CHAPTER SEVENTEEN

ENERGY

Introduction

Australia is well endowed with energy resources and is presently one of only five Organisation for Economic Co-operation and Development (OECD) countries that are net energy exporters. It presently supplies about two-thirds of its oil requirements from domestic sources and should be able to maintain this relatively favourable situation for some years at least.

Estimates of Australia's demonstrated economically recoverable resources of energy as at June 1986 were:

Brown Coal	43 gigatonnes
Black Coal	34 gigatonnes
Uranium	462 kilotonnes U
Natural Gas	691 teralitres
Crude oil, gas condensate and LPG	457 gigalitres

Additionally, there are huge inferred resources of black coal amounting to over 500 gigatonnes, and resources of oil shale equivalent to about ten times the level of crude oil and condensate resources.

In recognition of the importance of energy resources to Australia's national wealth, policies have been developed to respond to the changing pattern of world energy supplies, to try to minimise uncertainty for the future and to develop other energy sources which can substitute for oil in a wide range of uses, in both domestic and export markets. The basic aims of these policies are to:

- ensure that an adequate supply of energy is available at all times;
- in relation to liquid fuels,
  - achieve the optimum economic level of liquid fuels self-sufficiency through, for example:
    - .. encouraging the more efficient use of liquid fuels
    - .. replacing the use of oil by relatively abundant energy sources such as coal and natural gas
    - .. encouraging petroleum exploration and development;
    - .. supporting the development of technologies for alternative energy sources, particularly synthetic liquid fuels and renewables; and
  - prepare Australia for major interruptions to oil supplies through maintaining stocks, emergency-allocation schemes and other short lead-time measures;
- facilitate the efficient use of energy in Australia and the efficient development of Australia's energy resources in response to the needs of domestic and overseas energy markets;
- ensure that benefits of energy-resource development are shared equitably throughout the Australian community.

In addition, the Government has made a number of decisions on uranium policy which are of relevance to the determination of priorities for funding of Research Development and Demonstration (RD&D) projects in the nuclear area. Firstly, uranium mining will only be permitted at Nabarlek, Ranger and Olympic Dam. Secondly, development of further stages of the nuclear fuel cycle in Australia will not be permitted as the Government will not facilitate, or be otherwise involved in, uranium enrichment. However, the Government supports RD&D directed at improving radioactive waste management.

In establishing an appropriate framework within which Australia's energy industries can develop, the Government attaches key importance to the pricing and fiscal environment surrounding production, consumption and trade of Australia's energy resources. Realistic pricing of all energy resources is of fundamental importance in developing this framework.

The Government completed reviews of the crude oil marketing and taxation arrangements applying to the petroleum industry in mid-1987. Details of marketing, pricing and secondary tax arrangements are given on pages 639 and 640.

Advice and co-ordination

Institutional arrangements

The Commonwealth Minister for Primary Industries and Energy has portfolio responsibility for national energy policy matters, including the commercial development of hydrocarbon fuels and minerals.

The Department of Primary Industries and Energy provides advice to the Minister on energy policy and provides support for a number of advisory bodies including the National Energy Research Development and Demonstration Council (NERDDC), the Australian Minerals and Energy Council (AMEC), the National Oil Supplies Advisory Committee (NOSAC), the National Petroleum Advisory Committee (NPAC), the National Fuels Emergency Consultative Committee (NFECC), and the Australian Coal Consultative Council (ACCC).

It is also responsible for the implementation of action required from Australia's membership of the International Energy Agency (IEA) and for the national system of accounting for a control of nuclear materials under Australia's Agreement with the International Atomic Energy Agency (IAEA).

International Energy Agency—IEA

The IEA was established in Paris in November 1974 as an autonomous institution within the framework of the OECD. Australia joined the IEA in May 1979.

The Agency carries out the International Energy Program and the Long Term Co-operation Program. These programs aim to:

- prepare member countries against risk of oil supply disruptions and share remaining supplies in the event of a severe oil shortfall;
- develop alternative energy sources and the more efficient use of energy through co-operative research and development programs;
- promote co-operative relations with other oil-producing and oil-consuming countries.

The main decision-making body of the IEA is the Governing Board. The Board meets as required at Ministerial level and several times a year at senior official level. The IEA has standing groups on Long Term Co-operation, the Oil Market, Emergency Questions, a Committee on Research and Development and an ad hoc group on International Energy Relations.

Research and development

National Energy Research, Development and Demonstration Program—NERD&D

The NERD&D Program has been established to stimulate the level of energy research, development and demonstration in Australia in line with government energy policy and priorities. Grants under the NERD&D Program are approved by the Minister for Resources, who is advised by the National Energy Research, Development and Demonstration Council. The Council consists of twelve members drawn from government, private industry and tertiary institutions. It is supported by six technical standing committees covering all major areas of energy technology. High priority areas include energy management, oil and gas exploration and recovery techniques, coal combustion, coal evaluation, coal mining productivity and safety, coal beneficiation, production of liquid fuels from natural gas and synthesis gas, and substitution of diesel oil and petrol by natural gas and LPG.

The NERD&D Program is administered by the Department of Primary Industries and Energy. From the start of the program in 1978 to June 1987, $175.1 million had been committed to research projects undertaken by government, industry and universities.

Additional Commonwealth support for energy research and demonstration is provided through budget appropriations to Commonwealth agencies such as CSIRO, BMR, and ANSTO, and through Commonwealth funding of all Australian universities. The Commonwealth also provides an incentive for research and development through the 150 per cent tax deduction scheme and through the Grants for Industrial Research and Development Scheme.

Commonwealth Scientific and Industrial Research Organisation—CSIRO

Energy research within the Institute of Energy and Earth Resources is carried out with the objectives of improving methods of locating, evaluating, defining and characterising Australia's energy resources and planning their development and effective use, consistent with the minimisation of environmental stresses. Divisions of the Institute engaged in energy research include Geomechanics, Energy Chemistry, Energy Technology, Fossil Fuels, Mineral Chemistry and Mineral Engineering. Research on certain renewable sources of energy is carried out at the Centre for Irrigation and Freshwater Research.

Australian Minerals and Energy Council—AMEC

The Australian Minerals and Energy Council was established in April 1976 by agreement between State and Commonwealth mines and energy Ministers, replacing the former Australian Minerals Council. AMEC is principally a body for consultation on minerals and energy matters and provides a forum for Ministers to discuss policy issues of mutual concern and co-ordinate policy action. An AMEC advisory committee which is composed of the departmental heads or their nominees provides for officer level consulation and information exchange. AMEC establishes committees, sub-committees and working parties to undertake specific tasks and report back through its advisory committee as the need arises.

Australian Coal Consultative Council—ACCC

The Australian Coal Consultative Council was established in March 1983 to review and report from time to time on the economic and structural problems of the industry. The Council is a tripartite body, chaired by the Minister for Primary Industries and Energy. Its membership comprises the New South Wales and Queensland Ministers responsible for the industry, coal mine proprietors and mining unions. The Australian Mining Industry Council and the ACTU have observer status.

An advisory committee, whose membership reflects that of the ACCC, meets frequently (approximately monthly) and reports to the ACCC and through it to the relevant Commonwealth and State Ministers.

National Oil Supplies Advisory Committee—NOSAC

The National Oil Supplies Advisory Committee was formed in 1983 by the amalgamation of separate Commonwealth/industry and Commonwealth/State bodies set up during the period of tight oil supply in 1979. Representatives of the Commonwealth Government, State government energy authorities and major domestic oil producers and refiners meet about twice a year to review the situation and outlook for domestic and international oil supplies. Matters discussed include oil production, new oil and gas developments, imports, exports, stock levels, regional shortages, industrial relations, shipping, technical matters and government policies affecting the oil industry.

National Petroleum Advisory Committee—NPAC

Membership of NPAC is drawn from agricultural, general aviation, fishing, manufacturing, mining, oil, shipping and transport industries, the trade union movement and motorists' organisations, as well as Commonwealth, State and Territory Governments. The Department of Primary Industries and Energy provides the Secretariat for NPAC. In accordance with the NPAC recommendations, the Commonwealth Government has enacted the *Liquid Fuel Emergency Act 1984* and established, with the States and the Northern Territory, the National Fuels Emergency Consultative Committee.

National Fuels Emergency Consultative Committee—NFECC

The NFECC, chaired by the Commonwealth and comprising officials of the Commonwealth, States and the Northern Territory, was established in late 1983 to consult and advise governments on matters relevant to the preparation for, and detailed management of, a national liquid fuels crisis; and to act as the prime channel of consultation between governments in the event of such a crisis.

Australian Nuclear Science and Technology Organisation—ANSTO

ANSTO was established as a successor to the Australian Atomic Energy Commission (AAEC) pursuant to the *Australian Nuclear Science and Technology Organisation Act 1987*. For more details, *see* Chapter 22, Science and Technology.

Energy research and development statistics

Estimates of the expenditure on energy R & D carried out in Australia during 1984–85, and classified by energy objective, are presented in the table below.

The estimate of manpower resources devoted to energy R & D in Australia during 1984–85 was 2,851 man years. Of this amount, business organisations accounted for 1,033 man years, general government organisations for 937 man years, higher education organisations for 874 man years and private non-profit organisations for 8 man years.

More detailed statistics are contained in the ABS publication *Research and Experimental Development; All Sector Summary, Australia, 1984–85* (8112.0)

ENERGY RESEARCH AND EXPERIMENTAL DEVELOPMENT *(a)* CARRIED OUT IN AUSTRALIA, 1984–85 *(b)* R & D EXPENDITURE BY ENERGY OBJECTIVE *(c)* BY SECTOR *(d)* AND SOURCE OF FUNDS *(e)*
($'000)

		Sector					*Source of funds*	
		Business enterprise (g)		*General government*				
Energy objective	*Total expenditure (b) (f)*	*Private*	*Public*	*Commonwealth*	*State*	*Higher education*	*Industry*	*Government*
Production and utilisation of energy—								
Oil and gas								
Mining extraction techniques	5,756	n.p.	n.p.	141	..	342	n.p.	n.p.
Refining, transport and storage	1,987	1,418	..	..	..	569	n.p.	n.p.
Other	14,179	n.p.	n.p.	12,032	40	1,373	n.p.	n.p.
Oil shale and tar sands	5,626	690	..	4,267	..	669	831	4,794
Total oil and gas	27,547	8,015	100	16,440	40	2,953	8,218	19,329
Coal								
Mining extraction techniques	13,730	8,641	136	4,177	94	682	6,632	7,098
Preparation and transport	13,380	8,025	700	3,597	..	1,058	8,394	4,986
Combustion	6,277	691	2,468	1,090	923	1,106	2,581	3,696
Conversion	10,691	n.p.	n.p.	8,400	..	907	229	10,461
Other	12,439	n.p.	n.p.	1,657	61	2,065	8,382	4,057
Total coal	56,516	27,195	3,506	18,920	1,077	5,818	26,218	30,298
Solar energy								
Heating and cooling	4,983	n.p.	n.p.	434	131	2,292	2,066	2,916
Photo-electric	5,825	1,004	577	1,613	986	1,646	1,220	4,604
Thermal-electric	649	n.p.	n.p	..	50	412	201	448
Total solar	11,456	2,920	975	2,047	1,166	4,350	3,488	7,968
Nuclear								
Non-breeder								
Light water reactor	115	..	..	..	..	115	4	111
Other converter reactor	..	..	..	..	..	..	..	..
Fuel cycle	21,470	n.p.	n.p.	14,976	..	321	n.p.	n.p.
Supporting technologies	5,464	..	..	5,192	..	273	5	5,459
Breeder	..	..	..	..	..	..	..	..
Fusion	5,149	..	..	2,225	..	2,924	63	5,086
Total nuclear	32,197	n.p.	n.p.	22,393	..	3,631	n.p.	n.p.
Other primary sources								
Wind	729	62	308	..	48	312	299	430
Ocean	n.p.	n.p.	n.p.	..	..	n.p.	n.p.	n.p.
Geothermal	n.p.	n.p.	n.p.	..	..	n.p.	n.p.	n.p.
Biomass	1,966	n.p.	n.p.	..	..	918	901	1,065
Other sources and new vectors	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Total other primary sources	5,483	n.p.	n.p.	1,288	48	1,537	n.p.	n.p.
Total production and utilisation of energy	*133,200*	*46,265*	*5,228*	*61,087*	*2,331*	*18,289*	*44,750*	*88,450*

ENERGY RESEARCH AND EXPERIMENTAL DEVELOPMENT *(a)* CARRIED OUT IN AUSTRALIA, 1984–85 *(b)* R & D EXPENDITURE BY ENERGY OBJECTIVE *(c)* BY SECTOR *(d)* AND SOURCE OF FUNDS *(e)—continued*
($'000)

		Sector					*Source of funds*	
		Business enterprise (g)		*General government*				
Energy objective	*Total expenditure (b) (f)*	*Private*	*Public*	*Commonwealth*	*State*	*Higher education*	*Industry*	*Government*
Conservation of energy								
Industry	9,917	n.p.	n.p.	3,719	5	1,979	3,490	6,427
Residential and commercial	4,803	n.p.	n.p.	371	1,154	676	2,385	2,418
Transportation	n.p.	n.p.	n.p.	n.p.	..	n.p.	n.p.	n.p.
Other	n.p.	n.p.	n.p.	n.p.	..	n.p.	n.p.	n.p.
Total conservation of energy	*24,204*	*n.p.*	*n.p.*	*5,423*	*1,159*	*3,841*	*11,502*	*12,702*
Other energy R & D								
Electric power conversion	2,381	576	213	..	125	1,468	742	1,639
Electricity transmission and distribution	6,126	3,394	806	23	35	1,869	3,868	2,258
Energy storage n.e.c.	1,747	291	462	766	..	229	n.p.	n.p.
Energy systems analysis	2,214	182	113	..	243	1,675	n.p.	n.p.
Other	1,129	n.p.	n.p.	..	66	182	883	246
Total other energy R & D	*13,597*	*n.p.*	*n.p.*	*788*	*469*	*5,421*	*6,574*	*7,023*
Total (*b*)	**171,001**	**62,763**	**9,430**	**67,298**	**3,958**	**27,551**	**62,826**	**108,175**

(a) Refers to R&D activity predominantly directed towards producing, storing, transmitting, utilising and conserving energy. *(b)* Excludes Private Non-profit sector. *(c)* The energy objective categories represent ultimate national needs rather than the immediate objective of the researcher or organisation performing the energy R&D. *(d)* The sector classification used is adapted from the guidelines specified by the OECD for use in the conduct of R&D studies. *(e)* In accordance with IEA practice, source of funds are classified as either industry or government. *(f)* Includes expenditure associated with overhead staff providing indirect services to energy R&D. *(g)* Excludes enterprises in ASIC Division A, i.e. enterprises mainly engaged in agriculture, forestry, fishing and hunting.

Resources

Black coal

Black coal is currently the largest source of primary energy in Australia. By world standards, in relation to present population and consumption, Australia is fortunate in the availability of easily worked deposits of coal. The country's main black coal fields are located in New South Wales and Queensland, not far from the coast and the main centres of population.

Australia's inferred resources of black coal are very large, amounting to over 500 gigatonnes (Gt). At 30 June 1986, Australia's proven resources of black coal were estimated to total 54 Gt of which 34 Gt were considered economically recoverable. These recoverable resources are located largely in the Sydney Basin in New South Wales and the Bowen Basin in Queensland. There are other coal-bearing basins in New South Wales and Queensland, while small deposits are being worked in Western Australia, South Australia and Tasmania. Australian saleable black coal production in 1986–87 was 149 Mt.

For further details relating to the production of black coal in Australia *see* Chapter 15, Mineral Industry. Details about the nature and age of black coal are given in *Year Book* No. 64.

Brown coal

Australia's measured and indicated resources of brown coal are estimated at 43,300 Mt, located principally in Victoria's Latrobe Valley (39,700 Mt). Small deposits exist in other areas of south Gippsland, in south-eastern Victoria at Gelliondale and in the south-central region at Anglesea, Bacchus Marsh and Altona. Deposits are also known at many places along the southern margin of the continent, as far north as central Queensland. Large deposits are being tested in the Kingston area of South Australia, the Esperance area of Western Australia and at Rosevale in the north-east of Tasmania.

Because brown coal has a relatively low specific-energy value and high water content, its utilisation depends on large-scale, low-cost mining and negligible transportation costs in its raw state.

In Victoria, the brown coal industry has reached a high degree of sophistication in mining, on-site development for power generation, briquetting and char manufacture. Production of brown coal in Victoria during 1985–86 was 35 Mt. The brown coal deposits of the Latrobe Valley have been developed by the State Electricity Commission of Victoria (SECV) for the generation of electricity. By the end of 1985–86, about 915 Mt of raw brown coal had been mined.

Petroleum

The prospects of further discoveries of petroleum in Australia are considered to be good, particularly in sedimentary basins off the north-west coast. Consistent with the existing pattern of discoveries, undiscovered oil is likely to be of the light, low sulphur type and more gas fields than oil fields should be found. Assessments by the Bureau of Mineral Resources, Geology and Geophysics indicate that there is a 50 per cent chance of finding at least another 286 gigalitres (GL) (1,800 million barrels) of crude oil in Australia. This compares with demonstrated economically recoverable resources of 242 GL (1,522 million barrels) and demonstrated sub-economically recoverable resources of 20 GL (126 million barrels) as at 31 December 1986.

PETROLEUM RESOURCES *(a)* AS AT 31 DECEMBER 1986

(*Source:* Department of Primary Industries and Energy)

Basin	*Crude oil*	*Gas condensate*	*LPG*	*Sales gas*
	GL	GL	GL	TL
Demonstrated economic (*b*)—				
Gippsland (Vic.)	192	22	45	186
Carnarvon (W.A.)	24	84	28	438
Eromanga (S.A./Qld)	11	—	—	2
Cooper (S.A./Qld)	4	7	14	85
Amadeus (N.T.) and Bonaparte (W.A./N.T.)	10	3	12	187
Perth (W.A.)	—	—	—	2
Bowen/Surat (Qld)	—	—	—	2
Canning (W.A.)	1	—	—	—
Otway (Vic.)	—	—	—	(*c*)
Total	**242**	**116**	**99**	**902**
Demonstrated sub-economic (*d*)—				
Gippsland/Bass (Vic./Tas.)	12	8	5	29
Bonaparte (W.A./N.T.)	1	7	3	44
Carnarvon (W.A.)	6	4	2	400
Eromanga (S.A./Qld)	—	—	—	—
Browse (W.A.)	—	45	—	683
Perth (W.A.)	1	—	—	—
Amadeus (N.T.)	—	—	1	10
Cooper (S.A./Qld)	—	2	2	15
Bowen/Surat/Adavale (Qld)	—	—	—	6
Total (*e*)	**20**	**66**	**13**	**1,187**

(*a*) Based on the McKelvey classification which sub-divides resources in terms of the economic feasibility of extraction and their certainty of occurrence. (*b*) Demonstrated economic resources are resources judged to be economically extractable and for which the quantity and quality are computed from specific measurements and extrapolation on geological evidence. (*c*) Gas resource very small. (*d*) Demonstrated sub-economic resources are similar to demonstrated economic resources in terms of certainty of occurrence but are judged to be sub-economic at present. (*e*) Discrepancies between totals and sums of components are due to rounding.

Crude oil and condensate

Indigenous production, at 31,503 megalitres (543 thousand barrels per day) of crude oil and condensate in 1986–87, was only 0.7 per cent less than the peak level production in 1985–86. Since 1984–85, new wells came on stream in the Bonaparte and Harriet basins while production from Amadeus and Cooper-Eromanga also increased. In 1986–87, production in Gippsland basin dropped by 5.1 per cent from the 1985–86 level.

Exports of crude oil and condensate in 1986–87 increased by 13 per cent compared with 1985–86 and at 5,702 megalitres, was only 2.0 per cent below the level of exports in the peak year 1984–85. During 1986–87, more than 84 per cent of the exported crude oil and condensate originated from Bass Strait. The main markets were U.S.A., Singapore and Japan.

