Commodity forecasts for Western Australia to 2030

A report for the
AUSTRALIAN ENERGY MARKET OPERATOR (AEMO)

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Western Australian commodity forecasts

1. Introduction and background

This section presents commodity forecasts for selected commodity groups or types extending out 10 years to 2030 on a calendar year basis. The forecasts were prepared for both Western Australia and Australia.

By 31 December each year, AEMO is required to publish a WA Gas Statement of Opportunities (GSOO). A significant proportion of Western Australian gas demand is driven by the outlook for commodity production for specific metals and minerals. AEMO therefore requires commodity production forecasts for its expected, high and low gas demand forecasts.

Mining projects in Western Australia are usually located off the South West Interconnected System (SWIS), often in remote areas. Gas usage at these mines can include power generation for process use at the mine site and sometimes generation for the township of mine employees.

The commodity forecasts in this section are based on production for each commodity group or type. The commodity outlooks covered include the following:

- iron ore;
- alumina;
- gold;
- nickel;
- lithium;
- copper;
- zinc;
- lead;
- cobalt; and
- mineral sands.

The commodity production outlooks were forecast by considering the following:

- a consensus of commodity price outlooks;
- future project expansions/closures;
- world market developments and conditions;
- historical production/price movements;
- the impact of emerging new technologies; and
- the world, national and state economic outlooks as captured in NIEIR's economic forecast models.

The short-term outlooks for each commodity were largely based on expected levels of activity at existing and new mining projects. For the medium-term to long-term, the commodity production outlooks were shaped more by the world and Australian economic outlooks and trends within each respective commodity market.

Following a brief review of commodity production trends in Western Australia, the remaining sections discuss the outlook for each commodity. Forecasts of commodity production for the base, high and low scenarios to 2030 are presented at the end of this report.

2. Mining commodity production in Western Australia

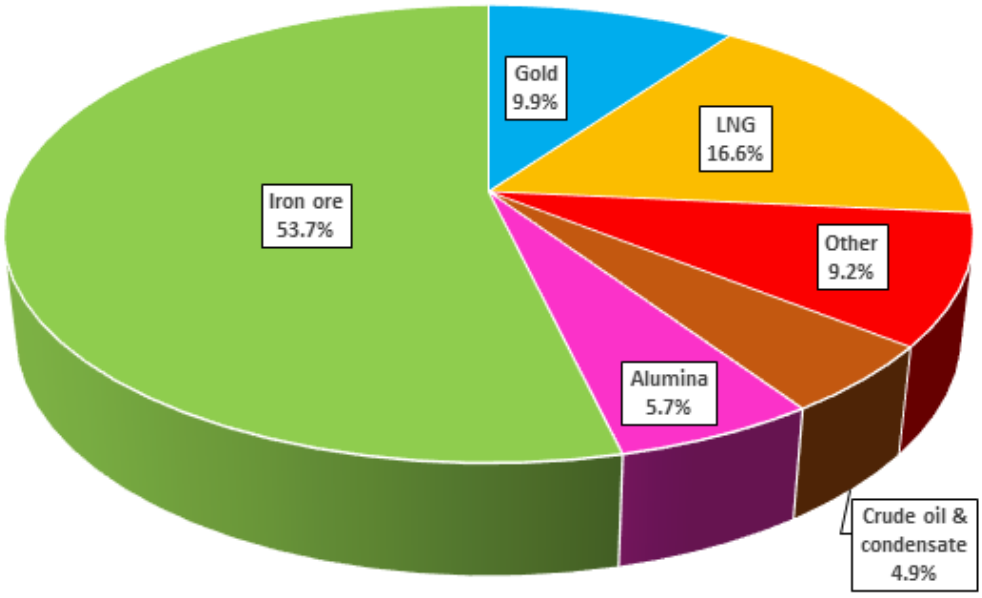
Western Australia mining commodity production by type is shown in Table 1 for 2013-14 to 2017-18. These are reported as values in Australian dollars. The table also shows the percentage change in the value of each commodity produced between 2013-14 and 2017-18.

The total value of mining commodities produced declined in 2014-15 and 2015-16, mainly reflecting a decline in commodity prices over this period. Rising production for some commodities and improved prices led total Western Australian commodity production to reach $1.5 billion in 2017-18.

Whilst Western Australia's overall mining commodity production is diverse, over 90 per cent of production values were concentrated in five groups in 2017-18. These were:

- iron ore (53.7 per cent);
- LNG (16.6 per cent);
- gold (9.9 per cent);
- alumina (5.7 per cent); and
- crude oil and condensate (4.9 per cent).

Figure 1: Value of commodity production, Western Australia, 2017-18 – Main commodities



Source: Department of Mines, Industry Regulation and Safety, Western Australia (DMIRS).

In terms of the value of production, the fastest growing commodity production groups in Western Australia were:

- LNG (28.9 per cent);
- gold (28.2 per cent);
- alumina (53.3 per cent);
- spodumene (954.4 per cent);
- cobalt (193.8 per cent);
- zinc (182.0 per cent); and
- coal (25.9 per cent).

Table 1 Nominal value of Western Australian mining commodities produced – 2013-14 to 2017-18

	Value by year					Per cent change 2013-14 to 2017-18 (%)	Per cent share 2017-18 (%)
	2013-14 (A$m)	2014-15 (A$m)	2015-16 (A$m)	2016-17 (A$m)	2017-18 (A$m)		
Iron ore	75166	54376	48768	63866	61692	-17.9	53.7
LNG	14804	13817	10765	12728	19078	28.9	16.6
Gold	8891	9107	10105	10858	11400	28.2	9.9
Alumina	4295	5023	4937	5074	6583	53.3	5.7
Crude oil and condensate	9758	7982	5303	4340	5600	-42.6	4.9
Nickel	3419	3170	2203	2095	2643	-22.7	2.3
Natural gas	1656	1827	1913	1830	1634	-1.3	1.4
Spodumene	151	246	242	590	1574	945.4	1.4
Copper metal	1560	1283	1183	1241	1332	-14.6	1.2
Cobalt	175	211	175	240	514	193.8	0.4
Mineral sands	471	493	572	505	358	-24.1	0.3
Zinc metal	118	197	195	204	334	182.0	0.3
Coal	264	307	336	338	332	25.9	0.3
LPG – butane and propane	586	406	249	273	331	-43.5	0.3
Diamonds	402	342	354	268	325	-19.1	0.3
Salt	410	375	336	292	301	-26.6	0.3
Silver	93	96	105	98	99	5.5	0.1
Construction materials	86	166	80	62	68	-20.9	0.1
Lead metal	179	137	15	10	23	-87.0	0.0
Other	577	595	164	417	729	26.2	0.6
Total	**123061**	**100153**	**88000**	**105330**	**114950**	**-6.6**	**100.0**
Total excluding crude oil/condensate	113303	92171	82697	100990	109350	-3.5	95.1

Source: DMIRS.

The Australian dollar value of Western Australian mining commodities produced is often significantly impacted by commodity prices. The data in Table 1 does not give an accurate picture of the volume of Western Australian commodity production, which, notwithstanding a fall in crude oil and condensate production, has increased significantly over recent years. The fall in the iron ore price has also had a significant impact on Western Australian production values over time.

Table 2 shows quantities of mining commodities produced in Western Australia by type from 2009-10 to 2017-18. As indicated in Table 2, there have been some large production increases over the last eight years in Western Australia. These include the following commodities:

- iron ore (10 per cent per annum);
- gold (3.2 per cent per annum)
- LNG (11.6 per cent per annum)
- silica-sand (10.4 per cent per annum); and
- spodumene (30.9 per cent per annum).

