

# Energy in Australia 2009



Australian Government  
Department of Resources  
Energy and Tourism

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# FOREWORD

The secure supply of affordable, reliable, environmentally sustainable energy is clearly essential to Australia's future economic growth and prosperity.

The energy sector has a central role to play in meeting our nation's most basic social and economic needs, with energy security being vitally important. It underpins every form of our economic activity, powering our industries, our vehicles, our workplaces, and our homes.

*Energy in Australia* is a vital reference for anyone with an interest in Australia's energy policy. It covers all aspects of energy production and use, from natural resources through to final consumption.

Australia's prosperity is built upon its abundance of energy sources including coal, uranium, gas and renewables. Australia's energy resources also play a vital role in helping our neighbours in the Asia Pacific to meet their energy needs.

The Australian Government is committed to Australia's sustainable energy future through the development of renewable energy, low emission technologies, and alternative fuels. In addition, the Government is promoting energy efficiency improvements, continuing reforms to Australia's electricity and gas markets, and intensifying exploration for new energy resources.

As demand for energy grows and governments and communities around the globe respond to environmental and resource pressures, the future use and management of energy will be one of our major challenges. In this regard, publications such as *Energy in Australia 2009* provide important information for those taking up that challenge. I recommend it to anyone with an interest in Australia's energy sector.



**The Hon Martin Ferguson AM MP**  
Minister for Resources and Energy





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# ABBREVIATIONS AND PRINCIPAL SOURCES OF ENERGY INFORMATION

ABARE	Australian Bureau of Agricultural and Resource Economics
DOE	Department of Energy (United States)
EIA	Energy Information Administration (US DOE)
ESAA	Energy Supply Association of Australia
IEA	International Energy Agency
LNG	liquefied natural gas (principally methane)
LPG	liquefied petroleum gas (principally propane and butane)
NEMMCO	National Electricity Market Management Company
NGL	natural gas liquid hydrocarbons, other than methane, derived from the natural gas stream in separation and/or liquefaction facilities
OECD	Organisation for Economic Cooperation and Development
ORF	other refinery feedstock
RET	Department of Resources, Energy and Tourism

Apelbaum Consulting Group	<a href="http://www.apelbaumconsulting.com.au">www.apelbaumconsulting.com.au</a>
ABARE	<a href="http://www.abare.gov.au">www.abare.gov.au</a>
Australian Bureau of Statistics	<a href="http://www.abs.gov.au">www.abs.gov.au</a>
Australian Business Council for Sustainable Energy	<a href="http://www.bcse.org.au">www.bcse.org.au</a>
Australian Financial Markets Association	<a href="http://www.afma.com.au">www.afma.com.au</a>
Australian Greenhouse Office	<a href="http://www.greenhouse.gov.au">www.greenhouse.gov.au</a>
Australian Institute of Petroleum	<a href="http://www.aip.com.au">www.aip.com.au</a>
Australian Wind Energy Association	<a href="http://www.auswea.com.au">www.auswea.com.au</a>
BP Statistical Review of World Energy	<a href="http://www.bp.com">www.bp.com</a>
Department of Resources, Energy and Tourism	<a href="http://www.ret.gov.au">www.ret.gov.au</a>
Energy Information Administration	<a href="http://www.eia.doe.gov">www.eia.doe.gov</a>
Energy Networks Association	<a href="http://www.ena.asn.au">www.ena.asn.au</a>
Energy Supply Association of Australia	<a href="http://www.esaa.com.au">www.esaa.com.au</a>
Geoscience Australia	<a href="http://www.ga.gov.au">www.ga.gov.au</a>
Hart Downstream Energy Group	<a href="http://www.hartenergy.com">www.hartenergy.com</a>
International Energy Agency	<a href="http://www.iea.org">www.iea.org</a>
Korea Energy Economics Institute	<a href="http://www.keei.re.kr">www.keei.re.kr</a>
National Electricity Market Management Co.	<a href="http://www.nemmco.com.au">www.nemmco.com.au</a>
Global-roam Pty Ltd	<a href="http://www.nem-review.info">www.nem-review.info</a>
Office of the Renewable Energy Regulator	<a href="http://www.rec-registry.gov.au">www.rec-registry.gov.au</a>
Ozmine	<a href="http://www.ozmine.com.au">www.ozmine.com.au</a>
Platts (McGraw Hill)	<a href="http://www.platts.com">www.platts.com</a>
Ports Australia	<a href="http://www.portsaustralia.com.au">www.portsaustralia.com.au</a>
Uranium Information Centre	<a href="http://www.uic.com.au">www.uic.com.au</a>

# GLOSSARY

<b>Bagasse</b>	The fibrous residue of the sugar cane milling process that is used as a fuel (to raise steam) in sugar mills.
<b>Biogas</b>	Landfill (garbage tips) gas and sewage gas. Also referred to as biomass gas.
<b>Brown coal</b>	(see lignite)
<b>Coal byproduct</b>	Byproducts such as blast furnace gas (from iron and steel processing), coal tar and benzene/toluene/xylene (BTX) feedstock and coke oven gas (from the coke making process).
<b>Coal seam gas</b>	Methane held within coal deposits, bonded to coal under the pressure of water. It may also contain small amounts of carbon dioxide and nitrogen (also referred to as coal seam methane and coal bed methane).
<b>Conversion</b>	The process of transforming one form of energy into another (derived) form before final end use. Energy used in conversion is the energy content of fuels consumed as well as transformed by energy producing industries. Examples are natural gas and liquefied petroleum gas used in town gas manufacturing, all hydrocarbons used as feedstocks in oil refineries, and all fuels (including electricity) used in powerstations — therefore, energy used in conversion also includes energy lost in the production, conversion and transport of fuels (such as energy lost in coke production) plus net energy consumed by pumped storage after allowance for the energy produced.
<b>Crude oil</b>	Naturally occurring mixture of liquid hydrocarbons under normal temperature and pressure.
<b>Condensate</b>	Hydrocarbons recovered from the natural gas stream that are liquid under normal temperature and pressure.
<b>Conventional gas</b>	Generally refers to methane held in a porous rock reservoir frequently in combination with heavier hydrocarbons. It may contain small amounts of ethane, propane, butane and pentane as well as impurities such as sulphur dioxide, and inert gases such as nitrogen.
<b>Derived or secondary fuels</b>	Fuels produced or derived 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.
<b>Economic demonstrated resources</b>	The quantity of resources that is judged to be economically extractable under current market conditions and technologies.



<b>Lignite</b>	Non-agglomerating coals with a gross calorific value less than 17 435 kJ/kg, including brown coal which is generally less than 11 000 kJ/kg.
<b>Liquid fuels</b>	All liquid hydrocarbons, including crude oil, condensate, liquefied petroleum gas and other refined petroleum products.
<b>Natural gas</b>	Methane that has been processed to remove impurities to a required standard for consumer use. It may contain small amounts of ethane, propane, carbon dioxide and inert gases such as nitrogen. In Australia natural gas comes from conventional gas and coal seam gas. Landfill and sewage gas are some other potential sources (also referred to as sales gas in some sectors of the gas industry).
<b>Petajoule</b>	The joule is the standard unit of energy in general scientific applications. One joule is the equivalent of one watt of power radiated or dissipated for one second. One petajoule, or 278 gigawatt hours, is the heat energy content of about 43 000 tonnes of black coal or 29 million litres of petrol.
<b>Petroleum</b>	Generic term for all hydrocarbon oils and gases, including refined petroleum products.
<b>Petroleum products</b>	All hydrocarbons used directly as fuel. These include 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).
<b>Primary fuels</b>	The forms of energy obtained directly from nature. They include nonrenewable fuels such as black coal, lignite, uranium, crude oil and condensate, naturally occurring liquefied petroleum gas, ethane and methane, and renewable fuels such as wood, bagasse and municipal waste gas, hydro and wind power, solar and geothermal energy.
<b>Total final energy consumption</b>	The total amount of energy consumed in the final or 'end use' sectors. It is equal to total primary energy-consumption less energy consumed or lost in conversion, transmission and distribution.
<b>Total primary energy consumption</b>	Also referred to as total domestic availability. The total of the consumption of each primary fuel (in energy units) 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 petroleum products and electricity. It also includes own use and losses in the conversion sector.

### *Units*

J	joule
L	litre
t	tonne
g	gram
W	watt
Wh	watt-hour
b	billion (10 <sup>9</sup> )

### *Metric prefixes*

k	kilo	10 <sup>3</sup> (thousand)
M	mega	10 <sup>6</sup> (million)
G	giga	10 <sup>9</sup> (1000 million)
T	tera	10 <sup>12</sup>
P	peta	10 <sup>15</sup>
E	exa	10 <sup>18</sup>

### *Other abbreviations*

bcm	billion cubic metres
m <sup>3</sup>	cubic metre
bbl	barrel
Mtoe	million tonnes of oil equivalent
na	not available
pa	per annum

### *Conversion factors*

1 barrel = 158.987 L

1 kWh = 3600 kJ

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

1 m<sup>3</sup> = 35.515 cubic feet

1 L propane liquid = 0.272m<sup>3</sup> gas

1 L butane liquid = 0.235 m<sup>3</sup> gas

1 L LNG = 0.625 m<sup>3</sup> natural gas

Indicative energy contents of fuels are listed at the end of the publication.

### *Conventions used in tables and figures*

0.0 is used to denote a negligible amount. Small discrepancies in totals are generally the result of the rounding of components.

Care should be taken in comparing data across tables as sources and time periods may vary.

## Australia's energy supply

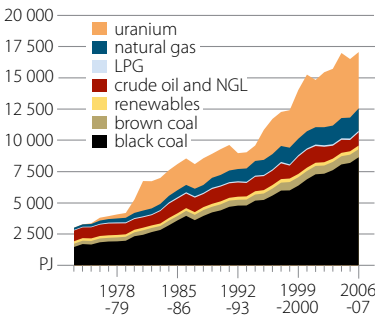
Australia's energy supply is utilised for export and for meeting Australia's domestic consumption needs. Energy exports account for 66 per cent of domestic energy production and domestic consumption accounts for the remaining 34 per cent. Australia is the world's eighth largest energy producer, accounting for around 2.4 per cent of the world's energy production. Given Australia's large energy resources, Australia is well positioned to continue to supply a significant proportion of the world's energy needs, while maintaining domestic energy supply.

The rate of growth in Australia's production of energy has been increasing. Over the 10 years from 1996-97 to 2006-07, energy production increased at an average rate of 4.3 per cent a year, compared with 3.4 per cent over the previous 10 years, being driven largely by a growing global demand for energy.

The main fuels produced in Australia are coal, uranium and natural gas. In 2006-07, Australia's energy production was dominated by coal production, which accounted for 54 per cent of total Australian energy production in energy content terms, followed by uranium with a share of

26 per cent and natural gas with a share of 11 per cent. Crude oil and LPG represented 7 per cent of total energy production, and renewables represented 2 per cent.

**Australian energy production**



Source: ABARE, *Australian commodity statistics*.

The Australian energy industry is an important part of the economy. The coal, petroleum, gas and electricity industries contributed around \$57 billion to industry gross value added in 2006-07, representing 6 per cent of the Australian total. The oil and gas extraction industries were the largest contributors to industry

value added, followed by the coal mining industry and the electricity supply industry.

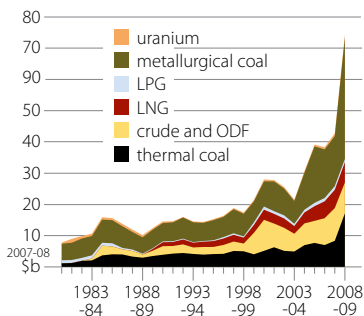
## 1 Energy related industries in Australia, 2006-07

	industry value added A\$b	gross fixed capital formation A\$b	employment '000
Coal mining	16.4	5.4	26.5
Oil and gas extraction	22.4	6.5	10.2
Petroleum refining and petroleum fuel manufacturing	2.2	0.5	5.8
Electricity supply	14.6	8.5	43.9
Gas supply a	1.5	0.8	2.0
Total	57.1	21.7	88.4
Australian economy	961.9	238.5	10 436

a Gas distributed to end users.

Sources: Australian Bureau of Statistics, Mining operations, cat. no. 8415, Manufacturing Industry, cat. no. 8221, Electricity, Gas, Water and Waste Services Australia, cat. no. 8226, Australian System of National Accounts, cat. no. 5204, Australian Labour Market Statistics, cat. no. 6105.

### Australian energy exports

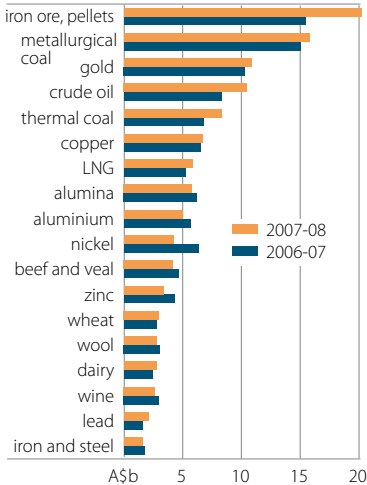


Source: ABARE, Australian commodity statistics, Australian commodities.

### Energy exports

Australia is a net energy exporter, exporting approximately two-thirds of its domestic energy production. However, Australia is a net importer of crude oil and refined petroleum products. Coal is Australia's largest energy export earner, with a value of \$24 billion in 2007-08, followed by crude oil and LNG. Crude oil and LNG are also among Australia's 10 highest value commodity exports. Energy exports accounted for 18 per cent

### Value of major Australian commodity exports



Source: ABARE, *Australian commodity statistics*.

of Australia's total exports of goods and services in 2007-08.

Since 1987-88, the value of Australia's energy exports (in 2007-08 Australian dollars) has increased by an average 7 per cent a year. Energy export earnings increased by 15 per cent in 2007-08 to \$43 billion.

In 2008-09, high contract prices for bulk commodities in place until the end of March 2009 are forecast to result in the value of Australia's energy exports increasing by 72 per cent to \$75 billion. The depreciation of the Australian dollar in mid-2008 has also supported export prices. As most energy commodities are traded in US dollar terms, Australian denominated energy prices are higher when the Australian dollar

is weaker. Coal is forecast to drive the majority of the growth in export earnings, with an increase of 124 per cent in the value of coal exports in 2008-09. Crude oil and LPG exports are forecast to decrease in value in 2008-09, by 11 per cent and 6 per cent respectively. The global financial crisis has resulted in sharp falls in prices for energy commodities from record highs in July 2008. Economic activity in many OECD countries is expected to continue to contract before a gradual recovery in late 2009. The effect of lower world prices on Australian export earnings will depend on how long low prices are sustained and future movements in the value of the Australian dollar.

## Domestic energy consumption

Although Australia's energy consumption is growing, the rate of growth has been decreasing over the past 50 years. Australia's energy consumption increased at an average rate of 2.3 per cent a year over the 10 years from 1996-97 to 2006-07, compared with 2.7 per cent over the previous 10 years.

In 2006-07 energy consumption increased by 2.3 per cent to 5770 petajoules, representing 34 per cent of total Australian energy production.

Over the past 20 years, domestic energy consumption has increased at a slower rate than production. Rapid growth in global demand for Australia's energy resources has driven growth in domestic production. As a result, the share of domestic consumption in Australian energy production has been decreasing, from around 50 per cent in the 1980s, to an average of 42 per

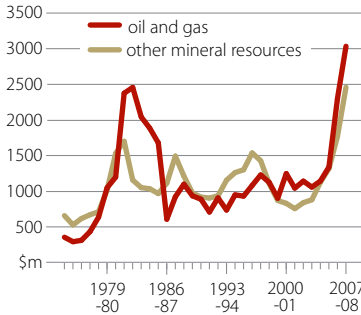
## 2 Australia's economic demonstrated resources, January 2007 <sup>a</sup>

unit		Australia	share of World %	reserves to production <sup>b</sup> yrs
<b>Coal <sup>c</sup></b>				
Black coal	Gt	39	5.4	>100
Brown coal	Gt	37	24.1	>500
<b>Petroleum</b>				
Oil	GL	173	0.3 <sup>d</sup>	8
Condensate	GL	258	na	36
LPG	GL	214	na	45
<b>Gas</b>				
Conventional gas	PJ	98 264	1.4	57
Coal seam methane <sup>e</sup>	PJ	12 833	na	101
Uranium <sup>f</sup>	kt	1 163	38.0	138

<sup>a</sup> Coal and Uranium as at January 2007, petroleum and gas as at January 2006. <sup>b</sup> 2007 rates of Australian production.

<sup>c</sup> Recoverable resources. <sup>d</sup> Naturally occurring crude oil, condensate and LPG combined. Shares of total world EDR reserves for oil and natural gas sourced from BP Statistical Review. <sup>e</sup> Proved and probable reserves as at November 2008. <sup>f</sup> RAR recoverable at costs of less than US\$80/kg U. Sources: Geoscience Australia 2008, *Australia's identified mineral resources 2007*, *Oil and gas resources of Australia 2005*; Energy Quest, *EnergyQuarterly*, November 2008.

### Private energy and minerals exploration expenditure 2007-08 dollars



Source: ABARE, *Australian commodity statistics*.

cent in the 1990s, and down to 34 per cent over the past eight years.

## Energy resources

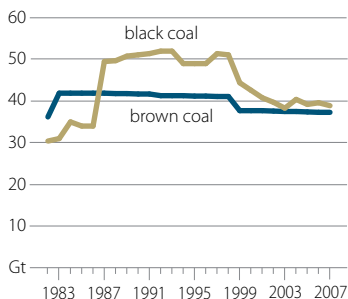
Australia has abundant, high quality energy resources. Australian resources of uranium, for instance, account for 38 per cent of total world resources, while Australian brown coal resources represent 24 per cent of the world total. A significant amount of black coal and natural gas reserves are also

located in Australia. A large proportion of Australian black coal resources are high quality bituminous coals, characterised by a low sulphur and low ash content. Australian crude oil and natural gas liquids are typically low in sulphur and of the light variety of liquid fuels, which have a higher value than the heavy variety because of their lower wax content.

At current rates of production, Australia's energy resources are expected to last for many more decades. The proportion of economic demonstrated reserves (EDR) to current production is estimated at 500 years for brown coal, 100 years for black coal and nearly 60 years for conventional gas. Despite increasing energy production, reserves to production ratios have remained steady over the past 10 years, reflecting the addition of new discoveries and the upgrading of resources which meet economic criteria. For example, over the past 20 years, the average reserve to production ratio for oil has been nine years, despite only slightly decreasing production.

Crude oil, LPG and natural gas exploration expenditure increased by 32 per cent in 2007-08 to around \$3 billion. Other minerals exploration expenditure, including exploration for coal resources, also increased sharply, to around \$2.5 billion. The sharp increase in exploration expenditure since 2005-06 reflects increased exploration activity in response to sustained high energy and minerals prices.

### Australia's economic demonstrated resources of coal



Source: Geoscience Australia 2008, *Australia's identified mineral resources 2007*.

### Coal

Black coal resources are located in most states with significant quantities of high quality black coal in New South Wales and Queensland. These two states have 42 per cent and 53 per cent, respectively, of Australia's black coal economic demonstrated resources. Australia's brown coal deposits are located in South Australia, Victoria, Western Australia and Tasmania.

