Australian Government

Department of Resources
Energy and Tourism

Energy in Australia 2011

www.abares.gov.au

ISSN 1833-038
ISBN 978-1-921448-86-7

Produced and compiled by Clara Cuevas-Cubria, Andrew Schultz, Rebecca Petchey, Farah Beaini and Robert New.

Published by:

ABARES
GPO Box 1563
Canberra ACT 2601
abares.gov.au

Produced for:

Department of Resources, Energy and Tourism
GPO Box 1564
Canberra ACT 2601

Foreword

Energy is at the top of minds of governments, businesses and, increasingly, individual citizens in Australia and around the world.

Energy in Australia provides a valuable insight into Australia's energy consumption and production. This concise and comprehensive publication is an excellent reference point for policymakers. Accurate and comprehensive data provide us with the necessary information to plan for our energy future and ultimately to maintain Australia's reliable, accessible and sustainable energy supply. This is fundamental to Australia's social and economic prosperity.

Demand for energy continues to grow, both domestically and overseas, with emerging economies, including those in our region, projected to account for a significant proportion of this growth in coming decades.

As *Energy in Australia* illustrates, Australia is well-placed to meet the challenge of increasing global energy demand as one of only three net energy exporting nations in the OECD.

New LNG projects are a tangible sign of confidence in Australia as an investment destination. Coal seam gas has great potential for development, and between October 2010 and January 2011 we have seen over $31 billion in new investment committed across two projects to export LNG from coal seam gas.

Its qualities as a readily accessible, lower emission, baseload fuel makes gas the transition fuel of choice. These projects will help Australia and our trading partners make this transition to cleaner energy while ensuring continued growth in employment and our overall prosperity.

But we also need to be investing in technology to deliver renewable and clean energy projects on a commercial scale. That is why the Australian Government has legislated the 20 per cent by 2020 expanded Renewable Energy Target, and is investing $5 billion through the Clean Energy Initiative to support the development of clean energy and energy efficiency technologies.

Energy underpins all economic activity, from powering industry to keeping highly-skilled jobs here in Australia. At a time of unprecedented change in the global energy sector, I recommend Energy in Australia as a valuable resource to better inform policy and investment decisions.

Martin Ferguson AM MP
Minister for Resources and Energy

Contents

Abbreviations and principal sources of energy information

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AEMO	Australian Energy Market Operator
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)
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

ABARES www.abares.gov.au
Australian Bureau of Statistics www.abs.gov.au
Australian Energy Market Operator www.aemo.com.au
Australian Financial Markets Association www.afma.com.au
Australian Institute of Petroleum www.aip.com.au
BP Statistical Review of World Energy www.bp.com
Clean Energy Council www.cleanenergycouncil.org.au
Department of Climate Change and Energy Efficiency www.climatechange.gov.au
Department of Resources, Energy and Tourism www.ret.gov.au
Energy Information Administration www.eia.doe.gov
Energy Networks Association www.ena.asn.au
Energy Supply Association of Australia www.esaa.com.au
Geoscience Australia www.ga.gov.au
Global-roam Pty Ltd www.nem-review.info
International Energy Agency www.iea.org
Office of the Renewable Energy Regulator www.orer.gov.au
Platts (McGraw Hill) www.platts.com
Ports Australia www.portsaustralia.com.au

Glossary

Bagasse	The fibrous residue of the sugar cane milling process that is used as a fuel (to raise steam) in sugar mills.
Biogas	Landfill (garbage tips) gas and sewage gas. Also referred to as biomass gas.
Brown coal	See lignite.
Coal by-product	By-products 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).
Coal seam gas	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).
Conversion	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.
Crude oil	Naturally occurring mixture of liquid hydrocarbons under normal temperature and pressure.
Condensate	Hydrocarbons recovered from the natural gas stream that are liquid under normal temperature and pressure.
Conventional gas	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.
Derived or secondary fuels	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.
Economic demonstrated resources	The quantity of resources that is judged to be economically extractable under current market conditions and technologies.
Electricity capacity utilisation	Actual electricity generation output as a proportion of generation capacity.

Electricity generation capacity	The maximum technically possible electricity output of generators at a given hour. The maximum annual output from generators is equal to generation capacity multiplied by the number of hours in a year.
Lignite	Non-agglomerating coals with a gross calorific value less than 17 435 kilojoules a kilogram, including brown coal which is generally less than 11 000 kilojoules a kilogram.
Liquid fuels	All liquid hydrocarbons, including crude oil, condensate, liquefied petroleum gas and other refined petroleum products, and liquid biofuels.
Natural gas	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).
Petajoule	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.
Petroleum	Generic term for all hydrocarbon oils and gases, including refined petroleum products.
Petroleum products	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 non-fuel applications (solvents, lubricants, bitumen, waxes, petroleum coke for anode production and specialised feedstocks).
Primary fuels	The forms of energy obtained directly from nature. They include non-renewable 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.
Total final energy consumption	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.
Total primary energy consumption	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, metric prefixes and converison factors

Units

J	joule
L	litre
t	tonne
g	gram
W	watt
Wh	watt hour

Metric prefixes

k	kilo	10^3 (thousand)
M	mega	10^6 (million)
G	giga	10^9 (1000 million)
T	tera	10^{12}
P	peta	10^{15}
E	exa	10^{18}
b	billion	10^9

Other abbreviations

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

Conversion factors

1 barrel = 158.987 L

1 mtoe (million tonnes of oil equivalent) = 41.868 PJ

1 kWh = 3600 kJ

1 MBTU (million British thermal units) = 1055 MJ

1 m^3 = 35.515 cubic feet

1 L LPG = 0.254 m^3 gas

1 L LNG = 0.625 m^3 natural gas

Conversion factors are at a temperature of 15 ^oC and pressure of 1 atmosphere.

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.

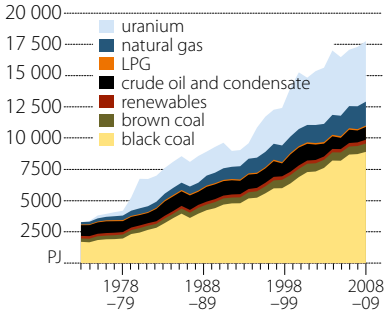
Australia's energy supply

Australia has abundant and diverse energy resources that supply energy for both domestic consumption and the world market. In 2008–09, Australia's energy production was 17 769 petajoules. Net energy exports accounted for 68 per cent of domestic energy production in 2008–09, while domestic consumption accounted for the remaining 32 per cent. Australia is the world's ninth largest energy producer, accounting for around 2.4 per cent of world energy production. Given its large energy resources, Australia is well positioned to continue its role as an important supplier of world energy needs, while maintaining domestic energy supply.

The main fuels produced in Australia are coal, uranium and natural gas. In 2008–09, Australia's energy production was dominated by coal, which accounted for 54 per cent of total Australian energy production in energy content terms, followed by uranium with a share of 27 per cent and natural gas with a share of 11 per cent. Crude oil and liquefied petroleum gas (LPG) represented 6 per cent of total energy production, and renewables represented 2 per cent.

The Australian energy industry is a significant contributor to the economy. The coal and petroleum industries contributed $68 billion to industry value added in 2008–09, representing 5.7 per cent of the Australian total. The electricity and gas supply industries contributed another $19 billion to industry gross value added.

Australian energy production



Source: ABARES, *Australian energy statistics.*

Energy exports

Australia is a net energy exporter, with domestic energy consumption representing only one-third of total 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

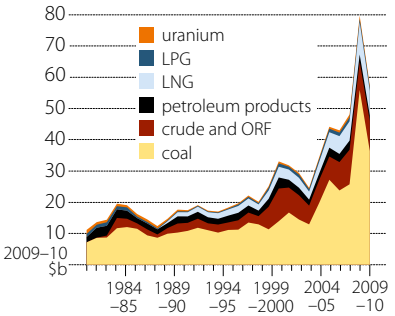
Energy-related industries in Australia 2008–09

	gross value added $b	gross fixed capital formation $b	employment '000
Coal mining	37.9	7.7	34.0
Oil and gas extraction	28.9	12.6	12.0
Petroleum and coal product manufacturing	1.2	1.0	7.0
Electricity supply	17.8	10.9	48.0
Gas supply	1.1	0.6	2.0
Total	86.9	32.8	103.0
Australia	1 194.5	356.4	10 809.0

Sources: Australian Bureau of Statistics (ABS), *Australian Industry*, cat. no. 8155; *Australian System of National Accounts*, cat. no. 5204; *Australian Labour Market Statistics*, cat. no. 6105.

$36 billion in 2009–10, followed by crude oil and liquefied natural gas (LNG). Crude oil and LNG are also among Australia's 10 highest value commodity exports. Energy exports accounted for 34 per cent of the value of Australia's total commodity exports in 2009–10.

Australian energy exports

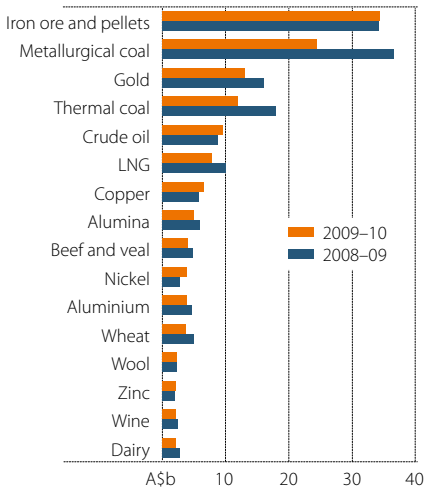


Source: ABARES, *Australian commodities*.

Since 1988–89, the value of Australia's energy exports (in 2009–10 Australian dollars) has increased at an average rate of 11 per cent a year. In 2009–10, energy export earnings declined by 26 per cent to $57.5 billion, largely as a result of lower export prices for bulk commodities than in 2008–09.

However, most energy commodity prices averaged higher in 2010 than in 2009. The price increases reflected strong demand from most regions, as a result of stronger economic growth. Restocking of energy commodities in many OECD economies also supported higher prices.

Major Australian commodity exports



Source: ABARES, *Australian commodities*.

Domestic energy consumption

Although Australia's energy consumption continues to increase, the rate of growth has slowed over the past 50 years. Australia's energy consumption increased at an average rate of 1.7 per cent a year over the 10 years from 1998–99 to 2008–09, compared with 2.8 per cent over the previous 10 years. In 2008–09, energy consumption increased by 0.2 per cent to 5773 petajoules, which was 32 per cent of 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 decreased, from an average of 49 per cent in the 1980s to an average of 42 per cent in the 1990s, and has continued to decrease, to an average of 33 per cent over the past decade.

Energy resources

Australia has large resources of both renewable and non-renewable energy. Australian resources of uranium, for instance, account for 47 per cent of total world resources, while Australian coal resources make up 10 per cent of the world total. In this report, data on energy resources are presented in energy units to allow comparison across different resources. A large proportion of Australian black coal resources are high-quality bituminous coals, characterised by a low sulphur and low ash content. A significant amount of natural gas reserves are also located in Australia. Although Australia does not

have large oil resources, Australian crude oil is 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.

Australia has significant and widely distributed wind, solar, geothermal, hydroelectricity, ocean energy and bioenergy resources. Except for hydroelectricity, where the available resource is already mostly developed, and wind energy, where use of the resource is growing rapidly, renewable resources are largely undeveloped and could contribute significantly more to Australia's future energy supply. Many of these resources are difficult to quantify and data on economic demonstrated resources for renewables were not available for inclusion in this report.

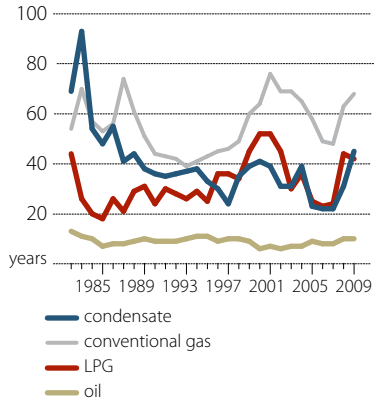
Australia's economic demonstrated resources 1 January 2010

	unit	Australia	share of world %	reserves to production [e] yrs
Coal [a]				
Black coal	PJ	987 064	10.6	111
Brown coal	PJ	359 870	8.9	539
Petroleum				
Oil	PJ	6 290	0.3 [b]	10
Condensate	PJ	12 691	na	45
LPG	PJ	4 399	na	42
Gas				
Conventional gas	PJ	123 200	1.6	68
Coal seam methane [c]	PJ	16 180	na	100
Uranium [d]	PJ	685 440	47.5	141

a Recoverable resources as at December 2009. **b** Crude oil, condensate and LPG combined. **c** As at December 2008, most recent data available at time of publication. **d** Reasonably assured resources recoverable at costs of less than US$80/kg U. **e** Estimated economic demonstrated reserves (EDR) under current production rates. **na** Not available.
Sources: Geoscience Australia, *Australia's Identified Mineral Resources 2010, Oil and Gas Resources of Australia 2009*; BP, *BP Statistical Review of World Energy*.

At current rates of production, Australia's energy resources are expected to last for many more decades. The ratio of economic demonstrated reserves (EDR) to current production is estimated at 539 years for brown coal, 111 years for black coal, 68 years for conventional gas and 100 years for coal seam methane.

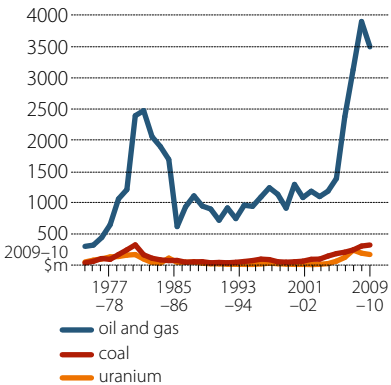
Reserves to production ratios a



a Estimated economic demonstrated reserves (EDR) under current production rates.

Source: Geoscience Australia 2010, *Oil and gas resources of Australia 2009*.

Private energy and minerals exploration expenditure



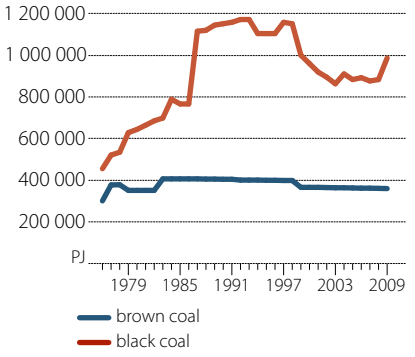
Source: ABARES, *Australian commodity statistics 2009*.

Despite increasing energy production, reserves to production ratios have not followed a declining trend over the past 10 years, reflecting the addition of new discoveries and the upgrading of resources that meet economic criteria. For example, over the past 20 years, the reserves to production ratio for oil has only fluctuated between six and 11 years. The reserves to production ratios for crude oil, condensate and natural gas all increased in 2009, with only a small decrease in the LPG reserves to production ratio.

Expenditure on oil and gas exploration is 88 per cent of total exploration expenditure on energy resources (comprising oil, gas, coal and uranium). Crude oil, LPG and natural gas exploration expenditure declined by around 8 per cent to $3.5 billion in 2009–10, although it was still the second highest recorded in Australia's petroleum industry. There was a sharp increase in petroleum exploration expenditure between 2005–06 and 2008–09, reaching a record high of $3.8 billion. This rapid growth arose from a significant increase in exploration activity until 2007–08, in response to high energy prices, combined with high exploration costs in the first half of 2008.

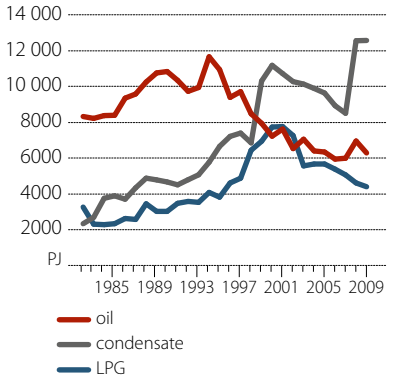
Exploration expenditure for coal increased by 8 per cent to around $321 million in 2009–10, in response to expectations of increasing world coal demand over the medium to longer term. Spending on uranium exploration decreased by 9 per cent, as sharp declines in uranium spot prices in recent years have resulted in some exploration activity being postponed.

Australia's economic demonstrated resources of coal



Source: Geoscience Australia.

Australia's economic demonstrated resources of petroleum



Source: Geoscience Australia.

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 resources. There are brown coal deposits in all Australian states, although Victoria accounts for 96 per cent of identified brown coal resources.

Petroleum

Australia's resources of crude oil and condensate are only a small proportion of world resources. Resources of crude oil, condensate and LPG all followed a generally decreasing trend from 2000 to 2007; however, crude oil and condensate resources both increased in 2008.

Most of Australia's petroleum resources are located off the coasts of Western Australia, the Northern

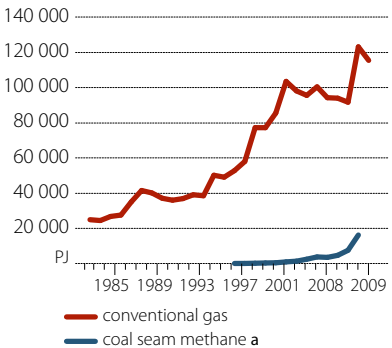
Australia's petroleum resources by state, 2009 a

	crude oil GL	condensate GL	LPG GL	natural gas bcm
Vic	35	25	28	237
Qld	1	0	0	13
SA	9	2	5	20
WA	108	256	96	2 431
NT	16	55	36	277
Tas	0	2	1	7
Total	170	340	166	2 984

a Economic demonstrated resources as at 1 January 2010.
Source: Geoscience Australia 2010, *Oil and gas resources of Australia, 2009*.

Territory and Victoria. Western Australia has 64 per cent of Australia's economic demonstrated resources of crude oil, 75 per cent of condensate resources and 58 per cent of LPG resources.

Australia's economic demonstrated gas resources



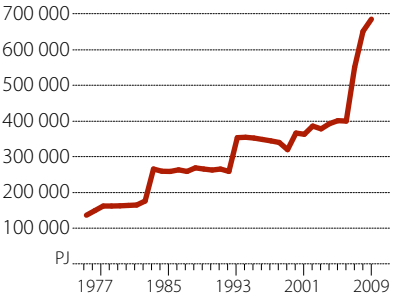
a Coal seam methane data for 2009 not available at time of publication.
Source: Geoscience Australia.

Gas

Australia's identified conventional gas resources have increased threefold 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

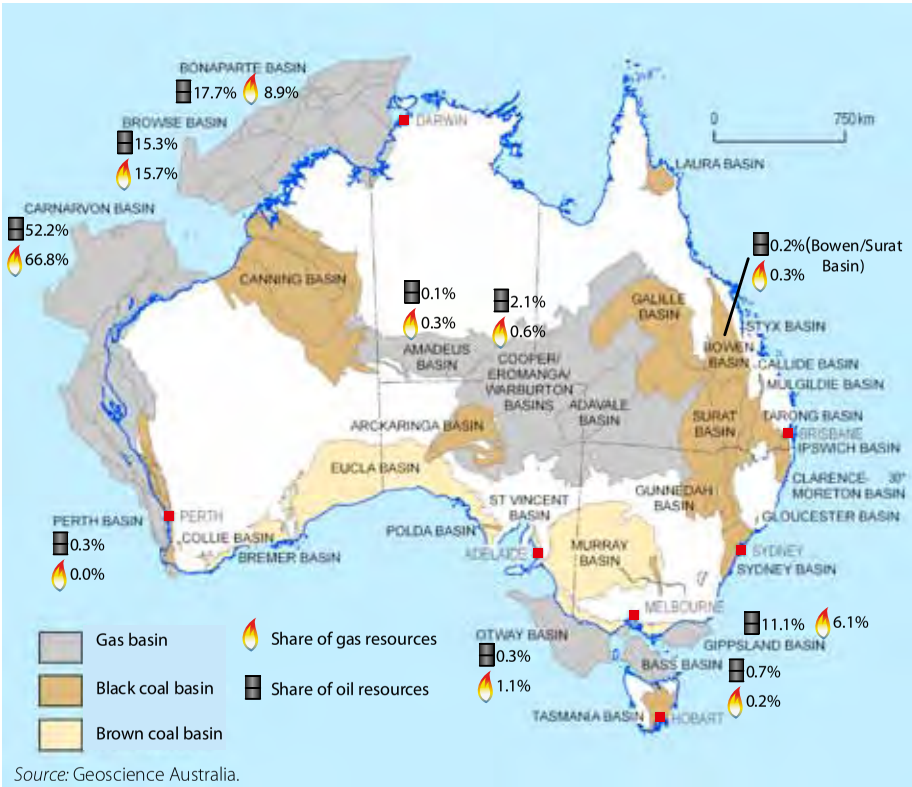


Source: Geoscience Australia.

Uranium

Australia's identified uranium resources have more than doubled over the past two decades, and increased by 71 per cent from 2006 to 2009. The majority of Australia's uranium resources are located in South Australia, the Northern Territory and Western Australia. The Olympic Dam deposit in South Australia is the world's largest uranium deposit.

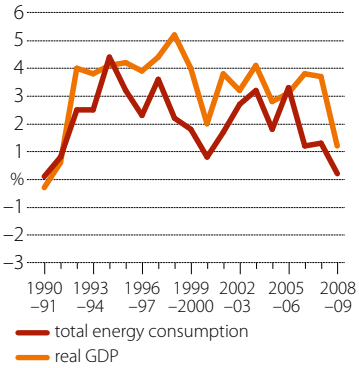
Distribution of Australia's oil, gas and coal resources



Source: Geoscience Australia.

Australia is the world's twentieth largest primary energy consumer and ranks fifteenth on a per person basis. Australia's energy consumption is primarily composed of fossil fuels (coal, oil and gas), which represent 95 per cent of total energy consumption.

Annual growth in primary energy consumption in Australia



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

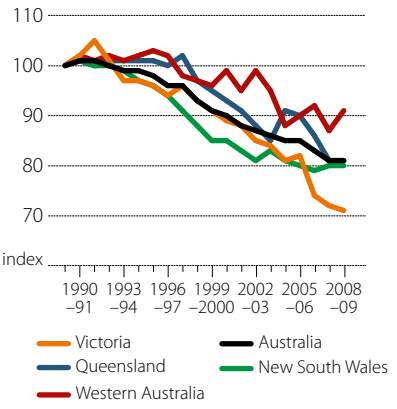
During the past five decades, Australia's growth in energy consumption has gradually slowed. Following annual growth of around 5 per cent during the 1960s, growth in energy consumption fell during the 1970s to an average of around 4 per cent a year, largely as a result of the two major oil price shocks. 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. In the early 1990s falling real energy prices and robust economic growth led to stronger growth in energy consumption. However, for the 1990s as a whole, annual growth in energy consumption also averaged around 2.3 per cent.

Since 2000, growth in energy consumption has averaged 1.6 per cent. In 2008–09 energy consumption was largely unchanged compared with the previous year, mainly reflecting reduced economic activity as a result of the global economic downturn.

Energy intensity

There has been a long-term decline in the energy intensity (energy consumption per unit of gross domestic product) of the Australian economy. This trend can be attributed to two main factors. First, energy

Energy intensity trends



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

efficiency improvements have been achieved through both technological change and fuel switching. Government policies at both the national and state/territory level have contributed to the implementation of new technologies that improve energy efficiency. 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 in energy intensity are not uniform across Australia. For example, in recent years the growing resources sectors of Western Australia and Queensland have led to energy intensity being higher in these states than in Victoria and New South Wales, where the services sectors have grown strongly.

Energy consumption, by fuel

Australian primary energy consumption consists predominantly of coal, petroleum and gas. Black and brown coal accounted for the greatest share of the fuel mix, at 39 per cent, followed by petroleum products (34 per cent), natural gas (21 per cent) and renewables (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. The share of renewables has remained largely constant over time, with a decrease in the use of hydroelectricity being offset by an increase in the use of wind energy, solar energy and biofuels.

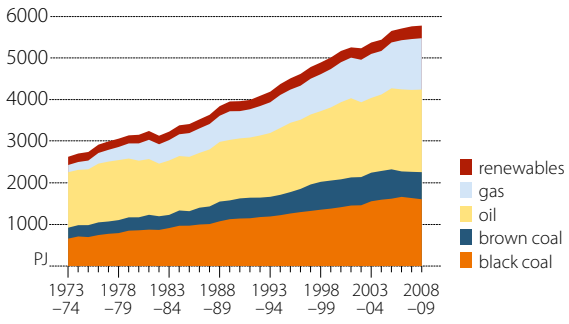
Energy consumption by state, by fuel, 2008–09

	black coal PJ	brown coal PJ	renewables [a] PJ	petroleum products PJ	natural gas PJ	state share [b] %
New South Wales	815	0.1	58	541	137	27
Victoria	1	651	42	433	256	24
Queensland	581	0	120	466	149	23
Western Australia	120	0	18	310	498	16
South Australia	72	0	12	119	141	6
Tasmania	15	0	39	40	10	2
Northern Territory	0	0	0	75	43	2
Total	1 603	651	303	1 983	1 233	100
Share of total	27.8%	11.3%	5.2%	34.4%	21.4%	

a State breakdown does not include wind and solar PV, which are included in the total. **b** Excluding wind, solar PV and biogas.

Source: ABARES, *Australian energy statistics.*

Primary energy consumption in Australia, by fuel



Source: ABARES, *Australian energy statistics.*

Australian energy consumption by fuel

	2004–05 PJ	2005–06 PJ	2006–07 PJ	2007–08 PJ	2008–09 PJ
Consumption of fuels					
Black coal	1 618	1 639	1 686	1 655	1 612
Brown coal/lignite	689	705	611	630	651
Coke	77	76	77	78	64
Coal by-products	76	77	75	77	57
Brown coal briquettes	5	4	3	3	3
Liquid biofuels	1	1	2	5	8
Wood, woodwaste	92	90	93	108	102
Bagasse	108	109	111	112	110
Refinery input	1 541	1 407	1 503	1 462	1 482
Petroleum products	1 943	1 968	2 000	2 062	2 039
Natural gas	1 052	1 108	1 187	1 237	1 250
Town gas	6	7	7	4	3
Solar hot water	3	2	6	7	8
Total electricity	884	891	904	929	939
of which hydro electricity	56	58	52	43	44
wind energy	3	6	9	11	14
solar electricity	0.3	0.4	0.4	0.4	0.6
Production of derived fuels					
Coke	103	98	98	98	74
Coal by-products	76	77	78	79	57
Brown coal briquettes	4	4	3	3	3
Petroleum products [a]	1 648	1 429	1 534	1 557	1 537
Town gas	5	5	5	4	3
Thermal electricity	813	847	857	863	881
Total energy consumption [b]	5 447	5 625	5 690	5 763	5 773

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: ABARES, *Australian energy statistics*.

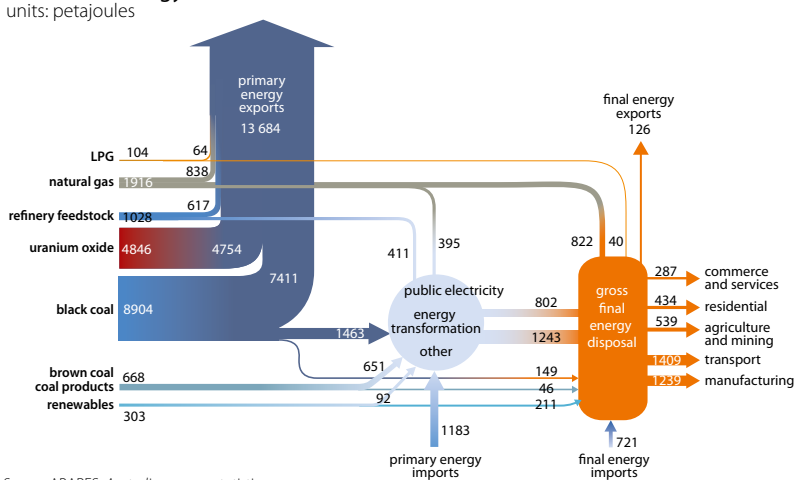
Energy consumption, by industry

Australia's primary energy consumption is estimated to have risen by 0.2 per cent to 5773 petajoules in 2008–09. The diagram of Australia's energy flows is a simplification of the energy supply and disposal table on pages 16 and 17. It shows the movement of primary fuels from the point at which they become available, through Australia's energy conversion sectors, until the 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 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. The next largest energy-consuming sectors were the mining, residential, and commercial and services sectors.

Australian energy flows, 2008–09

units: petajoules



Source: ABARES, *Australian energy statistics*.

Australian energy supply and disposal 2008–09

	coal and coal by-products PJ	natural gas, CSM PJ	crude oil and ORF PJ	propane, butane, LPG PJ	refined products PJ	liquid/ gas biofuels PJ
Supply						
Primary indigenous	9 572.0	1 915.9	1 028.1	104.1		23.8
plus all imports		238.3	944.4	25.7	695.6	
less all exports	7 410.7	838.3	617.1	64.2	125.8	
less stock changes and discrepancies	–91.9	82.4	–82.8	11.4	79.0	
Total domestic availability	2 253.3	1 233.4	1 438.2	54.2	490.8	23.8
less conversions						
Coke ovens	10.3				0.7	
Briquetting	2.6					
Petroleum refining	0.2	20.6	1 480.6	–38.0	–1 442.7	
Gas manufacturing		0.4		–2.3		
Electricity generation [a]	2 009.9	367.7	3.3	0.1	31.4	15.4
Other conversion [b]	35.7		–49.1	–6.8	14.3	
Fuel use in conversion		22.8		2.3	111.1	
Final domestic availability [c]	194.5	821.9	3.3	98.9	1 775.9	8.4
Disposal						
Agriculture		0.1		1.8	86.9	
Mining	6.9	244.9	2.0	1.7	114.3	
Food, beverages, textiles	10.3	40.1	0.5	1.1	1.9	0.9
Wood, paper and printing	10.8	21.3		0.8	0.6	
Chemical	7.6	86.1		9.5	58.7	
Iron and steel	48.0	21.2		0.5	1.9	
Non-ferrous metals	74.4	139.3	0.8	0.6	58.8	
Other industry	30.1	77.0		5.7	6.1	1.2
Construction		3.1		0.2	22.2	
Road transport		1.8		59.5	1 003.3	5.6
Rail transport					34.1	
Air transport					230.3	
Water transport	4.8	0.1			60.3	
Commercial and services	1.5	47.1		3.4	31.3	0.7
Residential	0.0	139.8		14.1	1.2	
Lubes, bitumen, solvents					63.8	
Gross final energy disposal	194.5	821.9	3.3	98.9	1 775.9	8.4

continued...

Australian energy supply and disposal 2008–09 *continued*

	biomass	wind electricity	solar	hydro-electricity	total electricity	U_3O_8 uranium	total
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Supply							
Primary indigenous	212.1	14.2	8.8	44.3		4 846.1	17 769.0
plus all imports							1 904.0
less all exports						4 753.6	13 809.6
less stock changes and discrepancies						92.5	90.7
Total domestic availability	212.1	14.2	8.8	44.3			5 772.6
less conversions							0.0
Coke ovens					0.1		11.1
Briquetting					0.2		2.8
Petroleum refining					6.8		27.6
Gas manufacturing							–1.9
Electricity generation **a**	18.1	14.2	0.6	44.3	–890.7		1 613.7
Other conversion **b**					–48.8		–54.6
Fuel use in conversion					130.4		266.6
Final domestic availability c	194.1		8.2		801.9		3 907.1
Disposal							0.0
Agriculture					6.2		95.1
Mining					73.7		443.6
Food, beverages, textiles	114.9				30.2		199.9
Wood, paper and printing	18.6				21.7		73.9
Chemical					15.1		177.0
Iron and steel					28.4		100.0
Non-ferrous metals	2.4				176.4		452.7
Other industry	0.9				24.5		145.5
Construction					0.3		25.8
Road transport							1 070.2
Rail transport					8.8		43.0
Air transport							230.3
Water transport							65.2
Commercial and services	0.3		0.3		202.8		287.4
Residential	57.0		8.0		213.7		433.8
Lubes, bitumen, solvents							63.8
Gross final energy disposal	194.1		8.2		801.9		3 907.1

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: 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. The electricity produced is included under 'electricity generation' and 'other conversion'. Totals may not add because of rounding

Source: ABARES, *Australian energy statistics*

Energy consumption in Australia by industry

	1974–75 PJ	1979–80 PJ	1989–90 PJ	1999–00 PJ	2008–09 PJ
Agriculture	39	47	55	72	95
Mining	65	81	160	273	429
Manufacturing	928	965	1 067	1 192	1 257
Electricity generation	540	743	1 066	1 427	1 744
Construction	29	38	41	29	26
Transport	701	825	1 012	1 267	1 435
Commercial **a**	87	104	151	219	277
Residential	246	262	322	392	434
Other **b**	59	66	69	77	76
Total	2 695	3 131	3 946	4 971	5 773

a Includes ANZSIC Divisions F, G, H, J, K, L, M, N, O, P, Q and the water, sewerage and drainage industries. **b** Includes consumption of lubricants and greases, bitumen and solvents, as well as energy consumption in the gas production and distribution industries.
Note: Totals may not add because of rounding.
Source: ABARES, *Australian energy statistics.*

Australian consumption of petroleum products

	2005–06 ML	2006–07 ML	2007–08 ML	2008–09 ML	2009–10 ML
LPG **a**	4 050	4 038	4 024	3 996	3 795
Automotive gasoline	19 048	19 251	19 234	18 734	18 644
Avgas	86	90	88	96	80
Turbine fuel	5 359	5 837	6 070	6 173	6 675
Kerosene	27	32	43	25	29
Heating oil	25	15	12	7	7
Automotive diesel oil	15 804	17 028	18 245	18 587	19 044
Industrial diesel fuel	19	15	11	16	26
Fuel oil	1 586	1 513	1 583	1 423	982
Lubes and greases	451	421	435	437	457
Bitumen	805	808	785	809	814
Other **b**	973	699	258	311	376
Total products **c**	48 234	49 746	50 788	50 614	50 928

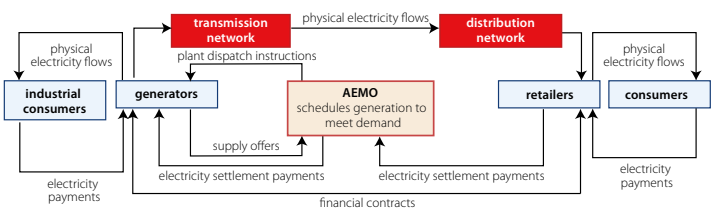
a Includes LPG used as petrochemical feedstock. **b** Includes other refined products, crude oil used as a fuel and specialty feedstocks. **c** Some petroleum products are produced from the conversion of other petrochemical products. *Sources:* RET, *Australian petroleum statistics.*

The electricity industry is one of Australia's largest industries, contributing 1.4 per cent to Australian industry value added in 2008–09. The industry consists of generators, transmission and distribution networks and retailers. Over the 10 years from 1998–99 to 2008–09, Australia's electricity use increased at an average rate of 2.5 per cent a year.