Table 2 Quantities of principal mining commodities produced in Western Australia – 2009-10 to 2017-18

	Unit	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average % change 2009-10 to 2017-18
Alumina	kt	12643	12281	12425	13531	13718	13771	13894	13855	13669	1.0
Copper metal	kt	152	150	159	209	211	184	190	171	164	1.0
Lead metal	kt	26	41	7	17	79	59	6	4	7	-14.6
Zinc metal	kt	88	71	64	56	54	78	83	83	94	0.8
Coal	kt	6712	7234	6986	7494	6275	6553	6891	6806	6680	-0.1
Aggregate	kt	3168	1935	3722	4391	2155	1964	1314	1053	1237	-11.1
Gravel	kt	185	231	284	561	52	173	177	261	155	-2.2
Rock	kt	531	298	510	1110	403	1747	220	409	268	-8.2
Sand	kt	3227	4818	6287	5416	3797	5939	3477	2578	4086	3.0
Diamonds	ct '000	16281	10122	8690	9609	11647	10424	13870	12607	15281	-0.8
Gem & semi-precious stones	kt	301	292	228	198	310	721	243	336	204	-4.7
Gold	kg '000	164	184	181	180	196	193	196	203	212	3.2
Gypsum	kt	878	587	334	1576	533	577	552	531	896	0.3
Garnet	kt	238	227	302	317	357	299	251	566	380	6.0
Ilmenite	kt	509	394	332	271	79	100	175	179	94	-19.0
Leucoxene	kt	77	26	22	29	29	17	18	7	14	-18.9
Rutile	kt	118	50	39	47	65	30	46	22	16	-22.4
Zircon	kt	352	299	180	216	212	183	192	185	62	-19.5
Iron ore	kt	384965	397604	454385	511760	623507	718807	748100	793102	825981	10.0
Limesand-limestone-dolomite	kt	4018	3721	4158	4092	3117	4903	4446	4178	3943	-0.2
Manganese ore	kt	747	873	846	650	712	801	425	237	393	-7.7
Cobalt	t	4398	3767	4950	6200	6236	6036	5479	4759	5194	2.1
Nickel	kt	180	194	209	227	210	183	176	158	163	-1.2
Palladium and platinum by-product	kg	1089	440	626	658	1015	464	687	9081	10795	33.2
Condensate	kt	7418	6882	5889	6117	5559	6753	6775	6038	7115	-0.5
Crude oil	kl '000	11842	13925	11122	8609	7304	7844	7686	5404	4808	-10.7
LNG	kl '000	15717	17290	15611	19805	20050	20448	20956	28685	37894	11.6
LPG – butane and propane	kt	988	924	835	753	631	553	532	527	451	-9.3
Natural gas	kt	9357	8981	9081	8714	9369	9875	10224	9709	10040	0.9
Salt	million m3	10969	12247	12807	12390	12992	11727	10975	10874	12964	2.1
Silica-silica sand	kt	442	430	453	498	450	484	582	729	974	10.4
Silver	kg '000	100	84	120	124	137	151	155	143	153	5.5
Spodumene	kt	247	352	461	486	342	489	417	887	2130	30.9

Source: DMIRS.

Australian metals and other minerals private exploration expenditure over the last 10 years is shown in Table 3. During the previous mining boom, exploration expenditure reached nearly A$3 billion in 2011-12. There was a significant fall in expenditure on exploration in Australia between 2012 and 2017. In 2015-16 exploration expenditure was only $1.2 billion.

With the increase in base metals prices over 2018 and 2019, exploration expenditures have risen quite significantly in Australia. Compared to 2016-17, large increases in Australian exploration expenditure occurred for copper, gold, nickel, cobalt, lead, silver, zinc and for mineral sands. Iron ore exploration expenditure has remained flat at around $300 million per year since 2015-16. Total exploration expenditure in Australia was $2 billion in 2018-19. Gold exploration over the last five years has accounted for 43 per cent of total Australian private metals and other mineral exploration expenditure.

Table 3 Australian metals and other minerals private exploration expenditure, Australia 2007-08 to 2018-19 ($ million)

	Copper	Diamonds	Gold	Iron ore	Mineral sands	Nickel, cobalt	Silver, lead and zinc	Other	Total metals and other minerals
2007-08	294	22	593	450	37	303	187	111	1,995
2008-09	179	10	438	589	31	260	81	154	1,741
2009-10	202	4	575	524	16	204	52	166	1,742
2010-11	323	1	652	665	6	271	76	224	2,218
2011-12	443	3	768	1,151	20	265	88	227	2,965
2012-13	319	6	662	1,011	38	165	80	161	2,442
2013-14	177	8	434	711	21	99	46	170	1,666
2014-15	144	5	396	448	27	83	52	131	1,286
2015-16	130	4	548	291	20	51	50	115	1,209
2016-17	136	2	689	291	20	81	55	150	1,423
2017-18	193	8	810	292	27	200	103	177	1,811
2018-19	290	9	935	298	35	199	92	189	2,048
5 year average	179	6	676	324	26	123	70	153	1,556
Per cent share	11%	0%	43%	21%	2%	8%	5%	10%	100%

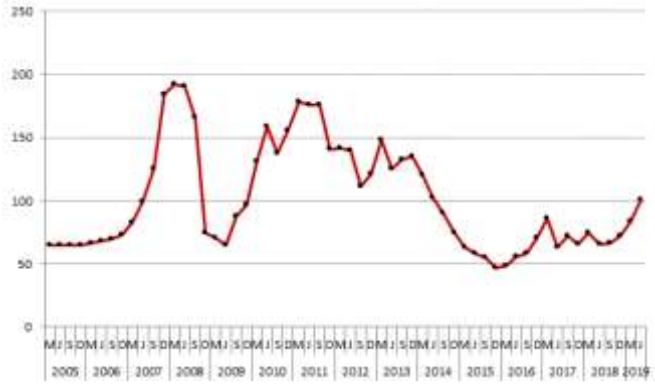
Source: Office of Chief Economist.

3. Iron ore

Figure 2: Iron ore production (Mt)

Source: Office of the Chief Economist.

Figure 3: Iron ore nominal price ($/dmtu)



Source: World Bank August 2019.

World iron ore production was 2,167.1 million tonnes in 2017. Australia's production was 883.4 million tonnes, or 41 per cent of the total world-wide production (*source:* Worldsteel Association, 2019). The other major producer of iron ore is Brazil.

The majority of mined iron ore is used for steel making. Iron ore minerals are found as hematite and magnetite. China is the world's largest producer of steel producing 928.3 million tonnes in 2018, or 51 per cent of total world production (Worldsteel Association, 2019). Australia has huge reserves of iron ore located mainly in the Pilbara region of Western Australia. Australia and Brazil export huge volumes of iron ore to China for steel making.

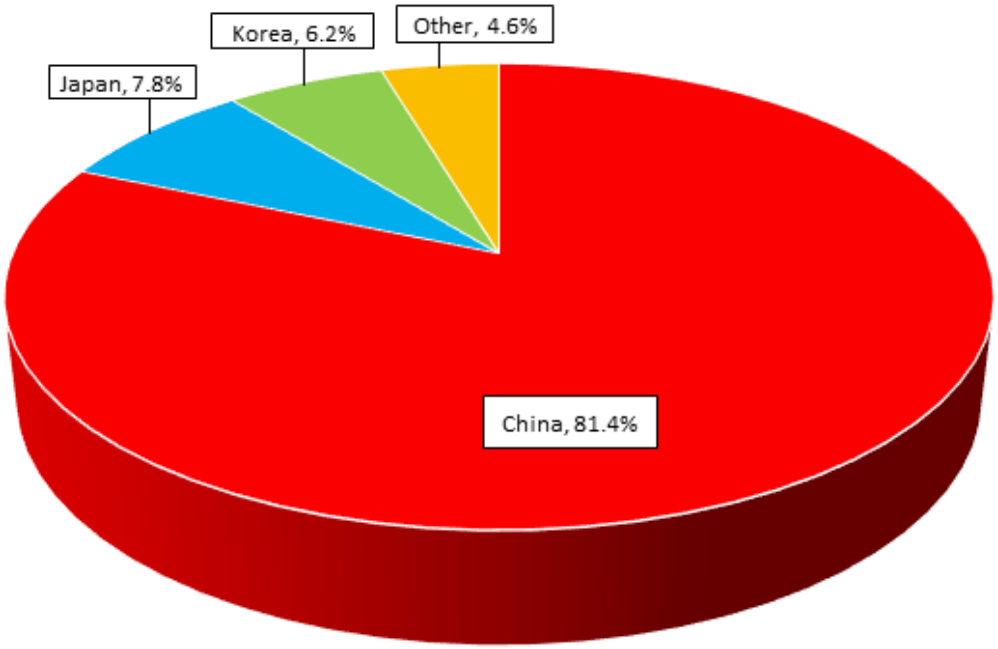
Australia's main iron ore producers are BHP, Rio Tinto and Fortescue Metals, all located in Western Australia. There has been a very rapid expansion in iron ore production over the last 10 years. Total Australian production rose from 390 million tonnes in 2009 to 740 million tonnes by 2014, and 901 million tonnes by 2018. World imports of iron ore from Australia rose from 362.9 million tonnes in 2009 to 834.8 million tonnes in 2018. China represented over 87 per cent of the growth over this period.

The iron ore price reached record highs of over $150 per tonne over the 2010 to 2013 period. The world price of iron, however, fell sharply in 2014 and 2015, reaching around $50 per tonne by the end of 2015. Australian producers continued to expand capacity through this period, investing in more efficient operations to meet China's increasing demand for iron ore for steel making.

The world iron ore price rose from $70 to $75 per tonne over 2017 and 2018. The iron ore price rose sharply in 2019 following a tailings dam rupture in January affecting Vale's Brazilian production. The world iron ore price was above $100 per tonne in May 2019. Australian production of iron ore in 2019 was also impacted by Cyclone Veronica.

