
Introduction	441
Energy resources	441
Energy supply, conversion and end use	444
Electricity and gas operations	445
Energy use and the environment	449
Renewable energy resources	450
Solar	450
Wind	450
Biomass	451
Wood	451
Bagasse	451
Ethanol	451
Administrative arrangements	451
Bibliography	452

Introduction

The energy sector encompasses all activities associated with the production, transformation, distribution, and use of energy. It is a major contributor to the Australian economy, accounting for about 5% of the Gross Domestic Product (GDP), 16% of total export income, and over 2% of total employment. Energy is a vital input to other sectors of the economy such as the transport, agriculture, and household sectors, and affects the conduct of economic activities and the standard of living of the Australian people. Due to its influence on all sectors, the efficiency with which energy is produced, transformed and used affects Australia's economic performance and international competitiveness. In recent years there have been growing community concerns about the environmental effects from the exploitation and use of Australia's energy resources.

Australia's energy consumption has increased, on average, by 2.7% per annum over the last 20 years. This increase in energy consumption reflects the country's pace of economic and population growth, and a shift towards energy intensive industries. Changing needs and priorities in the domestic and international markets have also resulted in major restructuring of the energy industry, and the introduction of new policy directions. These and several other energy issues were discussed in previous Year Books.

Information on the extraction of energy and other mineral resources in Australia is presented in *Chapter 16, Mining*. The present chapter focuses on key energy issues, which include an overview of Australia's current energy situation, the production, conversion, and consumption of both renewable and non-renewable energy resources, and the environmental implications of energy use.

Energy resources

Australia has abundant reserves of coal, natural gas and uranium to meet both its short and long-term domestic energy needs, and it is a major exporter of certain commodities. Crude oil and condensates are the only energy commodities where total reserves are limited. Australia also has the resource potential to develop a wide range of renewable energy technologies. These include both traditional renewables such as hydro-electricity, firewood and bagasse (the crushed remains of sugar cane), and new technologies including solar, wind, tidal, and geothermal energy. In energy terms, Australia is well placed compared to other countries. It is currently one of only five Organisation of Economic Cooperation and Development (OECD) countries that are net energy exporters (the other four are Canada, Norway, the Netherlands and the United Kingdom). It is also:

- the world's largest exporter of black coal, accounting for around one-third of the world seaborne coal trade;
- a major uranium producer and exporter, and;
- an exporter of liquefied petroleum gas (LPG), liquefied natural gas (LNG), and other petroleum products.

Recent estimates of Australia's identified economic energy resources are presented in table 17.1. At current production levels, the estimated life spans of these resources range from less than two decades for crude oil to over 800 years for brown coal. Black coal and uranium each have estimated life spans of several hundred years. With the exception of crude oil, Australia's energy consumption is unlikely to be constrained by resource availability in the near future.

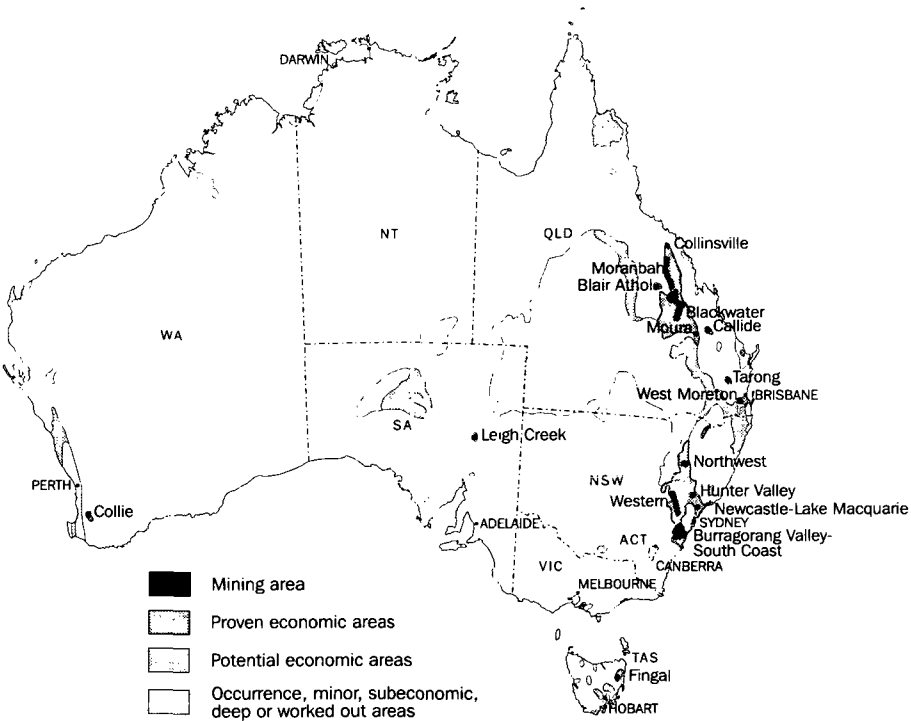
17.1 AUSTRALIA'S IDENTIFIED ENERGY RESOURCES

	Unit	Demonstrated resources		Inferred resources	Production 1993-94
		Economic	Subeconomic		
Black coal(a)	Gt	52	5	very large	0.18
Brown coal(a)	Gt	41	3	165	0.05
Petroleum(b)					
Crude oil(c)	Gl	382	106	n.a.	28.67
Natural gas	Tl	950	1 088	n.a.	26.35
LPG(d)	Gl	131	83	n.a.	3.70
Shale oil	Gl	—	4 564	40 468	0.00
Uranium	kt	631	76	(e)2 600	2.33

(a) As at December 1993. (b) As at January 1992. (c) Includes condensates. (d) Naturally occurring.
 (e) A 75% probability of undiscovered potential resources.

Source: Bush, Holmes and Ho Trieu 1995.

17.2 AUSTRALIAN BLACK COAL RESOURCES, 1994



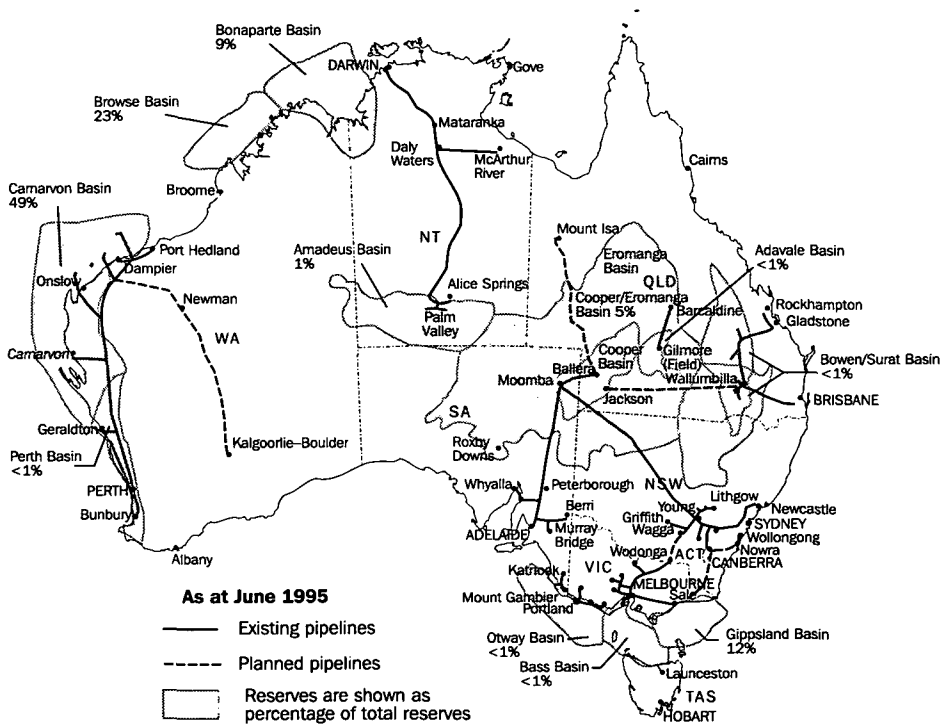
Source: AUSLIG 1996.

Figures 17.2 and 17.3 illustrate the locations of Australia's extensive black coal resources, natural gas reserves and pipeline networks.

Crude oil is the liquid equivalent of natural gas. Both are petroleum products which have resulted from the decomposition of plant and animal life deposited millions of years ago in mud and silt on the floors of ancient seas and lakes. These sedimentary layers were transformed over time to oil and gas and other

forms of petroleum, through a combination of chemical and bacterial action, heat and the tremendous pressure exerted by the overlying rocks. This common origin explains why crude oil and natural gas formations co-exist, as shown in these maps. Australia's most important oil-bearing sedimentary basins are found in the Bass Strait, the Timor Sea, the North West Shelf, and the Cooper–Eromanga Basin of southern Queensland.

17.3 AUSTRALIAN NATURAL GAS RESERVES, 1995



Source: AGA 1995, p. 66.

Australia's energy production from non-renewable fuels is shown in table 17.4. New South Wales and Queensland supply 98% of black coal. Western Australia and Victoria are the leading sources of crude oil (83%) and natural gas (75%).

In 1994–95 energy accounted for 16% of the value of all Australian exports. About 70% of all energy products are exported. Coal is the leading export commodity with a 10% share of the total exports (table 17.5). Exports of liquefied natural gas have increased following the deregulation of the energy industry in the mid 1980s.

17.4 ENERGY PRODUCTION FROM NON-RENEWABLE FUELS — 1993-94

	Petajoules	%
Black coal	4 787	54.5
Uranium	1 293	14.7
Crude oil	1 061	12.1
Natural gas	1 054	12.0
Brown coal	487	5.5
LPG	100	1.1
Total	8 781	100

Source: Bush, Holmes and Ho Trieu 1995.

17.5 EXPORTS OF ENERGY PRODUCTS — 1994-95

	\$m	% of total exports
Coal, whether or not pulverised but not agglomerated	6 889	10
Gas, natural and manufactured	1 335	2
Petroleum oils and oils obtained from bituminous minerals, crude	1 644	2
Petroleum products	1 307	2
Uranium and thorium ores and concentrates	188	—

Source: Foreign Trade, Australia: Merchandise Exports (5424.0).

Energy supply, conversion and end use

Compared with its vast energy resources, Australia's energy production and consumption are relatively low, estimated to be about 3% of the world's non-renewable primary fuel production and about 1% of primary energy consumption. However, Australia's energy intensity (i.e. energy used per unit of output), is higher than for many other countries.

Table 17.6 shows trends in Australia's energy supply, conversion, and consumption for the period 1982-83 to 1993-94. Energy production

increased by 34%, from 6,730 petajoules to 9,036 petajoules. This increase was due mainly to the increase in energy exports, which almost doubled during the 12 years. Net domestic supply accounted for about 29% of the increase in production. Imports of energy products rose by 60% to meet a growing domestic demand for certain energy products, particularly crude oil.

17.6 FLOW ACCOUNT FOR ENERGY SUPPLY, CONVERSION AND CONSUMPTION

	1988-89 petajoules	1989-90 petajoules	1990-91 petajoules	1991-92 petajoules	1992-93 petajoules	1993-94 petajoules
SUPPLY						
Production	8 570.6	8 923.8	9 299.4	9 603.2	8 981.0	9 035.7
Imports	619.7	625.6	625.2	672.8	860.4	890.9
Exports	-5 584.2	-5 257.4	-6 785.8	-6 517.7	-5 584.0	-6 414.1
Stock change(a)	225.9	-346.4	807.9	245.5	-178.4	661.6
Total supply	3 832.1	3 945.2	3 946.6	4 003.2	4 079.2	4 174.2
CONVERSION						
Coke ovens	50.9	29.8	36.0	36.0	31.9	28.9
Briquetting	0.3	0.3	0.3	0.5	0.2	0.5
Petroleum refining	11.7	13.9	13.3	13.2	13.2	13.6
Gas manufacturing	0.2	0.3	0.4	0.8	0.7	0.3
Electricity generation	973.4	991.0	993.2	1 020.0	1 019.9	1 045.8
Other conversion	28.8	61.6	60.3	55.8	41.2	43.0
Own fuel use	181.6	181.2	180.8	184.2	189.3	188.2
Total conversion	1 246.9	1 278.1	1 284.3	1 310.5	1 296.4	1 320.3
Net supply(b)	2 585.0	2 667.1	2 662.5	2 693.5	2 783.6	2 853.5
END USE						
Agriculture	58.1	57.6	58.4	58.5	60.3	62.3
Mining	130.7	162.8	167.8	173.5	192.3	196.1
Iron and steel	97.5	99.1	95.7	90.9	95.7	96.3
Chemical	126.1	129.8	132.9	135.7	128.6	130.1
Other industry	638.8	645.1	642.6	643.4	657.5	679.0
Construction	41.5	41.0	37.2	38.7	41.6	42.8
Road transport	792.8	808.9	791.3	801.4	828.8	849.9
Rail transport	31.1	30.7	30.5	31.1	29.4	29.5
Air transport	114.2	109.4	122.7	131.0	140.1	145.3
Water transport	60.1	56.3	49.1	48.8	45.6	47.7
Commercial	141.7	150.8	156.4	157.8	164.5	169.1
Residential	302.0	323.0	328.6	334.4	347.1	349.3
Others(c)	50.4	52.7	49.3	48.3	52.1	56.0
Consumption	2 585.0	2 667.1	2 662.5	2 693.5	2 783.6	2 853.5

(a) Includes discrepancies. (b) After conversion industrial sector use and losses. Equals total final energy consumption. (c) Includes lubricants, greases, bitumen and solvents.

Source: ABARE 1995.

Electricity and gas operations

In 1994-95 Australia's total electricity generation increased by 2%, from 161,813 kWh in 1993-94 to 165,063 kWh (table 17.7). Electricity consumption reached 140,527 kWh (85% of total generated), of which New South

Wales and Victoria used 35% and 23% respectively. The number of customers and total electricity consumed are shown in tables 17.8 and 17.9. They were approximately proportional to the State/Territory populations.

17.7 ELECTRICITY GENERATION(a)

Financial year	NSW(b) mill. kWh	Vic. mill. kWh	Qld mill. kWh	SA(c) mill. kWh	WA mill. kWh	Tas. mill. kWh	Aust. mill. kWh
1991-92	55 566	38 305	28 923	10 026	14 626	8 968	156 413
1992-93	57 794	37 576	30 404	10 227	15 007	8 864	159 872
1993-94	57 792	37 019	31 831	10 560	15 755	8 855	161 813
1994-95	60 016	36 043	33 517	10 044	16 756	8 688	165 063

(a) Statistics relate to generation of electricity within each State and take no account of interchange between States. (b) Includes the ACT. (c) Includes the NT.

Source: Manufacturing Production, Australia, Energy Products (8368.0).

17.8 ELECTRICITY, Number of Customers — 30 June 1995

	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
Residential	2 372 174	1 735 723	1 223 711	616 298	615 921	198 663	49 545	112 762	6 924 797
Commercial	267 837	174 306	131 862	86 242	90 564	41 001	9 647	11 944	960 942
Industrial	(a) 4 001	88 397	55 141	(b)	(b)	(b)	(b)	(b)	(b)
Other	28 889	3 937	128	1 616	149	212	34	9	34 974
Total	2 672 901	2 002 363	1 410 842	704 156	706 634	239 876	59 226	124 715	7 920 713

(a) The classification of 'Industrial' used in New South Wales differs from that used in other States. (b) See the figure for 'Commercial'. One figure is given to include both 'Commercial' and 'Industrial'.

Source: Electricity Supply Association of Australia.

17.9 ELECTRICITY CONSUMPTION — Year Ended 30 June 1995(a)

	NSW mill. kWh	Vic. mill. kWh	Qld mill. kWh	SA mill. kWh	WA mill. kWh	Tas. mill. kWh	NT mill. kWh	ACT mill. kWh	Aust. mill. kWh
Residential	16 077	8 933	7 727	3 375	2 937	1 751	331	1 041	42 172
Commercial	8 218	7 784	6 354	5 810	7 761	6 274	858	1 193	95 274
Industrial	23 807	15 570	11 645	(b)	(b)	(b)	(b)	(b)	(b)
Other	1 546	547	771	71	75	20	13	38	3 081
Total	49 648	32 834	26 497	9 256	10 773	8 045	1 202	2 272	140 527

(a) Figures do not include internal usage by supply authorities or consumption on unread meters at 30 June. (b) See the figure for 'Commercial'. One figure is given to include both 'Commercial' and 'Industrial'.

Source: Electricity Supply Association of Australia.

Table 17.10 presents a summary of operations and selected performance ratios for the electricity industry in 1994–95. Most of the items reported showed a slight decrease from their values in the previous year.

Australia's natural gas reticulation and transmission systems reached 76,352 km in 1994–95 (table 17.11). This represents an

increase of 1,692 km from 1993–94. About 370,000 terajoules of natural gas were sold to 2.8 million customers, yielding \$2,350m (tables 17.12 to 17.14). A summary of operations and selected performance ratios for Australia's gas industry is presented in table 17.15. As is the case for electricity, many measures related to gas utility operations fell slightly from their values in 1993–94.

17.10 ELECTRICITY ESTABLISHMENTS, Summary of Operations and Performance Ratios — 1994-95

	Unit	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
Income and expenditure										
Turnover	\$m	7 807.6	5 953.9	3 877.3	913.6	1 313.8	520.1	288.6	243.7	20 918.6
Plus closing stock	\$m	404.4	96.3	65.1	53.9	109.8	13.7	13.1	6.9	763.2
Less opening stock	\$m	430.6	112.7	62.2	65.0	78.8	14.7	13.5	6.6	784.1
Less purchases and expenses	\$m	4 590.8	3 574.6	2 170.2	312.8	588.9	77.2	167.5	158.9	11 640.9
Value added	\$m	3 186.4	2 362.6	1 658.4	587.7	755.9	441.8	115.6	85.1	9 193.5
Trading profit	\$m	2 534.6	2 004.8	994.2	506.0	775.8	348.9	67.6	122	7 353.9
Earnings before interest and tax	\$m	977.5	1 233.7	632.7	200.1	445.6	169.5	18.1	21.5	3 698.7
Operating profit before tax	\$m	326.4	403.0	333.2	124.0	161.7	-19.3	-4.5	12.4	1 336.9
Assets and liabilities										
Total value of assets	\$m	21 634.5	17 348.1	8 563.8	2 427.4	3 174.6	4 105.8	1 130.5	1 553.1	59 937.8
Total value of liabilities	\$m	8 257.9	14 938.4	3 664.6	964.6	2 573.1	2 043.3	322.4	155.9	32 920.2
Net worth	\$m	13 376.6	2 409.6	4 899.1	1 462.8	601.5	2 062.5	808.1	1 397.2	27 017.4
Selected performance ratios										
Trading profit margin	—	34.2	34.7	41.9	56.3	50.3	74.2	28.1	38.6	38.7
Liquidity ratio	—	0.8	0.7	1.0	0.7	1.5	0.5	1.2	0.7	0.7
Debt to assets	—	38.9	86.6	43.1	40.8	84	49.9	29.1	10.1	55.7
Employment details										
Establishments at 30 June	no.	28	19	19	5	4	1	3	1	80
Employment at 30 June	no.	17 661	6 916	8 317	2 806	3 678	1 720	549	739	42 386
Wages and salaries	\$m	776.4	468.1	323.5	127.9	169.6	75.1	24.3	35.8	2 000.7

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

17.11 NATURAL GAS RETICULATION AND TRANSMISSION, Mains Laid and Mains in Use — 1994-95

	NSW km	Vic. km	Qld km	SA km	WA km	Tas. km	NT km	ACT km	Aust. km
CONSTRUCTION MAINS LAID									
Reticulation mains									
Low and medium pressure	579	35	118	(a)-12	185	n.a.	—	108	1 013
High pressure	51	344	1	86	10	n.a.	5	10	507
Transmission — high pressure	336	55	240	174	—	n.a.	322	—	1 127
Total	966	434	359	248	195	n.a.	327	118	2 647
TOTAL PIPELINE NETWORK IN USE									
Reticulation mains									
Low and medium pressure	18 237	9 845	3 218	3 420	8 840	n.a.	—	2 838	46 398
High pressure	1 652	12 559	86	2 861	528	n.a.	24	184	17 894
Transmission — high pressure	2 043	2 187	1 362	1 609	2 648	n.a.	2 211	—	12 060
Total	21 932	24 591	4 666	7 890	12 406	n.a.	2 235	3 022	76 352

(a) Low pressure mains were replaced with high pressure reticulation mains.

Source: Australian Gas Association, Annual Survey of Distributors, Pipeliners and Producers.

17.12 NATURAL GAS OPERATIONS OF UTILITIES, By State/Territory, Terajoules Sold — 1994-95

	NSW(a)	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
Residential	13 346	74 641	1 477	7 300	6 194	n.a.	1	2 399	105 358
Commercial	10 742	20 310	1 190	3 100	1 835	n.a.	65	2 231	39 473
Industrial	73 821	76 116	8 490	28 100	39 281	n.a.	—	140	225 948
Total	97 909	171 067	11 157	38 500	47 310	n.a.	66	4 770	370 789

(a) Excludes the ACT but includes Albury.

Source: Australian Gas Association, Annual Survey of Distributors, Pipeliners and Producers.

17.13 NATURAL GAS OPERATIONS OF UTILITIES, By State/Territory, Number of Customers — 1994-95

	NSW(a)	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
Residential	644 807	1 264 446	118 759	304 134	334 970	n.a.	92	49 253	2 716 461
Commercial	22 139	34 885	3 838	7 002	6 320	n.a.	54	1 401	75 639
Industrial	2 309	4 185	527	1 252	234	n.a.	n.a.	4	8 511
Total	669 255	1 303 516	123 124	312 388	341 524	n.a.	146	50 658	2 800 611

(a) Excludes the ACT but includes Albury.

Source: Australian Gas Association, Annual Survey of Distributors, Pipeliners and Producers.

17.14 NATURAL GAS OPERATIONS OF UTILITIES, By State/Territory, Revenue — 1994-95

	NSW(a) \$m	Vic. \$m	Qld \$m	SA \$m	WA \$m	Tas. \$m	NT \$m	ACT \$m	Aust. \$m
Residential	161.8	680.6	27.2	92.5	92.6	n.a.	n.a.	24.6	1 079.3
Commercial	98.2	129.0	14.9	21.8	26.0	n.a.	0.8	20.1	310.8
Industrial	371.7	281.8	59.8	103.4	141.7	n.a.	n.a.	1.2	959.6
Total	631.7	1 091.4	101.9	217.7	260.3	n.a.	0.8	45.9	2 349.8

(a) Excludes the ACT but includes Albury.

Source: Australian Gas Association, Annual Survey of Distributors, Pipeliners and Producers.

17.15 GAS ESTABLISHMENTS, Summary of Operations and Performance Ratios

	Unit	1993-94	1994-95
Income and expenditure			
Turnover	\$m	2 437.4	2 803.0
Plus closing stocks	\$m	58.6	763.0
Less opening stocks	\$m	64.2	784.2
Less purchases and selected expenses	\$m	1 553.8	1 913.6
Value added	—	1 634.7	9 193.8
Trading profit	\$m	844.2	798.9
Earning before interest and tax	\$m	413.2	370.0
Operating profit before tax	\$m	326.6	316.6
Assets and liabilities			
Total value of assets	\$m	3 009.6	3 015.9
Total value of liabilities	\$m	1 826.7	1 432.8
Net worth	\$m	1 182.9	1 583.1
Selected performance ratios			
Trading profit margin	—	35.1	29.4
Liquidity ratio	—	0.6	0.8
Debt to assets	—	61.8	48.2
Employment details			
Establishments at 30 June	no.	29	22
Employment at 30 June	no.	7 685	7 094
Wages and salaries	\$m	315	297.5

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

Energy use and the environment

The energy sector is the leading producer of air pollutants and emissions of greenhouse gases. Compared with most industrialised countries in Europe or North America, Australia is generally well placed in terms of environmental impacts of energy use because of its lower population densities and the lower sulphur content of its indigenous crude oil and coal. Nevertheless, many Australian urban areas, particularly capital cities, suffer from air pollution problems such as lead and photochemical smog. Australian greenhouse gas emissions are regarded as significant, ranked seventeenth in total world emissions, and fourth in per capita emissions in which energy related activities are major contributors.

In the energy industry, air pollutants and greenhouse emissions generally fall into two broad categories: emissions resulting from fuel combustion, and emissions not related to combustion for energy, otherwise referred to as 'fugitive fuel emissions'. The fugitive emissions are generated from those sources associated with production, transmission, storage and distribution of fuel, and also from mining. In the oil and natural gas systems, emissions can occur in many ways, such as from venting, flaring and system leakage in production; and from evaporation, system or equipment leakage in

transmission, storage and distribution systems. Fuel combustion emissions make up the bulk of all emissions.

Wood fuels and bagasse also release air pollutants and greenhouse gases into the atmosphere during combustion, especially carbon dioxide, carbon monoxide, methane and sulphur dioxide.

Among the environmental impacts resulting from the production, conversion and consumption of energy, the most serious are the enhanced greenhouse effect, acid rain and urban air quality. There is scientific evidence to suggest that the constant release into the atmosphere of vast quantities of carbon dioxide, methane and nitrous oxide from fuel combustion will exacerbate the greenhouse effect (i.e. the atmosphere's natural capacity to trap some of the sun's energy that is re-radiated from the earth's surface), resulting in a net warming of the lower atmosphere. Any change in climate due to an enhanced greenhouse effect will have a substantial impact on Australia's environment, its terrestrial and aquatic ecosystems, primary and secondary production activities, human settlements and health, and short-term climatic conditions.

Some atmospheric pollutants that are released into the atmosphere during energy combustion undergo chemical changes to form sulphuric and nitric acids, which may fall as acid rain. Evidence from field studies suggests that acid rain is presently not a major problem in Australia, and the presence of any such problem is likely to be highly localised rather than regional or national in scope.

Urban air quality is a serious problem in many Australian cities. Air pollution, resulting mainly from fossil fuel combustion by vehicles and industries, affects human health and urban micro-climates. Recent policy initiatives, including the introduction of emission control on vehicles and industries, have led to an improvement in air quality in some areas.

Further information about the environmental impact of energy use in Australia is presented in *Chapter 13, Environment*.

Renewable energy resources

Renewable energy consists of energy sources that are, or can be, used at a rate that enables them to continue to be used indefinitely. Such resources include hydro-electric power, solar, wind, geothermal, and ocean or tidal energy, biomass (which includes wood and bagasse), and ethanol from manure and crop residues.

Despite significant recent technological gains, coupled with increasing concerns about the environmental costs of fossil fuel use, Australia's renewable energy consumption remains relatively low. High production costs relative to conventional energy sources, and problems of storage, continue to constrain the economic use of these resources. Solar power technologies have the best potential for making a large contribution to energy consumption in the short and long-term. The supply costs of these technologies are expected to fall by 68–80% in the next 20–30 years. Wind and hydro-electric power also have good potential.

On a regional basis, the types of renewable energy consumed vary according to the resources that are available. In Tasmania, for example, 75% of all renewable energy is from hydro electricity, whereas in Queensland most of the renewable energy is from bagasse used to power the sugar refineries. Wood is used by 18% of Australian households for space heating, while

solar energy is used by 5% of households to provide domestic hot water. Solar power is also used for drying crops and extracting salt.

One of the best prospects for using renewable energy technologies to generate electricity in the short to medium term is in remote areas where the cost of conventional fuels is high. Presently there are more than 10,000 Australian households and 300 communities, mainly in remote areas, that generate their own electricity.

Solar

The two main applications of solar energy to generate power in Australia are photovoltaics and solar thermal technologies. Photovoltaic (solar) cells currently provide electricity for remote telecommunication stations, navigational aids, and water pumps. Telstra is a leading user of photovoltaic cells to provide power supply systems for its remote and rural area telecommunication program. The cost of photovoltaic technologies is expected to decline considerably in the next 10–20 years, increasing the prospects for their more extensive use.

Solar thermal technologies are used to convert solar energy to electricity, as well as to provide space heating and hot water for domestic and commercial uses. 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 25% of the households have solar water heaters installed, while in the Northern Territory the figure is 58%.

Passive solar design is another 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 those for conventional buildings. Passive solar design principles have shown that solar energy can meet up to 90% of normal household space heating needs.

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. Australia's best wind resources are located in coastal regions of southern Australia, particularly in Tasmania, South Australia and Western Australia. These areas have low levels of solar radiation but high

and consistent wind speeds. Southern Australia alone has sufficient wind energy resources to provide at least 10% of Australia's electricity needs, if those resources could be harnessed.

The largest commercial wind energy system in Australia is found at Esperance on the south-west coast of Western Australia where the State Energy Commission has commissioned a 2.5 megawatt wind farm that provides about 14% of the town's power needs. In Victoria, a wind turbine has been installed at Breamlea, south-west of Melbourne, which produces about 100,000 kWh per year.

Wider use of windpower is constrained by such factors as variations in wind speeds, aesthetic value, noise, bird movements and interference with telecommunications systems.

Biomass

Wood

In Australia wood is used for industrial boilers and dryers, metallurgical processes, cooking, and home heating. About six megatonnes of firewood are currently used annually in Australia, equivalent in energy terms to about 100 petajoules. The main sources of wood fuels are forestry residues, sawlogs, pulplogs, and occasionally forest logging.

Solid wood fuels in Australia are mainly firewood, woodchips, fuel pellets, charcoal and wood wastes. Wood is also processed to yield ethanol and methanol as liquid fuels. Under high temperatures (approximately 900°C in the presence of oxygen), wood is gasified to produce combustible gases such as carbon monoxide, hydrogen and methane.

Bagasse

Bagasse is the fibrous residue from the production of sugar, and is used as fuel to provide process energy in sugar mills in New South Wales and Queensland. It is burnt and the heat is converted into electricity, providing about 70 petajoules. Bagasse is the second largest renewable energy source used in Australia, after wood fuel. It is also an important feedstock for fuel ethanol production.

Ethanol

In March 1994 the Commonwealth Government launched a \$3.94m Ethanol Research and Development Program as part of its lead

abatement strategy. The aim of the program is to encourage ethanol production through improved technologies and its use in vehicle fuel blends. Traditionally, ethanol has been produced from expensive feedstocks such as sugar and grains. This program focuses on the use of low cost feedstocks such as forestry wastes, sawdust, cereal straws, cotton trash and municipal tree trimmings.

Ethanol has a high blending research octane number, ranging from 105–120, which makes it a useful partial substitute for lead in petrol. It also has the potential to reduce lead and greenhouse gas emissions. The goal of the Ethanol Research and Development Program is to encourage the establishment of a sustainable ethanol transport fuel industry in Australia, and to eventually serve as a viable economic competitor to petroleum-based fuels. However, cost of production has made it uneconomic at current oil prices. The cost of production of ethanol from traditional feedstocks (sugar and grain) is about 70–80 cents per litre, compared to about 23 cents per litre for petrol. Presently there are over 90 petrol stations throughout New South Wales and Victoria selling a fuel ethanol blend.

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.

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The following organisations also produce energy statistics:

- the Australian Bureau of Agricultural and Resource Economics;

- the Australian Institute of Petroleum;

- the Electricity Supply Association of Australia;

- the Department of Primary Industries and Energy; and

- the Joint Coal Board

State government departments and instrumentalities are also important sources of energy data, particularly at the regional level. A number of private corporations and other entities operating within the energy field also publish or make available a significant amount of information.