



# Australian Resource Reviews

## Brown Coal 2017

Alanah Hughes, Geoscience Australia

**Resource figures are current as at 31 December 2016.**

Coal is a sedimentary rock formed from peat that has been subjected to temperature, pressure and microbial action over millions of years. Over time, coal progresses in rank from lignite, to sub-bituminous coal, to bituminous coal and finally to anthracite; a process known as coalification. As the coal increases in rank, the carbon content – and hence the energy content – increases, whilst the moisture content decreases. In Australia, sub-bituminous, bituminous and anthracite are collectively referred to as black coal, whilst lignite is referred to as brown coal. In Europe, sub-bituminous coal is also considered to be brown coal.

Brown coal, or lignite, is the lowest rank of coal and although it is present in all states of Australia it is most abundant in the Gippsland Basin (Victoria). Smaller amounts of brown coal are also located in the Otway (Victoria), Murray (Victoria/South Australia) and Eucla (Western Australia/South Australia) basins.

Although Victorian brown coals are low in ash and sulfur, they have high moisture contents and are not exported from Australia to overseas destinations. Brown coal is produced and utilised almost exclusively in Victorian mines and power stations. The Loy Yang Complex and Yallourn W power stations are located in the Latrobe Valley within the Gippsland Region of Victoria, the coal is mined from near-surface deposits in the Yallourn-Morwell and Loy Yang coalfields.

During the 2015-2016 financial year, brown coal generated 19% of Australian electricity, down from 20.2% during 2014-2015<sup>1</sup>.

*Table 1: Australian brown coal-fired power stations.*

State	Power Station	Capacity (MW)
VIC	Loy Yang A	2210
VIC	Loy Yang B	1026
VIC	Yallourn W	1480
VIC	Morwell (closed August 2014)	189
VIC	Anglesea (closed August 2015)	160
VIC	Hazelwood (decommissioned March 2017)	1760

*Source: Energy Supply Association of Australia, Electricity Gas Australia 2015, in Australian Energy Council, Retirement of coal fired power stations Submission 44, 10 November 2016.*

<sup>1</sup> Department of the Environment and Energy, *Australian Energy Statistics, Table O*, April 2018.

## JORC Reserves

Ore Reserves of brown coal are not publicly available; however, four mines were operating in 2016. The Measured and Indicated Mineral Resources at these mines accounted for 7% of the national total.

Table 2. Ore Reserves and Mineral Resources of recoverable brown coal (million tonnes) reported in compliance with the JORC Code at operating mines in 2016.

No. of Operating Mines <sup>1</sup>	Ore Reserves <sup>2</sup> at Operating Mines	Measured and Indicated Resources <sup>3</sup> at Operating Mines	Mine Production 2016 <sup>4</sup>	Average Reserve Life (years)	Average Resource Life (years)
4	n.a.	22 492 <sup>5</sup>	63.6	n.a.	354

1. The number of operating mines counts individual mines that operated during 2016 and thus contributed to production. Some of these mines may belong to larger, multi-mine operations and some may have closed during or since 2016.
2. The majority of Australian Ore Reserves and Mineral Resources are reported in compliance with the JORC Code, however there are a number of companies that report to foreign stock exchanges using other reporting codes, which are largely equivalent. In addition, Geoscience Australia may hold confidential information for some commodities. Ore Reserves are as at 31 December 2016.
3. Mineral Resources are inclusive of the Ore Reserves. Mineral Resources are as at 31 December 2016.
4. Mine production refers to raw coal. Source: Geoscience Australia estimation.
5. Measured and Indicated Resources for brown coal are presented on a recoverable basis (these are Geoscience Australia estimates unless provided by the company).

## Identified Resources

During 2015, a major review was completed in collaboration with the Geological Survey of Victoria. This resulted in a large upwards revision of Economic Demonstrated Resources (EDR) of recoverable brown coal from 44 164 Mt at December 2012 to 76 508 Mt at December 2015.

Australia's recoverable brown coal EDR did not change during 2016. The majority is located within the Latrobe Valley (Victoria). At 2016 production levels, Australia's recoverable brown coal EDR is expected to last more than 1000 years.