The total value of Australian iron ore exports was $63 billion in 2018. In terms of volumes, this was 835 million tonnes in 2018 compared to only 400 million tonnes in 2010. The main destination for Australian iron ore exports is China (81.3 per cent), followed by Japan (7.8 per cent) and Korea (6.2 per cent).

Figure 4: Percentage share of Australian iron ore exports by destination, 2018 (per cent)

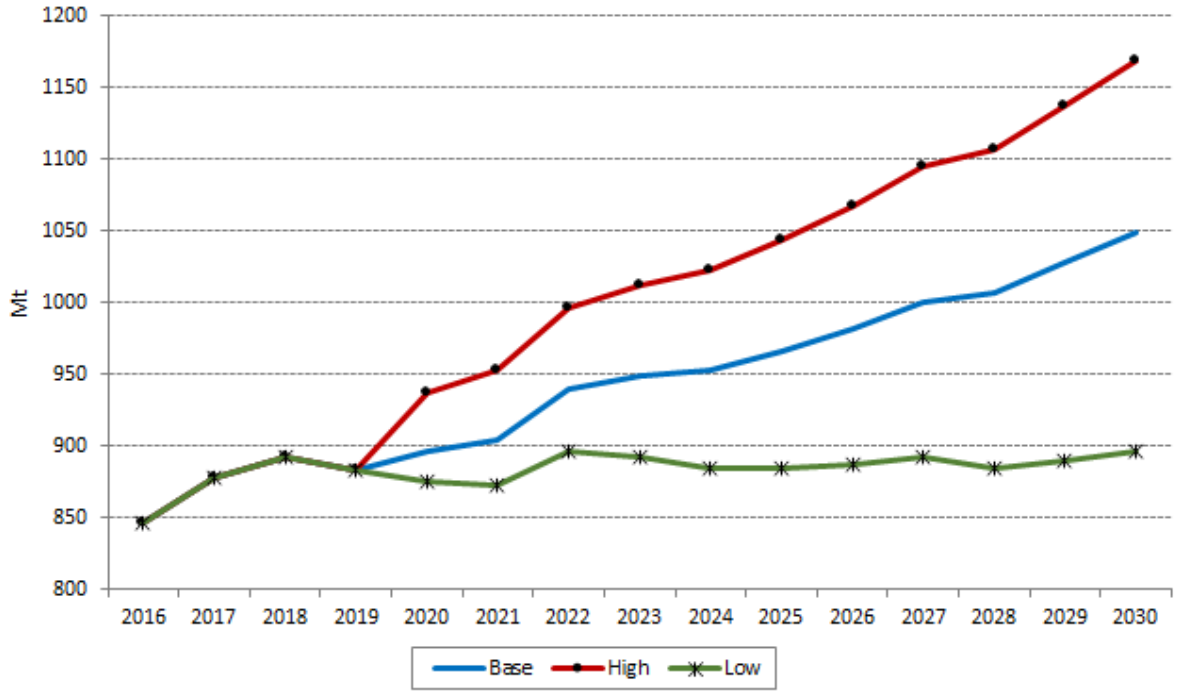


Australian iron ore production is expected to increase over the medium-term as BHP and Rio Tinto seek to meet their long-term production targets and Fortescue Mining seeks to expand its market share. It may be difficult for Brazil to capture back world trade market share in iron ore, as the Western Australian producers are some of the lowest cost producers in the world.

Australian producers are undertaking major expansion/development projects in iron ore production in the Pilbara in Western Australia. BHP is developing the South Flank deposit by 2021, which is intended to replace the Yandi mine as it depletes through to the mid-2020s. Rio Tinto is developing the Koodaideri mine with a capacity of 43 million tonnes per annum, which is due for completion in 2021. Fortescue Mining is developing the Iron Bridge Magnetite project with a capacity of 22 million tonnes per annum. This resource has premium 67 per cent Fe magnetite and is due for completion in 2022. Fortescue Mining is also developing the Eliwana Mine and Rail Project, a project with a capacity of 30 million tonnes and commissioning in late 2020.

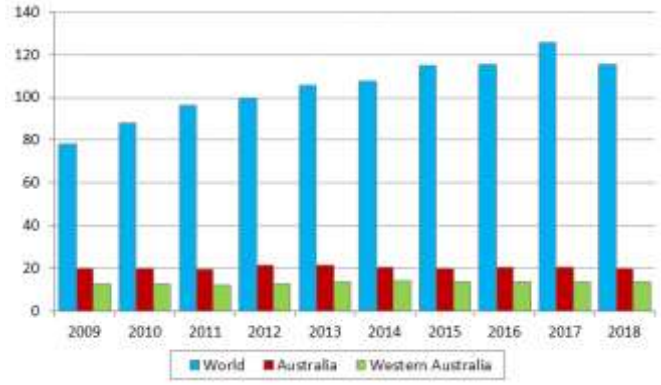
Figure 5 shows the forecasts for iron ore production for Western Australia to 2030 by scenario.

Figure 5: Western Australian iron ore production to 2030 by scenario (Mt)



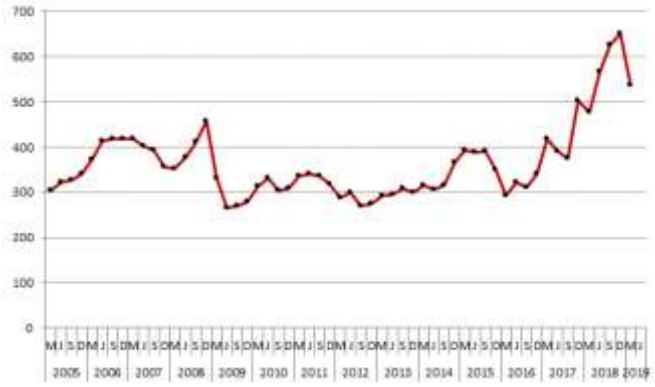
4. Alumina

Figure 6: Alumina production (Mt)



Source: Office of the Chief Economist and DMRIS.

Figure 7: Alumina export value (A$)

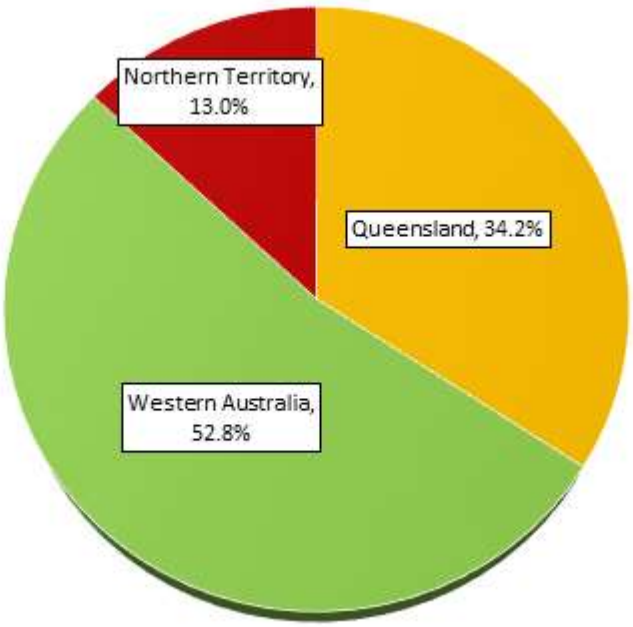


Source: DMRIS (WA).

Alumina is refined from bauxite which is mined within Western Australia. Alumina is then sent to be refined into aluminium. Both the production of alumina and aluminium are energy intensive. Aluminium is a lightweight metal that is used extensively for transport applications, where weight is an important criterion for design (e.g. aeroplanes). Aluminium is also commonly used for packaging and in construction. Aluminium is not smeltered in Western Australia.

Western Australia produced approximately 13.8 Mt per annum of alumina since 2015. This level of production was quite stable ever since Worsley expanded in 2013. Western Australia produces about 68 per cent of total Australian alumina production, and around 12 per cent of total world production. In Australia, alumina is produced at QAL in Gladstone and Yarwun in Queensland. Figure 8 shows shares of bauxite production by state for 2018 in Australia.