Liquefied petroleum gas

Liquefied petroleum gas (LPG) is a valuable co-product of oil and gas production and petroleum refining. The major constituents of LPG are propane, propylene and iso- and normal-butane, which are gaseous at normal temperatures and pressures and are easily liquefied at moderate pressures or reduced temperature. Operations involving LPG are expensive in relation to other liquid fuels because LPG has to be refrigerated or pressurised when transported and stored. LPG is an alternative transport fuel for high mileage vehicles in urban areas as well as a petrochemical feedstock and a traditional fuel.

Identified economically recoverable resources of LPG at June 1987 of 97,000 megalitres (ML) are concentrated in Bass Strait, the North West Shelf and the Cooper Basin.

Production of naturally occurring LPG in Australia in 1986–87 was 3,927 ML (2,878 ML Bass Strait and 964 ML Cooper Basin), virtually all being extracted from crude oil and natural gas from the Bass Strait fields. About 68 per cent of Australia's LPG production is exported (2,675 ML in 1986–87)—mainly to Japan. Domestic consumption of 2,038 ML in 1986–87 was met by 736 ML of product obtained from refineries with supply shortfalls being met by naturally occurring Bass Strait product and import.

PETROLEUM PRODUCTION IN AUSTRALIA

(*Source:* Department of Primary Industries and Energy)

Year	*Crude oil and Condensate*	*LPG (a)*	*Natural Gas*
	ML	ML	GL
1981–82	22,378	3,033	11,550
1982–83	22,069	2,909	11,654
1983–84	26,828	3,132	12,097
1984–85	30,956	3,864	12,963
1985–86	31,734	4,016	14,278
1986–87	31,503	3,927	14,683

(*a*) Naturally occurring.

North West Shelf Project

On 2 August 1985, the Joint Venture Participants (JVP) announced the signing of formal sales contracts for the export of Liquefied Natural Gas (LNG) to Japan from the North West Shelf project. The project is the largest single resource development program ever undertaken in Australia. Exports are to commence in October 1989 and will build up to six million tonnes a year from 1995, under take or pay provisions, until 2008. It is expected that some $50 billion, in dollars of the day terms, in export revenue will be generated. North West Shelf gas will be sold to five electricity and three gas utilities which supply a combined market of some 90 million people.

The project is estimated to have a total capital cost of $12 billion, excluding LNG tankers. Of this, $2,100 million has been spent by the JVP for the supply of natural gas to the domestic markets of south-west Western Australia and the Pilbara comprising the North Rankin 'A' platform, a 134 km submarine pipeline, the onshore domestic gas plant and associated site engineering services. The State Energy Commission of Western Australia (SECWA) also constructed a 1,500 km pipeline to service the domestic markets.

The second phase, the export of LNG, currently estimated to cost $9.8 billion, includes on-shore LNG plant ($3,500 million), two more off-shore production platforms, further drilling and pipelines, site engineering and the provision of infrastructure and housing in Karratha. Seven 125,000 m^3 LNG tankers (costing about $1 billion) will also be required.

On 12 March 1985 it was announced that the domestic gas contracts had been renegotiated in order to alleviate a potentially serious revenue shortfall for SECWA. This involved, in part, the waiver by the Commonwealth of a proportion of its share of domestic gas royalties in favour of the State.

The National Liaison Group (NLG) on the North West Shelf was subsequently established to serve as a forum for the exchange of information with a view to increasing Australian content in contracts and purchase orders for the project. It comprises representatives of the Commonwealth and State Governments, trade unions and industry associations

together with the JVP. The Commonwealth Minister for Primary Industries and Energy is joint chairman with the Western Australian Minister for Minerals and Energy. The aim of the NLG is to maximise Australian content consistent with cost, quality and performance criteria. The fundamental principle is that Australian industry should have a full and fair opportunity to compete in tenders for the project.

The North West Shelf project is one of national significance, with the potential for major impact on Australia's international trading position.

Oil shale

A description of the nature and location of Australian oil shale deposits was given in *Year Book* No. 67.

Major investigations into oil shale development have concentrated on the Condor, Rundle and Stuart deposits.

Uranium

Australia has about 28 per cent of the Western world's low-cost uranium reserves. Deposits occur in the Northern Territory, Western Australia, South Australia and Queensland. The major use for uranium is as fuel in nuclear reactors. It is also used for power generation in atomic energy research programs.

Uranium was first discovered in Australia in 1894 but systematic exploration did not begin until 1944 following requests from the United Kingdom and United States Governments. A number of significant deposits were identified, particularly in the Katherine/Darwin region of the Northern Territory and the Mt Isa/Cloncurry region in Queensland. This initial phase of exploration activity was from 1944 to the late 1950s, reaching a peak in 1954.

In the period from 1954 to 1971, about 9,120 tonnes of uranium oxide concentrate was produced from five plants at Rum Jungle, Moline and Rockhole in the Northern Territory, Mary Kathleen in Queensland and Radium Hill in South Australia. Uranium requirements for defence purposes decreased in the early 1960s, causing uranium demand and prices to fall rapidly, and exploration for uranium virtually ceased.

A revival of interest in the late 1960s was encouraged by the announcement of a new export policy in 1967, designed to encourage exploration for new uranium deposits while conserving known resources for future needs in Australia. The renewed activity which followed was very successful—major discoveries were made in South Australia: Beverley (1969), Honeymoon (1971), Olympic Dam (1975); in the Northern Territory: Ranger (1970), Nabarlek (1970), Koongarra (1970), Jabiluka (1971); and in Western Australia: Yeelirrie (1970). These and other discoveries have led to substantial additions to Australia's reasonably assured uranium resources which, at June 1986, totalled 462,000 tonnes of uranium recoverable at less than $US80 per kg U.

Commercial production at the Ranger mine commenced in 1981 at a planned rate of 3,000 tonnes U_3O_8 per annum. Plans are in progress to expand production to 4,500 tonnes per annum by 1989, with a further increase to 6,000 tonnes two or three years later. The Nabarlek deposit was mined in 1979 and the ore was stockpiled for later treatment. Production at a planned rate of 1,000 tonnes U_3O_8 per annum, commenced in 1980 and is scheduled to end in 1988. Total production to the end of June 1987, as reported by the mine operators amounted to:

Ranger—18,010t U_3O_8

Nabarlek—9,707t U_3O_8

The Olympic Dam mine received development approval in early 1984 and construction of the mine was undertaken in 1986. Production of uranium is scheduled to commence during 1988 at a planned rate of 2,000 tonnes U_3O_8. The mine will also produce copper and gold.

The Australian Government's uranium policy permits exports of uranium from only the Ranger and Nabarlek mines in the Northern Territory and the Olympic Dam mine in South Australia.

All exports of Australian uranium will continue to be subject to the most stringent safeguards. Uranium produced in Australia is exported in the form of yellowcake for use in nuclear reactors for the generation of electricity and for the production of radioisotopes and radio pharmaceuticals.

Production of uranium for 1986 was 4,899 tonnes U_3O_8 and exports were 4,164.5 tonnes valued at around $373 million. The *Nuclear Non-Proliferation (Safeguards) Act 1987* gives domestic effect to Australia's international nuclear non-proliferation obligations which require domestic legislation. The legislation establishes a system of permits for the possession and transport of nuclear material (defined to cover uranium, thorium and plutonium), and other physical items such as equipment and material used in nuclear reactors. The permit and related provisions also deal with the possession and communication of sensitive information about nuclear technology, in circumstances where that information is not already a matter of public record. The legislation is administered by the Australian Safeguards Office.

Thorium

Thorium is a radioactive mineral that is about three times as abundant as uranium, but occurs in fewer geological environments and in lower grade accumulation. Most of the world's resources of thorium occur in monazite, a complex phosphate recovered primarily for its rare-earth content. Primary thorium minerals are resistant to oxidation and form economically important placer deposits as well as hard-rock deposits.

In Australia, monazite is produced from titanium-bearing mineral sands on the east and west coasts. Other thorium occurrences are known, but are uneconomic. Australia presently supplies about 65 per cent of the world's traded monazite. Exports from Australia of thorium and thorium-containing ores require the approval of the Minister for Primary Industries and Energy under the Customs (Prohibited Exports) Regulations.

Solar energy

Solar energy, like wind, tidal and wave energy is, for all practical purposes, inexhaustible and shares with these other energy sources a number of properties which, in general, make it difficult and costly to collect, store and transform into useful work. These inherent characteristics include a relatively low energy intensity and a variation in the availability of the supply arising from geographic, seasonal and daily effects.

Nevertheless, for specific applications such as domestic water and space heating, solar energy is already beginning to play a valuable role in Australia. Some 5 per cent of Australian residences have a domestic solar water heater with the local industry currently producing around 30,000 units annually. The use of passive solar design principles in housing is also increasing as low-cost passive designs are developed.

The best prospects for using many solar energy technologies are in areas of Australia remote from the major electricity grids, where electricity costs can be anywhere from 3 to 20 times those in metropolitan areas. Photovoltaic (solar) cells are being used to meet the electrical requirements of remote telecommunication repeater stations, navigational buoys, water pumps and homestead-scale power supply systems. A locally-developed transportable photovoltaic power supply system has been designed to meet the lighting, refrigeration, communication and water pumping requirements of a small community.

Researchers at the University of New South Wales have developed techniques for producing photovoltaic cells with an energy conversion efficiency of 19 per cent using commercial grade silicon material. In contrast, the efficiency of commercially available photovoltaic cells typically does not exceed 14 per cent.

Wind energy

Using data from the Bureau of Meteorology wind stations, CSIRO has undertaken a continental wind assessment of Australia. In addition, a number of site specific wind resource assessments have been undertaken by CSIRO and other bodies. Broadly, these studies indicate that while the bulk of the Australia's inland has relatively low wind speeds, some coastal and island localities have good wind energy resources, notably on the Western Australian, South Australian and Tasmanian coasts, in Bass Strait and on Lord Howe Island.

At present the use of wind energy in Australia is confined principally to mechanical windmills for water pumping and small wind turbine generators for remote areas. It is unlikely that, in the short to medium term, wind energy will be able to compete on a widespread and large scale with coal for electricity generation in Australia. However, wind turbines could find increasing application in remote areas where wind resources are favourable and which currently rely on diesel fuel for electricity production.

