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Mining and energy

The mining industry

Introduction

Mining, as defined in the 1993 edition of the *Australian and New Zealand Standard Industrial Classification (ANZSIC)* (1292.0), broadly relates to the extraction of minerals occurring naturally as solids such as coal and ores; liquids such as crude petroleum; or gases such as natural gas.

The mining industry contributed \$16,450 million or 4% of Australia's Gross Domestic Product (GDP) in 1993–94.

Main features

Table 17.1 provides a summary of the operations of the mining industry in 1993–94. Turnover in the mining industry remained relatively unchanged at \$29,000.1 million (up less than 1%) whilst employment in the industry dropped by 3% to 56,440 people.

The industries which recorded a rise in turnover were coal, up \$679.2 million to \$9,897.5 million; and gold ore, up \$275.6 million to \$4,237.3 million. Other industries to increase turnover were copper ore, up \$73.2 million to \$966.5 million; mineral sands, up \$19.2 million to \$521.7 million and bauxite, up \$17.0 million to \$795.2 million.

Industries that declined in turnover were: oil and gas, down \$722.6 million to \$7,758.5 million; other metal ores, down \$144.2 million to \$680.3 million; iron ore, down \$52.3 million to \$3,208.3 million; and silver-lead-zinc, down \$14.4 million to \$934.9 million.

Table 17.2 contains a summary of the operations of the mining industry in 1993–94, by State and Territory.

17.1 Mining — summary of operations by industry (\$ million)

	Establish- ments (No.)	Employ- ment(a) (No.)	Wages & salaries(b) (\$m)	Turnover(c) (\$m)	Stocks		Purchases & selected expenses (\$m)	Value added (\$m)	Net capital expenditure (\$m)
					Open (\$m)	Close (\$m)			
Coal mining(d)	153	26 356	1 924	9 897	796	690	4 300	5 491	863
Oil & gas extraction	101	4 444	325	7 758	216	201	631	7 113	1 381
Metal ore mining									
Iron ore mining	18	6 336	400	3 208	346	338	1 023	2 177	492
Bauxite mining	9	1 749	86	795	45	49	276	524	56
Copper ore mining	15	2 674	154	967	181	153	342	596	120
Gold ore mining	168	8 003	363	4 237	513	542	2 158	2 109	646
Mineral sand mining	16	1 770	76	522	164	153	265	246	35
Silver-lead-zinc ore mining	17	2 975	173	935	159	153	585	344	68
Other(e)	18	2 133	115	680	201	249	422	307	359
Total metal ore mining	261	25 640	1 366	11 344	1 608	1 637	5 071	6 302	1 776
Total mining 1993–94(d)	515	56 440	3 615	29 000	2 620	2 529	10 002	18 907	4 020
Total mining 1992–93	494	57 987	3 487	28 870	2 613	2 603	9 590	19 270	4 004

(a) Includes working proprietors. (b) Excludes amounts drawn by working proprietors. (c) Includes transfer out to other establishments of the same management unit where appropriate. (d) Brown coal mining operations of the former State Electricity Commission of Victoria are now included in the mining sector. (e) Includes ANZSIC classes 1316 and 1319.

Source: Australian Mining Industry (8414.0).

17.2 Mining — summary of operations by State/Territory (\$ million)

	Establish- ments (No.)	Employ- ment(a) (No.)	Wages & salaries(b) (\$m)	Turnover(c) (\$m)	Stocks		Purchases & selected expenses (\$m)	Value added (\$m)	Net capital expenditure (\$m)
					Open (\$m)	Close (\$m)			
NSW	105	15 514	1 101	4 863	440	386	2 156	2 653	628
Vic.(d)	28	2 200	138	4 066	47	44	328	3 735	463
Qld	126	14 794	979	6 797	764	691	3 032	3 692	561
SA	16	2 160	109	1 065	86	69	208	840	87
WA	201	18 911	1 112	10 692	1 010	1 053	3 738	6 996	2 165
Tas.	9	1 398	85	344	50	61	188	165	35
NT	30	1 463	90	1 174	223	226	352	825	81
Aust.(d)	515	56 440	3 615	29 000	2 620	2 529	10 002	18 907	4 020

(a) Includes working proprietors. (b) Excludes amounts drawn by working proprietors. (c) Includes transfer out to other establishments of the same management unit where appropriate. (d) Brown coal mining operations of the former State Electricity Commission of Victoria are now included in the mining sector.

Source: Australian Mining Industry (8414.0).

Mineral production

Australian production in the metallic minerals, coal, oil and gas sectors for 1993–94 was valued at \$25,702 million, a decrease of 4% over the previous year (table 17.3).

Metallic mineral production dominated with \$10,861 million or 42% of the total, while coal was 29% of the total and oil and gas 29%.

By value, the two largest components of metallic mineral production were gold and iron ore which accounted for \$4,080 million and \$3,018 million, respectively, for a combined share of 65%.

Western Australia accounted for both the largest share of metallic mineral production with \$7,402 million (68%), and the largest share of total mineral production with \$10,231 million (40% of the total).

The decrease in the value of mineral production in 1993–94 was due to the oil and gas industry which fell to \$7,423 million from \$8,216 million in 1992–93. This represented a fall of \$793 million or 10%, primarily due to decreased prices.

17.3 Mineral production, selected minerals, Australia

	Units	1989–90	1990–91	1991–92	1992–93	1993–94
Metallic minerals						
Bauxite	kilotonnes	39 983	41 831	34 788	40 946	43 306
Copper concentrate(a)	kilotonnes	939	1 004	915	1 254	1 322
Copper precipitate(b)	tonnes	—	4 384	6 203	8 174	16 192
Gold bullion (dore)(c)	kilograms	256 725	264 993	259 656	275 331	274 687
Iron ore(d)	kilotonnes	110 119	111 475	114 781	115 703	123 631
Lead concentrate	kilotonnes	762	870	858	856	873
Manganese ore(e)	kilotonnes	1 261	724	375	597	815
Mineral sands(f)	kilotonnes	2 285	1 878	1 954	2 118	2 252
Uranium concentrate (U3O8)(a)	tonnes	3 077	2 913	2 901	1 342	1 457
Zinc concentrate(g)	kilotonnes	1 603	1 810	1 927	2 011	1 890
Total value of metallic minerals(h)	\$ million	10 838	10 910	10 957	10 920	10 861
Coal						
Black coal	kilotonnes	160 459	166 505	176 570	177 970	177 874
Brown coal	kilotonnes	45 959	48 169	50 731	47 912	49 684
Total value of coal(i)	\$ million	6 472	6 754	7 216	(j) 7 585	(j) 7 418

For footnotes see end of table.

...continued

17.3 Mineral production, selected minerals, Australia — continued

	Units	1989-90	1990-91	1991-92	1992-93	1993-94
Oil & gas						
Crude oil (k)	megalitres	31 700	29 189	31 984	30 592	29 583
Natural gas (l)	gigalitres	15 354	15 589	16 289	16 631	15 959
Ethane	gigalitres	186	175	182	187	202
Propane (m)	megalitres	2 067	2 013	2 064	2 078	2 115
Butane (m)	megalitres	1 570	1 504	1 574	1 651	1 622
Liquefied natural gas	kilotonnes	2 015	3 577	4 250	4 922	5 732
Total value of oil & gas	\$ million	5 983	8 629	7 812	8 216	7 423
Total value of metallic minerals, coal, oil & gas	\$ million	23 294	26 293	25 985	26 721	25 702

(a) Excludes South Australia. (b) Includes copper concentrate in other forms. (c) Includes alluvial gold. (d) Includes iron ore pellets. (e) Metallurgical grade. (f) Includes ilmenite, beneficiated ilmenite, leucoxene, monazite, rutile and zircon. (g) Includes zinc-lead concentrate. (h) Includes Tasmanian coal production. (i) Excludes Tasmania. (j) Excludes briquettes. (k) Stabilised. Includes condensate. (l) Includes field and plant usage. (m) Excludes refinery production.

Source: Australian Mining Industry (8414.0).

The value of metallic minerals decreased marginally, falling less than 1%, while the value of coal production fell 2% primarily due to decreased prices. The total value of the coal industry (excluding Tasmania) was \$7,418 million in 1993-94. New South Wales and Queensland are the major coal producing States with 46% and 45% of the market, respectively.

In 1993, Australia remained the world's largest producer of bauxite (41% of total world production); diamonds (39%); lead (19%); and the mineral sands concentrate zircon (41%).

Exports

Australia is the world's largest exporter of black coal, alumina, diamonds, lead, zinc, ilmenite, rutile and zircon; and the second largest exporter of iron ore, aluminium and gold.

Exports of mining products fell in value by 8% in 1993-94 to \$14,603 million or 23% of total merchandise exports. This followed a rise of 8% in 1992-93.