Figure 8: Shares of Australian bauxite production by state – 2018 (per cent)



Western Australian Alumina is produced exclusively around Kwinana in the south-west of Western Australia. Alumina is produced from four refineries that run almost continuously across the entire year and therefore close to capacity. In the absence of any expansions or supply disruptions, Alumina production remains stable between years. These refineries are:

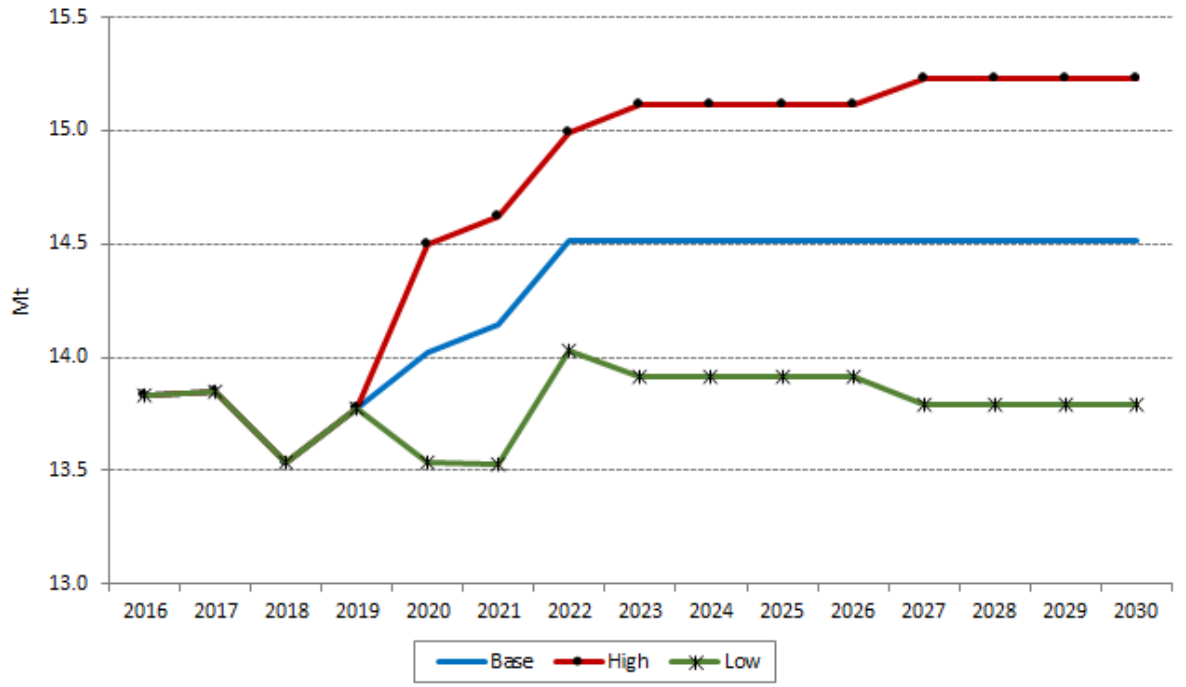
- Kwinana (Alcoa);
- Pinjarra (Alcoa);
- Wagerup (Alcoa); and
- Worsley (South32).

The export value of Alumina for the past ten years has remained at around A$300 per tonne with a few notable exceptions when the value has increased beyond this long-term level. This includes most of 2017 and in particular the second half of 2017 and early 2018 where the export value of Alumina has been at historically high levels. In 2017 the average export value reached A$421 per tonne, with prices spiking in the December quarter of A$502 per tonne. Prices rose further over 2018, peaking at A$650 per tonne in December 2018. Average alumina prices (export unit value) eased to around $540 in March 2019 and they may ease further in 2019 and 2020.

In May 2019, Alcoa has applied to increase refinery capacity to 5.0 million tonnes per annum at Pinjarra. This expansion was previously mooted in 2015. The existing nameplate capacity at Pinjarra is 4.2 Mt per annum, but it produced 4.5 Mt per annum in 2018. If this expansion proceeds, it would be commissioned by December quarter 2021. The Pinjarra expansion is included in the Base and High scenarios, but excluded from the Low scenario.

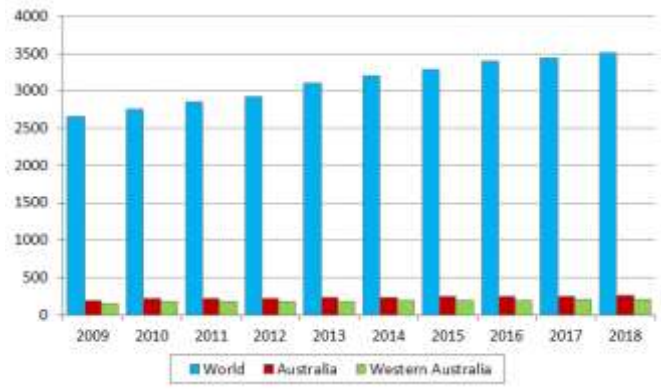
Figure 9 shows the forecasts for alumina production for Western Australia to 2030 by scenario.

Figure 9: Western Australian alumina production to 2030 by scenario (Mt)



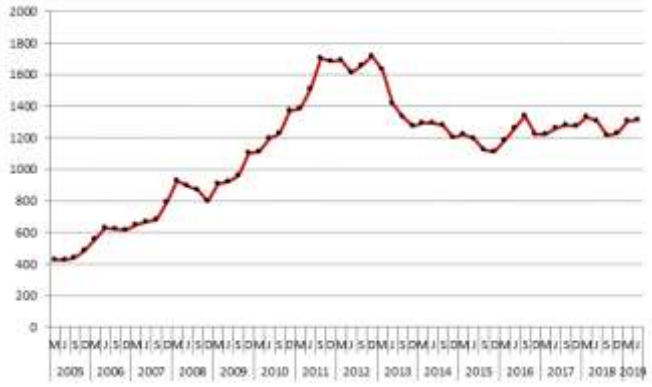
5. Gold

Figure 10: Gold production (t)



Source: Office of the Chief Economist.

Figure 11: Gold nominal price (US$/troy oz)



Source: World Bank, August 2019.

World gold production was around 3,500 metric tonnes in 2018. Total world production has been increasing steadily over the last 10 years. In 2009 world gold production was only 2,650 Mt. China is currently the world's largest producer of gold at around 400 metric tonnes, with Australia second, producing around 300 metric tonnes. Australia has 18 per cent of the world's Economic Demonstrated Resources of gold.

The world gold price rose very sharply between 2005 and 2012, reaching nearly US$1,720 per ounce in December 2012. Prices then retreated post 2012 to 2015, the price reaching a low of US$1,110 per ounce in December 2015. Since 2016, gold prices have remained high at between US$1,200 to US$1,350 per ounce. Trade tensions between the United States and China are likely to continue for the medium term, supporting a high gold price.

Gold has multiple end uses, including jewellery, electronics, gold coins and other dental and medical applications. Gold is also a major investment good, as gold bars, and is utilised for currency support by Central Banks across the world.

Gold mined in Australia is refined at the Perth Mint Refinery in Western Australia. The Perth Mint Refinery has a capacity of around 300 tonnes per annum. Most of the refinery output is exported.

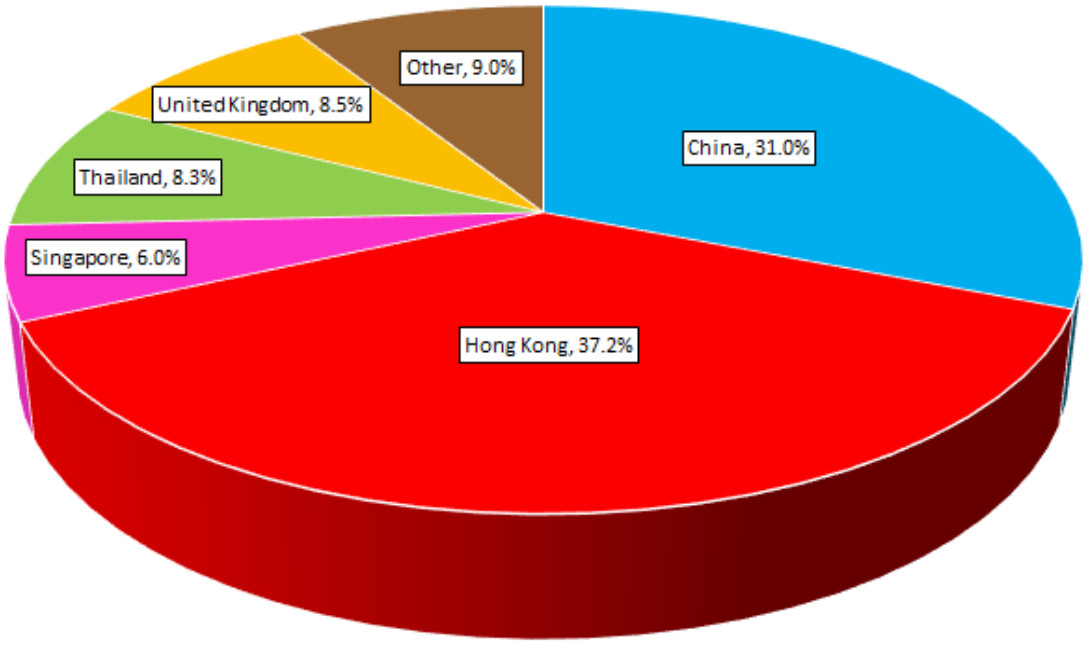
Australian gold production was 307 metric tonnes in 2018, an increase over production levels over 2017 as well as over average production levels of 250 to 270 tonnes over the 2010 to 2016 period. Western Australia produced 211 tonnes of gold in 2018, representing nearly 70 per cent of total Australian production. There are, however, significant gold deposits across other states of Australia, the largest being in New South Wales.

