Australian Government
Department of Resources, Energy and Tourism
Bureau of Resources and Energy Economics

Energy in Australia 2012

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From 1 July 2011, responsibility for resources and energy data and research was transferred from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) to the Bureau of Resources and Energy Economics (BREE).

Produced and compiled by Kate Penney, Andrew Schultz, Allison Ball, Nina Hitchins, Clare Stark and Kate Martin.

Postal address:
Bureau of Resources and Energy Economics
GPO Box 1564, Canberra, ACT, 2601 Australia

Phone: +61 2 6276 1000
Email: info@bree.gov.au
Web: bree.gov.au

Foreword

Access to secure, reliable and competitively priced energy underpins every facet of modern life. Understanding developments and trends in the energy sector helps us as a nation to make better decisions about how we should invest for our future.

Our energy future will include the development and increased deployment of clean energy technologies, further investment in energy infrastructure to maintain reliability and meet demand growth, as well as a significant increase in energy exports.

To help plan our energy future, we need accurate, comprehensive and readily-accessible energy data. *Energy in Australia 2012* provides this information along with valuable insights into Australia's energy sector.

This publication builds on the Government's release of the draft Energy White Paper and the National Energy Security Assessment last year, further informing Australia's energy policy development.

In finalising the Energy White Paper, my Department is seeking to develop a framework to provide strategic direction for Australia's energy sector out to 2030 and beyond. It is intended that the final Energy White Paper will be released around the middle of this year.

I recommend that you take full advantage of the facts and figures in *Energy in Australia 2012*. It provides a guide to where we currently stand, and where we are going in terms of our energy future.

Martin Ferguson AM MP
Minister for Resources and Energy
Minister for Tourism

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Data sources

The information contained in *Energy in Australia 2012* is obtained from a number of BREE and other sources. The key sources used in this report are:

Australian Bureau of Agricultural and Resource Economics and Sciences— daff.gov.au/abares

Australian Bureau of Statistics—abs.gov.au

Australian Energy Market Commission—aemc.gov.au

Australian Energy Market Operator—aemo.com.au

Australian Energy Regulator—aer.gov.au

Australian Institute of Petroleum—aip.com.au

Bureau of Resources and Energy Economics—bree.gov.au

BP Statistical Review of World Energy—bp.com

Clean Energy Council—cleanenergycouncil.org.au

Department of Climate Change and Energy Efficiency—climatechange.gov.au

Department of Resources, Energy and Tourism—ret.gov.au

EnergyQuest—energyquest.com.au

Energy Supply Association of Australia—esaa.com.au

Geoscience Australia—ga.gov.au

Global Roam Pty Ltd—nem-review.info

International Energy Agency—iea.org

Office of the Renewable Energy Regulator—orer.gov.au

Ports Australia—portsaustralia.com.au

Abbreviations and acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
BREE	Bureau of Resources and Energy Economics
CSG	coal seam gas
EDR	economic demonstrated resources
ERA	Economic Regulation Authority (Western Australia)
ESAA	Energy Supply Association of Australia
IEA	International Energy Agency
LNG	liquefied natural gas (principally methane)
LPG	liquefied petroleum gas (principally propane and butane)

LRET	Large-scale Renewable Energy Target
NEM	national electricity market
NER	national electricity rules
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
OPEC	Organisation of the Petroleum Exporting Countries
ORF	other refinery feedstock
R&D	research and development
RET	Department of Resources, Energy and Tourism
RET	Renewable Energy Target
SRES	Small-scale Renewable Energy Scheme
STTM	Short Term Trading Market (gas)

Glossary

Advanced biofuels: High energy drop-in liquid fuels derived from sustainable sources of organic matter that do not typically compete with food or feed production, for example, biofuels produced from wood residues, non-edible oilseeds or algae.

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 gas and liquefied petroleum gas used in town gas manufacturing, all hydrocarbons used as feedstock in oil refineries, and all fuels (including electricity) used in power stations—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.

Economic demonstrated resources: The quantity of resources that is judged to be economically extractable under current market conditions and technologies.

Electricity generation 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.

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, 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.

Lignite: Non-agglomerating coals with a gross calorific value less than 17 435 kJ/kg, including brown coal which is generally less than 11 000 kJ/kg.

Liquid fuels: All liquid hydrocarbons, including crude oil, condensate, liquefied petroleum gas and other refined petroleum products, and liquid biofuels.

Non-renewable resources: Resources, such as fossil fuels (crude oil, gas, coal) and uranium that are depleted by extraction.

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 nonfuel applications (solvents, lubricants, bitumen, waxes, petroleum coke for anode production and specialised feedstocks).

Primary fuels: The forms of energy obtained directly from nature, involving only the extraction or collection of the energy source. They include non-renewable energy sources such as coal, uranium, crude oil and condensate, naturally occurring liquefied petroleum gas, ethane and methane, and renewable energy

sources such as wood, bagasse, landfill gas, hydroelectricity, wind energy, solar energy and geothermal energy.

Renewable resources: Resources that can be replenished at a rate equal or greater than the rate of depletion, such as biomass, hydro, solar, wind, ocean and geothermal.

Secondary fuels: The forms of energy that result from transforming primary fuels. They include electricity, petroleum products, LPG produced in refineries and liquid biofuels produced through the transformation of agricultural or waste feedstocks.

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

Total net energy consumption: A measure of the total energy used within the economy. At an aggregate level, total net energy consumption is equivalent to total primary energy supply.

Total primary energy supply: TPES is a measure of the total energy supplied within the economy. It is equal to indigenous production plus imports minus exports, plus stock changes and statistical discrepancies. TPES includes the supply of both primary and secondary fuels.

Unconventional gas: Generally refers to gas trapped deep underground by impermeable rocks such as coal, sandstone and shale. The most common types of unconventional gas are coal seam gas, shale gas and tight gas.

Overview

Australia's overall energy resources are sufficient to supply energy for both domestic consumption and export markets. In 2009–10, Australia's primary energy production was 17 282 petajoules. Net energy exports accounted for 68 per cent of domestic energy production in 2009–10, while domestic consumption accounted for the remaining 32 per cent.

Australia is the world's ninth largest energy producer, accounting for around 2.5 per cent of world energy production and 5 per cent of world energy exports. Given its large energy resource base, Australia is well positioned to continue its role as an important supplier of world energy needs, while maintaining domestic energy supply.

Energy resources

Australia is endowed with abundant, high quality and diverse energy resources, including both renewable and non-renewable resources.

Australia has around 33 per cent of the world's uranium resources, 10 per cent of world black coal resources, and almost 2 per cent of world conventional gas resources. Australia has only a small proportion of world resources of crude oil. At current rates of production, Australia's energy resources are expected to last for many more decades.

In addition, Australia has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy and bioenergy resources. Except for hydroelectricity, where the available resource is largely developed, and wind energy, where the use

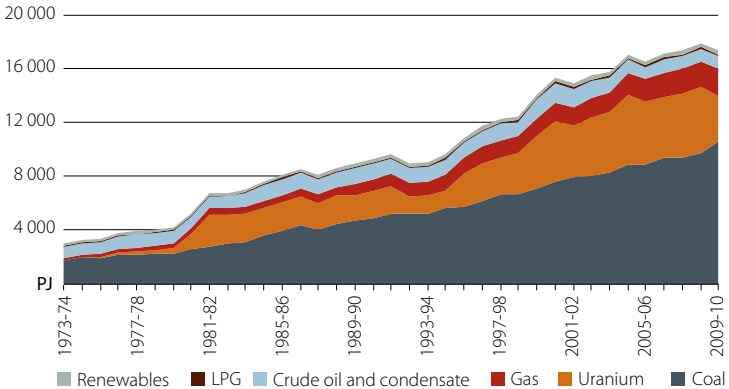
of the resource is growing rapidly, Australia's renewable energy resources are largely undeveloped.

Energy production

The main sources of primary energy produced in Australia are coal, uranium and gas. While Australia produces uranium, it is not consumed domestically, and all output is exported. Australia's energy production increased by 23 per cent between 1999–2000 and 2009–10.

In 2009–10, Australia's primary energy production was dominated by coal, which accounted for 61 per cent of total energy production in energy content terms, followed by uranium (19 per cent) and gas (12 per cent). Crude oil and LPG represented a further 6 per cent of total energy production in energy content terms, and renewables 2 per cent.

Figure 1: Australia's primary energy production



Source: ABARES 2011, Australian Energy Statistics.

The energy industry is a significant contributor to the Australian economy. The coal and petroleum industries contributed around $47 billion to industry value added in 2009–10, representing 3.5 per cent of the Australian total. The electricity and gas supply industries contributed another $22 billion to industry gross value added. It also provides significant employment and infrastructure.

Table 1: Energy-related industries in Australia, 2009–10

	gross value added	gross fixed capital formation	employment
	A$b	A$b	'000
Coal mining	22.5	5.3	34.0
Oil and gas extraction	22.6	16.2	14.0
Petroleum and coal product manufacturing	1.6	0.5	6.0
Electricity supply	20.5	11.3	50.0
Gas supply	1.0	0.4	2.0
Energy Total	68.2	33.8	106.0
Australian Total	**1 283.8**	**364.3**	**11 026.7**

Sources: Australian Bureau of Statistics 2011, Australian Industry, cat. no. 8155, Australian System of National Accounts, cat. no. 5204, Australian Labour Market Statistics, cat. no. 6291.

Energy consumption

Australia's energy mix is dominated by black and brown coal, accounting for around 37 per cent of total primary energy supply in 2009–10. This is followed by oil (35 per cent), gas (23 per cent) and renewable energy sources (5 per cent).

Although Australia's energy consumption continues to increase, the rate of growth has been slowing. Australia's net energy

consumption increased at an average annual rate of 1.8 per cent over the 10 years from 1999–2000 to 2009–10, compared with 2.3 per cent over the previous 10 years. In 2009–10, net energy consumption increased by 1.1 per cent to 5945 petajoules, which was equivalent to 32 per cent of Australian energy production.

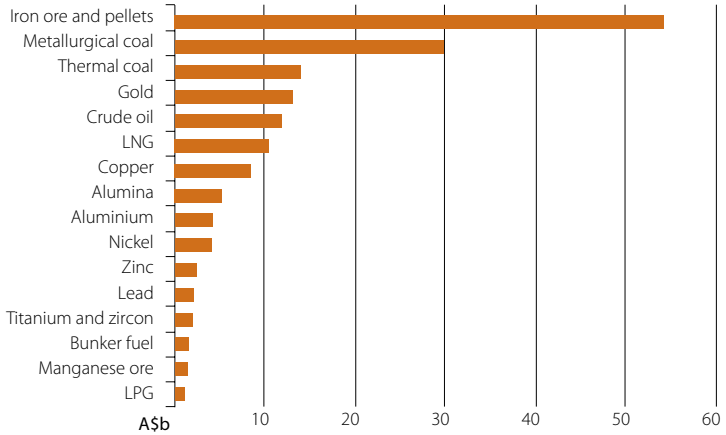
Over the past 20 years, domestic energy consumption has increased at a slower rate than production. Rapid growth in global demand for Australia's energy resources has driven growth in domestic production. As a result, the share of domestic consumption in Australian energy production has declined, from an average of 49 per cent in the 1980s to an average of 42 per cent in the 1990s, and has continued to decline, to an average of 34 per cent over the past decade.

Energy exports

Australia is a net energy exporter, with net energy exports representing 68 per cent 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 around $44 billion in 2010–11, followed by crude oil and liquefied natural gas (LNG). Energy exports accounted for 33 per cent of the value of Australia's total commodity exports in 2010–11.

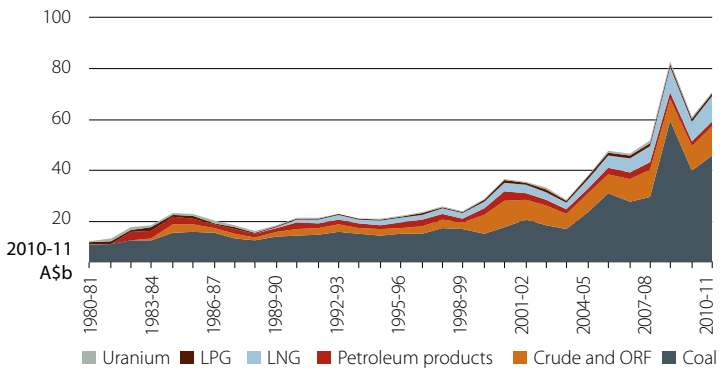
Since 1988–89, the value of Australia's energy exports (in 2010–11 Australian dollars) has increased at an average rate of 8 per cent a year. In 2010–11, energy export earnings increased by 21 per cent, largely as a result of higher prices for coal and LNG. The coal price increases reflected strong demand, and supply disruptions in key producing regions including Australia, Indonesia and South Africa.

Figure 2: Australia's major resources and energy exports, 2010–11



Source: BREE 2011, Resources and Energy Statistics.

Figure 3: Australia's energy exports



Source: BREE 2011, Resources and Energy Quarterly.

Energy policy in Australia

Government policies play an important role in shaping the energy market, and can affect both the pace of energy demand growth and the type of energy used. Policies designed to enhance energy efficiency, for instance, could slow the pace of energy demand growth. Policies designed to enhance energy security may encourage diversity in the types of fuel used in an economy, or where the energy is sourced from. Policies to address environmental issues such as climate change may target a greater uptake of renewable energy technologies.

The Australian Government released the Draft Energy White Paper, *Strengthening the Foundations for Australia's Energy Future* in December 2011. Four main policy priorities are identified: (1) enhancing energy policy through regular evaluations, (2) furthering competitiveness and efficiency in the energy market through reforms, (3) furthering the development of energy resources (with an emphasis on gas), and (4) promoting the transition towards clean energy technologies. It is anticipated that a final Energy White Paper will be released in mid 2012.

A key input into the Energy White Paper was the National Energy Security Assessment (NESA), which was also released in December 2011. The NESA found that Australia's overall energy security situation is expected to remain adequate and reliable but increasingly will be shaped by the strength of new investment going forward and the price of energy, which are both being materially influenced by global trends.

The Strategic Framework for Alternative Transport Fuels was also released in December 2011. It sets a long-term strategic framework to support the market-led development of alternative transport fuels in the context of maintaining liquid fuel security while moving toward a low emission economy.

Australia has a Renewable Energy Target, which mandates that 45 000 gigawatt hours of Australia's electricity supply will come from renewable energy sources by 2020. A carbon price will also be introduced from 1 July 2012, which will make large emitters of carbon financially liable for their emissions.

There are also a number of state-based policies affecting energy markets, including some aimed at promoting the transition to cleaner energy technologies. State governments can also influence access to and the development of energy resources through the issue of exploration and operating permits.

Energy resources

Australia is endowed with abundant, high quality and diverse energy resources, including both renewable and non-renewable resources.

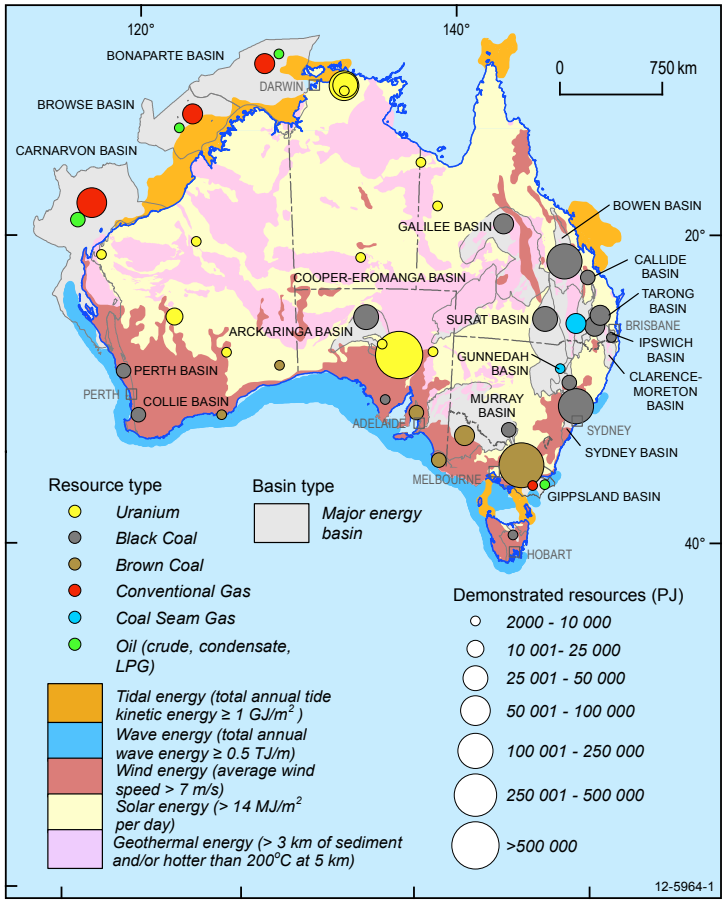
In this report, data on energy resources are presented in energy content terms to allow for comparison across the different resources.

Resources

Australia has around 33 per cent of the world's uranium resources, 10 per cent of world black coal resources, and almost 2 per cent of world conventional gas resources. Australia has only a small proportion of world resources of crude oil.

In addition, Australia has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy and bioenergy resources. Except for hydroelectricity, where the available resource is largely developed, and wind energy, where the use of the resource is growing rapidly, Australia's renewable energy resources are largely undeveloped. Many renewable energy resources, particularly solar and wind, are intermittent.

Map 1: Australia's energy resources



Source: Geoscience Australia 2012.

Table 2: Australia's economic demonstrated resources, 31 December 2010

		Australia	Share of World	Resources to production[a]
		PJ	%	yrs
Coal[b]	Black coal	1 255 470	10.3	128
	Lignite	384 689	8.6	517
Petroleum	Oil	5 685	0.2[c]	9
	Condensate	12 413	na	38
	LPG	4 063	na	38
Gas	Conventional gas	113 373	1.6	66
	Coal seam gas	35 055	na	175
Uranium[d]		648 480	33.0	134

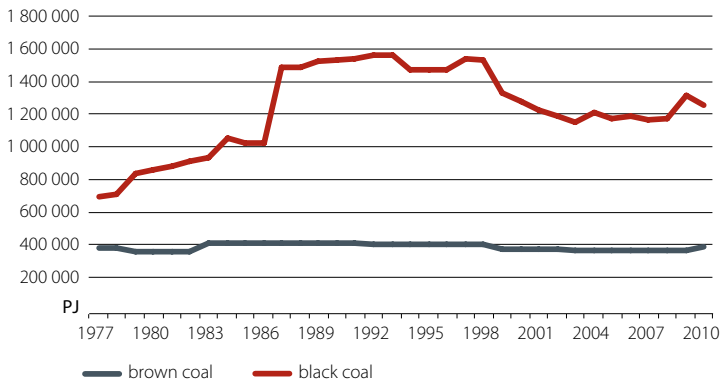
a based on 2009–10 output. **b** Recoverable resources. **c** Crude oil, condensate and LPG combined. **d** Reasonably Assured Resources recoverable at costs of less than US$80/kg U. **na** not available.

Sources: Geoscience Australia 2012; SKM-MMA 2011, 2011 Gas Market Review; BP 2011, Statistical Review of World Energy 2011; BREE 2011, Resources and Energy Statistics 2011.

A large proportion of Australia's black coal resources are high-quality bituminous coal, characterised by low sulphur and low ash content. Most states have black coal resources, with significant quantities of high-quality black coal in New South Wales and Queensland.

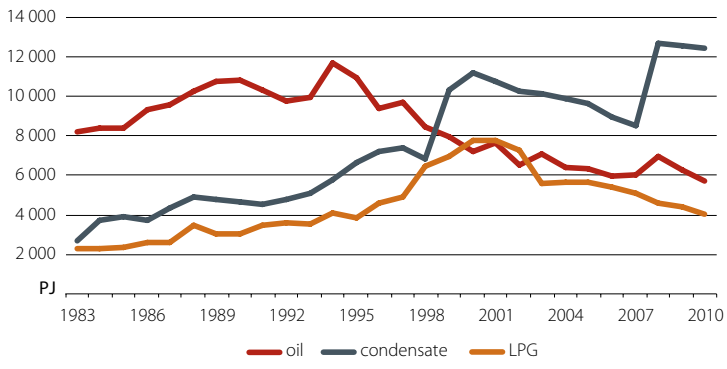
There are brown coal deposits in all Australian states, although Victoria accounts for the majority of Australia's identified brown coal resources.

Figure 4: Australia's economic demonstrated resources of coal



Source: Geoscience Australia 2012.

Figure 5: Australia's economic demonstrated resources of petroleum



Source: Geoscience Australia 2012.

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. Economically demonstrated resources of crude oil, condensate and LPG have generally declined in recent years, although condensate resources increased sharply in 2008 following the upgrading of resources into this category at the Ichthys field.

Most of Australia's petroleum resources are located off the coasts of Western Australia, the Northern Territory and Victoria. Western Australia has 62 per cent of Australia's economic demonstrated resources of crude oil, 76 per cent of condensate resources and 58 per cent of LPG resources.

Table 3: Australia's petroleum resources by state, 2010[a]

	Crude oil	Condensate	LPG	Conventional gas	Coal seam gas
	GL	GL	GL	Tcf	Tcf
VIC	34	23	24	8	0
QLD	1	0	0	1	29
SA	9	4	5	1	0
WA	95	254	89	84	0
NT	15	53	34	9	0
TAS	0	2	1	0	0
NSW	0	0	0	0	3
Total	**154**	**335**	**153**	**103**	**32**
Total (PJ)	**5 685**	**12 413**	**4 063**	**113 373**	**35 055**

a Economic demonstrated resources as at 31 December 2010.

Source: Geoscience Australia 2012; SKM-MMA 2011, 2011 Gas Market Review.

Australia's identified conventional gas resources have increased more than threefold over the past 20 years. Around 82 per cent of estimated recoverable reserves of conventional gas are located off the west and north-west coast of Australia.

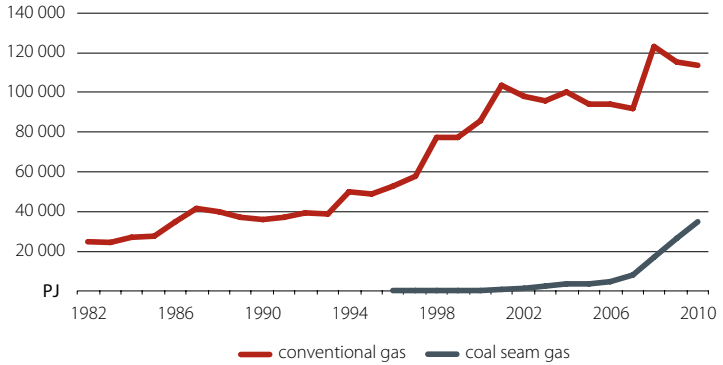
In addition to conventional gas resources, there is a growing commercial utilisation of Australia's resources of coal seam gas. Economically demonstrated resources of coal seam gas are now around one third of those of conventional gas. Most of these resources are located in the black coal deposits of Queensland and New South Wales.

Australia's identified uranium resources have more than doubled over the past two decades, and increased by 62 per cent from 2006 to 2010. Most 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.

At current rates of production, Australia's energy resources are expected to last for many more decades. The ratio of economic demonstrated resources to current production is estimated at 517 years for brown coal, 128 years for black coal, 66 years for conventional gas, 175 years for coal seam gas and 134 years for uranium.

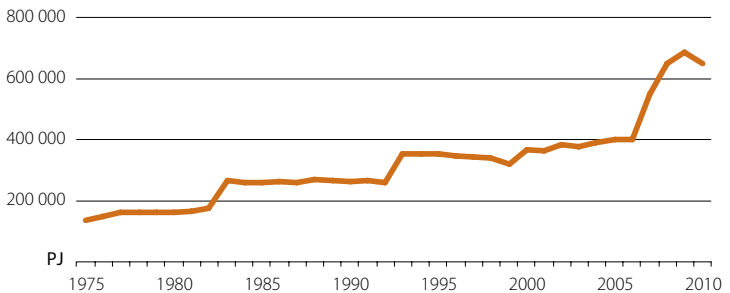
Despite increasing energy production, resources to production ratios have not followed a declining trend over the past decade, reflecting the addition of new discoveries and the upgrading of resources that meet economic criteria. For example, over the past 20 years, the reserves to production ratio for oil has fluctuated between six and 11 years.

Figure 6: Australia's economic demonstrated gas resources



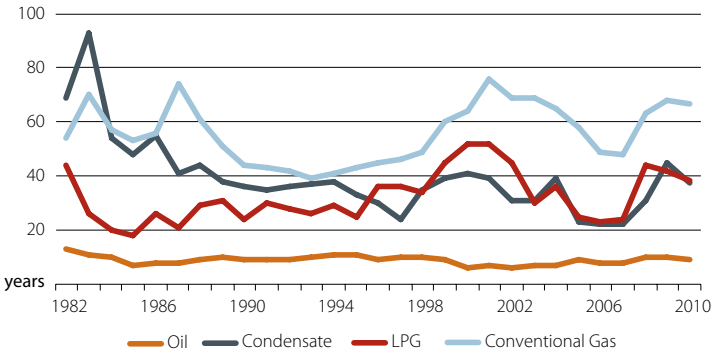
Sources: Geoscience Australia 2011, Oil and Gas Resources of Australia 2009; SKM-MMA 2011, 2011 Gas Market Review.

Figure 7: Australia's economic demonstrated uranium resources



Source: Geoscience Australia 2011, Australia's Identified Mineral Resources 2010.

Figure 8: Australia's resources to production ratio [a]



a Estimated economic demonstrated resources (EDR) at current production rates.

Source: BREE calculations.

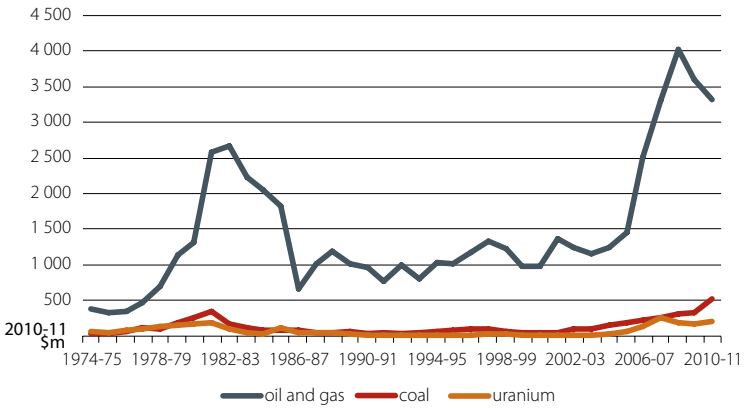
Exploration

The growth in resources has been underpinned by increased exploration activity. Commodity prices are typically the most important factor determining the level of exploration expenditure, as it influences perceptions of the likely returns from conducting exploration. In general, the level of exploration activity tends to lag commodity prices by around a year or more.

Expenditure on petroleum (oil and gas) exploration accounts for 82 per cent of total exploration expenditure on energy resources (including oil, gas, coal and uranium). There was a sharp increase in petroleum exploration expenditure between 2005–06 and 2008–09, reaching a record of $4 billion in 2008–09 (in 2010–11 dollars). Petroleum exploration expenditure declined by around 5 per cent to around $3.3 billion in 2010–11, although it was still the third highest expenditure recorded in Australia's petroleum industry.

In response to expectations of increasing world coal demand over the short to medium term, exploration expenditure for coal increased by 62 per cent to $520 million in 2010–11. Spending on uranium exploration increased by 26 per cent to $214 million, supported by relatively high uranium prices prior to the earthquake and tsunami in Japan in early 2011.

Figure 9: Australia's private energy and minerals exploration expenditure



Source: BREE 2011, Resources and Energy Statistics 2011.

Energy consumption

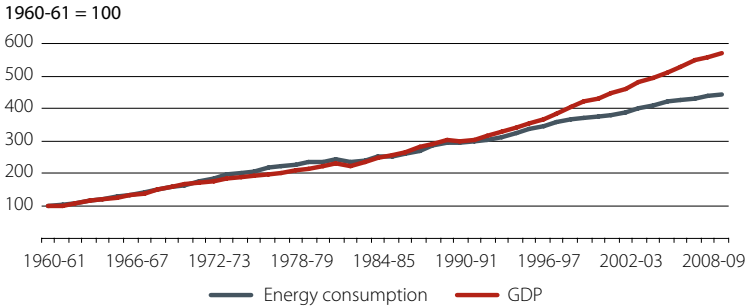
Australia is the world's eighteenth largest energy consumer and ranks fourteenth on a per person basis.

Australia's energy consumption is primarily composed of non-renewable energy sources (coal, oil and gas), which represent 95 per cent of total energy consumption. Renewables, mainly bioenergy (wood and woodwaste, biomass and biogas), account for the remaining 5 per cent.

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 oil price shocks. During the 1980s, an economic recession in 1982–83 and rising energy prices resulted in annual energy consumption growth falling to an average of around 2.3 per cent. In the 1990s, economic recession early in the decade contributed to slower energy consumption growth. However, falling energy prices (in real terms) and robust economic growth later in the decade resulted in annual growth in energy consumption remaining at around 2.3 per cent for the decade as a whole.

Since 2000, growth in energy consumption has averaged 1.8 per cent reflecting the ongoing decline in the energy intensity of the Australian economy.

Figure 10: Annual growth in Australia's energy consumption



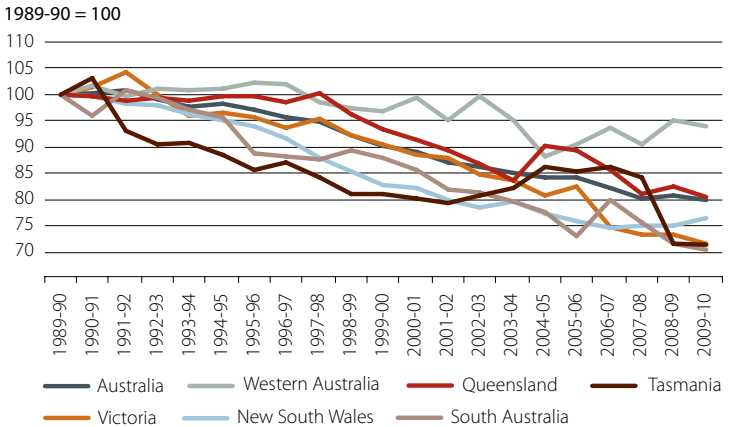
Sources: ABARES 2011, Australian Energy Statistics; ABS 2011, Australian National Accounts: State Accounts, cat. no. 5206.

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 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 modest 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.

Figure 11: Energy intensity trends, by state



Sources: ABARES 2011, Australian Energy Statistics; ABS 2011, Australian National Accounts, cat. No. 5220.

Energy consumption, by energy type

Total primary energy supply (TPES) is equal to net energy consumption. Australian total primary energy supply is dominated by coal, petroleum and gas.

Black and brown coal account for the greatest share of the energy mix, at 37 per cent, followed by petroleum products (35 per cent). The share of gas in Australian energy consumption has increased over the past 30 years and currently stands at 23 per cent. The share of renewables in Australia's total energy mix has remained largely constant at around 5 per cent over the last decade.

Currently, around 67 per cent of Australia's renewable energy is comprised of biomass (wood and bagasse). Hydro power for electricity generation makes up 16 per cent of renewables consumption, with the remaining 17 per cent comprising biofuels, wind and solar energy consumption. In recent years, a decline in the use of hydroelectricity has been offset by an increase in the use of wind energy, solar energy and biofuels.

Table 4: Total primary energy supply, by state, by energy type, 2009–10

	Coal	Petroleum products	Gas	Renewables[a]	Total[b]
	PJ	PJ	PJ	PJ	PJ
NSW	791	613	159	63	1 648
Vic	691	422	263	44	1 406
Qld	544	477	199	104	1 301
WA	117	327	566	14	1 026
SA	78	112	133	12	348
Tas	8	38	14	31	110
NT	0	68	38	0	107
Total	**2 229**	**2 058**	**1 371**	**286**	**5 945**
Share of total	**37.5%**	**34.6%**	**23.1%**	**4.8%**	**100.0%**

a State renewables data only includes hydroelectricity, solar hot water, biomass and biogas. It does not include wind or solar PV but these are included in the total.
b Includes wind and solar PV. Totals may not add due to rounding.

Source: ABARES 2011, Australian Energy Statistics.

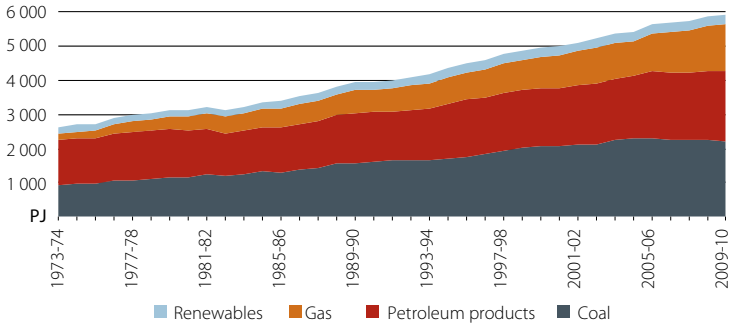
Table 5: Australia's energy consumption, by energy type

	2005-06	2006-07	2007-08	2008-09	2009-10
	PJ	PJ	PJ	PJ	PJ
Consumption of fuels	8 084	8 264	8 367	8 366	8 353
Black coal	1 639	1 686	1 655	1 527	1 488
Brown coal/lignite	705	611	630	751	742
Coke	76	77	78	63	73
Coal by-products	81	78	80	55	66
Liquid biofuels	1	2	5	7	10
Wood, woodwaste	90	93	108	103	103
Bagasse	109	111	112	103	88
Refinery input	1 407	1 503	1 462	1 480	1 439
Petroleum products	1 968	2 000	2 062	2 072	2 090
Natural gas	1 108	1 187	1 237	1 323	1 382
Town gas	7	7	4	3	0
Solar energy	2	6	7	8	10
Total electricity	891	904	929	871	860
of which Hydro	58	52	43	40	45
wind	6	9	11	14	17
solar	0.4	0.4	0.4	0.6	1.0
Production of derived fuels	2 460	2 574	2 605	2 487	2 409
Coke	98	98	98	69	76
Coal by-products	81	81	82	54	65
Petroleum products [a]	1 429	1 534	1 557	1 544	1 471
Town gas	5	5	4	3	0
Thermal electricity	847	857	863	817	797
Total energy consumption [b]	5 625	5 690	5 763	5 879	5 945

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 due to rounding.

Source: ABARES 2011, Australian Energy Statistics, Table C.

Figure 12: Australia's total primary energy supply, by energy type



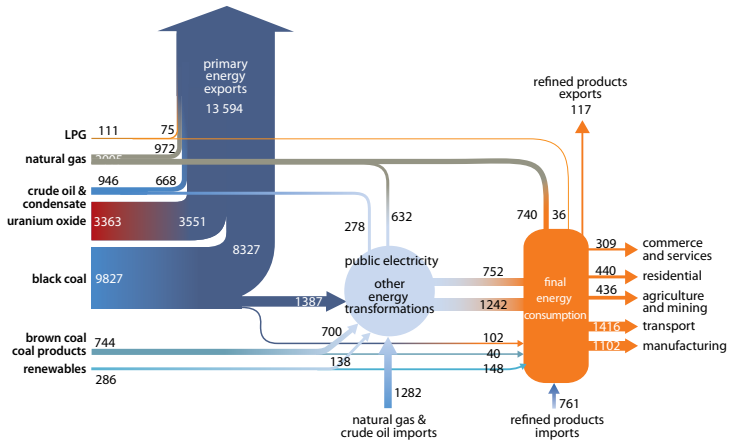
Source: ABARES 2011, Australian Energy Statistics.

Energy consumption, by sector

Australia's total primary energy supply is estimated to have risen by 1.1 per cent to 5945 petajoules in 2009–10. The diagram of Australia's energy flows is a simplification of the energy supply and consumption table on page 26 and 27. 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. In addition, 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.

Figure 13: Australia's energy flows, 2009–10 (units: petajoules)



Source: ABARES 2011, Australian Energy Statistics.

Table 6: Australia's energy supply and consumption, 2009–10

		Coal and coal by-products	Natural gas, CSG	Crude oil and ORF	Propane, butane, LPG	Refined products	Liquid/gas biofuels
		PJ	PJ	PJ	PJ	PJ	PJ
Supply							
Primary indigenous		10 571.0	2 004.9	946.2	110.6		21.2
plus	all imports		225.7	1 055.9	28.8	732.0	
less	all exports [a]	8 327.4	971.9	668.4	75.0	116.7	
less	stock changes and discrepancies	14.9	- 112.7	- 92.7	14.0	33.5	
Total primary energy supply [b]		2 228.7	1 371.4	1 426.4	50.4	581.8	21.2
less	conversions						
Coke ovens		35.3				0.6	
Petroleum refining		0.4	22.0	1 434.1	- 31.6	- 1 402.6	
Gas manufacturing			0.3		0.1		
Electricity generation [a]		1 983.9	390.6	0.5		39.3	10.1
Other conversion [c]		67.2	187.4	- 11.8	- 13.1	23.9	
Fuel use in conversion			31.5		0.2	97.5	
Consumption							
Total final energy consumption [d]		141.9	739.6	3.6	94.8	1 823.0	11.1
Agriculture			0.1		1.8	85.8	
Mining		0.2	145.5	2.9	1.8	125.9	0.8
Food, beverages, textiles		14.1	36.2	0.6	1.2	1.8	0.2
Wood, paper and printing		4.3	24.6		0.1	0.4	0.5
Chemical		7.9	119.1		12.7	68.5	0.2
Iron and steel		31.3	23.1			1.0	
Non-ferrous metals		54.9	122.4		0.1	67.4	
Other industry		27.7	69.6		7.0	8.7	1.2
Construction			3.0		0.2	21.8	
Road transport			2.3		55.2	999.8	7.6
Rail transport						37.3	
Air transport						245.5	
Water transport						60.1	
Commercial and services		1.4	49.5		3.4	32.1	0.7
Residential			144.1		11.1	1.2	
Lubes, bitumen, solvents						65.8	

(Continued)

Table 6: Australia's energy supply and consumption, 2009–10 *(Continued)*

		Biomass	Wind electricity	Solar	Hydro-electricity	Total electricity	U_3O_8 Uranium	Total
		PJ	PJ	PJ	PJ	PJ	PJ	PJ
Supply								
Primary indigenous		191.6	17.3	11.1	45.1		3 363.3	17 282.3
plus	all imports							2 042.4
less	all exports [a]						3 550.9	13 710.2
less	stock changes and discrepancies						- 187.5	- 330.5
Total primary energy supply [b]		191.6	17.3	11.1	45.1			5 944.9
less	conversions							
Coke ovens						0.1		36.0
Petroleum refining						6.2		28.5
Gas manufacturing								0.4
Electricity generation [a]		65.0	17.3	1.0	45.1	- 869.6		1 683.2
Other conversion [c]						0.5		254.0
Fuel use in conversion						110.7		240.0
Consumption								
Total final energy consumption [d]		126.6		10.1		752.2		3 702.8
Agriculture						8.3		96.0
Mining						62.6		339.7
Food, beverages, textiles		35.9				22.0		111.9
Wood, paper and printing		28.8				17.8		76.6
Chemical		1.9				17.3		227.7
Iron and steel						13.5		69.0
Non-ferrous metals		1.4				138.4		384.6
Other industry		0.9				25.6		140.7
Construction						0.3		25.4
Road transport								1 064.9
Rail transport						8.3		45.7
Air transport								245.5
Water transport								60.1
Commercial and services		0.3		0.4		221.4		309.1
Residential		57.4		9.8		216.5		440.1
Lubes, bitumen, solvents								65.8

Totals may not add due to rounding. **a** Includes air and water transport bunker fuels. **b** Total primary energy supply is a measure of the total energy supplied within the economy. It is equal to indigenous production plus imports minus exports, plus stock changes and statistical discrepancies. **c** Includes return streams to refineries from the petrochemical industry, consumption of coke in blast furnaces, blast furnace gas manufacture, briquette manufacturing and lignite tar in char manufacture. **d** Total final energy consumption is the total energy consumed in the final or 'end-use' sectors. It is equal to total primary energy supply less energy consumed or lost in conversion, transmission and distribution.

Table 7: Australia's net energy consumption, by sector

	1974-75	1979-80	1989-90	1999-00	2009-10
	PJ	PJ	PJ	PJ	PJ
Agriculture	39	47	55	72	96
Mining	65	81	160	273	509
Manufacturing	928	965	1 067	1 192	1 261
Electricity generation	540	743	1 066	1 427	1 793
Construction	29	38	41	29	25
Transport	701	825	1 012	1 267	1 447
Commercial [a]	87	104	151	219	295
Residential	246	262	322	392	440
Other [b]	59	66	71	102	78
Total	**2 695**	**3 131**	**3 946**	**4 971**	**5 945**

Totals may not add due to rounding. **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 and statistical discrepancies.

Source: ABARES 2011, Australian Energy Statistics.

Electricity

The electricity industry, consisting of generators, transmission and distribution networks, and retailers, is one of Australia's largest industries, contributing 1.4 per cent to Australian industry value added in 2009–10. Between 1999–2000 and 2009–10, Australia's electricity generation increased at an average rate of 1.4 per cent a year. However, in 2009–10, electricity generation declined by 1.2 per cent.

Industry structure

The current structure of Australia's south-east electricity market was shaped by industry reforms in the early 1990s. A key element of these reforms was the establishment of 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, from May 2005, Tasmania. Western Australia and the Northern Territory are not connected to the NEM, primarily because of their geographical 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). AEMO is responsible for aggregating and dispatching supply to meet demand in the lowest cost manner available. 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.

The Australian Energy Market Commission (AEMC) is responsible for reviewing, amending and expanding the National Electricity Rules (NER) which govern the operations of the NEM. The enforcement of these rules, in addition to the economic regulation of electricity transmission and distribution networks and covered gas pipelines, is 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 Gas Rules. The interaction between these three bodies (AEMO, the AEMC and the AER) allows a consistent near-national approach to regulate Australia's energy markets.

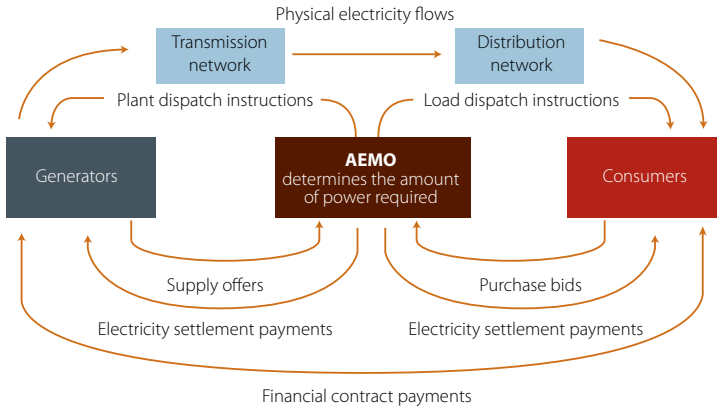
There is no formal, integrated electricity market in Western Australia. Electricity infrastructure is organised in several distinct systems including the South West Interconnected System (SWIS); the North West Interconnected System (NWIS); and a number of regional, non-interconnected power systems. SWIS is the largest network and serves Perth and the other major population centres in the south-west.

The SWIS became a wholesale market (where generators sell directly to retailers) in 2006. The Independent Market Operator (IMO) is responsible for the administration and operation of this market. Because of the small scale of the other systems in Western Australia it is impractical to introduce a wholesale market. Instead, they operate as retail markets where consumers purchase from competing retailers.

Western Australia retains state-based regulation of its electricity sector. The regulation of electricity transmission and distribution networks is the responsibility of the local Economic Regulation Authority (ERA). The ERA interprets, applies, and enforces the Electricity Networks Access Code which governs the operations of these networks.

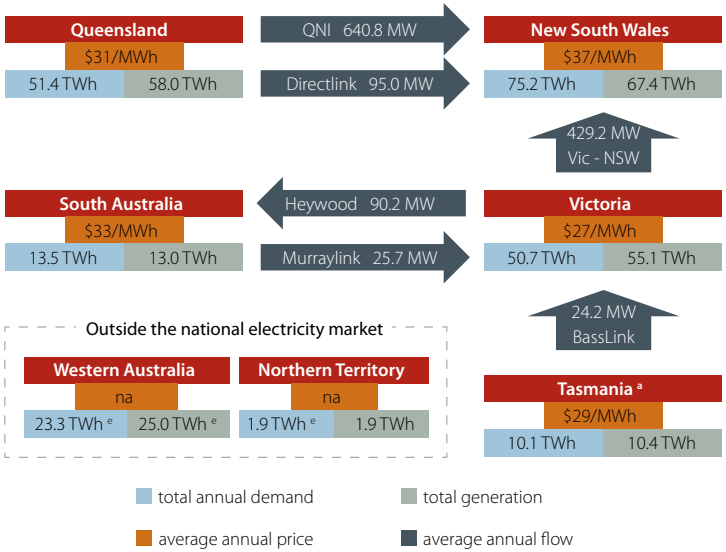
In the Northern Territory, market reforms were undertaken from 2000 to phase in competition of electricity supply and reduce the Power and Water Corporation's natural monopoly. New entrants into the Northern Territory electricity markets are permitted to use existing infrastructure (transmission and distribution) after signing an access agreement and paying a network charge. The Utilities Commission of the Northern Territory is responsible for the regulation of the market.

Figure 14: National electricity market structure



Source: AEMO 2010, An introduction to Australia's electricity market.

Figure 15: Regional electricity market activity, 2010–11



a Officially connected to the National Electricity Market in May 2005. **e** BREE estimate. **na** Not available.

Sources: Global Roam 2011, NEM Review; NT Power and Water Corporation 2011, Annual Report 2011.

Production

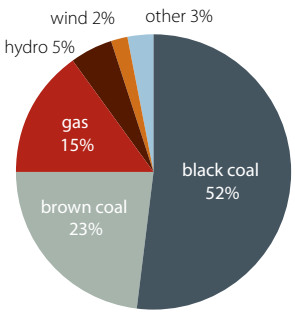
Around 242 terawatt hours of electricity (including off-grid electricity) was generated in Australia in 2009–10. Electricity generation declined in 2009–10, driven largely by falls in generation from combustible fuels (coal, oil and bioenergy). In addition, an unusually warm period during the September quarter in 2009–10 temporarily reduced demand for electricity.

Most of Australia's electricity is produced using coal, which accounted for 75 per cent of total electricity generation in 2009–10. 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.

Gas is Australia's second largest energy source for electricity generation, accounting for 15 per cent of electricity generation in 2009–10.

Renewable energy sources, mainly hydroelectricity, wind and bioenergy, accounted for around 8 per cent of the electricity generation mix in 2009–10.

Figure 16: Australia's electricity generation, by energy source, 2009–10[a]



a Other includes oil, bioenergy and solar PV.

Source: ABARES 2011, Australian Energy Statistics, Table O.

Table 8: Australia's electricity generation, by energy source

	2005-06	2006-07	2007-08	2008-09	2009-10
	TWh	TWh	TWh	TWh	TWh
Non-renewables					
black coal	131.0	138.7	143.0	129.3	124.5
brown coal	61.6	57.2	56.3	56.5	56.0
gas	30.8	32.0	35.5	35.9	36.2
oil products	2.4	2.1	2.8	3.0	2.7
other [a]	0.0	0.0	0.0	2.4	2.5
Total non-renewables	**225.8**	**230.1**	**237.6**	**227.1**	**221.9**
Renewables					
bagasse, wood	0.9	1.0	1.0	1.4	1.2
biogas	0.1	0.1	0.1	0.9	0.9
wind	1.7	2.6	3.1	3.8	4.8
hydro	16.0	14.5	12.1	11.1	12.5
solar PV	0.1	0.1	0.2	0.2	0.3
Total renewables	**18.9**	**18.3**	**16.3**	**17.3**	**19.7**
Total	**244.7**	**248.4**	**254.0**	**244.4**	**241.6**

a Includes multi-fuel fired power plants.

Source: ABARES 2011, Australian Energy Statistics, Table O.

Table 9: Key performance indicators for the Australian electricity industry

	Unit	2005-06	2006-07	2007-08	2008-09	2009-10
Generation capacity	GW	45	47	49	51	54
Capacity utilisation	%	56	55	54	52	49
Electricity generation [a]	TWh	220	227	228	230	230
Employment	('000)	41	44	46	44	52
Number of customers	('000)	9 530	9 684	9 892	10 011	10 166
Wholesale price [b]						
- nominal	c/kWh	39	62	54	49	45
- real [c]	c/kWh	47	72	60	54	48
System reliability [d]	SAIDI[e]	271	264	208	243	247
System energy not supplied	MWh	1 020	1 915	994	2 102	1 606
Distribution losses	%	6	6	5	6	5

a Represents electricity generation for public consumption only. Does not include generation for own use and should not be compared with data in Table 8. **b** Volume weighted average price (National Electricity Market). **c** 2011–12 A$. **d** Australian weighted average. System reliability figures represent the total of all distribution events, planned and unplanned, including significant events such as severe storms. **e** System Average Interruption Duration Index (minutes per customer per year).

Sources: Energy Supply Association of Australia 2011, Electricity Gas Australia 2011; ABS 2011, Australian Labour Market Statistics, cat. no. 6105.0.

Capacity

In 2009–10, Australia's principal electricity generation capacity was around 54 gigawatts. Average capacity utilisation remained between 49 per cent and 56 per cent over the past five years. The majority of Australia's electricity generation is supplied by steam plants, using coal or gas. Most of Australia's black coal-fired generation capacity is located in New South Wales and

Queensland, while Queensland also has the largest gas-fired generation capacity. A discussion on renewable electricity generation capacity is contained in the Clean Energy chapter.

As at the end of October 2011, there were 19 major electricity generation projects at an advanced stage of development on BREE's list (see appendix 1). These projects have a combined capacity of 2668 megawatts and a capital cost of around $4.8 billion from a range of energy sources. Seven of these projects are wind-powered, representing 41 per cent of the announced capacity of advanced electricity projects. Gas-fired projects account for a further 37 per cent of planned capacity, black coal-fired projects 17 per cent, and hydroelectricity and solar-powered projects account for the remaining 5 per cent. A further 167 major electricity generation projects were at a less advanced stage with a combined potential generation capacity of 47 187 megawatts.

The NEM is connected by six major transmission interconnectors. These interconnectors link the electricity networks in New South Wales, Queensland, South Australia, Tasmania and Victoria. The NEM electricity transmission and distribution networks consist of around 787 300 kilometres of overhead transmission and distribution lines and around 119 500 kilometres of underground cables. There are a number of projects that are under development to expand the capabilities of the interconnector system. AEMO lists 25 transmission projects in the Electricity Statement of Opportunities 2011 report. Table 12 identifies the nine projects scheduled to be completed in 2011–12.

Table 10: Australia's thermal electricity generation capacity, 2009–10

	NSW [a]	NT	Qld [b]	SA	Tas	Vic	WA [c]	Aus
	MW	MW	MW	MW	MW	MW	MW	MW
Steam								
- black coal	11 797	0	8 805	0	0	0	1 745	22 347
- brown coal	0	0	0	780	0	6 555	0	7 335
- gas	0	0	132	1 280	0	510	268	2 190
- multi-fuel	0	0	0	0	0	0	640	640
Reciprocating engine	0	77	0	50	0	0	0	127
Open cycle gas turbine								
- conventional gas	1 388	322	907	733	283	1 321	1 771	6 725
- coal seam gas	0	0	519	0	0	0	0	519
- oil products	50	30	457	113	0	0	83	733
- multi-fuel	0	0	0	0	0	0	586	586
Combined cycle gas turbine								
- conventional gas	595	131	215	663	208	0	680	2 492
- coal seam gas	0	0	1 395	0	0	0	0	1 395
Total thermal capacity	**13 830**	**560**	**12 430**	**3 619**	**491**	**8 386**	**5 773**	**45 089**

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 2011, Electricity Gas Australia 2011.

Table 11: Australia's major power network transfer capabilities, 2009–10

Interconnector	Location	Forward capability	Reverse capability
		MW	MW
NSW to Qld (QNI)	Armidale to Braemar	300	900
NSW to Qld (Terranora)	Terranora to Mullumbimby	122	220
Vic to NSW	Buronga to Dederang	983	456
Vic to SA (Heywood)	Heywood to Tailem Bend	360	400
Vic to SA (Murraylink)	Red Cliffs to Berri	220	136
Tas to Vic (Basslink)	Seaspray to Georgetown	594	390
Transmission and distribution		overhead	underground
length (km)		787 297	119 511

Source: Australian Energy Market Operator 2011, 2011 National Transmission Network Development plan; Global Roam 2011, NEM Review; Energy Supply Association of Australia 2011, Electricity Gas Australia 2011.

Table 12: Major committed transmission projects for Australia's National Electricity Market[a]

Region	Project details
New South Wales	Upgrading the Tamworth-Armidale 330 kV line 86 conductor clearance to improve the thermal rating
New South Wales	Commissioning the Armidale 330 kV SVC power oscillation damper
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
Queensland	Replacing the 132 kV line from Ingham to Yabulu substations
Queensland	Installing two 120 MVAr capacitor banks on the Millmerran-Middle Ridge 330 kV circuits (at the Middle Ridge end) and a 200 MVAr capacitor bank at the Millmerran 330 kV substation
South Australia	Construction of a 275/66 kV connection point at Mount Barker South
South Australia	Construction of a 275/132 kV injection point to provide supply to Dorrien and feed Roseworthy
South Australia	Establishing the City West Substation with two 300 MVA, 275/66 kV transformers and independent 275 kV supply from Torrens Island
South Australia	Expanding the capacity of the Kadina East substation by installing two 60 MVA 132/33 kV transformers and associated works

a Scheduled to be completed in 2011–12.

Source: Australian Energy Market Operator 2011, Electricity Statement of Opportunities 2011.

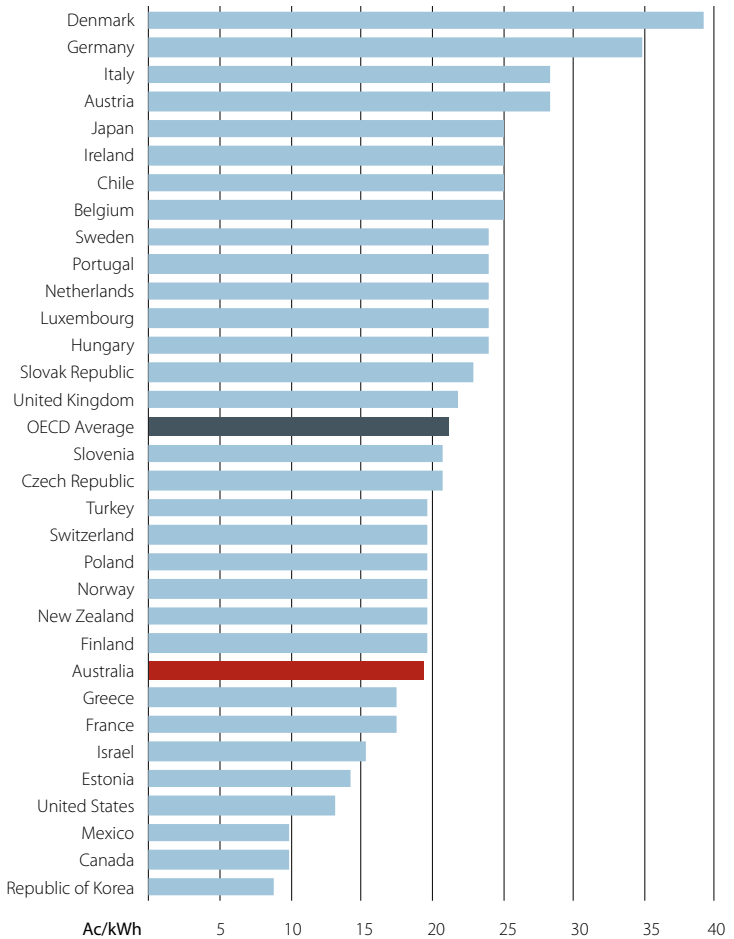
Prices

Households in Australia face relatively low retail electricity prices compared with many OECD economies. Although Australian electricity prices were above those in some countries such as the United States and Canada, they were just below the OECD average in 2010.

Energy, including gas and electricity, is a relatively small component of household consumption expenditure. Over the past three decades the proportion of total household expenditure attributable to energy has fallen slightly, from 2.8 per cent in 1978–79 to 2.1 per cent in 2009–10. In 2010–11, energy represented approximately 2.2 per cent of household expenditure.

The price of electricity is determined by a number of factors such as transmission and distribution network costs, the wholesale electricity price faced by retailers, and government policies. Recently, a major driver of rising retail electricity prices has been the significant investment in new and ageing transmission and distribution infrastructure required to support increasing demand for electricity. The Australian Energy Market Commission estimates that transmission and distribution network costs represented between 44 to 53 per cent of the retail electricity price faced by households in 2009–10, with wholesale electricity prices representing a further 35 to 40 per cent.

Figure 17: Household electricity prices, OECD economies, 2010



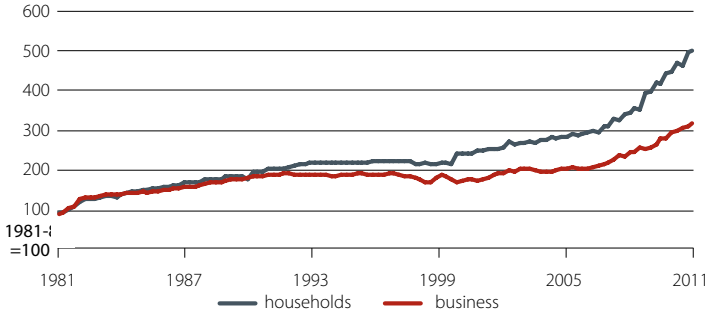
Sources: Australian Energy Market Commission 2011, Future Possible Retail Electricity Price Movements: 1 July 2010 to 30 June 2013; International Energy Agency 2011, Electricity Prices and Taxes.

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 because of drought conditions at the time. However, wholesale electricity prices have generally moderated since 2007. In 2010–11, wholesale electricity prices averaged around 23 per cent lower than in 2009–10, reflecting a comparatively mild summer that year that resulted in lower than expected electricity demand, and increased hydro generation.

Occasional price spikes are often caused by factors such as widespread heat waves or supply disruptions caused by natural disasters or generator malfunctions. For example, record demand associated with a heat wave at the beginning of 2011 contributed to significant increases in electricity spot prices in New South Wales and South Australia.

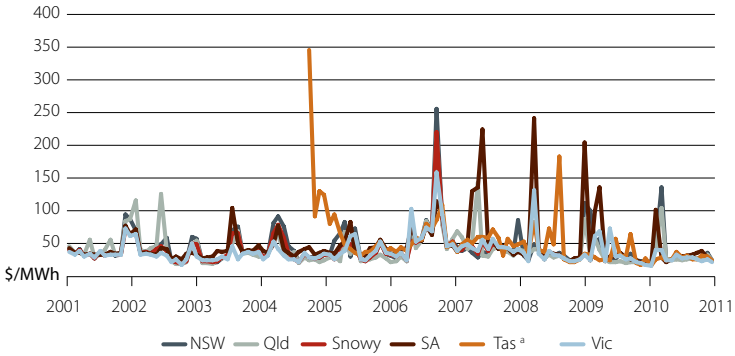
In contrast to wholesale prices, retail electricity prices have been increasing in recent years. Since about 2007, both household and business prices have risen sharply, especially for households. Rising network charges continue to be the largest contributor to price rises. Electricity prices paid by households have increased at a faster rate than those paid by Australian businesses. This is partly because of the removal of cross-subsidies from business to household customers in the 1990s.

Figure 18: Electricity price indices for households and businesses, Australia



Source: ABS 2011, Producer Price Indexes, Australia, cat. no. 6427.0; Consumer Price Index, Australia, cat. no. 6401.0.

Figure 19: Spot prices in the National Electricity Market



a Tasmania joined the NEM in 2005.

Source: Global Roam 2011, NEM Review; ABS 2011, Consumer Price Index, Australia, cat. no. 6401.0.

Table 13: Australia's principal generation businesses, 2010–11[a]

	Generation	Share of Australian generation
	GWh	%
NSW[a]		
Acciona Energy	35	0.0
Delta Electricity	22 998	10.0
Eraring Energy	14 243	6.2
Infigen Energy	4	0.0
Macquarie Generation	22 912	9.9
Marubeni	1 024	0.4
Origin Energy	261	0.1
Redbank Energy	1 110	0.5
Snowy Hydro	2 085	0.9
TRU Energy	2 731	1.2
Qld		
Alinta Energy	1 852	0.8
Alinta Energy & ERM & Contact	27	0.0
BG Group	692	0.3
CS Energy	12 169	5.3
CS Energy & OzGen	6	0.0
Ergon Energy	1 235	0.5
ERM Power	3 016	1.3
NRG & Comalco & Others	5 101	2.2
Origin Energy	6 275	2.7
OzGen & Marubeni	6 359	2.8
Rio Tinto Alcan	1 217	0.5
Stanwell Corporation	7 805	3.4
Tarong Energy	10 832	4.7
Transfield Services	1 386	0.6
SA		
AGL Energy	2 918	1.3
Alinta Energy	4 259	1.8
APA Group	304	0.1
Infigen Energy	446	0.2

(continued)

Table 13: Australia's principal generation businesses, 2010–11[a] *(continued)*

	Generation	Share of Australian generation
	GWh	%
Infratil Energy	1	0.0
International Power (Pelican)	2 939	1.3
International Power (Synergen)	7	0.0
Origin Energy	274	0.1
Pacific Hydro	169	0.1
Origin Energy & ATCO Power	1 044	0.5
TRUenergy	250	0.1
TrustPower	347	0.2
Tas		
Aurora Energy	1 506	0.7
Hydro Tasmania	8 890	3.9
Vic		
AGL Energy	616	0.3
Alcoa	1 280	0.6
Alinta GE	54	0.0
Ecogen Energy	275	0.1
Energy Brix	1 259	0.5
Eraring Energy	32	0.0
International Power & CBA	11 328	4.9
International Power & Mitsui	8 605	3.7
Loy Yang Power	16 883	7.3
Snowy Hydro	3 113	1.4
TRUenergy	11 606	5.0
WA[b]		
Horizon Power	978	0.4
Verve Energy	9 488	4.1
NT[b]		
Power and Water Corporation	1 582	0.7

a Includes the Australian Capital Territory. **b** Not part of the National Electricity Market.

Sources: Global Roam 2011, NEM Review; NT Power and Water Corporation 2011, Annual Report 2011; Verve Energy 2011, Annual Report 2010–11; Horizon Power 2011, Annual Report 2010–11.

Clean energy

Australia has access to abundant clean energy sources that are used for heating, electricity generation, and transportation. However, there are some significant constraints to the large-scale utilisation of Australia's clean energy resources. Currently, clean energy technologies generally have higher transformation costs relative to other technologies, renewable resources are often long distances from transmission and distribution infrastructure and markets, and the technologies used to utilise these resources are often immature. Despite these constraints, clean energy technologies will play an important role in moving to a low emissions future while meeting Australia's continued demand for energy.

Renewable energy accounts for around 5 per cent of Australia's energy consumption. Renewable energy sources comprise a small, although growing, share of Australia's electricity generation. Energy sources used in electricity generation include wind, hydro, solar energy and bioenergy, and make up around 8 per cent of the electricity generation mix. Wind-powered electricity and solar electricity have exhibited strong growth since 2004–05, albeit from a low base, increasing at an average annual rate of 23 per cent and 21 per cent, respectively.

Production

Clean energy sources currently used in Australia include hydro, biomass, biogas, wind energy, and solar energy. There is also potential for a number of emerging clean energy technologies that are yet to be commercially deployed, including large scale solar energy plants, geothermal generation technologies, ocean energy technologies, and carbon capture and storage (CCS) to reduce emissions from coal, oil and gas use.

Australian production of renewable energy (including electricity generation and direct use) is dominated by wood and wood products, bagasse and hydroelectricity, which combined accounted for around 83 per cent of renewable energy production in 2009–10. Wind, solar and other bioenergy (which includes biofuels and biogas) accounted for the remainder of Australia's renewable energy production. Most solar energy is used for residential water heating which accounts for around 2 per cent of final energy consumption in the residential sector.

Renewable energy production increased at an average rate of 1 per cent a year in the five years to 2009–10. In 2009–10, renewable energy production declined by 0.3 per cent compared with the previous year reflecting a fall in the use of bagasse for electricity generation by sugar manufacturers in Queensland and New South Wales. In 2009–10, the strongest growth in renewable energy production occurred in solar-powered electricity generation, which increased by 76 per cent, albeit from a small base. Wind-powered electricity generation and solar hot water also increased considerably, by 26 per cent and 23 per cent, respectively.

Solar energy in Australia

Solar energy is generated when energy from the sun is converted into electricity or used to heat air, water, and other fluids. There are two main types of solar energy technologies—solar thermal and solar photovoltaic.

Solar thermal is the conversion of sunlight into thermal energy (heat). Thermal energy (carried by air, water or other fluids) is typically used directly for space heating or to generate electricity using steam and turbines. Solar thermal is most commonly used in hot water systems. When used in electricity generation, it is typically designed for large scale generation. Solar thermal technologies can operate in hybrid systems with non-renewable power plants and, with appropriate storage, have the potential to provide baseload electricity generation.

Solar photovoltaic (PV) converts sunlight into electricity using photovoltaic cells. These systems can be installed on rooftops, integrated into the designs of buildings and cars, or expanded to provide electricity to the grid on a larger scale. Photovoltaic systems are well suited to off-grid electricity generation applications and where the cost of generation using other technologies is high.

In 2009–10, solar accounted for 0.2 per cent of Australia's energy mix. Solar thermal water heating has been the predominant form of solar energy use to date, but electricity generation is increasing through the deployment of PV and concentrating solar thermal technologies. Solar accounted for only 0.1 per cent of total electricity generation in Australia in 2009–10, but has grown by 21 per cent a year on average over the past five years.

The uptake of small scale solar PV has increased significantly in the past few years, supported by various Australian and state/territory government programs, such as rebates and feed-in tariffs. From 2001 to 2009, 86 000 solar panel systems were installed with a combined capacity of 123 megawatts. In 2010 there were over 158 000 solar panel installations with a combined capacity of 305 megawatts.

Relatively high capital costs remain the primary limitation to the widespread adoption of solar. Research into solar PV and solar thermal is largely focussed on reducing costs and increasing the efficiency of systems. The cost of PV panels has fallen significantly in recent years, largely because of a rapid increase in the scale of production as Chinese manufacturers begin to dominate the market.

Demand has fallen in some European countries that have wound back generous solar subsidies putting further downward pressure on prices. This downward trend in solar PV costs is expected to continue given the substantial research and development funds directed to this area and as these applications become more widespread.

In Australia, excellent solar resources can be large distances from the national electricity market, particularly the large population centres on the eastern seaboard. One of the key factors that will influence the location of large scale solar power plants in Australia will be the cost of connection to the electricity grid. This creates the challenge of maximising the access to solar radiation while minimising the costs of the project.

Table 14: Australia's energy production, by renewable energy source[a]

	2005-06	2006-07	2007-08	2008-09	2009-10
	PJ	PJ	PJ	PJ	PJ
Bagasse	109.1	110.8	111.9	103.4	88.2
Biogas and biofuels	9.4	10.2	20.5	18.6	21.2
Hydroelectricity	57.7	52.3	43.4	39.8	45.1
Solar hot water	2.4	6.0	6.5	8.2	10.1
Solar electricity	0.4	0.4	0.4	0.6	1.0
Wind	6.2	9.4	11.1	13.7	17.3
Wood and woodwaste	90.3	92.8	96.0	102.9	103.4
Total	**275.5**	**281.9**	**289.8**	**287.2**	**286.3**

a Includes both electricity and heat.

Source: ABARES 2011, Australian Energy Statistics.

Electricity generation

In 2009–10, renewable energy contributed around 8 per cent of energy used in electricity generation, with around two-thirds of this sourced from hydroelectricity. Wind-powered generation accounted for 2 per cent of total electricity generation. Both wind and solar-powered electricity generation grew considerably in 2009–10, although from small bases. Further information on renewable energy used in electricity generation is contained in the Electricity chapter of this report.

Capacity

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

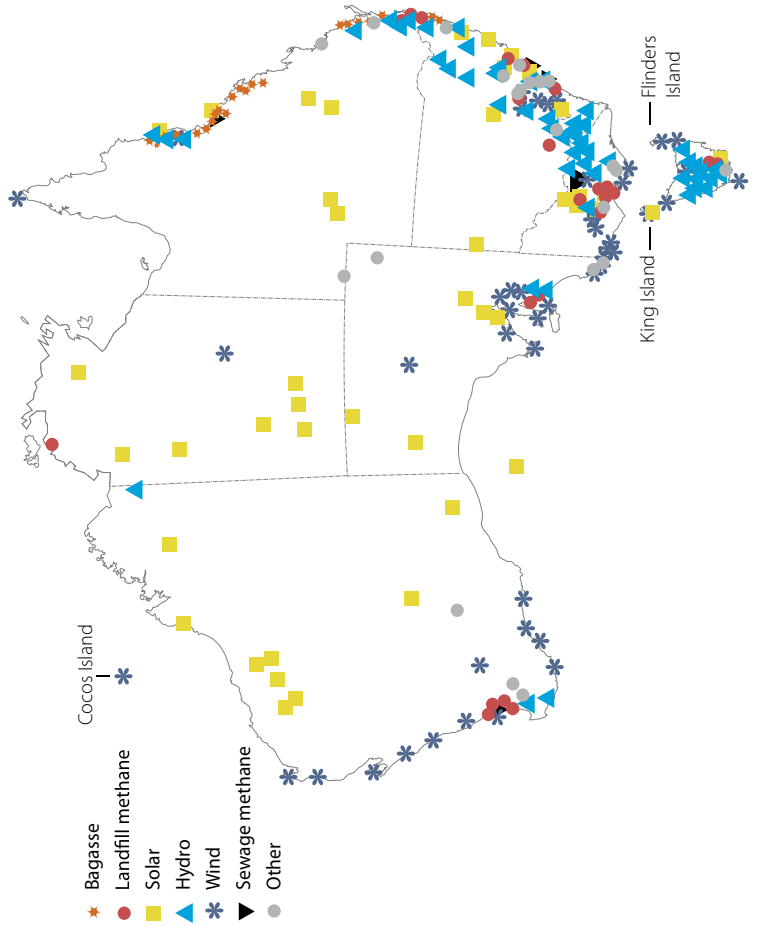
Table 15: Capacity of renewable electricity generation in Australia, 2010

	Hydro	Wind	Bioenergy	Solar PV [a]	Solar thermal	Geothermal	Wave	Total
	MW	MW	MW	MW	MW	MW	MW	MW
NSW	4 677	234	166	328	3	0	0	5 408
Tas	2 316	142	5	8	0	0	0	2 471
Vic	803	432	113	152	0	0	0.2	1 500
Qld	669	12	429	256	0	0.1	0	1 366
SA	4	1 151	20	130	0	0	0	1 305
WA	30	204	33	141	0	0	0.1	408
ACT	1	0	4	19	0	0	0	25
NT	0	0	1	6	0	0	0	7
Australia	**8 501**	**2 175**	**772**	**1 041**	**3**	**0.1**	**0.3**	**12 492**

a Includes small-scale Solar PV.

Source: Clean Energy Council 2011, Clean Energy Australia Report 2011.

Map 2: Renewable energy generators
operating plants with capacity of more than 30 kilowatts



Source: Geoscience Australia.

Interest in clean energy investment is continuing to grow, supported by technology advancements, improving commercial viability and a number of supportive government policies. Over time this will contribute to a major shift in the Australian energy landscape, with clean energy playing a larger role in the energy mix.

The Australian Government has implemented a number of measures to accelerate the uptake of clean energy technologies. The expanded Renewable Energy Target (RET) began on 1 January 2010, ensuring that 45 000 gigawatt hours of Australia's electricity supply will come from renewable energy sources by 2020. In January 2011, the RET was split into the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). Under the amended scheme, the interim LRET targets will increase from 16 338 gigawatt hours in 2012 to 41 000 gigawatt hours in 2020–2030. Households and small businesses are anticipated to provide, and potentially exceed, the additional 4000 megawatts required to meet the RET. Installation of small generation solar electricity units and solar water heaters have been encouraged through the Solar Credits Scheme and now form a large portion of generation under the SRES.

In addition, the Australian Government passed its Clean Energy Future plan in November 2011. The Clean Energy Future Plan targets the reduction of Australia's carbon emissions to 5 per cent below 2000 levels by 2020, and 80 per cent below 2000 levels by 2050. This target is to be achieved through the introduction of a carbon price and a package of complementary measures. The carbon price will commence on 1 July 2012 and will make large emitters of carbon financially liable for their emissions. The price will be fixed for three years before transitioning to an emissions trading scheme. The complementary measures include household and industry assistance and funding directed towards the development of renewable energy, energy efficiency and low emissions technologies.

As a part of its Clean Energy Future Plan the Australian Government is establishing the Australian Renewable Energy Agency (ARENA) from 1 July 2012. ARENA will provide funding support and will share knowledge and information to promote innovation in renewable energy and related technologies.

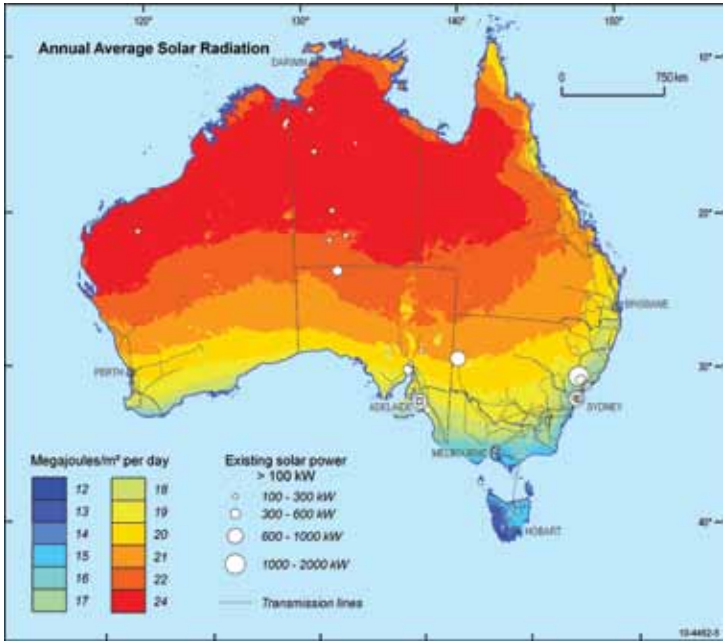
The Government is also supporting low emissions coal technology, primarily through the CCS Flagships program and the National Low Emissions Coal Initiative.

Potential

Significant growth in renewable electricity generation capacity is expected over the next few years. Of the 19 projects at an advanced stage of development on BREE's major electricity generation projects list as at October 2011, 10 were renewable projects. Seven of these projects were wind-powered, representing 89 per cent of the expected expansion in renewable capacity. Hydro-powered projects account for 7 per cent of planned generation capacity, and solar projects around 4 per cent. Details of these projects can be found in Appendix 1.

A further 114 renewable energy projects were at a less advanced stage of development, including 92 wind-powered projects and 12 solar-powered projects.

Map 3: Solar energy potential



Source: Geoscience Australia and ABARE 2010.

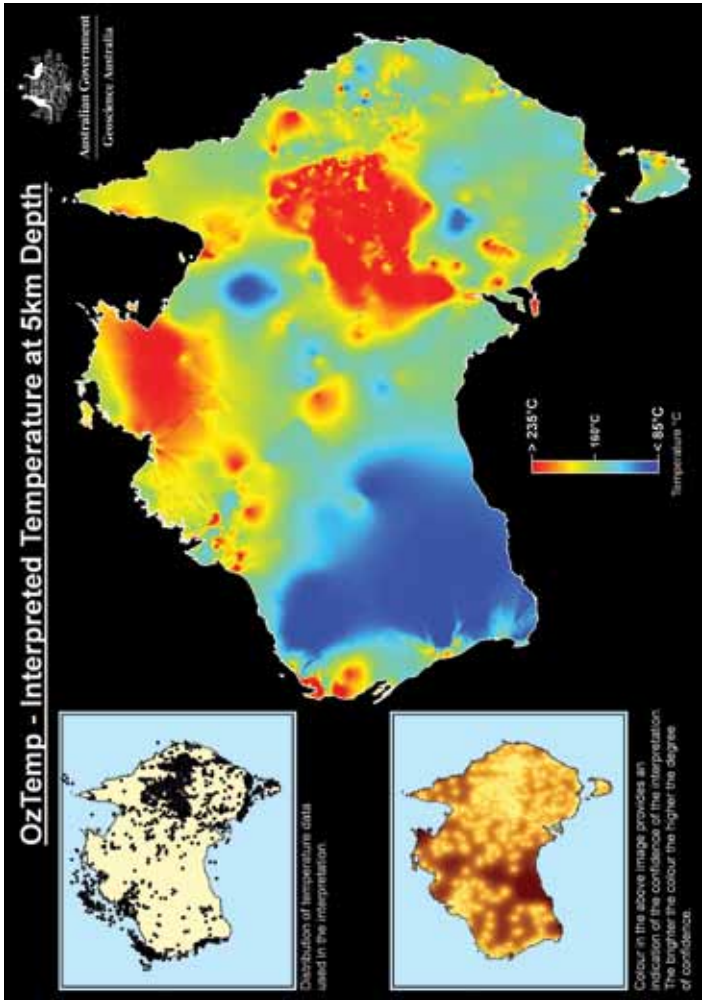
The large number of proposed wind-powered electricity projects reflects, in part, government policy measures to support the expansion of renewable energy sources and the cost competitiveness of wind relative to other, less mature renewable energy technologies. The advanced wind farms on the list are concentrated in Victoria, New South Wales and South Australia, which have the best wind resources. The capacity of planned wind farms is increasing, with an average size of around 190 megawatts and a few projects expected to have a capacity of up to 1000 megawatts.

Australia has the highest average solar radiation per square metre of any continent of the world. There is increased investment in large-scale solar electricity generation, with a number of large-scale solar projects under consideration around the country. The Solar Flagships program will support the construction and demonstration of large scale solar power stations in Australia.

Australia has considerable Hot Rock geothermal energy potential. There is also potential for lower temperature geothermal resources associated with naturally circulating waters in aquifers (Hot Sedimentary Aquifer Geothermal). Geothermal energy could provide baseload, low emission power generation. There is one geothermal electricity project operational in Australia, an 80 kilowatt facility in Birdsville, Queensland. There are also several large projects at the feasibility study and approval stage in Victoria and South Australia.

CCS, particularly when applied to coal-fired power generation, has significant potential to reduce Australia's greenhouse gas emissions while contributing to energy security and reliability. Governments and industries are aiming to demonstrate the commercial viability of integrated CCS projects by 2020. Towards this goal, Australia has developed a portfolio of CCS projects including the South West Hub Flagship project that has the potential to safely store up to six million tonnes of CO_2 a year.

Map 4: Geothermal energy potential



Source: Geoscience Australia.

Coal production and trade

Coal is Australia's largest commodity export, with earnings of around $44 billion in 2010–11. 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 75 per cent of electricity generation in 2009–10.

Production

Australia accounts for 6 per cent of world black coal production, around 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. More than three-quarters of this output is sourced from open cut mines.

Table 16: Australia's coal production, by state[a]

	2006-07	2007-08	2008-09	2009-10	2010-11
	Mt	Mt	Mt	Mt	Mt
Brown coal					
Vic	65.6	66.0	68.3	68.8	na
Total	**65.6**	**66.0**	**68.3**	**68.8**	**na**
Black coal					
NSW	130.9	135.0	137.8	147.3	156.9
Qld	184.1	180.5	190.4	207.4	159.4
Tas	0.6	0.6	0.6	0.6	6.7
WA	6.0	6.2	7.0	6.7	3.8
SA	3.9	3.9	3.8	3.8	0.6
Total	**325.4**	**326.2**	**339.6**	**365.9**	**327.5**

a Saleable production.

Source: BREE 2011, Resources and Energy Statistics.

Australian black coal production increased at an average annual rate of 3.6 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. In 2010–11, Australian black coal production declined by 10 per cent as production was hampered by floods in Queensland and heavy rainfall over New South Wales in January and June 2011. Growth in production has rebounded in the early part of 2011–12 as production returns to normal at flood affected operations.

Australia's coal production is likely to increase significantly over the medium term as a result of investment in new mining and export capacity. Investment in the Australian coal mining sector continues to be robust. As at October 2011, there were 20 committed coal mining projects and 76 proposed projects (see Appendix 1).

Trade

Around 87 per cent of Australia's black coal production is destined for export. Australia accounts for 28 per cent of world black coal exports—58 per cent of metallurgical coal exports and 18 per cent of thermal coal exports. In the past, infrastructure has been a constraint on Australian coal exports. However, expansions to port capacity have alleviated some of these constraints. For example, in 2010–11, growth in Australia's thermal coal exports was supported by the commissioning of new capacity at the Newcastle Coal Infrastructure Group terminal (annual capacity 30 million tonnes) and the expansion of the Kooragang Island Coal Terminal (annual capacity 11 million tonnes).

Figure 20a: World metallurgical coal trade, major exporters 2010

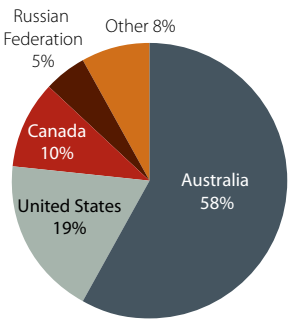
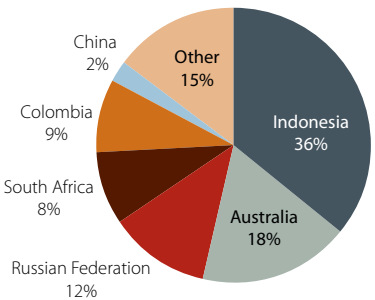


Figure 20b: World thermal coal trade, major exporters 2010



Source: BREE 2011, Resources and Energy Statistics 2011.

Most of Australia's metallurgical coal exports are destined for Asia and Europe where it is 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. China's imports of metallurgical and thermal coal from Australia have increased more than fivefold since 2006–07.

Table 17: Australia's coal exports, by type, by destination

	2006-07	2007-08	2008-09	2009-10	2010-11
	Mt	Mt	Mt	Mt	Mt
Metallurgical coal					
Brazil	3.05	3.87	4.19	4.23	2.88
China	2.97	1.53	14.75	27.28	15.72
Chinese Taipei	8.04	6.39	2.66	5.36	8.05
European Union 27	24.87	24.51	14.69	15.61	17.07
India	19.61	24.23	24.28	31.38	30.91
Japan	48.86	50.20	42.22	48.46	42.61
Korea, Rep. of	6.25	8.36	13.05	15.86	16.44
Other	18.31	17.83	9.40	9.08	6.77
World	131.97	136.92	125.24	157.26	140.45
Thermal coal					
China	3.22	1.48	8.40	13.92	16.67
Chinese Taipei	16.23	18.56	20.30	19.55	20.12
European Union 27	3.81	2.15	3.72	0.28	0.14
Japan	58.64	66.92	62.58	66.41	66.96
Korea, Rep. of	15.06	18.55	30.14	24.84	28.19
Other	14.66	7.41	11.22	9.98	11.24
World	111.62	115.07	136.36	134.98	143.32
Total coal	**243.59**	**251.99**	**261.60**	**292.25**	**283.77**

Source: BREE 2011, Resources and Energy Statistics 2011.

Australian exports of coal declined by 3 per cent in 2010–11 as increased volumes of thermal coal were more than offset by lower metallurgical coal export volumes.

Metallurgical coal exports increased at an average annual rate of 5 per cent between 2006–07 and 2009–10. Growth in metallurgical coal exports has been driven by increasing growth in Chinese and Indian steel production and associated import demand. In 2010–11, Australia's exports of metallurgical coal declined by 11 per cent to 140 million tonnes, reflecting significant production losses following heavy rain and flooding in Queensland in late 2010 and early 2011.

Over the period 2006–07 to 2010–11, Australia's thermal coal exports increased at an average annual rate of 5 per cent. This strong growth was underpinned by rising import demand from Asian economies including Japan, China and Chinese Taipei. In 2010–11, Australian exports of thermal coal increased by 6 per cent relative to 2009–10 to 143 million tonnes, supported by the completion of infrastructure projects in New South Wales.

Prices

Since April 2010, contract prices for most metallurgical coal from major producers have been set on a quarterly basis, a significant departure 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.

Average metallurgical coal prices for the first three-quarters of JFY 2011 were settled between Australian producers and Japanese steel mills at around US$299 a tonne. This represents a 39 per cent increase on the previous year. Thermal coal contract prices for JFY 2011 were settled at around US$130 a tonne, 33 per cent

higher than the previous year. Average contract prices for hard coking, semi-soft and thermal coal have been rising strongly, underpinned by strong increases in demand, particularly in developing economies, and supply disruptions in key producing countries. Over the past five years, real contract prices for hard coking, semi-soft and thermal coal have increased by 18 per cent, 21 per cent and 11 per cent, respectively.

Table 18: Australia's exports of coal

		2006-07	2007-08	2008-09	2009-10	2010-11
Metallurgical coal, high quality						
Volume	Mt	82.81	83.65	79.63	97.72	91.60
Value	2010-11 $m	12 386	11 802	26 737	17 589	21 146
Unit value	2010-11 $/t	149.57	141.07	335.78	180.00	230.85
Excluding high quality						
Volume	Mt	49.15	53.27	45.61	59.55	48.85
Value	2010-11 $m	4 532	5 648	12 100	7 696	8 650
Unit value	2010-11 $/t	92.21	106.04	265.28	129.25	177.06
Total metallurgical coal						
Volume	Mt	131.97	136.92	125.24	157.26	140.45
Value	2010-11 $m	16 918	17 450	38 837	25 285	29 796
Unit value	2010-11 $/t	128.20	127.44	310.11	160.78	212.14
Thermal coal						
Volume	Mt	111.62	115.07	136.36	134.98	143.32
Value	2010-11 $m	7 602	9 101	18 868	12 255	13 956
Unit value	2010-11 $/t	68.11	79.10	138.37	90.78	97.37

Source: BREE 2011, Resources and Energy Quarterly.

Table 19: Coal prices[a]

	2007	2008	2009	2010	2011
Metallurgical coal, hard [b]					
US$/t	98.00	300.00	128.00	214.75	298.75[e]
A$/t	112.95	377.68	150.07	227.73	285.37
Real A$/t	127.13	410.30	159.94	235.74	285.37
Metallurgical coal, other [c]					
US$/t	64.00	240.00	85.00	163.00	224.00[e]
A$/t	73.77	302.14	99.66	172.85	213.97
Real A$/t	83.03	328.24	106.21	178.93	213.97
Thermal coal [d]					
US$/t	55.50	125.00	70.35	98.00	129.85
A$/t	63.97	157.37	82.48	103.92	124.04
Real A$/t	72.00	170.96	87.91	107.58	124.04

a Japanese fiscal year beginning 1 April. Prices are fob Australia basis; real prices are in 2011 Australian dollar terms. **b** For example, Goonyella export coal. **c** Non-hard metallurgical coal price based on Australian/Japanese contract settlements. **d** For thermal coal with a calorific value of 6700 kcal/kg (gross air dried). **e** Average of first three quarters of year. BREE estimate.

Source: BREE 2011, Resources and Energy Statistics 2011.

Gas production and trade

Gas (conventional and unconventional) is becoming increasingly important for Australia, both as a domestic energy source and as a source of export income. Australia is a significant exporter of liquefied natural gas (LNG), with around half of all gas production exported. In 2010–11, the value of Australian LNG exports was $10.4 billion. Since 1999–2000, domestic gas consumption has increased at an average annual rate of 4 per cent. Gas accounted for 23 per cent of Australian energy consumption, and 15 per cent of electricity generation in 2009–10.

Production

Australia's conventional gas production is almost entirely sourced from three basins, with the Carnarvon (north-west Western Australia), Cooper/Eromanga (central Australia) and Gippsland (Victoria) basins accounting for 98 per cent of production in 2010–11.

Western Australia is the largest gas producing state in Australia, representing more than two thirds of national production in 2010–11. 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 around 6 per cent over the past five years, to reach 1439 petajoules in 2010–11. The majority of gas production in Western Australia

is sourced from the Carnarvon Basin, with the North West Shelf Venture accounting for a significant proportion of production.

The Gippsland Basin in Victoria is Australia's longest producing basin, accounting for around 16 per cent of national production in 2010–11. The remaining Victorian gas production is attributable to the offshore Otway and Bass basins. Over the past five years, gas production from the Gippsland, Otway and Bass basins has varied each year, and increased by 27 per cent to 342 petajoules in 2010–11. Contributing to this variability is the natural decline at 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 and other uses.

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 20 petajoules in 2010–11. Until 2005–06, all of the gas produced in the Northern Territory gas market was consumed locally. The development of the offshore Bayu Undan field in 2005–06 saw Darwin host Australia's second LNG facility. In 2009, the offshore Blacktip gas field in the Bonaparte Basin started production with gas being piped onshore to supplement the declining Amadeus Basin supply. A second LNG plant for Darwin to process gas from the Ichthys field was announced in January 2012.

Table 20: Australia's gas production, by state[a]

State	2006–07	2007–08	2008–09	2009–10	2010–11
	PJ	PJ	PJ	PJ	PJ
Qld					
Conventional	28	28	27	21	10
Coal seam gas	88	129	150	195	233
Total	116	157	177	216	243
NSW					
Coal seam gas	11	5	5	6	6
Vic	300	313	274	270	342
SA	50	78	134	107	41
WA	1 130	1 143	1 235	1 371	1 439
NT[b]	22	22	22	27	20
Australia	**1 629**	**1 717**	**1 846**	**1 997**	**2 091**

a Data converted from volume to energy content using average conversion factors as detailed in Appendix 2. **b** Joint Petroleum Development Area gas used in Darwin LNG not included.

Sources: BREE.

Production of coal seam gas (CSG) has increased significantly in the past five years, with its share of total Australian gas production, on an energy content basis, increasing from 2 per cent in 2002–03 to 11 per cent in 2010–11. CSG also accounted for 38 per cent of total gas production in the eastern market in 2010–11. Most CSG production is sourced from Queensland, which accounted for approximately 98 per cent of production in 2010–11, with the remaining production occurring in New South Wales. Production of CSG is expected to continue to grow, with a number of projects under construction and planned in both states, including three CSG export projects in the form of LNG under construction in Queensland, due for completion the middle of this decade.

Unconventional gas in Australia

Gas is a combustible mixture of hydrocarbon gases, including methane, ethane, propane, butane and condensate. It is formed by the alteration of organic matter. When accumulated in a subsurface reservoir that can be readily produced, it is known as conventional gas. It can also be found with oil in oil fields. Gas can also be found in more difficult to extract unconventional deposits, such as coal beds or in shales, low quality reservoirs or as gas hydrates.

Australia potentially has access to gas from several different sources, including both conventional and unconventional gas resources.

Coal seam gas (CSG) is naturally occurring methane gas in coal seams. It is also referred to as coal seam methane and coal bed methane. The first stand alone commercial production of CSG in Australia commenced in late 1996 in Queensland, and has grown rapidly since then. This expansion has been underpinned by the strong demand growth in the eastern gas market and the recent recognition of the large size of the coal seam gas resource.

Tight gas occurs within low permeability reservoir rocks. The largest known resources of tight gas in Australia are in low permeability sandstone reservoirs in the Perth, Cooper and Gippsland basins. Tight gas is not currently produced in Australia, although there are some projects planned.

Shale gas is gas which has not migrated to a reservoir rock but is still confined within low permeability, organic rich source rocks such as shales. Shale gas exploration is in its infancy in Australia, but the organic rich shales in some onshore basins have been assessed for their shale gas potential. There is currently no production of shale gas in Australia, although production in the United States has expanded significantly in recent years.

No definitive gas hydrates have been identified in Australian waters.

As the unconventional gas industry in Australia matures, it is expected that exploration will add to the inventory of these resources.

As an end use product, unconventional gas is similar to conventional gas. It can be added to gas pipelines without any special treatment and utilised in gas applications such as electricity generation and commercial operations.

Trade

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

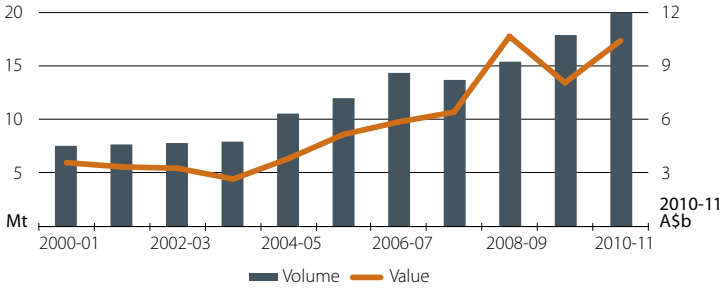
Until 1989–90, Australia consumed all of the gas that was produced domestically. Following the development of the North West Shelf Venture gas fields, located in the Carnarvon Basin (off the north-west coast of Western Australia), Australia began exporting LNG to overseas markets. Since 2005–06, LNG has also been exported from Darwin.

As of December 2011, Australia's annual LNG export capacity was 20 million tonnes. More than three quarters of this capacity is located in Western Australia.

Australia's LNG exports in 2010–11 were 20 million tonnes, an increase of 12 per cent relative to 2009–10. The higher production reflected a relatively light planned maintenance schedule at the North West Shelf project in that year compared with the previous year. The value of Australia's LNG exports in 2010–11 increased by 30 per cent relative to 2009–10 to $10.4 billion, reflecting higher oil prices, to which a number of LNG contracts are indexed, and increased export volumes.

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

Figure 21: Australia's LNG exports



Source: BREE 2011, Resources and Energy Statistics 2011.

LNG exports into the Asia Pacific region are expected to continue to grow over the next few years, with multiple projects under construction or committed expected to significantly expand Australia's LNG capacity. These include the conventional LNG projects of Pluto (4.3 million tonnes a year), Gorgon (15 million tonnes), Wheatstone (8.9 million tonnes), and Ichthys (8.4 million tonnes).

Exports of LNG are also expected to commence from Australia's east coast, with three projects based on coal seam gas—Queensland Curtis LNG (8.5 million tonnes a year), Gladstone LNG (7.8 million tonnes) and Australia Pacific LNG (4.5 million tonnes)—committed or under construction. Australia's first floating LNG project, Prelude (3.6 million tonnes a year), is also under construction.

Table 21: LNG export projects, Australia, as of December 2011

Project name	Owner	Location	Start up	Capacity Mtpa
Existing				
North West Shelf	Woodside Energy Ltd (operator); BHP Billiton Petroleum (North West Shelf) Pty Ltd; BP Developments Australia Pty Ltd; Chevron Australia Pty Ltd; Japan Australia LNG (MIMI) Pty Ltd; Shell Development (Australia) Pty Ltd	WA	1989	16.3
Darwin LNG	ConocoPhillips (operator); Eni; Santos; INPEX; Tokyo Electric ; Tokyo Gas	NT	2006	3.7
Under construction/committed				
Pluto	Woodside Energy Ltd (operator); Kansai Electric; Tokyo Gas	WA	2012	4.3
Australia Pacific LNG	Origin Energy Ltd (operator); ConocoPhillips; Sinopec	Qld	2015	4.5
Queensland Curtis LNG	QGC (BG Group)	Qld	2014	8.5
Gladstone LNG	Santos (operator); Petronas; Total; Kogas	Qld	2015	7.8
Gorgon LNG	Chevron (operator); Shell; ExxonMobil; Osaka Gas; Tokyo Gas; Chubu Electric	WA	2015	15
Prelude (floating LNG)	Shell	WA	2016	3.6
Wheatstone LNG	Chevron (operator); Apache; KUFPEK; Shell	WA	2016	8.9
Ichthys LNG	INPEX (operator); Total	NT	2017	8.4

Sources: BREE 2011, Mining industry major projects October 2011; Company websites.

Prices

The Australian domestic gas market consists of three distinct regional markets: the eastern market (Australian Capital Territory, New South Wales, Victoria, Queensland, 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. An additional hub in Brisbane commenced on 1 December 2011. 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.

Wholesale gas prices on the Victorian spot market rose by 18 per cent over the period 2000–01 to 2007–08, reflecting higher demand from households and power generators. Since then, 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; relatively mild seasonal demand; and weaker domestic economic growth. In 2010–11, the average Victorian wholesale gas spot price was $2.42 a gigajoule. The average STTM ex post price in 2010–11 was $5.26 a gigajoule in Sydney and $3.29 a gigajoule in Adelaide (the STTM price includes both the commodity and the cost of transportation to the hub, unlike the Victorian price which is commodity only).

Prices in the western market have also been increasing over the past decade, with Western Australian domestic gas prices increasing by 42 per cent between 2000–01 and 2010–11 in real terms. Rising production costs and strong gas demand, particularly in the mining sector, has put upward pressure on prices, as have relatively higher international LNG prices.

Table 22: Australian gas prices

			2006-07	2007-08	2008-09	2009-10	2010-11
Natural Gas [a]	Nominal	$A/GJ	3.62	3.77	3.32	2.03	2.42
	Real [d]	$A/GJ	4.08	4.10	3.50	2.09	2.42
Natural Gas [b]	Nominal	$A/GJ	2.77	2.94	3.77	3.71	4.11
	Real [d]	$A/GJ	3.12	3.20	3.98	3.83	4.11
LNG [c]	Real [d]	$A/t	409.87	465.66	690.00	449.45	522.98
		$A/GJ	7.53	8.56	12.68	8.26	9.61

a Financial year average of daily spot prices in the Victorian gas market. **b** WA domestic gas price. **c** Export unit value. **d** 2010-11 A$.

Source: BREE 2011, Resources and Energy Statistics; AEMO 2011; WA Department of Mines and Petroleum 2011.

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 oil-linked LNG contract prices between 2005 and 2008. In line with this trend, Australian LNG export prices increased by an average of 18 per cent a year between 2004–05 and 2008–09. However, in 2009, world LNG prices fell significantly, including price declines in

Japan (24 per cent), the United States (54 per cent) and European Union (32 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, coinciding with higher LNG export capacity in the Middle East, the Russian Federation and Indonesia and competition in the United States from shale gas. Prices rebounded in 2010 as gas demand recovered. In 2010–11, Australia's LNG export prices rose by 16 per cent to A$523 a tonne, equivalent to A$9.61 a gigajoule.

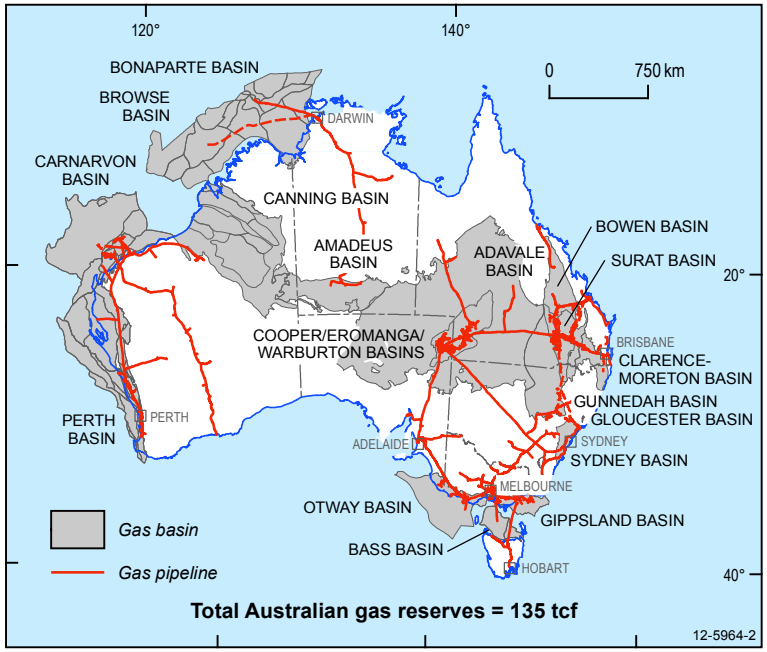
Table 23: International LNG prices

	average					US$/tonne
		2006	2007	2008	2009	2010
Australia exports[a]	all destinations	276	305	365	519	401
Japan imports	from Australia	335	359	602	459	609
	all origins	370	402	651	485	568
Korea imports	all origins	475	519	729	541	524
United States imports	all origins	363	358	507	233	247
United States pipeline imports	all origins	345	345	433	209	226
European Union imports	all origins	333	332	473	320	353

a Export unit value.

Sources: BREE 2011, Resources and Energy Statistics; IEA 2011, Energy Prices and Taxes 2011.

Map 5: Gas resources and infrastructure



Source. Geoscience Australia 2012.

Petroleum production and trade

Australia is a net importer of crude oil and condensate. In volume terms, Australia's crude oil and condensate production was equivalent to 62 per cent of refinery feedstock in 2010–11. Australia exports 79 per cent of its crude oil and condensate production, with the majority being sourced from the north-west coast of Australia. Around 83 per cent of input into refineries, which are largely based on the east coast of Australia, is sourced from imports. Domestic refineries account for around 74 per cent of Australia's refined product consumption. Australia is a net exporter of liquefied petroleum gas (LPG), with net exports equating to around 41 per cent of total production in 2010–11.

Production

In 2010–11, Australia's production of crude oil and condensate declined by 3 per cent to 24.8 gigalitres. This decline was primarily because of cyclone related disruptions and planned outages to oil production facilities on the north-west coast of Australia and flooding in the Cooper Basin. LPG production (from naturally occurring sources) declined by 5 per cent to 3.9 gigalitres in 2010–11.

Australia's largest petroleum producing basins are the Carnarvon Basin in the north-west of Australia and the Gippsland Basin in 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 73 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 17 per cent of Australia's total production of crude oil, condensate and LPG.

Table 24: Australia's production of primary petroleum, by basin

	2006–07	2007–08	2008–09	2009–10	2010–11
	ML	ML	ML	ML	ML
Crude oil					
Adavale	0	0	0	0	0
Amadeus	38	33	32	23	23
Bass	0	0	0	0	0
Bonaparte	1 440	1 052	894	1 004	515
Bowen–Surat	28	27	30	28	23
Canning	0	0	0	0	0
Carnarvon					
North West Shelf	5 181	3 807	2 740	2 127	1 172
Other	8 117	7 925	9 069	8 952	11 087
Cooper–Eromanga	1 024	1 160	1 277	1 058	920
Gippsland	3 952	3 562	3 906	3 162	2 269
Otway	0	0	0	0	0
Perth	822	668	407	284	220
Total	20 601	18 234	18 356	16 638	16 229
Condensate					
Adavale	0	0	0	0	0
Amadeus	18	18	13	9	6
Bass	124	121	116	46	98
Bonaparte	283	217	221	189	198
Bowen–Surat	13	13	10	5	5
Canning	0	0	0	0	0
Carnarvon					
North West Shelf	5 193	5 598	6 405	7 252	6 731
Other	165	139	104	174	156
Cooper–Eromanga	405	328	282	259	239
Gippsland	825	893	780	876	1 034
Otway	23	48	120	104	97
Perth	2	1	1	0	0
Total	7 051	7 376	8 051	8 945	8 564

(continued)

Table 24: Australia's production of primary petroleum, by basin (continued)

	2006–07	2007–08	2008–09	2009–10	2010–11
	ML	ML	ML	ML	ML
Liquefied petroleum gas					
Adavale	0	0	0	0	0
Amadeus	0	0	0	0	0
Bass	0	0	0	0	0
Bonaparte	0	0	0	0	0
Bowen–Surat	24	24	24	18	15
Canning	0	0	0	0	0
Carnarvon					
North West Shelf	2 067	1 500	1 582	1 780	1 687
Other	0	0	0	0	0
Cooper–Eromanga	551	557	560	560	560
Gippsland	1 908	1 883	1 628	1 616	1 497
Otway	0	6	136	122	148
Perth	0	0	0	0	0
Total	4 550	3 971	3 929	4 097	3 907

Sources: Energy Quest 2011; RET 2011, Australian Petroleum Statistics.

Trade

Australia is a net importer of refinery feedstock (crude oil and condensate) and refined petroleum products but a net exporter of LPG. In 2010–11, Australia imported 31.8 gigalitres of crude oil and other refinery feedstock. The high proportion of imports as a share of total production is because a significant proportion of Australia's oil production is exported. The location of Australia's oil production off the north-west coast is closer to Asian refineries than domestic refineries on the east coast. Conversely, most of Australia's 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 other refinery feedstock imports in 2010–11, accounting for 19 per cent of crude oil and other refinery feedstock imports, followed by Indonesia (15 per cent).

Table 25: Australia's imports of petroleum, by source

	2006-07	2007-08	2008-09	2009-10	2010-11
	ML	ML	ML	ML	ML
Crude oil and other refinery feedstock					
Indonesia	3 391	3 289	3 666	4 178	4 805
Malaysia	3 730	4 103	4 461	5 319	5 930
New Zealand	635	1 974	2 313	2 569	2 565
Other Middle East	118	43	40	43	0
Papua New Guinea	2 059	2 190	1 349	1 580	1 612
Qatar	106	0	0	0	42
Saudi Arabia	1 151	573	775	478	156
Singapore	841	713	555	605	497
United Arab Emirates	2 971	3 660	2 918	3 846	4 683
Viet Nam	6 677	6 318	5 277	3 904	2 554
Other	3 665	3 360	2 947	4 762	8 923
Total	**25 345**	**26 223**	**24 302**	**27 284**	**31 766**
Refined products					
Indonesia	17	11	45	95	259
Korea, Rep. of	821	785	1 704	1 960	2 013
Malaysia	8	316	184	249	263
Middle East	642	1 044	1 050	1 070	897
New Zealand	96	40	215	4	9
Singapore	7 681	10 215	10 217	10 249	9 471
United States	378	421	473	301	400
Other	4 375	5 149	5 808	6 039	5 459
Total	**14 018**	**17 982**	**19 697**	**19 967**	**18 771**

Sources: BREE 2011; ABARES 2011; RET 2011, Australian Petroleum Statistics; ABS 2011, International Trade, Australia, cat. no. 5465.0.

Despite being a net importer, Australia exports significant quantities of crude oil and other refinery feedstock. Australia's crude oil exports are typically of higher value, characterised by a low sulphur and wax content. In 2010–11, Australia's exports of crude oil and other refinery feedstock increased by 9 per cent to 19.6 gigalitres. This reflects increased production off the north-west coast of Australia, where the majority of production is sold to Asian refineries. In 2010–11, around 63 per cent of Australia's crude oil and other refinery feedstock was exported to Singapore, the Republic of Korea, China and Japan. Japan is Australia's largest market for LPG, accounting for 61 per cent of Australia's LPG exports in 2010–11.

Australia's exports of refined petroleum products are much lower, amounting to 0.8 gigalitres in 2010–11. Around 54 per cent of these exports went to Singapore and 29 per cent to New Zealand.

Australia's earnings from crude oil and other refinery feedstock exports increased by 23 per cent to $11.8 billion in 2010–11, as a result of higher export volumes and higher prices compared with 2009–10. By contrast, earnings from exports of refined petroleum products declined by 7 per cent in 2010–11, reflecting lower export volumes.

Table 26: Australia's exports of petroleum, by destination[ab]

	2006-07	2007-08	2008-09	2009-10	2010-11
	ML	ML	ML	ML	ML
Crude oil and other refinery feedstock					
China	518	972	1 009	2 185	3 632
Chinese Taipei	446	343	403	261	266
Japan	1 957	2 280	2 485	1 931	2 002
Korea, Rep. of	3 873	3 701	4 395	3 710	3 794
New Zealand	1 045	600	321	235	56
Singapore	3 752	3 089	3 543	3 838	2 648
United States	190	1 157	1 421	622	189
Other	4 183	3 833	3 011	5 283	7 050
Total	15 965	15 975	16 588	18 064	19 636
Liquefied petroleum gas					
China	308	465	354	383	256
Japan	1 821	1 587	1 474	1 965	1 509
Korea, Rep. of	384	178	292	80	190
Other	311	359	380	347	516
Total [c]	2 824	2 589	2 500	2 776	2 471
Refined products					
Fiji	4	3	2	2	1
Japan	84	71	56	31	15
New Zealand	872	837	400	317	223
Singapore	576	505	426	363	407
Other Pacific	131	275	256	73	87
United States	6	3	0	19	1
Other	81	113	25	45	26
Total	1 752	1 807	1 164	850	760

a Does not include LNG exports or ship and aircraft stores. **b** Actual values are used and aggregated for each category. **c** Includes confidential exports.

Sources: BREE 2011; Resources and Energy Statistics 2011; RET 2011, Australian Petroleum Statistics; ABS 2011, International Trade, Australia, cat. no. 5465.0.

Table 27: Value of Australia's trade in petroleum

	2006-07	2007-08	2008-09	2009-10	2010-11
	$m	$m	$m	$m	$m
Exports					
Automotive gasoline	468	444	171	138	120
Diesel fuel	188	363	225	131	94
Aviation turbine fuel	74	120	69	41	8
Fuel oil	84	130	96	54	99
Aviation gasoline	69	73	45	30	22
Kerosene	0	0	0	0	0
Lubricants	157	152	148	151	154
Other products	57	41	34	22	29
Total refined products	1 098	1 323	788	566	526
Liquefied petroleum gas	1 038	1 182	1 044	1 105	1 068
Bunkers [a]	1 295	1 457	1 537	1 315	1 508
Crude oil and other refinery feedstock	8 317	10 484	8 757	9 534	11 773
Imports					
Automotive gasoline	1 872	2 719	2 784	2 447	1 838
Diesel fuel	3 466	6 155	6 314	5 270	6 246
Aviation turbine fuel	668	1 505	1 393	1 283	1 440
Fuel oil	536	831	867	910	836
Lubricants	495	477	629	519	671
Liquefied petroleum gas	261	436	382	405	375
Other products	1 285	1 331	2 927	1 683	2 581
Total refined products	7 784	12 730	13 129	11 296	12 059
Crude oil and other refinery feedstock	13 360	17 149	14 727	15 031	19 579

a Ships and aircraft stores.

Sources: ABS 2011, International Trade, Australia, cat. no. 5465.0; RET 2011, Australian Petroleum Statistics.

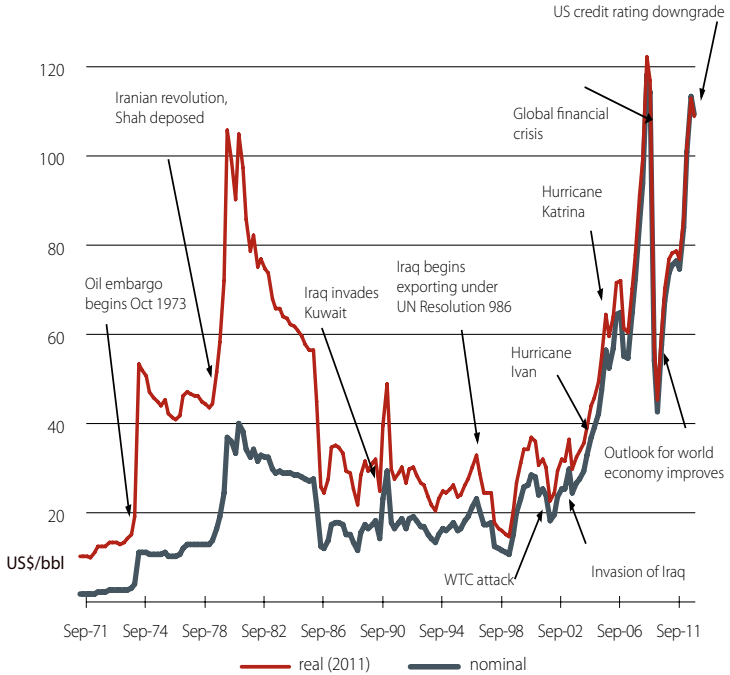
Prices

In 1970, the world trade weighted average oil price (in 2011 dollar terms) averaged US$10 a barrel. Oil prices increased during the 1970s as a result of the oil price shocks in both 1973 and 1979. By 1980, the oil price averaged US$100 a barrel. Oil prices dropped during most of the 1980s and in the 1990s. 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.

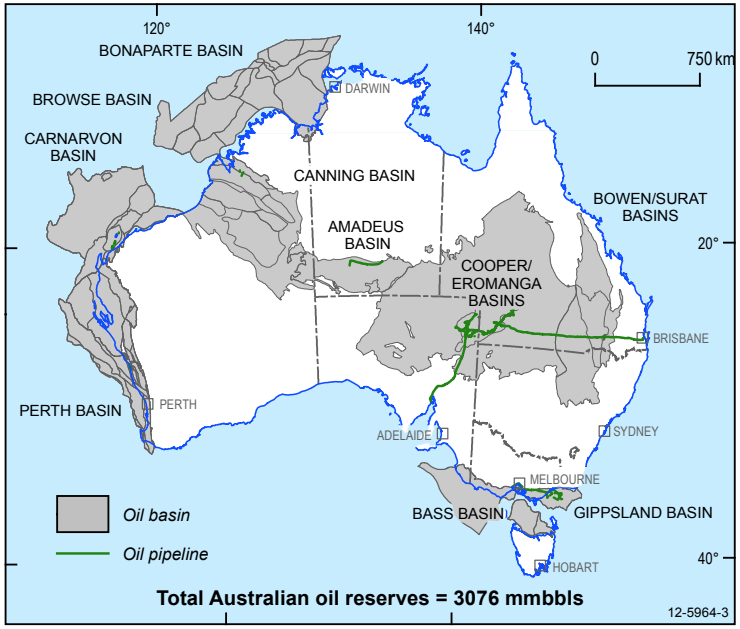
Continued political instability in a number of oil producing countries, increasing demand in Asia, particularly China, and speculative demand, drove oil prices to average US$122 a barrel in the June quarter 2008. However, by the December quarter 2008, oil prices had fallen by more than half to around US$57 a barrel. The rapid fall in oil prices was caused by falling demand as a result of the global financial crisis.

During 2009 and 2010, oil prices increased as a result of greater oil demand associated with economic recovery. In 2011, world trade weighted oil prices increased despite market concerns regarding sovereign debt issues in the United States and Europe, to average US$108 a barrel over the first nine months. Price increases were supported by relatively low OPEC spare production capacity, a range of disruptions to OPEC and non-OPEC supply and continued growing oil demand from emerging economies.

Figure 22: Crude oil prices



Map 6: Oil resources and infrastructure



Source: Geoscience Australia 2012.

Liquid fuels refining

In 2010–11, Australia's consumption of refined liquid fuels, excluding non-commercial sales and non-commercial consumption, was 52.1 gigalitres. Domestic production of marketable refined liquid fuels, excluding byproducts of petrochemical and downstream processing, totalled 38.4 gigalitres (around 74 per cent of consumption), while imports (including LPG) totalled 18.8 gigalitres. Australian exports of refined liquid fuels, excluding naturally occurring LPG, were around 0.8 gigalitres in 2010–11, equal to about 2 per cent of production. Australian consumption of refined petroleum products has increased at an average rate of 1.4 per cent a year over the past 10 years, reflecting consumption growth in the road and air transport sectors, 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 2010–11, Australian refineries produced 16.6 gigalitres of petrol and 12.9 gigalitres of diesel, comprising 43 per cent and 33 per cent of Australia's total production of petroleum products, respectively. In 2010–11, Australian refinery production increased by 3 per cent to 38.4 gigalitres, following unplanned maintenance at some refineries in late 2009 that reduced output.

Table 28: Australia's production of marketable refined petroleum products

	2006-07	2007-08	2008-09	2009-10	2010-11
	ML	ML	ML	ML	ML
Automotive gasoline	17 732	17 079	17 159	16 771	16 643
Automotive diesel oil	11 055	12 177	12 231	11 720	12 858
Aviation turbine fuel	5 332	5 182	5 494	5 341	5 448
Fuel oil	942	979	872	846	952
Liquefied petroleum gas	1 387	1 515	1 477	1 204	1 467
Industrial and marine diesel fuel	21	3	13	3	0
Bitumen	1 356	1 452	1 294	690	476
Lubricants	146	121	114	74	64
Aviation gasoline	119	119	105	104	91
Heating oil	86	102	69	35	16
Other [a]	1 017	845	718	412	378
Total products [b]	**39 194**	**39 575**	**39 546**	**37 200**	**38 393**

a includes kerosene (lighting and power). **b** excludes byproducts of petrochemical and downstream processing.

Source: RET 2011, Australian Petroleum Statistics.

Capacity

There are seven major petroleum refineries currently operating in Australia, which are managed by four companies—BP, Caltex, Mobil and Shell. These refineries have a combined capacity of around 44 gigalitres a year. The largest of these are BP's Kwinana refinery in Western Australia and Caltex's Kurnell refinery in New South Wales.

Table 29: Australia's 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**

MLpa Million litres per annum.

Source: Australian Institute of Petroleum, Downstream Petroleum 2009.

In July 2011, Shell announced its decision to stop refining operations at the Clyde refinery in Sydney and to convert it and the nearby Gore Bay Terminal into a fuel import terminal before mid-2013.

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 of unleaded petrol remains at a maximum of 150 ppm sulphur. A grade of

standard unleaded petrol with 10 per cent ethanol (E10) is also offered as an alternative to unleaded petrol, largely in eastern Australia. Another grade of standard unleaded petrol with up to 85 per cent ethanol (E85) is also supplied through a small number of metropolitan fuel outlets. 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.

In the Asia–Pacific region, many countries have 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 implemented maximum sulphur levels in gasoline of 150 parts per million (ppm) in 2009, with a 350 ppm sulphur limit in diesel postponed from 2010 until 2013. India reduced sulphur levels in gasoline to 150 ppm and in diesel to 350 ppm from 2010. Indonesia currently has a 500 ppm fuel sulphur limit in gasoline and diesel.

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 is also in use in a very small number of metropolitan buses and purpose built vehicles such as garbage trucks in Australia while liquefied natural gas is currently in limited use in heavy duty vehicles.

Biofuels production in 2010–11 represented around 1 per cent of Australia's petrol and diesel production. There are currently three major fuel ethanol production facilities in Australia, with a combined capacity of 440 million litres a year. These facilities produce ethanol primarily from wheat starch, grain sorghum and molasses. Around 68 per cent of ethanol production capacity is located in New South Wales, at a single production facility in Nowra.

Table 30: Liquid biofuels production facilities in Australia, 2012

Location	Capacity ML/yr	Feedstocks
Fuel ethanol		
Manildra Ethanol Plant, NSW	300	Waste starch
Dalby Biorefinery, Qld	80	Sorghum
Sarina Distilleries Qld	60	Molasses
Biodiesel		
In production		
Smorgon Fuels - BioMax Plant, Melbourne, Vic	15-100	Tallow, canola oil, dryland juncea (oilseed crop),
Biodiesel Producers Limited, Wodonga, Vic	60	Tallow, used cooking oil
Australian Renewable Fuels Largs Bay, Adelaide, SA	45	Tallow, used cooking oil
Australian Renewable Fuels Picton Plant, Picton, WA	45	Tallow, used cooking oil
Biodiesel Industries Australia Biodiesel Plant, Maitland, NSW	20	Used cooking oil, vegetable oil
Not in production		
Vopak, Darwin, NT	130	Palm oil
Eco-Tech Biodiesel, Narangba, Qld	30	Tallow, used cooking oil
Potential		
National Biofuels Plant, Port Kembla, NSW	300	Soya

Source: Biofuels Association of Australia 2012.

There are also five major biodiesel production facilities in Australia, with additional facilities producing small quantities. Total biodiesel operating capacity is around 270 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.

Non-conventional transport fuels in Australia

The transport sector is one of the largest energy consuming sectors in the Australian economy. Conventional fuels (petrol, diesel and jet fuel) currently account for around 95 per cent of Australia's transport fuel consumption, while non-conventional transport fuels (mainly LPG and biofuels) account for the remaining 5 per cent.

Australia's imports of petroleum products are expected to continue to rise, which potentially brings increased exposure to global oil markets. Increasing the use of alternative fuels and diversifying the fuel mix in the transport market can help mitigate some of the risks Australia is exposed to in the conventional fuel market. Some alternative transport fuels also assist in lowering emissions from the transport sector.

In late 2011, the Australian Government released its *Strategic Framework for Alternative Transport Fuels*. This document sets out a long-term strategic framework to support the market-led development of alternative transport fuels in the context of maintaining liquid fuel security while moving toward a low emission economy.

Alternative transport fuels available for use, or expected to become available over the medium to longer term, include biofuels (such as ethanol and biodiesel), gaseous fuels (compressed natural gas, liquefied natural gas and liquefied petroleum gas) and synthetic fuels (coal to liquids and gas to liquids and shale to liquids). Australia's electricity grid could also support the uptake of electric vehicles and further electrification of the rail network.

There are already a number of policies in place to encourage the production and use of alternative transport fuels in Australia. For example, under the Ethanol Production Grants program, grants of 38.143 cents a litre are provided for the domestic production of ethanol. The Energy Grants (Cleaner Fuels) Scheme provides 38.143 cents a litre for the domestic production and import of biodiesel and renewable diesel. There are also concessional excise arrangements in place for gaseous fuels (CNG, LNG and LPG). The LPG Vehicle Scheme provides grants for the purchase of a new LPG vehicle or the conversion of an existing vehicle to LPG. Fuel tax credits are also available to heavy duty vehicles in some circumstances.

The Australian Government has also committed funding to establishing the Australian Biofuels Research Institute (ABRI). The ABRI will progress the development and commercialisation of advanced biofuels in Australia. This initiative builds on existing support for biofuels research and development and will become part of the new Australian Renewable Energy Agency (ARENA) in July 2012.

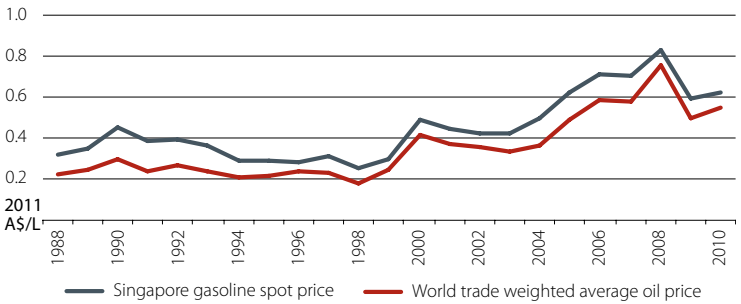
Prices

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. Similarly, the pre-tax component of Australian diesel prices is the sixth lowest, following Mexico, the United States, New Zealand, Canada and Japan.

Australian wholesale gasoline and diesel prices closely follow movements in Singapore gasoline prices, which are in turn largely set by world oil prices. In 2010–11, 50 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 2011 dollar terms)

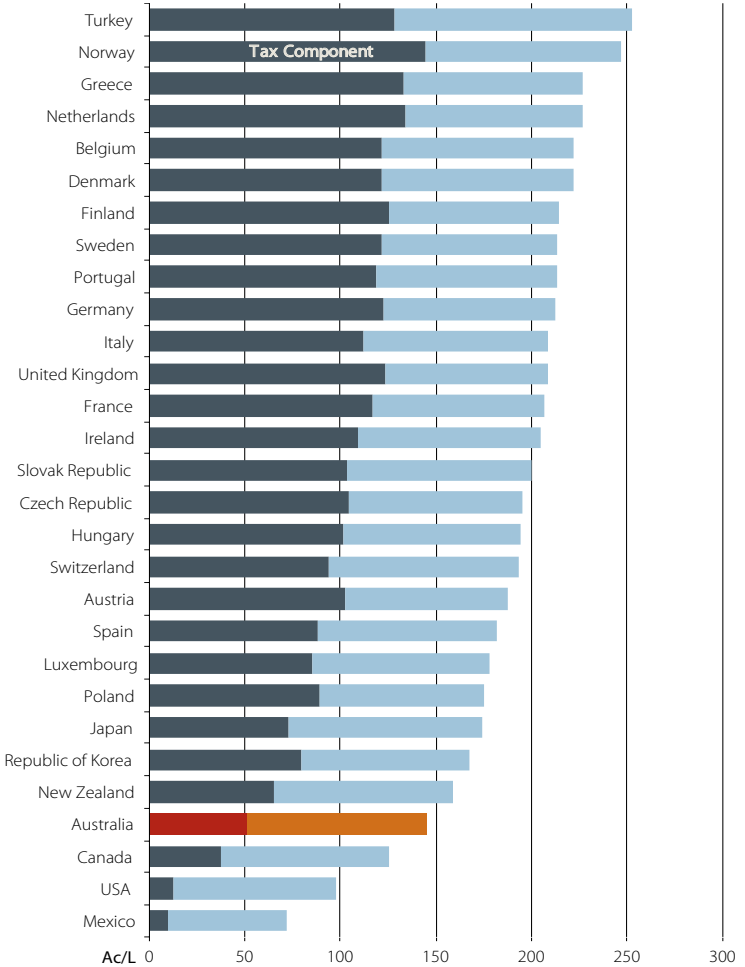
to average A$0.60 a litre in 2009, reflecting the effect of the slowdown in global economic activity on demand for petroleum products. In 2010, the Singapore gasoline spot price increased 4 per cent to average A$0.62 a litre for the year. The change in gasoline prices closely followed movements in crude oil prices—the world trade weighted average price of crude oil declined by 34 per cent in 2009, and increased by 10 per cent in 2010.

Figure 23: Petrol price indicators



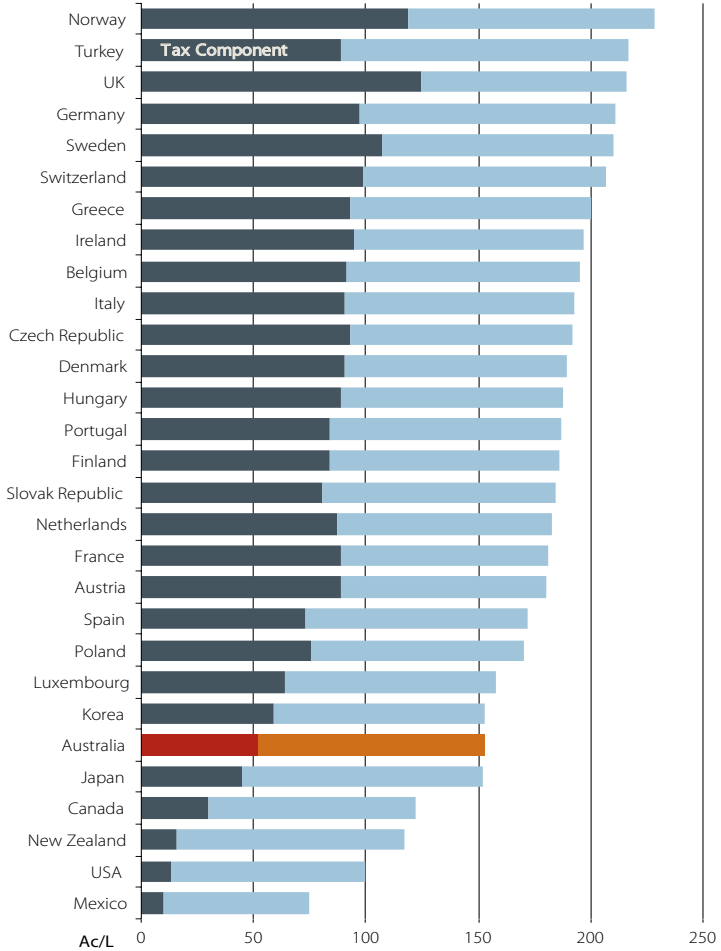
Sources: IEA 2011, Energy Prices and Taxes; BREE 2011, Resources and Energy Statistics.

Figure 24: OECD gasoline prices



Source: IEA 2011, Energy Prices and Taxes.

Figure 25: OECD diesel prices



Source: IEA 2011, Energy Prices and Taxes.

Transport and infrastructure

The transport sector is the largest end user of energy in Australia. More than 38 per cent of Australia's final energy use is employed in moving people and goods across the country. As a large continent characterised by major population centres located along its coastline, Australia requires goods to be transported long distances. The transportation sector is the largest consumer of liquid fuels (including LPG and refined products), accounting for 73 per cent of Australia's final use of liquid fuels.

Energy consumption

Within the transport sector, road transport is the largest user of final energy, accounting for 76 per cent of the sector's liquid fuel consumption. Largely reflecting improvements in fuel efficiency, average growth in road transport fuel consumption has moderated over the past 30 years, falling from around 3 per cent a year in the 1980s to average 1 per cent a year in the 2000s.

Table 31: Energy consumption in the transport sector [a]

	1979-80	1989-90	1999-00	2009-10
	PJ	PJ	PJ	PJ
Road transport	611.8	811.4	980.4	1 064.9
Railway transport	31.0	30.7	33.3	45.7
Water transport	97.6	55.6	55.6	60.1
Air transport	80.6	108.6	184.6	245.5
Other	3.6	6.2	12.8	30.9
Total	**824.6**	**1 012.5**	**1 266.7**	**1 447.1**

a Net energy consumption (defined as total fuel input less energy produced).

Source: ABARES 2011, Australian Energy Statistics.

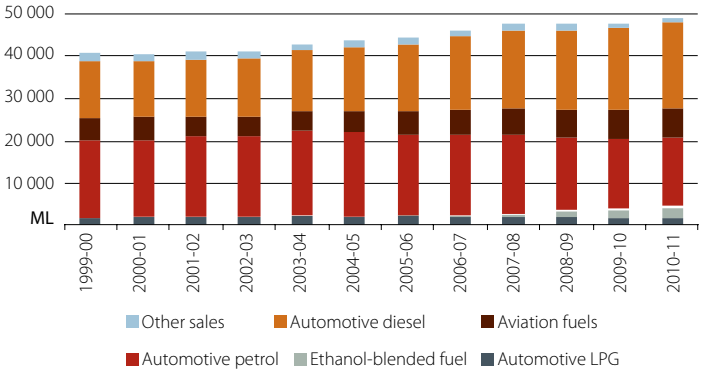
Air transportation has been the fastest growing consumer of transport fuels in Australia. After growing by more than 5 per cent a year in the 1990s, energy consumption growth in the sector has slowed to 2 per cent a year between 1999–2000 and 2010–11. This slow down largely reflects lower passenger traffic between 2001 and 2003 following the collapse of Ansett, the terrorist attacks in the United States and the outbreak of SARS. The increase in international air transportation has been at the expense of international sea transportation. As such, energy use in the water transport sector has declined steadily by 2 per cent a year over the past 30 years.

Australian demand for transport fuels has been rising steadily over the past 11 years, increasing almost 20 per cent from 40 765 megalitres in 1999–2000 to 48 769 megalitres in 2010–11. The majority of Australia's sales of transport fuels are diesel, followed by petrol and aviation fuels.

Automotive gasoline is the main fuel used in the transportation industry, accounting for around 43 per cent of total energy use in the sector. This reflects the large share of road transportation in transport sector consumption.

The phasing out of leaded automotive gasoline, starting in 1986 was completed in 2001. Over the same period, consumption of automotive LPG, which was excise free, increased at an average rate of 11 per cent a year. Demand for LPG declined temporarily following the announcement of the phase-in of taxes on excise exempt fuels in 2004.

Figure 26: Australia's sales of transport fuels



Source: RET 2011, Australian Petroleum Statistics.

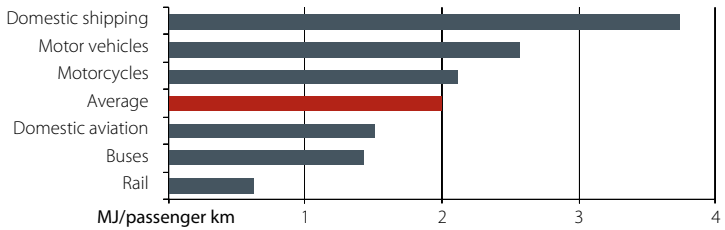
Fuel efficiency

Energy intensity for passenger travel can be measured as the energy required to travel one passenger kilometre. In 2008–09, motor vehicles were relatively more energy intensive, using more than four times the energy used by rail.

Within the freight transport sector, energy intensity can be measured as the energy required to travel one kilometre with a

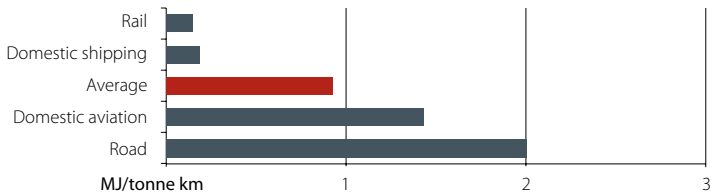
tonne of cargo. In 2008–09, rail and shipping were among the least-energy intensive transport modes to distribute goods and services within the economy.

Figure 27: Passenger vehicle fuel efficiency in Australia, 2008–09
MJ of energy used to travel 1 passenger kilometre



Source: BREE calculations.

Figure 28: Freight fuel efficiency in Australia, 2008–09
MJ of energy used to travel 1 kilometre per tonne of cargo



Source: BREE calculations.

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 2010–11, these ports had a combined capacity of around 393 million tonnes and loaded nearly 290 million tonnes of coal. Australian ports did not operate at capacity in 2010–11 for a number of reasons including weather-related incidents at the beginning of 2011.

Table 32: Loadings and capacity for major coal ports

	Loadings 2010-11	Capacity 2010-11	Short term capacity	Medium term capacity
	Mt	Mtpa	Mtpa	Mtpa
New South Wales				
Newcastle [a]	95	111	145	175
NCIG	14	30	30	66
Port Kembla	14	16	16	16
Queensland				
Abbot Point	15	25	50	110
Brisbane	6	7	7	7
Dalrymple Bay	55	85	85	85
Gladstone [b]	54	75	75	75
Hay Point	33	44	44	55
Wiggins Island	-	-	-	54

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

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

Past infrastructure capacity constraints (including port and rail) may 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 further expansions planned over the short to medium-term will overcome constraints. As at October 2011 there were 12 coal infrastructure projects at an advanced stage of development, with a combined capital cost of around $10.5 billion. Of these projects, six were

advanced port infrastructure projects expected to add more than 100 million tonnes to Australia's major ports' annual capacity. A further 11 projects were at less advanced stages of planning (see Appendix 1).

Australia has 11 major deepwater ports that have facilities to export petroleum liquids. The port at Dampier in Western Australia is Australia's largest exporting centre of oil and petroleum, accounting for around three-quarters of Australian oil and petroleum exports. Australian exports of crude oil and condensate are increasingly sourced from the west coast, while exports of refined products are largely sourced from the east coast. A large proportion of Australia's oil is located from floating production and storage and offtake vessels which are located over the oil fields.

Table 33: Export loadings at major petroleum ports, 2010–11

Oil and petroleum [a]	Mt
Dampier, WA	22.69
Brisbane, Qld	2.45
Fremantle, WA	2.34
Geelong, Vic	1.44
Hastings, Vic	0.84
Sydney, NSW	0.77
Melbourne, Vic	0.44
Darwin, NT	0.07
Bell Bay, Tas	0.01
Bunbury, WA	0.01
Cairns, Qld	0.01

a includes crude oil, oil products, condensate, petroleum products and refined petroleum.

Source: Ports Australia 2011.

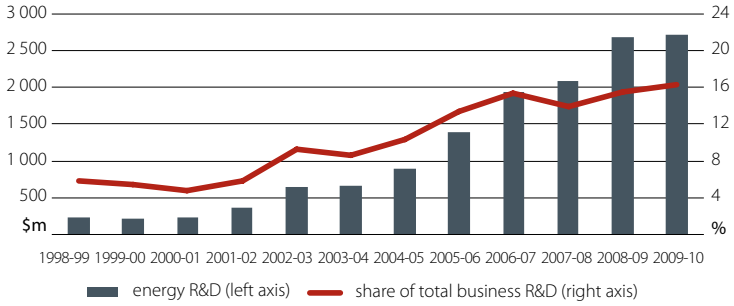
Energy research and development

Research and development (R&D) is innovative work that is undertaken on a systematic basis to increase knowledge, which may or may not have a specific practical application. In this context, energy R&D refers to the early stages of the innovation chain, rather than later stages such as demonstration and commercialisation.

Total expenditure on R&D in energy by all sectors of the economy (including business, governments, higher education and private not-for-profit organisations) was almost $2.9 billion in 2008–09 (data for 2009–10 are not available). This includes R&D related to energy resources (e.g. exploration for and mining of coal, uranium, oil, gas and geothermal energy), R&D related to preparing and transforming energy resources (e.g. preparing oil and coal and using it to generate electricity) and R&D for other aspects of energy (e.g. renewable energy, energy distribution and storage, energy efficiency, waste management, and carbon capture and sequestration).

In Australia, most of the R&D in energy is undertaken by private businesses. Business spending on energy R&D increased at an average rate of 28 per cent a year from 2000–01 to 2009–10, reaching $2.7 billion in 2009–10. Expenditure on energy R&D by Australian businesses represented around 16 per cent of total business R&D expenditure in 2009–10.

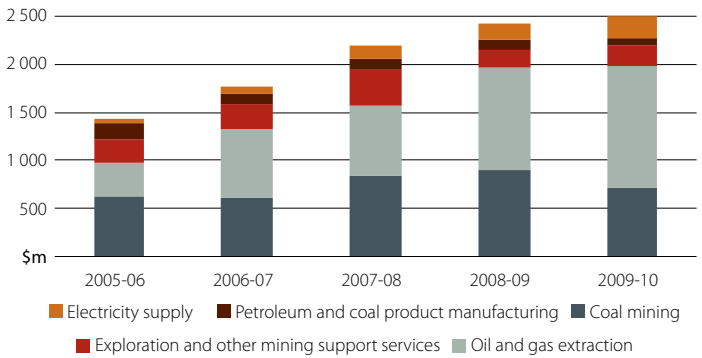
Figure 29: Australia's business R&D in energy



Source: ABS 2011, Research and Experimental Development, Businesses, Australia, cat. no. 8104.0.

Within the energy related industries, the oil and gas extraction industry had the largest R&D expenditure in 2009–10, with business R&D spending of $1.3 billion. This was followed by the coal mining industry with $717 million of R&D expenditure.

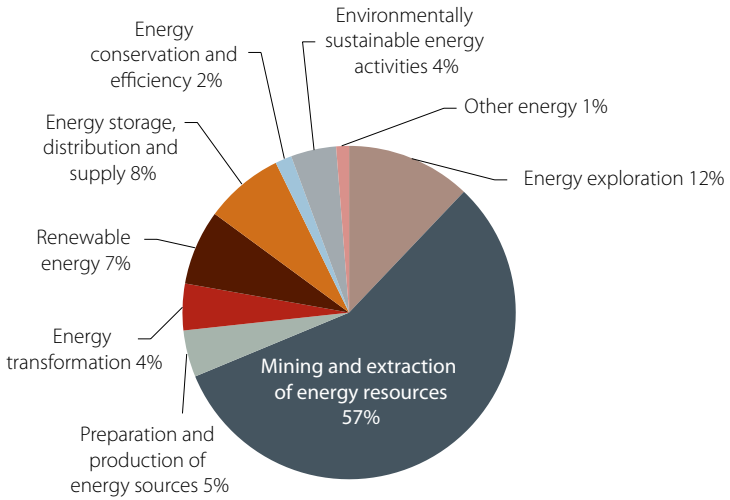
Figure 30: Australia's business R&D by industry



Source: ABS 2011, Research and Experimental Development, Businesses, Australia, cat. no. 8104.0.

The majority of energy R&D expenditure by Australian businesses is devoted to the mining and extraction of energy resources, representing 57 per cent of energy R&D in 2009–10. Around 7 per cent of business R&D was spent on renewable energy and 2 per cent of spending had the objective of improving energy efficiency or energy conservation.

Figure 31: Australia's business R&D by objective, 2009–10



Source: ABS 2011, Research and Experimental Development, Businesses, Australia, cat. no. 8104.0.

Prospects for energy in Australia

Over the medium to longer term there is expected to be a major change in the Australian energy landscape. The most significant change is expected in the energy mix, driven by policies that promote a less emission intensive economy.

The strongest growth prospects are in renewable energy, largely supported by the Renewable Energy Target and the Clean Energy Future plan. Within the renewables sector, the largest expansion is expected to occur in wind energy as it is a relatively mature technology compared with other renewable energy options. Solar and geothermal energy will play a growing role in the energy mix in the future.

Within the non-renewable energy sources, there is expected to be a large increase in the use of gas, particularly in electricity generation where the technology is more cost competitive relative to other low emission options. The growth in gas consumption is likely to be at the expense of coal. Despite this trend, coal is expected to continue to be an important component in the energy mix for some time to come. The development of cost effective lower emissions coal technologies, that include carbon capture and storage, will be critical to maintaining coal's position in electricity generation.

The transition to a lower carbon economy will involve some long–term structural adjustment of the Australian energy sector. Considerable investment is required in energy supply chains to meet the growing demand for energy and to allow for the greater integration of low emission technologies. The changes will also present opportunities, including trade and investment in new industries and technologies, both domestically and in overseas markets.

Appendix 1 – Current and proposed energy projects

Major electricity projects

New power stations and expansions as at October 2011[a]

Project	Company	Location	Status	Expected Startup	New Capacity	Capital Expend.
Black coal						
Eraring	Eraring Energy	40 km SW of Newcastle, NSW	Expansion, Committed	2012	240MW	$245m
Muja Power Station (Stages A and B)	Verve Energy/ Inalco Energy	200 km SE of Perth, WA	Refurbishment, Under construction	late 2012	220MW	$150m
Gas						
Blackwater Power Project	Bow Energy	15 km NE of Blackwater, Qld	New project, Under construction	2012	30MW	$35m
Channel Island Power Station	Power and Water Corporation	Channel Island, NT	Expansion, Under construction	late 2011	90MW	$120m
Kwinana Power Station rebuild	Verve Energy	Kwinana, WA	Refurbishment, Under construction	2012	200MW	$263m
Mortlake Stage 1	Origin Energy	12 km W of Mortlake, Vic	New project, Under construction	late 2011	550MW	$735m
Owen Springs	Power and Water Corporation	Alice Springs, NT	New project, Under construction	2012	33MW	$126m
Weddell stage 3	Power and Water Corporation	40 km SE of Darwin, NT	Expansion, Under construction	2012	43MW	$50m
Wilga Park B (Two Stages)	Eastern Star Gas/Santos	Narrabri, NSW	Expansion, Committed	2012 (initially 6MW)	29MW	$42m

Wind						
Collgar Wind Farm	UBS IIF/REST	25 km SE of Merredin, WA	New project, Construction completed	late 2011	206MW	$750m
Hallett 5 (The Bluff)	AGL Energy	12 km SE of Jamestown, SA	Expansion, Under construction	2012	53MW	$118m
Macarthur Wind Farm	AGL Energy/ Meridian Energy	230 km W of Melbourne, Vic	New project, Under construction	2013	420MW	$1b
Mumbida	Verve Energy/ Macquarie Capital Group	40 km S of Geraldton, WA	New project, Under construction	2012	55MW	$200m
Oaklands Hill Wind Farm	AGL Energy/ Oaklands Hill Pty Ltd	3 km S of Glenthompson, Vic	New project, Under construction	2012	67MW	$200m
Snowtown stage 2	TrustPower	5 km W of Snowtown, SA	Expansion, Under construction	2013	250MW	$550m
Woodlawn Wind Farm	Infigen Energy	40 km S of Goulburn, NSW	New project, Under construction	late 2011	48MW	$102m
Hydro						
Tumut 3 upgrade	Snowy Hydro	Talbingo, NSW	Expansion, Under construction	late 2011	50MW	$28m
Upper Tumut expansion	Snowy Hydro	Cabramurra, NSW	Expansion, Committed	2013	40MW	$20m
Solar						
Kogan Creek Solar Boost Project	CS Energy	near Chinchilla, Qld	Expansion, Committed	2013	44MW	$105m

a Summary of projects classified as committed. For proposed projects please refer to source.

Source: BREE 2011, Major electricity generation projects November 2011.

Major new coal, oil and gas projects

New mining Industry projects as at October 2011[a]

Project	Company	Location	Status	Expected Startup	New Capacity	Capital Expend.
Black coal – mining projects – NSW						
Bengalla expansion stage 1	Wesfarmers / Rio Tinto	Muswellbrook	Expansion, under construction	early 2012	2.1 Mt ROM	US$184m (A$179m)
Boggabri opencut	Idemitsu Kosan	17 km NE of Boggabri	Expansion, under construction	2014	3.3 Mt thermal	$400m
Hunter Valley Operations Expansion	Rio Tinto / Mitsubishi	24 km N of Singleton	Expansion, under construction	2012	6 Mt thermal and semi soft coking	US$260m (A$252m)
Metropolitan longwall	Peabody Energy	30 km N of Wollongong	Expansion, under construction	2013	1 Mt hard coking	US$70m (A$68m)
Mount Arthur (RX1)	BHP Billiton	5 km SW of Muswellbrook	New project, under construction	2013	4 Mt thermal (ROM)	$US400m (A$388m)
Narrabri Coal Project (stage 2)	Whitehaven	20 km SE of Narrabri	Expansion, under construction	2012	4.5 Mt thermal	$300m
Ravensworth North	Xstrata	18 km NW of Singleton	Expansion, under construction	2012	8 Mt thermal and semi soft	US$1.4b (A$1.36b)
Ulan West	Xstrata	Mudgee	Expansion, under construction	2014	7 Mt thermal	US$1.1b (A$1.07b)
Wilpinjong	Peabody Energy	40 Km NE of Mudgee	Expansion, under construction	2012	2-3 Mt thermal	US$90m (A$87m)
Black coal – mining projects – Qld						
Broadmeadow (mine life extension)	BHP Billiton Mitsubishi Alliance (BMA)	30 km N of Moranbah	Expansion, under construction	2013	0.4 Mt coking	US$900m (A$874m)
Burton	Peabody Energy	150 km SW of Mackay	Expansion, under construction	2012	2-3 Mt hard coking	na
Caval Ridge / Peak Downs expansion	BHP Billiton Mitsubishi Alliance (BMA)	20 km SW of Moranbah	New project, committed	2014	8 Mt coking	US$4.2b (A$4.1b)

Project	Company	Location	Status	Expected Startup	New Capacity	Capital Expend.
Curragh Mine	Wesfarmers	200 km W of Rockhampton	Expansion, under construction	2012	increase to 8.5 Mt	$286m
Daunia	BHP Billiton Mitsubishi Alliance (BMA)	25 km SE of Moranbah	New project, committed	2013	4.5 Mt coking	US$1.6b (A$1.55b) excl. pre FID funding
Ensham bord and pillar underground mine	Ensham Resources	40 km NE of Emerald	Expansion, under construction	2012	1.5-2.5 Mt thermal	$166m
Kestrel	Rio Tinto	51 km NE of Emerald	Expansion, under construction	2012-13	1.7 Mt coking	US$2b (A$1.9b)
Lake Vermont	Jellinbah Resources	60 Km SE of Moranbah	Expansion, under construction	2013	4 Mt	$200m
Middlemount (stage 1)	Macarthur Coal / Gloucester Coal	6 km SW of Middlemount	New project, under construction	2012	1.8 Mt coking (ROM)	$500m (includes stage 1 and 2)
Newlands Northern Underground	Xstrata	130 km W of Mackay	Expansion, under construction	Late 2011	3 Mt	US$150m (A$146m)
Oaky Creek (phase 1)	Xstrata	90 km NE of Emerald	Expansion, under construction	Late 2011	1 Mt coking	US$90m (A$87m)
Black coal – infrastructure projects – NSW						
Kooragang Island coal terminal expansion	Port Waratah Coal Services	Newcastle	Expansion, under construction	Late 2011	20 Mt (to 133 Mt)	$670m
Kooragang Island project	Port Waratah Coal Services	Newcastle	Expansion, under construction	Late 2012	12 Mt (to 145 Mt)	$227m
Minimbah Bank Third Rail Line (stage 2)	Australian Rail and Track Corporation	Maitland to Minimbah (23km)	Expansion, under construction	2012	na	$363m
NCIG export terminal (Newcastle Coal Infrastructure Group) (stage 2)	NCIG	Newcastle	Expansion, under construction	2013	23 Mtpa	$900m
NCIG export terminal (Newcastle Coal Infrastructure Group) (stage 3)	NCIG	Newcastle	Expansion, committed	2014	13 Mtpa	$1b
Nundah Bank 3rd Road (rail)	Australian Rail and Track Corporation	Maitland to Minimbah (23km)	Expansion, under construction	2012	na	$80m

Project	Company	Location	Status	Expected Startup	New Capacity	Capital Expend.
Black coal – infrastructure projects – Qld						
Blackwater System Power upgrade	QR National	Blackwater	Expansion, under construction	Mid 2012	9 Mtpa	$195m
Goonyella to Abbot Pt (rail) (X50)	QR National	North Goonyella to Newlands (70 km)	Expansion, under construction	early 2012	50 Mtpa	$1.1b
GSE 140 (rail)	QR National	Bowen Basin to Mackay	Expansion, under way	2014	11 Mtpa	$185m
Hay Point Coal Terminal (phase 3)	BHP Billiton Mitsubishi Alliance (BMA)	20 km S of Mackay	Expansion, under way	2014	11 Mtpa (to 55 Mtpa)	US$2.5b (A$2.4b) excl. pre FID funding
Wiggins Island Coal Terminal (stage 1)	Wiggins Island Coal Export Terminal	Gladstone	New project, committed	2014	27 Mtpa	$2.5b
Wiggins Island rail project	QR National	Gladstone	New project, committed	2014	27 Mtpa	$900m
Petroleum – oil and natural gas projects						
Australia Pacific LNG	APLNG (Origin / ConocoPhillips/ Sinopec)	Surat/Bowen basins/Gladstone, Qld	New project, committed	2015	4.5 Mt LNG	US$14b (A$13.6b)
Balnaves	Apache Energy / KUFPEC	NW of Dampier, WA	New project, committed	2014	30 kbpd	US$438m (A$425m)
BassGas (Yolla Mid Life Enhancement)	Origin / AWE / Calenergy Gas	Bass Strait, Tas	Expansion, under construction	2012	field life extension	$353m
Coniston (tie back to Van Gogh)	Apache Energy / Inpex	50 km N of Exmouth, Carnarvon Basin, WA	Expansion, under construction	2013	22 kbpd	US$537m (A$521m)
Gladstone LNG project	Santos / Petronas / Total / Kogas	Gladstone, Qld	New project, under construction	2015	7.8 Mt LNG	US$16b (A$15.5b) (includes production wells and 435 km pipeline)
Gorgon LNG	Chevron / Shell / ExxonMobil	Barrow Island, WA	New project, under construction	2015	15 Mt LNG, 110 PJ pa domestic gas	$43b
Kipper gas project (stage 1)	Esso / BHP Billiton / Santos	42 km offshore Gippsland, Vic	New project, under construction	2012	30 PJ pa gas, 10 kbpd condensate	US$1.8b (A$1.7b)

Project	Company	Location	Status	Expected Startup	New Capacity	Capital Expend.
Macedon	BHP Billiton / Apache Energy	100 km W of Onslow, WA	New project, under construction	2013	75 PJ pa gas	US$1.5b (A$1.45b)
Montara/Skua oilfield	PTTEP	Timor Sea, 650 km W of Darwin, NT	New project, under construction	2012	35 kbpd oil	US$700m (A$680m)
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	US$5.1b (A$5b)
Pluto (train 1)	Woodside Energy	Carnarvon Basin / Burrup Peninsula, WA	New project, under construction	early 2012	4.3 Mt LNG	$14.9b (inc site works for train 2)
Prelude (floating LNG)	Shell	Browse Basin, WA	New project, committed	2016	3.6 Mtpa LNG, 32 kbpd condensate, 0.4 Mtpa LPG	na
Queensland Curtis LNG project	BG Group	Gladstone, Qld	New project, under construction	2014	8.5 Mt LNG (12Mt ultimately)	US$15b (A$14.6b) (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	78 PJ pa gas	$1.05b
Spar	Apache Energy / Santos	120 km N of Onslow, WA	New project, committed	2013	18 PJ pa	US$120m (A$117m)
Turrum	ExxonMobil / BHP Billiton	Bass Strait, Vic	New project, under construction	2013	11 kbpd condensate, 77 PJ pa gas	US$2.7b (A$2.6b)
Wheatstone LNG	Chevron / Apache / KUFPEK / Shell	145 km NW of Dampier, Carnarvon Basin, WA	New project, committed	2016	8.9 Mt LNG	$29b
Petroleum – gas pipeline projects						
Moomba to Sydney	Australian Pipeline Group	Moomba (SA) to Sydney (NSW), NSW	Expansion, under construction	2013	na	$100m
Roma to Brisbane pipeline	Australian Pipeline Group	Roma to Brisbane (450 km), Qld	Expansion, under construction	2012	10 PJ pa	$50m
South West Queensland pipeline (stage 2 and 3)	Epic Energy	Wallumbilla to Ballera (755 km), Qld	Expansion, under construction	2012	77 PJ pa	$858m
Petroleum - energy processing facilities						
Dandenong LNG plant	BOC	Dandenong, Vic	Expansion, committed	2012	25 kt LNG	$65m

a Summary of projects classified as committed. For proposed projects please refer to source.

Source: BREE 2011, Mining industry major projects October 2011.

Appendix 2 – Units, prefixes and conversion factors

General

Units		Metric prefixes			Other abbreviations	
J	joule	k	kilo	10^3 (thousand)	bcm	billion cubic metres
L	litre	M	mega	10^6 (million)	m^3	Cubic metre
t	tonne	G	giga	10^9 (1000 million)	f^3	Cubic feet
g	gram	T	tera	10^{12}	bbl	barrel
W	watt	P	peta	10^{15}	Mtoe	million tonnes of oil equivalent
Wh	watt hour	E	exa	10^{18}	na	not available
		b	billion	10^9	pa	per annum
					Gcal	gigacalorie
					Btu	British thermal units

Conversion between units of energy

To:	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	4.1868×10^{4}	10^{7}	1	3.968×10^{7}	11630
MBtu	1.0551×10^{-3}	0.252	2.25×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

Source: IEA Energy Statistics Handbook.

Conversion factors

1 barrel = 158.987 L

1 mtoe = 41.868 PJ

1 kWh = 3600 kJ

1 MBtu = 1055 MJ

1 m^3 = 35.515 f^3

1 L LPG = 0.254 m^3 gas

1 L LNG = 0.625 m^3 natural gas

The factors used in the following tables are used when converting individual types of fuel from volume or weight to energy content, 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°C 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. Uranium oxide (U_3O_8) contains 84.8 per cent of the metal by weight.

Energy content of gaseous fuels

To:	m^3
From MJ:	divide by:
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	specific volume	weight
	MJ/L	L/t	GJ/t
Aviation gasoline	33.1	1412	46.8
Automotive gasoline	34.2	1360	46.4
Power kerosene	37.5	1230	46.1
Aviation turbine fuel	36.8	1261	46.4
Lighting kerosene	36.6	1270	46.5
Heating oil	37.3	1238	46.2
Automotive diesel oil	38.6	1182	45.6
Industrial diesel fuel	39.6	1135	44.9
LPG			
propane	25.5	1960	49.6
butane	28.1	1760	49.1
mixture	25.7	1890	49.6
naturally occurring (average)	26.5	1866	49.4

	volume	specific volume	weight
Fuel oil			
low sulphur	39.7	1110	44.1
high sulphur	40.8	1050	42.9
Refinery fuel (fuel oil equivalent)	40.8	1050	42.9
Naptha	31.4	1534	48.1
Lubricants and greases	38.8	1120	43.4
Bitumen	44.0	981	42.7
Solvents	34.4	1229	44.0
Waxes	38.8	1180	45.8
Crude oil and other refinery feedstocks			
indigenous (average)	37.0	1250	46.3
imports (average)	38.7	1160	44.9
Orimulsion			28.0
Ethanol	23.4	1266	29.6
Methanol	15.6	1263	19.7
Tallow			35.0
Liquefied Natural Gas (North West Shelf)	25	2174	54.4

Sources: BP, BHP Billiton, Mobil Exxon, Santos, Woodside Energy.

Energy content of solid fuels

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