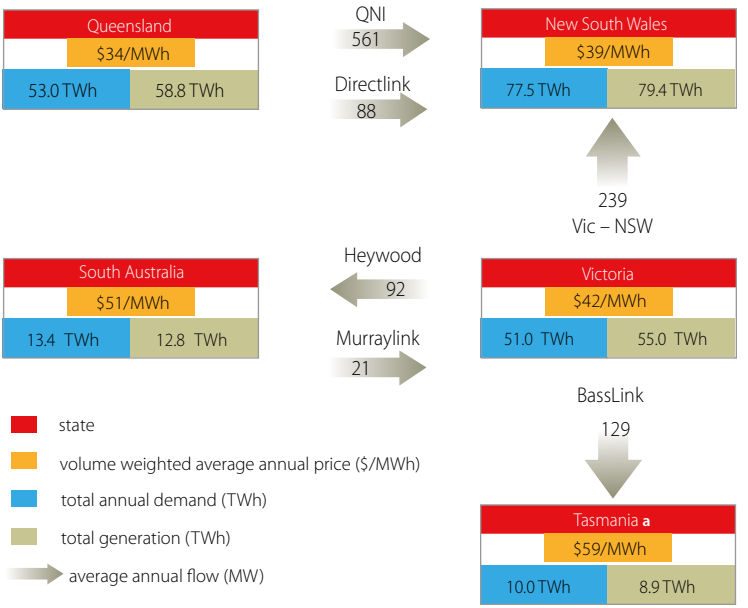
Industry structure

The current structure of Australia's eastern electricity market was shaped by industry reforms that began in the early 1990s. A key element of these reforms was the National Electricity Market (NEM), which began operation in 1998. The NEM allows market determined power flows across the Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria and Tasmania. Western Australia and the Northern Territory are not connected to the NEM, primarily because of their geographic distance from the east coast. The NEM operates as a wholesale spot market in which generators and retailers trade electricity through a gross pool managed by the Australian Energy Market Operator (AEMO), which aggregates and dispatches supply to meet demand. In addition to the physical wholesale market, retailers may also contract with generators through financial markets to better manage any price risk associated with trade on the spot market.

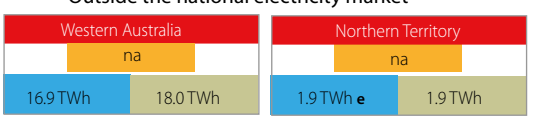
Market structure



Regional electricity market activity, 2009–10



Outside the national electricity market



a Officially connected to the national electricity market in May 2006.
e ABARES estimate.
na Not available.
Sources: Global Roam, *NEM Review*; WA Office of Energy; NT Power and Water Corporation, *Annual Report 2010.*

The regulation of electricity transmission and distribution networks in the NEM and covered gas pipelines are the responsibility of the Australian Energy Regulator (AER). The AER is also responsible for reporting on generator bidding behaviour in the NEM and compliance with the National Electricity Rules and National Gas Rules. This allows a consistent near-national approach to regulate Australia's energy markets. Western Australia retains state-based regulation of its electricity sector and, while the National Gas Access Law came into effect in Western Australia on 1 January 2010, the WA legislation is limited to regulatory matters and adopts the local Economic Regulation Authority and Energy Disputes Arbitrator to regulate the market in Western Australia instead of the AER.

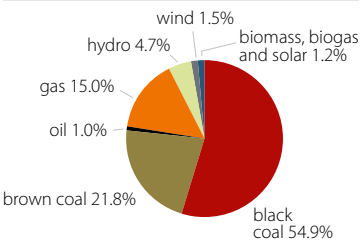
Production

Around 261 terawatt hours of electricity (including off-grid electricity) was generated in Australia in 2008–09. Over the past five years, the industry has increased electricity generation by 6 per cent and the number of customers has increased by around 7 per cent. Average capacity utilisation has remained relatively constant over the past five years at between 52 and 56 per cent.

Most of Australia's electricity is produced using coal, which accounted for 77 per cent of total electricity generation in 2008–09. 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.

Natural gas is Australia's second largest fuel source for electricity generation, accounting for 15 per cent of electricity generation in 2008–09.

Australian electricity generation by fuel, 2008–09



Source: ABARES.

Australian electricity generation by fuel

	2004–05 TWh	2005–06 TWh	2006–07 TWh	2007–08 TWh	2008–09 TWh
Thermal					
Black coal	130.0	131.0	138.7	141.7	143.2
Brown coal	61.1	61.6	57.2	55.7	56.9
Oil	1.9	2.4	2.1	2.7	2.6
Gas	32.3	30.8	32.0	37.7	39.1
Total thermal	225.3	225.8	230.1	237.8	241.8
Renewables					
Hydro	15.3	15.7	14.3	11.9	12.3
Wind	0.9	1.7	2.6	3.1	3.8
Solar	0.1	0.1	0.1	0.2	0.3
Biomass	1.1	1.1	1.1	1.2	1.5
Biogas	0.8	0.9	0.9	1.0	1.3
Total renewables	18.1	19.5	19.0	17.4	19.2

Source: ABARES.

Key performance indicators for the Australian electricity industry

	Unit	2001 –02	2002 –03	2003 –04	2004 –05	2005 –06	2006 –07	2007 –08	2008 –09
Generation capacity	GW	44	44	45	45	45	47	49	51
Capacity utilisation	%	52	54	54	55	56	55	54	52
Electricity generation **a**	TWh	201	206	213	217	220	227	228	230
Employment	('000s)	36	37	37	38	41	44	46	44
Number of customers	('000s)	8 969	9 093	9 268	9 351	9 530	9 684	9 892	10 011
Wholesale price **b**									
- Nominal	c/kWh	3.64	3.58	3.27	3.73	3.92	6.17	5.37	4.54
- Real **c**	c/kWh	4.45	4.26	3.79	4.22	4.30	6.58	5.54	4.54
System minutes not supplied **d**	mins	6.91	8.04	4.58	4.43	3.70	5.80	3.51	4.13
System energy not supplied	MWh	2 807	3 272	1 704	560	1 020	1 915	994	2 102
Distribution losses	%	5.80	5.90	5.70	5.90	5.90	5.60	5.10	5.50

a Excludes off-grid electricity. **b** Volume weighted - average price (National Electricity Market). **c** 2008–09 A$.
d Average minutes - excludes Northern Territory.
Sources: Energy Supply Association of Australia, *Electricity Gas Australia*; ABS.

Capacity

In 2008–09, Australia's principal electricity generation capacity was around 51 gigawatts. The majority of Australia's electricity generation is supplied by steam plants, using coal or natural gas as fuels. Most of Australia's black coal fuelled generation capacity is located in New South Wales and Queensland, while Queensland also has the largest generation capacity of gas fuelled plants.

Australian thermal electricity generation capacity
by plant and fuel type, 2008–09

	NSW a	Vic	Qld b	SA	WA c	Tas	NT	Aus
	MW	MW	MW	MW	MW	MW	MW	MW
Steam								
– black coal	11 730	0	8 805	0	1 537	0	0	22 072
– brown coal	0	6 555	0	780	0	0	0	7 335
– natural gas	0	510	132	1 280	268	0	0	2 190
– multi-fuel	0	0	0	0	640	0	0	640
Reciprocating engine	0	0	0	50	0	0	76	126
Open cycle gas turbine								
– conventional gas	640	1 321	907	733	1 441	165	322	5 529
– coal seam methane	0	0	450	0	0	0	0	450
– oil products	50	0	338	113	83	0	30	614
– multi-fuel	0	0	0	0	586	0	0	586
Combined cycle gas turbine								
– conventional gas	595	0	215	663	680	210	131	2 494
– coal seam methane	0	0	625	0	0	0	0	625

a Includes the ACT. **b** Includes generating capacity at Mt Isa. **c** Includes plants owned by Western Power Corporation (now Verve Energy) in the South West Interconnected System, and excludes plants operated under power purchase agreements.
Source: Energy Supply Association of Australia, *Electricity Gas Australia 2009*.

As at the end of October 2010, there were 16 electricity generation projects at an advanced stage of development and an additional 148 projects at a less advanced stage. The combined capacity of the 16 advanced projects was 2297 megawatts, of which around half will be supplied by wind generation and 38 per cent will be supplied by conventional gas.

Australian major power network transfer capabilities 2008–09

interconnector	location	forward capability MW	reverse capability MW
New South Wales to Queensland (QNI)	Armidale to Braemar	483	1 078
New South Wales to Queensland (Terranora)	Terranora to Mullumbimby	115	245
Snowy to New South Wales	Murray to Dederang	3 114	1 134
Victoria to Snowy	Buronga to Red Cliffs	1 274	1 780
Victoria to South Australia (Heywood)	Heywood to Tailem Bend	460	300
Victoria to South Australia (Murraylink)	Red Cliffs to Berri	220	180
Tasmania to Victoria (Basslink)	Seaspray to Georgetown	630	480

Transmission and distribution	overhead	underground
length (km)	790 736	113 705

Source: Energy Supply Association of Australia, *Electricity Gas Australia 2009*.

The NEM is connected by seven major transmission interconnectors. These interconnectors link the electricity networks in Queensland, New South Wales, Victoria, South Australia and Tasmania. The NEM electricity transmission and distribution networks consist of around 790 700 kilometres of overhead transmission and distribution lines and around 113 700 kilometres of underground cables. The table below identifies major committed transmission projects in the NEM. There are a number of projects that are under development to expand the capabilities of the interconnector system.

Major committed transmission projects for Australia's National Electricity Market

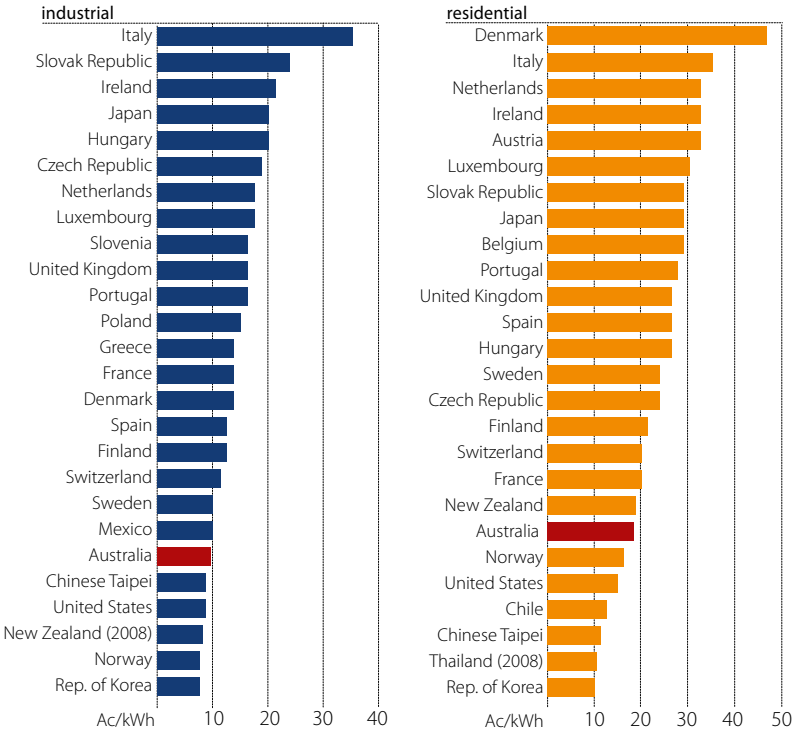
region	project details	start-up
Queensland	Construction of a Strathmore–Ross 275 kV line.	Summer 2010–11
South Australia	Construction of a 275/132kV injection point to provide supply to Dorrien and feed Roseworthy.	Summer 2010–11
New South Wales	Installation of real-time thermal rating equipment on several 330kV circuits in New South Wales.	From 2010 to 2014
Queensland	Installation of a 220 MVAr capacitor bank at the Belmont 275 kV substation, and a 50 MVAr capacitor bank at each of Loganlea and Ashgrove West 110 kV substations.	Summer 2011–12
South Australia	Construction of a 275/66kV connection point at Mount Barker South.	Summer 2012–13
South Australia	Installation of a second 160MVA transformer at Cultana to feed the lower Eyre Peninsula.	Winter 2015
South Australia	Installation of a 100MVAr capacitor bank at the Tungkillo switching station.	Winter 2015

Source: AEMO 2009, *National Transmission Statement 2009*.

Prices

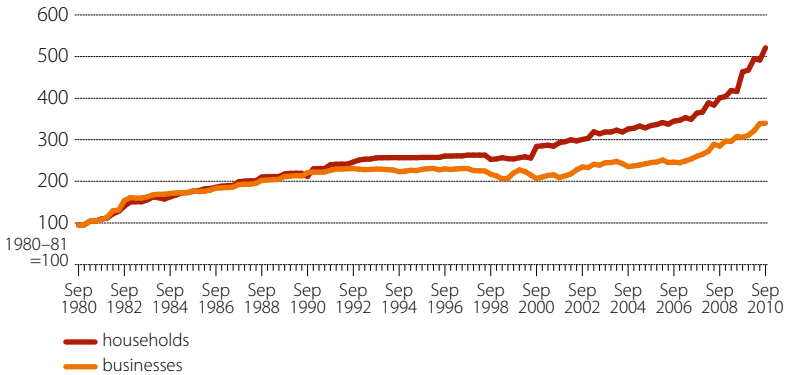
Australia has low electricity prices compared with most other OECD countries. Although Australian electricity prices were above those in some countries such as the United States and the Republic of Korea in 2009, they were below those in most European countries.

World electricity prices, selected countries, 2009 a



a Australian prices estimated using 2004 prices from IEA Energy Prices and Taxes, and ABS index of electricity prices for households and businesses.
Sources: IEA, *Energy Prices and Taxes 2010*; ABS.

Electricity prices for households and businesses
quarterly index



Sources: ABS, *Producer Price Indexes Australia*, cat. no. 6427.0; *Consumer Price Index Australia*, cat. no. 6401.0.

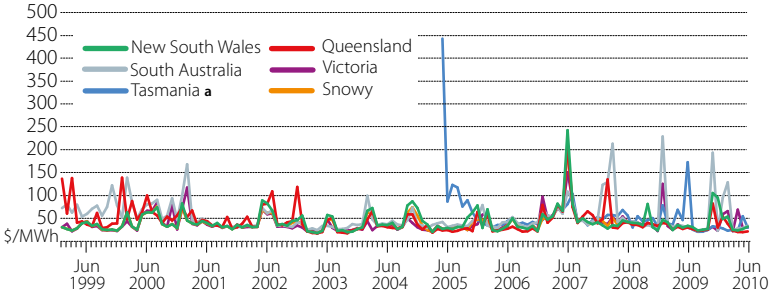
Electricity prices paid by households have increased at a faster rate than those paid by Australian businesses since 1991. Since the beginning of 2008, the difference in the growth rate of household and business prices has widened further.

Average wholesale electricity prices in the NEM increased in 2007, largely as a result of record average demand over the year combined with a tight supply situation due to the drought at that time. However, wholesale electricity prices have generally moderated since 2007. In 2009, electricity prices averaged around 6 per cent lower than in 2008.

Occasional price spikes are often caused by factors such as widespread heatwaves, industrial disputes or generator malfunctions. For example, electricity spot prices in Tasmania spiked in June 2009, mainly because of lower water inflows into hydroelectric plants.

Spot market prices in the National Electricity Market

average monthly wholesale, in 2009–10 dollars



a Tasmania joined the National Electricity Market in 2005.

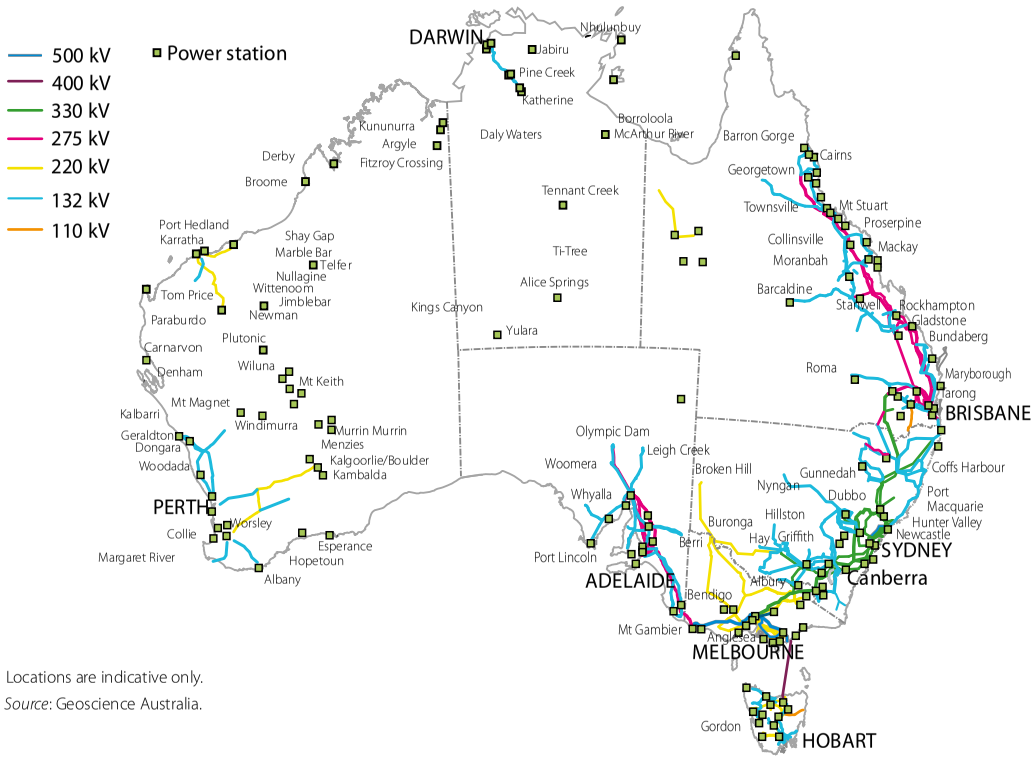
Source: AEMO.

Principal generation businesses in Australia 2009–10

	generation GWh	share of total generation %
New South Wales [a]		
Macquarie Generation	26 081	11.43
Delta Electricity	23 435	10.27
Eraring Energy	14 242	6.24
Snowy Hydro	3 930	1.72
Marubeni	1 021	0.45
TRUenergy	242	0.11
Redbank Project Pty Ltd	102	0.04
Victoria		
Loy Yang Power	17 345	7.60
International Power / Transfield Services	11 500	5.04
TRUenergy	11 313	4.96
International Power / Mitsui	8 595	3.77
Alcoa	1 327	0.58
Energy Brix	1 266	0.55
Prime Infrastructure / Babcock & Brown	725	0.32
Snowy Hydro	267	0.12
Alinta	67	0.03
AGL	50	0.02
Eraring Energy	20	0.01
Queensland		
CS Energy	13 455	5.89
Stanwell	9 210	4.04
Tarong Energy	7 905	3.46
Transfield Services / Comalco	7 241	3.17
OzGen / Marubeni	6 280	2.75
CS Energy / OzGen	5 780	2.53
Tarong Energy / TEPCO / Mitsui	2 312	1.01
Queensland *continued*		
Wambo Power	1 779	0.78
Transfield Services	1 769	0.78
ERM Power / Arrow Energy	1 698	0.74
BG Group ANZ Infrastructure Services	295	0.13
Origin Energy	262	0.11
Unknown	8 358	3.66
South Australia		
Babcock & Brown / Alinta	4 545	1.99
International Power	2 993	1.31
TRUenergy	2 131	0.93
Origin Energy / ATCO Power	1 178	0.52
AGL	605	0.27
Origin Energy	486	0.21
TrustPower	358	0.16
Tasmania		
Hydro Tasmania	7 770	3.40
Aurora Energy	1 077	0.47
Western Australia [b]		
South West Interconnected System	17 016	7.44
North West Interconnected System	468	0.20
Horizon Power	474	0.21
Northern Territory [b]		
Power and Water Corporation	1 599	0.70

a Includes the Australian Capital Territory. **b** Not part of the National Electricity Market.
Sources: Global Roam, *NEM Review*; WA Office of Energy; NT Power and Water Corporation, *Annual Report 2009*.

Transmission lines and generators



Locations are indicative only.

Source: Geoscience Australia.

Australia has access to abundant renewable energy sources that are used for heating, electricity generation and transportation. Renewable energy accounts for 5 per cent of Australia's primary energy consumption. Primary consumption and production of renewable energy include the quantity of fuel used in producing secondary forms of energy, such as electricity, and the associated losses in producing these secondary energy sources, as well as the fuels used directly by end users, such as the burning of fire wood.

Production

At present, renewable sources used to generate electricity include hydro, biomass, biogas, wind energy and solar energy. Renewable energy contributes around 7 per cent to Australian electricity generation, with 4.7 per cent sourced from hydroelectricity (renewable electricity data are available on page 22 of this report). Wind energy has grown strongly over recent years and is now 1.5 per cent of total electricity generation. Emerging renewable energy technologies that are yet to be commercially deployed include large-scale solar energy plants and geothermal generation technologies.

Australian production of renewable energy [a]

	2003–04 PJ	2004–05 PJ	2005–06 PJ	2006–07 PJ	2007–08 PJ	2008–09 PJ
Bagasse	101.1	108.3	109.1	110.8	111.9	110.1
Biogas and biofuels	10.1	8.7	9.4	10.2	17.6	23.8
Hydroelectricity	58.8	56.2	57.7	52.3	43.4	44.3
Solar hot water	2.6	2.6	2.4	6.0	6.5	8.2
Solar electricity	0.3	0.3	0.4	0.4	0.4	0.6
Wind	1.6	3.2	6.2	9.4	11.1	13.7
Wood and woodwaste	97.3	91.5	90.3	92.8	96	102.0
Total	271.7	270.8	275.5	281.9	286.9	302.7

a Includes both electricity and heat.
Source: ABARES, *Australian energy statistics.*

Australian production of renewable energy (including electricity generation, conversion losses and direct fuel use) is dominated by hydroelectricity, bagasse, wood and wood waste, which combined accounted for 85 per cent of renewable energy production in 2008–09. Wind energy, solar energy 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 accounts for 1.8 per cent of final energy consumption in the residential sector.

Renewable energy production increased at an average rate of 2 per cent a year in the five years from 2003–04 to 2008–09. In 2008–09, renewable energy production increased by 6 per cent. While still a small contributor, solar electricity experienced the strongest growth in 2008–09, increasing by 40 per cent. Solar hot water also increased strongly, with a 27 per cent increase from 6.5 petajoules in 2007–08 to 8.2 petajoules in 2008–09.

Capacity

The distribution of renewable energy production facilities in Australia reflects the climatic characteristics of different regions. Hydroelectricity capacity

Capacity of renewable electricity generation in Australia 2010

	biogas	bagasse	wood-waste	hydro	wind	solar	ocean and geothermal	other [b]	total
	MW	MW	MW	MW	MW	MW	MW	MW	MW
NSW [a]	74	43	42	4 293	179	5.1		3	4 639
Vic	83			769	458	1.2	0.2	34	1 344
Qld	19	377	15	667	12	0.5	0.1	4	1 095
SA	22		10	4	868	1.9			906
WA	28		6	32	203	0.9			270
Tas	4		0.0	2 284	144	0.2			2 432
NT	1				0.1	1.1			2
Other [c]						177			177
Aus	231	420	73	8 048	1 864	188	0.3	41	10 865

a Includes the ACT. **b** Mixed biomass feedstocks, municipal waste and black liquor. **c** Solar PV installations at unspecified locations.
Sources: Geoscience Australia; Watt, M 2010, *National Survey Report of PV Power Applications in Australia 2009*.

in Australia is located mostly in New South Wales, Tasmania, Queensland and Victoria, while wind farms are most common in South Australia and Victoria. 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.

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 Renewable Energy Target (RET). The expanded RET began on 1 January 2010, committing the Australian Government to a target of 20 per cent of Australia's electricity supply coming from renewable energy sources by 2020. The RET scheme requires an additional 45 000 gigawatt hours a year of renewable energy to be produced by 2020. The target will be maintained at that level until 2030 when the RET scheme is scheduled to

Increase in renewable energy under MRET 1997–2009 a

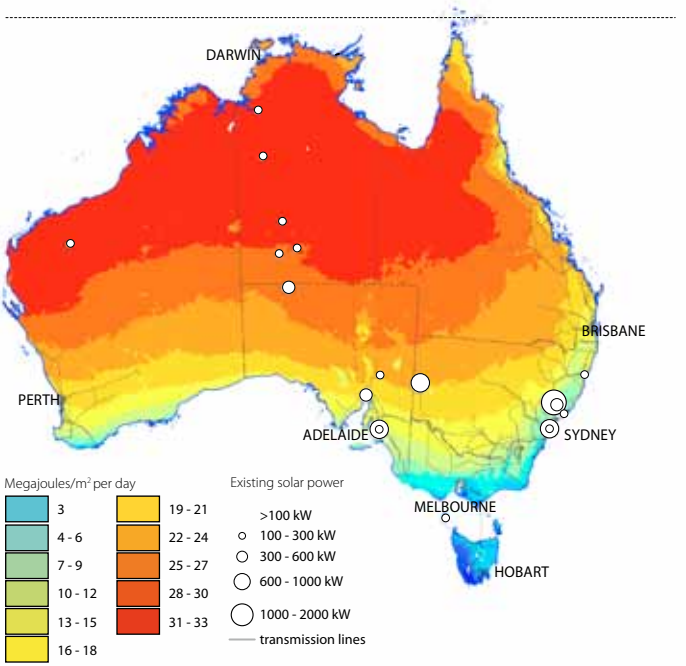
	increase		baseline generation
	GWh	share %	GWh
Bagasse	669	4.3	497
Black liquor	104	0.7	154
Hydro	225	1.4	15 629
Landfill gas	739	4.7	264
Sewage gas	100	0.6	5
Solar electricity	1 738	11.1	0.01
Solar hot water	7 501	48.1	0
Wind	4 212	27.0	5
Wood waste	175	1.1	33
Other b	121	0.8	0.1
Total	15 584	100	16 588

a Reported annual energy generation under the Mandatory Renewable Energy Target scheme, above baseline levels in 1997. **b** Includes municipal waste, food waste, agricultural waste and energy crops.
Source: Office of the Renewable Energy Regulator, *REC Registry*, www.rec-registry.gov.au.

end. In June 2010, legislation was passed to separate the RET scheme into two parts from 1 January 2011—the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET).

Before the RET scheme, the Mandatory Renewable Energy Target (MRET), which was in place until 31 December 2009, required an increase in electricity generation from renewable energy sources of 9500 gigawatt hours a year by 2010. The renewable energy sources that have experienced the greatest growth under the MRET are solar hot water, wind energy and solar electricity. In 2009, Australia's annual use of solar hot water was 7501 gigawatt hours higher than in 1997. Electricity generation from wind energy increased by 4212 gigawatt hours between 1997 and 2009.

Annual average solar radiation

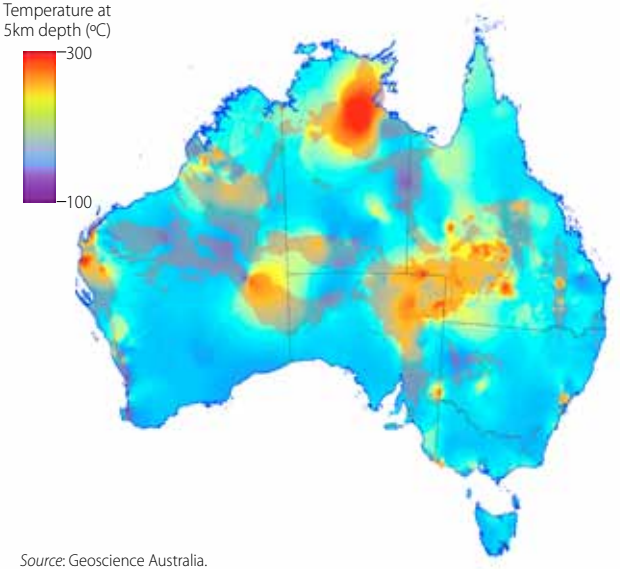


Source: Geoscience Australia.

Significant growth in renewable electricity generation capacity is planned for the next few years. As at the end of October 2010, there were 10 renewable electricity projects at an advanced planning stage, eight of which were wind projects and two of which were hydro projects. A further 99 renewable energy projects were at a less advanced stage of development, 79 of which were wind energy projects (ABARES–BRS 2010, Electricity generation major development projects - October 2010 listing).

There is growing interest in solar energy for electricity generation. There are several new solar plants being considered as part of the Australian Government's Solar Flagships Program, with successful applicants expected to be announced in mid-2011. Four ocean energy pilot projects have been completed in Australia, with several other proposed projects in the early

Australian geothermal energy potential

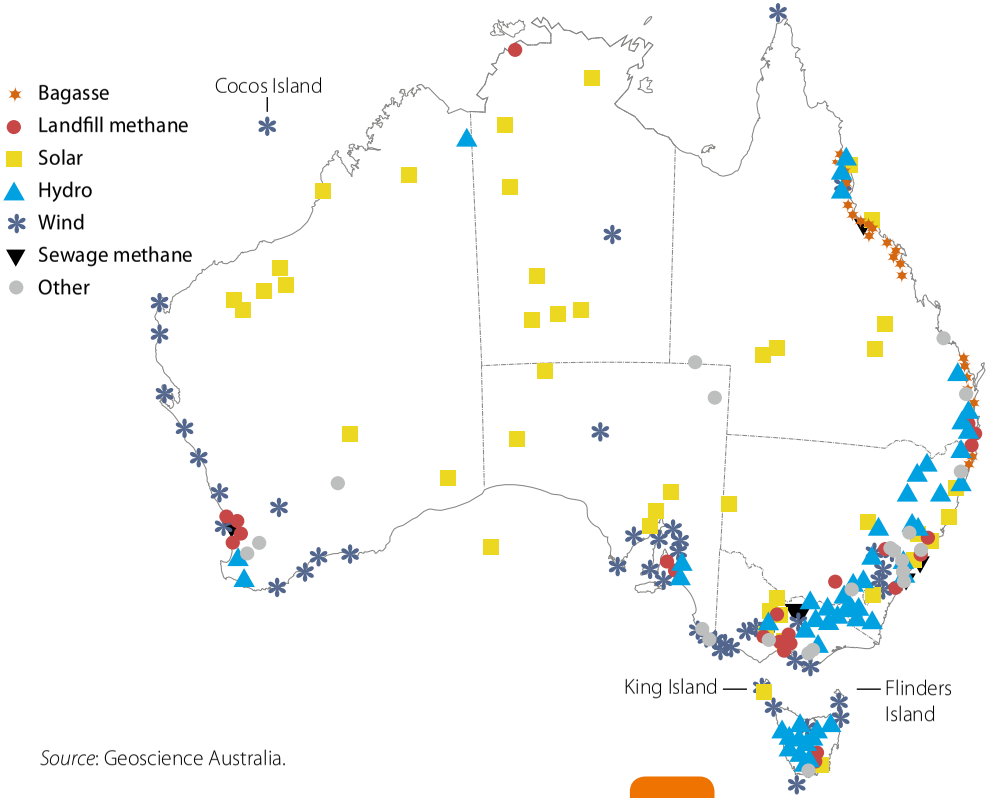


Source: Geoscience Australia.

stages of development. Geothermal energy, in the form of hot rock and hot sedimentary aquifer resources, is a renewable energy source that is currently relatively undeveloped. There is one geothermal electricity project in operation in Australia, at Birdsville in Queensland (see Appendix 1), and there are several proposed geothermal projects at early stages of development.

Renewable energy generators

operating plants



Source: Geoscience Australia.

Coal is Australia's largest commodity export, earning around $36 billion in 2009–10. 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 Australia's domestic energy needs, accounting for around 77 per cent of Australian electricity generation in 2008–09.

Production

Australia accounts for around 6 per cent of world black coal production, 97 per cent of which is sourced from New South Wales and Queensland. The majority of Australia's metallurgical (coking) coal is produced in Queensland, while production in New South Wales is largely classed as thermal (steaming) coal. Around three-quarters of this output is sourced from open cut mines.

Australian coal production by state [a]

	2005–06	2006–07	2007–08	2008–09	2009–10
	Mt	Mt	Mt	Mt	Mt
Brown coal					
Vic	67.7	65.6	66.0	68.3	68.7
Total	67.7	65.6	66.0	68.3	68.7
Black coal					
NSW	124.6	130.9	135.0	135.9	147.4
Qld	171.7	184.1	180.9	186.4	198.1
Tas	0.4	0.6	0.6	0.6	0.6
WA	6.7	6.0	6.2	7.0	6.8
SA	3.5	3.9	3.9	3.8	3.8
Total	306.9	325.4	326.6	333.8	356.7

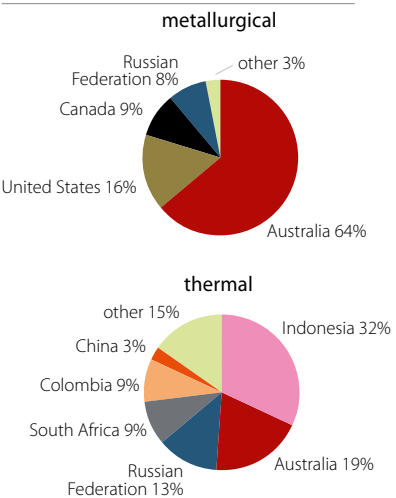
a Saleable production.
Source: ABARES, *Australian mineral statistics.*

Australian black coal production increased at an average annual rate of 3.8 per cent between 2005–06 and 2009–10, encouraged by strong global import demand. This growth was supported by the commissioning of new mines, rail networks and ports 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 investment in new mining and export capacity. Despite the economic downturn in many countries in 2008 and 2009, investment in the Australian coal mining sector has remained strong. As at November 2010, there were 12 committed coal mining projects planned in Australia (see Appendix 1).

Trade

More than three-quarters of Australia's black coal production is exported. Australia accounts for almost one-third of world black coal exports (64 per cent of metallurgical coal exports and 19 per cent of thermal coal exports).

World coal trade, major exporters, 2009



Source: ABARES, *Australian commodities.*

In the past, infrastructure has been a constraint on Australian coal exports; however, recent expansions to port capacity have begun to alleviate some of these constraints. For example, the 17 million tonne annual capacity expansion at Dalrymple Bay will support growth in metallurgical coal exports, and the Newcastle Coal Infrastructure Group's 30 million tonne annual capacity expansion at the Port of Newcastle will facilitate increased thermal coal exports from New South Wales.

The majority of Australia's metallurgical coal exports are destined for Asia and Europe, where they are used for steel

manufacture. The largest importers of Australian metallurgical coal are Japan, India, China, the Republic of Korea and the European Union. Australia's thermal coal exports are mainly destined for Japan, the Republic of Korea, Chinese Taipei and China. The fastest growing export destination for both metallurgical and thermal coal is China, which imported 18 times more metallurgical coal from Australia in 2009–10 than in 2007–08, and imported nine times more thermal coal from Australia in 2009–10 than in 2007–08.

Australian coal exports by type by destination

	2005–06	2006–07	2007–08	2008–09	2009–10
	Mt	Mt	Mt	Mt	Mt
Metallurgical coal					
Brazil	3.17	3.05	3.87	4.19	4.23
China	2.86	2.97	1.53	14.75	27.28
Chinese Taipei	7.72	8.04	6.39	2.66	5.36
European Union 27	24.34	24.87	24.51	14.69	15.61
India	16.39	19.61	24.23	24.28	31.38
Japan	44.22	48.86	50.20	42.22	48.46
Korea, Rep. of	7.70	6.25	8.36	13.05	15.86
Other	14.08	18.31	17.83	9.40	9.08
World	120.48	131.97	136.92	125.24	157.26
Thermal coal					
China	3.99	3.22	1.48	8.40	13.91
Chinese Taipei	13.21	16.23	18.56	20.30	19.55
European Union 27	2.32	3.81	2.15	3.72	0.28
Japan	59.33	58.64	66.92	62.58	66.41
Korea, Rep. of	20.24	15.06	18.55	30.14	24.84
Other	11.74	14.66	7.41	11.22	9.98
World	110.82	111.62	115.07	136.36	134.97

Source: ABARES, *Australian commodity statistics*.

Australian metallurgical coal exports recorded the largest fall on record in 2008–09 as a result of the global economic slowdown (down by 9 per cent), then recovered to increase by 26 per cent in 2009–10. Continued growth in Chinese and Indian steel production, and recovering steel production in developed economies, supported higher global consumption of metallurgical coal. As a result, exports to China and India increased to

record levels and import demand from developed economies improved, after having been negatively affected by adverse economic conditions in 2008–09. This has underpinned growth in Australian metallurgical coal exports, which grew at an average annual rate of 7 per cent from 2005–06 to 2009–10.

Over the period 2005–06 to 2009–10, Australia's thermal coal exports grew at an average annual rate of 5 per cent. This strong growth was supported strongly by import demand from Asian economies including Japan, China and Chinese Taipei. In 2009–10, Australian exports declined marginally, as infrastructure constraints and adverse weather conditions limited export growth. The commissioning of the Newcastle Coal Infrastructure Group's export terminal at Newcastle in early 2010 and a planned second stage expansion in 2013 will alleviate infrastructure related issues.

In 2009–10, earnings from Australian coal exports decreased by 33 per cent from the previous year, primarily resulting from lower negotiated contract prices for both metallurgical and thermal coal. Earnings from metallurgical coal exports declined by 33 per cent to $25 billion, and thermal coal export earnings were $12 billion, 34 per cent lower than the previous year. A detailed outlook for the metallurgical and thermal coal industries can be found in the ABARES quarterly journal *Australian commodities*.

Prices

Beginning in April 2010, contract prices for most metallurgical coal from major producers were set on a quarterly basis, departing from the decades-old annual price-setting system. The majority of thermal coal contract prices are still set on a Japanese Fiscal Year (JFY, April to March) basis.

Metallurgical coal contract prices for the first three quarters of JFY 2010 have been settled between Australian producers and Japanese steel mills, the average of which represents a 65 per cent increase on the previous year. Thermal coal contract prices for JFY 2010 were settled at US$98 a tonne, 39 per cent higher than the previous year. Contract prices for hard coking, semi-soft and thermal coal have risen strongly in real terms, underpinned by strong increases in demand from developing countries. Over the past five years, real contract prices have risen by 36 per cent, 111 per cent and 40 per cent, respectively.

Australian exports of coal

		2005–06	2006–07	2007–08	2008–09	2009–10
Metallurgical coal, high quality						
Volume	Mt	77.48	82.81	83.65	79.63	97.72
Value	2009–10 $m	13 704	12 014	11 447	25 934	17 060
Unit value	2009–10 $/t	176.86	145.07	136.84	325.69	174.59
Excluding high quality						
Volume	Mt	42.99	49.15	53.27	45.61	59.55
Value	2009–10 $m	5 391	4 396	5 478	11 736	7 465
Unit value	2009–10 $/t	125.38	89.44	102.85	257.31	125.37
Total metallurgical coal						
Volume	Mt	120.48	131.97	136.92	125.24	157.26
Value	2009–10 $m	19 095	16 410	16 925	37 670	24 526
Unit value	2009–10 $/t	158.49	124.35	123.61	300.79	155.95
Thermal coal						
Volume	Mt	110.82	111.62	115.07	136.36	134.97
Value	2009–10 $m	8 092	7 374	8 828	18 302	11 884
Unit value	2009–10 $/t	73.02	66.06	76.72	134.21	88.05

Source: ABARES, *Australian mineral statistics.*

Coal prices [a]

	2005–06	2006–07	2007–08	2008–09	2009–10
Metallurgical coal, hard [b]					
US$/t	115.00	98.00	300.00	128.00	208.50
A$/t	150.59	112.95	377.68	150.07	227.97
Real A$/t	168.81	123.20	396.46	154.55	227.97
Metallurgical coal, other					
US$/t	56.00	64.00	240.00	85.00	163.00
A$/t	73.33	73.77	302.14	99.66	178.22
Real A$/t	82.21	80.45	317.17	102.63	178.22
Thermal coal [c]					
US$/t	52.50	55.50	125.00	70.35	98.00
A$/t	68.75	63.97	157.37	82.48	107.15
Real A$/t	77.07	69.77	165.19	84.94	107.15

a Japanese Fiscal Year beginning 1 April; fob Australia basis; ABARES Australia–Japan average contract price assessment; real prices are in JFY 2010 Australian dollar terms. **b** For example, Goonyella export coal. **c** For thermal coal with a calorific value of 6700 kcal/kg (gross air dried).
Source: ABARES, *Australian commodity statistics.*


N G

Gas (both conventional and coal seam gas) is becoming increasingly important for Australia, both as a source of export income and as a domestic energy source. As for many other commodities, Australia is a significant exporter of liquefied natural gas (LNG), with around 50 per cent of gas production exported. In 2009–10, the value of Australian LNG exports was $7.8 billion, a decrease of 22 per cent from 2008–09. Gas is the third largest source of Australia's primary energy consumption, following coal and petroleum products. Since 1998–99, gas consumption has increased at an average annual rate of 3 per cent a year, compared with an average rate of 1.7 per cent for coal and 1.6 per cent for petroleum products.

Domestic gas market reform over the past decade has increased transparency and competition in the sector, as well as brought industry regulation under the national energy framework, in line with electricity. Ministerial Council on Energy initiatives such as the National Gas Law and National Gas Rules, National Gas Market Bulletin Board (BB) and the Short Term Trading Market (STTM) for gas have provided a framework for greater transparency.

The BB (www.gasbb.com.au), which commenced operation in July 2008, is a website publishing daily supply and demand information on major gas production plants, storage facilities, demand centres and transmission pipelines in southern and eastern Australia.

Production

To date, Australia's conventional gas production has been overwhelmingly sourced from three basins, with the Carnarvon (north-west Western Australia), Cooper/Eromanga (central Australia) and Gippsland (Victoria) basins accounting for 96 per cent of production.

Western Australia is the largest gas producing state in Australia, representing 65 per cent of national production in 2009–10. The Western Australian gas market is geographically and economically separate to the interconnected eastern gas markets. With the bulk of Western Australia's gas supply produced as part of LNG projects, the domestic market is uniquely exposed

to international energy market conditions. Gas production in Western Australia has grown at an average annual rate of 5 per cent over the past five years. In 2009–10, Western Australian gas production increased by 11 per cent to 1270 petajoules. The majority of gas production in Western Australia is sourced from the Carnarvon Basin, with the North West Shelf accounting for a significant proportion of the basin's production.

Australian gas production by state [a]

State	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Queensland [b]							
Conventional	26	35	26	26	23	19	18
Coal seam methane	29	36	63	85	124	149	188
Total	56	71	88	112	147	168	206
Victoria	312	317	360	380	492	357	345
South Australia [c]	155	154	144	141	130	124	109
Western Australia	811	936	975	1 046	1 061	1 140	1 270
Northern Territory [d]	22	23	22	22	21	20	19
New South Wales							
Coal seam methane	8	8	10	10	5	5	5
Total Australia	1 364	1 508	1 599	1 713	1 857	1 813	1 954

a 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. **b** Queensland conventional gas includes Denison Trough and Surat–Bowen Basin gas production. **c** All Cooper/Eromanga Basin conventional gas production is allocated to South Australia. **d** Timor Leste gas used in Darwin LNG not included.
Sources: State data; Energy Quest; ABARES.

The Gippsland Basin is Australia's longest producing basin, accounting for around 12 per cent of national production and approximately 70 per cent of Victoria's gas production in 2009–10. The offshore Otway and Bass basins in south-west Victoria supply the remaining 30 per cent of gas production into

the Victorian market. Over the past five years, natural gas production from the Gippsland, Otway and Bass basins has varied, declining by 3 per cent to 345 petajoules in 2009–10. Contributing to this is the natural declines in existing gas fields as well as the start-up of new fields. More importantly, gas sourced from these basins is used to support south-east Australia's energy consumption needs. As such, production from the Gippsland, Otway and Bass basins depends on domestic demand for electricity generation.

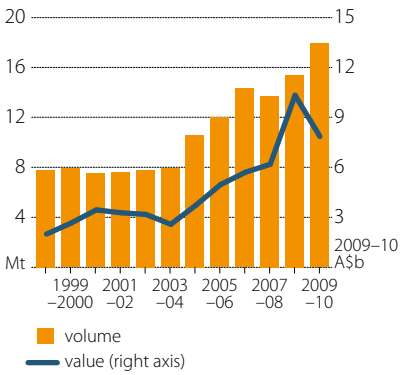
The Northern Territory is the smallest gas market in Australia, with supply historically sourced from the onshore Amadeus Basin. Gas production in the Northern Territory totalled 19 petajoules in 2009–10. Until 2005–06, all of the gas produced in the Northern Territory gas market was consumed locally. The development of the offshore Bonaparte Basin in 2005–06 saw Darwin host Australia's second LNG facility. In 2009, the offshore Blacktip gas field, part of the Bonaparte Basin, started production with gas being piped onshore to supplement the declining Amadeus Basin supply. This resulted in a larger share of gas for use in generating electricity for Darwin being piped from Blacktip to a processing plant at Wadeye and then to the Amadeus Basin – Darwin pipeline. There are plans to develop a second LNG plant for Darwin to process gas from the Ichthys field.

Production of coal seam gas (CSG) has increased significantly in the past five years, with its share of total Australian gas production increasing from 3 per cent in 2003–04 to 10 per cent in 2009–10. Most CSG production is sourced from Queensland, which accounted for approximately 97 per cent of production in 2009–10. The Sydney Basin in New South Wales supplied the remaining 3 per cent. Production of CSG is expected to continue to grow, with a number of projects planned in both states and a number of companies planning to export CSG in the form of LNG from Queensland from 2014 onwards.

Trade

The geographical distance between Australia and its key natural gas export markets prevents trade by conventional pipeline transport. Instead, cooling the gas to –161 ºC allows the volume to be reduced to enable it to be shipped as LNG.

Australian LNG exports



Sources: ABARES, *Australian commodity statistics, Australian commodities.*

Until 1989–90, Australia consumed all of the natural gas that was produced domestically. Following the development of the North West Shelf, located in the Carnarvon Basin (off the north-west coast of Western Australia), Australia began exporting LNG to overseas markets. Since 2005, LNG has also been exported from Darwin. In 2009–10 Australia's annual LNG export capacity was 19.6 million tonnes.

In 2009–10, the operation at close to capacity of the fifth train at the Darwin LNG plant contributed to Australia's LNG exports increasing by 16 per cent to 18 million tonnes. Despite the higher export volumes, lower LNG prices and the appreciation of the Australian dollar relative to the US dollar resulted in the value of Australia's LNG exports falling by 22 per cent to $7.8 billion.

The Asia–Pacific region is Australia's major exporting market. Major LNG trading partners are Japan, China and the Republic of Korea.

LNG exports into the Asia–Pacific region are expected to continue to grow over the next five years, with multiple projects, including the Gorgon project (15 million tonnes a year), BG Group's Queensland Curtis project (8.5 million tonnes a year) and Woodside's Pluto project (4.3 million tonnes a year), expected to significantly expand Australia's LNG capacity.

Prices

The Australian domestic gas market consists of three distinct regional markets: the eastern market (Queensland, New South Wales, Australian Capital Territory, South Australia and Tasmania); the western market (Western Australia); and the northern market (Northern Territory).

The geographical isolation of these markets makes interconnection costly and currently uneconomic. Until recently, and with the exception of Victoria, wholesale gas was sold under confidential long-term contracts between producers, pipeline operators, major users and retailers. The Victorian Wholesale Gas Market was established in 1999 to increase the flexibility of market participants in buying and selling gas. Overall, gas traded at the spot price accounts for around 10 to 20 per cent of wholesale volumes in Victoria, with the balance sourced through bilateral contracts or vertical ownership arrangements between producers and retailers.

In September 2010, the Sydney and Adelaide hubs of the Short Term Trading Market (STTM) commenced operation. The STTM is a day-ahead wholesale spot market for gas that aims to increase price transparency and improve efficiency and competition within the gas sector. Additional STTM hubs are intended, with a Brisbane hub expected to be operational by late 2011.

Between 2000–01 and 2007–08, domestic gas prices on the east coast, Australia's largest gas market, increased significantly. Over this period, wholesale gas prices on the Victorian spot market rose at a real annual average rate of 5 per cent, reflecting higher demand from households and

Gas prices 2009–10 dollars

		2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Natural Gas **a**								
Nominal	$A/GJ	2.96	2.99	3.03	3.62	3.77	3.32	2.03
Real	$A/GJ	3.51	3.47	3.40	3.96	3.98	3.40	2.03
LNG **b**	$A/t	326.32	350.24	397.04	375.04	419.05	610.55	404.48
Real	$A/GJ	6.00	6.44	7.58	7.31	8.31	12.31	8.07

a Financial year average of daily spot prices in the Victorian gas market. **b** Export unit value.
Sources: ABARES, *Australian commodity statistics*; AEMO.

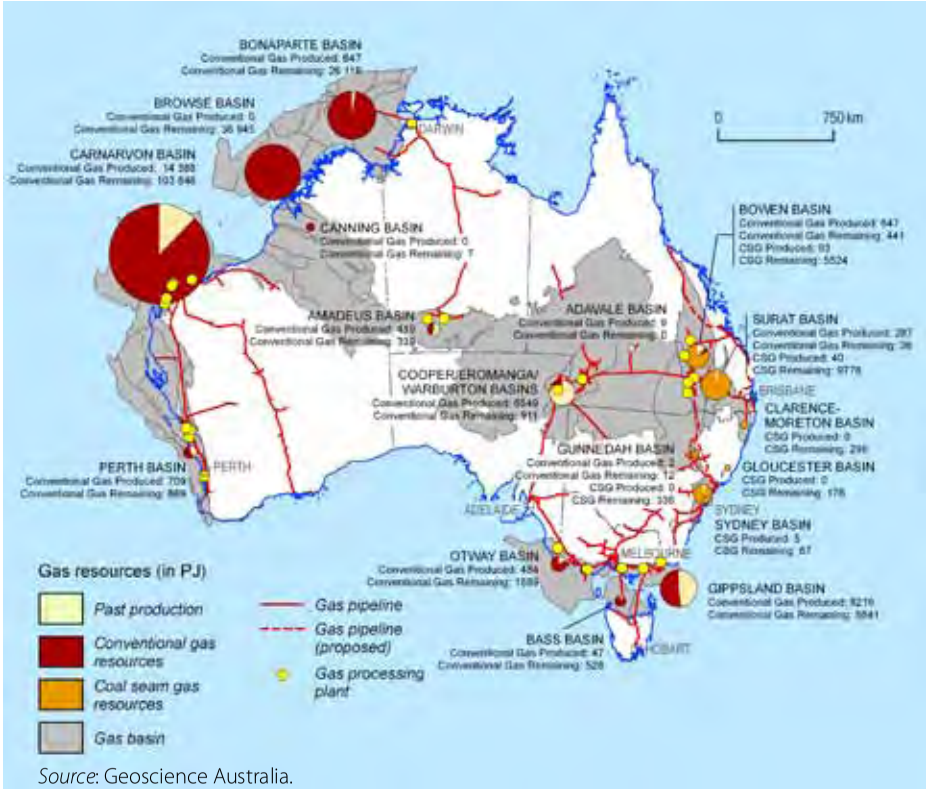
power generators. Water scarcity contributed to a reduction in the amount of electricity generated from coal-fired power plants, which increased demand for gas used in the generation of electricity. Over the past two years, gas prices in this market have generally eased, reflecting a number of factors, including: the easing of drought conditions, leading to reduced interstate gas demand for electricity generation; capacity expansions to the Victorian Transmission System in 2008; a relatively mild winter; and weaker domestic economic growth. In 2008–09, domestic gas prices fell by 15 per cent to $3.40, and declined by a further 40 per cent to $2.03 in 2009–10.

LNG contract prices are generally indexed to world oil prices, with higher world oil prices leading to higher LNG contract prices. Higher oil prices underpinned strong increases in LNG import prices between 2004 and 2008. In line with this trend, Australian LNG export prices increased by an average of 12 per cent a year between 2004–05 and 2008–09. However, in 2009, world LNG prices fell significantly, causing strong price declines in Japan (27 per cent), the Republic of Korea (34 per cent) and the United States (52 per cent). Contributing to this decline was the global economic downturn, which led to lower oil prices and weaker demand from major gas consuming economies such as Japan, the Republic of Korea and Chinese Taipei. This coincided with higher LNG production and export capacity in the Middle East, the Russian Federation and Indonesia, leading to a fall in Australia's LNG export prices by 34 per cent to $404 a tonne in 2009–10.

Asia–Pacific LNG and natural gas prices

		$US/tonne					
	average	2004	2005	2006	2007	2008	2009
Australia exports [a]	all destinations	305	281	276	305	365	520
Japan imports	from Australia	200	289	335	355	598	458
	all origins	269	370	311	401	652	473
Republic of Korea imports	all origins	296	359	451	510	756	499
United States imports	all origins	294	417	363	358	501	240
United States pipeline imports	all origins	294	409	345	345	437	205

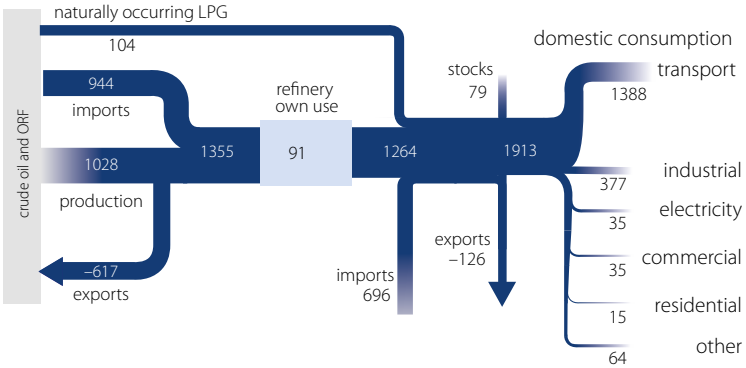
a Export unit value.
Sources: International Energy Agency; ABARES.



Source: Geoscience Australia.

Australia is a net importer of crude oil. Australia's crude oil production was equivalent to 76 per cent of refinery feedstock (in energy content terms) in 2008–09. Around 66 per cent (in energy content terms) of Australia's refined product consumption is sourced from domestic refineries. However, 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 liquefied petroleum gas (LPG), with net exports of 37 per cent of its total production in 2008–09.

Australian oil and LPG flows, 2008–09
Units: petajoules



Source: ABARES, *Australian energy statistics*.

Production

In 2009–10, Australia's production of crude oil and condensate declined by 5 per cent to 25.6 gigalitres. This decline was primarily because of flooding, which interrupted production in the Cooper Basin. LPG production increased by 4 per cent to 4097 million litres in 2009–10.

Australian production of primary petroleum by basin

	2004–05 ML	2005–06 ML	2006–07 ML	2007–08 ML	2008–09 ML	2009–10 ML
Crude oil						
Adavale	0	0	0	0	0	0
Amadeus	132	53	55	50	55	55
Bonaparte	1 868	1 403	1 470	826	812	1 026
Bowen–Surat	24	23	21	16	19	17
Canning	2	2	2	4	7	7
Carnarvon						
Barrow Island	448	390	394	364	325	321
North West Shelf	7 859	4 524	5 177	3 799	2 716	2 126
Other	3 831	5 854	7 999	7 817	9 578	9 075
Cooper–Eromanga						
Queensland	529	432	437	512	379	313
South Australia	401	489	742	814	1 072	745
Gippsland	4 647	3 681	3 850	3 392	3 922	3 233
Otway	0	0	0	0	0	0
Perth	517	395	816	668	418	320
Total	20 259	17 247	20 963	18 262	19 303	17 238
Condensate						
Adavale	0	0	0	0	0	0
Amadeus	0	0	0	0	0	0
Bonaparte	307	394	394	33	0	0
Bowen–Surat	23	20	21	19	21	16
Canning	0	0	0	0	0	0
Carnarvon						
Barrow Island	120	0	8	0	0	0
North West Shelf	5 041	5 265	5 692	5 572	6 436	7 235
Other	250	202	134	143	44	89
Cooper–Eromanga						
Queensland	270	205	158	81	90	77
South Australia	221	208	247	247	216	183
Gippsland	813	770	744	804	738	647
Otway	7	3	2	28	99	86
Perth	1	2	3	2	2	2
Total	7 052	7 069	7 403	6 930	7 647	8 334

continued...

Australian production of primary petroleum by basin *continued*

	2004–05 ML	2005–06 ML	2006–07 ML	2007–08 ML	2008–09 ML	2009–10 ML
Liquefied petroleum gas						
Adavale	0	0	0	0	0	0
Amadeus	0	0	0	0	0	0
Bonaparte	0	0	0	0	0	0
Bowen–Surat	24	23	24	24	24	18
Canning	0	0	0	0	0	0
Carnarvon						
Barrow Island	0	0	0	0	0	0
North West Shelf	1 963	2 160	2 067	1 500	1 582	1 780
Other	0	0	0	0	0	0
Cooper–Eromanga						
Queensland	0	0	0	0	0	0
South Australia	663	597	551	557	560	560
Gippsland	1 977	1 942	1 908	1 883	1 628	1 616
Otway	0	0	0	6	136	122
Perth	0	0	0	0	0	0
Total	4 628	4 722	4 550	3 971	3 929	4 097

Source: ABARES, *Australian commodity statistics*.

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 from the Gippsland Basin in south-eastern Australia is predominantly used in domestic refining. The Carnarvon Basin currently accounts for 72 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 24 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 2009–10, Australia imported 27 284 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 is closer to Asian refineries than domestic refineries on the east coast.

Australian imports of petroleum by source

	2004–05 ML	2005–06 ML	2006–07 ML	2007–08 ML	2008–09 ML	2009–10 ML
Crude oil and other refinery feedstock						
Indonesia	3 328	3 929	3 391	3 289	3 666	4 178
Malaysia	4 761	3 976	3 730	4 103	4 461	5 319
New Zealand	663	638	635	1 974	2 313	2 569
Other Middle East	158	199	118	43	40	43
Papua New Guinea	1 717	2 386	2 059	2 190	1 349	1 580
Qatar	77	0	106	0	0	0
Saudi Arabia	3 101	1 602	1 151	573	775	478
Singapore	652	830	841	713	555	605
United Arab Emirates	1 917	863	2 971	3 660	2 918	3 846
Vietnam	6 560	6 708	6 677	6 318	5 277	3 904
Other	3 122	3 287	3 665	3 360	2 947	4 762
Total	26 056	24 418	25 345	26 223	24 302	27 284
Refined products						
Indonesia	162	98	17	11	45	95
Korea, Rep. of	237	961	821	785	1 704	1 960
Malaysia	93	220	8	316	184	249
Middle East	588	691	642	1 044	1 050	1 070
New Zealand	4	84	96	40	215	4
Singapore	7 339	8 452	7 681	10 215	10 217	10 252
United States	423	456	378	421	473	301
Other	2 343	3 210	4 375	5 149	5 808	6 039
Total	11 188	14 172	14 018	17 982	19 697	19 970

Source: ABARES, *Australian commodity statistics.*

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.

Since the mid-1990s, Australia's imports of crude oil from South-East Asia have been increasing. Malaysia was the largest source for Australian crude oil and condensate imports in 2009–10, accounting for 19 per cent of refinery feedstock imports, followed by Indonesia (15 per cent) and Vietnam (14 per cent).

Despite being a net importer, Australia also exports significant quantities of crude oil and condensate, reflecting the proximity of oil production from Australia's north-west coast to Asian refineries. Australia's crude oil exports are typically of a higher value oil, characterised by its low sulphur and wax content. In 2009–10 Australia's exports of crude oil and condensate increased by 9 per cent to 18 064 million litres. This increase in exports reflects higher production from the Carnarvon Basin as a result of two new oil fields. Around 70 per cent of Australia's exports went to the Asian region, mostly to Singapore, the Republic of Korea, China and Japan. Japan is Australia's largest market for LPG, accounting for 71 per cent of Australia's LPG exports in 2009–10. Australia's exports of refined petroleum products are less significant, amounting to 858 million litres in 2009–10. Around 37 per cent of these exports went to New Zealand and another 43 per cent to Singapore.

Australia's earnings from crude oil and condensate exports increased by 9 per cent to $9.5 billion in 2009–10, as a result of higher export volumes and higher prices compared with 2008–09. In contrast, earnings from exports of refined petroleum products declined by 28 per cent in 2008–09, reflecting lower export volumes that arose from a decline in Australia's production of refined petroleum products.

Australian exports of petroleum [a] by destination

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	ML	ML	ML	ML	ML	ML
Crude oil and other refinery feedstock						
China	732	404	518	972	1 009	2 185
Chinese Taipei	916	346	446	343	403	261
Japan	1 927	2 201	1 957	2 280	2 485	1 931
Korea, Rep. of	2 787	2 725	3 873	3 701	4 395	3 710
New Zealand	1 425	465	1 045	600	321	235
Singapore	2 861	3 110	3 752	3 089	3 543	3 838
United States	1 154	297	190	1 157	1 421	622
Other	3 929	3 478	4 183	3 833	3 011	5 283
Total	15 731	13 026	15 965	15 975	16 588	18 064
Liquefied petroleum gas						
China	598	393	308	465	354	383
Japan	2 081	2 142	1 821	1 587	1 474	1 965
Korea, Rep. of	81	0	384	178	292	80
Other	84	264	311	359	380	348
Total [b]	2 844	2 800	2 824	2 589	2 500	2 776
Refined products						
Fiji	7	62	4	3	2	2
Japan	53	74	84	71	56	31
New Zealand	1 113	716	872	837	400	317
Singapore	471	771	576	505	426	371
Other Pacific	156	274	131	275	256	73
United States	0	37	6	3	0	19
Other	45	148	81	113	25	45
Total	1 846	2 082	1 752	1 807	1 164	858

a Does not include LNG exports or ships and aircraft stores. **b** Includes confidential exports.
Sources: RET, *Australian Petroleum Statistics*; ABS, *International Trade, Australia*, cat. no. 5465.0.

Value of Australian trade in petroleum

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	$m	$m	$m	$m	$m	$m
Exports						
Automotive gasoline	339	419	468	444	171	138
Diesel fuel	166	238	188	363	225	131
Aviation turbine fuel	108	80	74	120	69	41
Fuel oil	51	215	84	130	96	54
Aviation gasoline	26	54	69	73	45	30
Kerosene	0	0	0	0	0	0
Lubricants	112	139	157	152	148	151
Other products	41	52	57	41	34	22
Total refined products	844	1 195	1 098	1 323	788	566
Liquefied petroleum gas	804	1 002	1 038	1 182	1 044	1 105
Bunkers [a]	951	1 322	1 295	1 457	1 537	1 315
Crude oil and other refinery feedstock	6 330	6 638	8 317	10 484	8 757	9 534
Imports						
Automotive gasoline	1 463	2 342	1 872	2 719	2 784	2 449
Diesel fuel	1 933	4 071	3 466	6 155	6 314	5 270
Aviation turbine fuel	483	527	668	1 505	1 393	1 283
Fuel oil	364	569	536	831	867	910
Lubricants	288	418	495	477	629	519
Liquefied petroleum gas	143	198	261	436	382	405
Other products	447	635	1 285	1 331	2 927	1 683
Total refined products	5 121	8 608	7 784	12 730	13 129	11 299
Crude oil and other refinery feedstock	9 996	12 822	13 360	17 149	14 727	15 031

a Ships and aircraft stores.

Sources: RET, *Australian Petroleum Statistics*; ABS, *International Trade, Australia*, cat. no. 5465.0.

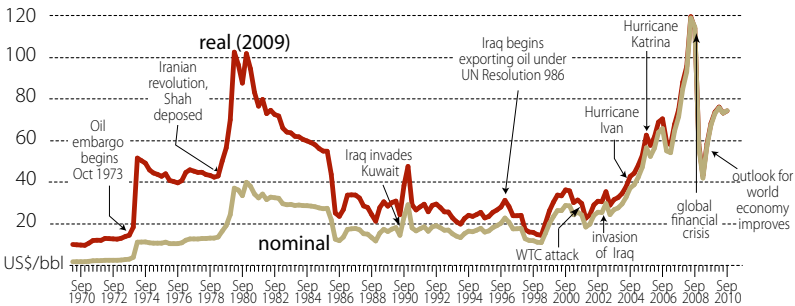
Prices

From 1986 to 2003, oil traded between US$15 and US$40 a barrel (in real terms). However, the loss of crude oil production from Venezuela and Iraq in 2003, combined with growing demand in the United States and Asia, caused oil prices to increase. Continued political instability in a number of oil producing countries, the increasing demand in Asia, particularly China, and speculative demand, drove oil prices to reach $119 a barrel in the June quarter 2008. However, by the December quarter 2008, oil prices had fallen by more than 52 per cent to around US$58 a barrel. The rapid fall in oil prices was caused by falling demand as a result of the global financial crisis.

From the June quarter 2009, oil prices began increasing as a result of market expectations of higher oil demand associated with economic recovery. By the first half of 2010, oil prices had increased to average around US$75 a barrel as economic conditions improved.

Crude oil prices

World average trade weighted prices, quarterly, ended September 2010



Source: ABARES, *Australian commodity statistics.*

In 2009–10, Australia's consumption of refined liquid fuels was 50 929 million litres. Domestic production of refined liquid fuels totalled 41 892 million litres (around 82 per cent of consumption), while imports totalled 19 970 million litres. Australian exports of refined liquid fuels were around 858 million litres in 2009–10, equal to about 4 per cent of production. Australian consumption of refined petroleum products has increased at an average rate of 1.3 per cent a year over the past 10 years, reflecting 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 2009–10 Australian refineries produced 16 771 million litres of petrol and 11 720 million litres of diesel, comprising 40 per cent and 28 per cent, respectively, of Australia's total production of petroleum products. In 2009–10, Australian refinery production declined by 5 per cent to 41 892 million litres. Unplanned maintenance at some refineries in late 2009 contributed to lower production.

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 44 210 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.

Australian production of refined petroleum products

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	ML	ML	ML	ML	ML	ML
Automotive gasoline	17 913	16 528	17 732	17 079	17 159	16 771
Automotive diesel oil	12 822	10 154	11 055	12 177	12 231	11 720
Aviation turbine fuel	5 325	5 216	5 332	5 182	5 494	5 341
Fuel oil	1 092	1 048	942	979	872	846
Liquefied petroleum gas **a**	995	1 125	1 387	1 515	1 477	1 204
Industrial and marine diesel fuel	22	31	21	3	13	3
Bitumen	1 091	831	1 356	1 452	1 294	690
Lubricants	202	163	146	121	114	74
Aviation gasoline	144	119	119	119	105	104
Heating oil	106	102	86	102	69	35
Other **a**	4 844	5 363	5 475	5 356	5 283	5 105
Total products	44 555	40 679	43 652	44 086	44 111	41 892

a Includes by-products of petrochemical downstream processing.
Source: RET, *Australian Petroleum Statistics.*

Australian refinery capacity

	operator	year commissioned	capacity MLpa
New South Wales			
Clyde	Shell	1928	4 740
Kurnell	Caltex	1956	7 810
Queensland			
Bulwer Island	BP	1965	5 910
Lytton	Caltex	1965	6 300
Victoria			
Altona	Mobil	1949	4 640
Geelong	Shell	1954	6 530
Western Australia			
Kwinana	BP	1955	8 280
Total			44 210

Source: Australian Institute of Petroleum, *Downstream Petroleum 2009.*

Fuel standards

Fuel quality standards have progressively improved in Australia, with the aim of reducing the adverse effects of motor vehicle emissions on air quality and human health and to enable Australia to effectively adopt new vehicle engine and emission control technologies. Currently, gasoline standards are in place that require a maximum sulphur content of 50 parts per million (ppm) for premium unleaded petrol. The standard grade unleaded petrol remains at 150 ppm sulphur maximum. A grade of standard unleaded petrol with 10 per cent ethanol is also offered as an alternative to unleaded petrol. The quality standard for diesel in Australia includes a maximum sulphur content of 10 ppm. The diesel quality standard also allows up to 5 per cent biodiesel fuel without a labelling requirement. Australian refineries have been progressively undertaking capital upgrades to meet these standards.

Fuel standards end of 2010

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

Source: Australian Institute of Petroleum, *Downstream Petroleum 2009.*

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. New Zealand currently has the same sulphur content requirements as Australia, having reduced maximum sulphur levels in diesel to 10 ppm in 2009. China, India and Indonesia reduced maximum sulphur levels in gasoline to 150 ppm between 2008 and 2010, from more than 500 ppm.

Non-conventional liquid fuels

The main alternatives to petrol and diesel that are currently used for motor vehicles in Australia are LPG and biofuels, comprising ethanol and biodiesel. Compressed natural gas and liquefied natural gas have also been considered as alternative transport fuels.

Biofuels currently represent around 1 per cent of Australia's petrol and diesel supply. There are currently three major fuel ethanol production facilities in Australia, with a combined capacity of just over 450 million litres a year. These facilities produce ethanol primarily from wheat starch, grain sorghum and molasses. Around 67 per cent of ethanol production capacity is located in New South Wales, at a single production facility in Manildra.

Liquid biofuels production facilities in Australia 2010

location	capacity ML/yr	feedstocks
Fuel ethanol		
Manildra Group, Nowra, NSW	300	Waste wheat starch, some low grade grain
Dalby Biorefinery, Dalby, Qld	90	Sorghum
CSR Distilleries, Sarina, Qld	60	Molasses
Biodiesel		
In production		
Smorgon Fuels, Melbourne, Vic	100	Tallow, canola oil, dryland juncea (oilseed crop)
Biodiesel Producers Limited, Wodonga, Vic	60	Tallow, used cooking oil
Australian Renewable Fuels, Adelaide, SA	45	Tallow, used cooking oil
Australian Renewable Fuels, Picton, WA	45	Tallow, used cooking oil
Biodiesel Industries Australia, Maitland, NSW	20	Used cooking oil, vegetable oil
Various small producers	5	Used cooking oil, tallow, industrial waste oilseeds
Not in production		
Vopak, Darwin, NT	130	Palm oil
Eco Tech Biodiesel, Narangba, Qld	30	Tallow, used cooking oil

Source: Biofuels Association of Australia.

There are also three major biodiesel production facilities in Australia, with additional facilities producing small quantities. Total biodiesel operating capacity is 275 million litres a year. The majority of Australia's biodiesel production currently occurs in Victoria. Biodiesel facilities in Australia use a

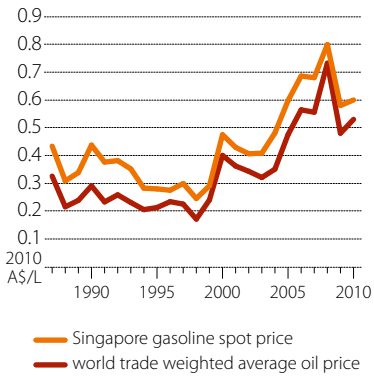
range of vegetable oils, animal fats and waste oils as feedstocks, which are selected according to price and availability.

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 Mexico, the United States and Canada.

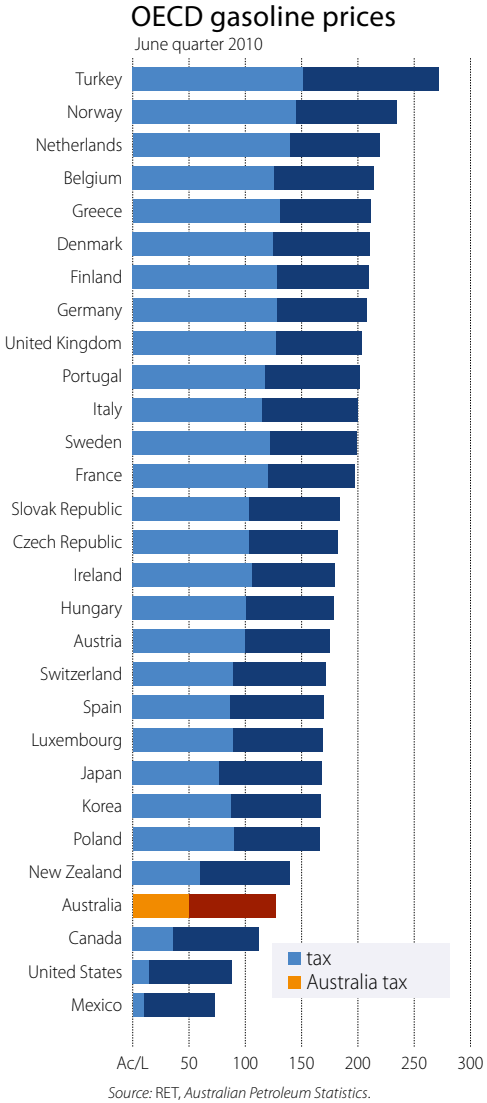
Australian wholesale gasoline and diesel prices closely follow movements in Singapore gasoline prices, which are in turn largely set by world oil prices. In 2009–10, 51 per cent of Australia's imports of refined petroleum products came from Singapore. After increasing by 18 per cent in 2008, the Singapore gasoline spot price declined by 28 per cent (in real terms) to average A$0.58 a litre, reflecting the effect of the slowdown in global economic activity on demand for petroleum products. The change in gasoline prices closely followed movements in oil prices—the world trade weighted average price of crude oil declined by 34 per cent in 2009.

Petrol price indicators



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

In 2010, economic recovery led to a 10 per cent increase in crude oil prices and a 4 per cent increase in the Singapore gasoline price.



Source: RET, *Australian Petroleum Statistics.*

The transport sector is the largest end user of energy in Australia. More than 35 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, Australia requires goods to be transported long distances. The transportation sector is the largest final consumer of liquid fuels (including LPG and refined products), accounting for 74 per cent of Australia's final use of liquid fuels.

Energy consumption

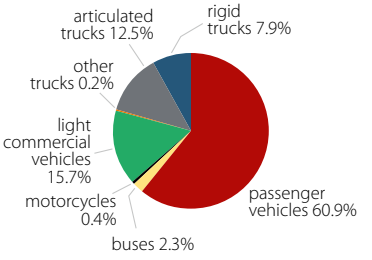
Road transport is the largest user of final energy in the transport sector, accounting for around three-quarters of the sector's fuel consumption. Largely reflecting improvements in fuel efficiency, average growth in road transport fuel consumption has eased steadily over the past 30 years, falling from around 3 per cent a year in the 1980s to average 1 per cent in the 2000s.

Energy consumption in the transport sector [a]

	1979–80 PJ	1989–90 PJ	1999–00 PJ	2005–06 PJ	2008–09 PJ
Road transport	611.8	811.4	980.4	1 059.5	1 070.2
Railway transport	31.0	30.7	33.3	35.2	43.1
Water transport	97.6	55.6	55.6	58.4	65.2
Air transport	80.6	108.6	184.6	201.1	230.3
Other	3.6	6.2	12.8	23.7	26.0
Total	824.6	1 012.5	1 266.7	1 377.9	1 434.8

a Net energy consumption (defined as total fuel inputs less energy produced).
Source: ABARES, *Australian energy statistics.*

Australian road fuel consumption by type of vehicle, 2007–08



Source: Adam Pekol Consulting, *Australian Transport Facts 2010.*

Passenger vehicles account for the majority of fuel consumption in the road transport sector. In 2007–08, almost 61 per cent of the fuel consumed in the road transport sector was for passenger vehicles.

Air transportation has been the fastest growing mode of transport in Australia. After growing by more than 5 per cent a year during the 1990s, energy consumption growth has since eased to less than 3 per cent a year since 1999–2000. 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 44 per cent of total energy consumption in the sector. This reflects the large proportion of road transport's energy use of total consumption.

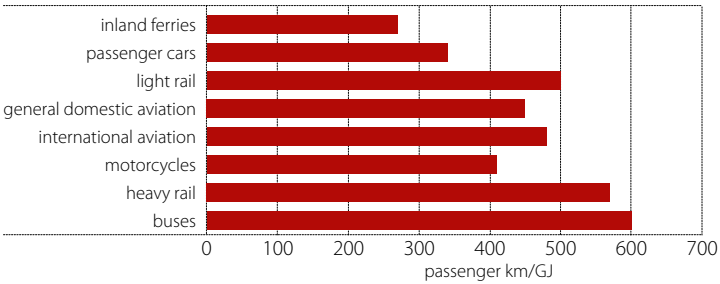
The phasing out of leaded automotive gasoline, starting in 1986 using pricing differential incentives, was completed in 2001. Over the same period, the consumption of automotive LPG, free of fuel excise tax, grew by an average of 13 per cent a year. LPG suffered a temporary decline in demand when a phasing in of taxes on excise-exempt fuels was announced, but 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

Energy intensity for passenger travel, as measured by passenger kilometres travelled with 1 gigajoule of energy, accounts for the fuel efficiency of the vehicle as well as the number of passengers in a vehicle. Cars were relatively energy intensive in 2007–08, compared with public transport, particularly rail and buses.

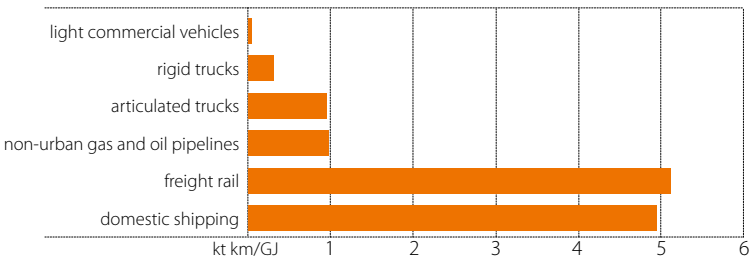
Within the freight transport sector, rail and shipping are among the least energy-intensive transport modes to distribute goods and services within the economy. This is because they are able to carry large loads over long distances, using less energy than other forms of transport such as trucks.

Passenger vehicle fuel efficiency in Australia, 2007–08
passenger kilometres travelled using 1 GJ of energy **a**



a Full fuel cycle basis.
Source: Adam Pekol Consulting, *Australian Transport Facts 2010.*

Freight fuel efficiency in Australia, 2007–08
kilometres travelled per thousand tonnes of cargo using 1 GJ of energy **a**



a Full fuel cycle basis.
Source: Adam Pekol Consulting, *Australian Transport Facts 2010.*

Port capacities

The ability to import and export energy in Australia depends heavily on the capacity of major ports. Australia has nine major coal exporting terminals located in New South Wales and Queensland. In 2009–10, these ports had a combined capacity of almost 350 million tonnes and loaded nearly 300 million tonnes of coal. Australian ports did not operate at capacity in 2009–10 for a number of reasons, including the temporary closure of some capacity for expansion work and weather-related incidents.

Export loadings and capacity for major coal ports

	loadings 2009–10 Mt	capacity 2009–10 Mtpa	short-term capacity Mtpa	medium-term capacity Mtpa
New South Wales				
Newcastle **a**	96	113	154	210
Port Kembla	14	16	16	16
Queensland				
Abbot Point	17	25	50	110
Brisbane	7	7	7	7
Dalrymple Bay	63	68	85	85
Gladstone **b**	60	75	75	100
Hay Point	36	44	44	55
Balaclava Island	–	–	–	35

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.

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 2010 there were seven coal infrastructure projects at an advanced stage of development, with a combined capital cost of around $3.8 billion. The nine advanced port infrastructure projects will add a combined 127 million tonnes to annual capacity. There were a further 15 projects at less advanced stages of planning (see Appendix 1).

Export loadings at major petroleum ports 2009–10

	Mt
Oil and petroleum [a]	
Dampier, WA	22.11
Brisbane, Qld	2.36
Fremantle, WA	2.05
Geelong, Vic	1.26
Hastings, Vic	1.05
Sydney, NSW	0.51
Melbourne, Vic	0.31
Darwin, NT	0.08
Cairns, Qld	0.01
Gas	
Dampier, WA	0.80
Hastings, Vic	0.30
Brisbane, Qld	0.24
Fremantle, WA	0.05
Sydney, NSW	0.04
Melbourne, Vic	0.01

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

Australia has 11 major deepwater ports that 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.

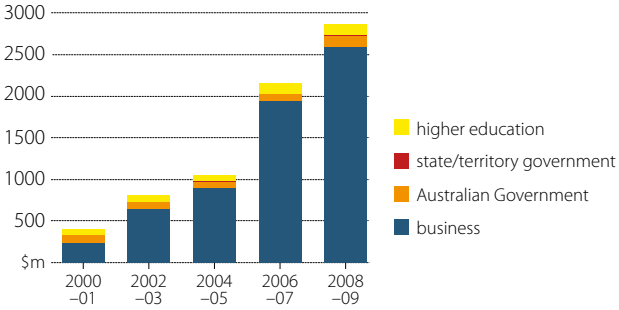

NPL 5×/

Expenditure on research and development (R&D) in energy represented 10 per cent of all R&D in Australia in 2008–09, at almost $2.9 billion, up from $2.1 billion in 2006–07. This includes R&D related to energy resources (for example, exploration for and mining of coal, uranium, oil, gas and geothermal energy), R&D related to preparing and transforming energy resources (for example, preparing coal and using it to generate electricity) and R&D for other aspects of energy (for example, renewable energy, energy distribution and storage, energy efficiency, and waste management).

Energy R&D in this context refers to the early stages of the innovation chain, rather than later stages such as demonstration and commercialisation. R&D can be defined as innovative work that is undertaken on a systematic basis to increase knowledge. R&D has the primary objective of gaining new knowledge, which may or may not have a specific practical application.

In Australia, the majority of energy R&D is undertaken in businesses. Australian businesses' expenditure on energy R&D in 2008–09 of $2.6 billion (up from $1.9 billion in 2006–07), was around 90 per cent of total energy R&D expenditure.

Energy R&D expenditure by sector



Source: ABS, *Research and Experimental Development, All Sector Summary, Australia*, cat. no. 8112.

Australian, state and territory government organisations spent $149 million on their own energy R&D activities in 2008–09, up from $91.5 million in 2006–07. Australian, state and territory governments are also important in funding of activities further along the innovation chain, particularly to help technologies move from the R&D stage to demonstration at a commercial scale.

Business spending on energy R&D is focussed on energy resource sectors. Ten per cent of business energy R&D expenditure was spent on energy exploration in 2008–09 and 56 per cent on mining and extraction of energy resources. This reflects the important role of energy commodities in the Australian economy. Eight per cent of business spending on energy R&D was in renewable energy. Governments and higher education organisations spent greater shares of their energy R&D expenditure on renewable energy, at 14 per cent and 26 per cent, respectively.

Energy research and development
by sector of performance, 2008–09

	business		government		higher education		total
	$m	% of sector total	$m	% of sector total	$m	% of sector total	$m
Energy exploration	257.9	10	14.4	10	11.3	8	303.2
Mining and extraction of energy resources	1 443.5	56	32.2	22	19.9	15	1 573.1
Preparation and production of energy sources	212.7	8	5.6	4	4.9	4	235.2
Energy transformation	91.3	4	42.6	29	13.3	10	179.2
Renewable energy	198.5	8	21.4	14	34.5	26	276.3
Energy storage, distribution and supply	170.1	7	5.6	4	21.8	16	207.9
Energy conservation and efficiency	58.2	2	8.3	6	9.2	7	83.5
Environmentally sustainable energy activities	108.9	4	15.6	10	14.6	11	153.7
Other energy	41.0	2	3.6	2	3.9	3	52.5
Total	2 582.1	100	149.2	100	133.3	100	2 864.6

Source: ABS.

Proposed new power stations and expansions [a]

as at October 2010

project	company	location	status	expected start-up	new capacity	capital expend.
Black coal						
Eraring	Eraring Energy	40 km SW of Newcastle, NSW	Expansion, committed	2011	240MW	$245m
Coal seam gas						
Blackwater Power Project	Bow Energy	15 km NE of Blackwater, Qld	New project, under construction	2011	30MW	$35m
Gas						
Channel Island Power Station	Power and Water Corporation	Channel Island, NT	Expansion, under construction	2011	90MW	$120m
Kwinana Power Station rebuild	Verve Energy	Kwinana, WA	Refurbishment, under construction	late 2011	200MW	$263m
Mortlake Stage 1	Origin Energy	12 km W of Mortlake, Vic	New project, under construction	2011	550MW	$710m
Owen Springs	Power and Water Corporation	Alice Springs, NT	New project, under construction	2010	33MW	$100m
Wind						
Collgar Wind Farm	UBS IIT/REST	25 km SE of Merredin, WA	New project, under construction	2012	206MW	$750m

continued...

Proposed new power stations and expansions [a] *continued*

project	company	location	status	expected start-up	new capacity	capital expend.
Crookwell 2	Union Fenosa Wind Australia	14 km SE of Crookwell, NSW	New project, under construction	2012	92MW	$238m
Gunning Wind Farm	Acciona Energy	50 km W of Goulburn, NSW	New project, under construction	2011	47MW	$147m
Hallett 4 (North Brown Hill)	Energy Infrastructure Investments	12 km SE of Jamestown, SA	Expansion, under construction	2011	132MW	$341m
Hallett 5 (The Bluff)	AGL	12 km SE of Jamestown, SA	Expansion, under construction	2011	52MW	$135–145m
Macarthur Wind Farm	AGL/ Meridian Energy	230 km W of Melbourne, Vic	New project, under construction	2013	420MW	$1b
Oaklands Hill Wind Farm	AGL/ Windlab Systems	5 km S of Glenthompson, Vic	New project, under construction	2011	67MW	$200m
Woodlawn Wind Farm	Infigen Energy	40 km S of Goulburn, NSW	New project, under construction	2011	48MW	$102m
Hydro						
Tumut 3 upgrade	Snowy Hydro	Talbingo, NSW	Expansion, under construction	2011	50MW	$28m
Upper Tumut expansion	Snowy Hydro	Cabramurra, NSW	Expansion, committed	2014	40MW	$20m

a Summary of projects classified as committed. For proposed projects please refer to source.
Source: ABARES, *Electricity generation – major development projects*, October 2010 listing.

Renewable power generators in Australia

as at November 2010

	state	owner	capacity kW
Bagasse			
Pioneer 2	Qld	CSR Sugar Mills	63 000
Invicta	Qld	Haughton Sugar Company	50 000
Condong	NSW	Sunshine Electricity	30 000
Rocky Point	Qld	National Power / Babcock & Brown joint venture	30 000
Tully	Qld	Independent Sugar North Ltd	21 400
Plane Creek	Qld	CSR Sugar Mills	20 000
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
Victoria	Qld	CSR Sugar Mills	11 800
South Johnstone	Qld	Bundaberg Sugar Ltd	11 500
Mossman	Qld	Mossman Central Mill Co Ltd	11 000
Isis	Qld	Isis Central Sugar Mill Co Ltd	10 700
Racecourse	Qld	Mackay Sugar Mills	10 500
Mulgrave	Qld	Independent Sugar North Ltd	10 500
Pleystowe	Qld	Mackay Sugar Mills	10 100
Kalamia	Qld	CSR Sugar Mills	9 000
Broadwater	NSW	NSW Sugar Milling Co-operative Ltd	8 000
Pioneer	Qld	CSR Sugar Mills	7 200
Other operators			46 250
Total			419 950
Biogas			
Woodlawn	NSW	Woodlawn Bioreactor Energy Pty Ltd (Veolia)	25 560
Carrum Downs 1 & 2	Vic	Melbourne Water	17 000
Clayton	Vic	Energy Developments Ltd	10 000
Werribee	Vic	AGL	10 000
Lucas Heights II	NSW	Energy Developments Ltd	9 000
Eastern Creek 2	NSW	LMS Generation Pty Ltd	8 800
Sunshine	Vic	ABB	7 500
Springvale	Vic	Energy Developments Ltd	7 000
Broadmeadows	Vic	Energy Development Ltd	7 000
Werribee 2	Vic	Melbourne Water	7 000

continued...

Renewable power generators in Australia

as at November 2010 *continued*

	state	owner	capacity kW
South Cardup	WA	Landfill Management Services Pty Ltd	6 000
Wingfield I	SA	Energy Developments Ltd	5 000
Belrose	NSW	Energy Developments Ltd	4 000
Canning Vale	WA	Landfill Gas and Power Pty Ltd	4 000
Lucas Heights I	NSW	Energy Developments Ltd	4 000
Berwick	Vic	Energy Developments Ltd	4 000
Bolivar	SA	SA Water Corporation	3 500
Camellia	NSW	EarthPower Technologies	3 500
Rochedale	Qld	LMS Generation	3 345
Luggage Point	Qld	Brisbane City Council	3 200
Other operators			81 791
Total			231 196
Geothermal			
Birdsville	Qld	Ergon Energy	80
Total			80
Ocean			
San Remo	Vic	Atlantis Resource Corporation	150
Total			150
Solar			
Liddell	NSW	Solar Heat and Power Pty Ltd	2 000
Adelaide Showground	SA	First Solar	1 000
Newington	NSW	Private	665
Newcastle - CSIRO	NSW	CSIRO	500
Singleton	NSW	EnergyAustralia	400
Ernaballa	SA	Umuwa Community	350
Marble Bar	WA	Horizon Power	304
Ballarat 3	Vic	Australian Greenhouse Office	300
Bendigo 2	Vic	Australian Greenhouse Office	300
Lajamanu	NT	Lajamanu Community	288
Kings Canyon	NT	Power and Water Corporation	241
Public Schools NSW	NSW	Integral Energy	204
Nullagine	WA	Horizon Power	203
Kogarah	NSW	Kogarah Council	200
Queen Victoria Market	Vic	Melbourne City Council	200

continued...

Renewable power generators in Australia

as at November 2010 *continued*

	state	owner	capacity kW
Greater Melbourne	Vic	Private homeowner/CitiPower	200
Hermannsburg	NT	Hermannsburg Community	192
Yuendumu	NT	Yuendumu Community	192
Kendall	NSW	Private	184
Other operators and residential use			179 892
Total			187 814
Hydro			
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 Tasmania	432 000
Tumut 1	NSW	Snowy Hydro Ltd	330 000
Poatina	Tas	Hydro Tasmania	300 000
Tumut 2	NSW	Snowy Hydro Ltd	286 000
Reece	Tas	Hydro Tasmania	231 200
Dartmouth	Vic	AGL	180 000
Kangaroo Valley	NSW	Eraring Energy	160 000
McKay Creek	Vic	AGL	150 000
John Butters	Tas	Hydro Tasmania	144 000
Bogong	Vic	AGL	140 000
Eildon	Vic	AGL	136 000
Tungatinah	Tas	Hydro Tasmania	125 000
Trevallyn	Tas	Hydro Tasmania	95 000
Tarraleah	Tas	Hydro Tasmania	90 000
Kareeya	Qld	Stanwell Corp (33% NRG)	86 400
Cethana	Tas	Hydro Tasmania	85 000
Other operators			1 577 454
Total			8 048 054
Wind			
Waubra Wind Farm	Vic	ACCIONA Energy (50%) / ANZ Energy Infrastructure Trust (50%)	192 000
Lake Bonney 2	SA	Infigen Energy	159 000
Woolnorth	Tas	Roaring 40s / Hydro Tasmania	140 250

continued...

Renewable power generators in Australia

as at November 2010 *continued*

	state	owner	capacity kW
Capital Wind Farm	NSW	Infigen Energy	132 300
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
Alinta Wind Farm	WA	Infigen Energy	90 000
Lake Bonney 1	SA	Infigen Energy	80 500
Emu Downs	WA	Transfield Services Infrastructure Ltd / Griffin Energy	79 200
Hallett 2	SA	Energy Infrastructure Trust (EIT)	71 000
Mount Millar	SA	Transfield Services Infrastructure Ltd	70 000
Cathedral Rocks	SA	Roaring 40s / Hydro Tasmania & ACCIONA Energy	66 000
Cape Bridgewater	Vic	Pacific Hydro	58 000
Clements Gap	SA	Pacific Hydro	57 000
Challicum Hills	Vic	Pacific Hydro	52 500
Canunda	SA	International Power / Wind Prospect Pty Ltd	46 000
Cape Nelson	Vic	Pacific Hydro	44 000
Starfish Hill	SA	Transfield Services Infrastructure Ltd	34 000
Discovery Bay	Vic	Synergy Wind Pty Ltd	30 000
Other operators			177 645
Total			1 863 595
Wood/woodwaste			
Tumut	NSW	Visy Pulp & Paper	17 000
Gladstone A&B	Qld	Comalco / NRG	10 000
Mount Gambier	SA	Carter Holt Harvey	10 000
Mount Piper	NSW	Delta Electricity	5 000
Bayswater	NSW	Macquarie Generation	5 000
Wallerawang C	NSW	Delta Electricity	5 000
Muja	WA	Verve Energy	5 000
Stapylton	Qld	Green Pacific Energy	5 000
Liddell	NSW	Macquarie Generation	5 000
Vales Point B	NSW	Delta Electricity	5 000

continued...

Renewable power generators in Australia

as at November 2010 *continued*

	state	owner	capacity kW
Narrogin	WA	Verve Energy / Oil Mallee Co / Enecon Pty Ltd	1 000
Big River	NSW	Big River Timbers	450
Tahune	Tas	Forestry Tasmania	45
Total			73 495
Other [a]			
Maryvale	Vic	Australian Paper	24 000
Hazelwood	Vic	International Power Hazelwood	10 000
Eastern Creek UR-3R	NSW	Global Renewables	3 000
Brisbane	Qld	Visy Pulp & Paper	2 000
Gympie	Qld	Ergon Energy	1 500
Total			40 500

a Mixed biomass feedstocks, municipal waste and black liquor.

Source: Geoscience Australia; Watt, M 2010, *National Survey Report of PV Power Applications in Australia 2009*.

Major new coal projects as at October 2010 a

project	company	location	status	expected start-up	new capacity	capital expend.
Black coal – mining projects – NSW						
Boggabri opencut	Idemitsu Kosan	17 km NE of Boggabri	Expansion, under construction	2013	2.8 Mt thermal	$150m
Mangoola (Anvil Hill opencut)	Xstrata Coal	20 km SW of Muswellbrook	New project, under construction	2011	8 Mt thermal	US$880m (A$978m)
Metropolitan longwall	Peabody Energy	30 km N of Wollongong	Expansion, committed	2014	1 Mt	$70m
Moolarben stage 1	Yancoal Australia	near Mudgee	New project, under construction	2010 (open cut) 2012 (underground)	8 Mt opencut; up to 4 Mt underground (ROM, thermal)	$405m (incl coal preparation plant)
Mount Arthur opencut (MAC20)	BHP Billiton	5 km SW of Muswellbrook	Expansion, under construction	2011	3.5 Mt thermal	US$260m (A$289m)
Ulan West	Xstrata Coal	Mudgee	Expansion, under construction	2014	6.7 Mt thermal	US$1.1b (A$1.2b)
Wilpinjong	Peabody Energy	40 km NE of Mudgee	Expansion, under construction	2013	2–3 Mt thermal	US$90m (A$100m)

continued...

Major new coal projects as at October 2010 a *continued*

project	company	location	status	expected start-up	new capacity	capital expend.
Black coal – mining projects – Qld						
Curragh Mine	Wesfarmers	200 km W of Rockhampton	Expansion, under construction	2011	increase to 8.5 Mt	$286m
Integrated Isaac Plains Project	Aquila Resources / Vale	180 km SW of Mackay	Expansion, under construction	na	1.6 Mt coking and thermal	$86m
Kestrel	Rio Tinto	51 km NE of Emerald	Expansion, under construction	2012	1.7 Mt coking	US$991m (A$1.1b)
Middlemount (stage 1)	Macarthur Coal / Gloucester Coal	6 km SW of Middlemount	New project, under construction	2012	1.8 Mt coking (ROM)	$400m (includes stage 1 and 2)
Newlands Northern Underground	Xstrata Coal	130 km W of Mackay	Expansion, under construction	2011	3 Mt	US$130m (A$144m)
Black coal – infrastructure projects – NSW						
Kooragang Coal Terminal expansion	Port Waratah Coal Services	Newcastle	Expansion, under construction	2012	Capacity increase of 20 Mt	$670m
NCIG export terminal (Newcastle Coal Infrastructure Group) stage 2	NCIG	Newcastle	Expansion, under construction	2013	23 Mtpa	$900m

continued...

Major new coal projects as at October 2010 a *continued*

project	company	location	status	expected start-up	new capacity	capital expend.
Black coal – infrastructure projects – Qld						
Abbot Point Coal Terminal X50 expansion	North Queensland Bulk Ports	Bowen	Expansion, under construction	mid-2011	25 Mtpa increase	$818m
Abbot Point Coal Terminal yard refurbishment	North Queensland Bulk Ports	Bowen	Refurbishment, under construction	mid-2011	na	$68m
Blackwater System Power upgrade	Queensland Rail	Blackwater	Expansion, under construction	2012	9 Mtpa	$140m
Goonyella to Abbot Pt (rail) (X50)	Queensland Rail	North Goonyella to Newlands (70 km)	Expansion, committed	early 2012	50 Mtpa	$1.1b
Rocklands to Kabra rail duplication	Queensland Rail	Rockhampton	New project, committed	2011	na	$66m

a Summary of projects classified as committed. For proposed projects please refer to source.
Source: ABARES, *Minerals and energy – major development projects*, October 2010 listing.

Major new oil and gas projects as at October 2010 a

project	company	location	status	expected start-up	new capacity	capital expend.
Oil and gas projects						
BassGas (Yolla Mid-Life Enhancement)	Origin Energy / AWE / CalEnergy Gas	Bass St, Tas	Expansion, committed	2012	field life extension	$345m
Gorgon LNG	Chevron / Shell / ExxonMobil	Barrow Island, WA	New project, under construction	2015	15 Mt LNG, 110 PJ pa domestic gas	$43b
Halyard	Apache Energy / Santos	120 km N of Onslow, WA	New project, committed	mid-2011	26 PJ pa gas	na
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$1.2b)
Kitan	Eni / Inpex / Talisman Resources	Timor Sea, 500 km NW of Darwin, NT	New project, committed	2011	35 kbpd oil	US$600m (A$667m)
Macedon	BHP Billiton / Apache Energy	100 km W of Onslow, WA	New project, under construction	2013	75 PJ pa gas	US$1.5b (A$1.7b)
Montara / Skua oil field	PTTEP	Timor Sea, 650 km W of Darwin, NT	New project, under construction	late 2011	35 kbpd oil	US$700m (A$778m)

continued...

Major new oil and gas projects as at October 2010 a

continued

project	company	location	status	expected start-up	new capacity	capital expend.
NWS North Rankin B	Woodside Energy / BHP Billiton / BP / Chevron / Shell / Japan Australia LNG	150 km NW of Dampier, Carnarvon Basin, WA	Expansion, under construction	2013	967 PJ pa gas	$5.1b (A$5.7b)
Pluto (train 1)	Woodside Energy	Carnarvon Basin / Burrup Peninsula, WA	New project, under construction	2011	4.3 Mt LNG	$12.1b (inc site works for train 2)
Queensland Curtis LNG project	BG Group	Gladstone, Qld	New project, committed	2014	8.5 Mt LNG (12Mt ultimately)	US$15b (A$16.7b) (BG Group's Share)
Reindeer gas field/Devil Creek gas processing plant (phase 1)	Apache Energy / Santos	80 km NW of Dampier, Carnarvon Basin, WA	New project, under construction	late 2011	40 PJ pa gas	$1.08b
Turrum	ExxonMobil / BHP Billiton	Bass St, Vic	New project, under construction	2011	11 kbpd condensate, 77 PJ pa	US$1.25b (A$1.4b)

continued...

Major new oil and gas projects as at October 2010 a *continued*

project	company	location	status	expected start-up	new capacity	capital expend.
Gas pipeline projects						
Moomba to Sydney	Australian Pipeline Group	Moomba (SA) to Sydney (NSW)	Expansion, under construction	2012	na	$100m
South West Queensland pipeline (stage 2 and 3)	Epic Energy	Wallumbilla to Ballera (755 km), Qld	Expansion, under construction	2012	77 PJ pa	$858m
Wollert to Euroa	Australian Pipeline Group	Wollert-Euroa, Vic	Expansion, under construction	late 2010	na	na
Young-Wagga Wagga pipeline	Australian Pipeline Group	Young to Wagga Wagga (131 km), NSW	Expansion, under construction	late 2010	na	na
Energy processing facilities						
Dandenong LNG plant	BOC	Dandenong, Vic	Expansion, committed	2012	25 kt LNG	$65m
Micro LNG plant	BOC	40 km W of Launceston, Tas	New project, under construction	early 2011	20 kt LNG	$150m

a Summary of projects classified as committed. For proposed projects please refer to source.
Source: ABARES, *Minerals and energy – major development projects*, October 2010 listing.

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 ºC and a 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 is 0.56 petajoules a tonne and of uranium oxide is 0.47 petajoules a tonne. The oxide contains 84.8 per cent of the metal by weight.

Energy content of gaseous fuels

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

Sources: RET; BHP Billiton.

Energy content of liquid fuels

	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
LPG			
– 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
Fuel oil			
– low sulfur	39.7	1 110	44.1
– high sulfur	40.8	1 050	42.9
Refinery fuel (fuel oil equivalent)	40.8	1 050	42.9
Naphtha	31.4	1 534	48.1
Lubricants and greases	38.8	1 120	43.4
Bitumen	44.0	981	42.7
Solvents	34.4	1 229	44.0
Waxes	38.8	1 180	45.8
Crude oil and other refinery feedstocks			
– indigenous (average)	37.0	1 250	46.3
– imports (average)	38.7	1 160	44.9
Orimulsion			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.

Energy content of solid fuels

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