Gold production in Western Australia is centred around the Kalgoorlie region, however, there are major mines in the Pilbara and South of Perth. The largest gold mines in Western Australia include Boddington, operated by Newcrest Mining, the Super Pit at Kalgoorlie and the Tropicana Gold Mine, a joint venture by Anglo Gold Ashanti and Independence Group. Outside of Western Australia, the Cadia gold mine near Orange in New South Wales is the second largest mine in Australia. Like the Super Pit mine at Kalgoorlie, the Cadia mine is an open cut mine.

Australian gold production increased significantly over 2018-19, reflecting increased output for several mines in New South Wales and Western Australia. There was increased production at Cadia and Telfer, as well as the Tanami operation in the Northern Territory.

Australian gold exports in 2018 were around $18.9 billion. In 2018, 31 per cent of gold exports went to China and 37 per cent to Chinese Hong Kong. Other significant export destinations for Australian gold were Singapore (6 per cent), Thailand (8.3 per cent) and the United Kingdom (8.5 per cent).

Figure 12: Percentage share of Australian gold exports by destination, 2018 (per cent)



In Western Australia, a number of new and mine expansions have recently been completed. These include the following:

- Mt Morgans near Laverton operated by Dacian Gold Limited;
- Telfer West Dome Stage 2 expansion in the Pilbara; and
- Dalgaranga project operated by Gascoyne Resources near Mt Magnett.

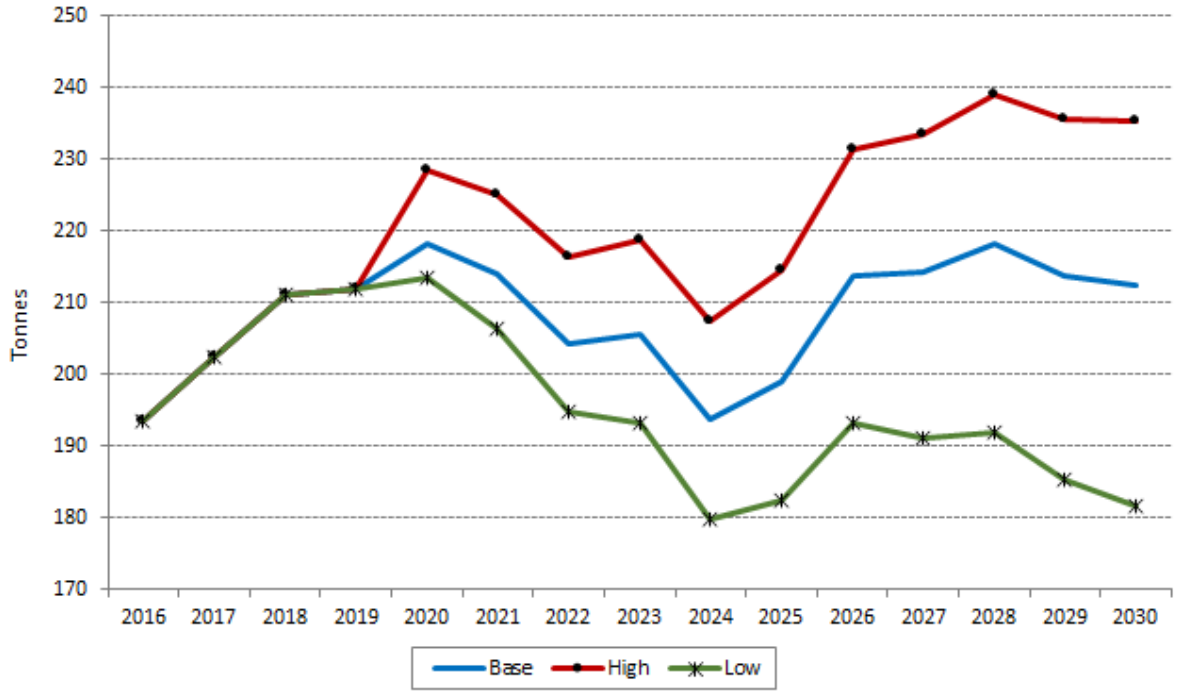
In addition, gold's near-term growth will be driven by new mines coming on line over the forecast period. These include the following:

- Gruyere Project operated by Gold Road with an annual capacity of 7.7 Mt;
- Capricorn Metals Karlawinda mine south of Newman with an annual capacity of around 3 Mt; and
- Barrick and Newmont's Super Pit Golden Pike Cutback expansion project due in 2021 with an annual capacity of around 74 Mt.

The high gold price, particularly in Australian dollar terms at around A$1,850 per ounce, implies there are a large number of prospective gold projects, both in Western Australia and other states of Australia. These include the Glenburgh gold mine operated by Gascoyne Resources in Western Australia and the possible expansion at the Cadia mine in New South Wales and at the Mt Todd mine in the Northern Territory.

Figure 13 shows the forecasts for gold production for Western Australia to 2030 by scenario.

Figure 13: Western Australian gold production to 2030 by scenario (tonnes)

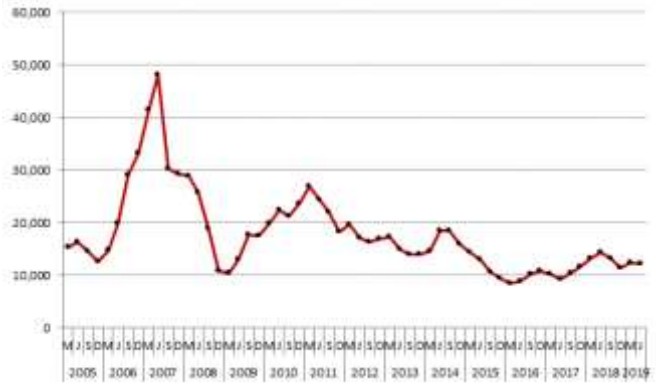


6. Nickel

Figure 14: Nickel production (kt)

Source: Office of the Chief Economist.

Figure 15: Nickel nominal price (US$/tonne)



Source: World Bank, August 2019.

World nickel mine production was around 2.4 million tonnes in 2018. World production increased quite sharply from 2010 to 2015, from 1.4 million tonnes in 2010 to 2.0 million tonnes in 2015 (refined nickel). Australian nickel production also rose over this period, reaching 266,000 tonnes in 2014. Production in Australia fell to 148,000 tonnes in 2018.

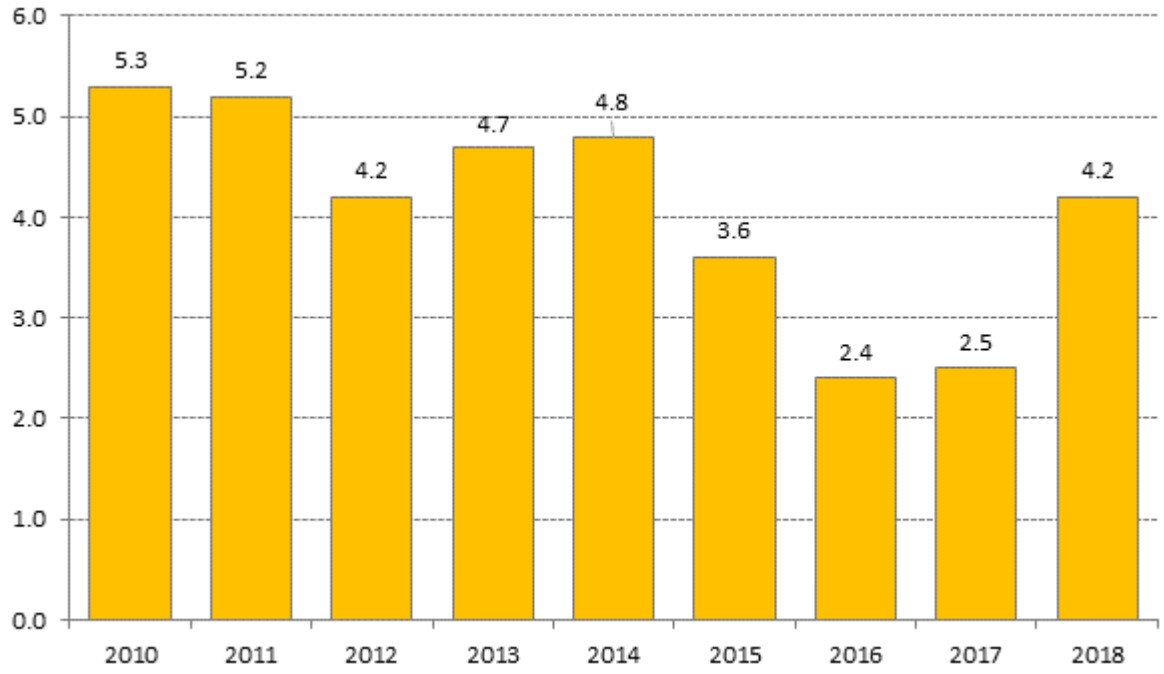
In 2018, Australia produced 7 per cent of the world-wide nickel production. All of this was produced in Western Australia.

The stainless steel industry is the largest user of primary and scrap nickel, although the battery industry is now accounting for a growing share of usage.

The largest producer of nickel in Western Australia is Nickel West, a division of BHP. BHP's operations in Western Australia includes mines at Mount Keith and Leinster, the Kambalda Nickel Concentrator, the Kalgoorlie nickel smelter and the Kwinana nickel refinery. Smaller producers of nickel in Western Australia include Mincor, Panoramic Resources, Independence Group, Western Areas NL and Minara/Glencore at Murrin.

The total value of Australian nickel exports in 2018 were A$4.2 billion. The majority of exports are refined and intermediate nickel, representing A$3.9 billion of the A$4.2 billion in Australian dollar export value. These exports are all sourced from Western Australia.

Figure 16: Australian nickel exports (A$ billion)



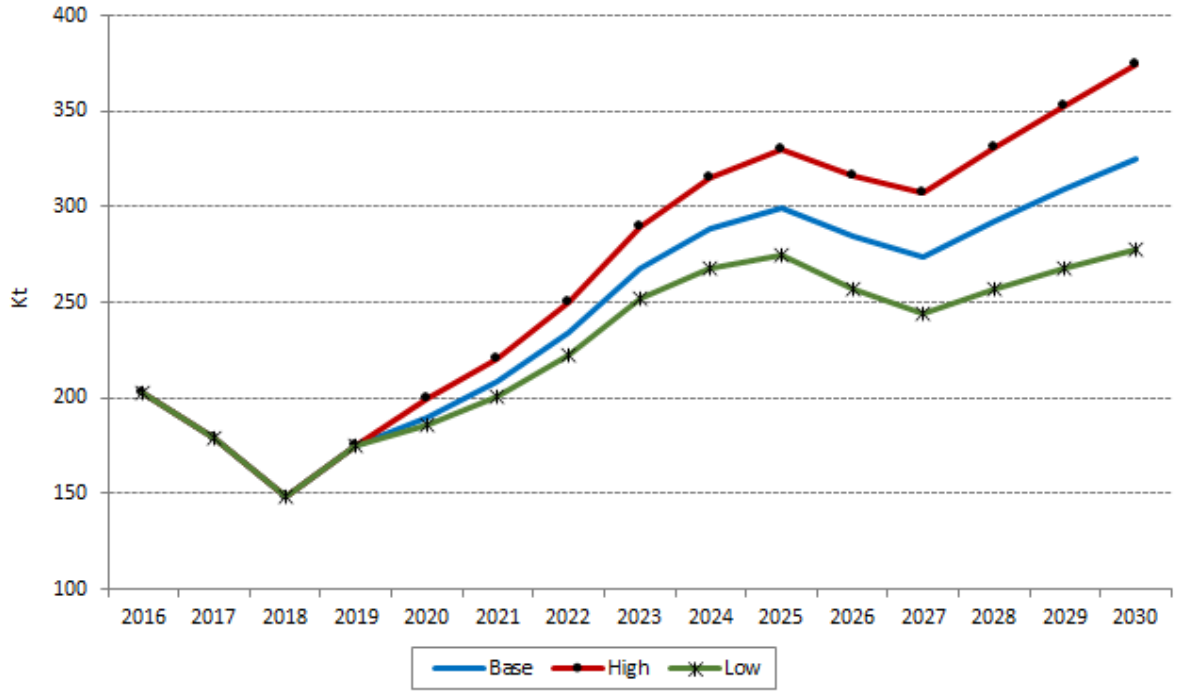
Source: Office of Chief Economist.

Many electric vehicle manufacturers use Nickel based cathodes in their batteries. An increasing share of Nickel West sales are for the battery market. BHP is developing a nickel sulphate plant at Kwinana with a capacity of 100 kt per annum, one of the largest nickel sulphate plants in the world. Nickel sulphate is used in the manufacture of lithium-ion batteries.

Australian nickel production is expected to recover over the 2019 to 2021 period with the commissioning/recommissioning of new mines, depending upon the nickel price. Panoramic Resources' Savannah mine restarted in 2019 and Poseidon Nickel has a number of mines currently under care and maintenance which could restart in 2020. Nickel West is also developing the Yakabindie deposit and the Venus deposit at Leinster. Section 4.11 on cobalt briefly outlines some new/current prospective nickel-cobalt mines.

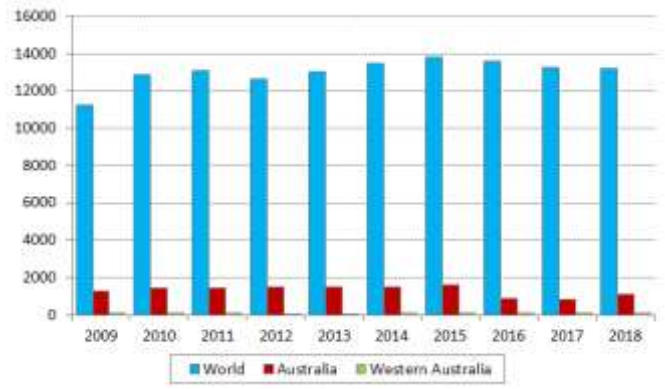
Figure 17 shows the forecasts for nickel production for Western Australia to 2030 by scenario.

Figure 17: Western Australian nickel production to 2030 by scenario (kt)



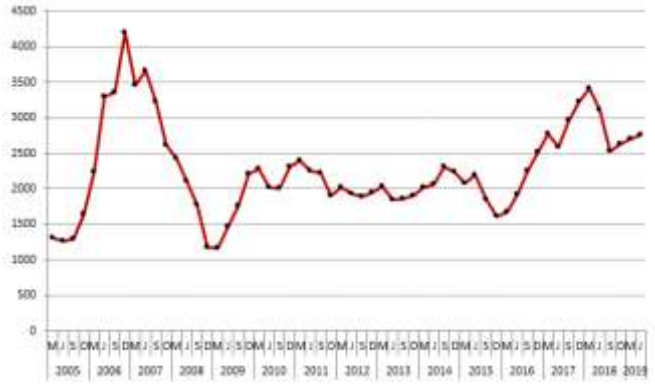
7. Zinc

Figure 18: Zinc production (kt)



Source: Office of the Chief Economist.

Figure 19: Zinc nominal price (US$/tonne)



Source: World Bank, August 2019.

Global production of zinc in 2018 was around 13.4 million tonnes, up 1.5 per cent from 13.2 million tonnes in 2017. The global zinc market has been in deficit over recent years, reflecting production cuts and some mine closures. Reflecting this deficit, global production is expected to increase over the next three years.

Global demand for zinc has recently been met by output from MMG's Dugald River project, the recommissioning of the New Century mine and the Hellyer River tailings project in Queensland. Australia is about the world's fourth largest producer of zinc behind China, India and Peru. China is the world's largest producer of zinc, accounting for nearly 40 per cent of total world production.

Global zinc prices rose strongly in 2016 from around US$1,650 per tonne to over US$3,400 per tonne in March 2018. Zinc prices have since fallen back and were around US$2,750 per tonne in June 2019. As production increases over 2019-20 and 2020-21, world zinc prices are expected to ease back further by 2021.

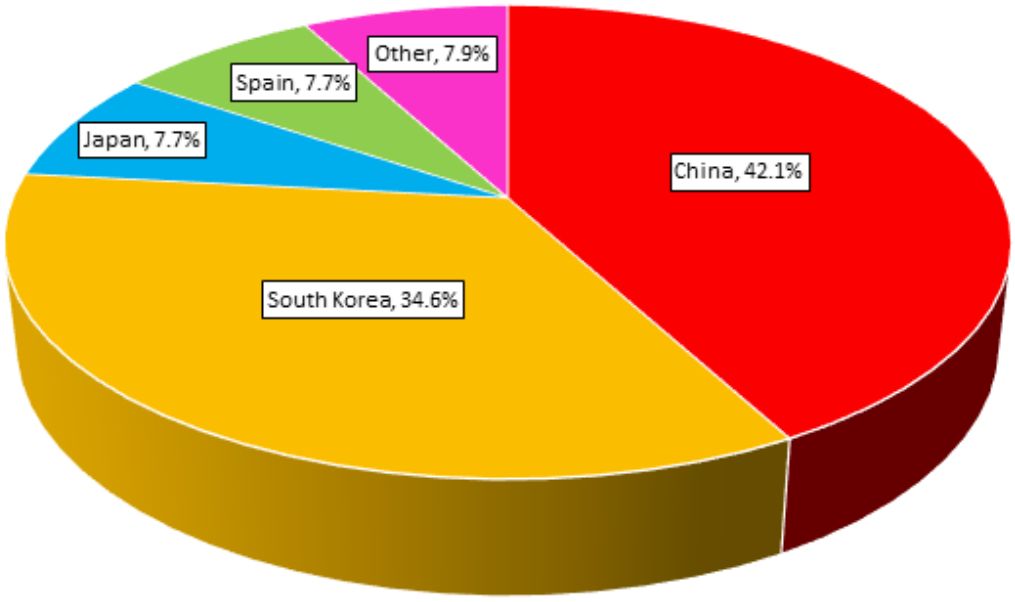
The main uses of zinc are in galvanised steel, diecasting and making brass and bronze alloys. Zinc oxide is used in many products, such as paints, cosmetics, pharmaceuticals, plastics, soaps, batteries and electrical equipment.

Australian zinc production in 2018 was 1.1 million tonnes, around 8.5 per cent of total world production. Australian production of zinc has ramped up over 2018-19 and could reach 1.3 to 1.4 million tonnes in 2018-19. Australia's main zinc mines are located in Queensland. These include large mines at George Fisher, Cannington and Century near Mt Isa in Queensland. There are also Glencore's Lady Loretta mine and MMG's Dugald River mine. In the Northern Territory there is the large McArthur River deposit and mine.

Western Australia produces around 8 per cent of Australian zinc production, with mines at Scuddles and Gossan Hill. Zinc ore is also produced at Elura in New South Wales and Rosebery in Tasmania.

Australian exports of zinc totalled A$4.2 billion in 2018. Of this total export value, A$2.5 billion were zinc concentrates and A$1.7 billion refined zinc. Major markets for zinc concentrate were China (42.1 per cent), South Korea (34.6 per cent) and Japan and Spain (7.7 per cent each). Australian refined zinc export markets include China (40.3 per cent), Chinese Taipei (14 per cent), Chinese Hong Kong (6.5 per cent) and Indonesia (7.6 per cent).

Figure 20: Percentage share of Australian zinc concentrate exports by destination, 2018 (per cent)



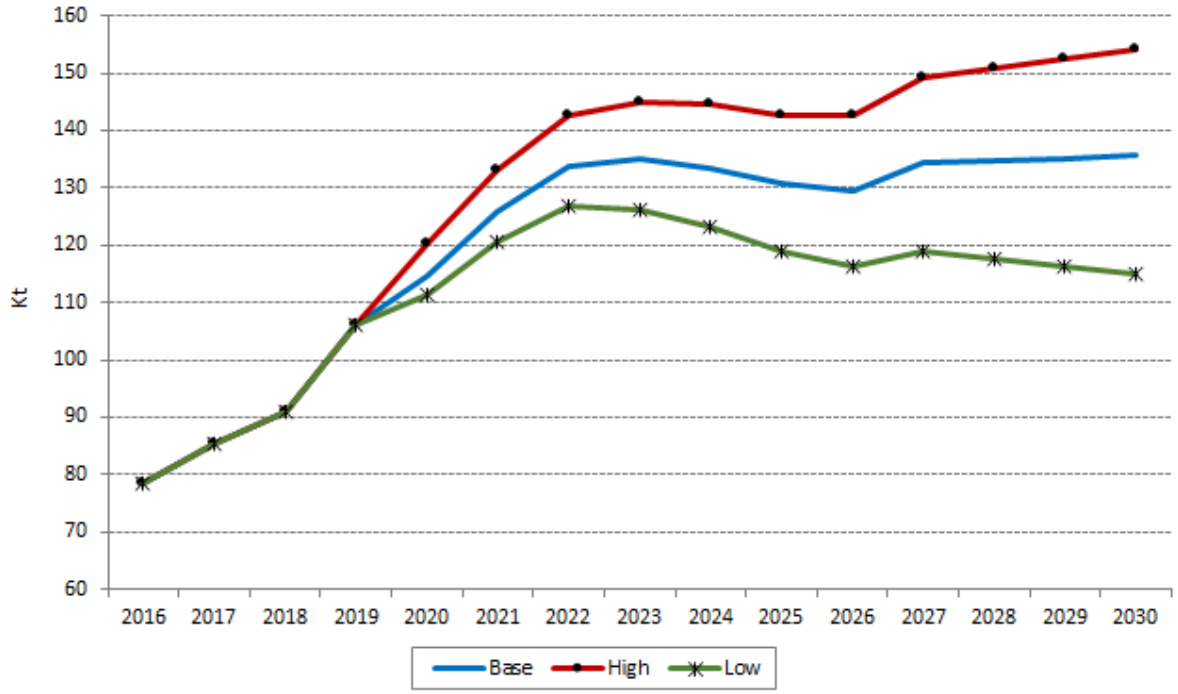
Source: Office of Chief Economist.

The ramp up in zinc production in Australia has been concentrated in Queensland. MMG's Dugald mine commenced production in December 2017 and has ramped up production to around 40,000 tonnes per quarter. MMG's Rosebery mine also produces around 80,000 tonnes per annum. Total zinc production in 2019 by MMG could be between 220,000 to 240,000 tonnes of zinc. The New Century mine (NCZ) continues to ramp up production and produced 20,450 tonnes in June 2019. Guidance for 2019-20 should be around 100,000 to 120,000 tonnes, compared to actual production of around 54,000 tonnes in 2018-19 and no production in 2017-18.

The Golden Grove mine in Western Australia consists of the underground mines of Scuddles and Gossan Hill. MMG sold the mine in 2017 to EMR Capital. The mine produces both zinc and copper. It produced around 24,000 tonnes of zinc concentrate in 2013.

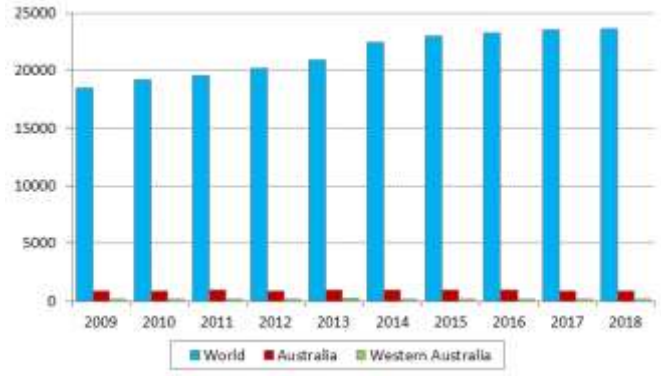
Figure 21 shows the forecasts for zinc production for Western Australia to 2030 by scenario.

Figure 21: Western Australian zinc production to 2030 by scenario (kt)



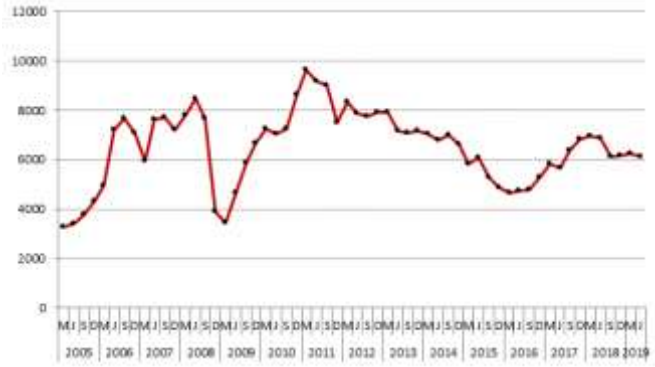
8. Copper

Figure 22: Copper production (kt)



Source: Office of the Chief Economist.

Figure 23: Copper nominal price (US$/tonne)



Source: World Bank, August 2019.

World production of copper in 2018 was 23.6 million tonnes. The largest producers of copper are Chile, Peru and China. Australia ranks at about the fifth largest producer. World production has been at around 23 million tonnes since 2015. Production world-wide was only 18.5 million tonnes in 2009.

World copper prices reached nearly US$7,000 per tonne in March 2018, however, it has since eased over late 2018 and 2019. The US$/tonne price was around US$6,100 in June 2019. These prices are still comparatively high compared to prices as low as US$4,700 per tonne in 2015-16.

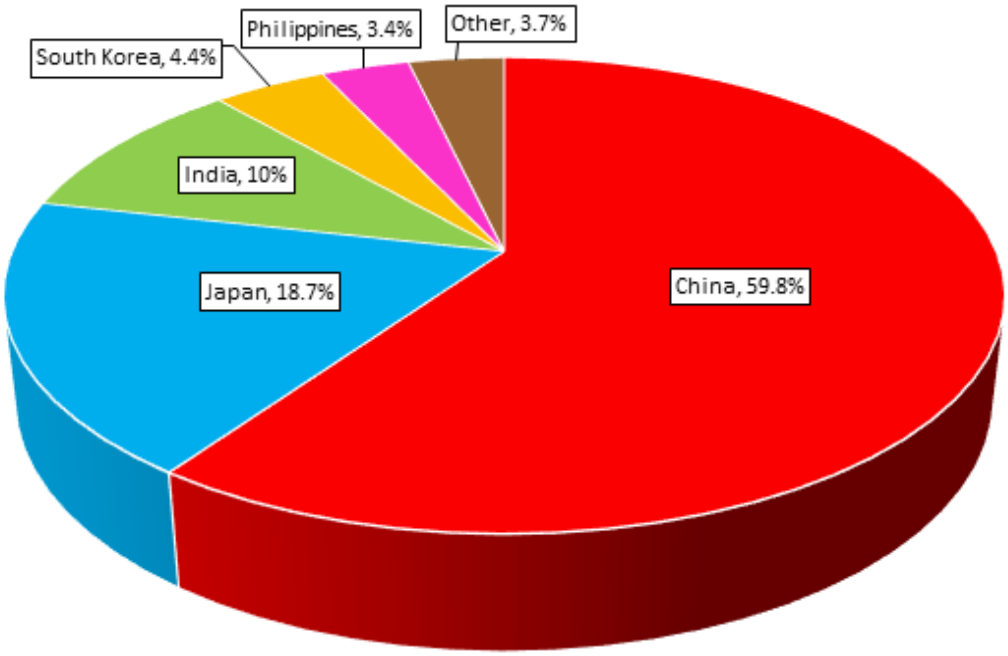
Copper is a good conductor and hence is used in electrical equipment and motors. It is also used extensively in the construction industry and the telecommunications sector of the economies of the world. In construction, copper is used in cabling and pipes. Copper is also used in jewellery and coins. The emergence of the electric vehicle industry could further stimulate the demand for copper world-wide. China consumes around half of total world production each year.

It is important to note that, like other metals, copper is recycled. Copper recycling is an important component of the industry. Recycling rates are not known but are believed to be well below other metals such as lead.

Total Australian production of copper was 920 kt in 2018. Australian production of copper has been between 900 and 1,000 kt annually since 2010. Western Australian production of copper in 2018 was 184 kt, around 20 per cent of total Australian production.

Australian exports of copper were A$9.2 billion in 2018, represented by A$6 billion in copper ore and concentrates and A$3.2 billion in refined copper. Major destinations for Australian copper ore and concentrates are China (59.8 per cent), Japan (18.7 per cent) and India (10 per cent).

Figure 24: Percentage share of Australian copper ore and concentrate exports by destination, 2018 (per cent)



Australian exports of refined copper are more diverse and include multiple Asian destinations, as well as Europe. The main markets for Australian refined copper in 2018 were China (37.4 per cent), Chinese Taipei (17.3 per cent) and Malaysia (27.2 per cent).

South Australia accounted for 30 per cent of Australia's copper production in 2018, with BHP's Olympic Dam mine and OZ Minerals Prominent Hill mine. The Olympic Dam mine is a copper, silver and uranium mine. Queensland copper mines are predominantly in the Mt Isa region. Queensland mines include Ernest Henry, Lady Annie and Mount Gordon. New South Wales copper mines include North Parks, Cadia-Ridgeway, Cobar and Tritton.

Copper mines in Western Australia include Nifty, DeGrussa, Boddington, Telfer and Golden Grove. The Sandfire Resources' DeGrussa gold-copper mine is one of the largest mines in Western Australia, producing some 60 kt in 2018-19. Sandfire Resources also operates the Monty gold-copper mine in Western Australia. Newcrest Mining operates the Telfer mine in the Pilbara and produced 15 kt of copper in 2018-19. Newcrest's production at Cadia in New South Wales was 91 kt in 2018-19. The Cadia mine increased copper production by nearly 30 kt in 2018-19.

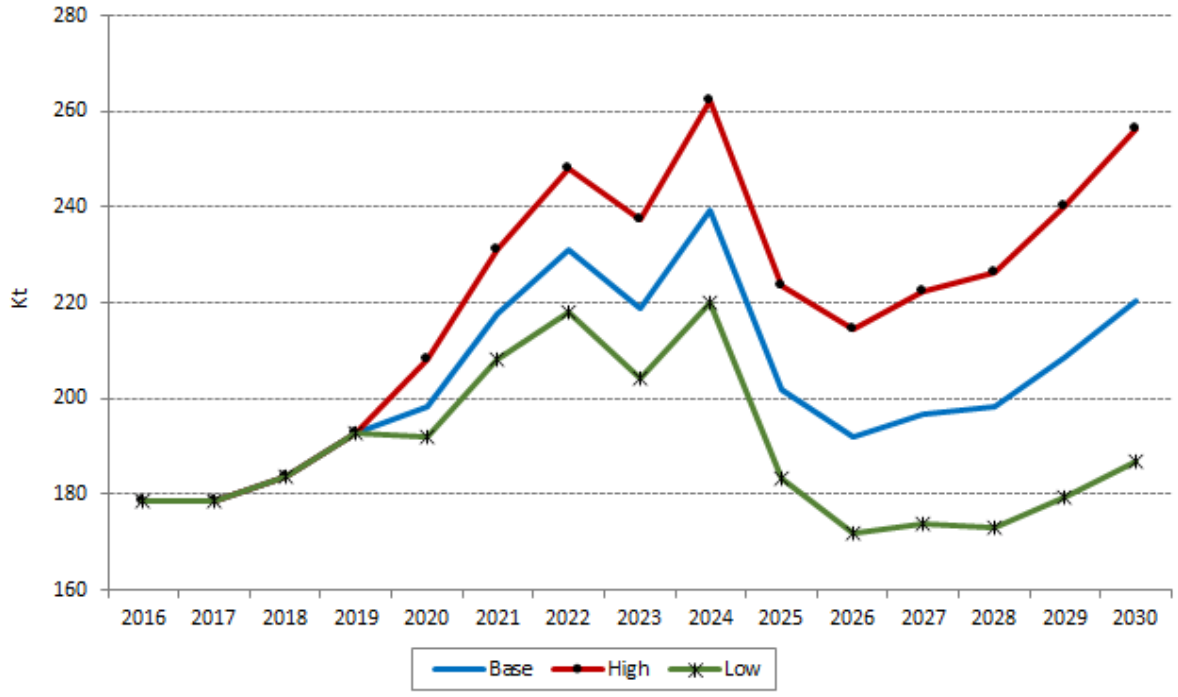
The Metals X Nifty copper mine is located in the east Pilbara region of Western Australia. Production at Nifty in 2018-19 was 18.9 kt of copper. The mine at Boddington operated by Newmont Mining is mainly a gold mine but produced 35 kt of copper in 2018-19.

The short-term expansion in copper production in Australia will mainly be met by mines in South Australia. This includes a major staged expansion at Olympic Dam, operated by BHP, of some 215 kt. The Carrapateena mine in South Australia operated by OZ Minerals is expected to produce 65 kt of copper annually. The Cloncurry copper project, a copper-gold resource in Queensland, is due to come on-line in 2021, producing 39 kt per annum.

In Western Australia, Caravel Resources is looking to develop a greenfield copper mining project known as Calingiri, north-east of Peth. Annual production is expected to be 35.5 kt of copper per annum, with production commencing in 2023. There are also prospects at Sultan's Thaduna project in Western Australia, located on a tenement near the DeGrussa mine.

Figure 25 shows the forecasts for copper production for Western Australia to 2030 by scenario.

Figure 25: Western Australian copper production to 2030 by scenario (kt)

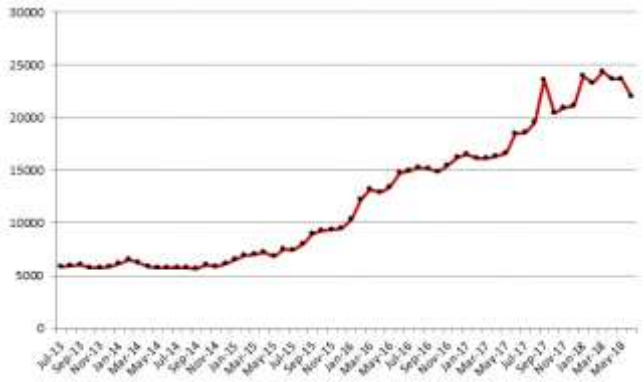


9. Lithium

Figure 26: Lithium Western Australian production (kt)

Note: Spodumene Concentrate Production WA.
Source: DMRIS (Western Australia).

Figure 27: Lithium carbonate nominal price (A$/tonne)



Source: DMRIS (WA).

Lithium is a prominent component in the manufacture of battery technology. The market for batteries is forecast to strengthen over the next ten years as the demand for electric vehicles, home and business battery storage, and other portable consumer products continues to grow. In 2017 around 1.1 million plug-in electric vehicles were sold worldwide, increasing the global stock of plug-in electric vehicles from around 2 million to 3 million vehicles. While Australia only accounts for a very small proportion of global sales, markets in China, