

# Australian energy outlook to 2019-20

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In this paper we report highlights from ABARE’s latest set of long term projections of Australian energy consumption and production covering the period to 2019-20. Key messages include:

- ¥ Over the next twenty years, final energy consumption is forecast to grow, on average, by 2.3 per cent a year.
- ¥ Coal and oil will continue to supply the vast bulk of Australia’s domestic energy needs, although the use of natural gas is expected to grow strongly.
- ¥ Electricity generation is forecast to grow by 2.3 per cent a year on average over the projection period, with black coal expected to continue to account for over 50 per cent of the mix.
- ¥ Energy use in road freight and air transport are both expected to grow strongly.
- ¥ In manufacturing, gas consumption in the iron and steel sector is forecast to increase sharply, reflecting a positive outlook for direct reduced iron.
- ¥ LNG exports are projected to grow, on average, by 5.9 per cent a year and to account for over 40 per cent of total Australian production of natural gas by 2019-20.
- ¥ In the absence of major new discoveries, Australia’s reliance on imported crude oil is expected to increase significantly.

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## Introduction

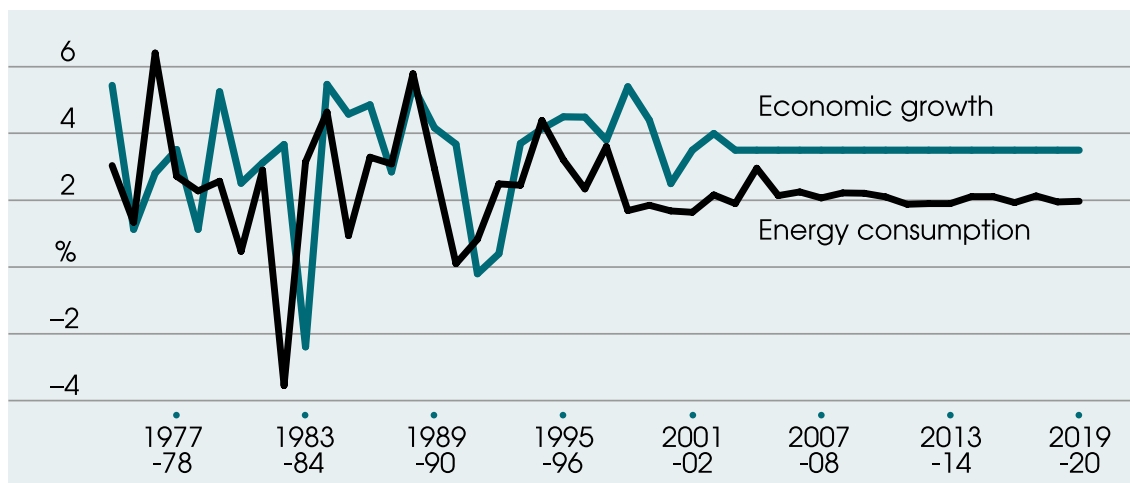
For more than twenty-five years ABARE has published, on a biennial basis, detailed long term projections of Australian energy consumption and production. ABARE's latest set of projections, which extend the forecast horizon to 2019-20, were released last month (see Dickson et al. 2001). This paper summarises the key highlights of the outlook.

For this cycle ABARE also undertook to change the way we prepare the long term outlook. In particular, emphasis has now been placed on adopting an integrated analysis of the electricity generation sector within an Australiawide domestic energy use model. The model, which we have called *E<sub>cast</sub>* (alluding to its primary role as an energy forecasting tool), ensures that a wide set of fundamental economic and engineering principles are brought to bear, explicitly and transparently, on the estimated long term trends. A full outline of *E<sub>cast</sub>* is not provided here and interested readers are referred to Dickson et al. (2001) for a more detailed description of the modeling approach and assumptions.

## Total consumption and energy intensity

The Australian energy sector has undergone significant change over the past twenty-five years. While many of the trends established in this period continue, market reforms and new opportunities, both domestic and international, are stimulating a fresh set of changes. As is evident from figure A, for much of the past twenty-five years the growth in Australian energy consumption has closely followed that in Australia's total output or real gross domestic product (GDP). A recent study by ABARE highlighted the dominance of economic growth as the major determinant of Australia's rising rate of energy consumption. If this had been the only factor at work, Australia's energy consumption in 1997-98 would have been more than double what it was in 1973-74 (Harris and Thorpe 2000, pp. 2-3). This position is unlikely to change over the outlook period, and with GDP growth assumed

Figure A: Annual growth in gross domestic product and primary energy consumption



to settle around a trend rate of 3.5 per cent a year, total energy consumption (or primary energy consumption) in Australia is projected to grow at an average rate of 2.0 per cent a year out to 2019-20.

The aggregate intensity of Australian energy consumption (or the amount of energy consumed per unit of total output) declined between 1973-74 and 1997-98 by an average 0.5 per cent a year, leading to an overall reduction in energy use over this period of 322 petajoules (Harris and Thorpe 2000). Without these changes, Australia's energy consumption in 1997-98 would have been 31 per cent higher than it was. Over the medium term, this trend is expected to continue, and in fact accelerate, with aggregate energy intensity expected to decline by around 1.4 per cent a year over the outlook period as a consequence of assumed technology improvements and structural change in the economy.

