



Australian Government

Department of Industry, Tourism and Resources

ENERGY IN AUSTRALIA 2004 ENERGY IN AUSTRALIA 2004 ENERGY IN AUSTRALIA 2004

Energy

IN AUSTRALIA

2004



abare

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GLOSSARY

Bagasse	The fibrous residue of the sugar cane milling process that is used as a fuel (to raise steam) in sugar mills.
Biogas	Landfill (garbage tips) gas and sewage gas. Also referred to as biomass gas.
Coal byproducts	Byproducts such as coke oven gas, blast furnace gas (collected from steelworks blast furnaces), coal tar and benzene/toluene/xylene (BTX) feedstock. The latter two are both collected from the coke making process.
Conversion	The process of transforming one form of energy into another before use. Energy consumed in conversion is the energy content of fuel consumed by energy producing industries — such as natural gas and liquefied petroleum gas used in gas manufacturing, petroleum products used in oil refineries, and all fuels (including electricity) used in power station — plus the energy lost in the production, conversion and transport of fuels, such as electricity or energy lost in coke production, plus energy used in pumped storage, less the energy produced.
Derived fuels	Fuels produced from primary or other derived fuels by conversion processes to provide the energy forms commonly consumed. They include petroleum products, thermal electricity, town gas, coke, coke oven gas, blast furnace gas and briquettes.
Natural gas	Gases that include commercial quality sales gas, liquefied natural gas, ethane, methane (including coal seam and mine mouth methane and gas from garbage tips and sewage plants) and plant and field use of noncommercial quality gas. In this report, natural gas also includes town gas.
Petroleum products	Crude oil and natural gas condensate used directly as fuel, liquefied petroleum gas, refined products used as fuels (aviation gasoline, automotive gasoline, power kerosene,

aviation turbine fuel, lighting kerosene, heating oil, automotive diesel oil, industrial diesel fuel, fuel oil, refinery fuel and naphtha) and refined products used in nonfuel applications (solvents, lubricants, bitumen, waxes, petroleum coke for anode production and specialised feedstocks).

In this report, all petroleum products are defined as primary fuels despite the fact that most petroleum products are transformed (refined). Accordingly, the distinction between the consumption of petroleum at the primary and final end use stages relates only to where the petroleum is consumed, not to the mix of different petroleum products consumed. The consumption of petroleum at the primary energy use stage is referred to collectively as oil. The consumption of petroleum at the final end use stage is referred to as petroleum products.

The one exception to this is liquefied petroleum gas (LPG). LPG is not included in the definition of end use consumption of petroleum and is modeled separately.

Petajoule

The joule is the standard unit of energy in electronics and general scientific applications. One joule is the equivalent of one watt of power radiated or dissipated for one second. One petajoule, or 280 terawatt hours, is the heat energy content of about 43 000 tonnes of black coal or 29 million litres of petrol.

Primary fuels

The forms of energy obtained directly from nature. They include nonrenewable fuels such as black coal, brown coal, uranium, crude oil and condensate, naturally occurring liquid petroleum gas, ethane and natural gas, and renewable fuels such as wood, bagasse, hydroelectricity, wind and solar energy.

Secondary fuels

Fuels produced from primary or other secondary (or derived) fuels by conversion processes to provide the energy forms commonly consumed. They include refined petroleum products, thermal electricity, coke, coke oven gas, blast furnace gas and briquettes.

Total primary energy consumption

(Also referred to as total domestic availability.) The total (in energy units) of the consumption of each primary fuel in both the conversion and end use sectors. It includes the use of primary fuels in conversion activities — notably the consumption of fuels used to produce electricity — and also includes own use and losses in the conversion sector.

Total final energy consumption The total amount of energy consumed in the final or 'end use' sector. It is equal to total primary energy consumption less energy consumed or lost in conversion, transmission and distribution.

Town gas All manufactured gases that are typically reticulated to consumers. These include synthetic natural gas, reformed gas, tempered liquid petroleum gas and tempered natural gas. In this report, town gas is included with natural gas.

UNITS

J	joules
L	litres
t	tonnes
g	grams
Wh	watt-hours
b	billion (or 1 000 million), used only in money quantities (\$b)

Standard metric prefixes

k	kilo	10^3 (thousand)
M	mega	10^6 (million)
G	giga	10^9 (1 000 million)
T	tera	10^{12}
P	peta	10^{15}
E	exa	10^{18}

Standard conversions

1 barrel = 158.987 L

1 kWh = 3600 kJ

Indicative energy conversion factors for fuel energy contents are provided at the end of the publication.

Conventions used in tables

0.0 is used to denote a negligible amount.

Small discrepancies in totals are generally the result of the rounding of components.

OVERVIEW

Australia is the sixth largest country in the world, with a land area of 7.69 million square kilometres — almost as great as that of the United States of America (excluding Alaska) and about 50 per cent larger than western Europe.

Australia's population was around 20 million in 2003 and is highly urbanised. Over half of all Australians live in the five largest cities, Sydney, Melbourne, Brisbane, Perth and Adelaide.

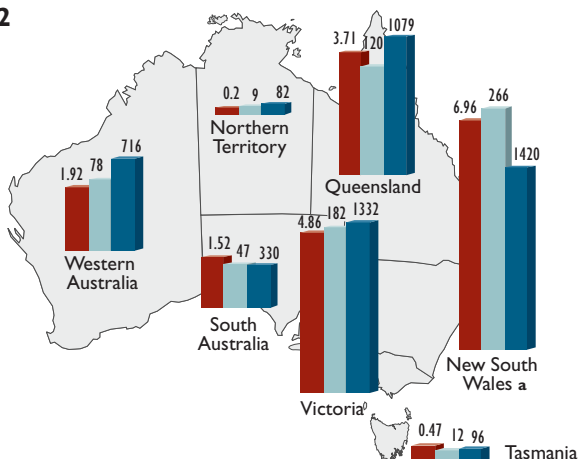
Australia's climate is one of extremes — cool to temperate in the south east, hot and semitropical in the north and north west. Rainfall is also highly variable — generally low but particularly high in the north.

Australia is divided into six states and two territories: New South Wales, Victoria, Queensland, Western Australia, South Australia, Tasmania, the Northern Territory and the Australian Capital Territory.

About Australia	
Land area	7.69 million km ²
Exclusive economic zone	11 million km ²
Population	20 million (December 2003)
Currency	Australian dollar (\$A)
Exchange rate	A\$1 = US58 cents (2002-03)
GDP	\$731 022 million (2002-03)
Value of commodity exports	\$86 684 million (2002-03)
Weights and measures system	Metric
Coastline length	35 877 km (mainland) 59 736 km (including islands)

State statistics, 2001-02

- Population (million)
- Gross state product (\$billion)
- Energy consumption (PJ)



^a Includes Australian Capital Territory

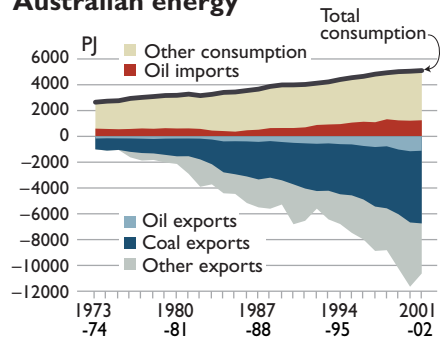
Australia's political system is based on a clear division of responsibilities for the provision of services to the community (and concomitant rights to taxation) across three levels of government: local, state and federal. Electricity is one of a large number of services that are the responsibility of state governments. Some specific areas of the energy industry (offshore petroleum exploration leases, interstate gas and electricity interconnections) are the responsibility of the federal government. In recent years Australia's energy sector has been the subject of significant market reform. The electricity industry, in particular, has undergone significant restructuring, with vertical disaggregation, corporatisation and in some cases privatisation of former state owned utilities.

Australia is an energy resource rich country with significant petroleum, natural gas and coal reserves. Australia is one of the few OECD countries that is a significant net energy exporter. Since 1986 it has been the world's largest coal exporter, and since 1989 Australia has emerged as one of the world's key suppliers of LNG.

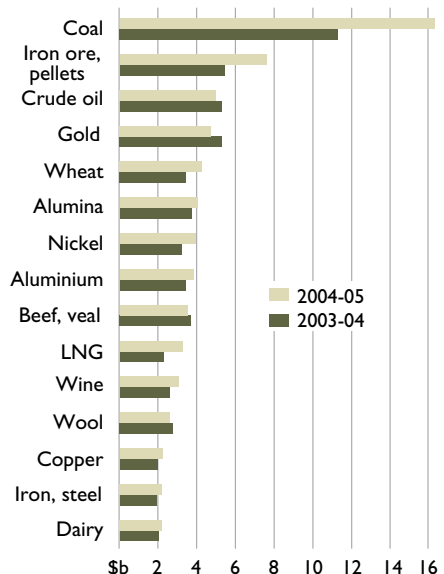
Australia's energy exports (and indeed Australia's commodity exports) are dominated by coal. Australia's exports of coal in 2001-02 equalled 5630 petajoules (in contained energy terms) or approximately 198 million tonnes valued at over \$13 billion. In 2004-05 this trade is forecast to increase to 237 million tonnes valued at approximately \$16 billion.

Australia is a net importer of liquid fuels (including crude oil and other refinery

Australian energy



Value of major Australian commodity exports



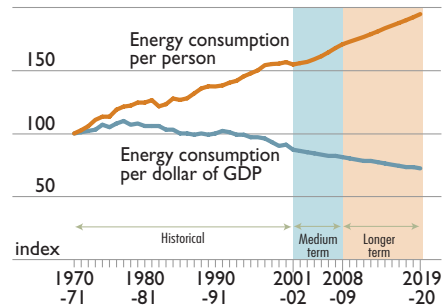
feed stocks, LPG and other refined petroleum products, such as gasoline, aviation turbine fuel, diesel and fuel oil). In 2000-01 Australia exported approximately 1093 petajoules of liquid fuels (not including LNG) while at the same time importing 1223 petajoules.

In 2001-02 exports of uranium declined by 24 per cent or 1107 petajoules (in contained energy terms). This decline is similar in magnitude to the reduction that occurred in 1992-93 when exports fell by 1150 petajoules.

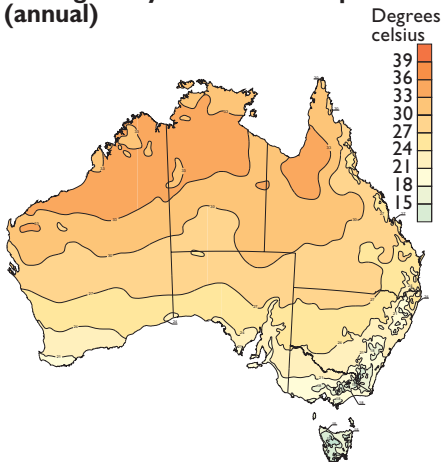
The total consumption of energy in Australia in 2001-02, equalled 5055 petajoules and is estimated to have been 5271 petajoules in 2003-04. Growth in energy consumption in Australia closely follows trends in aggregate economic growth and output from key energy intensive manufacturing and minerals processing sectors such as iron and steel, cement, paper and pulp, aluminium, alumina and LNG .

Domestic energy consumption is dominated by coal, which is used predominately in the electricity generation sector. Petroleum also accounts for a large share of energy consumption, reflecting the importance of road transport in Australia's economy. Natural gas use is relatively small, but has been growing rapidly in recent years.

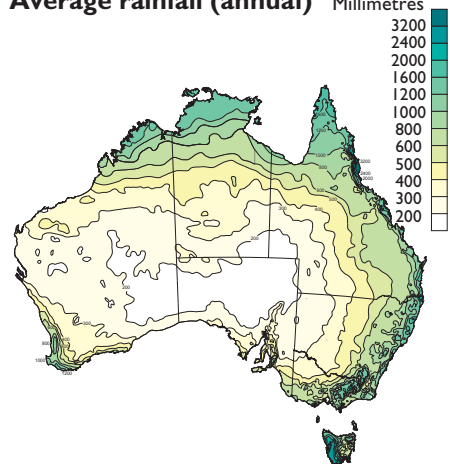
Energy use in Australia



Average daily maximum temperature (annual)



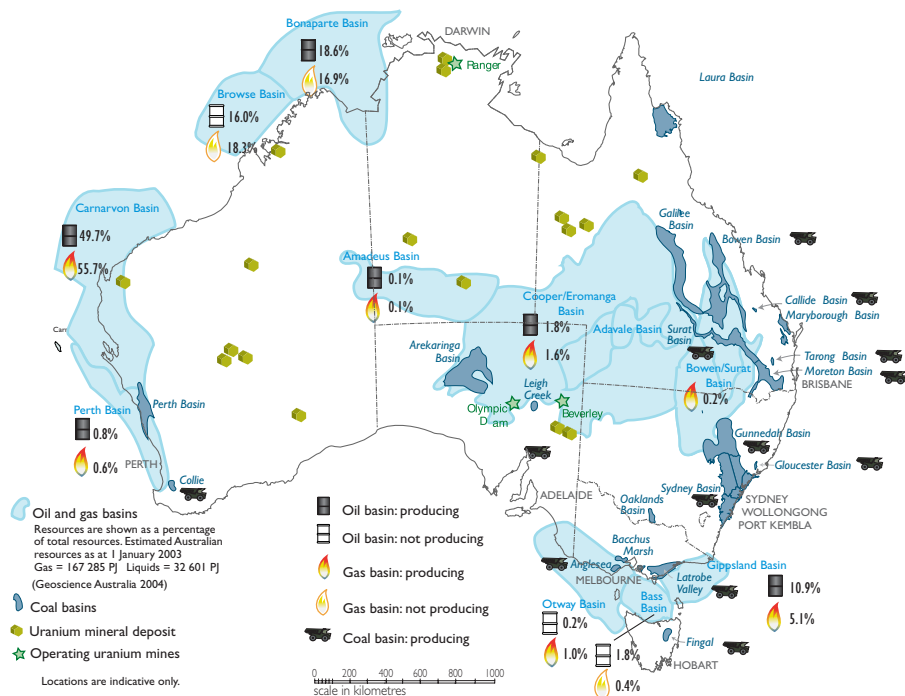
Average rainfall (annual)



RESOURCES

Australia has abundant demonstrated reserves of coal, gas, crude oil and uranium. At current levels of production, Australia's energy resources are expected to last for many decades to come.

Australia's recoverable economic demonstrated resource (EDR) for black coal is estimated to be more than 39 000 million tonnes, or more than 110 years worth of supply at current rates of production (Geoscience Australia 2004). A further 14 000 million tonnes of demonstrated recoverable coal resource is considered as subeconomic. At a lower level of geological assurance, the inferred resource of recoverable black coal is estimated at more than 52 000 million tonnes or close to 150 years of supply. Black coal resources are located in all states, with significant quantities of



high quality black coal occurring in New South Wales and Queensland. The black coal resources occurring in Western Australia, South Australia and Tasmania are small but locally significant.

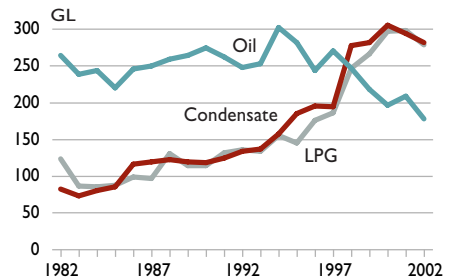
Australia's brown coal (or lignite) resources are of world significance, with 20 per cent of the world's EDR located in Australia. Brown coal can be found in Victoria, South Australia, Western Australia and Tasmania; however, all of Australia's EDR of brown coal (37 000 million tonnes) is located in Victoria. At current rates of production it is estimated that Australia's brown coal resources will last another 500 years.

Australia's identified natural gas resources have increased fourfold over the past two decades, particularly in the western and north western areas of Australia. Today around 90 per cent of Australia's EDR of natural gas is located off the west and north west coast of Australia. Total Australian natural gas resources as at 1 January 2003 are estimated to be 167 285 petajoules.

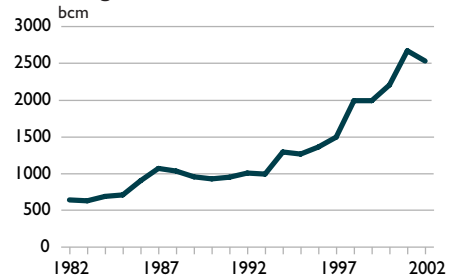
In addition to natural gas, there are prospects for the commercial utilisation of Australia's deposits of coal seam methane. The majority of these deposits are located in the black coal deposits of Queensland and New South Wales, relatively close to the Sydney and Brisbane gas markets. However, there is significant uncertainty about the extent of coal seam methane reserves in Australia and hence the true potential for future

Economic demonstrated resources

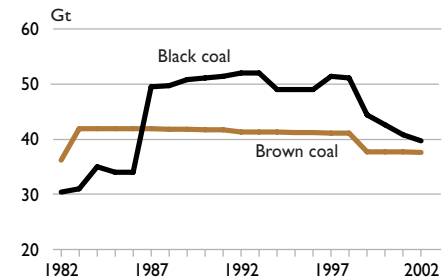
Petroleum



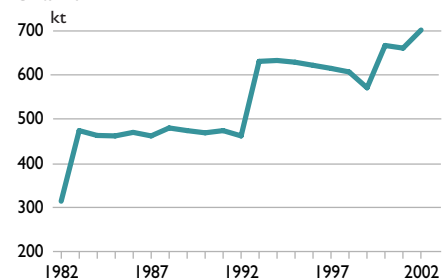
Natural gas



Recoverable coal



Uranium



production. The primary resource base is large but the majority of this is currently not commercial.

The importance of ongoing petroleum exploration activity is highlighted by Australia's EDR for crude oil, which is low relative to production levels. The EDR to production ratio has consistently been low for crude oil, but has declined overall from 13 years in 1982 to 6 years in 2002. In contrast, the EDR to production ratio for both condensate and LPG is relatively high, at 31 and 45 years respectively in 2002.

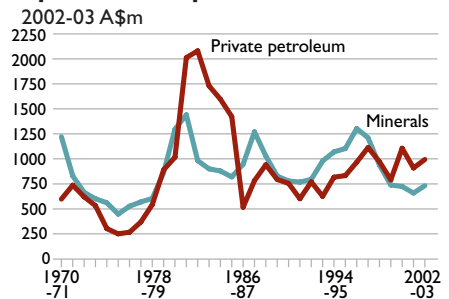
Since 1987-88 average annual expenditure by the private sector on petroleum exploration has averaged \$0.9 billion (in 2002-03 Australian dollars). Prior to this, private petroleum exploration expenditure increased sharply following the second oil shock, peaking at \$2.1 billion in 1982-83. However, following a large world oil price fall in 1996, real private petroleum exploration expenditure in Australia fell to only \$0.5 billion.

Australia's identified uranium resources have more than doubled over the past two decades. In 2002, total Australian economically demonstrated uranium resources were estimated at 702 000 tonnes, with the majority of these resources occurring in South Australia, the Northern Territory and Western Australia. The Olympic Dam deposit in South Australia is the world's largest uranium deposit.

Economic demonstrated resources in Australia		
		2002
Coal a		
Black coal	Gt	39.7
Brown coal	Gt	37.6
Petroleum b		
Oil	GL	28.8
Condensate	GL	277.0
LPG	GL	274.0
Natural gas c	bcm	2 528.0
Uranium d		
Total	kt	702.0

a Recoverable resources. b McKelvey classification estimates as at year end. c Sales quality gas. bcm – billion cubic metres. d RAR recoverable at costs of less than US\$80/kg U.
Sources: Geoscience Australia, *Australia's Identified Mineral Resources 2002*, Canberra; Petrie, E. and others, Geoscience Australia, *Oil and Gas Resources of Australia 2002*, Canberra.

Australian mineral and petroleum exploration expenditure



EXPORT MARKET drivers and prices

While commodity prices tend to move in cycles, the US denominated prices of most energy and minerals commodities have exhibited a downward trend since the 1970s. Long term real prices have trended down mainly as a result of reductions in the real costs of production. Over the past three decades, the production costs for minerals have declined worldwide as a result of advances in exploration and mining technology, improvements in workplace organisation and greater access to prospective mining areas. International prices for all types of coal in 2003-04 were 36–53 per cent lower (in real terms) than recorded in 1990-91.

		1990-91	1995-96	2000-01	2001-02	2002-03	2003-04
World price indicators							
Coal prices ^a							
Hard coking coal	US\$/t	71.10	59.62	41.34	43.69	48.10	45.32
Semisoft coking coal	US\$/t	60.09	50.28	31.83	36.79	33.05	30.46
Thermal coal	US\$/t	55.53	47.49	29.90	35.26	31.84	26.24
Oil and petroleum prices ^b							
Crude oil							
– world trade weighted ^c	US\$/bbl	29.84	20.55	27.89	22.07	26.26	28.69
Gasoline							
– Singapore spot price ^d	US\$/gal	na	0.63	0.80	0.62	0.74	0.94
	US\$/L	na	0.17	0.21	0.16	0.20	0.25
Gas prices ^e							
Natural gas							
– domestic spot price ^f	A\$/GJ	na	na	2.78	2.77	2.83	2.85
Liquefied natural gas							
– export unit value ^g ^s	A\$/t	317	211	376	354	333	274

^a Japanese – Australian benchmark prices: contract period in terms of Japanese financial year (April to March). 2002-03 US\$ value. ^b International prices, 2002-03 US\$ value. ^c Financial year averages of weekly rates; average contract selling prices fob of internationally traded crude oils only, weighted by estimated export volume. ^d Financial year averages of daily spot prices fob for regular gasoline. Average prices for 2003-04 are year to date to 21 June 2004. ^e 2002-03 A\$ value. ^f Financial year averages of daily spot prices in the Victorian gas market (commenced trading 15 March 1999). Average prices for 2003-04 are year to date to 31 May 2004. ^g Calculated from LNG export value and volume. ^s ABARE estimate. **na** Not available.

US\$/t = US\$ per tonne. US\$/bbl = US\$ per barrel. US\$/gal = US\$ per US gallon. US\$/L = US\$ per litre. A\$/GJ = A\$ per gigajoule. A\$/t = A\$ per tonne.

Sources: ABARE, Canberra; ABARE, *Australian Commodity Statistics 2003*, Canberra; Energy Information Administration (EIA), US Department of Energy, Washington DC; VENCop Gas Market, Victoria.

Despite a quick resolution to the conflict in Iraq, world oil prices remain relatively high. In 2003-04, world oil prices averaged US\$28.69 a barrel (in world trade weighted price terms) and remain higher than the upper bound of OPEC's target price range of US\$22–28 a barrel (for a basket of OPEC crude oils).

Prices for all major minerals and energy commodities are forecast to rise in 2004, supported by higher growth in global industrial activity. Prices for most commodities — in United States dollars — other than oil, are expected to receive support in 2004 from lower stocks and a depreciation of the US dollar against most major currencies. As global coal production is not expected to match consumption through to 2005,

Key world macroeconomic indicators ^a						
	1990	1995	2000	2001	2002	2003
Economic growth ^b	%	%	%	%	%	%
Australia	1.4	4.0	3.2	2.5	3.8	3.0
United States	1.8	2.7	3.8	0.3	2.4	3.1
European Union	3.1	2.5	3.4	1.6	1.0	na
Japan	5.3	1.6	2.8	0.4	-0.3	2.5
OECD ^c	3.1	2.5	3.8	0.7	1.6	2.0
China ^d	9.0	10.5	8.0	7.5	8.0	9.1
Korea, Rep. of	7.8	8.9	8.5	3.8	7.0	3.1
Industrial production growth						
Australia	2.4	0.2	5.5	0.1	1.3	1.4
United States	0.9	4.8	4.4	-3.4	-0.6	0.3
Japan	4.1	3.4	5.2	-6.5	-1.3	3.3
Germany ^e	5.5	0.7	5.6	0.2	0.0	0.4
United Kingdom	-0.3	1.7	1.9	-1.6	-1.0	-0.5
OECD	1.6	3.4	4.9	-2.6	-2.7	0.7
China	5.5	16.1	11.4	9.9	12.6	17.0
Korea, Rep. Of	8.8	12.0	16.8	1.8	8.1	na
Population growth ^f						
Australia	1.4	1.2	1.0	1.8	0.9	1.2
United States	1.0	0.9	1.0	1.0	0.9	0.9
European Union ^g	0.6	0.3	0.4	0.4	0.4	na
Japan	0.3	0.2	0.2	0.4	0.4	0.4
China	1.4	2.3	0.8	0.8	0.7	0.7
Other East Asia ^h	1.0	2.0	1.5	1.3	1.3	1.1
World ⁱ	2.0	1.5	2.2	1.5	1.5	1.6

^a Percentage change from previous year. ^b Growth of real gross domestic product. ^c Regarded as nineteen countries for all years. ^d Gross national product. Excludes Hong Kong. ^e West Germany until 1990; unified Germany from 1991. ^f Midyear. ^g Regarded as twelve countries for all years. ^h Chinese Taipei, Indonesia, Malaysia, the Philippines, the Republic of Korea, Singapore, Thailand. ⁱ United Nations estimates. **na** Not available.

Source: ABARE, *Australian Commodity Statistics 2003*, Canberra.

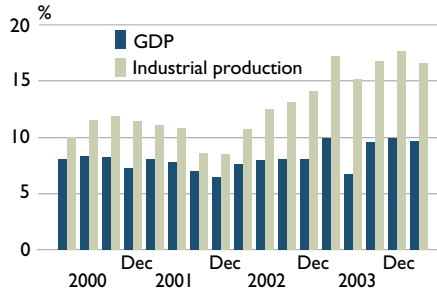
further reductions in stocks and higher contract prices are in prospect for 2005.

World economic growth is assumed to average around 4.2 per cent in 2004, before easing to 3.6 per cent in 2005, largely reflecting a moderation in the strong economic performance of the United States and China. In China, gross domestic product, in real terms, increased year on year by 9.7 per cent in the March quarter 2004, compared with average growth of 9.1 per cent in 2003. Strong growth in industrial production continues to underpin China's economic performance, with double digit growth in industrial production being consistently achieved, as it was in the mid to late 1990s.

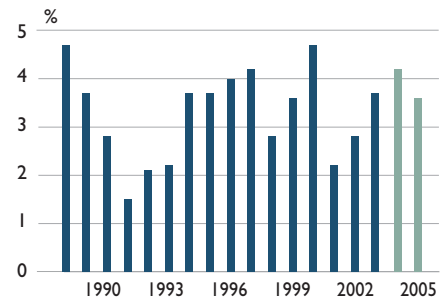
The outlook for the Australian economy remains positive, building on the robust performance of recent years. Economic growth in Australia is assumed to be 3.5 per cent in 2004-05, compared with an estimated 3.8 per cent in 2003-04.

Economic performance in China

Quarterly growth, ended March quarter 2004

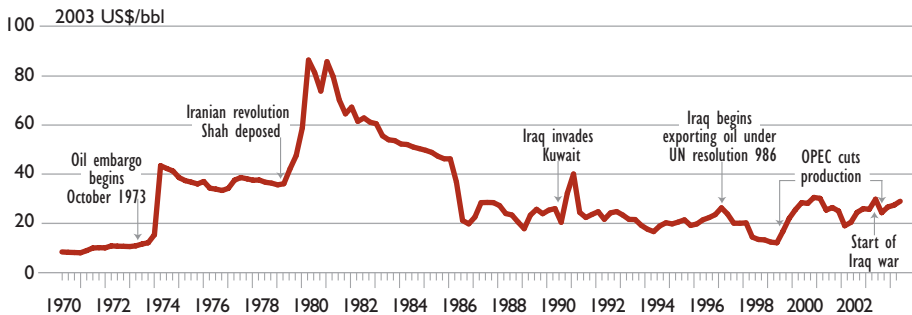


World economic growth



Crude oil prices since 1970

World trade weighted prices, weekly, ended 28 May 2004



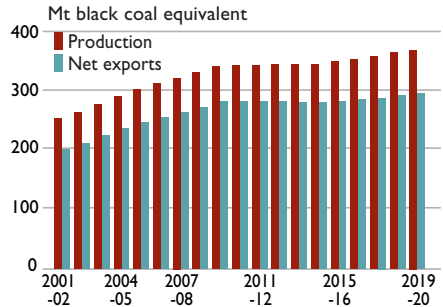
COAL production and trade

Australia is a secure, reliable and competitive supplier of high quality metallurgical and thermal coal. It has abundant resources of black coal, a large proportion of which is characterised as low sulphur, low ash bituminous coals.

Australia accounts for around 7 per cent of world black coal production. In 2002-03, Australia produced 274 million tonnes of black coal, of which 56 per cent came from Queensland and 40 per cent from New South Wales. Approximately three-quarters of Australian black coal production is sourced from opencut mines. Brown coal is only mined in Victoria where it is used principally for electricity generation.

Most of the coal produced from the Bowen Basin in Queensland is destined for export from ports near Mackay and Gladstone, including the large ports at Dalrymple Bay, Hay Point and Gladstone. In New South Wales, coal is exported from the ports

Australian coal industry



Salable coal production, by state

	1990-91	1995-96	2000-01	2001-02	2002-03
Black coal	Mt	Mt	Mt	Mt	Mt
New South Wales	80.1	91.9	110.2	114.3	111.0
Queensland	78.4	93.8	138.4	148.4	153.3
Western Australia	5.2	6.0	6.2	6.2	6.4
South Australia	2.5	2.4	3.2	3.1	3.1
Tasmania	0.4	0.4	0.3	0.4	0.4
Australia	166.6	194.5	258.3	272.4	274.1
Brown coal					
Victoria	49.4	54.3	65.0	66.7	66.8

Sources: Coal Services Pty Ltd (former NSW Joint Coal Board); Queensland Department of Natural Resources and Mines; Victorian Department of Primary Industries, Minerals and Petroleum; ABARE.

Export loadings and capacity for major Australian coal ports

	Capacity 2003 -04	Export loadings	
		2001 -02	2002 -03
New South Wales	Mt	Mt	Mt
Newcastle ^a	89.0	69.3	71.4
Port Kembla	16.0	8.2	9.0
Queensland			
Abbot Point	16.0	11.9	12.8
Brisbane	5.0	3.0	3.6
Dalrymple Bay	54.5	40.2	42.9
Gladstone ^a	40.0	37.5	38.2
Hay Point	34.0	30.5	31.8

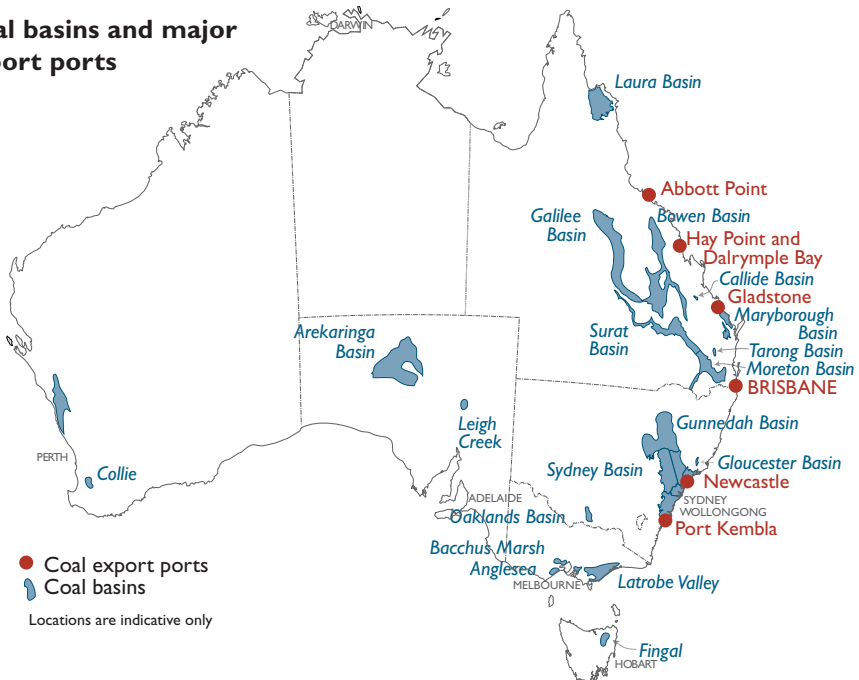
^a Ports with two coal loading terminals.

Sources: Coal Services Pty Ltd (former NSW Joint Coal Board); Queensland Department of Natural Resources and Mines; NSW Department of Mineral Resources.

of Newcastle and Port Kembla. The port of Newcastle has two coal loading terminals and in terms of tonnage is the largest coal exporting port in the world. In 2002-03, over 71 million tonnes of coal was exported from the port of Newcastle. Extensive rail networks in New South Wales and Queensland connect the coal ports with the major coal producing areas in each state.

Australia accounts for a third of world coal trade and around half of world metallurgical coal trade. More than three-quarters of Australia's black coal production is destined for export. New South Wales is the major source for thermal

Coal basins and major export ports



coal exports, while Queensland is the major source for metallurgical coal exports. The other states do not export black coal. In 2002-03, Australia exported 108 million tonnes of metallurgical coal and 100 million tonnes of thermal coal. Japan is Australia's largest export market of both metallurgical and thermal coal. Other major buyers of Australian coal include the European Union, Korea, India and Chinese Taipei.

Australian exports of coal are forecast to grow steadily over the next several years to meet increased world demand. Over the medium term, total coal exports are projected to reach 268 million tonnes by 2008-09. Most of this projected increase in exports is expected to come from new production capacity, which has been either committed or proposed to come on line over the next four years.

Australian coal exports by type, by destination					
	1990-91	1995-96	2000-01	2001-02	2002-03
Metallurgical coal, selected countries	Mt	Mt	Mt	Mt	Mt
Brazil	1.5	3.0	5.3	4.2	4.5
China ^a	0.3	0.1	0.4	0.0	0.7
Chinese Taipei ^b	3.3	na	na	na	na
European Union	9.2	12.2	20.9	21.2	18.6
India	0.0	9.9	10.7	11.9	14.1
Japan	31.4	25.3	43.5	40.4	41.3
Korea, Rep. of	5.7	8.0	6.4	6.6	7.4
Pakistan ^c	0.2	0.2	na	na	na
South Africa	0.1	0.0	1.3	1.6	1.5
Turkey	1.8	1.4	0.9	1.3	1.2
Total metallurgical coal	61.9	77.4	105.5	105.8	107.8
Thermal coal, selected countries					
ASEAN ^d	1.2	1.5	2.2	2.5	2.6
China ^a	–	1.4	0.6	3.0	4.0
Chinese Taipei	4.2	6.8	8.6	10.2	10.8
European Union	10.1	2.8	6.5	6.3	7.4
Hong Kong, China	3.5	1.6	0.4	0.3	0.7
India	0.0	0.4	2.2	1.5	1.2
Israel	0.4	1.0	2.1	2.3	1.0
Japan	26.7	35.0	50.0	49.6	52.4
Korea, Rep. of	4.9	9.6	12.8	13.4	14.2
Mexico	–	–	0.7	1.8	3.5
Total thermal coal	51.5	61.1	88.0	92.0	100.0

^a Excludes Hong Kong. ^b Confidential from 1995-96. ^c Confidential from 1997-98. ^d Includes Brunei Darussalam, Indonesia, Malaysia, the Philippines, Thailand and Viet Nam. **na** Not available.

Sources: ABS, *International Trade*, electronic data service, cat. no. 5464.0, Canberra; Department of Foreign Affairs and Trade, computer database compiled from trade data provided by the ABS.

Australian major coal projects

Project	Region	Operator	Mine type ^a	New capacity	Coal type ^b	Capex ^c	Start-up
				Mtpa		A\$m	
Black coal mines – committed							
New South Wales							
Ashton	Hunter Valley	White Industries	U/O	4	T/M	200	2004
Dartbrook expansion (Kayuga project)	Hunter Valley	Anglo Coal	U	5	T	55	2004
Dendrobium	near Wollongong	BHPBilliton	U	3.6	M	235	2005
Mandalong	near Newcastle	Centennial Coal	U	4.5	T	219	2005
Tahmoor North	near Wollongong	Austral Coal	U	1.6	M	135	2004
Queensland							
Broadmeadow	central	BMA	U	3.6	M	102	2005
Curragh North expansion	central	Wesfarmers	O	1.5	M/T	160	2005
Eaglefield	central	Peabody Energy	O	1	M	100–150	na
Grasstree	central	Anglo Coal	U	5	M	250	2006
Rolleston	central	Xstrata	O	8	T	291	2005
Black coal mines – proposed							
New South Wales							
Anvil Hill	Hunter Valley	Centennial Coal	O	9	T	na	2008
Mount Pleasant	Hunter Valley	Coal & Allied	O	7	T/M	310	2005-06
Wambo	Hunter Valley	Excel Coal	O	8	T/M	280	2004
Wilpinjong	near Mudgee	Excel Coal	O	5	T	156	2007
Queensland							
BMA coal expansion project	central	BMA	U/O	5	M	na	2005
Clermont	central	Rio Tinto	O	10	T	400	2008
Kogan Creek	south east	C S Energy	O	na	T	na	2006
Lake Lyndsay	central	Anglo Coal	O	na	M	na	2006
Minerva	central	Felix Resources	O	2.5	M/T	60	2005
Suttor Creek	central	Xstrata	O	3	T	na	2007
Wandoan	south east	Xstrata	O	3	T	na	2006
Black coal infrastructure – committed							
Queensland							
Blackwater coal handling and processing facility	central	BMA	na	na	na	234	2005
Brown coal mines – committed							
Victoria							
Yallourn development project	Latrobe Valley	Yallourn Energy	O	na	T	150	2005

^a U = underground; O = opencut. ^b M = metallurgical; T = thermal. ^c Capex = capital expenditure. Mtpa = million tonnes per annum. BMA BHPBilliton Mitsubishi Alliance. **na** Not available. Some proposed projects have been omitted from the list where the startup date is unknown.

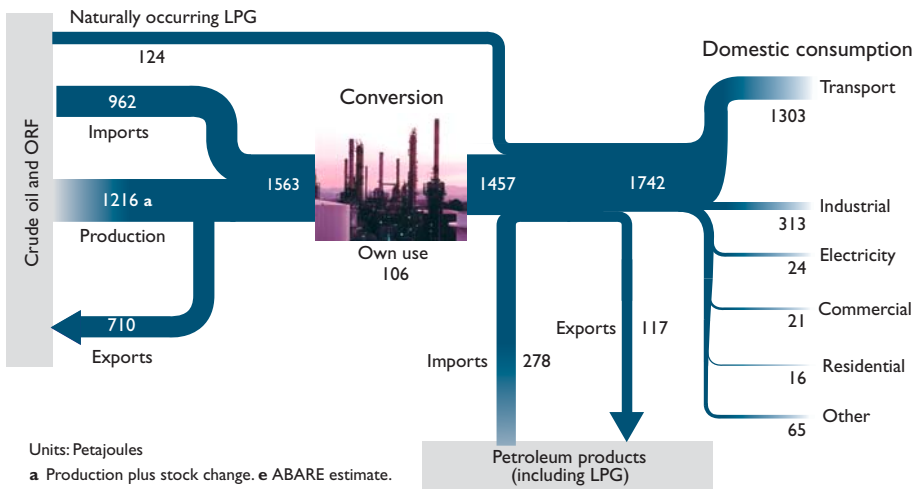
Source: Haine, I. 2004, 'Minerals and energy: major development projects', *Australian Commodities*, vol. 11, no. 2, Canberra.

LIQUID FUELS production and trade

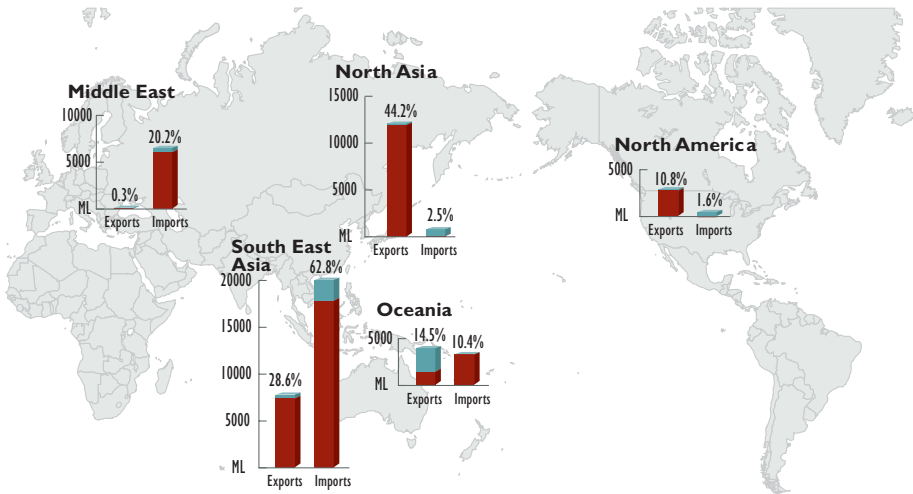
Australia is currently around 80 per cent self sufficient in the production of crude oil and natural gas liquids. In 2002-03, Australia's crude oil and condensate production was over 33 000 megalitres (or 574 000 barrels a day) of which 58 per cent came from the Carnarvon Basin in Western Australia. The Carnarvon Basin is Australia's most prolific oil producing region, producing more than 19 000 megalitres in 2002-03. The world class oil fields situated in the offshore Gippsland Basin, Victoria have been producing since the late 1960s. However, production from the Gippsland Basin peaked in the mid-1980s and has since steadily declined. In 2002-03, the Gippsland Basin produced around 7000 megalitres of crude oil and condensate or 22 per cent of Australia's total production. The other major oil producing region is the Bonaparte Basin off the north west coast of Australia. In 2002-03, nearly 5000 megalitres of crude oil and condensate were produced from oil fields in this region.

Crude oil and condensate is also produced from the onshore Cooper-Eromanga Basin, which straddles the border between South Australia and Queensland. Small quantities of oil and condensate are produced from several other onshore basins

Australian oil flows, 2004-05^e



Australian liquid fuels exports and imports, 2001-02



Exports = Australian exports to region
 Imports = Australian imports from region
 % = region as percentage of total

■ Refined products (ML)
 ■ Crude oil (ML)

Australian liquid fuels production, by basin

	1990-91	1995-96	2000-01	2001-02	2002-03
Crude oil and condensate	ML	ML	ML	ML	ML
Adavale	0	0	0	0	3
Amadeus	86	169	80	72	59
Bonaparte	4 078	1 377	8 898	5 985	4 918
Bowen–Surat	163	129	63	53	40
Canning	20	17	6	4	4
Carnarvon	6 838	14 279	18 804	19 745	19 303
Cooper–Eromanga					
– Queensland	1 143	887	615	635	690
– South Australia	2 106	1 117	906	868	762
Gippsland	17 482	12 247	9 328	8 719	7 418
Otway	0	4	4	12	2
Perth	39	26	3	7	121
Total	31 955	30 251	38 705	36 100	33 320
Liquefied petroleum gas ^a					
Total	3 547	3 649	4 056	4 612	4 682

^a Naturally occurring.

Source: DITR, *Australian Petroleum Statistics*, Canberra.

including the Perth and Canning Basins in Western Australia, the Amadeus Basin in the Northern Territory, the Bowen–Surat and Adavale Basins in Queensland and the Otway Basin straddling South Australia and Victoria.

Australia's production of naturally occurring liquefied petroleum gas (LPG) was 4682 megalitres in 2002-03, most of which was sourced from the Gippsland and Carnarvon Basins. The Cooper–Eromanga Basin also produces naturally occurring LPG.

Australian petroleum exports, by destination ^a					
	1990-91	1995-96	2000-01	2001-02	2002-03
Crude oil ^b	ML	ML	ML	ML	ML
China	na	315	912	1 051	1 704
Chinese Taipei	103	2 336	3 712	1 920	580
Japan	1 942	2 490	4 068	3 168	3 402
Korea, Rep. of	0	702	4 358	5 521	4 012
New Zealand	86	639	613	1 426	784
Singapore	2 226	1 342	6 079	6 215	6 567
United States	2 663	938	2 962	2 674	2 944
Other	641	544	1 839	1 989	2 195
Total	7 662	9 307	24 544	23 965	22 188
Liquefied petroleum gas ^c					
China	na	124	416	441	154
Japan	na	1 058	2 241	2 572	2 786
Korea, Rep. of	na	na	61	127	234
Other	na	80	67	71	21
Total ^d	1 507	1 469	2 785	3 211	3 194
Refined products					
Fiji	253	565	748	473	384
Japan	na	50	18	220	26
New Zealand	220	1 079	1 086	1 247	1 250
Singapore	890	710	697	367	246
Other Pacific	na	208	150	151	738
United States	na	92	331	153	99
Other	1 589	1 398	1 534	798	397
Total	2 952	4 101	4 564	3 409	3 140
Liquefied natural gas ^s	Mt	Mt	Mt	Mt	Mt
Total	3.40	7.48	7.53	7.60	7.83

^a Does not include ships and aircraft stores. ^b Includes other refinery feedstock. ^c Principally includes naturally occurring LPG. ^d Includes confidential exports. ^e 1 tonne of LNG is approximately equal to 2174 litres of LNG. ^s ABARE estimate. **na** Not available.

Sources: DITR, *Australian Petroleum Statistics*, Canberra; ABS; ABARE.

Several new projects off the west and north western coasts are expected to significantly contribute to Australia's production of liquid levels. The recently commissioned ConocoPhillips Bayu–Undan gas recycling project situated in the Bonaparte Basin is expected to produce around 115 000 barrels a day of condensate and LPG. As this field is located in the Joint Petroleum Development Area in the Timor Sea, Australia's share of revenues will be 10 per cent. Two other liquid projects are the Santos Mutineer/Exeter and the Woodside Enfield oil field developments. Both of these projects are located offshore in the Carnarvon Basin and each is expected to produce 100 000 barrels a day of oil at full capacity.

Australia is a net importer of crude oil and refined products, but a net exporter of LPG. In 2002-03, Australia imported nearly 28 000 megalitres of crude oil and over 5000 megalitres of refined product. Almost 63 per cent of these imports came from

Australian petroleum imports, by source					
	1990-91	1995-96	2000-01	2001-02	2002-03
Crude oil ^a	ML	ML	ML	ML	ML
Indonesia	2 591	4 713	3 788	6 795	5 380
Malaysia	883	839	2 249	2 290	2 299
New Zealand	1 045	1 093	1 104	1 089	990
Other Middle East	766	340	453	42	334
Papua New Guinea	0	4 667	2 772	2 208	1 683
Qatar	87	1 273	439	646	191
Saudi Arabia	4 334	4 469	4 016	3 004	3 680
Singapore	543	983	287	554	719
United Arab Emirates	2 195	3 153	3 170	2 305	2 294
Viet Nam	0	1 451	6 282	5 652	6 699
Other	945	723	1 784	2 724	3 690
Total	13 389	23 703	26 343	27 308	27 958
Refined products ^b	L				
Indonesia	26	125	121	87	57
Korea, Rep. of	5	50	141	289	156
Malaysia	13	77	6	29	45
Middle East	179	569	775	474	140
New Zealand	89	50	19	42	18
Singapore	839	1 387	1 688	2 124	2 907
United States	460	871	367	462	105
Other ^c	1 210	394	1 610	1 169	1 776
Total	2 821	3 522	4 726	4 676	5 204

^a Includes other refinery feedstock. ^b Includes refined LPG. ^c Includes confidential imports of refined products.

Sources: DITR, *Australian Petroleum Statistics*, Canberra; ABS; ABARE.

south east Asia, with Viet Nam, Indonesia and Malaysia being large suppliers of crude oil and Singapore being Australia's largest supplier of refined product. Countries in the Middle East accounted for 20 per cent of Australia's imports, with Saudi Arabia and the United Arab Emirates being the largest suppliers of crude oil to Australia from this region. Since the mid-1990s, Australia's imports of Middle Eastern crude oil have gradually fallen.

In 2002-03, Australia exported 22 000 megalitres of crude oil, 3000 megalitres of LPG and 3000 megalitres of refined product. About 44 per cent of these exports were shipped to north Asia (Korea and Japan). Japan is Australia's largest market for LPG. The south east Asian region accounted for a further 28 per cent of Australia's petroleum exports, with Singapore being Australia's largest market for crude oil. Oceania received another 14 per cent of Australia's liquids exports, with New Zealand being Australia's largest market for refined product.

In 2003-04, Australian crude oil and condensate production is expected to fall by 15 per cent to 28 500 megalitres, or 490 500 barrels a day. In 2004-05, production of crude oil and condensate is forecast to decline by another 1 per cent before rising in 2005-06 with the commencement of two new liquids projects.

Although much of the current oil production in Australia is sourced from mature oil and gas provinces, many prospective areas offshore are yet to be fully explored. The United States Geological Survey estimates that there are significant undiscovered oil and gas resources in Australia's four major offshore regions, the Gippsland Basin in Victoria,

Export loadings for major petroleum ports, 2002-03

Crude oil and condensate	Mt
Sydney, New South Wales	0.035
Brisbane, Queensland	0.046
Westernport, Victoria	2.126
Dampier, Western Australia a	4.883
Refined oil products	
Sydney, New South Wales	0.381
Brisbane, Queensland	2.565
Cairns, Queensland	0.048
Gladstone, Queensland	0.032
Geelong, Victoria	2.230
Melbourne, Victoria	0.635
Fremantle, Western Australia	2.403
Refined petroleum gases b	
Sydney, New South Wales	0.077
Brisbane, Queensland	0.033
Melbourne, Victoria	0.010
Liquefied petroleum gas c	
Westernport, Victoria	0.527
Dampier, Western Australia	1.025
Fremantle, Western Australia	0.230
Liquefied natural gas	
Dampier, Western Australia	7.899

a Condensate only. b Includes refined LPG, butane and other refined gases. c Naturally occurring LPG. na Not available. Mt = million tonnes.

Sources: Association of Australian Ports and Marine Authorities; Dampier Port Authority; Fremantle Port Authority; Port of Brisbane; Sydney Ports Corporation.

the Bonaparte Basin in the Northern Territory and the Browse and Carnarvon Basins in Western Australia. The continued development of technology is also bringing the economic production of oil from gas (gas to liquids) closer to economic reality.

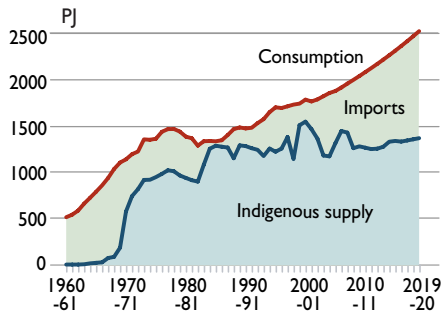
Reflecting these trends, as well as the overarching outlook for world crude oil prices, Australian crude oil production is projected to increase by 0.8 per cent a year over the medium to long term.

Largely on the basis of increasing production of natural gas, Australian LPG production is expected to reach almost 5177 megalitres by 2008-09. Australia currently produces significantly more LPG in total than is consumed and, although propane is likely to remain in short supply, Australia is expected to export increasing quantities of butane.

Overall, Australia's combined output of crude oil and naturally occurring LPG is forecast to decline from 1459 petajoules in 2001-02 to 1362 petajoules by 2019-20.

Australia has eleven major deepwater ports that have facilities to export petroleum liquids. Some liquids are also exported directly from offshore facilities. The port of Dampier in Western Australia is Australia's largest petroleum exporting port, accounting for 34 per cent of all Australian liquids exports (excluding LNG) in 2002-03. More than half of the export loadings through Dampier are LNG, with the remainder mostly crude oil and condensate. This reflects that Australian exports of crude oil and condensate are increasingly sourced from the west coast while exports of refined product are largely sourced from the east coast.

Australian crude oil self sufficiency



Liquid fuels export ports

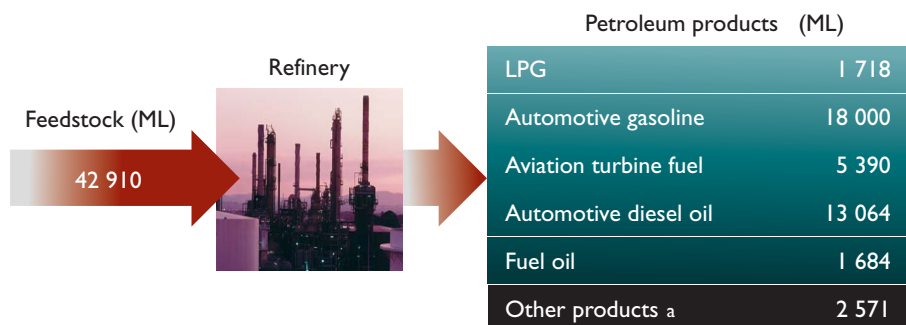


LIQUID FUELS domestic refining

Australia's downstream petroleum industry includes eight major oil refineries operated by four companies — BP, Caltex, Mobil and Shell. Six of these refineries are located in New South Wales, Victoria and Queensland and service the east coast domestic market. There is also a refinery at Kwinana in Western Australia, which services the west coast market. The only refinery in South Australia (Port Stanvac) ceased operating in July 2003 and is currently under care and maintenance. In addition to these major oil refineries there is also a small refinery at Eromanga, south west Queensland.

The petroleum refining industry produces a wide range of products from crude oil and condensate feedstock. In 2001-02, 4227 megalitres of petroleum products were refined from 4290 megalitres of feedstock. In 2001-02, automotive gasoline, diesel fuel and aviation turbine fuel accounted for 86 per cent of the total production of refined products in Australia. Australia's self sufficiency (measured as gross consumption relative to production) is relatively high for these products — 96 per cent for automotive gasoline, 92 per cent for diesel fuel and 159 per cent for aviation turbine fuel in 2001-02. Australia is a net exporter of LPG, producing far more than is required domestically (largely naturally occurring LPG). Australia is less self sufficient in the heavier distillation fractions such as lubricating oils, greases and bitumen.

Australian refinery input and production, 2001-02



^a Includes aviation gasoline, kerosene, industrial and marine diesel, lubricating oils, greases and basestocks, bitumen and other products.

Source: Department of Industry, Tourism and Resources, *Australian Petroleum Statistics*.

Australian refineries



Capacity of Australian refineries

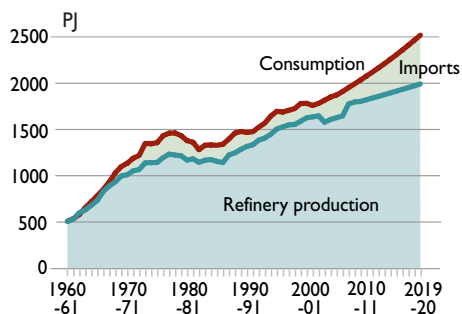
	Operator	Year ^a	Capacity	Capacity utilisation ^b
New South Wales				
			MLpa	MLpa
Clyde	Shell	1928	4 991	4 294
Kurnell	Caltex	1956	7 225	6 267
Queensland				
Bulwer Island	BP	1965	5 107	4 410
Eromanga (mini refinery)	IOR	1985	87	na
Lytton	Caltex	1965	6 122	5 281
South Australia				
Port Stanvac ^c	Mobil	1963	4 526	na
Victoria				
Altona	Mobil	1949	7 834	6 790
Geelong	Shell	1954	6 906	5 977
Western Australia				
Kwinana	BP	1955	8 037	6 964
Australia				
Total ^d			46 309	39 984

^a Year refinery was commissioned. ^b Average for 2002. ^c Ceased production in July 2003; current status care and maintenance. ^d Total of current operating refineries. **na** Not available. MLpa = megalitres per annum.

Source: Australian Institute of Petroleum.

With the mothballing of the Port Stanvac refinery in South Australia, gross refinery output, including that of petrochemicals, in Australia is expected to fall by more than 4 per cent to 1576 petajoules in 2003-04. With a consistent increase in the domestic consumption of petroleum products over the medium term and an improvement in the economics of petroleum refining in Australia, the Port Stanvac refinery is assumed to resume production in 2007-08. This is expected to result in an 8 per cent increase in output in that year.

Refined products self-sufficiency



Over the period 2010-11 to 2019-20, refining capacity as well as refinery output in Australia is assumed to increase by around 1 per cent a year. Reflecting this, output of petroleum products is forecast to increase from 1634 petajoules in 2001-02 to 1989 petajoules by 2019-20, an overall increase of around 22 per cent or 354 petajoules of refined products. At the same time, the consumption of petroleum products in Aus-

Australian consumption of petroleum products

	1990-91	1995-96	2000-01	2001-02
Marketable petroleum products a	ML	ML	ML	ML
LPG b	3 209	4 448	4 746	4 009
Automotive gasoline	16 870	17 884	18 165	18 670
Aviation turbine fuel	3 228	4 665	5 318	4 649
Automotive diesel oil	9 803	11 947	13 416	14 188
Fuel oil	2 271	2 131	1 933	1 644
Other products c	3 917	4 786	4 768	3 990
Other and total petroleum products				
Total a	38 789	45 436	48 162	47 150
Refinery fuel d	2 169	2 333	2 300	2 699
Total	40 958	47 769	50 462	49 849

a Excludes refinery fuel used in refineries and losses. Some petroleum product is produced from the conversion of other petroleum products. This element of double counting has been netted off total marketable petroleum products. b Includes LPG used as petrochemical feedstock. c Includes aviation gasoline; kerosine; heating oil; industrial diesel fuel; lubricants and greases; bitumen; crude oil used as fuel; naphtha; refinery fuel sold; solvents; petroleum coke and speciality feedstocks. d Fuel oil equivalent.

Source: Donaldson, K. *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com).

tralia is projected to increase by around 2 per cent a year, reflecting strong underlying growth in the transport sector (especially road freight and air transport). As a result, the share of petroleum products sourced from local refineries is projected to fall from the current level of around 93 per cent to less than 80 per cent by 2019-20.

Australian major liquid fuels projects						
Project	Region	Operator	New capacity	Liquids type a	Capex b	Start-up
Committed					A\$m	
New South Wales						
Kurnell refinery upgrade	Sydney	Caltex	na	na	125	2005
Queensland						
Lytton refinery upgrade	Brisbane	Caltex	na	na	125	2005
Western Australia						
Enfield oilfield development	offshore Carnarvon Basin	Woodside	100 kbpd	OL	1480	2006
Liquidgaz methanol plant	Burrup Peninsula	GTL Resources	1 Mtpa	ME	700	2006
Mutineer/Exeter oilfield development	offshore Carnarvon Basin	Santos	100 kbpd	OL	480	2005
Proposed					A\$m	
Northern Territory						
Tassie Shoal methanol project	Timor Sea	Methanol Australia	3.5 Mtpa	ME	2000	2008
Queensland						
Stuart oil shale plant (stage 2)	near Gladstone	Queensland Energy Resources	14.8 kbpd	OL	600	on hold
Victoria						
Hazelwood brown coal to diesel project	Latrobe Valley	GTL Energy/International Power	10 kbpd	DI/NA	500	2008
Victorian power and liquids project	Latrobe Valley	Australian Power and Energy Ltd	52.6 kbpd 1060 MW	DI EL	6000	2008
Western Australia						
Cliff Head oilfield discovery	offshore Perth Basin	Roc Oil	10–20 kbpd	OL	140	2005
Dimethyl Ether project	Burrup Peninsula	Japan DME	1.7 Mtpa	DE	1100	2006
Gas to liquid fuels plant (stage 1)	Barrow Island	SASOL/ Chevron	45 kbpd 7.3 kbpd	DI NA/LPG	2000	na

a OL = oil; ME = methanol; DI = diesel; NA = naphtha; DE = dimethyl ether; LPG = liquefied petroleum gas; EL = electricity.
b Capex = capital expenditure. Mtpa = million tonnes per annum; kbpd = thousand barrels per day; MW = megawatt. na Not available.

Source: Haine, I. 2004, 'Minerals and energy: major development projects', *Australian Commodities*, vol. 11, no. 2, Canberra.

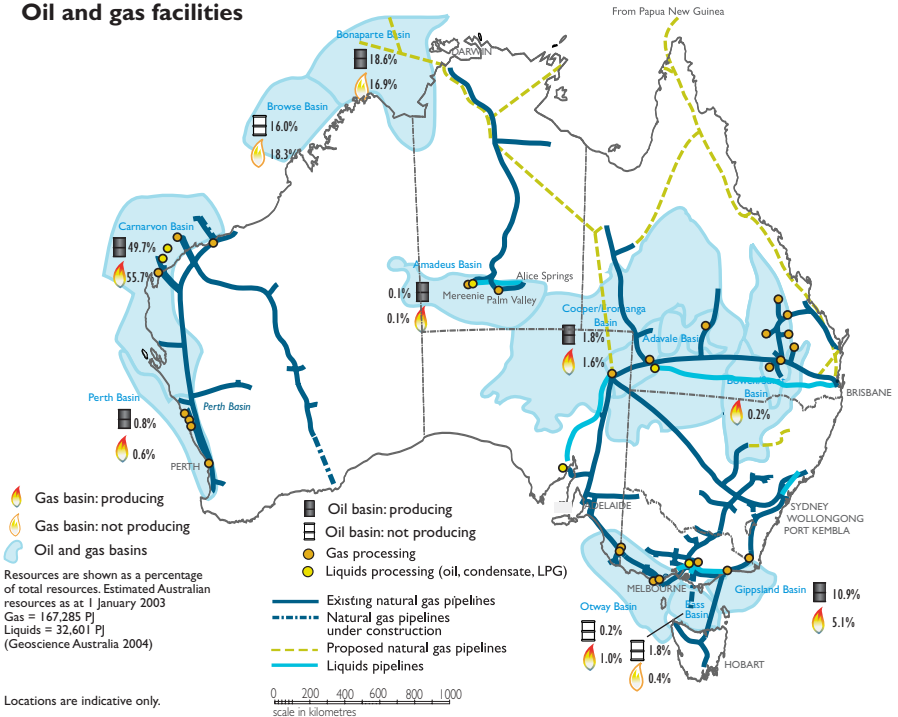
GAS production and trade

Increasingly the majority of Australia's natural gas production is being sourced from gas fields located off the west coast of Australia. This reflects the growing share of known natural gas reserves being located to the west and north west of Australia.

In 2001-02, Australia's natural gas production (including naturally occurring ethane) was over 35 000 gigitalitres, of which almost 55 per cent was produced in Western Australia. Of this, around half (or over 18 000 gigitalitres) was produced from the Carnarvon Basin alone.

Natural gas production in South Australia accounted for about 19 per cent of Australia's total natural gas production in 2001-02, the majority of which came from the onshore Cooper–Eromanga Basin. Victoria accounted for another 18 per cent, the majority of

Oil and gas facilities



which came from the offshore Gippsland Basin. The onshore Otway Basin in south western Victoria has also contributed small volumes to the Victorian market for many years. Several gas fields off the southern coast of Victoria in the Bass and Otway Basins are also being developed. Gas from the Otway Basin was delivered to South Australia via the SEAgas pipeline for the first time in 2004 and proved to be critical in managing the temporary cessation of supplies from the Cooper–Eromanga Basin.

Gas produced in Queensland and the Northern Territory account for only 5 per cent and 3 per cent respectively of total Australian gas production. Queensland natural gas production is sourced from the Queensland sector of the Cooper–Eromanga, Bowen–Surat and Adavale basins, while gas production in the Northern Territory has been sourced solely from the onshore Amadeus Basin in central Australia.

Adding to Australia’s gas production is the small but growing contribution from coal seam methane (CSM). It is estimated that in 2002, CSM production in Australia was 0.88 gigitalitres, of which 74 per cent came from the Bowen–Surat Basin in Queensland and the remainder from the Sydney Basin in New South Wales.

Australia exports natural gas in the form of liquefied natural gas (LNG). Exports of LNG totaled 7.8 million tonnes in 2002-03. All of Australia’s LNG exports are currently sourced from the Carnarvon Basin in Western Australia. Here, the North

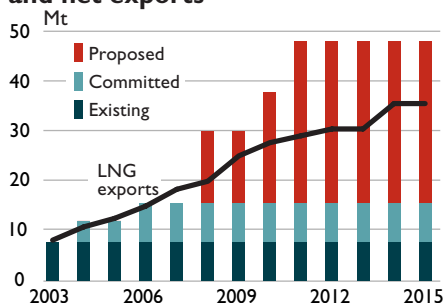
Australian gas production, by state				
	1990-91	1995-96	2000-01	2001-02
Naturally occurring ethane and natural gas ^a	GL	GL	GL	GL
New South Wales	0	0	0	0
Victoria	5 825	6 685	6 630	6 394
Queensland	977	1 250	1 494	1 866
Western Australia	9 389	16 407	19 166	19 275
South Australia	5 063	5 310	6 545	6 625
Tasmania	0	0	0	0
Northern Territory	341	441	500	1 028
Total	21 595	30 093	34 335	35 188
Coal seam methane ^b				
New South Wales	na	na	0.20	0.23
Queensland	na	na	0.34	0.65
Total	na	na	0.54	0.88

^a Only includes methane or ethane produced from natural gas fields. ^b Calendar year estimates for 2001 and 2002. GL = gigitalitres.

Sources: Donaldson, K. *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com); Petrie, E. and others, *Oil and Gas Resources of Australia 2002*, Geoscience Australia, Canberra.

West Shelf joint venture supplies natural gas from several offshore gas fields to an LNG processing facility located on the Burrup Peninsula. In the near future natural gas will also be supplied from the ConocoPhillips Bayu–Undan gas field in the Bonaparte Basin, Timor Sea, to support LNG production near Darwin in the Northern Territory. With firm growth in demand for natural gas in the Asia Pacific region, the medium to longer term prospects for Australian LNG exports are strong.

Australian LNG production capacity and net exports



The domestic market for natural gas in Australia is characterised by a small number of producers, a small number of large consumers and limited diurnal or seasonal variation in demand (what might be described as limited depth in the market). Historically, two major gas producers have largely supplied the east Australian natural gas market (South Australia, Victoria, New South Wales, Queensland and Tasmania). In 2001-02, almost 94 per cent of natural gas supplied to this market was from the Esso/

Australian major gas projects

Project	Region	Operator	New capacity	Gas type a	Capex b	Start-up
LNG – committed			Mtpa		A\$m	
Northern Territory						
Darwin LNG plant	Darwin	ConocoPhillips	3.5	LNG	3000	2006
Western Australia						
North West Shelf (4th train)	Burrup Peninsula	Woodside	4.2	LNG	2500	2004
LNG – proposed						
Northern Territory						
Sunrise LNG project	Timor Sea	Woodside	5.3	LNG	5000	2010
Tassie Shoal LNG project	Timor Sea	Methanol Australia	2.5	LNG	na	2010
Western Australia						
Browse LNG project	Browse Basin	Woodside	10	LNG	na	2011
Gorgon LNG	Barrow Island	Chevron	10	LNG	11000	2008
			300 TJpd	NG		
North West Shelf (5th train)	Burrup Peninsula	Woodside	4.2	LNG	1600	2008

continued

BHP Gippsland Basin joint venture and the Santos led Cooper–Eromanga Basin joint venture. While the Carnarvon Basin dominates supplies for the Western Australian natural gas market, there are several producers supplying natural gas to the domestic market from this region.

Australian major gas projects <i>continued</i>						
Project	Region	Operator	New capacity	Gas type a	Capex b	Start-up
			PJpa		A\$m	
Gas – committed						
New South Wales						
Camden Gas CSM stages 2 & 3	near Sydney	Sydney Gas	14.5	CSM	150	2005-06
Queensland						
Moranbah CSM	central	CH4	13	CSM	62	2005
Tasmania						
BassGas	offshore Bass Basin	Origin	20 67 ktpa 2.5 kbpd	NG LPG CO	450	2004
Victoria						
Geographe/Thylacine	offshore Otway Basin	Woodside	60	NG	1100	2006
Minerva gas	offshore Otway Basin	BHPBilliton	150 TJpd 600 bpd	NG CO	230	2004
Gas – proposed						
Victoria						
Casino gas	offshore Otway Basin	Santos	24	NG	200	2006
Western Australia						
Blacktip gas	Bonaparte Basin	Woodside	40	NG	1000	2007
John Brookes gas	Carnarvon Basin	Apache Energy	20 mcfpd	NG	170	2005
Gas infrastructure – committed						
Queensland						
North Queensland gas pipeline	Moranbah to Townsville	Enertrade	20	CSM	150	2004
Western Australia						
Telfer gas pipeline	Port Hedland to Telfer	GasNet Australia	na	NG	114	2004
Gas infrastructure – proposed						
Queensland						
PNG – Qld gas pipeline	PNG to Queensland	ExxonMobil	300	NG	1900	2007-08

a LNG = liquefied natural gas; NG = natural gas; CSM = coal seam methane; CO = condensate; LPG = liquefied petroleum gas. **b** Capex = capital expenditure. Mtpa = million tonnes per annum; PJpa = petajoules per annum; TJpd = terrajoules per day; mcfpd = million cubic feet per day; kbpd = thousand barrels per day. **na** Not available.

Source: Haine, I. 2004, 'Minerals and energy: major development projects', *Australian Commodities*, vol. 11, no. 2, Canberra.

ELECTRICITY

The Australian electricity industry, like many electricity industries around the world, has been undergoing a process of substantial change to both its structure and institutions for over ten years, which has led to significant improvements in performance and lower costs. With over \$86 billion in assets, the electricity industry ranks as one of Australia's largest, making a direct contribution of 1.5 per cent to Australia's gross domestic product. Compared with 1989-90, the industry in 2001-02 delivered more electricity (up 45 per cent), to more customers (up 26 per cent) with less than half the number of employees. The total time that electricity was not available for delivery through the transmission network (due either to generation or transmission outages)

Key performance indicators for the Australian electricity industry

		1997-98	1998-99	1999-2000	2000-01	2001-02
Generation capacity	MW	39 383	40 715	40 975	42 088	44 772
Asset value	A\$m	74 867	76 319	83 509	86 042	na
Capacity utilisation	%	58.8	59.0	59.9	56.4	52.9
Electricity generation	GWh	179 096	186 252	192 846	198 780	201 141
Employment	no.	33 099	33 073	32 308	32 927	30 032
Labor productivity	GWh/ employee	5.4	5.6	6.0	6.0	6.7
Number of customers	no.	8 364 957	8 534 914	8 650 445	8 825 378	8 969 093
Retail price a						
– nominal	c/kWh	8.67	8.90	8.82	9.46	10.16
– real b	c/kWh	9.84	9.98	9.66	10.04	10.47
Wholesale price c						
– nominal	c/kWh	na	3.75	4.04	4.76	3.39
– real b	c/kWh	na	4.20	4.42	5.05	3.49
System minutes not supplied d	mins	5.17	5.05	9.56	13.53	5.11
System energy not supplied	MWh	1 591	1 314	3 439	3 656	1 440
Distribution losses	%	6.0	5.9	5.9	5.8	5.8
Transmission operation cost	A\$/MWh	1.56	1.45	1.53	1.34	1.52

a Average price. **b** 2002-03 A\$ value. **c** Volume weighted – average price (national electricity market). **d** Average minutes – excludes Northern Territory. **na** Not available.

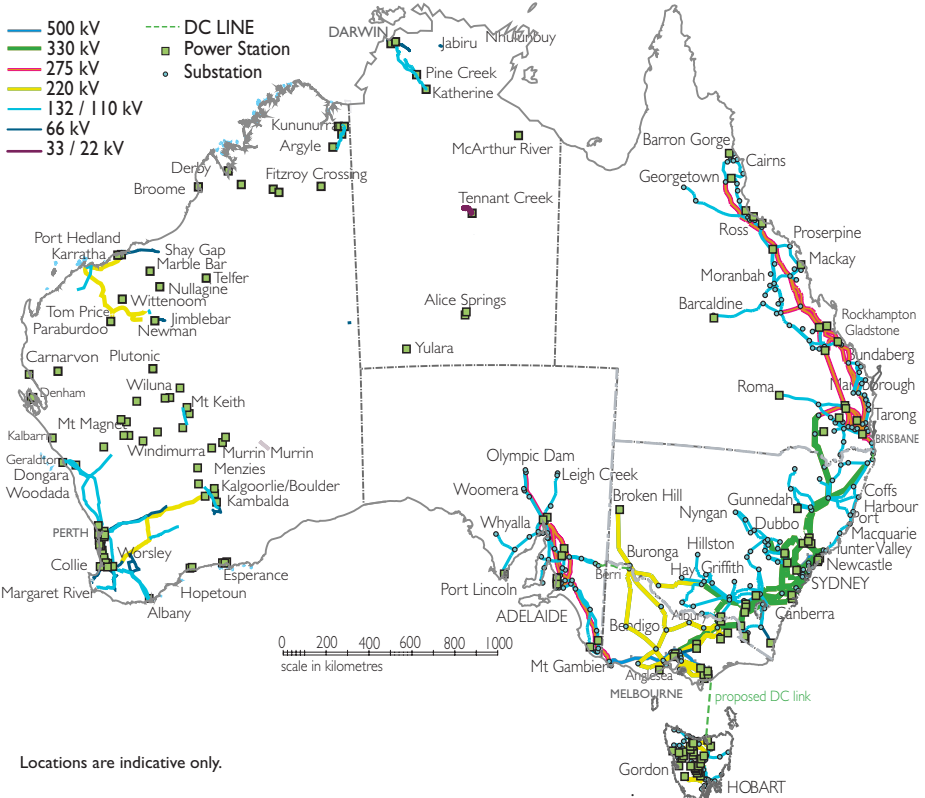
Sources: Electricity Supply Association of Australia Limited, *Electricity Australia 2003, 2002, 2001 and 2000*; ABS, *Electricity, Gas, Water and Sewerage Operations*, cat. no. 8226.0.

in 2001-02 is estimated to have been 5.1 minutes, with approximately 1440 MWh of energy demand not met. The capacity of Australia's electricity industry in 2001-02 was almost 45 000 megawatts, generating approximately 201 140 GWh in total.

Final consumption of electricity in Australia has more than tripled since 1973-74, from 213 petajoules (59 170 GWh) to 690 petajoules (191 110 GWh) by 2001-02. Consumption is projected to continue to grow strongly to reach 1056 petajoules (293 340 GWh) by 2019-20. Servicing these levels of demand will require significant new investment. The energy industry has estimated that investment of around \$37 billion in generation and network capacity will be needed over the period to 2020.

In the early 1900s, the electricity supply industry consisted of a mixture of both private and public enterprises. By the late 1940s, the industry was predominantly

Transmission lines and generators



Electricity capacity in Australia, by plant and fuel type, 2001-02

	New South Wales ^a	Victoria	Queens- land ^b	South Australia	Western Australia	Tas- mania	Northern Territory	Australia
	MW	MW	MW	MW	MW	MW	MW	MW
Hydro ^c	3 031	453	132	0	2	2 276	0	5 894
Pump storage	990	0	500	0	0	0	0	1 490
Steam								
– coal	11 670	6 395	8 105	760	330	0	0	27 260
– natural gas	0	510	0	1 280	156	0	0	1 946
– oil product	0	0	0	0	0	240	0	240
– dual/multi-fuel	0	0	0	0	1 920	0	0	1 920
Internal combustion	0	0	0	0	106	26	136	268
Gas turbine								
– gas	0	979	627	646	112	0	207	2 571
– oil product	50	0	851	113	83	0	38	1 135
– dual fuel	0	0	0	0	607	0	0	607
Gas combined cycle	162	0	476	680	0	0	123	1 441
Total	15 903	8 337	10 691	3 479	3 316	2 542	504	44 772

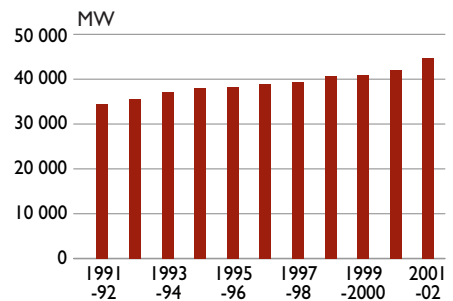
^a Includes generating capacity at Mount Isa. ^b Nonscheduled small hydro plants are excluded. ^c Includes the ACT and the Snowy region. MW = megawatt.

Source: Electricity Supply Association of Australia Limited, *Electricity Australia 2003*.

government owned. Successive state governments chose to organise the delivery of electricity to consumers organised through state owned, vertically integrated monopolies with only limited interconnection between the states.

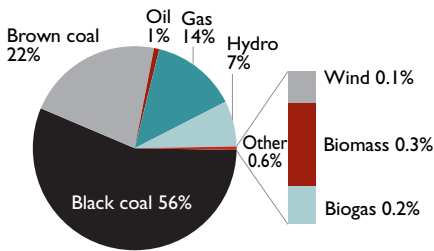
The restructuring of the Australian electricity industry, which commenced in the early 1990s, has consisted of vertical disaggregation of the integrated, state owned utilities into separate generation, transmission, distribution, and retail supply components; corporatisation and in some cases privatisation of electricity businesses; horizontal separation of the generation sector into numerous competing businesses; separation and regulation of the transmission and distribution functions; ring fencing of distribution and retail businesses (activities undertaken by one company); and the introduction of retail competition.

Electricity capacity in Australia

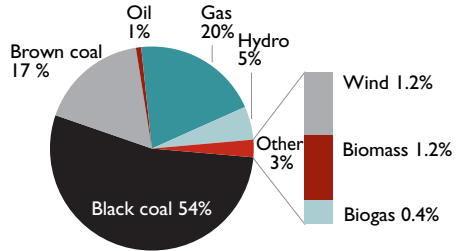


Shares in Australian electricity generation, by fuel

2001-02



2019-20



A key element of the reforms was the commencement in December 1998 of the 'national electricity market' (NEM), which is composed of the Australian Capital Territory, New South Wales, Victoria, South Australia and Queensland (with Tasmania to join in 2005). The NEM consists of market supply of electricity by generators; a competitive retail sector with the majority of the 7.7 million customers free to choose their retailer (or, in some cases, contract directly with generators); and regulated network sectors.

In creating the NEM, the principal aims were to promote competition and efficiency in the production and consumption of electricity and associated services, to allow customers flexibility and choice of supplier; and to not discriminate on the basis of

Australian electricity generation, by fuel					
	2001-02	2005-06	2010-11	2015-16	2019-20
Fossil fuels	PJ	PJ	PJ	PJ	PJ
Black coal	452.6	475.8	533.6	603.3	667.1
Brown coal	174.0	179.6	190.9	203.9	213.9
Oil	8.2	8.3	8.4	8.6	8.7
Gas	109.9	147.0	180.1	217.3	249.6
Total	744.7	810.7	913.1	1 033.1	1 139.2
Renewables					
Hydro	57.1	59.0	64.4	64.2	64.1
Wind	1.0	4.7	14.2	14.4	14.6
Biomass	2.6	10.4	14.9	14.9	14.9
Biogas	1.2	4.1	5.4	5.4	5.4
Total	62.0	78.2	98.9	98.9	99.0

Source: Akmal, M. et al, *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

supply technologies or on the location of customers and suppliers. In 2003, there were 43 different companies that bid their generation output into the NEM, and approximately eight major large retailers (with a number of generators and niche retailers targeting specific customers).

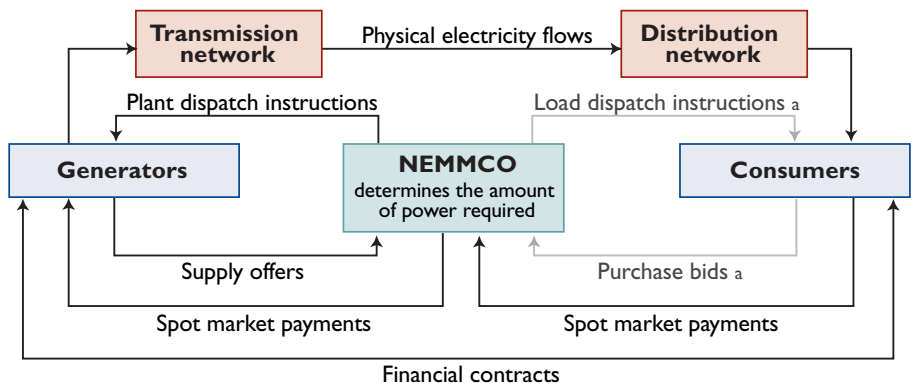
Most network service providers (transmission and distribution networks operating as regional monopolies) are regulated through various Commonwealth and state economic regulatory bodies. In addition, merchant transmission development is permitted under certain conditions.