The percentage contributions of the major mineral products to total exports have remained fairly stable over the period 1990-91 to 1993-94. Black coal remains the largest single export item and the main mineral exported, with a value of \$7,189 million in 1993-94, 11% of total exports. Other major exports were iron ore (\$2,777 million, 4% of total exports), crude oil (\$1,350 million, 2%), zinc ores

(\$429 million, 1%) and uranium (\$195 million, less than 1%).

Exports of mining products together with basic manufactures of mineral origin remained relatively unchanged in 1993-94 following growth of 6% in 1992-93. However, as a proportion of total exports they declined from 39% in 1992-93 to 36% in 1993-94.

A significant increase in refined gold export earnings offset the decline in export value from other mineral resources. The value of refined gold exports rose an estimated \$1,115 million (26%) to \$5,417 million because of increased export volumes and higher prices.

Other substantial value increases in 1993-94 included iron, steel and ferroalloys, up \$253 million (22%) to \$1,402 million; aluminium up \$89 million (5%) to \$1,814 million; and uranium, up \$70 million (57%) to \$193 million. Aluminium exports rose over the year because of increased production from an expansion of the Tomago smelter in New South Wales.

The small overall increase in export earnings was largely attributable to falls in the value of crude oil and other refinery feedstock, down \$381 million (21%) to \$1,469 million; coking coal, down \$220 million (5%) to \$4,326 million; steaming coal, down \$143 million (5%) to \$2,480 million; and zinc, down \$225 million (22%) to \$795 million. The lower value of coal exports reflects reduced contract prices, together with a decline in production and lower export demand in early 1994.

Imports

In 1993–94, mining sector imports were \$2,573 million, a rise of 1% on the 1992–93 total of \$2,551 million.

With the inclusion of basic manufactures of mineral origin, mineral resources imports were valued at \$5,725 million in 1993–94, a fall of \$507 million (8%) on 1992–93. The dominant contributors to the fall were crude oil and other refinery feedstock, down \$406 million (13%) to \$2,837 million; and refined petroleum products, down \$78 million (12%) to \$556 million.

Selected commodity review

Gold

Gold production (content of all minerals) in Australia during 1993–94 was 255,757 kg. Western Australia accounted for most production with 76%, followed by Queensland with 12%, Northern Territory (7%), New South Wales (3%) and Victoria (1%).

Gold is Australia's second biggest export earning commodity, having overtaken wool in 1990–91. In 1993–94 it accounted for 8% of total exports at a value of \$5,295 million. The main markets were Japan (\$1,433 million), Singapore (\$1,197 million) and Republic of Korea (\$670 million).

The gold mining industry employed 8,000 people in 1993–94, 14% of total employment in the metallic minerals, coal, oil and gas industries, making it the second highest employer in the mining sector behind coal.

Australia accounts for 10% of estimated world gold production, with South Africa being the world's biggest gold producer.

Iron ore

Iron ore production in 1993–94 was 123.6 million tonnes of which 93% or 114.4 million tonnes was exported. Iron ore mining employs over 6,300 people.

Almost 97% of production takes place in Western Australia's Pilbara region. Iron ore is also mined in South Australia and Tasmania.

Iron ore accounted for \$2,777 million or 4% of total exports in 1993–94. Japan is

Australia's largest market, taking nearly half of its exports (47% in dollar terms). Other important markets are Republic of Korea (16%), China (16%), Taiwan (6%) and United Kingdom (3%).

Bauxite and alumina

Australia is the world's largest bauxite and alumina producer and the fourth largest aluminium producer.

Bauxite mining employed 1,750 people nationally (June 1994), with mines in Western Australia south of Perth, in the Northern Territory on the Gove Peninsula and in Queensland at Weipa. Generally the bauxite ore is not sold but is processed to alumina for sale or for conversion to aluminium. Alumina production reached 12.8 million tonnes in 1993–94 while refined aluminium production was 1.4 million tonnes.

In 1993–94, alumina ranked fifth by value among major commodity exports with 3% of total exports, 9.9 million tonnes valued at \$2,246 million; aluminium ranked seventh with 3% of exports, 1.2 million tonnes valued at \$2,153 million.

Japan was the major market for aluminium, taking 36%; Northeast and Southeast Asia together (which includes Japan) accounted for over 93% of exports.

Mineral sands

Mineral sands describes the group of minerals comprising ilmenite, leucoxene, rutile, monazite and zircon, which are produced from deposits on the east and west coasts of Australia. Australia was the world's largest producer of zircon (41%) in 1993.

As a result of overall increases in the quantity of production of mineral sands, the value of production increased by 4% to \$470.9 million in 1993–94. For the same period, exports were valued at \$302.4 million, a rise of 28% from the 1992–93 value.

Ilmenite, leucoxene and rutile are sources of titanium metal and are used in the manufacture of paint and other pigments and as a coating on welding-rod electrodes. Zircon is the major source of zirconium which is a corrosion-resistant metal used in nuclear reactors and chemical processing equipment. Monazite contains certain rare-earth elements

and thorium which is used in incandescent gas mantles and as a fuel in nuclear reactors.

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, which in Australia is produced from titanium-bearing mineral sands. Australia presently supplies about 65% 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*.

Diamonds

Diamonds were first extracted in 1982 in Western Australia.

Australia is now the world's largest producer of diamonds (gem and industrial) with 39% of world production in 1993. Most of this is from the Argyle Diamond Mine in the Kimberley region of Western Australia. This mine commenced operations in December 1985 and is the world's biggest single producer of diamonds.

In 1993–94, 31.7 mega carats of diamonds (sorted and unsorted) were exported with a value of \$562 million.

Uranium

Australia has about 39% of the Western world's low-cost uranium reserves. Deposits occur in the Northern Territory, Western Australia, South Australia and Queensland.

Australia's reasonably assured uranium resources, at December 1993, totalled 631,000 tonnes of uranium recoverable at less than \$US80 per kg U.

The Australian Government maintains its 'three mines' policy with regard to uranium mining, the mines being the Ranger and Nabarlek mines in the Northern Territory and Olympic Dam in South Australia.

The Ranger deposit was discovered in 1969, 250 km east of Darwin, and mining commenced in 1981.

The Nabarlek deposits were discovered in 1970. The Nabarlek 1 deposit is completely

mined out and the mine has been on care and maintenance since 1989.

The Olympic Dam deposits were discovered in 1975 and mining commenced in 1988.

Production of uranium (contained in uranium oxide) for 1993–94 was 2,334 tonnes, with 1,240 tonnes from Ranger and 1,094 tonnes from Olympic Dam.

Uranium oxide exports in 1993–94 were 3,992 tonnes valued at \$193 million.

All Australian uranium production is exported, in the form of yellow cake, principally for use as fuel for nuclear power stations. Minor quantities are used in medical, industrial and scientific applications.

All exports of Australian uranium are subject to the most stringent safeguards which provide assurance that none of the material is diverted from peaceful uses.

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.

Australia has no nuclear power stations.

In 1993 Australia produced 10% of the world's uranium (excluding the centrally planned economies).

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.

Of Australia's identified resources of black coal, currently estimated at 76 gigatonnes (Gt), about 54 Gt are considered to be economically recoverable. They 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.

Black coal production in 1993-94 was 178 million tonnes. Two States dominated black coal production, New South Wales (84.0 million tonnes) and Queensland (85.7 million tonnes). The coal industry was the single largest employer in the mining sector in 1993-94 employing 26,356 people.

More than half of New South Wales coal production is from underground mines whereas over 88% of Queensland coal production is from open-cut mines.

Black coal produced in South Australia and Western Australia, is used for electricity generation, while coal mined in Tasmania is used for industrial purposes such as steam generation.

Black coal is Australia's biggest export earning commodity accounting for 11% of the total value of exports in 1993-94 or \$7,189 million, down from \$7,542 million (and down from 12% of total exports) in 1992-93. By far the biggest market for Australian coal was Japan which bought 61.5 million tonnes for \$3,391 million, 47% of total sales. Republic of Korea bought 16.6 million tonnes for \$934 million (13%) and Taiwan 8.3 million tonnes for \$433 million (6%).

Two-thirds of black coal production, consisting of steaming coal and hard and soft coking coal, is exported.

Australia's Economic Demonstrated Resources (EDR) of brown coal were estimated to be around 41 Gt at December 1994. The main deposits are located in Victoria's Latrobe Valley (over 39 Gt). 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 to exist at many places along the southern margin of the continent, and 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 of power generation, briquette and char manufacture.

Crude oil and condensate

Indigenous production of crude oil and condensate in 1993-94 at 29,583 megalitres (ML) (510 thousand barrels per day) was slightly lower than production in 1992-93 of 30,592 ML. In 1993-94, the Bonaparte Basin produced 1,969 ML of crude oil, nearly 7% of the total indigenous oil production. Production of crude oil from the Gippsland Basin accounts for 58% of total indigenous crude oil production. The North West Shelf was the major producer of condensate during 1993-94 with 60% of indigenous production sourced in that region.

Export volumes of crude oil and condensate decreased by 2% to 9,855 ML in 1993-94 compared with 1992-93. The main markets were Japan, Indonesia and Singapore. Imports of crude oil and condensate increased by 5% to 20,338 ML.

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 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 domestic fuel.

Identified economically recoverable resources of LPG at December 1993 of 131,000 ML were concentrated in Bass Strait, the North West Shelf and the Cooper Basin.

Production of naturally occurring LPG in Australia in 1993-94 was 3,737 ML. The major

contributors to this total were the Bass Strait fields (2,667 ML or 71% of total production) and the Cooper Basin (834 ML or 22% of total production). About 35% of domestic LPG production is exported (1,290 ML in 1993–94), mainly to Japan. Domestic consumption of 3,721 ML in 1993–94 was met by 1,618 ML of product derived from processing industries, with supply shortfalls being met by naturally occurring product and imports.

Natural gas

During 1993–94, 24,855 million cubic metres of natural gas (including liquefied natural gas (LNG)) was produced for domestic consumption and export representing an increase of 3.8% from the 1992–93 production level. In 1993–94, 8,896 million cubic metres of natural gas from the export phase of the North West Shelf Project was liquefied for shipment to Japan. This export earned \$993 million and represented 36% of total Australian natural gas production.

It is estimated that exports of LNG to Japan will continue to expand, rising to a peak of seven million tonnes per year by 1995–96.

Oil and gas resources

The prospects of further discoveries of petroleum in Australia are considered to be only modest, the most prospective area being the 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 Resource Sciences indicate that there is an average probability of finding at least another 380 giga litres (GL) (2,400 million barrels) of crude oil in Australia. This compares with demonstrated economically recoverable resources of 244 GL (1,533 million barrels) and demonstrated sub-economically recoverable resources of 38 GL (244 million barrels) as at December 1992.

17.4 Oil and gas resources(a), December 1992

Basin	Crude oil (GL)	Gas condensate (GL)	LPG (GL)	Sales of gas (TL)
Demonstrated economic resources(b)				
Gippsland (Vic.)	111	21	39	216
Carnarvon (WA)	96	102	84	672
Cooper/Eromanga (SA/Qld)	12	6	11	74
Amadeus & Bonaparte (WA/NT)	21	4	1	34
Perth (WA)	4	—	—	4
Bower/Surat (Qld)	—	—	—	5
Canning (WA)	—	—	—	—
Otway (Vic.)	—	—	—	1
Total	244	133	135	1 006
Demonstrated sub-economic resources(c)				
Gippsland (Vic.)	30	3	—	34
Bonaparte (WA/NT)	2	5	12	155
Carnarvon (WA)	4	4	2	385
Cooper/Eromanga (SA/Qld)	—	4	6	40
Browse (WA)	—	32	61	497
Perth (WA)	—	—	—	—
Amadeus (NT)	—	—	—	7
Bower/Surat/Adavale (Qld)	—	—	—	2
Bass (Tas.)	2	6	8	10
Otway (Vic.)	—	—	—	—
Total	38	54	89	1 130

(a) Based on the McKelvey classification which subdivides 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 extrapolations on geological evidence. (c) 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.

Source: Department of Primary Industries and Energy.

Mineral processing and treatment

As few minerals can be directly used in the form in which they are mined, most minerals must undergo processing and treatment

before utilisation. Table 17.5 shows the production of the main manufactured products of mineral origin during recent years.

17.5 Production(a) of principal manufactured products of mineral origin

	Units	1991-92	1992-93	1993-94
Metals(b)				
Non-ferrous				
Alumina	'000 tonnes	11 824	12 221	12 761
Refined aluminium	'000 tonnes	1 234	1 301	1 384
Refined copper	'000 tonnes	276	312	330
Lead bullion (for export)(c)	'000 tonnes	202	238	208
Refined lead	'000 tonnes	r215	r225	220
Refined zinc	'000 tonnes	325	r332	315
Refined tin	tonnes	248	258	186
Ferrous				
Pig iron	'000 tonnes	6 394	6 445	7 209
Precious				
Refined gold(d)	kg	281 835	288 188	307 336
Refined silver	tonnes	382	355	379
Fuels				
Petroleum products				
Diesel-automotive oil	megalitres	10 279	10 603	11 063
Industrial & marine fuel	megalitres	111	87	95
Fuel oil	megalitres	2 571	r2 498	2 263
Petrol	megalitres	r17 074	r17 728	17 724
Building materials				
Clay bricks	millions	1 632	1 722	1 814
Portland cement	'000 tonnes	5 731	6 225	6 733
Chemicals				
Sulphuric acid	'000 tonnes	816	868	833
Superphosphate(e)	'000 tonnes	1 337	1 440	1 344

(a) Some products exclude production of single establishment manufacturing establishments employing less than four persons and production of establishments predominantly engaged in non-manufacturing activities but which may carry on, in a minor way, some manufacturing. (b) Excludes secondary metal with the exception of basic iron. (c) Metallic content. (d) Newly won gold of Australian origin. (e) Double and triple superphosphate expressed in terms of single phosphate, that is 9% P equivalent.

Source: Australian Bureau of Agricultural and Resource Economics (non-ferrous, precious metals and petroleum products only).

Mineral geology

Minerals of economic significance occur throughout Australia, their geological age ranging from Pre-Cambrian to recent. Many of the large deposits such as the base metal deposits at Broken Hill (New South Wales), Mount Isa and Hilton (Queensland), McArthur River (Northern Territory); the copper-uranium-gold deposit at Olympic Dam (South Australia); the gold deposits of the Kalgoorlie region and iron ore deposits of the Pilbara region (both in Western Australia); and the uranium deposits of the Alligator Rivers area of the Northern Territory, are Pre-Cambrian

in age. In eastern Australia major deposits such as the Elura, Cobar, Woodlawn, Hellyer and Rosebery base metal deposits; the Renison tin deposit; Kidston, Mount Leyshon and most other gold deposits; and most black coal deposits, are Palaeozoic in age. Deposits formed in Tertiary times include the brown coals of Victoria; the oil shales of eastern Queensland; the bauxites of Weipa (Queensland), Gove (Northern Territory) and the Darling Ranges in Western Australia; nickeliferous laterites at Greenvale (Queensland); and the mineral sands deposits of the Murray Basin.

Petroleum has been identified in the Australian sediments as old as Pre-Cambrian. Australia's major petroleum bearing basins are under Bass Strait (mainly Tertiary) and offshore north-western Australia (mainly Mesozoic). The main onshore basins are the Amadeus, Bowen/Surat, Cooper/Eromanga and Perth Basins.

Australia has over 20% of the world's economically recoverable resources of bauxite, iron ore, mineral sands, uranium, industrial diamonds and tantalum. We have over 10% of the world's economically recoverable brown coal, lead, manganese, cadmium and zinc and over 5% of the world's economically recoverable black coal, silver, nickel, lithium and gold.

Mineral exploration

Exploration consists of the search for new ore occurrences and undiscovered oil or gas, and/or appraisal intended to delineate or extend the limits of known deposits of minerals and oil or gas reservoirs by geological, geophysical, geochemical and other methods. This includes drilling but excludes activities of a developmental or production nature. Exploration for water is excluded.

Mineral exploration expenditure

Table 17.6 shows expenditure on private mineral exploration other than for petroleum in Australia during the last six years.

17.6 Private mineral exploration expenditure (other than for petroleum)
(\$ million)

State	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
New South Wales	55.1	60.6	63.3	60.9	73.6	79.2
Victoria	21.0	12.7	12.6	12.2	20.7	31.2
Queensland	128.4	124.1	109.9	117.9	140.2	176
South Australia	13.2	15.5	19.7	21.3	24.7	20.9
Western Australia	315.4	324.8	332.8	348.1	453.7	495.5
Tasmania	11.8	9.9	7.9	7.8	10.2	14.9
Northern Territory	62.6	53.9	57.8	63.5	69.5	75.8
Australia	607.5	601.7	604.0	631.8	792.6	893.3

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

Drilling methods used in Australia

In 1994, the ABS collected additional information on exploration drilling for minerals in Australia.

Private sector companies spent \$284 million on direct drilling costs exploring for minerals in Australia in 1993-94. This represents 36%

of the total Australian mineral exploration expenditure of \$793 million.

Tables 17.7 and 17.8 show drilling methods totals for all areas (including production leases and other areas) by State/Territory.

17.7 Total metres drilled
('000 metres)

Drilling method	NSW	Vic.	Qld	SA	WA	Tas.	NT	Total
Diamond	138.3	n.p.	196.9	n.p.	809.0	42.0	n.p.	1 310.8
Reverse circulation	130.8	52.6	299.3	n.p.	2 715.1	n.p.	196.2	3 435.8
Percussion	45.5	n.p.	169.0	n.p.	n.p.	—	n.p.	344.9
Rotary air blast	n.p.	n.p.	335.8	n.p.	3 755.4	—	n.p.	4 422.3
Other	n.p.	n.p.	14.4	n.p.	n.p.	n.p.	n.p.	568.3
Total	406.6	101.7	1 015.3	124.0	7 764.8	55.5	614.2	10 082.2

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

17.8 Total drilling expenditure, 1993-94 (\$ million)

Drilling method	NSW	Vic.	Qld	SA	WA	Tas.	NT	Total
Diamond	14.8	n.p.	22.0	n.p.	78.6	4.5	7.9	131.9
Reverse circulation	n.p.	1.2	9.3	n.p.	69.6	n.p.	n.p.	91.3
Percussion	1.4	n.p.	n.p.	0.4	n.p.	—	n.p.	11.3
Rotary air blast	n.p.	n.p.	3.8	0.5	33.0	—	1.7	40.0
Other	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	0.6	9.0
Total	21.3	4.2	40.8	3.6	192.1	4.9	16.6	283.6

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

Petroleum exploration expenditure

Petroleum exploration expenditure for all States and Territories for 1993-94 was \$506.7 million, a decrease of 17% compared to 1992-93. Expenditure on production leases rose by 1% but this was more than offset by the drop in expenditure on all other areas of 20%.

Table 17.9 shows expenditure on private petroleum exploration in Australia during the last six years.

17.9 Private petroleum exploration expenditure (\$ million)

	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
Onshore	143.2	217.1	135.3	115.2	144.5	163.8
Offshore	439.4	365.4	338.8	496.7	362.2	519.8
Total	582.6	582.6	473.9	611.9	506.7	683.6

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

Overseas exploration

A survey was conducted during 1994 to collect details of overseas exploration expenditure by Australian resident companies. During 1993-94, \$255.5 million was spent on mineral and petroleum exploration outside Australia.

Petroleum exploration was the largest component of total overseas exploration expenditure (65% in 1993-94).

Table 17.10 shows overseas exploration expenditure for 1993-94.

17.10 Overseas exploration expenditure of Australian resident companies(a), 1993–94 (\$ million)

	North America(b)	Latin America(c)	Papua New Guinea	Indonesia	Other Asia	Africa	Other	Total
Petroleum	n.p.	n.p.	23.9	n.p.	26.2	n.p.	n.p.	166.2
Copper, lead, zinc, silver, nickel & cobalt	n.p.	n.p.	n.p.	3.8	4.0	..	1.7	14.0
Gold	4.3	8.2	6.1	18.0	10.0	2.2	5.3	54.2
Iron ore	..	..	..	..	..	..	..	..
Mineral sands	4.3	n.p.	..	n.p.	n.p.	n.p.	n.p.	5.7
Tin, tungsten, scheelite & wolfram	..	..	..	..	..	..	..	..
Uranium	..	..	..	..	..	..	..	..
Coal	..	..	n.p.	..	n.p.	..	..	0.3
Construction materials	..	..	..	..	n.p.	..	..	n.p.
Bauxite	..	..	..	..	..	..	..	..
Diamonds	n.p.	n.p.	..	1.5	2.1	0.1	3.0	12.3
Other	n.p.	..	..	..	n.p.	..	..	1.2
Unknown(d)	..	..	..	..	n.p.	..	n.p.	n.p.
Total	47.5	42.0	31.7	29.9	45.0	7.1	52.3	255.5

(a) Excludes overseas subsidiaries of Australian resident companies. (b) Includes Canada. (c) Comprises Mexico, South America, Central America and the Caribbean. (d) Preliminary exploration where the commodity is not yet known.

Source: *Actual and Expected Private Mineral Exploration, Australia (8412.0)*.

Administrative and financial arrangements

Mineral rights

Mineral rights in Australia are held by the State and Territory Governments and the granting of exploration and mining titles is administered by them under the respective State or Territory legislation. The Commonwealth Government holds rights to minerals on Australia's continental shelf beyond coastal waters of the States and the Northern Territory and certain prescribed substances in the Northern Territory, within the meaning of the *Atomic Energy Act* (principally uranium). The Commonwealth Government is also able to influence overall development and production activity in the mineral industry by virtue of its constitutional powers with respect to international trade, customs and excise, taxation and foreign investment and has also established consultative mechanisms, such as the Australian Coal Industry Council.

Mining and exploration for other than petroleum — legislation

Onshore

Each State and Territory has its own Mining Act and Regulations governing the prospecting for and working of mineral deposits. These Acts and Regulations,

although similar in principle, are different in detail.

Rights to explore for minerals are awarded by granting prospecting licences and (for larger areas) exploration licences or exploration permits. Each tenement is granted subject to conditions such as minimum exploration expenditure each year, methods of prospecting and the requirement for progressive relinquishment of area held. The tenure is usually limited. Most States and Territories make provision for Miner's Right which permits an individual to prospect or fossick for minerals on Crown Land.

On 3 June 1992 the High Court of Australia brought down its decision in *Mabo and Others v the State of Queensland*. This decision, and the subsequent *Native Title Act 1993* which came into force on 1 January 1994, will have a profound significance on Indigenous people and the various industry groups with vested interests in land. Any land that has been subject to tenure such as freehold, will be free from the Act, as the tenure will be deemed to have extinguished native title. Procedures for carrying out the Act have been designed to be fair, just, economical and prompt, and to safeguard against vexatious and frivolous claims. Exploration will have minimal effect on native title as it has been excluded from the Act. In terms of mining, there is no provision in the Act for the activity to be

vetoed by native title holders. However, the Act does give native title holders the right to negotiate under certain circumstances.

Offshore

Following the enactment of the *Seas and Submerged Lands Act 1973*, the High Court confirmed that the Commonwealth has sovereignty over the territorial sea and sovereign rights over the resources of the whole of Australia's continental shelf. However, in the Offshore Constitutional Settlement between the Commonwealth and the States reached in June 1979, it was agreed that responsibility for mining of the seabed of coastal waters (that is, the area landward of three nautical miles from the baseline of the territorial sea) should lie with the States and the Northern Territory and should be governed by their legislation, while the Commonwealth should have responsibility for areas beyond. The *Offshore Minerals Act 1994*, which replaced the *Minerals (Submerged Lands) Act 1981*, provides for the granting and administration of exploration and mining licences in those areas of sea covered by Commonwealth legislation/powers.

Petroleum mining and exploration — legislation

Onshore

In Australia, full control of petroleum mining rights is vested with the relevant State or Territory Government. Any organisation or individual proposing to undertake petroleum exploration or development must first satisfy the relevant government that it has access to the necessary financial and technical resources to undertake the proposed operations.

Offshore

The situation is the same as that detailed above for mining exploration and development, with the Commonwealth having sovereignty but administrative responsibility shared between the Commonwealth and the States; in the case of petroleum, under the *Petroleum (Submerged Lands) Act 1967*.

The offshore legislation provides for:

- exploration permits, providing exclusive exploration rights over a specific area;
- production licences to authorise development and commercial production from discovered fields; and
- retention leases to allow security of tenure over discoveries not currently regarded as economic to develop.

Offshore projects, except the area around the North West Shelf Gas Project, are subject to Petroleum Resource Rent Taxation (PRRT). The tax is levied at a rate of 40% on net project revenues. All exploration expenditures incurred by the explorer in PRRT liable areas are allowable deductions. The North West Shelf Project is subject to an excise on crude oil production and a royalty on the net wellhead value of all petroleum production.

The Timor Gap Zone of Cooperation Treaty designates an area of the Continental Shelf between Australia and Indonesia subject to control by a Joint Administration. Revenue collected from petroleum production taxation is shared between the two nations. The Treaty has provisions to prevent double taxation.

Mineral royalties

Mineral resources are owned by the Crown in Australia, either by the State and Territory Governments, within their borders (and up to three nautical miles offshore), or by the Commonwealth Government in offshore areas outside of the three nautical mile limit. Accordingly, royalties are collected by State and Territory Governments for mining onshore and up to three nautical miles offshore and by the Commonwealth outside that limit.

State royalties regulations vary in regard to types of royalties, rates levied and those commodities subject to royalties.

In recent years some State Governments have negotiated special royalty arrangements with companies which are seeking mineral leases for large-scale developments. These royalty rates may vary, depending on whether production is for export or for domestic processing. Examples of this type of royalty agreement are the Argyle Project in Western Australia and the Olympic Dam mine in South Australia. Mineral royalties received by governments in recent years are shown in table 17.11.

17.11 Mineral royalty receipts by governments(a) (\$'000)

	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
New South Wales(b)	99 387	128 966	155 006	141 819	150 380	158 008
Victoria(c)	60 043	60 146	53 359	62 600	57 527	48 564
Queensland(b)	178 301	208 820	227 566	263 406	303 194	301 731
South Australia	34 914	44 004	80 570	71 767	71 344	61 114
Western Australia(d)	168 479	244 330	284 842	308 257	310 582	285 200
Tasmania	3 800	6 394	5 350	4 729	5 795	3 938
Northern Territory	9 514	24 079	28 350	28 265	14 942	28 715
Commonwealth Government	182 670	273 077	361 791	102 459	178 436	100 327
Total	737 108	989 816	1 196 834	983 302	992 200	987 597

(a) Significant revisions have occurred to some figures due to the reclassification of petroleum royalty payments and payments to the States under arrangements relating to the collection of offshore petroleum royalties. (b) Includes royalties on sand and gravel from Crown lands. (c) Includes royalties on brown coal paid by State Electricity Commission. (d) Includes prepaid royalty of \$50 million in respect of diamond royalty agreement.

Source: Federal, State and Territory departments responsible for mining.

Crude oil marketing and pricing arrangements

The crude oil market was deregulated on 1 January 1988. Refiners and producers are allowed to negotiate freely the quantities and prices of crude oil they buy and sell. Crude oil producers also have complete freedom to export crude oil as an alternative to selling on the domestic market, subject to government policy in times of emergency. The Commonwealth government no longer fixes an Import Parity Price nor requires refiners to absorb quantities of Australian oil at that price, as it did prior to deregulation.

Decisions on major refinery investment associated with changes in domestic crude availability have been easier in a deregulated market and a significant program of investment in upgraded plant and equipment has already been undertaken.

The price of crude oil used for the purposes of excise tax assessment is the monthly volume weighted average of realised prices of sales of oil from the area subject to excise.

Pricing of liquefied petroleum gas

As from January 1991 the pricing of LPG became subject to market forces alone. The Prices Surveillance Authority (PSA) ceased to have responsibility for determining the maximum wholesale price of LPG in each capital city, although it maintains a close monitoring role.

Pricing and export approval system for liquefied natural gas (LNG)

The Commonwealth government removed volume controls on LNG exports in November 1991, but a price approval and monitoring system has been maintained to ensure that community returns are safeguarded. The Department of Primary Industries and Energy has responsibility for price monitoring.

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 Petroleum Resource Rent Tax (PRRT) applies to petroleum projects in the majority of Australia's offshore areas beyond the States' territorial seas. Excluded are the 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) may be applied to onshore petroleum projects by State governments. Where RRR is applied the legislation 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 North West Shelf projects offshore and all onshore areas (except Barrow Island where a RRR applies).

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 and 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 fields that were not developed as at 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 from the North West Shelf project area. Proceeds are shared by the Commonwealth with Western Australia. Onshore petroleum rights are vested in the State and Northern Territory governments and the Commonwealth does not, in general, receive a share of this royalty.

Incentives to encourage petroleum exploration and development

Australia remains underexplored and its full petroleum potential is yet to be determined. Through both macro-economic policies and micro-economic reform, the Commonwealth government has introduced measures to

encourage investment to ensure that Australia's potential is realised.

Key government initiatives specific to the petroleum industry include:

- the offshore exploration strategy, which includes a twice yearly program of releasing exploration areas on which companies can bid;
- the Petroleum Resource Rent Tax (PRRT) reforms (see *Secondary tax arrangements in the petroleum industry* above);
- development of a national gas strategy, which aims to free up domestic gas markets;
- deregulation of the crude oil and LPG markets, which removed controls on prices and restrictions on sale of these commodities within and outside Australia;
- accelerated depreciation and investment allowance arrangements under company tax.

In the 1995 Budget the Commonwealth government set the rate of company tax in Australia at 36%. This rate of taxation is significantly lower than the 49% rate that applied in 1988.

Administrative 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 support for a number of advisory bodies including the Energy Research and Development Corporation, the Australian Minerals and Energy Council, the National Energy Consultative Council, the National Oil Supplies Advisory Committee, the National Petroleum Advisory Committee, the National Fuels Emergency Consultative Committee, and the Australian Coal Industry Council.

The Department is also responsible for the implementation of action required from Australia's membership of the International Energy Agency and for the national system of accounting for control of nuclear materials under Australia's Agreement with the International Atomic Energy Agency.

Energy Research and Development Corporation (ERDC)

The ERDC manages the Commonwealth's direct investment in energy innovation and research. Since establishment the Corporation has committed approximately \$48 million to investments in innovative projects which have a total cost of approximately \$161 million.

The ERDC invests in energy projects from the conceptual stage through to commercialisation. It focuses investments on traditional energy supply, alternative and renewable energy sources and systems, and sustainable energy use. Research priorities reflect industry needs, the Commonwealth's key energy objectives and the *National Greenhouse Response Strategy*.

The investment objectives of the ERDC are to continue to diversify energy supply options while increasing the efficiency of energy supply and use, and ensuring the development of competitive Australian industries. At the same time it aims to reduce the impact of energy projects on the environment as well as consumers' energy costs. Investment projects are selected to meet these objectives.

As ERDC's priorities are needs driven, it works closely with industry, focusing on industry needs, identifying the potentially most viable areas and, where appropriate, funding them. It has refined its project design, selection and management processes to emphasise outputs, commercial platforms, management, relevance and coherent effort.

International Energy Agency (IEA)

The IEA (of which Australia is one of the 23 members) was founded in 1974 to safeguard members' collective energy security through cooperation and, if necessary, sharing of energy supplies between members.

While energy security remains a major objective, the IEA is giving increasing attention to helping members achieve global energy and environmental objectives, preserving open trade in energy, and fostering greater competition in domestic energy markets. The IEA also fosters international collaboration in energy research and development.

Research

Research into exploration, mining, ore-dressing and metallurgy is conducted by government bodies, universities, private enterprise, and by the combined efforts of all these. A summary of the main organisations and their functions follows.

Australian Geological Survey Organisation (AGSO)

The Australian Geological Survey Organisation (AGSO), formerly called the Bureau of Mineral Resources, Geology and Geophysics (BMR), is Australia's national geoscientific agency.

AGSO's primary mission is to build a national geoscientific mapping effort to encourage economically and environmentally sustainable management of Australia's minerals, energy, soil and water resources.

AGSO's role is to improve the quality, extent and accessibility of the geoscience knowledge base to underpin the development of a more competitive and diversified Australian mineral and petroleum exploration industry. It also aims to improve the management of Australia's natural resources consistent with the principles of ecologically sustainable development while at the same time developing effective strategies to mitigate the effects of natural geological hazards.

AGSO provides expert professional geoscientific advice on minerals, petroleum, ground water, coastal and marine issues and seismological and geological hazard analysis to support the development of management principles and land use strategies. AGSO also contributes to Commonwealth Government involvement in international geoscientific activities and development assistance programs, and actively pursues commercial geoscientific projects in collaboration with Australian industry and other organisations as appropriate.

AGSO's activities include regional mapping and analysis of major mineral provinces and petroleum basins, regional environmental mapping (including land resources such as soils and ground water), airborne magnetic and radiometric surveying, onshore and offshore seismic surveying, the operation of geophysical observatories and the development of an accessible National Geoscience Information System.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Minerals research by the CSIRO is primarily undertaken within the Institute of Minerals, Energy and Construction (IMEC).

Research and development activities of the Institute are designed to play a major contributing role in the development of sustainable and competitive minerals, energy and construction industries in Australia and in the creation of a better living and working environment for all Australians.

This will be achieved by the provision of high-quality research, development and service capabilities to support existing and emerging industries as well as providing for the next generation of technology, products and processes. At the same time the Institute will continue to bring about safe and ecologically sustainable development for all Australians through research and advice on environmental issues related to IMEC's client industries. In addition, by working closely with industry, government and other organisations the Institute will help transform research outcomes into new or improved business opportunities including, where appropriate, the championing of individual projects.

Australian Mineral Industries Research Association Limited

The Association provides high-quality development and management of jointly funded research projects for the benefit of the Association's members. Membership includes all the largest Australian mineral and coal companies, smaller exploration companies, and suppliers of services to the industry. It sustains an active involvement in four Co-operative Research Centres and was appointed in 1992 to manage the Australian Coal Association Research Program.

Energy

Energy is fundamental to Australia's standard of living and economic performance. It has an important role to play in restructuring Australia's economy and improving its competitiveness.

The Commonwealth Government has a significant involvement in the activities of the energy sector. Its responsibilities for export policy and offshore petroleum activities have a major impact on specific development projects.

Key Australian energy policy objectives are:

- responsible development of a growing, internationally competitive energy export sector;
- promotion of efficient production, distribution and use of energy to maximise its contribution to Australia's economic performance;
- development of a flexible, dynamic energy sector capable of responding effectively to change;
- integration of economic efficiency in the production and use of energy with environmental goals through the principles of ecologically sustainable development; and
- promotion of domestic R&D aimed at efficient, ecologically sustainable energy production, diversification and use, complemented with international energy R&D cooperation.

In 1991, the Commonwealth released an energy policy discussion paper, *Issues in Energy Policy: Agenda for the 1990s*, which identified a number of key issues:

- developing a framework for a coordinated energy policy for all of Australia;
- developing effective mechanisms to incorporate the costs of environmental damage, risk or rehabilitation into energy costs and prices;
- improving energy efficiency as a cornerstone of sustainable energy production and use;
- reforming the electricity supply industry;
- drawing up a national strategy for the development of natural gas;
- maintaining energy supplies for Australia; and
- enhancing Australia's position as a reliable supplier of a diversified mix of clean fuels.