## Final energy consumption, by fuel

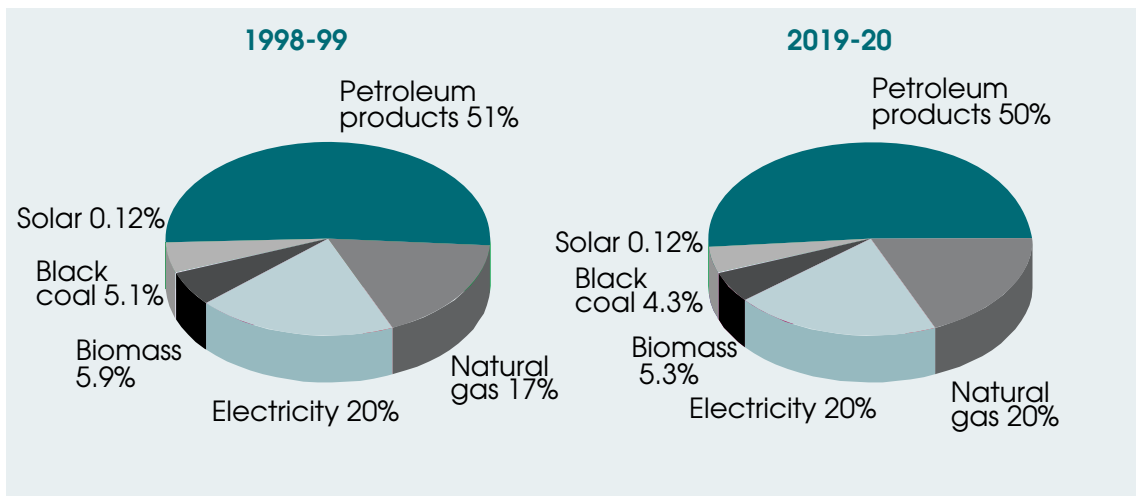
The projections for final energy consumption, by fuel, are presented in table 1 and the fuel mix in final energy consumption, in 1998-99 and 2019-20, is illustrated in figure B. Over the projection period, total final energy consumption is forecast to grow by an average 2.3 per cent a year, reaching 4917 petajoules by 2019-20. Overall the fuel mix is set to continue to be dominated by petroleum products, with petroleum's share of final energy consumption in 2019-20 estimated at around 50 per cent. Nevertheless, the substitution away from oil toward gas that has occurred in the past is also expected to continue, albeit at a reduced rate (figure B).

In the late 1970s and early 1980s the consumption of natural gas increased strongly; and occurred almost exclusively at the expense of the consumption of petroleum products. New growth in the use of natural gas is also expected, reflecting developments in the iron and steel and basic nonferrous metals industries. Between 1998-99 and 2019-20, the consumption of natural gas in end use sectors is estimated to increase by an average 3.0 per

**Table 1: Final energy consumption, by fuel**

	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Black coal	156.2	210.1	5.1	4.3	1.4
Petroleum products	1 570.6	2 461.2	51.4	50.1	2.2
Natural gas	521.1	974.3	17.1	19.8	3.0
Electricity	623.9	1 004.3	20.4	20.4	2.3
Biomass	180.9	260.6	5.9	5.3	1.8
Solar	3.8	6.1	0.1	0.1	2.3
Total	3 056.5	4 916.5	100.0	100.0	2.3

Figure B: Final energy consumption, by fuel



cent a year. In absolute terms, of the increase in final energy consumption projected between 1998-99 and 2019-20, 48 per cent is accounted for by oil, 24 per cent by gas, 20 per cent by electricity, 4.4 per cent by renewables and 2.9 per cent by coal (principally coal byproducts in steel manufacture).

## Final energy consumption, by sector

In Australia, the transport sector is the largest end user of energy, followed by the manufacturing and construction sector (hereafter simply referred to as manufacturing). Collectively these two sectors account for 73 per cent of final energy consumed over the outlook period.

### Transport

The transport sector itself accounts for approximately 40 per cent of final energy use — this share has been relatively constant over the past two decades — with around 97 per cent of the fuel mix comprised of liquid fuels (table 2). Since the early 1970s, growth in transport sector energy use has averaged around 2.4 per cent a year. Over the medium term, energy use in this sector, is projected to grow, on average, by 2.3 per cent a year.