In late 2004, a single National Energy Regulator will be created. Initially, it will have responsibility for transmission assets and market monitoring. However, it is anticipated that by the end of the decade, it will be the sole regulatory body for the electricity industry.

The NEM spot market is the mechanism for the balancing of electricity demand and supply. Generators with a capacity greater than 30 megawatts are required to sell all electricity through the spot market. The rules and procedures that govern the operation of the NEM are contained in the National Electricity Code. The code is intended to allow participants in the market to act with a maximum level of commercial freedom in a market environment that is transparent and efficient. Trading risks are hedged via financial contracts managed in secondary markets.

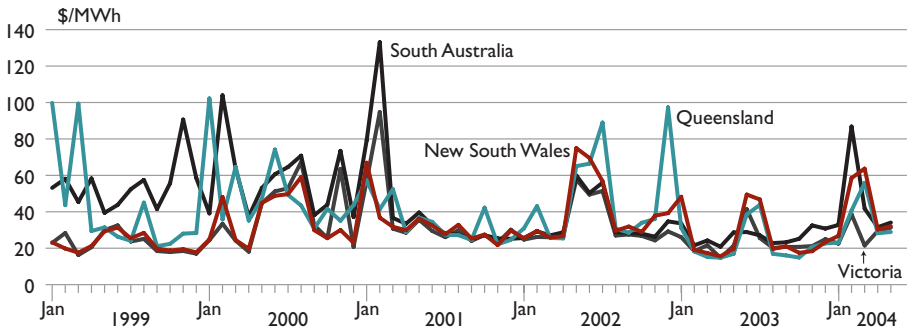
The National Electricity Market Management Company (NEMMCO) is responsible for managing both the spot market and the central coordination of the dispatch of

Structure of the 'national electricity market'



a Currently there are no dispatchable loads actively bidding in the market.

Average spot market prices Monthly, ended May 2004



electricity from all generators to ensure there is sufficient supply to meet demand. NEMMCO also has responsibility for maintaining power system security.

Wholesale spot prices for the 2003-04 year averaged \$31/MWh in Queensland; \$37/MWh in New South Wales; \$27/MWh in Victoria; and \$39/MWh in South Australia. Compared with the first full year of the market in 1999-2000, these prices represent a reduction of around 40 per cent in Queensland and South Australia. Prices in Victoria have fallen for the third consecutive year, while in New South Wales prices have remained steady since 2001-02.

For each of the 48 half hourly trading intervals in a day, generators compete by submitting a supply offer for each generation unit in their portfolio. A supply offer is a commitment to generate a nominated amount of electricity if the spot price that the generator receives is no less than the price nominated in the offer. Each supply offer contains up to ten price bands (with associated quantities) that may range from \$1000/MWh up to the value of lost load (VoLL), the maximum spot price in the NEM. The VoLL is currently set at \$10 000/MWh. Generators are able to rebid or vary their supply offer quantities for each trading period in their offer up to the start of that period. Although, demand side participants can submit consumption bids, there are no dispatchable loads actively bidding into the market

With 48 trading intervals each day, there are more than 17 500 market clearing prices each year in each region. Electricity prices over a year can usefully be described using a price duration curve, which measures the number of hours per year that price is at or above any given level. Although the price duration curve describes completely the total time that prices were at or above some level, it does not include information about the sequence of price levels.

In the price duration curves presented here the price axis has been capped at \$100/MWh as approximately 95 per cent of all prices in each region are less than this level. In New South Wales for example, prices in 2000-01 exceeded the long run average price of \$32.70/MWh for 47 per cent of the time in contrast to 2003-04 when prices exceeded that level for only 9 per cent of the time.

On average, around 35 trading intervals each year in each region have prices that range between \$1000/MWh and \$10 000/MWh, creating significant volatility and risk management requirements for those trading in the spot market. However, the increase in baseload and peaking capacity that has been constructed in recent years has reduced both the frequency with which prices exceed \$1000/MWh and the magnitude of those prices.

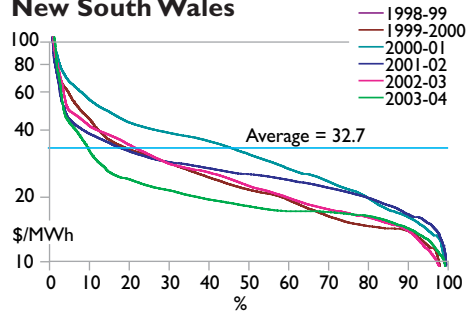
Retail electricity prices, 2001-02 ^a

	Residential	Business	Total
	c/kWh	c/kWh	c/kWh
New South Wales	10.98	7.98	8.93
Victoria	14.70	10.38	11.53
Queensland	11.62	8.57	9.39
Western Australia	15.00	10.37	11.84
South Australia	15.35	11.90	13.16
Tasmania	11.36	4.28	5.66
Northern Territory	15.36	15.06	15.15
Australian Capital Territory	9.78	11.20	10.57
Australia	12.54	9.19	10.16

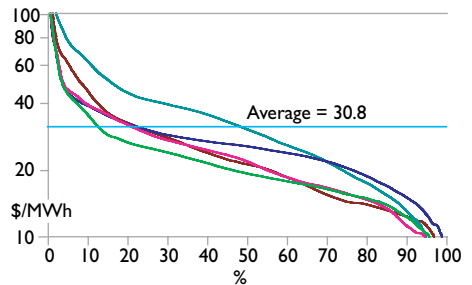
^a Average nominal prices.

Source: Electricity Supply Association of Australia Limited, *Electricity Australia 2003*.

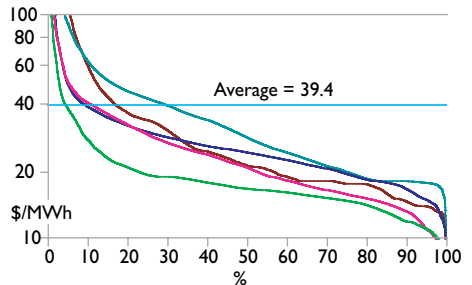
**NEM price duration curves
New South Wales**



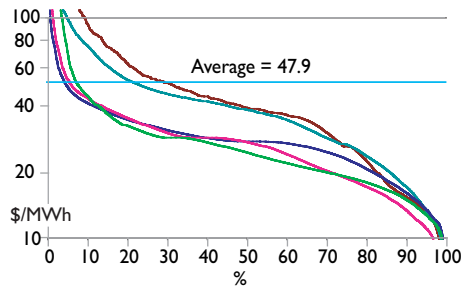
Victoria



Queensland



South Australia



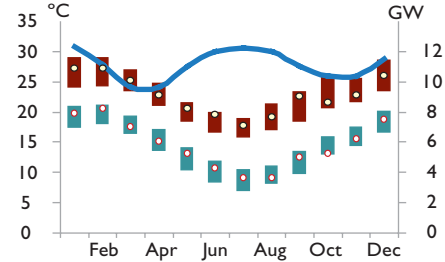
Another factor contributing to lower wholesale prices has been the increase in interconnector capacity between NEM regions by 1700 megawatts.

A prime determinant of changes in electricity consumption across a year is the changes in seasonal climatic conditions. For example, in Victoria, where gas is a significant fuel for heating in winter, the peaks in electricity consumption occur in summer as they do in South Australia and Queensland. In contrast, in New South Wales, the maximum demand can occur in winter or in summer, although with increasing penetration of air conditioners across households in New South Wales, as in the rest of Australia, peak demand in the future is expected to occur in summer.

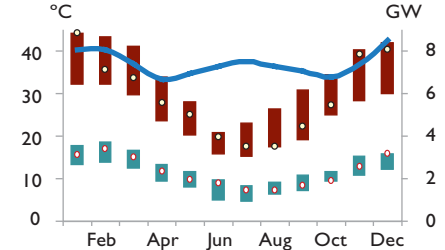
Temperature^a and load profiles

■ maximum temperature range ○ 2003 maximum
 ■ minimum temperature range ○ 2003 minimum
 — 2003 monthly peak demand

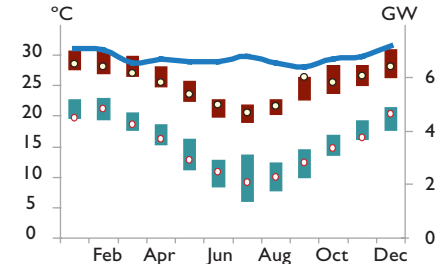
New South Wales



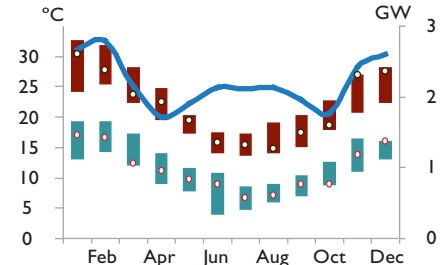
Victoria



Queensland



South Australia



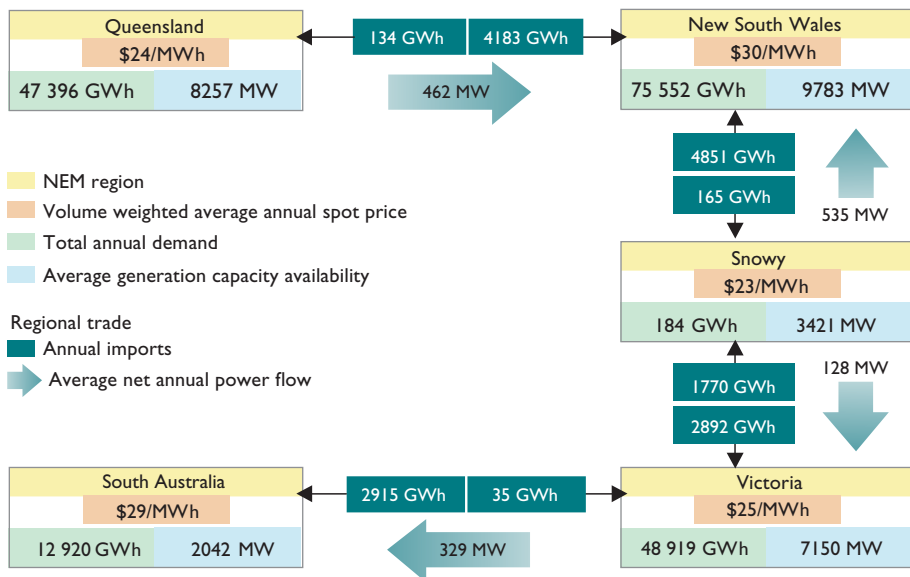
^a Monthly mean temperatures for 1970–2003

Interconnection capacity ^a		
Interconnector	Export capacity	Import capacity
	MW	MW
New South Wales to Queensland (QNI)	700	950
New South Wales to Queensland (Directlink)	180	180
Snowy to New South Wales	winter 3 200	summer 2 800
Victoria to Snowy	1 100	1 900
Victoria to South Australia (Heywood)	460	300
Victoria to South Australia (Murraylink)	220	120

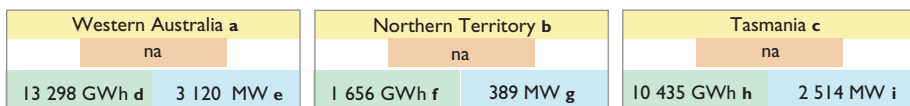
^a Notional interregional capabilities. MW = megawatt. Source: NEMMCO, 2003 Statement of Opportunities.

2003 snapshot of the Australian electricity market

The 'national electricity market'



Outside the 'national electricity market'



a For the south west interconnected system for 2002-03. **b** For 2002-03. **c** For 2002-03. **d** Total sent out energy.

e Total installed capacity on a sent out basis. **f** Total electricity generated. **g** Total power and water installed capacity.

h Total energy generated. **i** Total installed capacity. **na** Not available.

Sources: NECA 2004 (see www.neca.com.au); Hydro Tasmania, 2003 Annual Report Tasmania; Power and Water Corporation, 2003 Annual Report; Western Power Corporation, 2003 Generation Status Review.

Major Australian electricity businesses

Company	Owner	Share	Registered country
Generators		%	
New South Wales a			
AGL	Australian Gas Light Company	100	Australia
Delta Electricity	New South Wales Government	100	Australia
Eraring Energy	New South Wales Government	100	Australia
Macquarie Generation	New South Wales Government	100	Australia
Snowy Hydro Limited	New South Wales, Victorian and Australian Federal Government	100	Australia
Northern Territory			
Power and Water Corporation	Northern Territory Government	100	Australia
Queensland			
CS Energy	Queensland Government	100	Australia
InterGen Australia	InterGen	100	US
NRG Gladstone	Comalco	42	Australia
	NRG Asia Pacific	38	US
	Other	21	
	Queensland Government	100	Australia
Stanwell Corporation	Queensland Government	100	Australia
Tarang Energy	Queensland Government	100	Australia
Origin Energy	Origin Energy	100	Australia
Enertrade b	Queensland Government	100	Australia
South Australia			
AGL	Australian Gas Light Company	100	Australia
International Power Australia	International Power Australia	100	UK
NRG Flinders	NRG Asia Pacific	leased	US
TXU	TXU	100	US
TXU Torrens Island	TXU	leased	US
Origin Energy	Origin Energy	100	Australia
Tasmania			
Hydro Tasmania	Tasmanian Government	100	Australia
Victoria			
AGL	Australian Gas Light Company	100	Australia
Ecogen Energy	Primary Infrastructure	50	Australia
	Babcock&Brown, other	50	
	Edison Mission Energy	100	US
Hazelwood Power	International Power Australia	92	UK
	Commonwealth Financial Services	8	Australia
	CMS	50	US
Loy Yang Power	NRG	25	US
	Horizon	25	Australia
	Meridian Energy	100	NZ
Southern Hydro	Meridian Energy	100	NZ
TXU	TXU	100	US
Yallourn Energy	CLP Power International	92	Hong Kong
	Deutsche Asset Management	8	Germany
	Origin Energy	100	Australia
Western Australia			
Western Power Corporation	WA Government	100	Australia
Edison Mission Energy	Edison Mission Energy	100	US

continued

Major Australian electricity businesses *continued*

Company	Owner	Share	Registered country
Transmitters		%	
New South Wales a			
TransGrid c	New South Wales Government	100	Australia
TransÉnergie d	Hydro-Québec	100	Canada
Northern Territory			
Power and Water Corporation c	Northern Territory Government	100	Australia
Queensland			
Powerlink c	Queensland Government	100	Australia
TransÉnergie d	Hydro-Québec	100	Canada
South Australia			
ElectraNet c	ABB, Powerlink, YTL Power Investmentl	leased	International consortium
TransÉnergie d	Hydro-Québec	100	Canada
Tasmania			
Transend c	Tasmanian Government	100	Australia
Victoria			
SPI PowerNet c	Singapore Power International	100	Singapore
TransÉnergie d	Hydro-Québec	100	Canada
Western Australia			
Western Power Corporation c	Western Australian Government	100	Australia
Distributors		%	
New South Wales a			
ActewAGL	ACT Government	50	Australia
	AGL	50	Australia
AGL	Australian Gas Light Company	100	Australia
Australian Inland	New South Wales Government	100	Australia
Country Energy	New South Wales Government	100	Australia
Energy Australia	New South Wales Government	100	Australia
Integral Energy	New South Wales Government	100	Australia
Northern Territory			
Power and Water Corporation	Northern Territory Government	100	Australia
Queensland			
ENERGEX	Queensland Government	100	Australia
Ergon Energy	Queensland Government	100	Australia
South Australia			
AGL	Australian Gas Light Company	100	Australia
ETSA Utilities	Chueng Kong Infrastructure	leased	Hong Kong
TXU	TXU	100	US

continued

Major Australian electricity businesses *continued*

Company	Owner	Share	Registered country
Distributors <i>continued</i>		%	
Tasmania			
Aurora Energy	Tasmanian Government	100	Australia
Victoria			
AGL	Australian Gas Light Company	100	Australia
CitiPower	Chueng Kong Infrastructure	100	Hong Kong
Powercor	Chueng Kong Infrastructure	100	Hong Kong
TXU	TXU 100	US	
Western Australia			
Western Power Corporation	Western Australian Government	100	Australia
Licensed retailers		%	
New South Wales a			
ActewAGL	ACT Government	50	Australia
	AGL 50		Australia
AGL	Australian Gas Light Company	100	Australia
Australian Inland	New South Wales Government	100	Australia
Country Energy	New South Wales Government	100	Australia
Energy Australia	New South Wales Government	100	Australia
Integral Energy	New South Wales Government	100	Australia
Northern Territory			
Power and Water Corporation	Northern Territory Government	100	Australia
Queensland			
ENERGEX	Queensland Government	100	Australia
Ergon Energy	Queensland Government	100	Australia
Origin Energy	Origin Energy	100	Australia
South Australia			
AGL	Australian Gas Light Company	100	Australia
Origin Energy	Origin Energy	100	Australia
TXU	TXU 100	US	
Tasmania			
Aurora Energy	Tasmanian Government	100	Australia
Victoria			
AGL	Australian Gas Light Company	100	Australia
Origin Energy	Origin Energy	100	Australia
TXU	TXU 100	US	
Western Australia			
Western Power Corporation	Western Australian Government	100	Australia

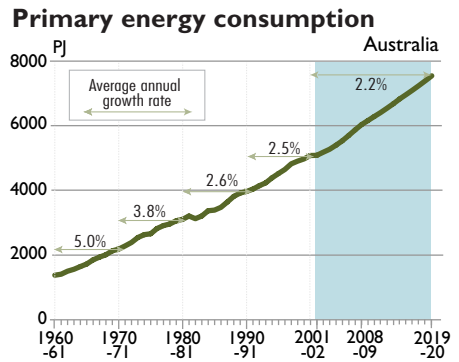
a Including the Australian Capital Territory. **b** Generation trader. **c** Transmission. **d** Interconnection transmission.

Source: Electricity Supply Association of Australia Limited, *Electricity Australia 2003*.

ENERGY consumption

The consumption of energy in Australia is dominated by three sectors — electricity generation, transport and manufacturing. Together these sectors have accounted for almost 80 per cent of total energy consumption throughout the past 25 years, albeit with their relative shares changing significantly. In 2002-03, the electricity generation sector was the largest consumer of primary energy in Australia, followed by transport and then manufacturing. In terms of final energy use, the transport and manufacturing sectors dominate outcomes, although the mining and commercial sectors have also experienced rapid growth in recent years.

In Australia during the 1960s, energy use grew by a robust 5.0 per cent a year. This growth rate fell to 3.8 per cent a year during the 1970s largely as a result of the two major oil price shocks. During the 1980s, economic recession and sharply



Australian energy consumption, by industry				
	2001-02	2002-03	2003-04	20019-20
	PJ	PJ	PJ	PJ
Agriculture	79.5	80.0	81.2	103.0
Mining	188.0	196.5	204.9	518.5
Manufacturing ^a	889.3	909.7	919.0	1 327.7
Electricity generation	2 326.3	2 372.1	2 410.9	3 311.4
Transport	1 264.6	1 282.5	1 308.8	1 823.0
Commercial	63.6	64.5	66.3	96.5
Residential	208.4	209.5	214.7	289.8
Other ^b	64.0	64.2	64.7	74.4
Total	5 083.8	5 179.0	5 270.5	7 544.1

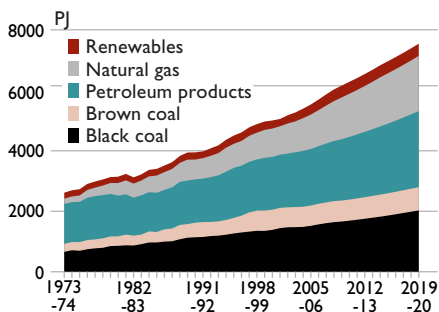
^a Includes construction, ^b Includes consumption of lubricants and greases, bitumen and solvents.

Source: Akmal et al. *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

rising energy prices resulted in growth falling to 2.6 per cent a year, before falling (real) energy prices and robust economic growth in the 1990s arrested this decline.

In the medium term, growth in Australian energy consumption is projected to continue to moderate and reflects the impacts of government environmental and energy conservation measures as well as a range of energy efficiency and

Energy consumption, by fuel



Australian energy consumption, by fuel

	1990-91	1995-96	2000-01	2001-02	2003-04 ^s
Consumption of fuels	PJ	PJ	PJ	PJ	PJ
Black coal	1 141.3	1 283.2	1 393.1	1 462.7	1 474.6
Brown coal	484.1	514.4	664.7	669.5	665.0
Coke	105.5	97.0	76.8	73.4	78.4
Coal byproducts	51.4	50.5	33.7	40.1	34.0
Brown coal briquettes	14.2	9.7	11.3	8.1	8.0
Wood, woodwaste	100.1	109.1	108.4	92.0	113.5
Bagasse	78.2	101.5	93.8	79.8	98.5
Refinery input	1 421.4	1 623.4	1 678.6	1 634.5	1 577.0
Petroleum products	1 440.3	1 662.9	1 753.8	1 764.0	1 813.0
Natural gas	655.4	797.1	938.9	950.1	1 039.7
Town gas	2.6	1.6	1.0	1.1	1.0
Total electricity	564.5	639.4	784.6	808.1	838.8
of which hydroelectricity	58.3	58.2	59.9	58.5	58.3
Solar energy	2.4	3.5	4.4	4.4	4.4
Production of derived fuels					
Coke	114.3	123.8	94.4	101.7	78.4
Coal byproducts	51.4	50.5	34.4	40.2	27.4
Brown coal briquettes	15.8	10.1	9.8	6.6	8.0
Petroleum products ^a	1 421.4	1 623.4	1 678.6	1 634.5	1 584.0
Town gas	2.7	1.6	1.0	1.0	1.0
Thermal electricity	506.2	581.2	724.7	749.6	776.6
Energy consumption in Australia ^b					
Total	3 949.9	4 505.5	5 003.8	5 054.7	5 270.5

^a Production may exceed refinery input as some petroleum products are produced from other petroleum products. ^b Total energy consumption is the total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced. ^s ABARE estimate. ^{na} Not available

Source: Donaldson, K. *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com).

Australian energy supply and disposal, 2001-02

	Black coal	Brown coal	Coke	Coal by-products	Briquettes	Wood	Bag-asse	Crude oil and ORF	LPG
Supply	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary indigenous	7 282.3	669.7				92.0	79.8	1 335.7	122.2
Imports								1 056.8	15.1
Exports	5 630.3	0.2	2.2	0.0	0.0			885.6	82.5
Stock changes and discrepancies	189.3		17.9		-1.4			-121.4	-4.0
Total domestic availability	1 462.7	669.5	-20.1		1.4	92.0	79.8	1 628.3	58.9
Conversion									
Coke ovens	129.2		-101.7	-13.4					
Briquetting		7.9			-6.6				
Petroleum refining								1 634.5	-44.2
Gas manufacturing									1.2
Electricity generation	1 219.7	661.6		5.5	2.9	1.9			0.0
Other conversion a			73.4	-26.8				-7.0	
Fuel use in conversion									0.2
Final domestic availability b	113.8	0.0	8.3	34.6	5.2	90.1	79.8	0.8	101.5
End use									
Agriculture									0.9
Mining	6.7		0.3	1.0				0.8	0.4
Iron and steel	2.6		0.4	27.2					0.3
Chemical	4.6		0.9	6.1	1.6				15.5
Other industry	95.9	0.0	6.7	0.3	0.9	24.4	79.8		4.4
Construction									0.3
Road transport									65.7
Rail transport									
Air transport									
Water transport	3.5								
Commercial	0.4				2.6	0.4			3.3
Residential	0.1				0.1	65.2			10.8
Lubricants, greases bitumen and solvents									
Total final energy consumption	113.8	0.0	8.3	34.6	5.2	90.1	79.8	0.8	101.5

continued

Australian energy supply and disposal, 2001-02 *continued*

	Petroleum products	Bio-fuels c	Natural gas	Town gas	Hydro-electricity	Electricity	Solar	Uranium	Total
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Supply									
Primary indigenous		9.0	1 354.6		57.7		4.4	3 781.9	14 787.6
Imports	149.6								1 221.6
Exports	124.6		413.4					3 462.5	10 601.4
Stock changes and discrepancies	-45.8				-0.8			319.5	353.2
Total domestic availability	70.8	9.0	941.1	0.1	58.5	0.0	4.4		5 054.7
Conversion									
Coke ovens	1.1					0.1			15.4
Briquetting						0.1			1.4
Petroleum refining	-1 590.3		20.8			4.9			25.6
Gas manufacturing			0.7	-1.0					0.9
Electricity generation	17.1	7.5	242.9		58.5	-783.3			1 434.3
Other conversion a	7.0					-24.8			21.8
Fuel use in conversion	105.9		28.6	0.0		113.2			247.9
Final domestic availability b	1 530.0	1.5	648.2	1.1		689.9	4.4		3 307.5
End use									
Agriculture	78.5		0.1			6.0			85.5
Mining	76.3		125.5			57.2			268.1
Iron and steel	1.2		43.4			22.0			97.1
Chemical	38.9		84.5			15.1			167.2
Other industry	52.7	1.4	222.5			223.3			712.4
Construction	25.4		2.4			0.1			28.2
Road transport	930.0		1.0			0.0			996.7
Rail transport	21.6		0.0			7.3			28.9
Air transport	172.0								172.0
Water transport	42.8		0.1						46.3
Commercial	22.3	0.1	43.9	0.3		174.5	0.2		248.0
Residential	4.2		124.9	0.8		184.4	4.2		393.0
Lubricants, greases bitumen and solvents	64.0								64.0
Total final energy consumption	1 530.0	1.5	648.2	1.1		689.9	4.4		3 307.5

a Includes return streams to refineries from the petrochemical industry, consumption of coke in blast furnaces, blast furnace gas manufacture, electricity produced through cogeneration and brown coal tar produced in char manufacture. Because it is not possible to separate the fuels used to produce cogenerated electricity, they are included in the industry in which production occurs. b After conversion sector use and losses. Equals total final energy consumption. The end use sector totals may differ from other published tables due to some conversion activities occurring in those sectors. c Excludes wood and bagasse and includes recyclables.

Source: Donaldson, K. *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com).

Final energy consumption in Australia, by fuel

	2001-02	2005-06	2010-11	2015-16	2019-20
	PJ	PJ	PJ	PJ	PJ
Black coal	129.3	135.0	148.4	151.3	154.5
LPG	103.7	124.0	160.3	198.5	235.7
Other petroleum products	1 525.1	1 614.1	1 772.2	1 957.9	2 126.0
Natural gas	534.2	627.2	762.9	876.1	954.5
Biomass	146.4	152.6	162.1	173.1	182.6
Electricity	690.0	760.0	864.1	966.2	1 056.4
Solar energy	2.7	3.0	3.4	3.9	4.3
Total	3 131.5	3 415.8	3 873.4	4 327.0	4 714.1

Source: Akmal, M. et al, *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

Final energy consumption in Australia, by industry

	2001-02	2005-06	2010-11	2015-16	2019-20
	PJ	PJ	PJ	PJ	PJ
Agriculture	85.5	89.6	96.3	103.7	110.1
Mining	160.7	194.7	251.0	324.0	395.6
Manufacturing and construction	918.7	1 014.2	1 172.9	1 277.9	1 350.4
Transport and storage	1 271.9	1 367.8	1 516.4	1 684.0	1 832.6
Commercial and services a	237.7	265.2	308.1	358.2	403.1
Residential	393.0	418.7	460.3	507.6	548.0
Other b	64.0	65.7	68.5	71.7	74.4
Total	3 131.5	3 415.8	3 873.4	4 327.0	4 714.1

a Includes ANZSIC divisions F–H, J–Q, ANZSIC 3700 water, sewerage, drainage and ANZSIC 6700 storage industries.

b Includes consumption of lubricants and greases, bitumen and solvents.

Source: Akmal, M. et al, *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

Industrial output of energy intensive industries

		1990-91	1995-96	2000-01	2001-02	2002-03
Cement a	kt	6 859	7 013	7 984	7 306	7 497
Clinker a	kt	6 205	5 998	6 557	6 425	6 354
Paper and paper products	kt	na	2 404	2 656	2 897	3 061
Aluminium	kt	1 236	1 331	1 788	1 809	1 855
Alumina	kt	11 402	13 326	16 098	16 417	16 413
Iron and steel b s	Mt	6 219	8 471	8 003	8 311	9 399

a Refers to calendar year production. Production in 1990 is displayed under 1990-91. b Includes recovery from scrap. s ABARE estimate. na Not available.

Sources: ABARE, *Australian Mineral Statistics, March quarter 2004*, Canberra; Cement Industry Federation 2003 (see www.cement.org.au); Pulp and Paper Manufacturers Federation of Australia 2003 (see www.apic.asn.au).

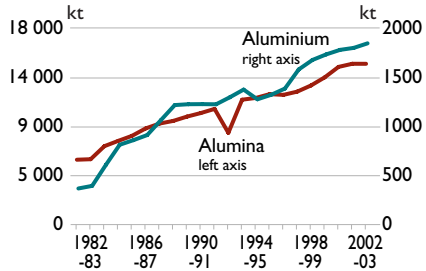
conservation improvements. Reflecting these factors, primary energy consumption in Australia is projected to grow by an average 2.2 per cent a year between 2001-02 and 2019-20, reaching 7544 petajoules in 2019-20. Coal and oil will continue to meet the bulk of Australia's energy needs, accounting for more than 70 per cent of primary energy consumption in 2019-20.

In terms of primary energy consumption, the electricity generation sector accounted for around 46 per cent of total energy consumed, in 2002-03, in addition to around 90 per cent of all domestic consumption of coal (black and brown coal). In the period to 2019-20, the electricity generation sector is expected to account for approximately 40 per cent of the total increase in primary energy use in Australia.

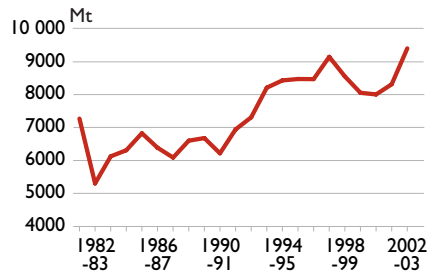
Overall, growth in energy consumption in Australia closely follows trends in aggregate economic growth and output from a number of key energy intensive manufacturing and minerals processing sectors such as iron and steel, cement, paper and pulp, aluminium, alumina and LNG manufacture.

The transport sector currently accounts for 25 per cent of primary energy use and 70 per cent of liquid fuels used. Reflecting strong growth in road and air transport energy use, transport sector energy use is projected to grow by around 2.1 per cent a year to 2019-20.

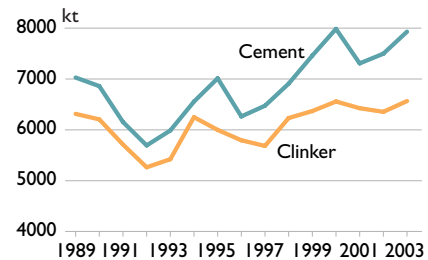
Australian production Aluminium and alumina



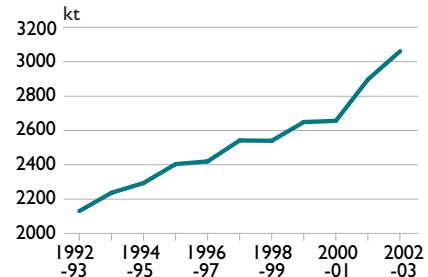
Iron and steel



Cement and clinker



Paper and paper products



The aggregate energy intensity of the Australian economy, measured as total primary energy consumption per dollar of GDP, fell by an average 1.1 per cent a year during the 1990s, after remaining more or less stable during the 1970s and 1980s.

Energy consumption in Australia's transport sector ^a						
	1990-91	1995-96	2000-01	2001-02	2010-11 ^z	2019-20 ^z
	PJ	PJ	PJ	PJ	PJ	PJ
Road transport	796.6	904.3	971.5	1 004.6	1 155.3	1 342.0
Railway transport	30.5	28.7	33.7	28.9	31.4	33.5
Water transport	48.4	63.7	51.1	46.1	41.3	44.0
Air transport	121.9	175.5	204.2	174.2	253.7	368.1
Other	5.5	9.4	18.4	19.3	34.8	45.1
Total	1 003.0	1 181.5	1 275.8	1 265.6	1 516.4	1 832.6

^a Net energy consumption (defined as total fuel input less energy produced). ^z ABARE projection.

Sources: Donaldson, K. 2004, *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com); Akmal, M. et al, *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

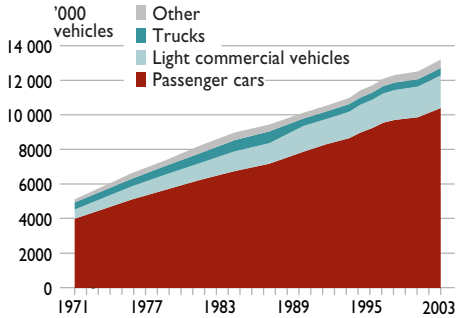
Motor vehicle usage in Australia									
		Passenger vehicles		Light commercial vehicles		Trucks		Total ^a	
		1995-96	2000-01	1995-96	2000-01	1995-96	2000-01	1995-96	2000-01
Number of registered vehicles									
– total b	'000	8 962	9 836	1 602	1 770	416	419	11 401	12 477
– per 1000 persons b	no.	488	508	87	91	23	22	621	644
– new registrations	'000	532	685	87	100	14	17	659	840
Estimated age of vehicles b									
	years	10.4	10.1	11.2	11.4	13.8 ^c	13.7 ^c	10.6	10.5
Total vehicle kilometres d									
	million km	142 025	155 818	25 985	30 318	11 147	12 642	182 350	202 050
Total tonne freight kilometres d									
	Mt km	na	na	4 474	5 488	107 366	137 850	111 840	143 339

^a Includes other vehicles such as buses, motorcycles and campervans. ^b Data as at 31 October 1996 and 31 March 2001. ^c Average age for rigid, articulated, and non-freight carrying trucks. ^d Data for 1996 and 2001. **na** Not available. Mt km = million tonne kilometres.

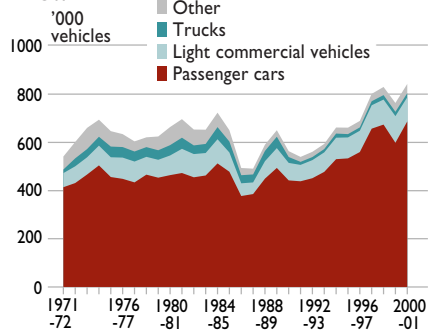
Sources: ABS, *New Motor Vehicle Registrations*, cat. no. 9301.0, Canberra; ABS, *Motor Vehicle Census*, cat. no. 9309.0, Canberra; ABS, *Australian Demographic Statistics*, cat. no. 3101.0, Canberra; ABS, *Survey of Motor Vehicle Use*, cat. no. 9208.0, Canberra; Bureau of Transport and Regional Economics 2002, *Greenhouse Gas Emissions from Australian Transport: Australian Trends to 2020*, Canberra.

Vehicle registrations in Australia

Total



New



In the period to 2019-20, aggregate energy intensity in Australia is projected to decline by a further 1.1 per cent a year. In stark contrast, the aggregate energy intensity of the Northern Territory is projected to increase rapidly, reflecting the strong growth anticipated in the Territory's LNG exports.

Energy sector emissions constitute the major part (68 per cent) of Australia's total net greenhouse gas emissions, driven mainly by emissions from energy industries (36 per cent). In 2002, total energy sector greenhouse gas emissions (in CO₂-equivalent terms) amounted to 371 million tonnes. Total net greenhouse gas emissions were estimated to be 550 million tonnes (Australian Greenhouse Office 2004).

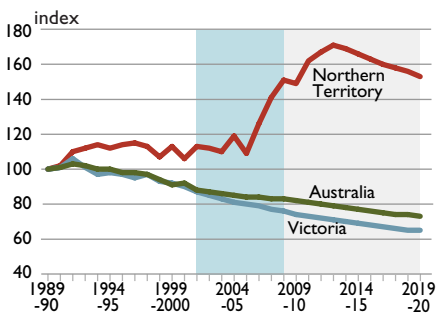
CO₂-equivalent emissions for Australia's energy sector, 2002

	Total CO ₂ -e emissions ^a	Total net national emissions
	Mt	%
Energy industries	199.7	36.3
Manufacturing and construction	43.0	7.9
Transport	79.2	14.4
Other sectors	18.7	3.4
Subtotal	341.2	62
Fugitive emissions	30.2	5.5
Total energy sector	371.0	67.5
Total net emissions	550.1	–

^a Includes CO₂ (carbon dioxide), CH₄ (methane), and N₂O (nitrous oxide).

Source: Australian Greenhouse Office, *National Greenhouse Gas Inventory 2002*, Canberra.

Energy intensity trends Australia



RENEWABLES

Renewable energy currently accounts for less than 5 per cent of total energy consumption in Australia. In 2001-02, wood and woodwaste, bagasse (sugar cane waste) and hydroelectricity collectively accounted for 95 per cent of all renewable energy production in Australia. Biofuels (which includes landfill gas and sewage gas) and solar energy accounted for the remainder. In 2001-02, over 59 per cent of solar energy was used for residential water heating.

In 2001-02, Australia's production of renewable energy was 244 petajoules, down 11 per cent from the previous year. This decline in renewable energy production occurred mainly in biomass fuels (wood, woodwaste and bagasse), where handling and processing costs are high and energy content is low. The consumption of bagasse is also closely related to activity in the sugar refining sector.

Of the renewables used in electricity generation, hydroelectricity contributes the largest share, accounting for 95 per cent of renewable electricity generated in 2001-02. Tasmania and the Snowy Mountains region are Australia's largest producers of hydroelectricity, accounting for 85 per cent of all hydroelectricity produced in 2001-02. The Snowy Mountains region is located principally in southern New South Wales,

Capacity of renewable electricity generation in Australia, 2001-02

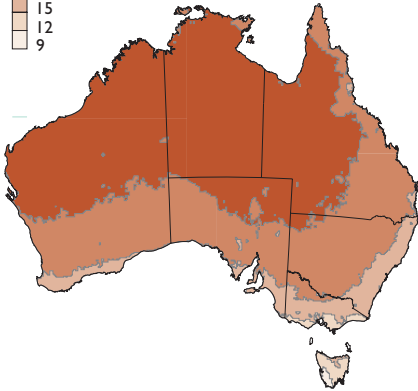
	Bagasse	Hydro	Landfill gas	Waste and waste-water		Wind	Total
	MW	MW	MW	Solar MW	MW	MW	MW
New South Wales ^a	15.5	209.9	29.8	2.4	28.5	17.3	287.8
Victoria	0.0	545.7	44.2	0.1	66.0	39.2	695.1
Queensland	347.1	150.5	3.0	0.1	5.2	12.5	171.3
Western Australia	6.0	32.0	7.1	0.1	0.0	25.3	64.6
South Australia	0.0	0.0	14.5	0.1	5.5	0.2	20.2
Tasmania	0.0	2 275.7	0.0	0.0	0.1	11.3	2 287.0
Snowy region	0.0	3 006.0	0.0	0.0	0.0	0.0	3 006.0
Northern Territory	0.0	0.0	0.0	0.1	0.0	0.1	0.2
Total	368.6	6 219.8	98.7	2.8	105.2	105.8	6 532.2

^a Includes the Australian Capital Territory.

Source: Electricity Supply Association of Australia, *Electricity Australia 2003*.

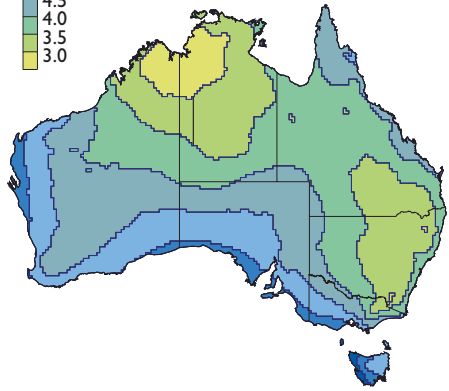
Average daily solar exposure (annual)

megajoules/metre²



Average annual wind speed ^a

metres/second



^a This analysis shows the broad patterns of wind speed across Australia. It should be used with caution because it does not show the finer scale (or localised) structure of wind speed. The analysis, which was based on observational data from automatic stations, has a grid point resolution of 0.25 degrees (approx. 25 kilometres). Approximately 370 automatic stations were used in the analysis — these had at least three years of data, with at least 330 days of data in the year and six observations per day.

but is also partially located in northern Victoria and the Australian Capital Territory. Total hydroelectricity generation is estimated to grow by only 0.6 per cent a year, reaching around 18 TWh by 2019-20. This is a reflection of the limited availability of suitable locations for the expansion of large grid based hydroelectricity generation.

The generation of electricity from all renewable sources is projected to grow by 2.6 per cent a year, reaching around 27 TWh by 2019-20. Most of this increase is

Australian production of renewable energy				
	1990-91	1995-96	2000-01	2001-02
	PJ	PJ	PJ	PJ
Biomass				
– bagasse	78.2	101.5	93.8	79.8
– wood and woodwaste	100.1	109.1	108.4	92.0
Biofuels ^a	na	na	9.3	9.0
Hydroelectricity	58.3	58.2	59.9	58.5
Solar	2.4	3.5	4.4	4.4
Total	239.0	272.3	275.8	243.7

^a Includes landfill and sewage gas. **na** Not available.

Source: Donaldson, K. *Energy Statistics – Australian Energy 2004*, ABARE (www.abareconomics.com).

expected to be from wind and biomass (mainly bagasse and bagasse cofired with woodwaste). Growth in wind power in the medium to long term in Australia is forecast to be relatively high (16 per cent a year) but is coming from a negligible base.

A range of policy measures have been introduced in Australia to support the uptake and development of renewable energy. These include the Mandatory Renewable Energy Target (MRET) scheme and the New South Wales Government's greenhouse gas emissions benchmark scheme. The MRET scheme requires the generation of 9500 GWh of extra renewable electricity a year by 2010, relative to output from renewable sources in 1997.

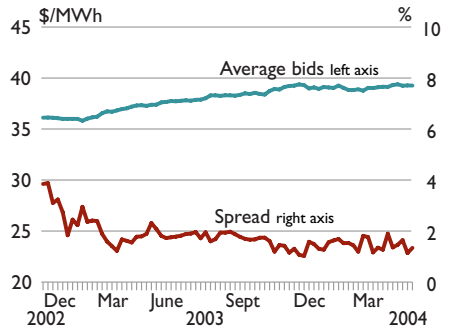
The MRET scheme is implemented by issuing certificates for electricity generated from eligible technologies and requires purchasers of electricity (usually at the wholesale level) to surrender a specified number of certificates for the electricity that they require during the year.

Renewable electricity generation in Australia, by fuel			
	2001	2009	2019
	-02	-10	-20
	GWh	GWh	GWh
Hydroelectricity	15 871	17 888	17 797
Wind energy	286	3 217	4 068
Biomass	732	4 143	4 143
Biogas	329	1 490	1 490
Total	17 217	26 737	27 498

Source: Akmal, M. et al, *Australian Energy: National and State Projections to 2019-20*, ABARE eReport 04.11, Canberra.

Spot prices for renewable energy certificates (ex GST) ^a

Weekly, ended 19 May 2004



^a Only includes non woodwaste.

Source: AFMA (Australian Financial Markets Association) 2004 (www.afma.com.au).

Renewable generation under Australia's MRET scheme ^a

	Total	Share
	GWh	%
Bagasse cogeneration	715.0	9.7
Black liquor	239.9	3.3
Hydroelectricity	3 240.3	44.0
Landfill gas	540.3	7.3
Sewage gas	70.7	1.0
Photovoltaic	2.4	0.03
Solar water heater	1 543.0	21.0
Wind	748.4	10.2
Wood waste	255.6	3.5
Other ^b	2.9	0.04
Total	7 358.7	100.0

^a Data as at 6 May 2004. ^b Includes municipal solid waste combustion; food and agricultural wet waste. MRET = Mandatory Renewable Energy Target.

Source: Office of the Renewable Energy Regulator 2004 (www.rec-registry.com).

CONVERSION factors

The factors listed in the following tables are to be used when converting individual types of fuel from volume or weight to energy equivalence, or vice versa. The values are indicative only, because the quality of any fuel varies with such factors as location, air pressure and temperature. Values given here apply at a temperature of 15° Celsius and pressure of 1 atmosphere (101.3 kilopascals). The values are the gross energy content of the fuel — that is, the total amount of heat that will be released by combustion.

The usable energy content of uranium metal (U) is 0.56 petajoules per tonne, and that of uranium oxide (U₃O₈) is 0.47 petajoules per tonne. The oxide contains 84.8 per cent of the metal by weight.

Energy content of gaseous fuels	
	Energy content
	MJ/m ³
Natural gas (sales quality)	
– Victoria	38.7
– Queensland	38.5
– Western Australia	41.5
– South Australia, New South Wales	38.3
– Northern Territory	40.5
Ethane (average)	60.0
Town gas	
– synthetic natural gas	39.0
– reformed gas	20.0
– tempered LPG	25.0
– tempered natural gas	25.0
Coke oven gas	20.0
Blast furnace gas	4.0

Sources: Department of Industry, Tourism and Resources; BHP.

Energy content of solid fuels	
	Energy content
	GJ/t
Black coal	
New South Wales	
Exports	
– coking coal	29.0
– steaming coal	27.0
Electricity generation	23.5
Steelworks	30.0
Washed steaming coal	27.0
Unwashed steaming coal	23.9
Queensland	
Exports	
– coking coal	30.0
– steaming coal	27.0
Electricity generation	21.4
Other	23.0
South Australia	15.2
Western Australia	19.7
Tasmania	22.8
Brown coal	
Victoria	
Coal	9.7
Briquettes	22.1
Other	
Coke	28.7
Wood (dry)	16.2
Bagasse	9.6

Sources: BHP; State Electricity Commission of Victoria; ABARE.

Energy content of liquid fuels

	By volume	Specific volume	By weight
	MJ/L	L/t	GJ/t
LPG			
– propane	25.4	1 960	49.6
– butane	28.0	1 760	49.1
– mixture	26.2	1 890	49.4
– naturally occurring (average)	26.5	1 866	49.4
Aviation gasoline	33.1	1 412	46.8
Automotive gasoline	34.2	1 360	46.4
Power kerosene	37.5	1 230	46.1
Aviation turbine fuel	36.8	1 261	46.4
Lighting kerosene	36.6	1 270	46.5
Heating oil	37.3	1 238	46.2
Automotive diesel oil	38.6	1 182	45.6
Industrial diesel fuel	39.6	1 135	44.9
Fuel oil			
– low sulfur	39.7	1 110	44.1
– high sulfur	40.8	1 050	42.9
Refinery fuel (fuel oil equivalent)	40.8	1 050	42.9
Naphtha	31.4	1 534	48.1
Lubricants and greases	38.8	1 120	43.4
Bitumen	44.0	981	42.7
Solvents	34.4	1 229	44.0
Waxes	38.8	1 180	45.8
Crude oil and other refinery feedstocks			
– indigenous (average)	37.0	1 250	46.3
– imports (average)	38.7	1 160	44.9
Orimulsion	na	na	28.0
Ethanol	23.4	1 266	29.6
Methanol	15.6	1 263	19.7
Tallow	na	na	35.0
Liquefied natural gas (north west Shelf)	25.0	2 174	54.4

Sources: BP; BHP Billiton; MobilExxon; Santos; Woodside Petroleum.

Other conversion factors

1 MBTU = 1055 MJ (BTU = British Thermal Unit)

1 m³ = 35.315 ft³

1 L propane liquid = 0.272 m³ gas

1 L butane liquid = 0.235 m³ gas

1 L LNG = 0.625 m³ natural gas