Table 3: Australia's identified in situ brown coal resources (million tonnes) for selected years from 1975-2016.

Year	Demonstrated Resources			Inferred Resources <sup>2</sup>
	Economic <sup>1</sup>	Paramarginal	Submarginal	
2016	92 887	44 069	234 987	124 326
2015	92 887	44 069	234 987	124 326
2014	49 075	37 465	16 873	123 813
2013	49 075	37 465	16 873	123 529
2012	49 035	37 465	16 873	123 240
2011	49 135	37 465	16 873	121 198
2010	44 189	44 896	18 727	114 923
2009	41 200	43 500	18 100	112 400
2008	44 300	43 100	18 100	112 300
2007	41 400	43 400	18 100	112 000
2006	41 500	43 400	18 100	112 000
2005	41 500	43 400	18 100	112 000
2000	42 000	43 400	18 100	113 600
1995	46 000	1000	2000	184 000
1990	46 400		3300	204 000
1985	46 500		2900	203 000
1980	39 400	83 200 <sup>3</sup>		
1975	36 400	29 000	56 800	

1. EDR includes Ore Reserves and most Measured and Indicated Mineral Resources reported in compliance with the JORC Code.

2. Total Inferred Resources in economic, subeconomic and undifferentiated categories.

3. In 1980, paramarginal and submarginal resources were not differentiated.

Table 4: Australia's identified recoverable brown coal resources and world figures (million tonnes) for selected years from 1975-2016.

Year	Demonstrated Resources			Inferred Resources <sup>2</sup>	Accessible EDR <sup>3</sup>	Australian Mine Production <sup>4</sup>	World Economic Resources <sup>5</sup>	World Mine Production <sup>6</sup>
	Economic <sup>1</sup>	Paramarginal	Submarginal					
2016	76 508	41 112	215 449	103 579	66 439	63.3	317 000	783.3
2015	76 508	41 112	215 449	103 579	66 439	65.4	286 000	807.4
2014	44 164	33 402	15 186	103 017	34 095	60.7	201 000	810.5
2013	44 164	33 402	15 185	103 052	34 095	73.0	201 000	905
2012	44 164	33 402	15 185	102 502	34 095	66.73	195 000	1041
2011	44 219	33 402	15 185	100 664	34 150	66.73	195 000	1044
2010	39 254	37 045	15 942	95 155	34 150	69	195 387	1042
2009	37 100	39 100	16 300	101 200	32 100	68	148 000	880
2008	37 200	38 800	16 300	101 100	32 200	66	147 000	870
2007	37 300	39 000	16 300	100 800	32 300	66	148 000	860
2006	37 300	39 000	16 300	100 800	29 800	67	155 000	850
2005	37 400	39 000	16 300	100 800	30 000	67	155 000	840
2000	37 700	39 000	16 300	102 200		66	189000	900
1995	41 000	1000	2000	166 000		50.7		
1990	41 700	400	3000	184 000		48	270 000	1400
1985	41 900		2500	183 000		37	254 000	1130
1980	36 200	69 600 <sup>7</sup>				33	140 000	993
1975	12 600	12 000				28	233 000	855

1. EDR includes Ore Reserves and most Measured and Indicated Mineral Resources reported in compliance with the JORC Code plus non-JORC equivalents.
2. Total Inferred Resources in economic, subeconomic and undifferentiated categories.
3. Accessible Economic Demonstrated Resources (AEDR) is the portion of total EDR that is accessible for mining. AEDR does not include resources that are inaccessible for mining because of environmental restrictions, government policies or military lands.
4. Source: Geoscience Australia estimation.
5. Source: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), 2015. Energy Study 2016: Reserves, Resources and Availability of Energy Resources. Federal Institute of Geosciences and Natural Resources (BGR), Hannover, Germany. Note: World economic resources are dated 2015.
6. Source: International Energy Agency (IEA) 2017, Coal Information 2017 Edition, International Energy Agency, Paris.
7. In 1980, paramarginal and submarginal resources were not differentiated.

Table 5: Recoverable resources of brown coal in Australian jurisdictions as at December 2016.

Jurisdiction	Demonstrated Resources (Mt)			Inferred (Mt)
	Economic	Paramarginal	Submarginal	
South Australia	0	2820	247	776
Tasmania	0	106	0	0
Victoria	75 995	37 821	215 202	101 058
Western Australia	513	365	0	1746
<b>Total Australia</b>	<b>76 508</b>	<b>41 112</b>	<b>215 449</b>	<b>103 579</b>

## Production

During 2016, brown coal production, both international and domestic, fell. Australian lignite production went from 65.3 Mt in 2015 to 63.6 Mt in 2016; world production went from 811.1 Mt in 2015 to 787.3 Mt in 2016. World trade, however, increased marginally from 8.9 Mt in 2015 to 9.0 Mt in 2016<sup>2</sup>.

Table 6. Major brown coal producers 2015 and 2016.

Country <sup>1</sup>	Production (Mt)		Annual change (%)
	2015	2016p	
Germany	178.1	171.5	-3.7
Russian Federation	73.6	73.7	<1
United States <sup>2</sup>	64.9	66.5	+2.4
<b>Australia<sup>2</sup></b>	<b>65.4</b>	<b>63.6</b>	<b>-2.7</b>
Poland	63.1	60.2	-4.6
Turkey	56.1	56.8	+1.3
India	43.8	45.0	+2.6
Czech Republic <sup>2</sup>	38.1	38.5	+1.1
Serbia	37.8	38.4	+1.6
Greece	46.2	32.2	-30.3
Other	143.8	140.6	-2.2
<b>World</b>	<b>811.1</b>	<b>787.3</b>	<b>-2.9</b>

p = provisional.

Source: IEA (2017), see footnote 2.

1. Some countries, most notably the People's Republic of China and Indonesia, produce and consume brown coals, however these data are reported under other coal types included in thermal coal and are not shown here.
2. Brown coal data excludes sub-bituminous coal

## World Ranking

During 2016, Australia was the fourth largest reported producer of brown coal in the world after Germany, the Russian Federation and the United States. During 2016, Australia's brown coal production decreased by nearly 3% from 2015<sup>3</sup>.

There is more than one coal classification system: in Australia, sub-bituminous, bituminous and anthracitic coals are considered black coals. World lignite statistics are affected by regional classification systems: both Indonesia and China report the production and consumption of brown coal as types of bituminous coal<sup>4</sup>. China is possibly the second largest producer and consumer, after Germany, of brown coal in the world<sup>5</sup>.

## Industry Developments

In Victoria, the **Morwell** power station closed during 2014 then, in August 2015, the **Anglesea** coal mine and power station ceased operations. The **Hazelwood** power station and mine in Victoria were decommissioned in March 2017.

The Commonwealth and Victorian Governments' **Advanced Lignite Demonstration Program**, to promote development of lignite beneficiation technology commenced in May 2014. **Coal Energy Australia Ltd** received a grant of \$30 million. Located in the Latrobe Valley, the company is developing a proprietary pyrolysis process to generate up to four products from lignite, including high-quality PCI Coal, pyrolysis oil, ammonium sulphate and coal gas.

In December 2014, **Mantle Mining** and **Exergen Pty Ltd** confirmed their joint venture plans to construct a 'Pre-Commercial Demonstration Plant' over a four-year period to prove Exergen's patented Continuous Hydro-Thermal Dewatering technology. This technology is designed to efficiently remove moisture from lignite and moist sub-bituminous coals, to ultimately reduce greenhouse gas emissions from brown coal power generation.

2 International Energy Agency (IEA) 2017, *Coal Information 2017 Edition*, International Energy Agency, Paris.

3 ibid.

4 IEA (International Energy Agency) 2018, *Coal Information 2018 Edition*, International Energy Agency, Paris.

5 ibid.

**Contact Details**

mineral.promotions@ga.gov.au

**Department of Industry, Innovation and Science**

Minister for Resources and Northern Australia: Senator the Hon Matthew Canavan  
Secretary: Dr Heather Smith PSM

**Geoscience Australia**

Chief Executive Officer: Dr James Johnson

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