Within the transport sector, road transport dominates energy use patterns, accounting for 77 per cent of energy used in 1998-99 (figure C). Over the outlook period, energy use in road transport is forecast to grow by around 1.8 per cent a year. Within road transport itself, however, energy use in road freight (which accounts for 35 per cent of the sector) is forecast to grow by 2.8 per cent a year, while the passenger car sector (accounting for the remaining 65 per cent) is forecast to grow by only 1.1 per cent a year. These growth rates might well be higher, but for the fact that efficiency improvements are assumed to be

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Table 2: Final energy consumption, by sector

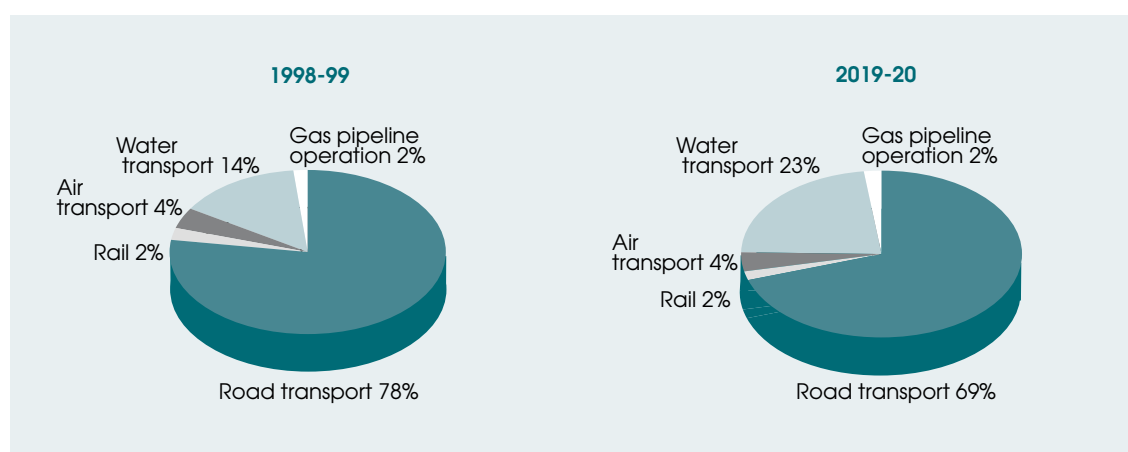
	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Agriculture	70.0	105.0	2.3	2.1	2.0
Mining	128.3	219.4	4.2	4.5	2.6
Manufacturing	968.4	1 574.7	31.7	32.0	2.3
Transport	1 238.3	1 997.0	40.5	40.6	2.3
Commercial and services	207.9	345.1	6.8	7.0	2.4
Residential	385.4	590.5	12.6	12.0	2.1
Other <sup>a</sup>	58.2	84.8	1.9	1.7	1.8
Total	3 056.5	4 916.5	100.0	100.0	2.3

<sup>a</sup> Includes solvents, lubricants, greases and bitumen.

stronger in road transport than in many other sectors of the economy, reflecting the relatively higher fuel cost conditions assumed to prevail throughout the outlook period.

Continued strong growth is expected in both the domestic and international air transport subsectors, with growth in energy use, over the outlook period, forecast to average 4.4 per cent and 4.6 per cent a year, respectively. A key factor behind this is expectations of strong growth in private passenger demand. In the short term this is assumed to have come from increased demand from tourism activities associated with the Olympic Games. Over the longer term expectations are for continued strong (international) tourism demand; and rising incomes and lower real airfares domestically. Reflecting these trends, the share of energy used in the transport sector accounted for by air transport is projected to increase from 14 per cent in 1998-99 to 23 per cent by 2019-20 (figure C).

Figure C: Final energy consumption, by transport subsector



**Box 1: Lower growth scenario**

The tragic events in the United States in September 2001 and their implications for the world economy clearly demonstrate the risks associated with any long term forecasting exercise, not least of which something as integrally linked to economic growth as energy consumption and production. An alternative scenario was prepared to examine the impact on Australian energy consumption of assuming significantly lower long term growth.

For this scenario, growth in GDP was assumed to average 2.7 per cent a year over the long term compared with 3.5 per cent in the reference case. Growth in output from the iron and steel and nonferrous metals sectors was also assumed to be appreciably lower. A comparison of the results of this scenario with the reference case is provided in the accompanying table.

Total (primary) energy consumption is down by around 900 petajoules by 2019-20, with average growth over the outlook period estimated to fall from 2.0 per cent a year to 1.4 per cent a year. The reduction in the growth in final energy consumption is also lower by a similar amount, averaging 1.6 per cent a year under the low growth scenario compared with 2.3 per cent in the reference case. In the case of air transport, the long term (forecast) average growth rate declines to 3.6 per cent compared with 4.6 per cent in the reference case.

