1,586	..	..	..
Contained in copper concentrate	715	..	..	..	..
Contained in gold bullion	163,076	191,970	141,054	67,783	217,794
Total gold	182,826	193,556	141,054	67,941	217,794
Iron (tonne)—					
Contained in bauxite	390	..	310	209	..
Contained in iron ore	172	71	322	280	292
Total iron	562	71	632	489	292
Lead (tonne)—					
Contained in lead concentrate	1	..	..	..	..
Palladium (gm)—					
Contained in copper concentrate	1,757	..	..	..	..
Platinum (gm)—					
Contained in copper concentrate	1,190	..	..	..	..
Silver (gm)—					
Contained in copper concentrate	5,412	..	..	..	..
Contained in gold bullion	218	8,305	3,732	n.a.	n.a.
Total silver	5,630	8,305	3,732	n.a.	n.a.
Tin (tonne)—					
Contained in tin concentrate	3	18	7	7	4

Sources : Victorian Mines Department and Australian Bureau of Statistics.

VICTORIA—COAL PRODUCTION AND VALUE (a)

Period (b)	Black coal		Brown coal	
	Production	Value	Production	Value
	tonnes	\$'000	tonnes	\$'000
1926-1930	678,901	1,786	1,539,917	386
1931-1935	479,606	888	2,484,461	512
1936-1940	330,118	568	3,666,671	712
1941-1945	290,872	818	5,090,974	1,052
1946-1950	158,798	722	6,755,137	2,404
1951-1955	145,838	1,590	8,868,202	7,186
1956-1960	102,512	1,050	12,389,332	11,302
1961-1965	53,418	599	18,607,269	16,605
1966	36,089	497	22,132,593	20,064
1967	32,581	251	23,758,913	20,686
1968	26,736	209	23,339,331	21,555
1968-69	13,312	105	23,499,703	20,879
1969-70	407	6	24,310,900	22,131
1970-71	20	(c)	23,180,539	22,975
1971-72	..	..	23,630,467	25,706
1972-73	..	..	24,121,155	28,555
1973-74	..	..	26,354,577	31,532
1974-75	..	..	27,541,462	45,341

(a) Value of output at the mine. This is essentially the unit selling price of the commodity, less any unit transport costs from the mine or associated treatment works, multiplied by the production. Where a commodity is transferred to another location for further processing without being sold, the unit value is based on production costs plus an allowance for overhead and profit.

(b) Figures for five-yearly periods are annual averages.

(c) Under \$1,000.

Further reference, 1976; Mining in Victoria, 1964; Underground water, 1964; Groundwater in Victoria, 1969; Victorian clays, 1970; Minerals in Victoria, 1970; History of the Mines Department, 1970; Mineral exploration, 1972; Geological Survey of Victoria, 1975; Mineral exploration, 1975; Extractive industries, 1975; Mineral deposits in Victoria, 1976

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