Four imported wind turbines in the 20–55 kW range have been demonstrated in Western Australia and Victoria, with two of the machines on Rottnest Island, one at Fremantle and one at Ballarat. A large, imported 150 kW wind turbine is located at Malabar headland in the eastern suburbs of Sydney.

Locally manufactured wind turbines in the 30–60 kW range are also operating in Australia including a group of six at Esperance which form the basis of Australia's first wind farm. Electricity produced by the wind farm is used to supplement that provided to the Esperance grid by diesel generators.

Geothermal energy

The most intensive and well-documented study in Australia of subsurface temperatures has been made using bore holes in the Great Artesian Basin. In this basin, about 20 per cent of the indexed bore holes penetrate to depths greater than 1,000 metres and, since the thermal gradients are generally above 30°C per 1,000 metres, it is reasonable to assume that hot water can be obtained from such aquifers. However, of the total number of indexed bores, only a very small proportion have water temperatures exceeding 100°C.

In general, it appears that cost constraints will largely restrict the use of our geothermal resources to the supply of hot water for space heating and light industrial purposes. However, for remote homesteads and communities in areas of the Great Artesian Basin, hot artesian bores may well be used to provide an economically viable alternative source of electricity to that obtained from diesel generators.

An Australian company has developed an organic rankine cycle heat engine which can utilise low grade sources of heat (80–100°C) to generate electricity. A 20 kW version of the engine has been used as the basis for Australia's first geothermal power plant at Mulka Station in the north-east of South Australia. There are also plans to construct a larger scale power plant (120 kW) at Birdsville in Queensland.

Ocean energy

A number of potential energy sources are associated with the world's oceans, including mechanical energy in waves and tidal action and thermal energy absorbed by ocean waters.

Tidal energy is a dispersed energy source derived from regular fluctuations in the combined gravitational forces exerted by the moon and the sun at any one point on the earth's surface as the earth rotates. The mean tidal range in the open ocean is about one metre, but under suitable hydraulic and topographical conditions, much higher tides than this can build up in coastal locations.

Theoretically, around Australia there are very large amounts of tidal energy available, especially on the north-west coast where the tidal range is as great as 11 metres. Studies into prospective tidal power-plant sites in north-western Australia were conducted in 1965 and 1976. The 1976 study concluded that, at that time, the cost of generating electricity at this location would be more than three times the cost of electricity generated by a coal fired power plant. This estimate did not take into consideration the significant costs which would be involved in the transmission of electricity produced by the tidal plant to population centres.

Waves are generated by the interaction of the wind with large bodies of water. The amount of energy transferred depends on the wind speed, the distance over which it interacts with the water, and for how long the wind blows. There are plans by a local company to establish the world's largest wave power plant at Esperance in Western Australia. It is envisaged that the plant will have a capacity of 1 MW and will be used to supplement the existing Esperance electricity supply which is provided by diesel generators and a wind farm.

The temperature difference between the surface of the ocean and water located at depth can be as high as 25°C, particularly in equatorial regions (20°S to 20°N). Power cycles can be devised to operate between these temperature differences, thereby providing a source of electricity. No ocean thermal energy conversion systems are ready for commercialisation at this time.

Biomass

Biomass includes crops, wood, agricultural and forestry residues, and animal wastes. Currently, only two forms of biomass are used significantly as energy in Australia. These are firewood and bagasse, both converted to energy by direct combustion.

Approximately 5.5 megatonnes of firewood are currently used annually in Australia, equivalent in energy terms to about 86 petajoules, or 2.5 per cent of Australia's total energy consumption. This proportion of consumption is expected to remain stable through the 1980s.

Bagasse is the fibrous residue remaining after extraction of the juice from sugar cane. It is the major fuel used in the sugar industry, providing about 71 petajoules, or 2.1 per cent of Australia's total energy consumption.

Biomass also has a possible use as a source of liquid fuels for transport, particularly ethanol and methanol. In 1979, the CSIRO completed a survey of the potential for the production of these fuels from agricultural and forestry resources in Australia. The resources considered were both new energy crops and forest plantations, as well as the residues from existing crop and forest production. In estimating potential new crop production, it was assumed that all land with suitable climate, soil and terrain for an energy crop would be available for energy farming except land at present under crops or sown pastures. The total biomass resources considered could provide a net liquid fuels output of 460 petajoules, or about 46 per cent of energy currently used as liquid fuel in road transport vehicles and off-road vehicles (e.g. agriculture, mining and construction equipment). This is a net figure, taking into account the liquid fuel used in production. It does not take into account socio-economic considerations such as more profitable or socially desirable use of the land available for new crops, and must be considered as an upper limit only.

Although technologies have been developed to convert biomass to liquid fuels, studies have shown that liquid fuel derived from biomass is not competitive with petroleum-based fuels at this stage.

Crude oil marketing and pricing arrangements

After a review in the first half of 1987 of the marketing arrangements for Australian crude oil, the Government completely deregulated crude oil marketing with effect from 1 January 1988. The review began with the issue in February 1987 of a discussion paper, *Marketing Arrangements for Indigenous Crude Oil*, and took account of the views of the industry, State governments, and trade unions.

Deregulation allows refiners and all crude oil producers to negotiate freely the quantities and prices of crude oil they buy and sell, without government involvement. The decision to deregulate means:

- There is no longer any obligation on refiners to absorb particular quantities of Australian crude oil under the allocation system which had been in operation, in various forms, since 1965.
- The Government no longer fixes an Import Parity Price (IPP) for such crude purchased under the pricing system which had been in operation since 1978. The IPP was calculated on the basis of the replacement cost of Australian crude oils with imported crudes, with appropriate adjustments for freight costs and quality differentials.
- The Bass Strait Coastal Freight Adjustment Scheme, in operation since 1984, which placed a levy on allocated Bass Strait crude oil for redistribution among refiners as compensation for differential shipping costs, is no longer in operation.

Crude oil producers also gained complete freedom to export crude oil, as an alternative to selling on the domestic market, except in time of emergency. This is subject to other relevant government policies.

The move to a free market, together with crude oil excise concessions announced on 4 June 1987, optimises future crude oil self-sufficiency consistent with the efficient allocation of resources and places the industry on a competitive footing.

Secondary tax arrangements in the petroleum industry

In addition to general taxation arrangements applying to companies in Australia, petroleum production projects are subject to secondary taxes. The type and rate of secondary taxation (resource rent tax, resource rent royalty, or excise and royalties) depends on the location of the petroleum resource, the date of discovery of the petroleum reservoir and the date upon which production commenced.

A *Resource Rent Tax* (RRT) applies to petroleum projects in the majority of Australia's offshore areas beyond the States' territorial seas. Excluded are the Bass Strait and North West Shelf production licence areas and associated exploration permits. Where RRT applies, it replaces excise and royalties which would otherwise have been levied.

A *Resource Rent Royalty* (RRR) policy applies to onshore petroleum projects and provides for the Commonwealth to waive its crude oil excise whenever the relevant State government negotiates an acceptable RRR agreement with the project producers and agrees to a satisfactory revenue sharing formula with the Commonwealth.

Excise applies to crude oil production from the Bass Strait and North West Shelf projects offshore and all onshore areas (except Barrow Island where a RRR applies). Excise also applies to LPG produced from offshore projects.

Crude oil excise is based on the annual level of crude oil sales from individual production areas and is levied as a percentage of the realised price received by producers.

Different excise scales are applicable to oil production depending upon the date of discovery of the production area and the date when the area was first developed. In the case of new offshore projects to which excise and royalty apply, and all onshore fields, the first 30 million barrels of crude oil production are exempt from excise. Production beyond this level is subject to the appropriate excise rate.

Oil discovered before 18 September 1975 ('old' oil) attracts a higher rate of excise than oil discovered on or after this date ('new' oil). An 'intermediate' scale also applies to oil produced from 'old' oil production areas that were not developed as of 23 October 1984. However, in the case of all onshore fields that commenced production after 1 July 1987, production in excess of 30 million barrels is subject to 'new' oil excise.

A *Commonwealth Royalty* is also levied on offshore petroleum production except in the case where RRT applies. Proceeds are shared on a 40:60 basis by the Commonwealth and the appropriate State or Territory. Thus, Victoria receives a share of the royalty from petroleum produced from Bass Strait, and Western Australia receives a share of the royalties from the North West Shelf. Onshore petroleum rights are vested in the State and Northern Territory Governments and the Commonwealth does not generally receive a share of this royalty.

Pricing of liquefied petroleum gas—LPG

The Commonwealth Government sets the price that producers receive for LPG sold for automotive and traditional domestic, commercial and industrial uses. The current pricing arrangements for naturally-occurring and refinery-produced LPG were introduced on 1 November 1986 following a review of LPG pricing policy. Under these arrangements, adjustments to the maximum wholesale price are made on 1 October and 1 April each year. The price is determined at $20 a tonne above the average export parity price of Bass Strait propane for the six-month period ending on the last day on the previous August for the 1 October adjustments, and the last day of the previous February for the 1 April adjustments. These arrangements do not apply to non-traditional commercial, industrial and petrochemical uses or exports. In these areas the price is determined by commercial negotiation.

Reticulated energy

The two main forms of energy reticulated throughout Australia are gas, of which almost 98 per cent is natural gas; and electricity, the majority of which is generated by coal-fired thermal power stations.

Electricity and gas establishments in Australia

The census of electricity and gas industries covers distribution as well as production and is conducted as a component of the Australian Bureau of Statistics' integrated economic statistics system. This system has been developed so that data from each industry sector conform to the same basic conceptual standards, thereby allowing comparative analysis between and across different industry sectors. The results of this census are therefore comparable with economic data collections undertaken annually for the mining and manufacturing industries and periodically for the retail and wholesale trade, construction, transport and selected services industries.

The following table shows a summary of operations of electricity and gas establishments for 1984–85. Further details are available in the publication *Electricity and Gas Establishments: Details of Operations, Australia 1984–85* (8208.0).

ELECTRICITY AND GAS ESTABLISHMENTS—SUMMARY OF OPERATIONS, 1984–85

State or Territory	Establishments at 30 June	Employment at 30 June			Wages and salaries	Turnover	Stocks		Purchases, transfers in and selected expenses	Value added	Fixed capital expenditure less disposals
		Males	Females	Total			Opening	Closing			
		No.	No.	No.	$m	$m	$m	$m	$m	$m	$m
New South Wales—											
Electricity	34	27,222	2,807	30,029	711.5	4,374.7	358.8	313.1	2,494.5	1,834.5	979.8
Gas	20	2,213	580	2,793	55.9	431.7	30.8	25.0	271.6	154.4	37.0
Queensland—											
Electricity	11	10,918	1,501	12,419	293.2	1,869.1	142.4	117.9	991.5	853.2	589.4
Gas	7	619	133	752	15.6	97.4	8.3	8.0	48.3	48.8	5.9
Other States and Territories (a)—											
Electricity	38	37,013	3,150	40,163	996.1	3,910.5	213.2	200.2	1,728.8	2,168.6	1,192.5
Gas	7	5,956	1,016	6,972	157.9	1,126.0	32.7	36.9	508.5	621.8	341.1
Australia—											
Electricity	**83**	**75,153**	**7,458**	**82,611**	**2,000.8**	**10,154.4**	**714.5**	**631.2**	**5,214.8**	**4,856.3**	**2,761.6**
Gas	**34**	**8,788**	**1,729**	**10,517**	**229.4**	**1,655.2**	**71.8**	**70.0**	**828.5**	**825.0**	**384.1**

(a) At the end of June 1985 the number of establishments were; Victoria—electricity 14, gas 1; South Australia—electricity 13, gas 2; Western Australia—electricity 6, gas 2; Tasmania—electricity 2, gas 1; Northern Territory—electricity 2 and Australian Capital Territory—electricity 1, gas 1.

Electricity

Responsibility for public electricity supply rests with the State governments, which control electricity production and distribution through public authorities. The Commonwealth Government's major direct role in the electricity supply industry is its responsibility for the Snowy Mountains Scheme.

Hydro-electric resources

With the exception of Tasmania, Australia is generally not well-endowed with hydro-electric resouces because of low average rainfall and limited areas of high relief. Major hydro-electric potential is confined to Tasmania and the Great Dividing Range areas of Victoria, New South Wales and Queensland, with some small potential on rivers draining into the Timor Sea in Western Australia and Northern Territory.

The practical potential of hydro-electric power in Australia has been estimated at 24,000 gigawatt hours (GWh) per year, of which about 60 per cent has currently been developed. In 1985–86, hydro-electric generation was 14,917 GWh.

At 30 June 1986 the installed hydro-electric generating capacity of 7,028 megawatts (MW) represented 21 per cent of total installed capacity.

Future hydro development will be mainly limited to environmentally acceptable sites in Tasmania and, to a lesser extent, North Queensland, as most of the low cost resource elsewhere has already been developed. Although hydro-electric power stations will continue to be constructed into the 1990s and probably beyond, hydro's share of total generation will decline as increasing load is met mainly by coal-fired power stations.

Snowy Mountains Hydro-Electric Scheme

The Snowy Mountains Scheme is a dual purpose complex which supplies water for generation and irrigation. It is located in south-eastern Australia, and on its completion was one of the largest engineering works of its type in the world. It impounds the south-flowing waters of the Snowy River and its tributary, the Eucumbene, at high elevations and diverts them inland to the Murray and Murrumbidgee Rivers through two tunnel systems driven through the Snowy Mountains. The scheme also involves the regulation and utilisation of the headwaters of the Murrumbidgee, Tumut, Tooma and Geehi Rivers. The diverted waters fall some 800 metres and together with regulated flows in the Geehi and Tumut River catchments generate mainly peak load electricity for the States of New South Wales, Victoria and the Australian Capital Territory as they pass through power stations to the irrigation areas inland from the Snowy Mountains.

A special article on the scheme appeared in the Energy Chapter of *Year Book* No. 70.

Electricity generation and transmission

The following table shows details of thermal and hydro electricity generated in Australia during recent years.

ELECTRICITY (*a*)—THERMAL AND HYDRO

Year	*Million kWh*
1980–81	100,782
1981–82	104,975
1982–83	105,933
1983–84	111,696
1984–85	119,188
1985–86	124,369

(*a*) Figures represent estimates of total electricity generated by public utilities, factories generating for their own use, and factories supplying electricity for domestic and other consumption.

Gas

Natural gas was not discovered in any quantity until the 1960s. Before then, coal gasification was Australia's main source of reticulated gas. Over the past 20 years about 7,500 km of pipeline have been laid to link the gasfields with the major mainland metropolitan and urban centres. The distribution networks within these centres encompass a further 50,000 km of mains which supply about 2 million domestic, commercial and industrial customers Australia wide.

Whereas in the electric power industry almost all utilities are in the public sector, gas reticulation is a mixture of public and private enterprise with significant interstate activity. More details are provided within the State segments following.

New South Wales

Department of Energy

As part of a broader restructuring of the State's energy supply industries, the Energy Authority of New South Wales was abolished and a new Department of Energy created on 1 July 1987 under the provisions of the *Energy Administration Act, 1987*. The new Department continues the activities of the former Energy Authority and has added roles and functions in relation to the electricity councils and the Electricity Commission.

The legislation confers broad powers on the Department to co-ordinate and develop the public electricity supply industry. The functions of the Department include the promotion of the wise use of electricity, especially its use for industrial and manufacturing purposes and for primary production. Guidelines are given to electricity supply authorities on various aspects of their activities such as the framing of electricity tariffs, public lighting and the standardising of materials and equipment.

The Department administers the Special Assistance Scheme, which provides subsidies to electricity supply authorities to assist them to maintain their supply system and to implement various tariff rationalisation measures introduced by the State government. The subsidy in 1986 amounted to $32.75 million.

The Department of Energy continues to administer the Rural Electricity Subsidy Scheme which terminated on 30 June 1982. Under the scheme, the rural electrical development of the State has now been virtually completed in areas where the extension of supply is economically feasible. Electricity supply authorities receive subsidies towards the cost of new rural lines. At 30 June 1987, the scheme was committed to the payment of $46,924,963 in subsidies, of which $43,566,598 had been paid.

The Traffic Route Lighting Subsidy Scheme provides for financial assistance to councils towards the cost of installation of improved lighting on traffic routes traversing built-up areas with the objective of reducing the incidence of road accidents at night.

Electricity Commission of New South Wales and electricity supply authorities

The main function of the Commission is the generation and transmission of electricity, which it sells in bulk to distributing authorities (mainly local government bodies) throughout a large part of the State, to the government railways and to certain large industrial consumers.

As the major generating authority, it is also responsible for the development of major new power sources except in the Snowy Mountains region.

The retail sale of electricity to the public is, in general, carried out by separate electricity supply authorities. At 30 June 1986 there were 26 retail supply authorities throughout the State, comprising 23 electricity county councils (consisting of groups of shire and/or municipal councils), 1 city council, 1 shire council, and 1 private franchise holder.

Generation and transmission

Of the State's electrical power requirements during the year ended 30 June 1986, almost all was generated in New South Wales (over 93 per cent by six major thermal power stations and the balance from the Snowy Mountains Hydro-Electric Authority and other hydro-electric stations). Interchange with other States and other small generating authorities in New South Wales was negligible.

At 30 June 1986 the major power stations of the State system of the Electricity Commission of New South Wales and their effective capacities were as follows: Bayswater (Hunter Valley), 1,980 MW; Liddell (Hunter Valley), 1,840 MW; Munmorah (Tuggerah Lakes), 1,200 MW; Vales Point (Lake Macquarie), 1,890 MW; Eraring (Lake Macquarie), 2,648 MW; and Wallerawang (near Lithgow), 1,030 MW. The total nominal capacity of the Electricity Commission's system as at 30 June 1986 was 11,520 MW. The greater part of the Commission's generating plant is concentrated within a 185 km radius of Sydney.

Several local government bodies operate their own power stations and generate a portion of their requirements which is supplemented by interconnection with the system of the Electricity Commission. The aggregate effective capacity for the whole of New South Wales systems and isolated plants was approximately 11,555 MW at 30 June 1986 while the number of ultimate consumers at this date was 2,251,361.

The retailing of electricity to 97 per cent of the population of New South Wales is in the hands of local distributing authorities, which obtain electricity in bulk from the Commission's major State network. This network of 500 kV, 330 kV, 220 kV, 132 kV, 66 kV and some 33 kV transmission lines links the Commission's power stations with the load centres throughout the eastern portions of the State, extending geographically over 650 kilometres inland.

New development

Bayswater Power Station, which is situated in the Hunter Valley, was completed in 1987. It has a total capacity of 2,640 MW. Two 660 MW units are being installed at Mount Piper Power Station which is located on the western coalfield near Wallerawang. Commissioning of the Mount Piper station is planned for the early 1990s.

Construction of a double circuit 500 kV transmission line between Eraring and Kemps Creek, west of Sydney is complete. A double circuit 500 kV transmission link operating initially at 330 kV has been constructed from Bayswater Power Station to Mount Piper Power Station. An extension to Marulan is planned to interconnect with the existing transmission system between the Snowy Mountains and Sydney.

Hydro-electricity

The greater part of the hydro-electric potential of New South Wales is concentrated in the Snowy Mountains area (*see* page 641). Apart from this area, major hydro-electric stations are in operation at the Warragamba Dam (50 MW) and Hume Dam (50 MW). In addition, there are five smaller hydro-electric installations in operation in various parts of the State. A pumped-storage hydro-electric system to produce 240 MW has been installed as part of the Shoalhaven Scheme in conjuction with the Metropolitan Water Sewerage and Drainage Board.

Gas reticulation

Natural gas (NG) was made available to Sydney consumers with the completion of an overland supply pipeline from the Moomba field in South Australia in 1976. During the following five years, lateral pipelines were completed to Wollongong (1978), Bowral-Mittagong (1979), Goulburn (1980), and Canberra, Queanbeyan and Wagga Wagga (1981). A major trunk line between Sydney and Newcastle was completed in 1982.

With the connection of natural gas pipelines into existing reticulation systems, the use of manufactured (usually coal) or petroleum gas is gradually being superseded in the main

population centres of the State. By the end of 1986, more than half the Sydney homes with reticulated gas supply had been converted to the direct use of natural gas, with this program being scheduled for completion in 1991. At December 1986 Sydney users of direct natural gas totalled about 237,000 residential and 141,000 other (mainly commercial/industrial).

A smaller number of regional centres not yet connected to the natural gas distribution network still retain their own manufactured gas production and reticulation systems. These systems are operated either by local government or by commercial interests. However, together they account for less than 3 per cent of total sales in New South Wales.

The total amount of gas (all types) available for issue through mains in New South Wales was 81,725 terajoules in 1984–85, 92,532 terajoules in 1985–86 and 93,689 terajoules in 1986–87.

Work still in the development stages includes extraction of methane gas from coal seams south of Sydney and the investigation of potential bulk natural gas storage facilities adjacent to the main population centres.

Victoria

State Electricity Commission—SEC

The SEC is Australia's largest electricity supply authority and individual coal producer. It is a semi-government authority with the principal responsibility of generating or purchasing electricity for supply throughout Victoria. It may own, develop and operate brown coal open cuts and briquetting plants and develop the States's hydro-electric resources. It is required to meet, from its own revenue, all expenditure involved with operating its power and fuel undertakings and to provide for statutory transfers to the consolidated revenue of the State. In 1985–86 its revenue was $1,779 million. At 30 June 1986 it had total fixed assets of $8,607 million and a staff of 22,045.

The SEC was established by an Act of the Victorian Parliament in 1921 and now operates under the *State Electricity Commission Act 1958*. Since it began operating, the SEC has expanded and co-ordinated the generation, purchase and supply of electricity on a State-wide basis to the stage where its system provides almost all the electricity produced in Victoria and its transmission covers almost the entire population of the State. At 30 June 1986 it distributed electricity directly to 1,457,000 customers and indirectly to a further 279,300 through 11 metropolitan councils which buy power in bulk for retail distribution under franchises granted by the Victorian Government before the SEC's establishment.

Existing electricity system

The SEC Act requires the SEC to apply the natural resources of the State. Of the State's recoverable fossil fuel reserves, brown coal represents 94.6 per cent, natural gas 2.6 and oil 2.8. The SEC therefore has committed itself to increasing the proportion of total Victorian requirements met with coal based energy.

Victoria's electricity system is based upon the State's extensive brown coal resource in the Latrobe Valley, 140 to 180 km east of Melbourne in central Gippsland. It is one of the largest single brown coal deposits in the world, amounting to 200,000 megatonnes, of which 52,000 are economically winnable.

The coal is young and soft with a moisture content of 60 to 70 per cent and occurs in thick seams located from relatively close to the surface to a depth of several hundred metres. The coal can be won continuously in large quantities and at low cost by a specialised mechanical plant. The SEC's coal-fired power stations have been established near the coal deposits because the coal's high moisture content would make the coal expensive to transport.

The major brown coal-fired generating plants in the system are the 2,000 MW Loy Yang 'A', the 1,600 MW Hazelwood and 1,450 MW Yallourn 'W' power stations. Other brown coal-fired plants are Morwell (170 MW) and Yallourn 'E' (240 MW). These stations are all located in the Latrobe Valley and generate 80 per cent of the State's electricity requirement.

Other thermal stations are Jeeralang (465 MW) gas turbine station in the Latrobe Valley and Newport 'D' (500 MW) gas-fired station in Melbourne. There are hydro-electric power stations in north-eastern Victoria: Kiewa (184 MW), Dartmouth (150 MW) and Eildon/Rubicon/Cairn Curran (135 MW). Victoria is also entitled to about 30 per cent of the output of the Snowy Mountains Hydro-Electric Scheme and half of the output of the Hume hydro-electric station near Albury.

The SEC's total installed generating plant capacity at 30 June 1986 was 7,003 MW, including both capacity within the State and that available to it from New South Wales. In 1985–86 electricity generated by the SEC in its thermal and hydro-electric power stations, or purchased, totalled 28,151 GWh.

Power station construction

Construction of the Loy Yang 'A' power station complex south-east of Traralgon in the Latrobe Valley was authorised by the Victorian Government in 1976. It is the largest single engineering project undertaken in Australia. Coal-fired, Loy Yang will provide base load electricity for the Victorian grid and almost double the State's generating capacity. The project nominally comprises two 2,000 MW power stations, Loy Yang 'A' and Loy Yang 'B', in eight 500 MW units.

Transmission and distribution

The Victorian electricity distribution system has been completed, except for some isolated and remote areas of the State. Main transmission is by 500, 330, 220 and 66 kV lines which supply the principal distribution centres and interconnection between generating sources.

Three 500 kV transmission lines and six 220 kV lines link the Latrobe Valley stations with Melbourne and the State grid while three 330 kV lines provide the interstate link, two through the Snowy scheme. Bulk distribution of power throughout the main regional areas is by 220 kV lines to terminal stations which reduce the voltage to 66 kV or 22 kV for delivery to zone substations for further distribution. Feeder lines then deliver to distribution substations which in turn reduce the voltage to 415/240 volts for reticulation to individual customers. Some big industrial concerns take power at higher voltages.

The main transmission grid is currently being augmented to provide for increased power from the Latrobe Valley and to meet load growth in north-eastern and western areas of the State and the Mornington Peninsula.

Gas reticulation

The Gas and Fuel Corporation of Victoria is the largest gas undertaking in Australia, the sole reticulator of gas in Victoria, and a major marketer of liquefied petroleum gas (LPG). Constituted on 6 December 1950, it was formed by merging the interests of the privately-owned Metropolitan and Brighton Gas Companies with the State Government. (Through its predecessor, the Metropolitan, the Corporation is descended from the first gas company in Victoria—The City of Melbourne Gas and Coke Company founded in 1850 and incorporated in 1853.)

The merger gave the newly-formed Corporation an unusual status—that of a public authority owned jointly by the State and private shareholders. With its expanded capital structure, the Corporation was able to build a plant at Morwell to gasify indigenous brown coal, with the objective of improving Victoria's gas supply. Commissioned in 1956, the Lurgi high pressure brown coal gasification works supplemented metropolitan gas production until the introduction of natural gas in 1969.

Commercial reserves of natural gas were discovered in the offshore Gippsland Basin in 1965 by Esso-BHP from which the Corporation purchases, under agreement, the State's natural gas requirements.

Supply is drawn from the Marlin, Barracouta, and Snapper fields in Bass Strait, and transported by pipeline to an onshore treatment plant at Longford, near Sale. Before it enters the Corporation's transmission system, an odorant is added to give the gas a distinctive smell, for safety reasons.

The Corporation reticulates gas, 99 per cent of which is natural gas, through a 20,000 kilometre network of underground transmission pipelines and mains to more than one million industrial, commercial, and domestic consumers.

Queensland

Organisation

The electricity supply industry in Queensland operates under a two-tier structure consisting of the Queensland Electricity Commission and seven electricity boards. The Queensland Electricity Commission, under the terms of the *Electricity Act 1976–1986* is responsible for the co-ordination and regulation of the electricity supply industry in Queensland.

The Commission has direct responsibility for electrical safety, loan raising, fixing tariffs and planning the electricity system as well as for construction and operation of major power stations and the main transmission system. It provides electricity to the seven electricity boards and certain special major users of power.

Electricity generation, transmission and distribution

During 1986–87, nearly 97.8 per cent of the State's generation of 21,133 GWh was produced by coal fuelled steam power stations. Two hydro-electric stations in the north of the State provided 2 per cent, while the balance was produced by internal combustion plant located in towns remote from the interconnected grid and by gas turbine plant at several locations. Wivenhoe pumped storage generating station produced 554 GWh at times of peak system load while using 767 GWh for pumping purposes. A further 184.7 GWh was purchased from private producers of electricity for re-distribution to customers within the State-wide interconnected system.

At 30 June 1987, the total generating capacity in the State was 5,126 megawatts (MW), comprising 4,256 MW of coal-fired steam plant, 632 MW of hydro-electric plant, 178 MW of gas turbine plant and 60 MW of internal combustion plant. For the foreseeable future, coal-fired power stations will provide the bulk of the State's electrical energy requirements, augmented by pumped storage and conventional hydro-electric stations for peaking capacity.

At the end of June 1987 the transmission and distribution system within the State comprised 156,663 circuit kilometres of electric lines providing electricity to 1,039,753 customers. The main transmission voltages are 275, 132, 110 and 66 kV. The single wire earth return (SWER) system is used extensively in rural electrification and 49,642 kilometres of this line was in service at 30 June 1987.

New development

The completion of Tarong Power Station in November 1986 brought into operation a generating capacity of 1,400 MW. There are two generating stations presently under construction that will provide an additional 2,100 MW of generating capacity for the State network.

The Callide 'B' power station, located in the central region of the State, near Biloela, will consist of two generating sets each of 350 MW capacity. The station was 85 per cent complete by the end of 1986–87.

Work on the Stanwell power station, near Rockhampton, is proceeding to a schedule proposing first generation in 1993. This station will comprise four sets each rated at 350 MW capacity.

Gas reticulation

Queensland has a reticulated gas system in the Brisbane region and in the cities and towns of Bundaberg, Cairns, Toowoomba and Dalby. By June 1986 there were over 2,908 kilometres of mains laid in these centres and the systems serviced 154,047 consumers. South Brisbane, Toowoomba and Dalby reticulate natural gas, whereas North Brisbane, Bundaberg and Cairns reticulate reformed town gas. Total sales of natural gas in 1985–86 were 17,325 TJ compared with 17,542 TJ in 1984–85. Sales of reformed town gas were 1,053 TJ and 1,062 TJ respectively.

Western Australia

State Energy Commission of Western Australia

On 1 July 1975 the Government of Western Australia combined the State Electricity Commission and the Fuel and Power Commission to form a new organisation known as the State Energy Commission of Western Australia. The Commission is specifically responsible for ensuring the effective and efficient utilisation of the State's energy resources and for providing economical and reliable supplies of electricity and gas.