Progress on these issues means that Australia is now well placed to meet its key energy policy objectives.

Australia has abundant reserves of coal, gas and uranium to meet both export and domestic demands. Given currently known resources, it can continue current production rates in these energy sources for 300 years (black coal), 45 years (gas), and 145 years (uranium), respectively. Australia is one of only five Organisation for Economic Cooperation and Development (OECD) countries that are net energy exporters. Australia is:

- the world's largest exporter of coal, accounting for around one-third of the world seaborne coal trade;
- a major uranium producer and exporter; and
- currently an exporter of Liquefied Petroleum Gas (LPG) and petroleum products, and a major exporter of Liquefied Natural Gas (LNG).

Information on petroleum resources is available in table 17.4.

Energy resources

Information relating to mineral energy resources — black coal, brown coal, petroleum, uranium and thorium — is contained in the Mining Industry section of this chapter.

Information on other forms of energy resources follows.

Solar

One of the best prospects for using many renewable energy technologies to generate electricity in the short to medium term appears to be in remote areas, where there are a total of more than 10,000 households and 300 communities which generate their own electricity. Remote area power supply systems can be based on different renewable energy technologies, depending on local resources. Photovoltaic cells are the most widely used technology, with some wind powered systems and a small number of micro-hydro systems. Batteries store electricity produced by the solar cells or wind turbines

for use during periods when the sun is not shining or when there is no wind.

There are two main applications of solar energy that have the potential to make a significant contribution to grid-based electricity supply. These are photovoltaics and solar thermal technologies. One of the most promising applications of photovoltaics would appear to be on long feeder lines. It is also possible that solar power supply systems could be a cost effective source of peaking power in those electricity grids where the maximum annual load occurs in summer. A wide range of solar thermal technologies are the subject of research and development around the world. These include systems where sunlight from a large field of mirrors is focused on a central receiver, where the heat is used to produce electricity; smaller, dispersed systems, each unit of which operates as a separate collector; and solar ponds which effectively collect and store low grade heat.

Passive solar design is an economically viable means of using solar technology throughout Australia. Careful attention to building design, materials and orientation can greatly decrease heating and cooling requirements (and increase comfort) for a modest increase in construction costs over conventional buildings. Passive solar design principles have shown that solar energy can meet up to 90% of normal household space heating needs.

Australia has a well established domestic solar water heater industry. At June 1994, domestic solar water heaters were installed on some 300,000 or 5% of Australian houses. In Western Australia one in four households has a solar water heater, while in the Northern Territory the figure is 58%. In the 1993–94 Budget, the Commonwealth Government announced that it would provide \$6 million for a program to enable solar water heaters to be provided to consumers at low initial outlay. The aim of the program is to develop, trial and demonstrate innovative means of financing solar water heaters. The program encouraged cooperative action between industry, energy utilities and financiers to provide households with solar water heaters at a low initial cost, with the balance to be recovered through payments collected through customers energy bills.

Wind

Of the renewable energy technologies to emerge in the last 10–15 years, wind farms are probably the most promising and lowest cost option for large-scale power supplies in the near term. Australia's best wind resources are located in coastal regions of southern Australia, particularly in Tasmania, South Australia and Western Australia.

At Esperance in south-west Western Australia, the State Energy Commission of Western Australia has commissioned a 2.5 megawatt wind farm which will supply some 14% of the town's power supply. In Victoria, a wind turbine has been installed at Breamlea, south-west of Melbourne, which produces some 100,000 kWh per annum.

Wave

Wave power plants are another potential source of electricity for Australia. Although detailed studies of Australia's best wave resources have yet to be undertaken, the best conditions appear to be in southern regions.

The commercial use of wave power throughout the world is presently confined to small-scale applications in areas which have traditionally relied upon high cost sources of electricity such as diesel generators. At this stage there appears to be considerable uncertainty about the cost of electricity produced by wave power plants.

Geothermal

Geothermal heat can be used for the production of electricity. Commercially available geothermal power plant technology relies upon heat extracted from aquifers located in regions with significant geothermal activity. Possible areas identified in Australia are near the Great Artesian Basin. Hot water from bores in these areas could provide an opportunity to produce electricity for homesteads and communities. A 120 KW demonstration plant is operating in Birdsville, Queensland. In Portland, Victoria, geothermal energy is currently being used for water heating at the municipal swimming pool, and also for space heating at the hospital and police station.

Hot dry rocks technology involves pumping water into holes drilled into hot areas deep beneath the earth's surface. This water is then

collected and brought to the surface where it is used to generate electricity. Significant resources exist in central Australia.

Given the scale of the engineering required, this technology is likely to be only appropriate for grid connected applications. Further exploration is needed to delineate Australia's resources, as the best resources identified to date are located in central Australia, and significant costs would be associated with transmitting electricity from this source to major metropolitan centres.

Municipal waste

Rubbish dumps or landfills contain large amounts of organic matter. As time passes some of this organic matter is converted into methane by bacterial action. This methane is known as landfill gas and can be collected using drill holes and used either to power an engine to generate electricity for sale to the electricity grid, reticulated in natural gas pipelines or used as a source of heat for applications adjacent to the landfill (for example, brick works, heated swimming pool). The use of landfill gas power plants in Australia was pioneered by Northcote City Council with a Commonwealth grant.

Major landfill gas developments have occurred in the States of Victoria, New South Wales and South Australia. The first landfill gas-fuelled power station was commissioned in Victoria in May 1992, and that State now has three such power stations operating at Berwick (5.6 MW), Corio (0.9 MW) and Broadmeadows (5.0 MW). Similar power stations are now operating in New South Wales at Lucas Heights (4.0 MW, commissioned in May 1994) and at Wingfield in South Australia (5.0 MW, commissioned in July 1994).

Biomass

Two forms of biomass most frequently used in Australia are wood and bagasse. Approximately 6.0 megatonnes of firewood are currently used annually in Australia, equivalent in energy terms to about 100 petajoules, or 2.5% of total energy consumption.

Bagasse, the fibrous residue remaining after extraction of the juice from sugar cane, is the major fuel used in the sugar industry, providing about 70 petajoules, or 1.75% of Australia's total energy consumption.

Electricity and gas supply

Administrative changes in the electricity and gas industries

Reform of the electricity supply industry, which began within utilities in the late 1980s, continued to accelerate in 1993–94 and 1994–95.

In every State and in the Australian Capital Territory organisations were subject to substantial change, but there were significant differences in emphasis and action in all jurisdictions.

The most radical change occurred in Victoria with the State Electricity Commission and the Melbourne municipal distribution organisations being turned into five distribution businesses and seven generation companies, and the subsequent privatisation of these assets.

Inter-government agreement was pursued on construction of a transmission system (Eastlink) between Queensland and New South Wales and on corporatisation of the Snowy Mountains Hydro-Electric Authority.

Substantial activity continued on the structure of the proposed competitive electricity market for the eastern and southern seaboard, while in Western Australia the integrated electricity and gas supply utility was preparing to split in two and competition in electricity generation began to emerge through development projects involving independent power producers.

Overall, the new electricity market will be strongly influenced by the emergence of a national competition regulation system flowing from the Hilmer inquiry which will lead to national oversight of utility market conduct for the first time. At the same time, in Victoria and New South Wales, the activities of the electricity suppliers came strongly under the influence of government price regulators.

COAG (The Council of Australian Governments) agreed in February 1994 to an initiative to implement free and fair trade in natural gas by 1 July 1996. Reform of the gas sector is part of the wider competition policy reforms being pursued by COAG in other sectors of the economy.

The potential for major advances in the gas industry through competitive policies being developed under the gas reform initiative is strong. Moreover, the economic and environmental benefits of increased competition in the gas sector, and between gas and other fuels, will be substantial for Australia. Furthermore, emissions of greenhouse gases will be reduced with increased efficiency in energy use and greater fuel substitution, especially for coal in electricity generation. The new arrangements for the industry will need to include pro-competitive policy measures for third party access to gas transmission facilities and a transition strategy for effective implementation of a national framework for free and fair trade in gas after 1 July 1996.

Electricity and gas supply

At 30 June 1994, the total installed public electric generating capacity in Australia was 37.3 million kilowatts. Total electricity generation in 1993–94 was 156,564 million KWh.

Of total public electrical energy produced during 1993–94, hydro-electric sources provided approximately 11%, and the balance was supplied by fossil fuels with approximately 81% provided by coal. The development of coal-fired power stations has been facilitated by the presence of large demonstrated economic resources of coal close to the major industrial areas in New South Wales and Victoria.

Natural gas consumption in 1993–94 was 733 petajoules, an increase of 3.8% on 1992–93, and contributed 17.6% of Australia's energy consumption.

Natural gas exports in the form of LNG (Liquefied Natural Gas) began in 1989 and for the year 1993–94 were equal to 311 petajoules.

17.12 Electricity and gas establishments — summary of operations, 1993–94

Items	Electricity					Gas
	NSW	Vic.	Qld	Other(a)	Aust.	Aust.
Income & expenditure						
Turnover (\$m)(b)	7 720.9	5 946.0	3 717.6	3 296.1	20 680.6	3 132.9
Plus closing stocks (\$m)	433.0	49.1	89.6	169.7	741.5	58.6
Less opening stocks (\$m)	447.9	64.7	105.0	201.4	819.1	64.2
Less purchases, transfers in & selected expenses (\$m)	4 121.7	3 442.5	1 858.1	1 225.9	10 648.2	1 492.6
Value added (\$m)	3 584.3	2 487.8	1 844.0	2 038.7	9 954.8	1 634.7
Fixed capital expenditure less disposals (\$m)	558.5	618.7	526.5	374.6	2 078.3	240.5
Employment details						
Establishments at 30 June (no.)	28	21	17	13	79	(c)29
Employment at 30 June(d) (no.)	18 350	7 570	8 500	9 760	44 180	7 690
Wages & salaries(e) (\$m)	700.3	481.6	324.3	503.4	2 009.6	315.0

(a) South Australia, Western Australia, Tasmania, Northern Territory and Australian Capital Territory. (b) Includes transfers out to other establishments of the same management unit where appropriate. (c) The number of gas establishments operating at 30 June 1994 for the States/Territories were NSW — 15; Vic. — 3; Qld — 5; SA — 2; WA — 1; Tas. — 1; NT — 1; ACT — 1. (d) Includes working proprietors. (e) Excludes amounts drawn by working proprietors.

Source: *Electricity and Gas Operations, Australia* (8208.0).

The main features of the production and distribution of electricity and gas in each State and Territory are outlined below.

Snowy Mountains Hydro-Electric Scheme

The Commonwealth Government's major direct role in the electricity supply industry is its major responsibility for the Snowy Mountains Scheme. It supplies water for both electricity generation and irrigation. Located in south-eastern Australia, on its completion in 1974, the Scheme 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 and 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 *Year Book Australia* 1986.

New South Wales

Energy activities in NSW include coal production, electricity generation and distribution, gas distribution, petroleum refining and distribution, and renewable energy technology, research, development and production.

NSW has significant resources of high quality black coal which is used for electricity generation, steel making and industrial process heat generation. It is the State's main export earner.

The total primary energy consumption of oil, gas, coal, bagasse and wood in 1993–94 was 3,285 petajoules (PJ), including exports (mainly coal) of 1,749 PJ. The final end use of energy by industrial, commercial, transport and domestic sectors in 1993–94 was 939 PJ, excluding the conversion and distribution losses of 691 PJ.

Coal fired thermal power stations generate 94% of the State's electricity, the balance by the Snowy Mountains Hydro Electric Scheme together with smaller hydro and gas turbine power stations.

Electricity is generated primarily by the State owned utility, Pacific Power (the trading name of the Electricity Commission of NSW), transmitted around the State by the Electricity Transmission Authority, and distributed to consumers by twenty-five regional electricity

distributors. Electricity is also sold directly by Pacific Power to a few large customers under contract, and is sold interstate. A national competitive electricity market is to commence in July 1996. In preparation for the market, the structure of the NSW generation and distribution sectors is under review.

At June 1994, Pacific Power operated seven coal fired power stations with a total capacity of 11,520 MW, six hydro-electric stations with a total capacity of 335 MW and four oil fired gas turbine power stations with a total capacity of 295 MW. In addition, NSW is entitled to a two thirds share from the Snowy scheme with a generating capacity of 3,740 MW. There are also several private generators (such as BHP) with a total installed capacity of about 300 MW and these include hydro as well as thermal power stations based on coal, bagasse, coal seam methane, oil and landfill gas.

The total electricity generated in NSW from all sources (except private generators) in 1993–94 was 55,689 gigawatt hours (GWh) including 3,329 GWh from the Snowy scheme. The maximum demand for electricity from the Pacific Power system in 1993–94 was 9,890 MW. The total electricity consumption in 1993–94 was 48,409 GWh, of which 32% was consumed by the residential sector while the rest was used by the industrial and commercial sectors.

NSW has no known economically recoverable natural gas or petroleum resources but has large resources of coal seam methane which may be economically recoverable.

All of NSW's natural gas supply comes from interstate and is transported to NSW via the 1,351 km Moomba–Sydney pipeline. Distribution within NSW is mostly undertaken by private operators. The total amount of reticulated gas sales in NSW in 1993–94 was 91,474 terajoules, of which 75% is used by the industry and the rest is shared by the residential and industrial sectors.

NSW imports crude oil and refined petroleum products from interstate and overseas. Domestic refineries process the crude, and petroleum products are distributed by private industry. The total sales of petroleum products in 1993–94 was 10.465 megalitres, with the transport sector accounting for 83%.

Victoria

During 1993–94 the State Electricity Commission (SEC) of Victoria was restructured, resulting in the establishment of Generation Victoria. This restructure was part of the ongoing reform of electricity supply in the state, intended to facilitate the introduction of competition into the electricity generation sector.

Generation Victoria operates three major brown coal mines producing a total of approximately 50 million tonnes annually, three major base load coal-fired power stations with a total capacity of 5,050 MW, two gas-fired power stations with an intermediate/peaking capacity of some 1,000 MW, and Victorian Hydro with a capacity of 470 MW.

Generation Victoria is a state owned enterprise but will shortly be competing in an open industry against a variety of private and interstate generators. The organisation is the second largest generator of electricity in Australia.

In 1993–94 approximately 30,000 GWh brown coal generation was undertaken, resulting in an increase in the amount of coal mined to 48.3 million tonnes (46.8 million tonnes in 1992/93). During the same period the Lurgi Plant began producing pulverised dried coal for Loy Yang B Power Station.

Victorian Hydro increased generation by about 10% above the long term averages (1,117 GWh), despite the late return to service of Dartmouth Power Station following reconstruction. This was largely due to heavy spring rainfall in 1993.

Major overhauls at Newport Power Station and Jeeralang gas turbine station limited power production to 2,230 GWh (2,835 GWh in 1992–93). Hazelwood Power Station generated 4,664 GWh, 50% of its average generation level over the previous two years.

The Gas and Fuel Corporation of Victoria combines the resources of government with those of private enterprise to supply gas, which is reticulated to approximately 1.27 million domestic, industrial and commercial customers through some 24,089 kilometres of pipelines.

In addition to the Greater Melbourne area, gas is also supplied to 50 cities and towns throughout Victoria and in Albury, New South Wales. Ninety-nine per cent of reticulated supply is Bass Strait natural gas, purchased from Esso and BHP. Six towns in western Victoria receive a reticulated supply of tempered petroleum gas.

Queensland

The main supply of electricity in Queensland is controlled by the Queensland Electricity Commission (QEC). The QEC provides electricity to major users of power and to seven Electricity Boards which in 1993–94 provided power to 1,174,558 domestic and 181,103 commercial and industrial consumers, increases of 4.5 and 3.1%, respectively over the previous year.

Electricity generation in Queensland is based primarily on the State's plentiful resources of black coal. In 1993–94, Stanwell, Callide B, Tarong, Gladstone Swanbank A and Swanbank B steam plants consumed 12,041 kilotonnes of coal and 12,992 tonnes of oil. This generated 27,696.3 GWh of energy or 87% of electricity generated in Queensland. The hydro-electric plants at Kareeya, Barron Gorge and Wivenhoe generated 540.1 GWh of energy in 1993–94.

Coal-fired power stations provide the bulk of Queensland's electrical energy needs, augmented as necessary by pumped-storage and conventional hydro-electric stations for peaking capacity.

Up to 1991–92 the main gas producing region in Queensland were the Roma–Surat and Denison Trough areas but in recent years production from the Cooper Basin in South West Queensland has far outstripped that from the original fields and now contributes over 75% of the State's natural gas production. It has been estimated that the annual demand for natural gas in Queensland will at least double in the next few years to 80 petajoules in line with the overall rate of commercial and industrial growth. Areas of growth not only include Brisbane and the coastal strip but also the mineral rich North West.

South Australia

The Electricity Trust of South Australia (ETSA) is responsible for unification and coordination of the major portion of the State's electricity supply.

At June 1993, the Electricity Trust's installed capacity was 2,350 MW. Its major power stations are Torrens Island (1,280 MW), Port Augusta Northern Power Station (500 MW), and Port Augusta Playford 'B' (240 MW). The Trust also operates gas turbine stations at Dry Creek (156 MW), Mintaro (90 MW) and Snuggery (75 MW) and a small diesel station at Port Lincoln (9 MW).

The Electricity Trust supplies directly or indirectly more than 99% of all electricity customers connected to the public supply within the State. The remainder are supplied by small diesel generating plants situated in towns in the more remote areas of the State. The total number of Electricity Trust customers at 30 June 1994 was about 687,500.

A 500 MW capacity interconnection with the Victorian–New South Wales systems has been operational since March 1990.

SAGASCO Holdings Ltd has responsibility for oil and gas exploration, development and production, and the distribution within the State of gas and LPG. It has three subsidiaries: South Australian Gas Company Ltd (to supply gas to Adelaide and surrounding areas), SAGASCO Resources Ltd (to undertake oil and gas exploration, development and production) and SAGASCO LPG Pty Ltd.

In October 1993, Boral Ltd acquired the SAGASCO Holdings group of companies.

Natural gas is reticulated through most of the Adelaide metropolitan areas, as well as Port Pirie (since 1976), Angaston (1983), Peterborough (1987), Whyalla (1988), Mount Gambier (1991), Murray Bridge (1994) as well as being available for major industries in the Riverland (1994). Mount Gambier is supplied from the Katnook gas field located 80 km north of the city. Liquefied petroleum gas is reticulated to consumers in Roxby Downs.

Western Australia

On 1 January 1995, State Electricity Commission of Western Australia (SECWA) was divided into separate electricity and gas corporations, trading as Western Power and Alinta Gas and a regulatory agency called the Office of Energy. This initiative was aimed at maximising the scope for efficiency improvements in the electricity and gas generation, transmission and distribution industries in Western Australia. The potential for private firms to compete in the energy sector has been increased substantially.

As corporatised government businesses, each will operate similar to private companies with Boards of Directors and managerial autonomy. However, the State Government will continue as the sole shareholder but with less direct involvement.

Most of the electricity production in the State will now be generated by Western Power, whose responsibilities include ensuring the effective and efficient use of the State's energy resources and the provision of economical and reliable supplies of electricity and gas. Significant amounts of electricity are also generated by private enterprise, particularly large-scale mining companies in the Pilbara region.

Western Power will continue the operation of the two power grid systems, one for the Pilbara and the other for the south-west, which supply the electricity needs of 98% of the State's population.

The South-West Interconnected System services an area from Kalbarri in the north to Bremer Bay in the south and from Perth east to Kalgoorlie. Three major thermal power stations provide the bulk of electricity for the system. Two coal fired stations are located at Muja (1,040 MW capacity) and Bunbury (120 MW), and the third at Kwinana (880 MW) is fuelled by coal, heavy fuel oil and North West Shelf gas. Gas turbines are located at Pinjar (north of Wanneroo), Mungarra (south-east of Geraldton), Kwinana, Geraldton and Kalgoorlie to provide peak and emergency power. The commissioning of an additional four 36 MW and one 116 MW gas turbines during 1993, make Pinjar the third largest station in this system with 18.0% of the total capacity of 2,754 MW.

The Pilbara Interconnected System links Karratha, Dampier, Cape Lambert, Wickham, Roebourne, Port Hedland and Goldsworthy. Electricity is supplied from Cliffs Robe River Iron Associate's gas-fired station at Cape Lambert. Additional power can be drawn from the Western Power stand-by diesel generating facility at Port Hedland, from Hamersly Iron Proprietary Limited's power station at Dampier and from a Western Power gas turbine generating unit also located in Dampier.

Outside the electricity grid systems, Western Power will operate another 28 smaller diesel power stations and provides support services for the Aboriginal and Torres Strait Islander Commission to help run 34 Aboriginal village power stations in remote areas of the State. At 30 June 1994, SECWA had 700,353 customer accounts for electricity throughout Western Australia.

Alinta Gas operations comprise the purchase, transmission, distribution and sale of natural, tempered liquefied petroleum and synthetic natural gases to commercial, industrial and domestic customers.

Much of Australia's natural gas reserves are located in Western Australia. The availability of gas from the North West Shelf has changed Western Australia's energy consumption patterns significantly. Natural gas now supplies more than 60% of Western Australia's total energy requirements.

The North West Shelf will continue to provide most of the natural gas to Alinta Gas with a small amount of gas also being received from the onshore Woodada gas field (near Dongara). In addition to reticulating (principally) North West Shelf natural gas to customers linked to the Dampier to Bunbury pipeline, Alinta Gas will also reticulate tempered liquefied petroleum (TLP) gas to customers in Albany on the south coast, and Simulated Natural Gas (SNG) to customers in Mandurah, south of Perth. At 30 June 1994, there were 319,644 customer accounts for natural gas, 3,014 customer accounts for TLP gas and 3,890 for SNG gas. This represents an increase in customers of 7.8% since June 1993.

Research continues into alternative sources of energy. Western Australia's geographical and climatic characteristics are such that it has potential to take advantage of advances in the use of solar, wind, hydro-electric and tidal or wave power.

Wind power was of some significance as an energy source in the early days of settlement and is still used extensively in agricultural and pastoral areas for pumping water for stock. In March 1987, SECWA commissioned six 60 kilowatt wind turbines at Salmon Beach, a few kilometres west of the south coastal town of Esperance, to augment the local electricity supply. A second wind farm was commissioned at Ten Mile Lagoon, Esperance during March 1994. The wind farm consists of nine 225 kW units and is capable of supplying up to 30% of Esperance's power needs. During its first year of operation it was estimated that over half a million dollars worth of fuel oil was saved. During its first year of operation the wind farm produced 4.6 million kW hours of electricity which resulted in a 3,600 tonnes reduction in carbon dioxide emissions normally associated with diesel fuel generated power. A wind power generator is also being used to augment the electricity supply on Rottnest Island.

Work has started on the Ord river hydroelectric scheme which will consist of two 15 MW power stations to convert water energy from Lake Argyle into electricity. The scheme will supply power to the townships of Kununurra and Wyndham, the Argyle Diamond Mine and future downstream processing facilities.

Agreement has been reached to buy electricity from Western Australia's first private power station using landfill gas. The power station at the Redhill landfill site (approximately 25 km north-east of Perth) was commissioned in June 1993, and has a capacity of about two MW which is sufficient to supply electricity for 2,000 average homes.

Tasmania

Tasmania's electricity requirements are provided by the Hydro-Electric Commission (HEC). The total installed generator capacity on mainland Tasmania at 30 June 1995 was 2,602 MW, consisting of 27 hydro power stations and an oil-fired thermal station of 240 MW located at Bell Bay. In addition two diesel generator power stations supply electricity to King and Flinders Islands.

Hydro-electric power accounts for almost all reticulated energy in Tasmania. A usually reliable distribution of rainfall throughout the year and the establishment of numerous lakes within the state, has created substantial artificial storage.

The Hydro-Electric Commission purchased approximately five GWh of electricity from three private suppliers in 1994-95.

During the 1994-95 financial year approximately 8,680 GWh was generated by the HEC in mainland Tasmania, a decrease from the previous year. Total sales amounted to 8,044 GWh of which 4,866 GWh was sold to the major industrial sector.

Total water storage at 1 July 1995 were 57.7% of full supply energy, a rise of 4.0% in the 12 month period. The total yield to storage during 1994-95 was 92% of the long term average. Bell Bay thermal station did not supply energy during this financial year.

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

Northern Territory

The Power and Water Authority (PAWA) is responsible for the provision of electric power supply, water supply and sewerage services throughout the Northern Territory, servicing not only large urban areas such as Darwin and Alice Springs, but also many small remote communities and Aboriginal outstations. In addition, the Authority has responsibility for water resources and natural gas development.

The Aboriginal Essential Services Branch (AES) operates and maintains power services to 66 remote communities across the Territory. PAWA also maintains minor water supply systems on more than 450 Aboriginal outstations.

Total energy generated in the Northern Territory in 1993-94 was 1,209 GWh. Total sales comprised 779 GWh to businesses, of which 298 GWh was government sales, and 313 GWh to domestic consumers.

Natural gas pipelines from the Amadeus Basin in central Australia supply the Territory's four major centres — Darwin, Katherine, Tennant

Creek and Alice Springs — all of which use indigenous natural gas, replacing imported heavy fuel oil and distillate as fuel for electricity generation.

PAWA has entered into a 20 year agreement with McArthur River Mining to supply electricity for the new lead, zinc and silver mine in the Gulf region. This includes provision, operation and maintenance of a power station at the mine, and supply of gas via a pipeline to be operated and maintained by the Authority.

Australian Capital Territory

Electricity is distributed within the Territory by the ACTEW Corporation Ltd (ACT Electricity and Water Authority prior to 1 July 1995). During 1993–94 the total bulk

electricity purchased was 2,318 GWh, comprising 1,648 GWh provided by Pacific Power, and 670 GWh reserved from the Snowy Mountains Hydro-Electric Authority. The system's maximum demand was 547 MW. ACTEW supplied 121,679 customers at June 1994.

Natural gas from the Moomba fields in South Australia is piped to Canberra via a 70 km spur which branches from the main Moomba-Sydney pipeline at Dalton.

During 1993–94, AGL Canberra Ltd reticulated 4,377 terajoules of natural gas to 1,274 commercial and industrial establishments and about 44,500 homes.

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