**Results of the lower growth scenario**

	Consumption		Annual growth 1998-99 to 2019-20 %
	1998-99	2019-20	
	PJ	PJ	
<b>Reference case</b>			
Primary energy consumption	4 852.4	7 429.6	2.0
Final energy use	3 056.5	4 916.5	2.3
Coal	156.2	210.1	1.4
Oil	1570.6	2 461.2	2.2
Gas	521.1	974.3	3.0
Electricity	623.9	1 004.3	2.3
Biomass	180.9	260.6	1.8
Solar	3.8	6.1	2.3
<b>By sector</b>			
Agriculture	70.0	105.0	2.0
Mining	128.3	219.4	2.6
Manufacturing b	968.4	1 574.7	2.3
Transport	1 238.3	1 997.0	2.3
Commercial	207.9	345.1	2.4
Residential	385.4	590.5	2.1
Nonenergy fuel uses	58.2	84.8	1.8
<b>Low growth scenario</b>			
Primary energy consumption	4 852.4	6 526.3	1.4
Final energy use	3 056.5	4 307.1	1.6
Coal	156.2	182.0	0.7
Oil	1 570.6	2 190.2	1.6
Gas	521.1	804.6	2.1
Electricity	623.9	886.5	1.7
Biomass	180.9	238.3	1.3
Solar	3.8	5.4	1.7
<b>By sector</b>			
Agriculture	70.0	95.0	1.5
Mining	128.3	193.5	2.0
Manufacturing b	968.4	1 350.0	1.6
Transport	1 238.3	1 766.1	1.7
Commercial	207.9	300.6	1.8
Residential	385.4	525.7	1.5
Nonenergy fuel uses	58.2	76.1	1.3

Recent tragic events in the United States may well have serious implications for the world economy, not least of which on the outlook for energy consumption and production. An alternative scenario was prepared to examine the impact on Australian energy consumption of assuming a lower long term growth outlook. The results of this scenario are discussed in box 1.

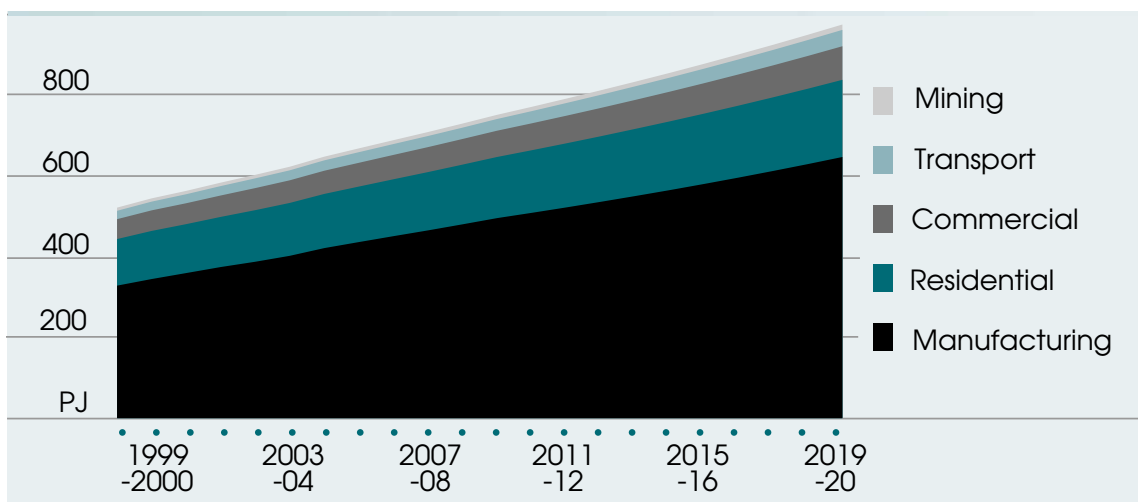
### Manufacturing and construction

Over the past twenty-five years the manufacturing sector has grown relatively slowly, such that its share of total final energy consumption declined from 38 per cent in 1973-74 to 33 per cent by 1998-99. Nevertheless, in 1998-99, the manufacturing sector accounted for 63 per cent of all end use gas demand and 39 per cent of purchased electricity. Over the outlook period, energy use in the manufacturing sector is projected to grow by 2.3 per cent a year, accounting for almost 33 per cent of the total increase in final energy use (table 2). At the same time, the share of natural gas in the fuel mix (in manufacturing) is expected to increase significantly, representing around 70 per cent of the increased use of natural gas across all end use sectors and mainly reflects developments in the iron and steel and basic nonferrous metals sectors (figure D).

Energy consumption in the iron and steel sector is projected to increase, on average, by 4.6 per cent a year between 1998-99 and 2019-20. At the same time, however, the fuel mix in iron and steel — comprising coal byproducts, electricity and gas — is expected to shift strongly toward gas.

Total direct reduced iron (DRI) production in Australia is forecast to reach 7 million tonnes by 2019-20, up from only 60 000 in 1998-99. The DRI production process is particularly gas intensive and, hence, this positive outlook for DRI underpins a forecast 8.4 per cent

Figure D: Natural gas consumption, by end use sector



a year growth in gas use in the iron and steel sector. Overall, iron and steel accounts for 27 per cent of the total increase in the end use consumption of gas over the outlook period.

To examine the sensitivity of the projections to the underlying iron and steel production forecasts, an alternative *E<sub>cast</sub>* scenario was developed assuming lower growth in iron and steel production. The results of this scenario are discussed in box 2.

Gas consumption in the nonferrous metals sector is also projected to grow strongly at 2.3 per cent a year, reflecting major additions to Australia's alumina refining capacity as well as the emergence of an Australian magnesium industry. Overall, nonferrous metals account for some 13 per cent of the total projected increase in end use gas consumption. Some modest expansion to existing aluminium facilities also sees this sector account for 18 per cent of the total forecast increase in consumption of electricity.

### Box 2: Impacts of lower DRI production

*E<sub>cast</sub>* was used to assess the impact of a less optimistic outlook for the Australian iron and steel industry. In the alternative scenario it was assumed that BHP Billiton's Port Hedland hot briquetted iron facility would reach its capacity of 2.2 million tonnes in 2004-05 and thereafter achieve some modest productivity improvements over the forecast period. Other than this, however, it was assumed no new DRI or steel making projects would commence in Australia.

As expected, the implications of this to the iron and steel sector are sizable, with the average growth in energy use in the sector estimated to fall from 4.6 per cent a year to only 1.0 per cent a year, an absolute reduction of around 129 petajoules in 2019-20. At the same time, growth in energy use in manufacturing is reduced by 0.4 percentage points. However, and perhaps illustrating the relative importance of the iron and steel sector to Australia's overall energy economy, total final energy consumption is only reduced by 0.1 percentage points.

#### Results of the lower iron and steel production scenario

	Final energy consumption				Annual growth	
	1998-99	2004-05	2009-10	2019-20	1998-99 to 2019-20	2004-05 to 2019-20
	PJ	PJ	PJ	PJ	%	%
<b>Iron and steel</b>						
Reference case	95.7	115.9	157.8	247.7	4.6	5.2
Lower production scenario	95.7	115.9	117.1	118.8	1.0	0.2
<b>Total manufacturing</b>						
Reference case	968.4	1 134.7	1 277.9	1 574.7	2.3	2.2
Lower production scenario	968.4	1 134.7	1 237.5	1 446.9	1.9	1.6
<b>Total final energy consumption</b>						
Reference case	3 056.5	3 524.7	3 943.1	4 916.5	2.3	2.2
Lower production scenario	3 056.5	3 524.7	3 902.3	4 787.3	2.2	2.1

## Commercial and residential

The commercial and services sector comprises wholesale and retail trade, communications, finance, government, community services and recreational industries. In 1998-99 this sector accounted for around 6.8 per cent of total final energy use. In the commercial sector, energy efficiency improvements of 1.0 per cent a year have been assumed to reduce overall energy requirements over the outlook period. As a result, energy use is forecast to grow, on average, by only around 2.4 per cent a year, compared with an average well in excess of 3.5 per cent a year since the early 1980s.

Final energy use in the residential sector represented 13 per cent of total final energy consumption in 1998-99. As with the commercial sector, reductions in the energy intensity of consumption (principally reflecting end-use efficiency improvements) of around 1 per cent a year are expected to dampen future growth. Accordingly, residential sector energy use is forecast to increase, on average, by around 2.1 per cent a year.

Solar energy use (for solar hot water systems) is forecast to increase by around 2.3 per cent a year, displacing almost 1700 megawatts of electricity by 2019-20.

## Primary energy consumption, by fuel

Total primary energy consumption is the total energy used by the economy. In these projections the primary fuels are defined to include: coal, both black and brown; crude oil and petroleum products (hereafter referred to simply as oil); natural gas; and renewables (hydro-electricity, biomass, biogas, wind and solar energy). Since the early 1970s the mix of fuels in total energy consumption in Australia has changed radically, with the combination of oil price shocks, natural gas discoveries and the development of gas transmission and distribution infrastructure, collectively providing the catalyst for significant growth in natural gas consumption at the expense of oil. Over the past twenty-five years the consumption of natural gas increased on average by 6.9 per cent a year, almost tripling its share of total energy consumption. Over the same period, the share of crude oil fell from over 50 per cent to around 35 per cent.

Currently coal (that is, black and brown coal collectively) is the main fuel used in Australia's primary energy mix, accounting for 41 per cent in 1998-99; oil is the second largest and accounts for just over 35 per cent of total consumption. Over the forecast period to 2019-20, total primary energy consumption is projected to increase by around 2577 petajoules or 2.0 per cent a year, with coal and oil expected to continue to dominate the energy mix, collectively accounting for some 70 per cent of primary energy use in the final year (table 3).

Table 3: **Primary energy consumption, by fuel**

	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Black coal	1 366.2	1 841.2	28.2	24.8	1.4
Brown coal	638.6	701.0	13.2	9.4	0.4
Oil	1 687.7	2 644.5	34.8	35.6	2.2
Natural gas	871.3	1 773.7	18.0	23.9	3.4
Renewables	288.6	469.2	5.9	6.3	2.3
Biomass	217.1	357.6	4.5	4.8	2.4
Biogas	8.9	25.5	0.2	0.3	5.1
Hydroelectricity	58.7	68.8	1.2	0.9	0.8
Solar	3.8	6.1	0.1	0.1	2.3
Wind	0.1	11.1	0.0	0.1	25.2
Total	4 852.4	7 429.6	100.0	100.0	2.0

## Primary energy consumption, by sector

Looking at the overall picture of primary energy consumption by sector, it can be seen that electricity generation is currently the largest user of primary energy in the economy and that this situation is not expected to change much over the outlook period (table 4). Thirty-one per cent of the projected increase in Australia's primary energy use over the outlook period occurs in electricity generation. Of the remainder, transport and storage accounts for 29 per cent while manufacturing accounts for 21 per cent. Given that the results for final energy consumption have already been discussed (and there is significant overlap between primary and final energy use), the remainder of this section focuses on the electricity generation sector.

Table 4: **Primary energy consumption, by sector**

	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Agriculture	59.9	90.6	1.2	1.2	2.0
Mining	214.7	470.0	4.4	6.3	3.8
Petroleum refining	100.0	156.6	2.1	2.1	2.2
Manufacturing a	845.0	1 374.1	17.4	18.5	2.3
Electricity generation	2 065.4	2 851.4	42.6	38.4	1.5
Transport and storage	1 231.6	1 986.2	25.4	26.7	2.3
Commercial and services	62.5	100.0	1.3	1.3	2.3
Residential	215.1	315.7	4.4	4.2	1.8
Other b	58.2	84.8	1.2	1.1	1.8
Total	4 852.4	7 429.6	100.0	100.0	2.0

a Excludes petroleum refining. b Includes solvents, lubricants, greases and bitumen.

## Electricity

Perhaps the most important element to ABARE's new model based approach to forecasting long term energy trends is the emphasis placed on modeling the electricity generation sector in an integrated manner. *E<sub>4</sub>cast* is used to determine the least cost mix of electricity generation sources (including choosing whether or not to invest in new capacity) and to simultaneously determine fuel input requirements. The recently introduced mandated renewable energy target policy is also explicitly modeled in *E<sub>4</sub>cast* in the business as usual scenario.

With an estimated 40 000 megawatts of capacity, generating approximately 202 terawatt hours of electricity, this sector accounted for almost 43 per cent of total Australian energy consumption in 1998-99. Further, with over \$74 billion in assets and \$16 billion in electricity sales, the electricity industry ranks as one of Australia's largest in the mining, manufacturing and utility sector, directly contributing around 1.4 per cent of Australia's GDP (Dickson and Warr 2000, p. 12).

Over the past two decades, energy use in the electricity generation sector has increased markedly, with annual growth averaging almost 4.2 per cent a year, reflecting increased electrification in all end use sectors in addition to rapid growth in a number of industries in which electricity is the prime fuel source. The introduction of competitive market reforms to Australia's electricity sector has also resulted in significant improvements. Compared with 1989-90, the Australian industry in 1997-98 delivered more electricity (up 25 per cent) at a lower real price to more customers (up 18 per cent) with half the number of employees (Dickson and Warr 2000, p. 12). It is also estimated that the reforms will deliver over \$21 billion (in 2001 dollars) in economywide benefits between 1995 and 2010, with around \$1.5 billion in 2001 alone (Short et al. 2001).

Over the next two decades, gross generation of electricity in Australia is forecast to increase by an average 2.3 per cent a year, increasing to 325 terawatt hours by 2019-20 (table 5). Black coal is expected to continue to provide the lion's share of electricity generation in the foreseeable future reflecting both the underlying competitiveness of black coal generation on a unit cost basis and already committed plans to build over 2280 megawatts of new capacity in the short to medium term, particularly in Queensland (NEMMCO 2001). Over the full outlook period, electricity generation from black coal plant is forecast to increase by 59 terawatt hours, reaching 170 terawatt hours by 2019-20.

Generation from natural gas is forecast to grow by 4.9 per cent a year, accounting for 31 per cent of the total increase in electricity generation over the outlook period, lifting its share of the total from 10.7 per cent in 1998-99 to 18.3 per cent by 2019-20. However, reflecting both the impact of the mandated renewable energy target policy and committed plans to expand coal fired generation capacity, the growth in gas's contribution is forecast to be

Table 5: Electricity generation, by fuel

	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Black coal	398.9	611.2	54.8	52.3	2.1
Brown coal	178.8	220.4	24.5	18.8	1.0
Oil	8.2	14.0	1.1	1.2	2.6
Natural gas	77.8	213.8	10.7	18.3	4.9
Renewables	64.8	110.1	8.9	9.4	2.6
Hydroelectricity	58.7	68.8	8.1	5.9	0.8
Biomass	4.6	23.5	0.6	2.0	8.1
Biogas	1.4	6.6	0.2	0.6	7.5
Wind energy	0.1	11.1	0.0	1.0	25.2
Total	728.5	1 169.4	100.0	100.0	2.3

appreciably weaker in the first half of the period (3.6 per cent) compared with the second (6.5 per cent).

High capital costs and environmental concerns are expected to limit the addition of new brown coal generation capacity in Australia. Nevertheless, improvements in utilisation and some refurbishment of existing capacity are expected, resulting in electricity generation from brown coal plant increasing by approximately 1 per cent a year.

The Australian government's Mandatory Renewable Energy Target commenced on 1 April 2001. The *Renewable Energy (Electricity) Act 2000* requires the generation of 9500 gigawatt hours of extra renewable electricity a year by 2010. Interim targets have been set (commencing at 300 gigawatt hours in 2000) to ensure that there will be consistent progress toward achieving the 9500 gigawatt hour target by 2010 and that all of the investment does not occur in the final years of the scheme. The Office of the Renewable Energy Regulator has been established to oversee the implementation of the measure. Further information on the measure can be found at their web site ([www.orer.gov.au](http://www.orer.gov.au)).

Achievement of the mandated renewable energy target policy is modeled explicitly in *E<sub>cast</sub>* and, consistent with this, renewable electricity generation is estimated at around 27 500 gigawatt hours in 2009-10. Biomass (mainly bagasse) is forecast to capture around 42 per cent of the quota in 2009-10, with wind (26 per cent), new hydro (17 per cent) and biogas (11 per cent) sharing the remainder. Beyond 2009-10 renewable electricity generation is forecast to grow only marginally, at around 1 per cent a year.

## Energy production and trade

The projections for the production of primary energy fuels from 1998-99 to 2019-20 are presented in table 6, while the net trade forecasts are presented in table 7.

### Black coal

Australia is the world's fourth largest black coal producer and in the calendar year 2000 produced a record 246 million tonnes of salable black coal (304 million tonnes of raw coal) from 105 operating mines (56 opencut and 49 underground). Of this, some 180 million tonnes was exported. With more than 80 billion tonnes of demonstrated in-situ

Table 6: Australian energy production

	Consumption		Shares		Annual growth
	1998-99	2019-20	1998-99	2019-20	1998-99 to 2019-20
	PJ	PJ	%	%	%
Black coal	6 188.0	8 881.2	64.7	60.6	1.7
Brown coal	638.6	701.0	6.7	4.8	0.4
Crude oil <b>a</b>	1 047.1	1 298.7	11.0	8.9	1.0
LPG <b>b</b>	103.5	125.8	1.1	0.9	0.9
Natural gas	1 296.7	3 188.1	13.6	21.7	4.4
Hydroelectricity	58.7	68.8	0.6	0.5	0.8
Biomass	217.1	357.6	2.3	2.4	2.4
Biogas	8.9	25.5	0.1	0.2	5.1
Wind energy	0.1	11.1	0.0	0.1	25.2
Solar energy	3.8	6.1	0.0	0.0	2.3
Total	9 562.5	14 664.0	100.0	100.0	2.1

**a** Includes condensate. **b** Naturally occurring LPG.

Table 7: Australia's net energy trade

	Net exports			Net imports
	Black coal	LPG	LNG	of crude oil and ORF
	PJ	PJ	PJ	PJ
1998-99	4 821.8	85	425	622
1999-2000	5 010.0	97.7	431.0	324.3
2004-05	5 978.0	81.1	556.8	733.4
2009-10	6 437.0	100.4	979.2	895.8
2014-15	6 780.0	123.7	1 196.8	1 108.1
2019-20	7 040.0	152.1	1 414.4	1 372.1
Annual growth rate	%	%	%	%
1998-99 to 2019-20	1.8	2.8	5.9	3.8

coal resources, Australia's current coal reserves are estimated to last around 250 years based on current production levels.

Over the outlook period, black coal production is projected to increase, on average, by 1.7 per cent a year to reach 8881 petajoules in 2019-20, an increase of 94.5 million tonnes over the 1998-99 level. In 1998-99, about 78 per cent of Australian black coal production was exported; by 2019-20 this share is projected to be marginally higher, at 79 per cent. Coal exports will continue to predominantly serve Asian markets for applications mainly in power generation and blast furnace steel making. With Asian import demand expected to moderate over the longer term (mainly in line with an easing in regional economic growth) the growth in coal exports is also expected to moderate. Australian black coal exports are forecast to grow, on average, by 1.8 per cent a year over the outlook period to reach 250 million tonnes.

### **Crude oil production and net imports**

In 1998-99 Australian oil production was 1047 petajoules, or approximately 28 300 million litres and included temporary production shutdowns in Western Australia and Victoria. Over the outlook period, Australia's production of crude oil and condensate is forecast to increase by 1.0 per cent a year, reaching 1300 petajoules by 2019-20. Contrasting this, net oil imports are projected to increase by 3.8 per cent a year, reaching 1370 petajoules by 2019-20. Accordingly, Australia's reliance on crude oil imports is forecast to increase significantly over the outlook period, with the share of total primary consumption of oil accounted for by imports rising to around 52 per cent by the end of the projection period.

In the absence of any definitive schedule for further rationalisation of the Australian refining industry, it was assumed that, over the outlook period, there will be little change in Australia's refined petroleum net trade position. This implies that net production capacity within each state will continue to expand to match projected growth in domestic consumption. Accordingly, total output of petroleum products from Australian refineries is forecast to increase from around 1680 petajoules in 1998-99 to 2680 petajoules by 2019-20, a total increase of around 27 billion litres of fuel.

### **LNG exports and natural gas production**

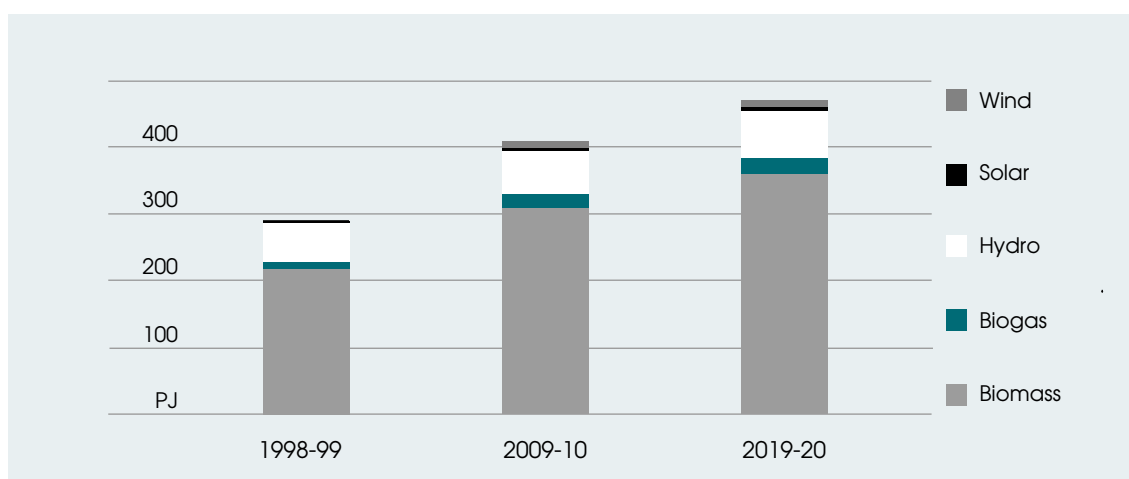
The outlook for Australia's LNG industry is for continued strong growth, with exports forecast to increase from approximately 7.8 million tonnes in 1998-99 to 20 million tonnes by 2010-11, before reaching 26 million tonnes by 2019-20. This scenario assumes the addition of three LNG liquefaction trains in the medium term (the first of which is largely committed) and the processing of gas from the Gorgon project and the Timor Sea in the longer term (beyond 2010-11). Reflecting this export outlook, total domestic gas production in Australia is expected to increase, on average, by 4.4 per cent a year over the outlook period to reach 79 700 gigalitres (or million m<sup>3</sup>) by 2019-20.

## Renewables

Australia’s renewable energy industry is diverse, encompassing a wide range of energy sources, technologies and scales. In absolute terms, however, renewables only contribute a small proportion of Australia’s total energy mix. In 1998-99 the contribution of renewables to total energy consumption was just 5.9 per cent, comprising biomass, hydro, biogas, solar and a very small quantity of wind power (figure E).

Over the outlook period, the major area where the use of renewable energy is set to increase is in the electricity generation sector with the commencement of the Australian Government’s Mandatory Renewable Energy Target, as discussed earlier. The contribution of renewables to total energy consumption is forecast to increase marginally over the outlook period, reaching 6.3 per cent in 2019-20, reflecting forecast average growth of 2.3 per cent a year.

Figure E: **Renewable energy**



## Conclusion

In preparing this set of long term energy consumption and production trends for Australia, ABARE chose to completely revise the forecasting approach used. This proved to be a complex and time consuming task. Nevertheless, *E<sub>cast</sub>* is already proving its worth as a research tool and we trust the presentation of a number of alternative scenarios to the reference case improves the transparency and usefulness of the results.

In developing *E<sub>cast</sub>* it was necessary to simplify the treatment of some fuels and/or sectors. In the immediate future we intend to revisit a number of these simplifications with a view to updating the model. Over the longer term a number of major model developments are envisaged. These include:

- development of a more sophisticated treatment of electricity consumption and production, particularly to differentiate between base load and peak load technologies; and
- enhancement of the current treatment of end use fuel demands to model interfuel substitution.

The outlook presented here represents a significant departure from ABARE's previous published projections, both in terms of methodology and overall outlook. The current forecast for Australian energy consumption is for relatively strong growth, albeit tempered by expected energy efficiency improvements of around 0.5–1.0 per cent a year across most sectors.

The electricity generation sector will continue to be the largest consumer of primary fuels in Australia and in the short term is expected to have a significant impact on national outcomes. At the same time, however, developments in the manufacturing and transport sectors are also expected to be very influential. The outlook for natural gas is bullish (again) and consumption is forecast to grow by around 3.4 per cent a year over the outlook period. As a counterpoint to this, however, oil and coal (black and brown) are forecast to continue to account for well over two-thirds of Australia's primary energy mix in 2019-20, declining slightly from the 76 per cent share achieved in 1998-99. Within manufacturing the iron and steel sector is set to grow strongly on the strength of the outlook for DRI, while across the states Western Australia and Queensland will continue to provide the vanguard on growth.

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