Electricity generation and distribution

The Commission owns and operates three major thermal power stations. These are located at Muja, (1,040 MW capacity) and Bunbury (120 MW), both using local coal to produce electricity, and at Kwinana (900 MW). Kwinana power station has the capacity to burn coal, oil or natural gas, although natural gas (from the North West Shelf) is the major fuel used. A small (2 MW) hydro-electric station is situated at Wellington Dam near Collie, and there are 20 MW capacity gas turbine generating units at Geraldton, Kalgoorlie and Kwinana.

Two power grid systems operate in Western Australia and supply the electricity needs of 98 per cent of the State's population. The two systems are:

- *The South West interconnected system.* Power from the three major stations is fed to the South West system. This grid services the metropolitan area and the South West and Great Southern areas, including an area extending eastwards to Kalgoorlie and northwards as far as Kalbarri, some 100 km north of Geraldton. Kalgoorlie was brought into the South West grid system in 1984 following construction of a 680 km transmission line from Muja, one of the longest radial feed lines constructed in Australia.
- *The Pilbara interconnected system.* This system was established during 1985–86 and interconnects Karratha, Cape Lambert and Port Hedland. Electricity is supplied from generating plant at Cliffs Robe River Iron Associate's power station at Cape Lambert. The plant is fuelled by North West Shelf natural gas. When necessary, additional power can be drawn from the Commission's stand-by diesel power generating facility at Port Hedland or from Hamersley Iron Pty Ltd's power station at Dampier.

In areas too remote to utilise the interconnected grid systems, the Commission operates 29 diesel power stations. The Commission owns and operates 8 of these stations while the remaining stations are owned by local authorities but operated by the Commission under the Country Town's Assistance Scheme (CTAS). Under this scheme, the Commission operates the electricity undertakings but ownership remains with the shires which are required to raise the funds needed for capital works, including generating plant, distribution extensions and upgrading.

At 30 June 1986, the Commission's generating capacity from its interconnected grid system was 2,177 MW, while the capacity of its supply system in country areas was 162 MW. There were 536,254 customer accounts for electricity throughout the State.

The Commission is also responsible for the design, construction and maintenance of power stations at isolated Aboriginal communities in the Pilbara, Kimberley, Central Aboriginal Reserve and Eastern Goldfields. At 30 June 1986, there were 38 such village power stations funded by the Commonwealth Government.

Gas reticulation

The Commission is the main supplier of gas in Western Australia. It operates an extensive North West Shelf natural gas reticulation system in the Perth metropolitan area as well as smaller country reticulation systems at Geraldton to the north and Pinjarra and Bunbury in the south-west. The Commission also reticulates tempered liquefied petroleum (TLP) gas through a local system at Albany on the south coast.

At 30 June 1986, there were 160,369 customer accounts for natural gas and 2,389 customer accounts for TLP gas.

South Australia

Electricity Trust of South Australia

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

Capacity and production

At 30 June 1987, the Electricity Trust's installed capacity was 2 680 MW. Its major power stations are Port Augusta Northern Power Station (500 MW), Torrens Island (1 280 MW) and Port Augusta Playford 'B' (240 MW). Of the older stations, Playford 'A' (90 MW) and most of Osborne (240 MW) have been placed on cold storage. The Trust also operates gas turbine stations at Dry Creek (156 MW), Mintaro (90MW) and Snuggery (75 MW) and a small diesel station at Port Lincoln (9 MW).

The Trust supplies approximately 630 000 customers, accounting for over 99 per cent of all electricity consumers in the State. Following the acquisition of seven district council

electricity undertakings on Eyre Peninsula during 1986–87, the Trust is now responsible for supplying only 900 customers indirectly through bulk supply. Approximately 3 000 additional customers are supplied by small independent electricity undertakings operating mainly diesel generating plant in remote areas of the State.

The two main fuels used by the Trust are coal from Leigh Creek for the Port Augusta power stations and natural gas from the Cooper Basin for the Torrens Island, Dry Creek and Mintaro stations.

Future developments

To meet future demands, a third 250 MW unit at the Northern Power Station, also fuelled by Leigh Creek coal, is scheduled for commissioning in 1993.

A 500 MW capacity interconnection with the Victorian-New South Wales systems, being constructed, is scheduled for commissioning in 1990.

Gas reticulation

The South Australian Gas Company (SAGASCO), a privately owned company regulated by State legislation, was incorporated by Act of Parliament in 1861. The first gas was produced at Brompton in 1863.

When natural gas became available from the Cooper Basin in the late 1960s, SAGASCO, in 1966, contracted a supply of this indigenous fuel. Deliveries commenced in 1969 and, with the complete conversion of the metropolitan area to natural gas in January 1971, coal carbonising and carburetted water gas plants were shut down.

Under the 1966 contract, SAGASCO paid the producers who, in turn, paid the transportation charge of the Natural Gas Pipelines Authority. In 1974, major changes to contracts and other arrangements were effected. The Pipelines Authority—renamed the Pipelines Authority of South Australia (PASA)—became responsible for purchasing gas at the Cooper Basin and on-selling to customers. The 1966 contract was shortened to expire on 1 January 1988, from which date a new supply contract with PASA takes effect.

Natural gas is reticulated through most of the Adelaide metropolitan area, Angaston and Port Pirie. Liquefied petroleum gas is distributed by reticulation at Mount Gambier and Whyalla, and is available elsewhere as bottled gas.

The conversion of the metropolitan distribution system to natural gas brought marked changes in the Company's operations. The Company is now concerned largely with the distribution and marketing of gas, rather than manufacturing. Great emphasis is placed on marketing gas to industry, where, as a cheap, non-polluting fuel, it is able to compete successfully with other fuels.

Tasmania

A considerable part of the water catchment in Tasmania is at high altitude. The establishment of numerous dams has created substantial artificial storage which has enabled the State to produce energy at a lower cost than elsewhere in Australia and in most other countries. Another factor contributing to the low cost is that rainfall is distributed fairly evenly throughout the year with comparatively small yearly variations. Abundant and comparatively cheap supplies of electricity played an important role in attracting industry to Tasmania.

Hydro-Electric Commission

The Commission was created in 1930, taking over the activities of the Hydro-Electric Department and the existing small hydro-electric installations. Development initially concentrated on hydro-electric generation feeding into a State-wide power grid (King Island from 1951 and Flinders Island from 1968 are outside the grid and are supplied by diesel generators). During 1974, the construction of a substantial oil fired thermal station with a capacity of 240 MW was completed to supplement the continuing hydro development program.

Installed capacity

At 30 June 1987 the generating system had an installed capacity of 2 171 MW. The most recent completion, the Pieman River Power Development (231 MW), was officially opened on 1 May 1987.

Installation of a third 144 MW generator at the Gordon Power Station will bring the capacity at that site to 432 MW and is expected to be completed by March 1988.

Work began in 1982–83 on Stage 2 of the Gordon River Power Development but was halted when the Federal Government refused consent for the project to proceed. The Hydro-Electric Commission then began work (in August-September 1983) on two smaller hydro power schemes in Western Tasmania. These are the King River Power Development, scheduled for completion in mid-1991 and the Anthony Power Development, expected to be commissioned some 18 months later. They will add about 227 MW to the installed capacity of the system.

Gas reticulation

Gas is only a minor energy source in Tasmania. Town gas is manufactured and reticulated only in Launceston. Bottled LPG is a minor domestic, commercial and motor fuel in the State.

Northern Territory

The Power and Water Authority is a Statutory Authority, created on 1 July 1987, with responsibility for the sale of natural gas, electricity generation, distribution, transmission and sale, and water and sewerage services.

In Darwin, the major electricity source is the gas-fired Channel Island Power Station completed in October 1987 with a capacity of 186 MW. In Alice Springs, power is generated at the Ron Goodwin Power Station which operates on natural gas. In Katherine, electricity is generated at the Katherine Power Station, completed in September 1987. Natural gas is also used as a fuel for electricity generation at the Tennant Creek Power Station.

A natural gas pipeline from the Amadeus Basin in Central Australia to Darwin was completed in December 1986, enabling electricity generation in Darwin, Katherine and Tennant Creek to use an indigenous fuel to replace expensive, imported fuel. The Alice Springs Power Station is fuelled by natural gas from Palm Valley via a separate pipeline.

Many small communities in the Territory generate their own power using diesel-fired generating sets and responsibility for these operations has been transferred to the Power and Water Authority.

Australian Capital Territory

Electricity distribution

The supply authority is the A.C.T. Electricity Authority within the Territory. Supply was first made available in Canberra during 1915 and was met from a local steam plant. Connection to the New South Wales interconnected system was effected in 1929. The Authority's electricity supply requirements are met by a Snowy Mountains reservation of 670 GWh and the balance is provided by the Electricity Commission of New South Wales. The locally-owned plant consists of 3 MW diesel alternators which are retained as a standby for essential supplies. The total number of ultimate consumers at 30 June 1987 was 98,201. During the year 1986–87 the bulk electricity purchased was 1,963 GWh and the system maximum demand was 546 MW.

Gas reticulation

Reticulated gas first became available in the Australian Capital Territory in January 1982. Natural gas from the Moomba fields in South Australia is piped to Canberra via a 60 km spur which branches from the main Moomba—Sydney pipeline at Dalton. AGL Canberra Ltd has invested capital of $45 million to set up the infrastructure necessary to service and support a major utility and, to date, has laid over 1,600 kilometres of gas mains, bringing reticulated natural gas within reach of an estimated 46,500 dwellings in 50 suburbs.

During 1986–87, AGL Canberra Ltd reticulated 2,597 terajoules of natural gas to 570 commercial and industrial establishments and about 12,000 homes. Over the next five years the company expects to invest a further $55 million and, in the long term, over 2,500 kilometres of gas mains will service over 50,000 customers in the Territory.

National survey of household energy usage

About 27 per cent of all reticulated electricity and 13 per cent of reticulated gas is consumed by households. To facilitate planning by energy authorities to meet this demand, the Austra-

lian Bureau of Statistics conducted a national survey of energy usage by household in private dwellings. The survey sought information on:

- what facilities and major appliances were held by the household at the time of interview;
- the quantity and cost of reticulated gas and electricity consumed by the household over a twelve month period prior to interview;
- the usage patterns for major appliances and reticulated energy consumption recorded in a special diary over a seven day period after the interview.