### 3 Australia's petroleum resources by state 2006 <sup>a</sup>

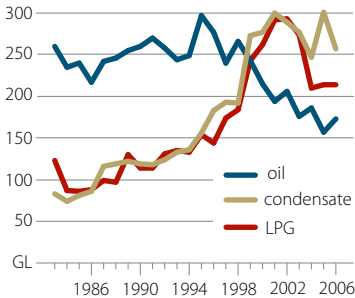
	crude oil	condensate	LPG	conventional gas
	GL	GL	GL	bcm
VIC	37	18	27	210
QLD	9	1	0	12
SA	1	2	5	34
WA	115	155	122	1 851
NT	10	79	58	314
TAS	1	2	2	8
Total	173	257	214	2 429

<sup>a</sup> Economic demonstrated resources only.

Sources: Geoscience Australia 2008, *Oil and gas resources of Australia, 2005*.



### Australia's economic demonstrated resources of petroleum



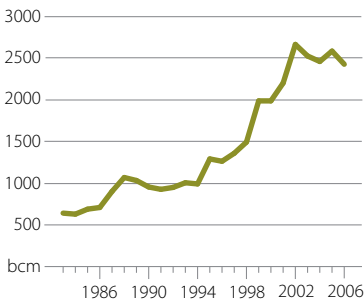
Source: Geoscience Australia 2008, *Oil and gas resources of Australia, 2005*.

### Petroleum

Australia's resources of crude oil and condensate represent a small proportion of world resources. While crude oil resources decreased over the 10 years from 1996 to 2006, condensate and LPG resources have increased.

Most of Australia's petroleum resources are located off the coasts of Western Australia, the Northern Territory and Victoria. Western Australia has 66 per cent of Australia's economic demonstrated resources of crude oil and 57 per cent of Australia's LPG resources.

### Australia's economic demonstrated resources of conventional gas

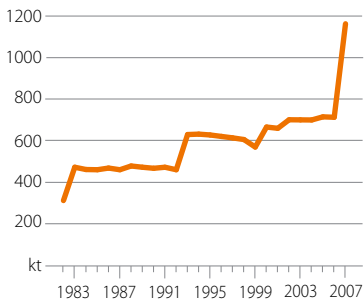


Source: Geoscience Australia 2008, *Oil and gas resources of Australia, 2005*.

### Gas

Australia's identified conventional gas resources have increased fourfold over the past 20 years. Around 90 per cent of estimated recoverable reserves of conventional gas are located off the west and north-west coast of Australia. In addition to conventional gas resources, there is growing commercial utilisation of Australia's resources of coal seam gas. Most of these resources are located in the black coal deposits of Queensland and New South Wales.

### Australia's economic demonstrated resources of uranium

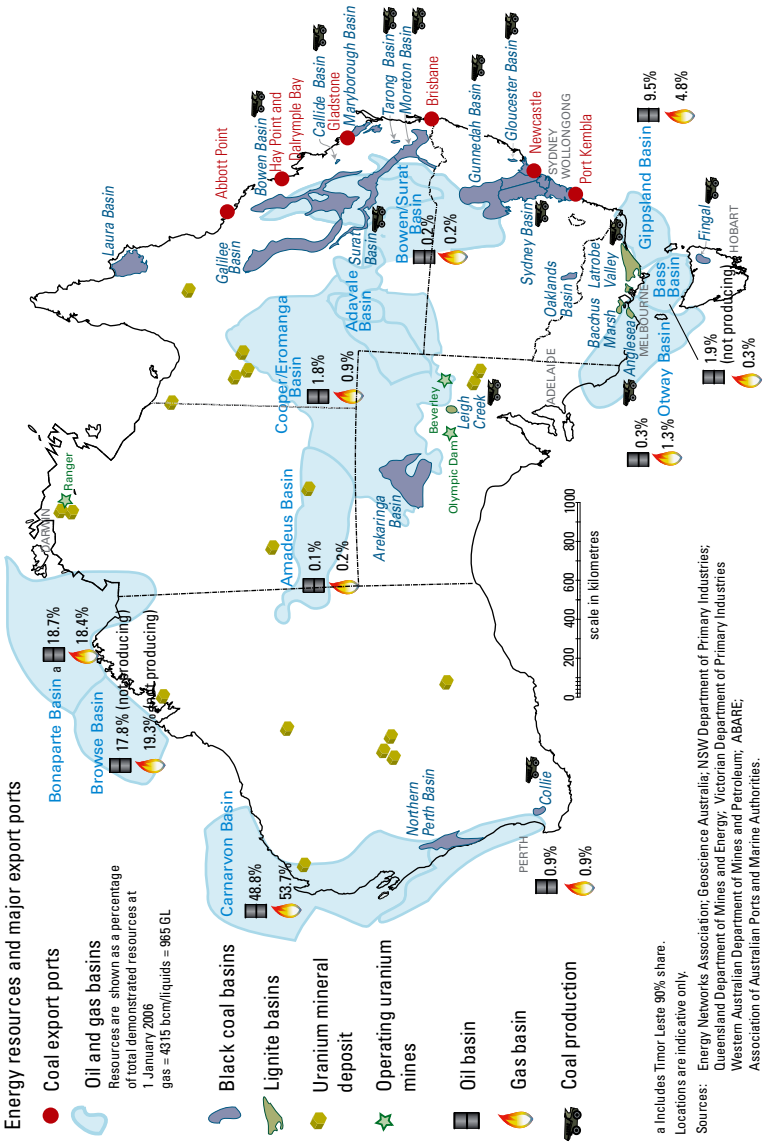


Source: Geoscience Australia 2008.

### Uranium

Australia's identified uranium resources have more than doubled over the past two decades, with the majority of these resources located in South Australia, the Northern Territory and Western Australia. The Olympic Dam deposit in South Australia is the world's largest uranium deposit.

## Energy resources and major export ports



a includes Timor Lease 90% share.

Locations are indicative only.

Sources: Energy Networks Association; Geoscience Australia; NSW Department of Primary Industries;

Queensland Department of Mines and Energy; Victorian Department of Primary Industries;

Western Australian Department of Mines and Petroleum; ABARE;

Association of Australian Ports and Marine Authorities.



# ENERGY CONSUMPTION

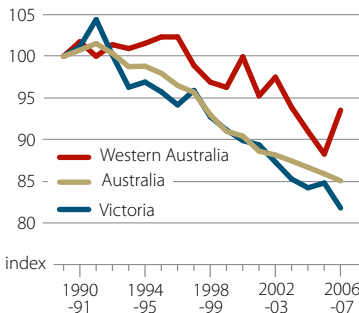
Australia is the world's twentieth largest primary energy consumer, ranking sixteenth on a per person basis.

## Energy intensity

During the past five decades, Australia's growth in energy consumption has gradually slowed. Following growth of around 5 per cent during the 1960s, annual growth in energy consumption fell during the 1970s to an average of around 4 per cent a year, largely as a result of the two major oil price shocks. During the 1980s, economic recession and sharply rising energy prices resulted in annual growth falling to an average of 2.3 per cent a year. Despite falling real energy prices and robust economic growth, annual average growth in energy consumption has remained around 2.3 per cent.

This trend indicates a longer term decline in energy intensity of the Australian economy which can be attributed to two main factors. First, greater efficiency has been achieved through technological improvement and fuel switching. Second, rapid growth has occurred in less energy intensive sectors such as the commercial and services sector relative to the more moderate growth of the energy intensive manufacturing sector. Trends

### Energy intensity trends



Sources: ABARE, *Australian energy statistics*; ABS, *Australian National Accounts: State Accounts*, cat. no. 5220.

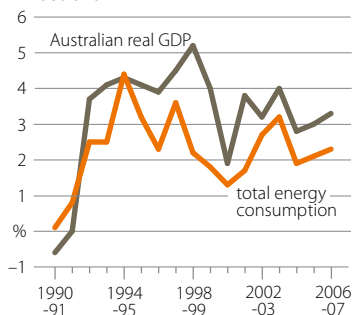
in energy intensity are not uniform across Australia. For example, in recent decades the growing resources sector of Western Australia has contributed to energy intensity being higher in this state than in Victoria, where the services sector has grown strongly.

## Energy consumption by fuel

Australian primary energy consumption consists predominantly of petroleum

## Energy consumption

### Annual growth in energy consumption in Australia



Sources: ABARE, *Australia's energy statistics*; *Energy statistics*; ABS, Australian National Accounts: State Accounts, cat. no. 5220.

and coal. Black and brown coal accounted for the greatest share of the fuel mix, at around 40 per cent, followed by petroleum products (34 per cent), natural gas (20 per cent) and renewable energy sources (5 per cent). The share of natural gas in Australian energy consumption has increased in the past 30 years and this trend is likely to continue in the longer term.

### Energy consumption by industry

Australia's primary energy consumption is estimated to have risen by 2.3 per cent in 2006-07 to 5770 petajoules. The diagram of Australia's energy flows (page 17) is a simplification of the energy supply and disposal table (table 6). It shows the movement of primary fuels from the point at which they become available, through Australia's energy conversion sectors, until the

#### 4 Gross energy consumption by state, by fuel, 2006-07

	black coal PJ	brown coal PJ	renewables <sup>a</sup> PJ	petroleum products PJ	natural gas PJ	state share <sup>b</sup> %
New South Wales	807	62	46	567	139	28
Victoria	0	675	27	447	261	24
Queensland	648	0	116	491	109	23
Western Australia	125	0	14	279	474	15
South Australia	70	0	9	112	115	5
Tasmania	15	0	44	41	13	2
Northern Territory	0	0	0	64	45	2
Total	1 664	737	285	2 001	1 157	
Share of total	28%	13%	5%	34%	20%	

<sup>a</sup> State breakdown does not include wind, solar PV or biogas which are included in the total. <sup>b</sup> Excluding wind, solar PV and biogas.

Source: ABARE, *Australian energy statistics*.

## 5 Australian energy consumption by fuel

	2002-03	2003-04	2004-05	2005-06	2006-07
	PJ	PJ	PJ	PJ	PJ
<b>Consumption of fuels</b>					
Black coal	1 518	1 566	1 625	1 639	1 664
Brown coal/lignite	674	679	693	705	675
Coke	75	80	77	76	77
Coal by-products	70	75	72	80	81
Brown coal briquettes	8	8	8	9	9
Wood, woodwaste	99	97	92	90	93
Bagasse	95	101	101	109	111
Refinery input	1 626	1 496	1 534	1 413	1 510
Petroleum products	1 781	1 882	1 971	1 981	2 001
Natural gas	1 024	1 059	1 074	1 069	1 157
Town gas	5	5	6	8	8
Solar energy	3	3	3	2	6
Total electricity	837	866	901	914	941
of which Hydro electricity	59	57	56	57	52
and wind and solar PV	1	2	3	6	23
<b>Production of derived fuels</b>					
Coke	97	103	103	98	98
Coal by-products	61	64	62	76	78
Brown coal briquettes	5	4	3	2	2
Petroleum products <b>a</b>	1 640	1 546	1 621	1 424	1 530
Town gas	5	5	5	5	5
Thermal electricity	781	810	841	847	855
Total energy					
consumption <b>b</b>	5 257	5 422	5 526	5 640	5 770

**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. Totals may not add because of rounding.

Source: ABARE, *Australian energy statistics*.

final distribution to industries and households. Domestically produced or imported primary energy may be used directly by industries and households but is generally first transformed in refineries and power plants for use as petroleum products and electricity. Additionally, many final energy products are not manufactured in Australia, but are directly imported for

## 6 Australian energy supply and disposal, 2006-07

	coal and by-products	natural gas, CSM	crude oil and ORF	propane, butane, LPG	refined products	liquid/ gas biofuels	biomass
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
<b>Supply</b>							
Primary indigenous plus all imports less all exports less stock changes and discrepancies	9 292.7	1 792.6	1 056.6	120.6		12.8	204.6
		214.0	984.9	19.2	642.3		
	6 943.3	826.9	593.9	72.6	144.1		
	25.0	22.0	-60.4	6.8	77.0		
<b>Total domestic availability</b>	<b>2 324.4</b>	<b>1 157.8</b>	<b>1 508.1</b>	<b>60.4</b>	<b>421.2</b>	<b>12.8</b>	<b>204.6</b>
<b>less conversions</b>							
Coke ovens	13.2				0.9		
Briquetting	4.5						
Petroleum refining		22.3	1 514.2	-36.0	-1 478.2		
Gas manufacturing		3.7		1.4			
Electricity generation <b>a</b>	2 050.2	284.2		0.1	25.3	7.3	4.7
Other conversion <b>b</b>	42.2		-8.9	-7.4	14.9		
Fuel use in conversion		24.6		2.1	120.1		
<b>Final domestic availability <b>c</b></b>	<b>214.3</b>	<b>823.0</b>	<b>2.7</b>	<b>100.2</b>	<b>1 738.2</b>	<b>5.6</b>	<b>200.0</b>
<b>Disposal</b>							
Agriculture		0.1		1.6	83.2		
Mining	7.8	242.2	1.3	1.2	147.5		
Food, beverages, textiles	13.4	38.6	0.6	1.0	15.3	1.8	115.5
Wood, paper and printing	11.9	20.7		0.8	1.5		18.7
Chemical	12.5	88.2		14.2	61.2		
Iron and steel	55.7	26.2		0.5	1.8		
Non-ferrous metals	73.2	144.8	0.8	0.6	49.2		2.3
Other industry	30.8	80.1		5.3	10.7	1.9	0.9
Construction		3.1		0.3	22.7		
Road transport		1.6		61.4	951.0	1.9	
Rail transport		0			27.7		
Air transport					217.8		
Water transport	5.2	0.1			61.7		
Commercial and services	3.7	43.8		3.0	23.0		0.3
Residential	0.2	133.5		10.2	1.3		62.3
Lubes, bitumen, solvents					62.7		
<b>Gross final energy disposal</b>	<b>214.3</b>	<b>823.0</b>	<b>2.7</b>	<b>100.2</b>	<b>1 738.2</b>	<b>5.6</b>	<b>200.0</b>



## 6 Australian energy supply and disposal, 2006-07

	solar/ wind electricity	hydro- electricity	total electricity	solar hot water	U <sub>3</sub> O <sub>8</sub> uranium	total
	PJ	PJ	PJ	PJ	PJ	PJ
Supply						
Primary indigenous plus all imports less all exports less stock changes and discrepancies	22.5	52.0		5.9	4 509.0	17 069.4 1 860.4 13 054.7
Total domestic availability	22.5	52.0		5.9	35.1	5 769.8 105.3
less conversions						
Coke ovens			0.1			14.1
Briquetting			0.2			4.8
Petroleum refining			7.1			29.3
Gas manufacturing			0.1			5.2
Electricity generation <b>a</b>	22.5	52.0	-901.0			1 545.3
Other conversion <b>b</b>			-46.0			-5.2
Fuel use in conversion			134.7			281.5
Final domestic availability <b>c</b>			804.8	5.9		3 894.8
Disposal						
Agriculture			6.7			91.6
Mining			69.4			469.4
Food, beverages, textiles			29.1			215.3
Wood, paper and printing			21.1			74.8
Chemical			22.7			198.8
Iron and steel			27.3			111.5
Non-ferrous metals			185.4			456.4
Other industry			25.9			155.5
Construction			0.3			26.3
Road transport						1 016.0
Rail transport			8.1			35.8
Air transport						217.8
Water transport						67.0
Commercial and services			178.2	3.7		255.8
Residential			230.5	2.2		440.2
Lubes, bitumen, solvents						62.7
Gross final energy disposal			804.8	5.9		3 894.8

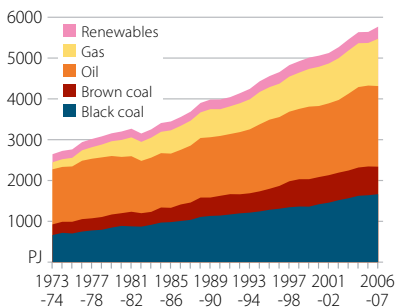
**a** Grid connected power stations only, except for Total electricity. **b** Includes return streams to refineries from the petrochemical industry, consumption of coke in blast furnaces, blast furnace gas manufacture, electricity produced through cogeneration and lignite tar in char manufacture. **c** After conversion sector use and losses. Equals gross final energy disposal which is the final disposal of energy within the end use sectors.

Note: Totals may not add due to rounding. Because it is not possible to separate the fuels used to produce embedded electricity, those fuels are included in the industry in which production occurs although the electricity produced is included under Total electricity against Electricity generation and Other conversion.

Source: ABARE, Australian energy statistics.

## Energy consumption

### Primary energy consumption in Australia by fuel



Source: ABARE, Australian energy statistics.

use by Australian industries and households. Australia is a net exporter of primary energy, with a far greater amount of Australia's primary energy production exported than consumed domestically.

The major energy using sectors of electricity generation, transport and manufacturing, together accounted for more than 75 per cent of Australia's energy consumption. Next in terms of energy consumption were the mining, residential, and commercial and services sectors.

## 7 Energy consumption in Australia by industry

	1974-75	1979-80	1989-90	1999-00	2006-07
	PJ	PJ	PJ	PJ	PJ
Agriculture	39	47	55	72	92
Mining	65	81	160	273	457
Manufacturing	928	965	1 067	1 192	1 369
Electricity generation	540	743	1 066	1 427	1 695
Construction	29	38	41	29	26
Transport	701	825	1 012	1 267	1 359
Commercial <sup>a</sup>	87	104	151	219	252
Residential	246	262	322	392	442
Other <sup>b</sup>	59	66	69	77	78
<b>Total</b>	<b>2 695</b>	<b>3 131</b>	<b>3 944</b>	<b>4 946</b>	<b>5 770</b>

<sup>a</sup> Includes ANZSIC Divisions F, G, H, J, K, L, M, N, O, P, Q and the water, sewerage and drainage industries. <sup>b</sup> Includes consumption of lubricants and greases, bitumen and solvents, as well as energy consumption in the gas production and distribution industries.

Source: ABARE, Australian energy statistics.

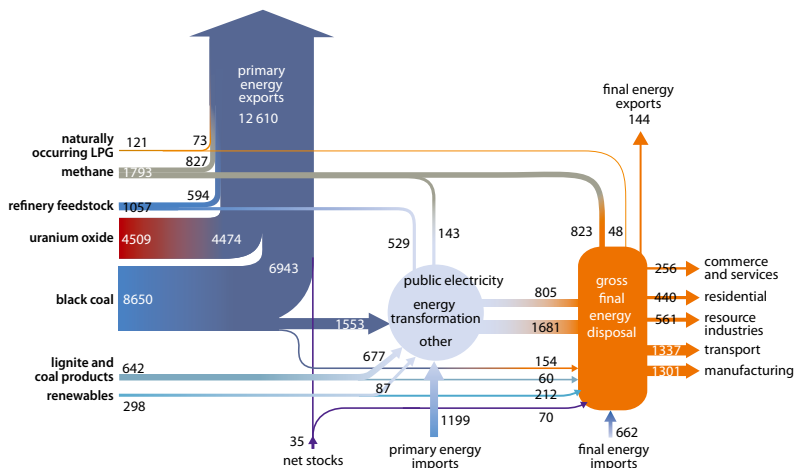
## 8 Australian consumption of petroleum products

	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML
LPG <sup>a</sup>	3 569	3 386	4 050	4 038	4 024
Automotive gasoline	19 962	19 876	19 048	19 251	19 234
Avgas	90	91	86	90	88
Turbine fuel	4 329	4 730	5 359	5 837	6 070
Kerosene	22	12	27	32	43
Heating oil	46	34	25	15	12
Automotive diesel oil	14 461	15 185	15 804	17 028	18 245
Industrial diesel fuel	17	15	19	15	11
Fuel oil	1 466	1 595	1 586	1 513	1 583
Lubes and greases	618	470	451	421	435
Bitumen	742	812	805	808	785
Other <sup>b</sup>	953	939	973	699	258
Total products <sup>c</sup>	46 276	47 145	48 234	49 746	50 788

<sup>a</sup> Includes LPG used as petrochemical feedstock. <sup>b</sup> Includes other refined products, crude oil used as a fuel and specialty feedstocks. <sup>c</sup> Some petroleum products are produced from the conversion of other petrochemical products. Sources: RET, *Australian petroleum statistics*.

## Australian energy flows

units: petajoules



Source: ABARE, *Australian energy statistics*.



# ELECTRICITY

The electricity industry is one of Australia's largest individual industries, contributing around 1.5 per cent of Australia's gross domestic product. Australia's electricity generation sector faces a number of challenges over the medium to longer term, including the need to meet increasing domestic consumption through investment in new assets and policy measures aimed at reducing greenhouse gas emissions.

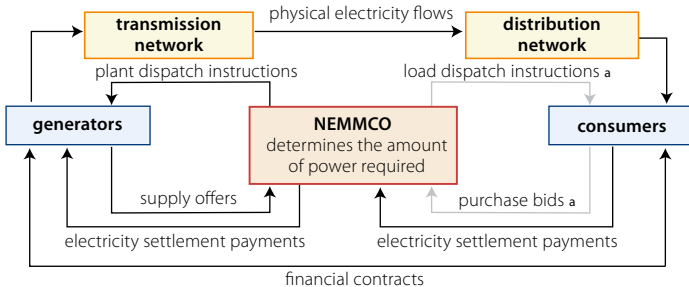
Over the past decade, final consumption of electricity in Australia increased at an average annual rate of 3.3 per cent.

## Industry structure

The National Electricity Market (NEM) was established in 1998, to allow for market determined power flows across the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria (Tasmania joined in 2005). Western Australia and the Northern Territory are not connected to the NEM primarily because of their geographic distance from the rest of the market.

The NEM is comprised of a wholesale sector and a competitive retail sector. All electricity dispatched in the market must be traded through the central spot market. However, electricity retailers and generators also enter into contractual arrangements as a means of managing the risk associated with spot market price volatility.

## Market structure



a Currently no customers submit demand side bids  
Source: NEMMCO.

## 9 Key performance indicators for the Australian electricity industry

	unit	2002-03	2003-04	2004-05	2005-06	2006-07
Generation capacity	GW	44	45	45	45	47
Asset value	A\$b	98	na	na	na	na
Capacity utilisation	%	53.62	54.40	55.10	56.04	54.56
Electricity generation	TWh	206	213	217	220	227
Employment	'000	37	37	38	41	44
Number of customers	'000	9 093	9 268	9 351	9 530	9 684
Wholesale price <b>a</b>						
- nominal	¢/kWh	3.36	3.21	3.73	3.92	6.17
- real <b>b</b>	¢/kWh	3.75	3.49	3.96	4.03	6.17
System minutes						
not supplied <b>c</b>	mins.	8.04	4.58	4.43	3.70	5.80
System energy						
not supplied	MWh	3 415	1 494	1 566	1 112	1 915
Distribution losses	%	5.9	5.7	5.9	5.9	5.6

**a** Volume weighted - average price (National Electricity Market). **b** 2006-07 A\$ value. **c** Average minutes - excludes Northern Territory. **na** Not available.

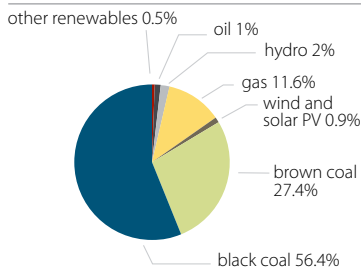
Sources: Energy Supply Association of Australia, *Electricity gas Australia*; Australian Bureau of Statistics.

The management of the electricity spot market and the central coordination of the dispatch of electricity from generators is the responsibility of the National Electricity Market Management Company (NEMMCO). This role is scheduled to be transferred to a new body, the Australian Energy Market Operator, on 1 July 2009. The Australian Energy Regulator (AER) monitors the market to ensure participants comply with the National Electricity Law and Rules.

## Production

Around 230 terawatt-hours of electricity was generated in Australia in 2006-07. Over the past five years, the industry has increased electricity generation by 10 per cent, while the number of customers has increased by around 7 per cent.

### Fuel inputs into Australian electricity generation, 2006-07 <sup>a</sup>



<sup>a</sup> This chart should not be compared with the chart of electricity generation by fuel in *Energy in Australia 2008* because that chart represented electricity generation output, rather than fuel inputs into electricity generation. Hydroelectricity accounts for a larger proportion of electricity generation output than of fuel inputs into electricity generation.

Source: ABARE, *Australian energy statistics*.

The majority of Australia's electricity is produced using coal, accounting for 84 per cent of all fuels consumed by generators (in energy content terms) in 2006-07. This is because coal is a relatively low cost energy source in Australia. It also reflects the abundance of coal reserves along the eastern seaboard, where the majority of electricity is generated and consumed.

## 10 Fuel inputs into Australian electricity generation

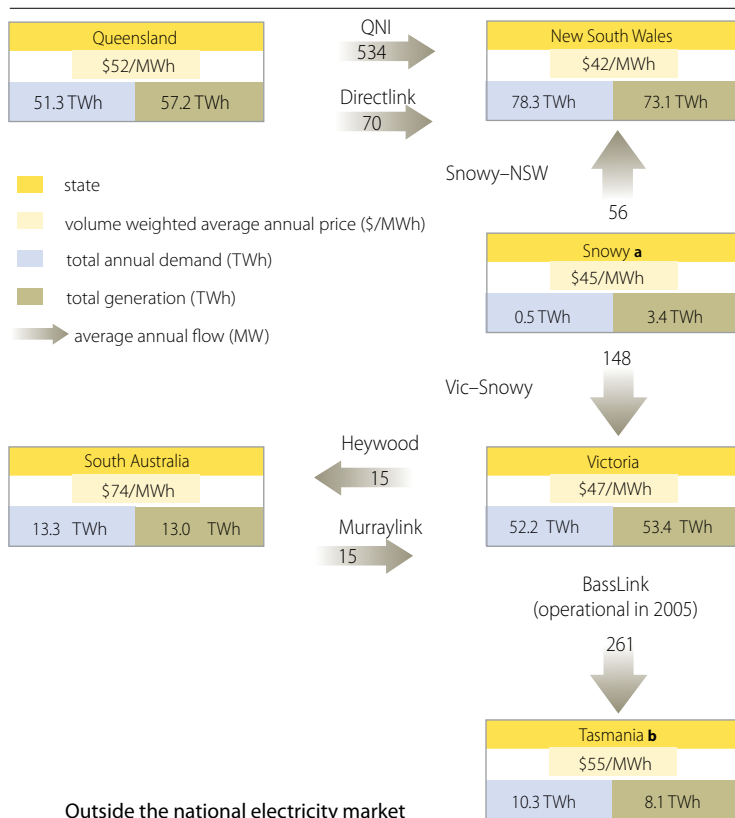
	2003-04	2004-05	2005-06	2006-07
	PJ	PJ	PJ	PJ
<b>Thermal</b>				
Black Coal	1 296	1 297	1 357	1 379
Brown coal	674	683	701	671
Oil	22	25	26.4	25
Gas	264	267	263	284
Total thermal	2 256	2 272	2 348	2 360
<b>Renewables</b>				
Hydro	58	56	58	52
Wind <sup>a</sup>	0	3	6	23
Biomass	5	5	5	5
Biogas	8	7	7	7
Total renewables	71	71	76	87

<sup>a</sup> Includes solar photovoltaic electricity generation.

Source: ABARE, *Australian energy statistics*.

# Electricity

## Regional electricity market activity, 2007-08



**a** Region was abolished 1 July 2008 and split between New South Wales and Victoria

**b** Officially connected to the national electricity market in May 2006

**e** ABARE estimate

**na** not available.

Sources: NEM Review, NT Utilities Commission 2008, Independent Market Operator.



## 11 Principal generation businesses in Australia, 2007-08

	share of Australian generation		share of Australian generation		
	GWh	%	GWh	%	
<b>New South Wales <sup>a</sup></b>					
Macquarie Generation	27 781	12.08	Flinders Power	4 897	2.13
Delta Electricity	25 746	11.20	TRUenergy	3 304	1.44
Eraring Energy	17 352	7.55	International Power	3 289	1.43
Snowy Hydro	3 437	1.49	Osborne Cogeneration	1 225	0.53
Bacbrock and Brown Power	1 185	0.52	Origin Energy	224	0.10
Marubeni	1 003	0.44	AGL	28	0.01
<b>Victoria</b>					
Loy Yang Power	17 292	7.52	International Power (Synergen)	21	0.01
Hazelwood Power	11 393	4.95	Cummins Power Generation	2	0.00
TRUenergy	10 300	4.48	<b>Tasmania</b>		
IPM Australia	8 950	3.89	Hydro Tasmania	6 809	2.96
Ecogen Energy	1 912	0.83	Bell Bay Power	1 243	0.54
Alcoa	1 324	0.58	<b>Western Australia <sup>bc</sup></b>		
Energy Brix	1 185	0.52	<b>Northern Territory <sup>b</sup></b>		
Snowy Hydro	395	0.17	Water and Power Corporation	1 550	0.67
AGL Hydro	257	0.11			
Alinta	235	0.10			
AGL	119	0.05			
Eraring Energy	32	0.01			
<b>Queensland</b>					
CS Energy	19 249	8.37			
Stanwell	10 168	4.42			
Comalco/NRG	8 442	3.67			
Tarong Energy	7 583	3.30			
InterGen	6 988	3.04			
Transfield Services	2 113	0.92			
NewGen Power	1 965	0.85			
Origin Energy	144	0.06			
Enertrade	76	0.03			
Oakey Power Holdings	28	0.01			

<sup>a</sup> Includes the Australian Capital Territory. <sup>b</sup> Not part of the national electricity market. <sup>c</sup> State total. Individual businesses not available. <sup>na</sup> Not available

Sources: Global Roam - NEM Review, [www.horizonpower.com.au](http://www.horizonpower.com.au), Independent Market Operator, [www.nt.gov.au/powerwater](http://www.nt.gov.au/powerwater).

## Electricity

Black coal is expected to remain the most commonly used fuel in electricity generation. However, given that a large proportion of advanced and less advanced projects will be using natural gas or coal seam methane as fuel, these energy sources will account for an increasing proportion of power generation.

## Capacity

In 2006-07, Australia's electricity generation capacity was around 47 000 megawatts. As at the end of October 2008, there were 29 committed electricity generation projects and an additional 92 proposed projects. The combined capacity of the 29 committed projects was 6285 megawatts.

### 12 Australian thermal electricity generation capacity by plant and fuel type, 2006-07 <sup>a</sup>

	NSW <sup>b</sup>	VIC	QLD <sup>c</sup>	SA	WA <sup>d</sup>	TAS	NT	AUS
	MW	MW	MW	MW	MW	MW	MW	MW
<b>Steam</b>								
Black coal	11 730	0	8 055	0	1 329	0	0	21 114
Brown coal	0	6 555	0	780	0	0	0	7 335
Natural gas	0	510	132	1 280	268	240	0	2 430
Multi-fuel	0	0	0	0	880	0	0	880
Reciprocating engine	0	0	0	50	0	0	74	124
<b>Open Cycle Gas Turbine</b>								
Conventional gas	0	1 321	907	605	1 189	105	236	4 364
Oil products	50	0	338	113	83	0	30	614
Multi fuel	0	0	0	0	586	0	0	586
<b>Combined Cycle Gas Turbine</b>								
Natural gas	160	0	840	663	360	0	131	2 154

<sup>a</sup> Non-scheduled small hydro plants are excluded. <sup>b</sup> Includes the ACT and the Snowy region. <sup>c</sup> Includes generating capacity at Mt Isa. <sup>d</sup> Includes plants owned by Western Power Corporation (now Verve Energy) in the South West Interconnected System, and exclude plants operated under power purchase agreements. MW = Megawatt.  
Source: Energy Supply Association of Australia, *Electricity gas Australia 2008*.

### 13 Major committed interconnector projects for Australia's National Electricity Market

capacity interconnector	project details	net impact	start-up
Central to northern Queensland	Stage 2 of a 3 stage project. Constructing a Nebo-Strathmore 275 kV line	Increase transfer capacity by 80-160MW	Summer 2008-09
Central to northern Queensland	Stage 3 of a 3 stage project. Constructing a Strathmore-Ross 275 kV line	Increase transfer capacity by 450-520MW	Summer 2010-11
South-west Queensland to South-east Queensland	Installation of a 120 MVAR capacitor bank at the South Pine 275 kV substation	Increases voltage stability limit by 25MW for Tarong and Gold Coast by 10MW	Summer 2008-09
South-west Queensland to South-east Queensland	Establishment of the Abermain 275 V substation and installing a 275/110 kV transformer	Increases voltage stability limit by 25MW for Tarong and Gold Coast by 10MW	Summer 2008-09
South-west Queensland to South-east Queensland	Installation of a 200 MVAR capacitor bank at Tarong; a fifth 200 MVAR capacitor bank at Greenbank; and a 120 MVAR capacitor bank at the Mt England and South Pine 275 kV substations	Increases voltage stability limit by 135MW for Tarong and Gold Coast by 50MW	Summer 2009-10
South-west Queensland to northern NSW	Installation of a phase angle regulating transformer on the Armidale-Kempsey	Removes impact of mid-North Coast 132 kV line rating limitations on Queensland exports to New South Wales	Summer 2008-09
South-east Queensland to northern NSW	132 kV line no.965		

### 13 Major committed interconnector projects for Australia's National Electricity Market

capacity interconnector	project details	net impact	start-up
Northern NSW to South-west Queensland			
South-west Queensland to northern NSW	Upgrade of the Tamworth-Armidale 330 kV line no.86	Increases the 15 minute summer day thermal rating of the line	Summer 2008-09
Northern NSW to central NSW	Upgrading the supply to Newcastle, Sydney and Wollongong to 500 kV.	Reduces thermal limitations, voltage control limitations,	Network support from Summer 2008-09;
Central NSW to Canberra	Involves transformer and 500 kV substation works.	and reactive power support limitations	Augmentation by Summer 2009-10

Source: NEMMCO Statement of opportunities, 2008

## 14 Australian major power network transfer capabilities, 2007-08

interconnector	location	forward	reverse
		capability MW	capability MW
New South Wales to Queensland (QNI)	Armidale to Braemar	486	1 078
New South Wales to Queensland (Directlink)	Terrinora to Mullumbimby	105	234
Snowy to New South Wales	Murray to Dederang	3 309	1 090
Victoria to Snowy	Buronga to Red Cliffs	1361	1 786
Victoria to South Australia (Heywood)	Heywood to Tailem Bend	460	300
Victoria to South Australia (Murraylink)	Red Cliffs to Berri	220	220
Tasmania to Victoria (Basslink expected capability)	Seaspray to Georgetown	594	469
<b>Transmission and distribution length (km)</b>		<b>Overhead</b> 781 383	<b>Underground</b> 102 725

Sources: Energy Supply Association of Australia, *Electricity gas Australia 2008*.

The National Electricity Market is linked by six major transmission interconnectors. These interconnectors link the electricity networks in Queensland, New South Wales, Victoria, South Australia and Tasmania. The National Electricity Market electricity transmission and distribution network consists of more than 781 000 kilometres of overhead transmission and distribution lines and more than 102 000 kilometres of underground cables. There are a number of projects which are under development to expand the capabilities of the interconnector system.

## Prices

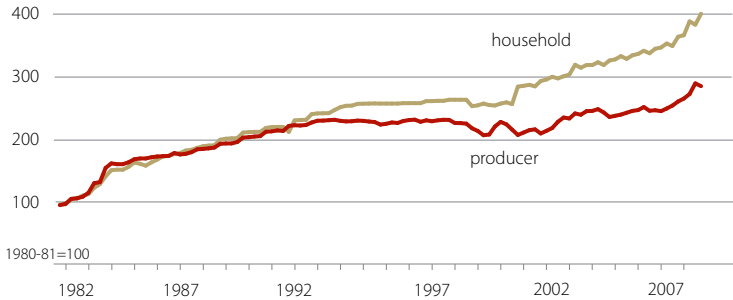
Australian electricity prices are among the lowest in the world. The average wholesale price of electricity for the NEM as a whole remained relatively constant until 2007. At the beginning of 2007, average market electricity prices increased significantly, largely as a result of record demand combined with tight supply. In particular, drought constrained hydroelectricity

## Electricity

generation in the Snowy region, Tasmania and Victoria, and the limited availability of water for cooling in some coal-fired generators led to higher spot market prices. However, electricity prices have since moderated.

### Electricity prices for households and businesses

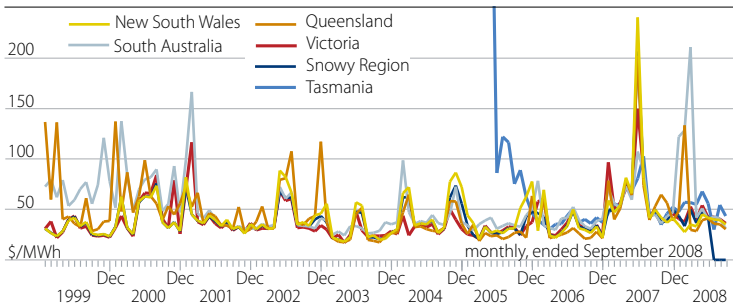
index, quarterly, ended September 2008



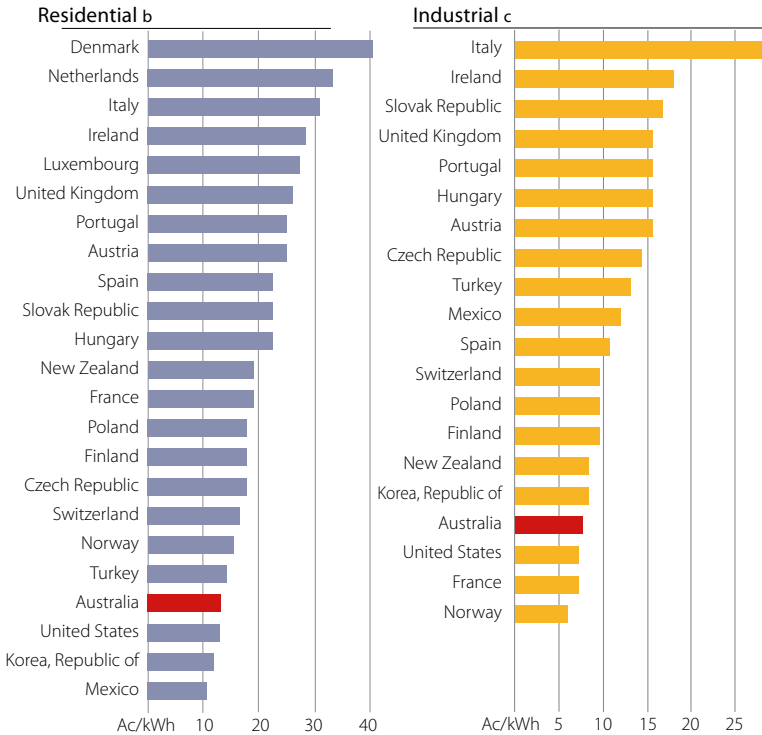
Source: ABS, Producer price index cat. no. 6427, Consumer price index cat. no. 6401.