To determine the significance of seasonal usage patterns, interviews were conducted progressively over the period June 1985 to June 1986 with the sample of over 19,000 households being spread both geographically and temporally to provide, for any State/area, a series of observations over the year.

RETICULATED ENERGY: AVERAGE ANNUAL CONSUMPTION AND EXPENDITURE BY HOUSEHOLD COMPOSITION BY STATE/TERRITORY AND CAPITAL CITIES, 1985–86.

	Household composition								
	One adult and number of children			*Two adults and number of children*			*Three or more adults and number of children*		
	None	*1 or 2*	*3 or more*	*None*	*1 or 2*	*3 or more*	*None*	*1 or 2*	*3 or more*
SINGLE HOUSEHOLDS IN PRIVATE DWELLINGS ('000)									
New South Wales	312.8	37.1	*4.8	506.3	281.2	104.5	273.8	149.0	21.4
Sydney	223.7	29.0	*	315.1	183.1	61.3	189.4	92.7	12.6
Victoria	245.9	20.7	*6.5	350.9	223.0	69.8	217.6	127.2	20.2
Melbourne	179.9	12.8	*4.4	245.4	164.7	43.0	172.4	92.9	14.6
Queensland	149.8	13.8	*4.5	221.2	131.9	54.6	113.9	74.6	10.4
Brisbane	77.8	*5.8	*	101.2	67.8	21.0	64.1	36.7	*2.9
South Australia	83.4	8.6	*3.1	153.5	78.2	25.0	74.2	36.2	*2.7
Adelaide	62.4	6.2	*2.0	113.8	58.9	16.4	58.8	27.6	*
Western Australia	83.5	10.0	*	132.9	84.7	29.1	67.7	36.1	*3.3
Perth	64.6	9.1	*	102.7	63.6	21.0	53.7	26.9	*
Tasmania	27.7	3.1	*	40.9	29.2	9.7	17.0	11.8	2.6
Hobart (*a*)	12.8	2.0	*	17.5	12.6	3.0	7.0	3.7	*1.0
Northern Territory (*a*)	*3.2	*	*	6.3	9.1	*	*2.4	*2.4	*
Australian Capital Territory	12.8	*1.9	*	19.7	16.3	5.7	13.0	8.6	*
Australia	**919.0**	**96.1**	**20.4**	**431.8**	**853.6**	**300.0**	**779.7**	**445.7**	**61.4**
AVERAGE ANNUAL CONSUMPTION (MJ)									
New South Wales	15,900	26,900	*34,200	25,100	34,200	37,400	37,100	39,800	51,500
Sydney	15,700	27,000	*	25,700	35,400	40,000	39,700	41,400	53,000
Victoria	29,900	50,600	*70,700	48,300	71,200	80,200	74,500	81,800	78,000
Melbourne	31,100	58,400	*81,000	54,100	79,000	100,300	81,700	91,500	86,900
Queensland	13,200	19,500	*23,700	19,900	27,100	29,400	27,600	30,200	32,100
Brisbane	13,900	*21,000	*	20,800	27,300	32,900	29,300	33,000	*35,200
South Australia	20,400	31,000	*39,700	30,400	41,400	43,100	42,100	47,700	*55,800
Adelaide	21,700	35,900	*45,200	32,100	44,600	47,300	45,200	50,100	*
Western Australia	13,900	22,100	*	20,300	26,800	30,500	28,300	31,300	*28,400
Perth	14,700	23,200	*	20,500	28,300	33,300	30,100	33,800	*
Tasmania	22,900	31,600	*	31,200	37,500	46,600	40,500	43,000	41,300
Hobart (*a*)	24,400	32,400	*	31,100	37,700	50,800	43,100	42,400	*43,700
Northern Territory (*a*)	*16,300	*	*	24,600	32,400	*	*27,400	*41,400	*
Australian Capital Territory	29,400	*41,800	*	36,300	43,800	63,800	43,100	45,500	*
Australia	**19,800**	**31,200**	**44,300**	**30,500**	**43,000**	**46,700**	**46,000**	**50,300**	**55,300**
AVERAGE ANNUAL EXPENDITURE ($)									
New South Wales	300	449	*598	451	588	642	628	688	829
Sydney	285	438	*	442	591	646	648	696	812
Victoria	397	544	*772	572	756	846	816	909	870
Melbourne	404	563	*820	604	795	948	861	950	895
Queensland	337	469	*502	470	607	652	616	668	705
Brisbane	345	*472	*	471	605	704	628	705	*727
South Australia	348	481	*578	508	659	728	686	784	*839
Adelaide	351	512	*598	507	671	737	705	785	*
Western Australia	342	448	*	467	585	680	628	688	*666
Perth	353	459	*	468	618	712	652	741	*
Tasmania	365	479	*	491	586	695	638	690	656
Hobart (*a*)	386	485	*	493	585	759	666	684	*682
Northern Territory (*a*)	*537	*	*	677	841	*	*700	*1,072	*
Australian Capital Territory	464	*602	*	538	680	894	684	732	*
Australia	**345**	**479**	**624**	**494**	**645**	**710**	**685**	**758**	**808**

(*a*) As reticulated gas was not available at the time of the survey, these averages are for reticulated electricity only.

NOTE: Estimates preceded by the symbol (*) have a relative standard error of between 25 and 40 per cent. Estimates replaced by the symbol (*) have a standard error greater than 40 per cent.

TYPE OF ENERGY USED BY STATE AND STATE CAPITAL CITIES, 1985–86
('000 of single households in private dwellings)

Type of energy used	N.S.W. Sydney	N.S.W. Total	Vic. Melbourne	Vic. Total	Qld Brisbane	Qld Total	S.A. Adelaide	S.A. Total
Households using electricity	1,119.5	1,735.1	939.3	1,298.4	381.4	806.9	351.9	474.9
Households not using electricity	*	9.4	*	*1.8	*	*4.2	*	*
Households using gas	367.1	538.2	780.1	971.9	100.2	183.8	221.5	253.5
Reticulated (mains) gas	327.5	398.3	753.3	879.9	77.3	86.2	214.6	223.7
Bottled gas	35.8	126.2	18.8	81.2	22.8	92.2	4.9	26.0
Not asked type of gas	*3.8	13.7	8.0	10.8	*	5.4	*2.0	3.8
Households using wood/solid fuel	123.6	337.3	132.5	288.9	24.4	96.4	69.8	128.0
Households using oil	63.5	126.0	43.3	82.6	*4.1	15.8	34.0	54.9
Households using kerosene	63.3	114.9	18.7	29.7	43.7	92.7	19.2	27.8
Households using solar energy	35.2	67.2	7.1	17.9	13.0	43.0	12.7	18.2
Main energy combinations—								
Electricity only	555.8	762.7	99.9	151.4	222.6	453.1	58.3	84.2
Electricity and gas only	267.9	312.3	637.2	732.2	61.6	68.0	166.0	172.5
Electricity and wood only	74.4	213.4	27.8	102.8	14.7	60.0	33.0	70.3
Electricity and oil only	47.2	89.4	20.6	37.8	*2.8	10.6	25.5	38.9
Electricity and solar only	17.5	24.2	*	*2.8	7.3	24.1	*1.7	*2.5
Electricity, gas and wood only	24.9	38.8	82.5	106.5	*4.2	5.4	25.4	26.3
Total	*987.6*	*1,440.8*	*868.3*	*1,133.4*	*313.3*	*621.2*	*309.9*	*394.6*
All other combinations	*131.9*	*303.6*	*71.0*	*166.8*	*68.4*	*189.9*	*42.2*	*80.5*
Total	**1,119.5**	**1,744.5**	**939.3**	**1,300.2**	**381.7**	**811.1**	**352.1**	**475.1**

Type of energy used	W.A. Perth	W.A. Total	Tas. Hobart	Tas. Total	N.T.	A.C.T.	Australia State capitals	Australia Total
Households using electricity	347.4	460.5	60.3	144.8	26.7	78.8	3,199.7	5,026.2
Households not using electricity	*	*2.1	*	*	*	*	*	17.9
Households using gas	173.3	250.4	3.3	13.0	4.1	10.3	1,645.4	2,225.2
Reticulated (mains) gas	153.2	159.4	*	1.8	*	5.6	1,525.8	1,754.8
Bottled gas	18.2	83.4	3.3	10.7	4.1	4.7	103.9	428.5
Not asked type of gas	*1.8	7.7	*	*0.5	*	*	15.7	41.8
Households using wood/solid fuel	99.6	162.5	30.6	89.6	*	19.2	480.5	1,122.4
Households using oil	43.3	54.7	12.4	23.0	*	17.4	200.6	374.9
Households using kerosene	47.4	61.0	*1.1	3.8	*	*1.7	193.4	332.3
Households using solar energy	92.3	114.2	*0.8	*1.4	10.6	5.6	161.3	278.1
Main energy combinations—								
Electricity only	54.9	65.5	17.9	31.3	13.5	35.2	1,009.4	1,596.9
Electricity and gas only	78.6	80.3	*	*	*	*3.4	1,211.3	1,368.9
Electricity and wood only	25.2	35.6	25.5	75.0	*	12.7	200.6	569.7
Electricity and oil only	11.0	12.1	8.8	16.2	*	11.7	115.9	216.6
Electricity and solar only	15.8	18.5	*	*	8.7	*1.6	42.8	82.5
Electricity, gas and wood only	24.3	27.0	*	*1.3	*	*	161.4	206.1
Total	*209.8*	*239.0*	*52.3*	*124.0*	*22.3*	*65.3*	*2,741.3*	*4,040.7*
All other combinations	*137.6*	*223.6*	*7.9*	*21.1*	*4.5*	*13.5*	*458.9*	*1,003.4*
Total	**347.4**	**462.6**	**60.3**	**145.1**	**26.7**	**78.8**	**3,200.2**	**5,044.1**

NOTE: Estimates preceded by the symbol (*) have a relative standard error of between 25 and 40 per cent. Estimates replaced by the symbol (*) have a standard error greater than 40 per cent.

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