### Spot market prices in the National Electricity Market

average wholesale, in 2007-08 dollars



Source: NEMMCO

OECD electricity prices, 2007 <sup>a</sup>

**a** Does not include all countries, only a sample of OECD countries has been selected. **b** Australian price is based on ABS residential electricity price index. **c** Australian price is based on ABS commercial electricity price index. This may be an overestimate of the industrial price.

Source: International Energy Agency, *Energy prices and taxes 2008*.

## Electricity

Occasional price spikes are often caused by factors such as widespread heatwaves, industrial disputes or generator malfunctions. For example, electricity spot prices in South Australia increased considerably in March 2008 following a 15 day heatwave, which encouraged record high electricity demand. However, reduced maximum allowable flows on the Heywood interconnector from December 2007 constrained the available supply.







# RENEWABLE ENERGY

Australia has access to a range of high quality renewable energy sources which are used for heating, electricity generation and transportation. Renewable energy accounts for 5 per cent of Australia's total energy consumption. At present, renewable sources used to generate electricity include hydro, biomass, wind and solar. Renewable energy contributes around 6.5 per cent of electricity generation for public consumption in Australia with some 6.1 per cent sourced from hydroelectricity. While wind and solar energy have enjoyed strong growth over recent years, these sources still only represent 0.4 per cent of electricity generation for public consumption. Emerging renewable energy technologies include geothermal, wave and large scale solar generation technologies.

## Production

Australian production of renewable energy is dominated by bagasse, wood and wood waste, and hydroelectricity, which combined accounted for 86 per cent of renewable energy production in 2006-07. Wind, solar and biofuels (which include landfill and sewage gas) accounted for the remainder of Australia's renewable energy production. Most solar energy is used for residential water heating and this represents less than 1 per cent of final energy consumption in the residential sector.

### 15 Australian production of renewable energy <sup>a</sup>

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
	PJ	PJ	PJ	PJ	PJ	PJ
Bagasse	91.7	95.1	96.8	108.3	109.1	110.8
Other biofuels <sup>b</sup>	10.1	10.7	10.6	10.4	12.3	12.8
Hydroelectricity	57.5	58.7	58.0	56.2	57.7	52.0
Solar hot water	2.7	2.8	2.6	2.6	2.4	5.9
Wind <sup>c</sup>	0.6	1.0	1.6	3.2	6.2	22.5
Wood and woodwaste	95.0	99.2	96.9	91.5	82.3	93.8
<b>Total</b>	<b>257.6</b>	<b>267.5</b>	<b>266.5</b>	<b>272.2</b>	<b>270.0</b>	<b>297.8</b>

<sup>a</sup> Electricity and heat. <sup>b</sup> Includes biogas, black liquor, crop and municipal waste. <sup>c</sup> Includes solar photovoltaic.  
Source: ABARE, Australian energy statistics.

## Renewable energy

Renewable energy production increased by 16 per cent in the five years from 2001-02 to 2006-07. In 2006-07 renewable energy production increased by 10 per cent. Wind energy and photovoltaic electricity production experienced the largest increase, from 6 petajoules in 2005-06 to 23 petajoules in 2006-07. Solar hot water also increased strongly, from 2 petajoules in 2005-06 to 6 petajoules in 2006-07. Hydroelectricity was the only renewable energy source to fall in 2006-07, with a decrease of 10 per cent.

## Capacity

The distribution of renewable energy production facilities in Australia reflects the climatic characteristics of different regions. Hydroelectricity capacity in Australia is located mostly in New South Wales, Tasmania, Queensland and Victoria; while wind farms are mostly located in South Australia, Victoria and Western Australia. Almost all bagasse-fuelled energy production facilities are located in Queensland where sugar production plants are located. In contrast, there is a more even distribution of biogas-fuelled facilities across Australia, as these facilities are mostly based on gas generated from landfill and sewerage.

### 16 Capacity of renewable electricity generation in Australia, 2007

	biogas	bagasse	wood- waste	other renewables <sup>b</sup>	hydro	wind	solar	other <sup>c</sup>	total
	MW	MW	MW	MW	MW	MW	MW	MW	MW
NSW <sup>a</sup>	68	16	42	36	4 275	18	4.0	0.5	4 459
VIC	78	0	0	34	566	134	0.7	0.0	813
QLD	17	359	15	4	659	13	0.4	0.1	1 066
SA	22	0	10	0	5	740	0.7	0.0	778
WA	27	6	6	63	32	201	0.7	0.0	336
TAS	5	0	0	0	2 276	144	0.0	0.0	2 425
NT	1	0	0	0	0	0	1.6	0.0	3
Other <sup>d</sup>							63		63
Aust	218	380	73	137	7 814	1 249	71	1	9 942

<sup>a</sup> Includes the ACT. <sup>b</sup> Black liquor, crop waste, municipal waste and biodiesel. <sup>c</sup> Oceanwave and geothermal.

<sup>d</sup> Domestic, recreational and remote installations.

Sources: Geoscience Australia; NEMMCO; Watt, M 2007. National Survey Report of PV Power Applications in Australia.

## Potential

A range of policy measures have been introduced in Australia to support the uptake and development of renewable energy. These measures include the Australian Government's Mandatory Renewable Energy Target (MRET). The MRET was designed to increase electricity generation from renewable energy sources by 9500 gigawatt hours per year by 2010. The renewable energy sources which have experienced the greatest growth under the MRET are wind energy and solar hot water. In 2007, electricity generation from wind was 2330 gigawatt hours higher than in 1997.

In 2007, the Australian Government committed to ensuring 20 per cent of Australia's electricity supply comes from renewable energy sources by 2020. This is to be achieved by increasing the national renewable energy target from 9500 gigawatt hours to 45 000 gigawatt hours by 2020.

### 17 Increase in renewable generation under MRET from 1997 to 2007 <sup>a</sup>

	increase		baseline generation
	GWh	share %	GWh
Bagasse	516	8.4	513
Black liquor	113	1.8	154
Hydro	711	11.5	15 604
Landfill gas	576	9.3	264
Sewage gas	66	1.1	5
Photovoltaic	109	1.8	0
Solar water heater	1 515	24.6	0
Wind	2 330	37.8	5
Wood waste	150	2.4	63
Other <sup>b</sup>	83	1.4	4
<b>Total</b>	<b>6 169</b>	<b>100</b>	<b>16 614</b>

<sup>a</sup> Reported generation under the Mandatory Renewable Energy Target scheme, above baseline levels in 1997.

<sup>b</sup> Includes municipal solid waste combustion and food and agricultural wet waste.

Source: Office of the Renewable Energy Regulator, REC Registry, <https://www.rec-registry.gov.au/>

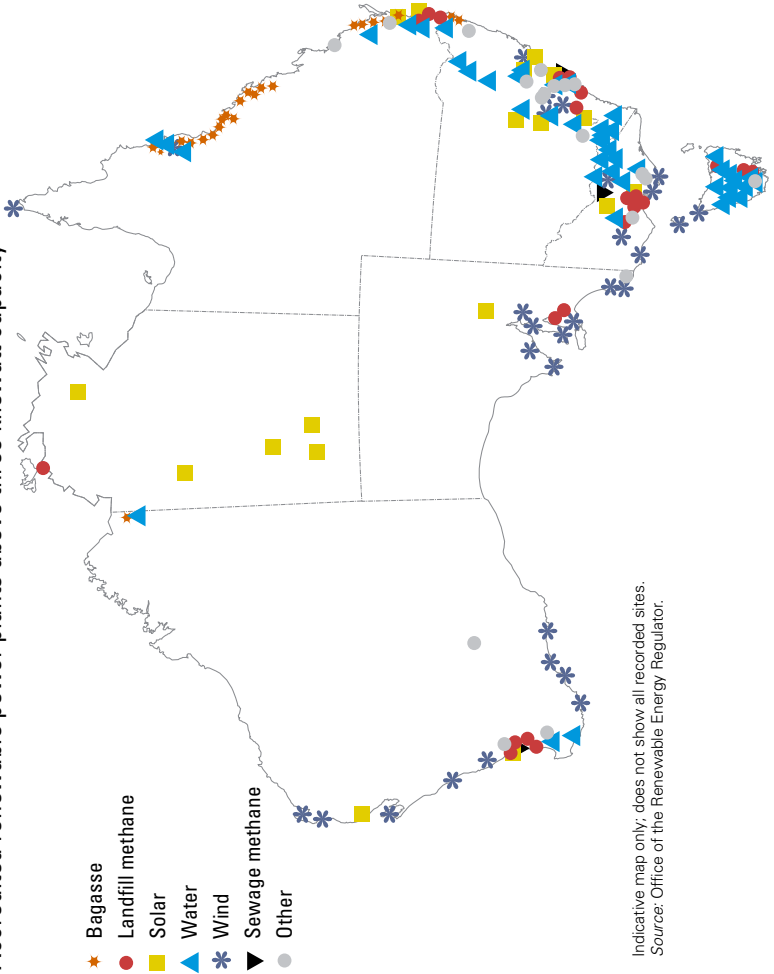
Significant growth in renewable electricity generation capacity is planned for the next few years. There are 11 renewable electricity projects at an advanced planning stage and a further 49 projects at a less-advanced stage.

Of these, seven are advanced wind energy projects and 42 are wind projects at a less-advanced stage (ABARE, Electricity generation major development projects, October 2008). There is growing interest in solar thermal technology for electricity generation. A 10 megawatt solar thermal plant is expected to be constructed in Cloncurry, Queensland, by 2010. There are also several wave energy projects planned for 2010 to 2011.

Geothermal energy is a potential renewable energy source which is currently relatively undeveloped. There is one geothermal project in operation in Australia. A recent addition to geothermal energy prospects in Australia is the development of hot rock technology. Hot rock technology is similar to conventional geothermal energy in that it uses the heat emanating from inside the earth. However, where conventional geothermal energy relies on steam which is vented naturally near volcanic centres, the hot rock process requires water to be pumped deep below the earth's surface. Although hot rock technology is not yet commercially viable, significant investment has been made to develop the technology. Work programs in place for the period from 2002 to 2013 are valued at more than \$1 billion. In November 2008, there were 10 hot rock companies listed on the Australian Stock Exchange. This investment is currently focused on resource exploration. By November 2008, 40 companies had applied for geothermal exploration licenses, which cover an area of more than 265 500 square kilometres.

Accredited renewable power plants above three kilowatt capacity

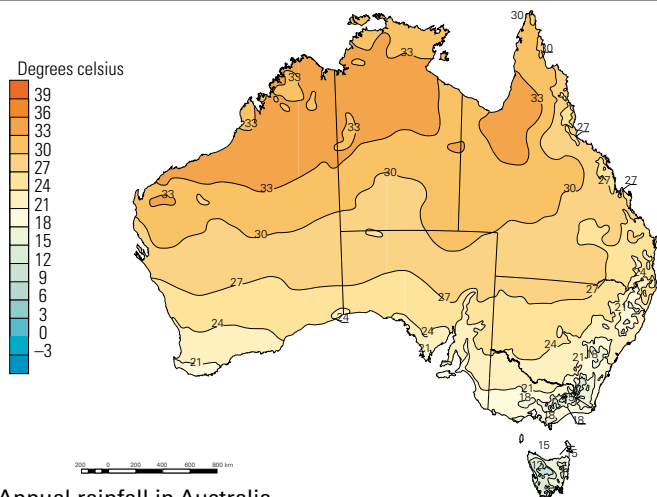
- ★ Bagasse
- Landfill methane
- Solar
- ▲ Water
- ✱ Wind
- ▼ Sewage methane
- Other



Indicative map only, does not show all recorded sites.  
Source: Office of the Renewable Energy Regulator.

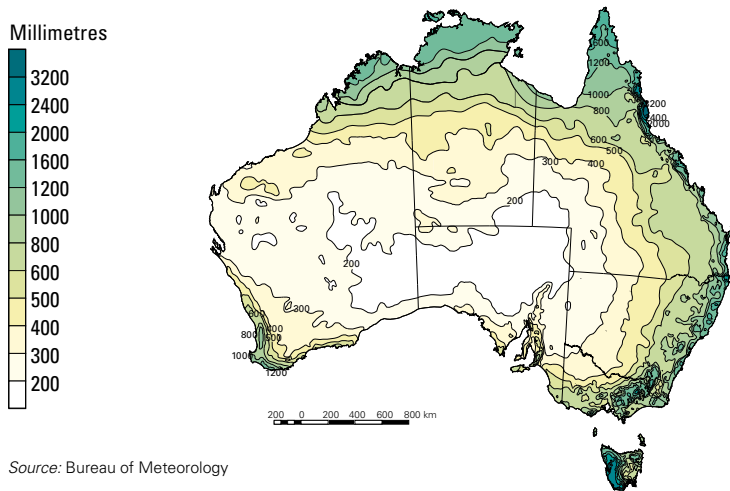
### Average annual daily maximum temperature in Australia

Based on a 30-year climatology (1961 to 1990)



### Annual rainfall in Australia

Based on a 30-year climatology (1961 to 1990)

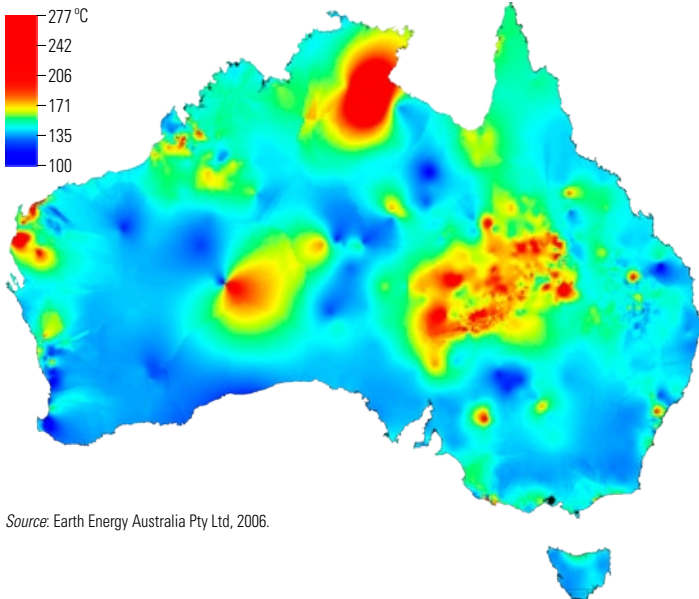


Source: Bureau of Meteorology



## Geothermal potential in Australia

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Source: Earth Energy Australia Pty Ltd, 2006.



# COAL PRODUCTION AND TRADE

Coal is Australia's largest commodity export, earning around \$24 billion in 2007-08. Australia's success in world coal markets has been based on reliable and competitive supplies of high quality metallurgical and thermal coal.

Coal is also a significant component of domestic energy needs comprising 84 per cent of fuel used for electricity generation in 2006-07.

## Production

Australia accounts for around 6 per cent of world black coal production, 98 per cent of which is sourced from New South Wales and Queensland. The majority of Australia's metallurgical (or coking) coal is produced in Queensland, while New South Wales' production is largely classed as thermal (or steaming) coal. Around three-quarters of this output is sourced from open cut mines. In addition, brown coal is mined in Victoria and South Australia, where it is used for domestic electricity generation.

There has always been significant foreign investment in the Australian coal industry. Major producers of coal in Australia include Loy Yang (brown coal), Hazelwood (brown coal), CLP Power Asia (brown coal), BHP Billiton-Mitsubishi Alliance, and Coal and Allied Industries.

### 18 Australian coal production by state <sup>a</sup>

	2003-04	2004-05	2005-06	2006-07	2007-08
	Mt	Mt	Mt	Mt	Mt
<b>Brown Coal</b>					
VIC	66.3	67.2	67.7	65.6	72.4
SA	3.2	3.6	3.8	3.6	3.8
Total	69.6	70.8	71.5	69.2	76.2
<b>Black coal</b>					
NSW	114.2	122.1	124.6	130.9	135.0
QLD	162.2	172.7	171.9	182.8	180.9
TAS	0.4	0.4	0.6	0.6	0.6
WA	6.0	6.2	6.3	6.1	6.4
Total	282.8	301.4	303.4	320.3	323.0

<sup>a</sup> Saleable production. Sources: Coal Services Pty Ltd; Queensland Department of Mines and Energy; Victorian Department of Primary Industries; ABARE, *Australian commodities*.

## Coal production and trade

Australian black coal production increased at an average annual rate of 3.2 per cent between 2003-04 and 2007-08, encouraged by strong global import demand. This growth was supported by the addition of new capacity in Queensland and New South Wales. Australia's coal production is likely to continue to increase significantly over the medium term as a result of considerable investment in new mining capacity. As at October 2008 there were 11 committed coal mining projects and an additional 41 proposed projects (see Appendix 1).

## Trade

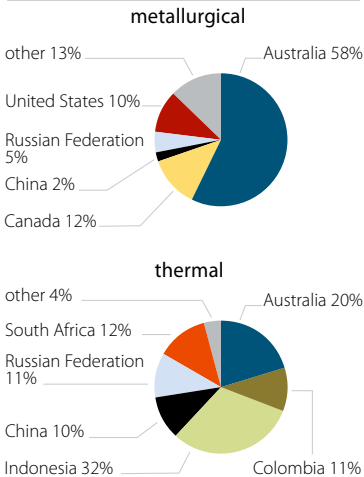
More than three-quarters of Australia's black coal production is destined for export. Australia accounts for approximately one-third of world black coal trade — almost 60 per cent of world metallurgical trade and 20 per cent of thermal coal trade. Growth in Australian export volumes has been limited by

infrastructure constraints. The ability of the industry to meet future coal demand will be improved by recent additions and planned expansions to infrastructure capacity.

The majority of Australia's metallurgical coal exports are destined for Asia and Europe, where it is used in steel-making. The largest importers of Australian metallurgical coal are Japan, India, Chinese Taipei and the European Union. Australia's thermal coal exports are mainly destined for Japan, the Republic of Korea and Chinese Taipei for use in power generation.

Australian exports of metallurgical coal increased at an average annual rate of 5.2 per cent between 2003-04 and 2007-08, driven by rapid demand growth in

**Volume of world exports of coal, by coal type and major exporters, 2007**



Source: ABARE, *Australian commodity statistics*.

## 19 Australian coal exports by type, by destination

		2003-04	2004-05	2005-06	2006-07	2007-08
<b>Metallurgical coal</b>						
Brazil	Mt	3.85	3.09	3.17	3.05	3.87
China	Mt	3.56	4.19	2.86	2.97	1.53
Chinese Taipei	Mt	5.31	7.09	7.72	8.04	6.39
France	Mt	4.11	3.89	3.33	3.44	3.06
Italy	Mt	1.93	2.53	2.26	2.29	2.25
United Kingdom	Mt	4.06	4.45	3.93	3.76	3.78
Other EU	Mt	12.40	13.79	14.82	15.39	15.42
India	Mt	13.58	17.44	16.39	19.61	24.23
Japan	Mt	41.38	44.96	44.22	48.86	50.23
Korea, Republic of	Mt	10.14	12.46	7.70	6.25	8.36
South Africa	Mt	1.28	1.88	1.53	1.45	1.36
Rest of world	Mt	10.13	9.13	12.54	16.86	16.47
Total	Mt	111.73	124.92	120.48	131.97	136.95
<b>Thermal coal</b>						
Chile	Mt	1.12	0.41	0.83	0.67	0.42
China	Mt	2.45	1.75	3.99	3.22	1.48
France	Mt	0.58	0.47	0.74	1.20	0.68
India	Mt	1.74	1.21	1.23	0.66	0.66
Japan	Mt	58.78	57.28	59.33	58.64	66.92
Korea, Republic of	Mt	16.22	17.95	20.24	15.06	18.53
Malaysia	Mt	2.53	3.37	2.77	3.54	2.40
Mexico	Mt	2.29	4.24	4.76	5.07	0.82
Spain	Mt	0.91	0.29	0.50	0.49	0.38
Chinese Taipei	Mt	9.89	14.33	13.21	16.23	18.56
Other EU	Mt	7.28	3.01	1.57	2.53	1.46
Rest of world	Mt	2.89	2.09	1.65	4.22	2.72
Total	Mt	106.69	106.40	110.82	111.62	115.05

Source: ABARE, Australian commodity statistics.

Chinese Taipei, India, Japan and the European Union. Over the same period, thermal coal exports increased by a relatively slower 1.9 per cent a year. This growth was mainly in the form of higher imports by Chinese Taipei, Japan and the Republic of Korea. Over the medium term, Australia's coal exports

are likely to increase significantly, underpinned by strong growth in steel-making and electricity generation capacity.

In 2007-08, earnings from Australian coal exports increased by 11 per cent because of higher volumes shipped and higher contract prices. Earnings from metallurgical coal exports are estimated to have increased by 5 per cent to \$15.8 billion and thermal coal export earnings by 23 per cent to \$8.3 billion. A detailed outlook for the metallurgical and thermal coal industries can be found in ABARE's quarterly journal *Australian commodities*.

## 20 Australian exports of coal

		2003-04	2004-05	2005-06	2006-07	2007-08
<b>Metallurgical coal, high quality</b>						
Volume	Mt	67.55	80.73	77.48	82.81	83.77
Value	\$m	4 883	8 447	12 986	11 384	10 720
Unit value	\$/t	72.29	104.63	167.59	137.47	127.96
<b>Metallurgical coal, excluding high quality</b>						
Volume	Mt	44.19	44.19	42.99	49.15	53.30
Value	\$m	2 441	3 368	5 108	4 166	5 074
Unit value	\$/t	55.23	76.21	118.81	84.75	95.19
<b>Total metallurgical coal</b>						
Volume	Mt	111.73	124.92	120.48	131.97	137.08
Value	\$m	7 323	11 814	18 094	15 550	15 794
Unit value	\$/t	65.54	94.58	150.18	117.83	115.22
<b>Thermal coal</b>						
Volume	Mt	106.69	106.40	110.82	111.62	114.85
Value	\$m	4 919	6 958	7 668	6 987	8 336
Unit value	\$/t	46.10	65.40	69.19	62.60	72.58

<sup>a</sup> Values are in 2007-08 Australian dollar terms.

Source: ABARE, *Australian commodity statistics*.

## Prices

Contract negotiations for the Japanese Fiscal Year (JFY) 2008 (1 April 2008 to 31 March 2009) resulted in prices for metallurgical coal (hard) and thermal coal increasing by 206 per cent and 125 per cent, respectively. Compared with four years ago (JFY 2008 versus JFY 2004), metallurgical coal and thermal coal contract prices have increased by 426 and 178 per cent, respectively.

Contributing to the large increase in metallurgical coal prices were strong global demand for metallurgical coal associated with growing steel production, combined with supply difficulties resulting from congested Australian coal export infrastructure and heavy rainfall in Queensland in early 2008. Similarly, increases in thermal coal contract prices stemmed from strong growth in coal-fired electricity generation in Asia and limited increases in export growth from major suppliers such as Australia, South Africa and China.

### 21 Coal prices <sup>a</sup>

	2004-05	2005-06	2006-07	2007-08	2008-09
<b>Metallurgical coal, hard</b>					
US\$/t	57.00	125.00	115.00	98.00	300.00
Real A\$/t	87.84	184.16	161.22	117.59	340.74
<b>Metallurgical coal, semi-soft <sup>b</sup></b>					
US\$/t	41.00	80.00	56.00	64.00	240.00
Real A\$/t	63.18	117.86	78.51	76.79	272.60
<b>Thermal coal</b>					
US\$/t	45.00	52.50	52.50	55.50	125.00
Real A\$/t	69.35	77.35	73.60	66.59	141.98

<sup>a</sup> Australian-Japanese prices. Japanese fiscal year beginning 1 April. Real prices are in 2007-08 Australian dollar terms. <sup>b</sup> Based on Australian/Japanese contract settlements.

Sources: International Energy Agency, Coal Information, OECD, Paris; ABARE, Australian commodity statistics.





## GAS PRODUCTION AND TRADE

Natural gas is becoming increasingly important for Australia, both as a source of export income and as a domestic energy source. Around 50 per cent of Australia's gas production is exported. In 2007-08, the value of Australian LNG exports was \$5.9 billion, an increase of 12 per cent from 2006-07. Natural gas is the third largest source of Australia's primary energy consumption, following coal and petroleum products. Since 1996-97, natural gas consumption in Australia has increased at an average rate of 3.5 per cent a year, compared with an average rate of 2.4 per cent for coal and 1.6 per cent for petroleum products.

### Production

Around 96 per cent of Australian conventional gas production is sourced from three petroleum basins; the Gippsland Basin (Victoria), Cooper-Eromanga Basin (central Australia) and the Carnarvon Basin (north-west Western Australia).

Western Australia is the largest producer of gas in Australia, accounting for nearly two-thirds of national production in 2007-08. The Carnarvon Basin accounts for 99 per cent of state gas production, with the North West Shelf accounting for a significant proportion of the Carnarvon Basin production. In total, Western Australian gas production was 1141 petajoules in 2007-08, an increase of 1.1 per cent on 2006-07 production. Despite this modest growth, gas production in Western Australia has grown at an average annual rate of 6.8 per cent over the past seven years.

In 2007-08, Victoria, the second largest gas producing state, accounted for around 20 per cent of Australia's natural gas production, or 312 petajoules. The majority (75 per cent) is sourced from the offshore Gippsland Basin. The offshore Otway and Bass Basins in south-west Victoria supply the remaining 25 per cent of gas into the Victorian market. Gas production in Victoria has been increasing at an annual average rate of 3.2 per cent over the past seven years.

Gas production in the Northern Territory totalled 22 petajoules in 2007-08. All of this production was sourced from the onshore Amadeus Basin

22 Australian gas production by state <sup>a</sup>

	2001	2002	2003	2004	2005	2006	2007
	-02	-03	-04	-05	-06	-07	-08
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
<b>Queensland</b>							
Conventional	21	26	25	28	26	22	17
Coal seam methane	16	26	33	37	57	81	122
Total	37	52	58	65	83	104	139
<b>Victoria</b>	259	253	301	301	288	298	312
<b>South Australia</b>	242	220	164	159	153	145	124
<b>Western Australia</b>	770	837	853	1 020	1 074	1 129	1 141
<b>Northern Territory</b>	19	18	17	19	20	22	22
<b>New South Wales</b>							
Coal seam methane	8	8	8	8	10	10	5
<b>Total Australia</b>	1 335	1 389	1 402	1 572	1 629	1 708	1 743

<sup>a</sup> Data converted from volume to energy content using average conversion factors as detailed in Appendix 2.

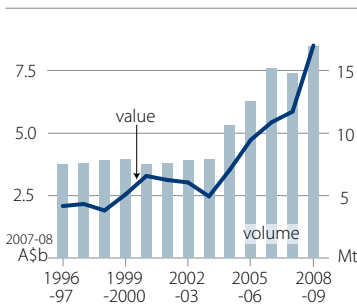
Conversion factor of 0.037 PJ per gigalitre has been used for all coal seam methane production.

Sources: RET; Energy Quest; Geoscience Australia; ABARE.

in central Australia. Gas production from the Amadeus Basin has been increasing at 2.3 per cent a year over the past seven years. The ENI Blacktip project will be the first offshore gas project to supply the Northern Territory market and is expected to commence production in early 2009.

Production of coal seam methane (CSM) has increased significantly in the past seven years with its share of total Australian gas production increasing from 2 per cent in 2001-02 to 7 per cent in 2007-08. CSM is only produced in Queensland and New South Wales, accounting for around 90 per cent and 100 per cent of total gas production, respectively. Production of CSM is expected to continue to grow with five projects planned in Queensland and another three in New South Wales. Accompanying these projects are five planned LNG plants in Queensland with a combined capacity of around 17 million tonnes, equivalent to the LNG capacity of the North West Shelf Joint Venture.

## Australian LNG exports



Source: ABARE, *Australian commodity statistics, Australian commodities*.

## Trade

The geographical distance between Australia and its key natural gas export markets prevents trade by conventional pipeline transport. Instead, by cooling the gas to  $-161^{\circ}$  Celsius, so that it becomes a liquid known as liquefied natural gas (LNG), its volume is reduced and this enables storage and transport. Australia's major LNG trading partners include Japan, Chinese Taipei, the Republic of Korea and China. With future expansions to Australia's LNG

capacity, LNG trade with countries such as India and the United States is likely.

Most of Australia's exports of natural gas are sourced from the Carnarvon Basin off the north-west coast of Western Australia, with the rest coming from Darwin. Australia's two producing LNG projects are the North West Shelf Joint Venture, and Conoco-Phillips Darwin LNG project. The North West Shelf Joint Venture began exporting in 1989, and in September 2008 reached a production capacity of 16.3 million tonnes a year after commissioning of the fifth LNG production train. The Darwin LNG project began production in 2006 and has a capacity of 3.5 million tonnes a year, sourcing its natural gas supply from the Bayu-Undan gas field in the Timor Sea.

Australia's LNG exports are forecast to increase by 15 per cent in 2008-09 as capacity is increased at the North West Shelf and the Darwin LNG plant returns to full capacity following a maintenance shutdown in 2007-08. As a result of increased exports and higher prices, the value of LNG exports is also forecast to increase in 2008-09.

LNG exports are expected to continue increasing over the next five years. Substantial growth in Australia's LNG production is planned over the medium term with the development of the Pluto LNG project, as well as the possibility of various LNG projects using CSM as a feedstock (Appendix 1).

## Prices

Domestic gas prices on the east coast, Australia's largest gas market, have increased significantly over the past eight years as demand for gas from households and power generators has increased. Over this period, wholesale gas prices in the Victorian spot market have increased at a real average annual rate of 2.9 per cent. Domestic gas prices have increased significantly since 2005-06 as water scarcity reduced the amount of electricity generated from coal-fired power plants, increasing demand for gas used in the generation of electricity.

LNG contract prices are generally indexed to world oil prices with higher world oil prices leading to higher LNG contract prices. Reflecting higher oil prices, LNG import prices have increased significantly over the past four years, with the prices of LNG imports in Japan, the Republic of Korea and the United

### 23 Gas Prices in 2007-08 dollars

	2000	2001	2002	2003	2004	2005	2006	2007
	-01	-02	-03	-04	-05	-06	-07	-08
Natural Gas <sup>a</sup> \$A/GJ	3.20	3.19	3.26	3.33	3.28	3.22	3.75	3.90
LNG <sup>b</sup> \$A/t	433.07	408.04	383.56	309.07	331.73	376.05	355.22	396.90

<sup>a</sup> Financial year average of daily spot prices in the Victorian gas market. <sup>b</sup> Export unit value.

Sources: ABARE, *Australian commodity statistics*; VENcorp.

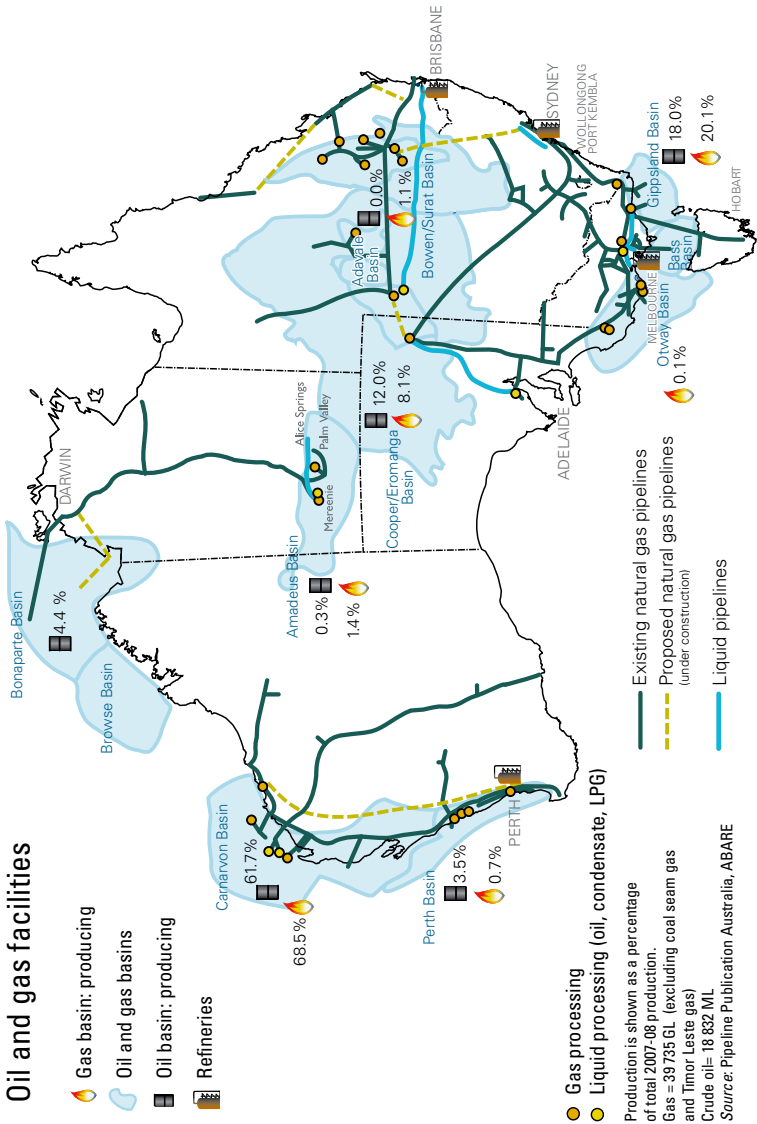
### 24 Asia Pacific LNG and Natural gas prices, 2007

	average	\$US/tonne
Australian exports	all destinations	217
Japan imports	from Australia	355
	all origins	401
Republic of Korea imports	all origins	510
United States imports	all origins	358
United States pipeline imports	all origins	345

Sources: International Energy Agency; ABARE, *Australian commodity statistics*.

States undergoing average annual growth of 14 per cent, 20 per cent and 7 per cent, respectively. Higher world LNG prices have led to a corresponding increase in Australia's average LNG export price. Between 2004-05 and 2007-08, Australian export prices increased by an average 18 per cent per annum. Despite this, the average Australian export price declined in 2006-07 reflecting increased shipments under lower priced contracts.

# Oil and gas facilities



# PETROLEUM PRODUCTION AND TRADE

Australia's crude oil production is equivalent to around 70 per cent of refinery feedstock, meaning Australia is a net importer of crude oil. Around 78 per cent of Australia's refined product consumption is sourced from domestic refineries. However, more than 60 per cent of Australia's crude oil production is exported, resulting in 70 per cent of refinery feedstock being sourced from imports. In contrast, Australia is a net exporter of LPG, exporting around 60 per cent of its annual LPG production.

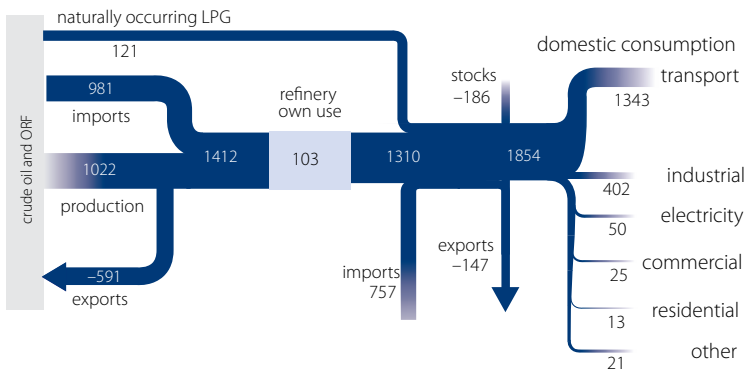
## Production

Australia's production of crude oil, condensate and LPG all decreased in 2007-08. Crude oil and condensate production combined decreased by 7 per cent in 2007-08, while LPG production decreased by 13 per cent. Crude oil and condensate production has experienced similar decreases over the past five years, excluding an increase of 17 per cent in crude oil and condensate production in 2006-07. In contrast, LPG production has remained relatively constant over the five years prior to 2007-08.

Australia's largest petroleum producing basins are the Carnarvon Basin in the north-west of Australia and the Gippsland Basin in the Bass Strait. While production from the Carnarvon Basin is mostly exported, production

### Australian oil and LPG flows, 2006-07

units: petajoules



Source: ABARE, Australian energy statistics.

25 Australian production of primary petroleum, by basin

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML	ML
<b>Crude oil</b>						
Adavale	2	0	0	0	0	0
Amadeus	59	136	132	53	55	50
Bonaparte	4 806	3 037	1 868	1 403	1 470	826
Bowen-Surat	27	28	24	23	21	16
Canning	4	3	2	2	2	4
Carnarvon						
Barrow Island	547	502	448	390	390	2 849
North West Shelf	8 842	8 564	7 859	4 524	5 850	4 063
Other	4 284	3 688	3 831	5 854	7 044	4 710
Cooper-Eromanga						
Queensland	450	387	529	432	791	901
South Australia	413	445	401	489	1 116	1 354
Gippsland	6 937	6 019	4 647	3 681	3 850	3 392
Otway	0	0	0	0	0	0
Perth	119	387	517	395	816	668
Total	26 492	23 198	20 259	17 247	21 405	18 832
<b>Condensate</b>						
Adavale	1	0	0	0	0	0
Amadeus	0	0	0	0	0	0
Bonaparte	0	46	307	394	394	33
Bowen-Surat	12	15	23	20	21	19
Canning	0	0	0	0	0	0
Carnarvon						
Barrow Island	349	203	120	0	8	0
North West Shelf	6 686	5 840	5 041	5 265	5 692	5 572
Other	101	142	250	202	134	143
Cooper-Eromanga						
Queensland	239	242	270	205	167	163
South Australia	349	176	221	208	239	193
Gippsland	769	836	813	770	744	804
Otway	23	13	7	3	2	28
Perth	2	1	1	2	3	2
Total	8 532	7 515	7 052	7 069	7 404	6 957



25 Australian production of primary petroleum, by basin *continued*

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML	ML
<b>Liquefied petroleum gas</b>						
Adavale	0	0	0	0	0	0
Amadeus	0	0	0	0	0	0
Bonaparte	0	0	0	0	0	0
Bowen-Surat	18	20	24	23	24	24
Canning	0	0	0	0	0	0
Carnarvon						
Barrow Island	0	0	0	0	0	0
North West Shelf	1 911	1 817	1 963	2 160	2 067	1 500
Other	0	0	0	0	0	0
Cooper-Eromanga						
Queensland	0	0	0	0	0	0
South Australia	783	827	663	597	551	557
Gippsland	1 970	1 976	1 977	1 942	1 908	1 883
Otway	0	0	0	0	0	6
Perth	0	0	0	0	0	0
Total	4 682	4 639	4 628	4 722	4 550	3 971

Source: RET, Australian petroleum statistics.

from the Gippsland Basin in south-eastern Australia is predominantly used in domestic refining. The Carnarvon Basin currently accounts for 62 per cent of Australia's production of crude oil, condensate and LPG. Production from the Gippsland Basin peaked in the mid-1980s and has declined steadily since. The Gippsland Basin now constitutes 18 per cent of Australia's total production of crude oil, condensate and LPG.

## Trade

Australia is a net importer of crude oil and refined petroleum products but a net exporter of LPG. In 2007-08, Australia imported 26 222 million litres of refinery feedstock (crude oil and condensate). The high proportion of imports as a share of total production reflects a significant proportion of Australia's oil production being located off the north-west coast, which

## 26 Major Australian listed oil and gas companies and their resources

company	ASX code	market capitalisation April 2009 A\$b	proved plus probable mboe
BHP Billiton	BHP	114.1	321
Woodside	WPL	27.8	1227
Origin	ORG	13.3	989
Santos	STO	10.2	879
Oil Search	OSH	6.2	74
Arrow Energy	AOE	2.0	200
Australian Worldwide Exploration	AWE	1.4	53
Beach Petroleum	BPT	0.9	145
Karooon	KAR	0.5	1230
Roc Oil	ROC	0.3	21
Nexus Energy	NXS	0.2	122
AED Oil	AED	0.2	na

Note: Mboe = million barrels oil equivalent.

Source: Annual reports of listed companies.

is closer to Asian refineries rather than domestic refineries on the east coast. Conversely, the majority of refinery capacity is located close to the major consumption markets on the east coast in Queensland, New South Wales and Victoria. In 2007-08, Australia was a net exporter of LPG. Japan is Australia's largest market for LPG, accounting for around 60 per cent of Australia's LPG exports.

Since the mid-1990s, Australia's imports of crude oil from the Middle East have been gradually declining. Instead, crude oil has been increasingly sourced from South East Asia. Viet Nam is currently the largest source for Australian crude oil and condensate imports. In 2007-08, Australia imported 6317 million litres of crude oil and condensate from Viet Nam, while 4275 million litres were imported from the Middle East.

Despite being a net importer, Australia also exports significant quantities of crude oil and condensate, with exports of 15 975 million litres in 2007-08. Around 65 per cent of Australia's crude oil and condensate is exported

to the Asian region, mostly to the Republic of Korea, Singapore and Japan. Australia's exports of petroleum products are less significant; amounting to 1807 million litres of petroleum products in 2007-08. Around 46 per cent of these exports were destined for New Zealand and another 28 per cent were destined for Singapore.

Reflecting higher prices and stable export volumes, the value of crude oil and condensate exports increased by 26 per cent in 2007-08. Similarly, the value of exports of refined petroleum products increased by 20 per cent in 2007-08.

## 27 Australian imports of petroleum, by source

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML	ML
<b>Crude oil and other refinery feedstock</b>						
Indonesia	5 380	4 012	3 328	3 929	3 391	3 239
Malaysia	2 299	4 073	4 761	3 976	3 730	4 202
New Zealand	990	708	663	638	635	1 974
Other Middle East	334	42	158	199	118	43
Papua New Guinea	1 683	1 189	1 717	2 386	2 059	2 190
Qatar	191	0	77	0	106	0
Saudi Arabia	3 680	1 517	3 101	1 602	1 151	573
Singapore	719	596	652	829	841	713
United Arab Emirates	2 294	2 207	1 917	863	2 971	3 659
Viet Nam	6 699	5 778	6 560	6 708	6 677	6 317
Other	3 690	3 375	3 122	3 286	3 665	3 311
<b>Total</b>	<b>27 958</b>	<b>23 498</b>	<b>26 054</b>	<b>24 416</b>	<b>25 345</b>	<b>26 222</b>
<b>Refined products</b>						
Indonesia	57	281	162	98	17	11
Korea, Rep. of	144	280	237	961	821	794
Malaysia	45	97	93	220	8	316
Middle East	140	1 036	588	691	642	1 047
New Zealand	17	3	4	84	96	40
Singapore	2 832	5 904	7 395	8 452	7 681	10 257
United States	407	434	423	456	378	421
Other	1 855	3 370	2 334	2 926	3 099	3 961
<b>Total</b>	<b>5 497</b>	<b>11 405</b>	<b>11 236</b>	<b>13 887</b>	<b>12 742</b>	<b>16 848</b>

Source: ABARE, Australian commodity statistics.

## 28 Australian exports of petroleum, by destination

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML	ML
<b>Quantity</b>						
<b>Crude oil and other refinery feedstock</b>						
China	1 699	2 389	732	404	518	972
Chinese Taipei	580	125	916	346	446	343
Japan	3 402	2 079	1 927	2 201	1 957	2 280
Korea, Rep.of	4 012	3 778	2 787	2 725	3 873	3 701
New Zealand	784	722	1 425	465	1 045	600
Singapore	6 567	3 948	2 861	3 110	3 752	3 089
United States	2 944	1 808	1 154	297	190	1 157
Other	962	2 677	3 929	3 478	4 183	3 833
<b>Total</b>	<b>20 950</b>	<b>17 526</b>	<b>15 731</b>	<b>13 026</b>	<b>15 965</b>	<b>15 975</b>
<b>Liquefied petroleum gas</b>						
China	154	696	598	393	308	465
Japan	2 783	2 109	2 081	2 142	1 821	1 587
Korea, Rep.of	234	0	81	0	384	178
Other	23	111	84	264	311	359
<b>Total</b>	<b>3 194</b>	<b>2 916</b>	<b>2 844</b>	<b>2 800</b>	<b>2 824</b>	<b>2 589</b>
<b>Refined products</b>						
Fiji	384	122	7	62	4	3
Japan	26	29	53	74	84	71
New Zealand	1 250	827	1 113	716	872	837
Singapore	246	127	471	771	576	505
Other Pacific	861	776	156	274	131	275
United States	99	123	0	37	6	3
Other	292	482	63	168	90	113
<b>Total</b>	<b>3 159</b>	<b>2 488</b>	<b>1 864</b>	<b>2 102</b>	<b>1 762</b>	<b>1 807</b>

Source: ABARE, Australian commodity statistics.

## 29 Value of Australian trade in petroleum

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	\$m	\$m	\$m	\$m	\$m	\$m
<b>Exports</b>						
Automotive gasoline	367	280	339	419	468	443
Diesel fuel	366	292	166	238	188	363
Aviation turbine fuel	228	172	108	80	74	120
Fuel oil	29	21	51	215	84	130
Aviation gasoline	29	20	26	54	69	73
Kerosene	0	0	0	0	0	0
Lubricants	141	100	112	139	157	152
Other products	39	33	41	52	57	41
Total refined products	1 198	918	844	1 195	1 098	1 321
Liquefied petroleum gas	855	647	804	1 002	1 038	1 182
Bunkers	775	696	951	1 322	1 295	1 457
Crude oil and other refinery feedstock	6 402	5 055	6 330	6 638	8 317	10 487
Liquefied natural gas	2 607	2 174	3 199	4 416	5 222	5 854
<b>Imports</b>						
Automotive gasoline	569	1 168	1 463	2 342	1 872	2 719
Diesel fuel	561	1 134	1 933	4 071	3 466	6 160
Aviation turbine fuel	146	220	483	527	668	1 505
Fuel oil	180	313	364	569	536	831
Lubricants	190	206	288	418	495	477
Liquefied petroleum gas	76	166	143	198	261	436
Other products	328	388	448	637	1 285	1 331
Total refined products	2 050	3 595	5 123	8 761	8 583	13 459
Crude oil and other refinery feedstock	8 610	6 594	9 995	12 820	13 360	17 059

Source: ABARE, Australian commodity statistics.

## Prices

In December 2008, oil prices in World Trade Weighted Average terms traded at US\$40 a barrel, prices not seen since late 2004. In the first half of 2008, world oil prices averaged US\$112 a barrel and were supported by growing world oil demand, weak non-OPEC output and speculative demand for commodities. Since oil prices peaked at US\$147 a barrel in July 2008, they have fallen by 70 per cent and are estimated to have averaged US\$86 a barrel in the second half of 2008 and US\$57 a barrel in the December quarter.

The rapid fall in oil prices has been caused by falling demand. This fall in demand has been driven by two factors. First, consumption fell in response to record high prices. Second, consumption was affected by the global financial crisis, which led to slower economic growth in most developing economies and recession in many countries, including the United States and Japan. For 2008 as a whole, oil prices averaged around US\$98 a barrel, an increase of 40 per cent compared with 2007.

### Oil price

World average trade weighted prices, quarterly, ended December 2008



Source: ABARE, Australian commodity statistics.

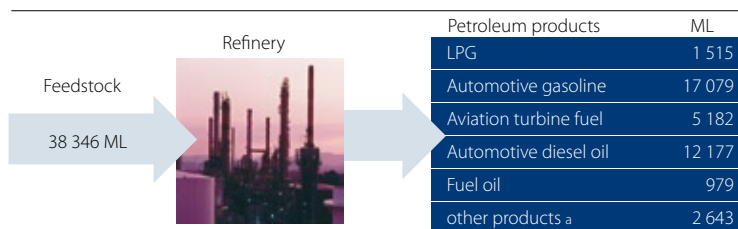
# LIQUID FUELS REFINING AND PRICING

In 2007-08, Australia's consumption of refined liquid fuels totalled around 50 788 million litres. Domestic production of refined liquid fuels totalled around 39 575 million litres (around 78 per cent of consumption), while imports totalled 17 982 million litres. Australian exports of refined liquid fuels were around 2169 million litres in 2007-08, equal to about 5 per cent of production. Australian consumption of refined petroleum products has increased at an average rate of 2 per cent a year over the past 10 years, driven by growth in the transport sector, which accounts for the vast majority of refined liquid consumption.

## Production

The petroleum refining industry in Australia produces a wide range of petroleum products such as gasoline, diesel, aviation turbine fuel and LPG, which are derived from crude oil and condensate feedstock. In 2007-08 Australian refineries consumed 38 346 million litres of crude oil and condensate, of which imports accounted for around 68 per cent (62 per cent of Australia's crude oil and condensate production is exported). In 2007-08, Australian refinery production increased by 2 per cent. The majority of this increase was a result of the higher production of diesel, which increased by 10 per cent in 2007-08, offsetting a 4 per cent fall in gasoline production.

### Australian refinery input and production, 2007-08



<sup>a</sup> Includes aviation gasoline, kerosene, industrial and marine diesel, lubricating oils, greases and basestocks, bitumen and refinery fuels.  
Source: RET, Australian petroleum statistics.

## 30 Australian production of refined petroleum products

	2003-04	2004-05	2005-06	2006-07	2007-08
	ML	ML	ML	ML	ML
Automotive gasoline	17 375	17 668	16 528	17 732	17 079
Automotive diesel oil	12 544	12 661	10 154	11 055	12 177
Aviation turbine fuel	4 964	5 275	5 216	5 332	5 182
Fuel oil	1 105	1 078	1 048	942	979
Liquefied petroleum gas	1 062	974	1 125	1 387	1 515
Industrial and marine diesel fuel	84	22	31	21	3
Bitumen	678	1 081	831	1 356	1 452
Lubricants	259	202	163	146	121
Aviation gasoline	114	140	119	119	119
Heating oil	118	106	102	86	102
Other products <sup>a</sup>	882	994	959	618	845
Total products	39 186	40 202	36 274	38 795	39 575

<sup>a</sup> Includes biproducts of petrochemical downstream processing.

Source: RET, Australian petroleum statistics.

## Capacity

There are seven major petroleum refineries currently operating in Australia, which are managed by four companies – BP, Caltex, Mobil and Shell. These seven refineries have a combined capacity of 42 720 million litres a year. The largest of these are BP's Kwinana refinery in Western Australia and Caltex's Kurnell refinery in New South Wales. An eighth refinery at Port Stanvac in South Australia ceased producing in 2003 and is currently under care and maintenance.

Fuel quality standards are progressively being increased in Australia with the aim of reducing emissions from fuel use. In 2008, gasoline standards requiring a maximum sulphur content of 50 parts per million were implemented. The diesel quality standard has been revised as of 1 January 2009 to a maximum sulphur content of 10 parts per million. Australian refineries have recently undertaken upgrades to meet these standards.

In the Asia Pacific region, many countries have also implemented stricter fuel quality standards in response to environmental concerns resulting from rapidly increasing gasoline and diesel consumption. For example, China,



## 31 Australian refinery capacity

	operator	year commissioned	capacity MLpa
<b>New South Wales</b>			
Clyde	Shell	1928	4 930
Kurnell	Caltex	1956	7 540
<b>Queensland</b>			
Bulwer Island	BP	1965	5 110
Lytton	Caltex	1965	6 270
<b>South Australia</b>			
Port Stanvac <sup>a</sup>	Mobil	1963	(4 520)
<b>Victoria</b>			
Altona	Mobil	1949	4 530
Geelong	Shell	1954	6 380
<b>Western Australia</b>			
Kwinana	BP	1955	7 960
<b>Total <sup>b</sup></b>			<b>42 720</b>

<sup>a</sup> The Port Stanvac refinery ceased production in July 2003. <sup>b</sup> Total of currently operating refineries. MLpa Megalitres per annum.

Sources: Australian Institute of Petroleum, *Downstream petroleum 2007*.

32 Fuel standards  
at 1 January 2009

	sulphur content (ppm)	
	gasoline	diesel
Australia	50	10
New Zealand	50	50
Japan	10	10
Singapore	50	50
Malaysia	500	500
Thailand	150	350
Indonesia	500	500
China	150	350
India	150	50

Sources: Australian Institute of Petroleum, *Downstream petroleum 2007*, RET.

India and Thailand reduced maximum sulphur levels in gasoline to 150 parts per million during 2008, from more than 500 parts per million.

Non-conventional liquid  
fuels

Coal to liquids (CTL) and gas to liquids (GTL) are two alternatives to petroleum fuels that are currently being developed in Australia.

CTL is the process of converting coal, by either a hydrogenation or

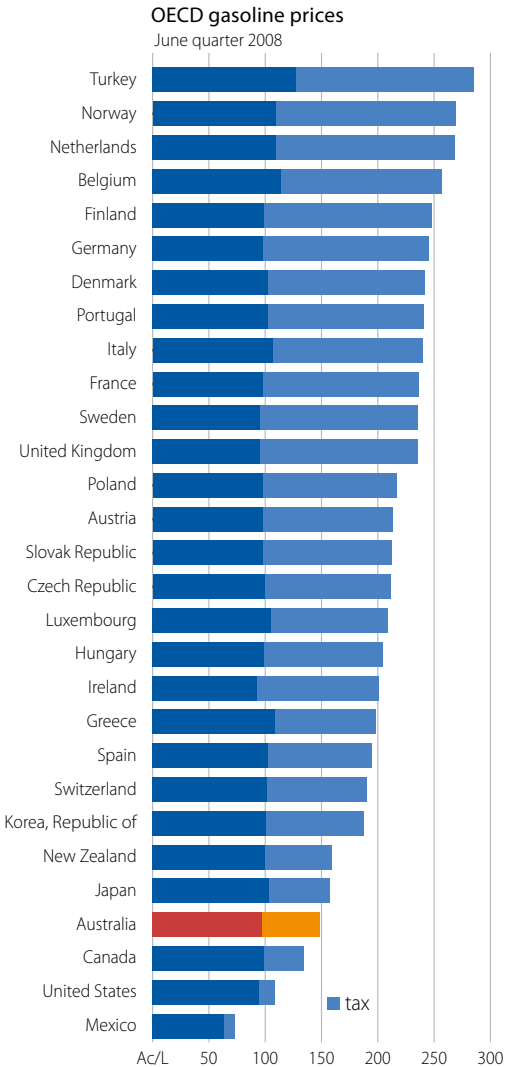
carbonisation process, into a liquid fuel. Coal can also be converted into a liquid fuel by first converting it into a gas (syngas) and then converting the syngas into a hydrocarbon which is processed into a liquid fuel. GTL is the process of converting either natural gas or refineries' waste gas into liquid fuels.

Several proposed CTL projects are expected to come on line over the next few years. Linc Energy has completed construction of a five barrels a day CTL demonstration plant in Queensland. The demonstration plant will produce liquid fuel from syngas produced by an underground coal gasification process, in which coal is converted into a gas in the coal seam. Monash Energy is currently undertaking feasibility studies for a 62 000 barrels a day CTL plant in the Latrobe Valley in Victoria. The plant is planned

### 33 Liquid biofuels production facilities in Australia

location	capacity ML/yr	feedstocks
<b>Fuel ethanol</b>		
Manildra Group, Nowra, NSW	180	Waste wheat starch, some low grade grain
CSR Distilleries, Sarina, QLD (North Queensland)	38	Molasses
Dalby Biorefinery, Dalby, QLD (started production November 2008)	90	Grain sorghum
<b>Biodiesel</b>		
Biodiesel Industries Australia, Maitland, NSW	20	Used cooking oil, vegetable oil
Eco-Tech Biodiesel, Narangba, QLD	30	Tallow, used cooking oil
Biodiesel Producers Limited, Wodonga, VIC	60	Tallow, used cooking oil
Smorgon Fuels, Melbourne, VIC	25	Tallow, used cooking oil, vegetable oil

Sources: Media releases, company websites and direct communication with companies.



Source: RET, Australian petroleum statistics.

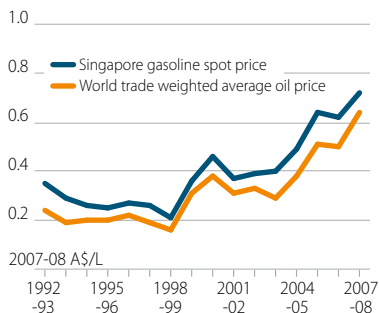
to produce liquid fuels from low grade brown coal and would include the capture and storage of carbon dioxide emissions in geological formations in the Bass Strait.

Liquid biofuels, comprising fuel ethanol and biodiesel, are another alternative to petroleum fuels. There are currently three major fuel ethanol production facilities in Australia with a combined capacity of just over 300 million litres a year. These facilities produce ethanol primarily from wheat starch, wheat, grain sorghum and molasses.

There are four major biodiesel production facilities in Australia, with additional facilities producing small quantities. Total biodiesel production is approaching 100 million litres a year. Biodiesel facilities in Australia use a range of vegetable oils and animal fats as feedstocks, which are selected according to price and availability. The limited availability of low priced

## Liquid fuels refining and pricing

### Petrol price indicators



Source: Energy Information Administration;  
ABARE, Australian commodity statistics.

market. Around 60 per cent of Australia's imports of refined petroleum products are sourced from Singapore. In 2007-08 the Singapore gasoline spot price increased by 16 per cent (in real terms) to average A\$0.72 a litre. This was a more subdued increase than that in the World Trade Weighted average price of crude oil, which increased by 30 per cent in 2007-08.

feedstocks has been a constraining factor for the expansion of the Australian biofuels industry.

### Prices

The pre-tax component of Australian gasoline prices remains among the lowest in the OECD and the tax-inclusive gasoline price is the fourth lowest, following the United States and Canada.

Australian wholesale gasoline and diesel prices closely follow movements in Singapore prices, as Singapore is the major competitor for these products in the Australian

# TRANSPORT AND INFRASTRUCTURE

The transport sector is the largest user of final energy in Australia. Around 34 per cent of Australia's final energy use is employed moving people and goods across the country. Being a large continent characterised by major population centres located along the coastline, significant amounts of freight are transported long distances. The transportation sector is the largest consumer of liquid fuels (including LPG and refined products) accounting for 72 per cent of Australia's total use.

## Energy consumption

Road transport is the largest user of final energy in the transport sector, accounting for around three-quarters of the sector's fuel consumption. Growth in road transport fuel consumption has slowed over the past 30 years, from almost 5 per cent a year to less than 2 per cent a year.

Passenger vehicles account for the majority of fuel consumption in the road transport sector. In 2005-06, 61 per cent of the fuel consumed in the road transport sector was in passenger vehicles.

Air transportation has been the fastest growing mode of transport in Australia. Growth in the consumption of aviation fuels averaged 6 per cent a year during the 1990s, compared with an average of 3 per cent during the previous decade. The majority of this growth was driven by increased

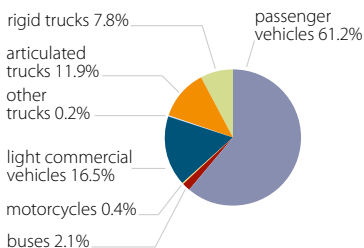
### 34 Energy consumption in the transport sector <sup>a</sup>

	1979-80	1989-90	1999-00	2004-05	2006-07
	PJ	PJ	PJ	PJ	PJ
Road transport	611.8	811.4	980.4	1 044.4	1 014.1
Railway transport	31.0	30.7	33.3	38.4	35.8
Water transport	97.6	55.6	55.6	58.2	67.0
Air transport	80.6	108.6	184.6	178.4	217.8
Other	3.6	6.2	12.8	22.4	24.6
Total	824.6	1012.5	1 266.7	1 341.8	1 359.3

<sup>a</sup> Net energy consumption (defined as total fuel input less energy produced).

Source: ABARE, *Australian energy statistics*.

### Australian road fuel consumption by type of vehicle, 2005-06



Source: Apelbaum Consulting Group, *Australian transport facts*.

international aviation, which now accounts for the majority of the air transportation sector's fuel consumption.

The increase in international air transportation has been at the expense of international sea transportation. As such, energy use in water transport has declined steadily over the past 30 years.

Automotive gasoline is the main fuel used in the transportation industry, accounting for around 48 per cent of total energy consumption in the sector.

The phasing out of leaded automotive gasoline, starting in 1986 using pricing differential incentives, was completed in 2001. Over the same period, the consumption of automotive LPG, free of fuel excise tax, grew by an average of 13 per cent a year. LPG suffered a temporary decline in demand when a phasing in of taxes on excise exempt fuels was announced. Demand recovered with the reintroduction of subsidies on LPG conversions in the Australian Government's LPG Vehicle Scheme to promote the use of cleaner burning fuels.

## Fuel efficiency

Buses are the most fuel efficient mode of passenger transportation, travelling around 670 passenger kilometres for every gigajoule of energy consumed. Buses account for only a small proportion of Australian road fuel consumption.

Domestic shipping is the most fuel efficient form of freight transportation, travelling around 6 kilometres per 1000 tonnes of cargo for every gigajoule of energy consumed. This is closely followed by freight rail, travelling 4.8 kilometres per 1000 tonnes of cargo for every gigajoule of energy consumed.

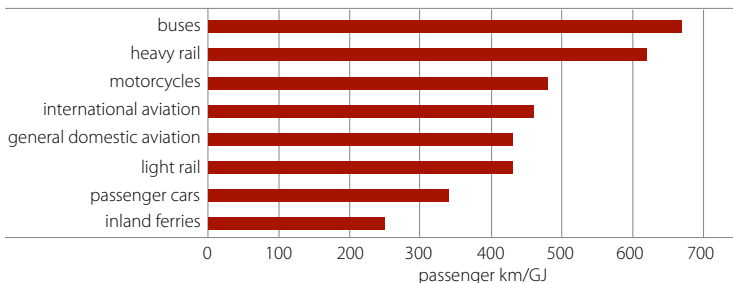
## 35 Energy use in Australian transport sectors by fuel type, 2006-07

	sea		air		road	rail	other
	domestic	international	domestic	international			
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Black coal	5.2						
Aviation \ gasoline			3.0				
Aviation turbine fuel			80.3	134.5			
LPG					61.4		
Diesel	18.4	4.6			300.8	27.7	6.4
Fuel oil	7.1	31.6					
Natural gas	0.1				1.4		16.7
Electricity						8.1	1.4
Auto gasoline-unleaded					650.2		
Energy consumption	30.8	36.2	83.3	134.5	1013.9	35.8	24.5

Source: ABARE, Australian energy statistics.

### Passenger vehicle fuel efficiency in Australia, 2005-06

passenger kilometres travelled using 1 GJ of energy a

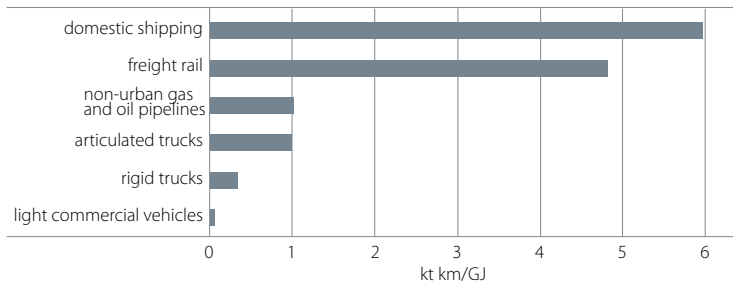


a Full fuel cycle basis.

Source: Apelbaum Consulting Group, *Australian transport facts 2008*.

### Freight fuel efficiency in Australia, 2005-06

kilometres travelled per thousand tonnes of cargo using 1 GJ of energy a



a Full fuel cycle basis.

Source: Apelbaum Consulting Group, *Australian transport facts 2008*.



### 36 Export loadings at major petroleum ports, 2006-07

Oil and petroleum <sup>a</sup>	Mt
Fremantle, WA	2.36
Brisbane, QLD	2.20
Geelong, VIC	1.83
Hastings, VIC	1.10
Sydney, NSW	0.93
Melbourne, VIC	0.23
Darwin, NT	0.06
Broome, WA	0.03
Cairns, QLD	0.03
Gas	
Dampier, WA	4.55
Hastings, VIC	0.46
Sydney, NSW	0.17
Brisbane, QLD	0.05
Fremantle, QLD	0.05
Melbourne, VIC	0.01

<sup>a</sup> Includes crude oil, oil products, condensate, petroleum products and refined petroleum.  
Source: Association of Australian Ports & Marine Authorities.

### Port capacities

The ability to import and export energy in Australia is heavily dependant on the capacity of major ports. Australia has nine major coal exporting terminals located in New South Wales and Queensland. In 2007-08, these ports had a combined capacity of more than 330 million tonnes and loaded around 255 million tonnes of coal. Australian ports did not operate at capacity in 2007-08 for a number of reasons including the temporary closure of some capacity for expansion work and weather related incidents.

Infrastructure capacity constraints (including port and rail) have limited the Australian coal industry's ability to respond to growing global demand over the past few years. However, recent additions to capacity, together with more expansions planned over the short to medium term will help alleviate these constraints. As at October 2008, there

were 11 coal infrastructure projects (including both port and rail) at an advanced stage of development with a combined capital cost of around \$4.2 billion. The seven advanced port infrastructure projects will add a combined 116 million tonnes to annual capacity. There were a further 19 coal infrastructure projects at less advanced stages of planning (see Appendix 1).

Australia has 11 major deepwater ports which have facilities to export petroleum liquids. The ports at Fremantle and Dampier in Western Australia are Australia's largest exporting centres of oil and petroleum and gas, respectively. 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.

### 37 Export loadings and capacity for major coal ports

	loadings 2007-08 Mt	capacity 2007-08 Mtpa	short term capacity Mtpa	medium term capacity Mtpa
<b>New South Wales</b>				
Newcastle <b>a</b>	89	102	113	157
Port Kembla	13	16	16	16
<b>Queensland</b>				
Abbot Point	12	21	25	110
Brisbane	6	6	9	9
Dalrymple Bay	44	68	85	85
Gladstone <b>b</b>	54	75	75	100
Hay Point	37	44	44	55

**a** Includes Carrington and Kooragang Island. **b** Includes RG Tanna and Barney Point.

Sources: McCloskey, Ports Corporation of Queensland, Port Waratah Coal Services, Port Kembla Coal Terminal, Gladstone Ports Corporation.

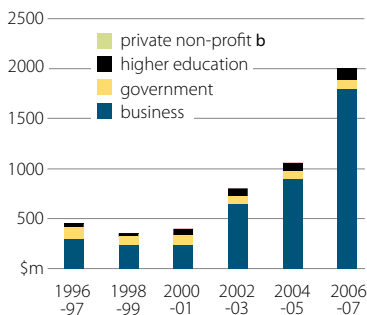
# ENERGY RESEARCH AND DEVELOPMENT

Expenditure on research and development (R&D) in energy represented nearly 10 per cent of total Australian R&D expenditure in 2006-07. Spending on energy R&D increased significantly, from \$828 million in 2002-03 to \$2 billion in 2006-07.

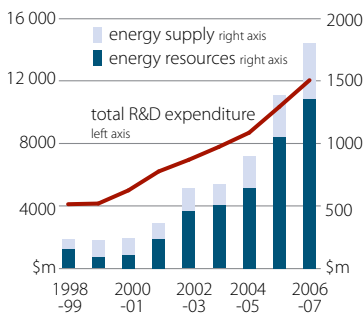
In Australia, the majority of R&D in energy is undertaken by private businesses. Australian businesses spent \$1.8 billion on energy R&D in 2006-07, representing 90 per cent of total energy R&D expenditure in Australia. Australian and state governments invested 4 per cent of total energy R&D expenditure and another 6 per cent was invested by higher education organisations. The share of business expenditure in total energy R&D expenditure has increased from 80 per cent in 2002-03, while the share of government expenditure has decreased from 11 per cent in 2002-03. The share of higher education organisations expenditure in total energy R&D has decreased from 9 per cent in 2002-03.

Fifteen per cent of total R&D expenditure by Australian businesses is devoted to energy developments. An increasing proportion of business R&D expenditure has been devoted to energy over the past five years. In 2002-03, the share of energy R&D in total business R&D spending was 9 per cent.

Energy R&D expenditure, by sector a



Business R&D expenditure a

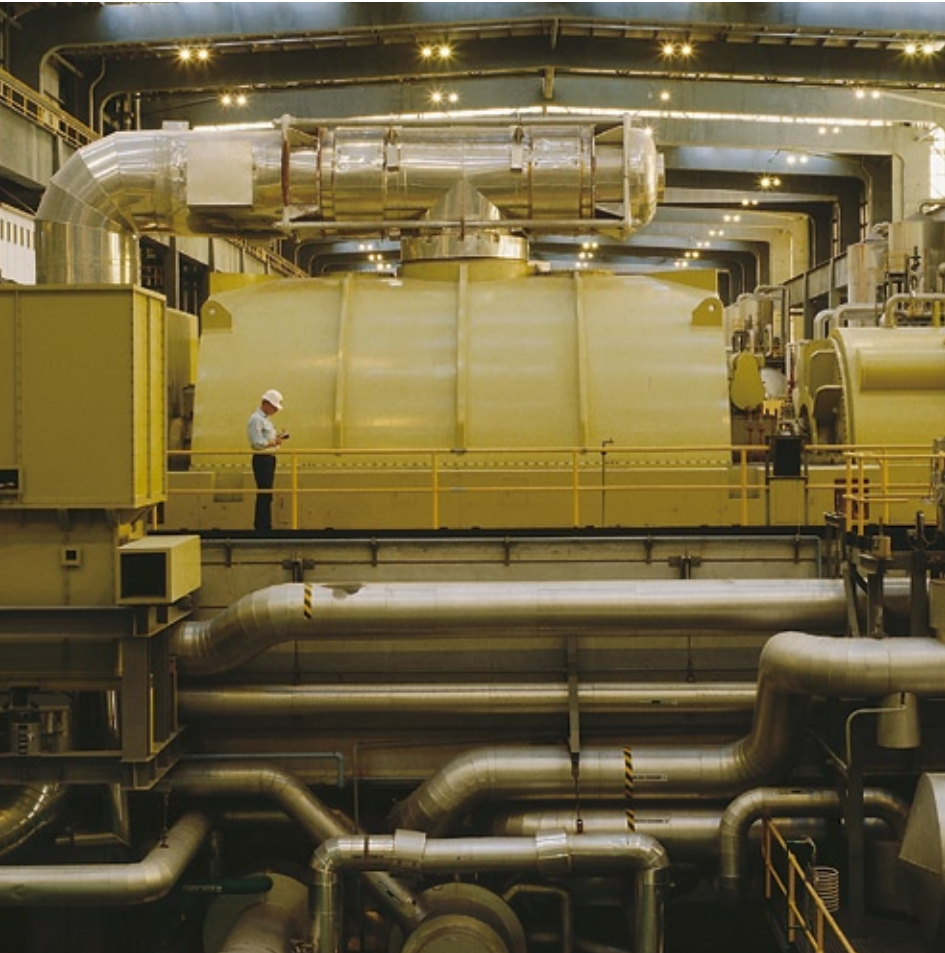


a Data from 1996-97 to 2000-01 is not directly comparable to data from 2002-03 onwards because of an increase in the coverage of the ABS survey of energy R&D. b Less than \$0.2m.

Source: ABS, Research and experimental development, cat. no. 81120 and 81040.

## Energy Research and Development

In 2006-07, one-quarter, or \$442 million, of business expenditure on energy R&D was spent on developments in the supply of energy. This includes R&D in energy production and transmission and distribution of energy to end users. Another \$1.4 billion was spent on R&D in energy resources, which includes development of new fuel sources and innovation in energy extraction.



### 38 Proposed new power stations and expansions <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Black coal Bluwaters stage 1	Griffin Energy	5 km NE of Collie, WA	New project, under construction	late 2008	208MW	\$400m
Bluwaters stage 2	Griffin Energy	5 km NE of Collie, WA	Expansion, under construction	2009	208MW	\$400m
CSM Braemar 2	ERM Power/ Arrow Energy	40 km W of Dalby, QLD	Expansion, under construction	2009	450MW	\$546m
Condamine	QLD Gas Company & ANZ Infrastructure Services	8 km E of Miles, QLD	New project, under construction	2009	140MW	\$170m
Darling Downs	Origin Energy	40 km W of Dalby, QLD	New project, under construction	late 2009	630MW	\$951m (inc pipeline)
Gas Colongra gas project	Delta Electricity	Munmorah, NSW	New project, under construction	late 2009	660MW	\$500m
Kwinana	Perth Energy	30 km S of Perth, WA	New project, committed	na	120MW	\$120m
Mortlake Stage 1	Origin Energy	12 km W of Mortlake, VIC	New project, committed	2010	550MW	\$640m

38 Proposed new power stations and expansions <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Neerabup	Babcock and Brown Power/ERM	50 km N of Perth, WA	New project, under construction	2009	330MW	\$425m
NewGenKwinana	Babcock and Brown Power/ERM	30 km S of Perth, WA	New project, under construction	late 2008	330MW	\$400m
Newman	Babcock and Brown Power	Newman, WA	Expansion, under construction	2009	37MW	\$90m
Owen Springs	Power and Water Corporation	25 km S of Alice Springs, NT	New project, under construction	2009	22MW	\$80m
Quarantine Expansion	Origin Energy	20 km NE of Adelaide, SA	Expansion, under construction	2008	120MW	\$86m
Tallawarra Stage 1	TRUenergy	13 km S of Wollongong, NSW	New project, under construction	early 2009	400MW	\$350m
Tamar Valley	Aurora Energy	Bell Bay, TAS	New project, under construction	early 2009	375MW	\$464m
Uranquinty	Origin Energy	15 km SW of Wagga Wagga, NSW	New project, under construction	2009	640MW	\$700m
Weddell stage 2	Power and Water Corporation	40 km SE of Darwin, NT	Expansion, under construction	late 2008	40MW	na
Oil Mount Stuart	Origin Energy	Townsville, QLD	Expansion, under construction	2009	126MW	\$92m

## 38 Proposed new power stations and expansions <sup>a</sup>

## Current and proposed energy projects

project	company	location	status	expected startup	new capacity	capital expend.
Wind Capital Wind Farm	Renewable Power Ventures	50 km NE of Canberra, NSW	New project, under construction	2009	132MW	\$220m
Crowlands Wind Farm	Pacific Hydro	30 km NE of Ararat, VIC	New project, under construction	2009	172MW	\$360m
Cullerin Range Wind Farm	Origin Energy	30 km W of Goulburn, NSW	New project, under construction	mid-2009	30MW	\$90m
Hallett 2	Energy Infrastructure Trust	20 km from Burra, SA	Expansion, under construction	2010	71MW	\$159m
Portland stage 2	Pacific Hydro	Cape Bridgewater, VIC	New project, commissioning under way	late 2008	58MW	\$130m
Portland stage 3	Pacific Hydro	Cape Nelson South, VIC	New project, under construction	mid-2009	44MW	na
Waubra Wind Farm	Acciona Energy	35km NW of Ballarat, VIC	New project, under construction	2009	192MW	€238m (A\$400m)
Hydro Bogong Power Development	AGL	300 km NW of Melbourne, VIC	New project, under construction	late 2009	140MW	\$230m
Biomass Broadwater	Delta Electricity	20 km SW of Ballina, NSW	New project, under construction	late 2008	30MW	\$105m
Condong	Delta Electricity	5 km NW of Murwillumbah, NSW	New project, under construction	late 2008	30MW	\$105m

<sup>a</sup> Summary of projects classified as committed for proposed projects please refer to source. Source: ABARE, Electricity generation - major development projects, October 2008 listing. Available at [http://www.abare.gov.au/publications\\_html/energy/energy\\_08/energy\\_08.html](http://www.abare.gov.au/publications_html/energy/energy_08/energy_08.html)

## 39 Renewable power generators in Australia, 2007

	state	owner	capacity kW
<b>Bagasse</b>			
Pioneer 2	QLD	CSR Sugar Mills	68 000
Invicta	QLD	CSR Sugar Mills	39 000
Rocky Point	QLD	National Power and Babcock and Brown JV	28 000
Tully	QLD	Independent Sugar North Ltd	21 400
Marian	QLD	Mackay Sugar Mills	18 000
Proserpine	QLD	Independent Sugar North Ltd	16 000
Farleigh	QLD	Mackay Sugar Mills	13 000
Inkerman	QLD	CSR Sugar Mills	12 000
South Johnstone	QLD	Bundaberg Sugar Ltd	11 500
Victoria	QLD	CSR Sugar Mills	11 000
Mossman	QLD	Mossman Central Mill Co Ltd	11 000
Isis	QLD	Isis Central Sugar Mill Co Ltd	10 700
Mulgrave	QLD	Independent Sugar North Ltd	10 500
Racecourse	QLD	Mackay Sugar Mills	10 500
Pleystowe	QLD	Mackay Sugar Mills	10 100
Plane Creek	QLD	CSR Sugar Mills	10 000
Kalamia	QLD	CSR Sugar Mills	9 000
Broadwater	NSW	NSW Sugar Mills Co-Op	8 000
Other operators			62 450
Total			380 150
<b>Biogas</b>			
Lucas Heights II stage 2	NSW	Energy Developments Ltd	18 000
Carrum Downs 1 & 2	VIC	Melbourne Water	17 000
Lucas Heights II	NSW	Energy Developments Ltd	13 000
Clayton	VIC	Energy Developments Ltd	10 000
Eastern Creek 2	NSW	LMS Generation Pty Ltd	8 800
Werribee (AGL)	VIC	AGL	7 800
Sunshine	VIC	ABB	7 500
Woodlawn	NSW	Energy Australia	7 000
Broadmeadows	VIC	Energy Development Ltd	7 000
Werribee 2	VIC	Melbourne Water	7 000
Berwick	VIC	Energy Developments Ltd	7 000
South Cardup	WA	Landfill Management Services Ltd	6 000



## 39 Renewable power generators in Australia, 2007

	state	owner	capacity kW
Wingfield I	SA	Energy Developments Ltd	5 000
Springvale	VIC	Energy Developments Ltd	4 000
Belrose	NSW	Energy Developments Ltd	4 000
Canningvale	WA	Landfill Gas and Power Pty Ltd	4 000
Lucas Heights I	NSW	Energy Developments Ltd	4 000
Other operators			80 542
Total			217 642
<b>Woodwaste</b>			
Tumut	NSW	Visy Paper	17 000
Gladstone A&B	QLD	Comalco/NRG	10 000
Mount Gambier	SA	Carter Holt Harvey	10 000
Bayswater	NSW	Macquarie Generation	5 000
Liddell	NSW	Macquarie Generation	5 000
Mount Piper	NSW	Delta Electricity	5 000
Muja	WA	Verve Energy	5 000
Stapylton	QLD	Green Pacific Energy	5 000
Vales Point B	NSW	Delta Electricity	5 000
Wallerawang C	NSW	Delta Electricity	5 000
Narrogin	WA	Verve Energy/Oil Mallee Co/Enecon P/L	1 000
Other operators			495
Total			73 495
<b>Other renewables <sup>a</sup></b>			
Kalgoorlie - biodiesel	WA	Verve Energy	63 000
Hunter Economic Zone (biodiesel)	NSW	Infratil Energy	29 000
Maryvale	VIC	Australian Paper	24 000
Hazelwood	VIC	International Power Hazelwood	10 000
EarthPower	NSW	Country Energy	4 000
Eastern Creek UR-3R	NSW	Global Renewables	3 000
Brisbane	QLD	Visy Paper	2 000
Gympie	QLD	Ergon Energy	1 500
Upper Chittering	WA	Rufftuff	10
Total			136 510

## 39 Renewable power generators in Australia, 2007

	state	owner	capacity kW
<b>Geothermal</b>			
Birdsville	QLD	Ergon Energy	80
Total			80
<b>Hydroelectricity</b>			
Tumut 3	NSW	Snowy Hydro Ltd	1 500 000
Murray 1	NSW	Snowy Hydro Ltd	950 000
Murray 2	NSW	Snowy Hydro Ltd	550 000
Wivenhoe Dam	QLD	Tarong Energy	500 000
Gordon	TAS	Hydro TAS	432 000
Tumut 1	NSW	Snowy Hydro Ltd	330 000
Poatina	TAS	Hydro TAS	300 000
Tumut 2	NSW	Snowy Hydro Ltd	286 000
Reece	TAS	Hydro TAS	231 200
Kangaroo Valley	NSW	Eraring Energy	160 000
Dartmouth	VIC	Southern Hydro (owned by AGL)	150 000
John Butters	TAS	Hydro TAS	144 000
Eildon	VIC	Southern Hydro (owned by AGL)	136 000
Tungatinah	TAS	Hydro TAS	125 000
McKay Creek	VIC	Southern Hydro (owned by AGL)	120 000
Trevallyn	TAS	Hydro TAS	95 000
Tarraleah	TAS	Hydro TAS	90 000
Cethana	TAS	Hydro TAS	85 000
Liapootah	TAS	Hydro TAS	83 700
Tribute/Newton	TAS	Hydro TAS	82 800
Bendeela	NSW	Eraring Energy	80 000
Blowering	NSW	Snowy Hydro Ltd	80 000
Bastyan	TAS	Hydro TAS	79 900
Mackintosh	TAS	Hydro TAS	79 900
Kareeya	QLD	Stanwell Corp (33% NRG)	79 000
Other operators			1 064 065
Total			7 813 565

## 39 Renewable power generators in Australia, 2007

	state	owner	capacity kW
<b>Ocean (wave)</b>			
Port Kembla	NSW	Oceanlinx	500
Portland	VIC	Ocean Power Technologies (Aust) P/L and Powercor Aust	20
<b>Total</b>			<b>520</b>
<b>Solar</b>			
Broken Hill	NSW	Australian Inland Energy	1 000
Newington	NSW	Private	665
Newcastle - CSIRO	NSW	CSIRO	500
Singleton	NSW	Energy Australia	400
Lajamanu	NT	Solar Systems	288
Kings Canyon	NT	NT PowerWater	241
Ernabella	SA	Solar Systems	220
Public Schools NSW	NSW	Integral Energy	204
Greater Melbourne	VIC	Private Homeowner/Citipower	200
Kogarah	NSW	Kogarah Council	200
Queen VIC Market	VIC	Melbourne City Council	200
Hermannsburg	NT	Solar Systems	192
Yuendumu	NT	Solar Systems	192
Hamersley Iron	WA	Hamersley Iron	151
Olympic Boulevard	NSW	Sydney Olympic Park Authority	150
Public Schools SA	SA	SA Government	148
Other commercial and research operators			3 223
Domestic, recreational and other			62 777
<b>Total</b>			<b>70 951</b>
<b>Wind</b>			
Lake Bonney stage 2	SA	Babcock and Brown Wind Partners	159 000
Woolnorth	TAS	Roaring40s/Hydro TAS	140 250
Snowtown	SA	Wind Prospect and Trust Power	98 700
Hallett 1	SA	AGL	94 500
Wattle Point	SA	ANZ Energy Infrastructure Trust/ Wind Farm Developments	91 000
Walkaway - Alinta	WA	Babcock and Brown Wind Partners/ Alinta Ltd	90 000

## 39 Renewable power generators in Australia, 2007

	state	owner	capacity kW
Lake Bonney 1	SA	Babcock and Brown Wind Partners	80 500
Emu Downs	WA	Transfield Services Infrastructure Ltd & Griffin Energy	79 200
Mount Millar	SA	Transfield Services Infrastructure Ltd	70 000
Cathedral Rocks	SA	Roaring40s/Hydro TAS & Acciona Energy	66 000
Challicum Hills	VIC	Pacific Hydro	52 500
Canunda	SA	International Power and Wind Prospect Pty Ltd	46 000
Starfish Hill	SA	Transfield Services Infrastructure Ltd	34 000
Yambuk (Portland stage 1)	VIC	Pacific Hydro Ltd	30 000
Albany	WA	Verve Energy	22 000
Toora	VIC	Transfield Services Infrastructure Ltd	21 000
Codrington	VIC	Pacific Hydro	18 000
Windy Hill	QLD	Transfield Services Infrastructure Ltd	12 000
Wonthaggi	VIC	Wind Power Pty Ltd	12 000
Blayney	NSW	Eraring Energy	9 900
Crookwell	NSW	Eraring Energy	6 000
9 Mile Beach	WA	Verve Energy	3 600
King Island	TAS	Hydro TAS	2 450
10 Mile Lagoon	WA	Verve Energy	2 025
Hampton	NSW	Hickory Hill Wind Energy Pty Ltd	1 200
Hopetoun	WA	Verve Energy	1 200
Other operators			5 761
<b>Total</b>			<b>1 248 786</b>

a Black liquor, crop waste, municipal waste and biodiesel.

Sources: Geoscience Australia; NEMMCO; Watt, M 2007. National Survey Report of PV Power Applications in Australia.

## 40 Major new coal projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
<b>Black coal – mining projects – NSW</b>						
Blakefield South	Xstrata/ Nippon Steel	16 km SW of Singleton	New project, under construction	2010	nil (replacement for Beltana)	\$375m
Mangoola (Anvil Hill opencut)	Xstrata Coal	20 km SW of Muswellbrook	New project, committed, subject to mining lease	2011	10.5 Mt thermal	\$ 1.1b
<b>Black coal – mining projects – QLD</b>						
Narrabri Coal Project (stage 1)	Whitehaven	20 km SE of Narrabri	New project, under construction	mid-2009	1.5 Mt thermal	\$185m
Rocglen (Belmont) opencut	Whitehaven	26 km N of Gunnedah	New project, committed	late 2008	1.5 Mt thermal	\$35m
<b>Black coal – mining projects – QLD</b>						
Blackwater Creek Diversion	Wesfarmers	200 km W of Rockhampton	Expansion, committed	2010	Nil (extension of Curragh mine life)	\$130m
Carborough Downs longwall	Vale	20 km NE of Moranbah	Expansion, under construction	2009	3 Mt coking	US\$330m (A\$390m)
Clermont opencut	Rio Tinto	11 km N of Clermont	New project, under construction	2010	12 Mt thermal (replacing Blair Athol capacity)	US\$1.3b (A\$1.5b)

40 Major new coal projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Ensham bord and pillar underground mine	Ensham Resources	40 km NE of Emerald	New project, committed	2010	2 Mt thermal	\$120m
Kestrel	Rio Tinto	51 km NE of Emerald	Expansion, under construction	2012	1.7 Mt coking	US\$991m (A\$1.17b)
Lake Lindsay opencut	Anglo Coal Australia/Mitsui	near German Creek – central QLD	New project, under construction	late 2008	19Mt hard coking, 1.8 Mt PCI, 0.3 Mt thermal	US\$726m (A\$854m)
Vermont Coal Project	QCMM Dysart	15 km NE of	New project, under construction	2009	4 Mt coking	\$264m
<b>Black coal – infrastructure projects – NSW</b>						
Kooragang Island coal terminal expansion	Port Waratah Coal Services	Newcastle	Expansion, under construction	2010	Capacity increase of 11 Mt	\$456m
NCIG export terminal (Newcastle Coal Infrastructure Group)	NCIG	Newcastle	New project, under construction	2010	Capacity of 30 Mtpa initially; ultimately 66 Mtpa	US\$1.1b (A\$1.3b)
<b>Black coal – infrastructure projects – QLD</b>						
Abbot Point Coal Terminal X25 expansion	Ports Corporation of Queensland	Bowen	Expansion, under construction	mid 2009	Terminal capacity increase from 21 Mtpa to 25 Mtpa	\$95m

40 Major new coal projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Abbot Point Coal Terminal X50 expansion	Ports Corporation of Queensland	Bowen	Expansion, committed	mid 2010	Terminal capacity increase from 25 Mtpa to 50 Mtpa	\$818m
Abbot Point Coal Terminal yard refurbishment	Ports Corporation of Queensland	Bowen	Refurbishment, committed	late 2008	na	\$68m
Brisbane Coal Terminal expansion	Queensland Bulk Handling	Brisbane	Expansion, under construction	2009	3 Mtpa increase	\$60m
Dalrymple Bay Coal Terminal 7X expansion project Phases 2/3	Babcock & Brown Infrastructure	Dalrymple Bay	Expansion, under construction	early 2009	Port capacity increase from 68 to 85 Mtpa	\$679m
Grantleigh to Tunnel	Queensland Rail	70 km W of Rockhampton	Expansion, under construction	late 2009	na	\$49m
Jilalan Rail Yard Upgrade	Queensland Rail	35 km S of Mackay	Expansion, under construction	late 2009	System capacity increase of 38 Mtpa	\$500m
Stanwell–Wycarbah upgrade	Queensland Rail	40 km W of Rockhampton	Expansion, under construction	mid-2009	na	\$72m
Vermont Rail Spur and Balloon Loop	Queensland Rail	15 km NE of Dysart	New project, under construction	2009	4 Mtpa increase	\$70m

<sup>a</sup> Summary of projects classified as committed, for proposed projects please refer to source. Source: ABARE, *Minerals and energy - major development projects*, October 2008 listing. Available at [http://www.abare.gov.au/publications\\_html/energy/energy\\_08/energy\\_08html](http://www.abare.gov.au/publications_html/energy/energy_08/energy_08html)

41 Major new oil and gas projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Coal seam methane Darling Downs development (including Spring Gully Phase V and Tallinga) (includes wells from Tallinga)	Origin Energy	80 km N of Roma, QLD	Expansion, under construction	2009	44 PJ pa	\$500m
Darling Downs development (Tallinga)	Origin Energy	80 km N of Roma, QLD	Expansion, committed	2010	23 PJ pa	\$260m
Lacerta Gas Field	Queensland Gas Company	50 km NE of Roma, QLD	New project, under construction	2009	4–8 PJ pa	\$67m
Petroleum– oil and natural gas projects						
Blacktip gas discovery	ENI Australia	Offshore, Bonaparte Basin, WA	New project, under construction	2009	650 million cubic metres initially; 1.1 billion cubic metres ultimately	\$500m
Henry gasfield	Santos/ AWE/ Mitsui	20 km offshore Otway Basin, VIC	New project, under construction	early 2009	11 PJ pa	\$275m
Kipper gas project (stage 1)	Esso/ BHP Billiton/Santos	42 km offshore Gippsland, VIC	New project, under construction,	2011	30 PJ pa gas 10 kbpd condensate	US\$1.1b (A\$1.3b)
Longtom gas project	Nexus Energy	Bass St, VIC	New project, under construction	mid 2009	25 PJ pa gas	US\$237m (A\$278m)



41 Major new oil and gas projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Montara/Skua oilfield (Phase 1)	Coogee Resources	Timor Sea, 650 km W of Darwin, NT	New project, under construction	late 2008	na	US\$700m (A\$805m) includes Phase 2
Montara/Skua oilfield (Phase 2)	Coogee Resources	Timor Sea, 650 km W of Darwin, NT,	Expansion committed	late 2009	na	na
NWS North Rankin B	Woodside Energy/ BHP Billiton/ Chevron/ Shell/ Japan Australia LNG	150 km NW of Dampier, Carnarvon Basin, WA	New project, committed	2012	967 PJ pa	\$5.1b (A\$6.0b)
Pluto (train 1)	Woodside Energy	Carnarvon Basin/ Burrup Peninsula, WA	New project, under construction	late 2010	4.3 Mt LNG	\$12b (inc site works for train 2)
Pyrenees	BHP Billiton/ Apache Energy	55 km N of Exmouth, Carnarvon Basin, WA	New project, committed	early 2010	96 kbpd, 23 PJ pa gas	US\$1.86b (A\$2.18b)
Reindeer gas field/ Devil Creek gas processing plant (phase 1)	Apache Energy / Santos	80 km NW of Dampier, Carnarvon Basin, WA	New project, committed	late 2010	40 PJ pa gas	US\$744m (A\$875m)
Turrum	ExxonMobil/ BHP Billiton	Bass St, VIC	New project, committed	2011	11 kpbpd condensate	US\$1.25b (A\$1.47b)

41 Major new oil and gas projects <sup>a</sup>

project	company	location	status	expected new startup	new capacity	capital expend.
Van Gogh	Apache Energy/ Inpex Alpha	50 km N of Exmouth, Carnarvon Basin, WA	New project, committed	early 2009	63 kbpd	\$700m
Petroleum – gas pipeline projects						
Bonaparte gas pipeline (to carry Blacktip gas)	Australian Pipeline Trust	Wadeye (to link with Darwin pipeline), NT	New project, under construction	2009	30 PJ pa	\$150m
Eastern Gas Pipeline	SP AusNet	Wollongong (NSW) to Longford (VIC)	Expansion, committed	2009	20 PJ pa	\$41m
Queensland Gas \Pipeline	SP AusNet	Wallumbilla to Gladstone (550 km), QLD	Expansion, committed	2010	25 PJ pa	\$112m
South Gippsland natural gas pipeline	Multinet Gas	South Gippsland (250 km from Lang Lang to five regional towns), VIC	New project, under construction	2010	na	\$50m
SWQP stage 1 (incl QSN Link)	Epic Energy	Ballera (QLD) to Moomba (SA) (180 km)	New project, under construction	early 2009	60 PJ pa	\$165m

41 Major new oil and gas projects <sup>a</sup>

project	company	location	status	expected startup	new capacity	capital expend.
Uranium Honeymoon	Uranium One/ Mitsui	420 km NE of Adelaide, SA	New project, on hold (seeking approval for sale ownership stake)	2010	0.40 kt U <sub>3</sub> O <sub>8</sub>	US\$76m (A\$89m)
Ranger Laterite Processing Plant	Energy Resources of Australia	227 km E of Darwin, NT	New project, under construction	late 2008	0.40 kt U <sub>3</sub> O <sub>8</sub>	\$28m
Ranger pit extension	Energy Resources of Australia	227 km E of Darwin, NT	Expansion, committed	2011	na	\$57m

<sup>a</sup> Summary of projects classified as committed, for proposed projects please refer to source.

Source: ABARE, *Minerals and energy - major development projects*, October 2008 listing. Available at [http://www.abare.gov.au/publications\\_html/energy/energy\\_08/ME08\\_OctListing.xls](http://www.abare.gov.au/publications_html/energy/energy_08/ME08_OctListing.xls)



## APPENDIX 2

### ENERGY CONTENT CONVERSIONS

The factors listed in the following tables are 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 factors such as location and air pressure. 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 ( $U_3O_8$ ) is 0.47 petajoules per tonne. The oxide contains 84.8 per cent of the metal by weight.

#### 42 Energy content of gaseous fuels in Australia

	Energy content MJ/m <sup>3</sup>
<b>Natural gas (sales quality)</b>	
Victoria	38.8
Queensland	39.5
Western Australia	41.5
South Australia, New South Wales	38.3
Northern Territory	40.5
Ethane (average)	57.5
<b>Town gas</b>	
– synthetic natural gas	39.0
– other town gas	25.0
Coke oven gas	18.1
Blast furnace gas	4.0

Sources: RET; BHP Billiton.

## 43 Energy content of liquid fuels in Australia

	volume MJ/L	specific volume L/t	weight GJ/t
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
<b>LPG</b>			
– propane	25.5	1 960	49.6
– butane	28.1	1 760	49.1
– mixture	25.7	1 890	49.6
– naturally occurring (average)	26.5	1 866	49.4
<b>Fuel oil</b>			
– 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
<b>Crude oil and other refinery feedstocks</b>			
– indigenous (average)	37.0	1 250	46.3
– imports (average)	38.7	1 160	44.9
Orimulsion			28.0
Ethanol	23.4	1 266	29.6
Methanol	15.6	1 263	19.7
Tallow			35.0
Liquefied natural gas (north west shelf)	25	2 174	54.4

Sources: BP; BHP Billiton; Mobil Exxon; Santos; Woodside Petroleum.

## 44 Energy content of solid fuels in Australia

energy content		energy content	
	GJ/t		GJ/t
<b>Black coal</b>		<b>Black coal</b>	
<b>New South Wales</b>		<b>Western Australia</b>	
Exports		Thermal coal	19.7
– metallurgical coal	29.0	<b>Tasmania</b>	
– thermal coal	27.0	Thermal coal	22.8
Electricity generation	23.4	<b>Lignite</b>	
Steelworks	30.0	<b>Victoria</b>	9.8
Washed thermal coal	27.0	Briquettes	22.1
Unwashed thermal coal	23.9	<b>South Australia</b>	15.2
<b>Queensland</b>		<b>Other</b>	
Exports		Coke	27.0
– metallurgical coal	30.0	Wood (dry)	16.2
– thermal coal	27.0	Bagasse	9.6
Electricity generation	23.4		
Other	23.0		

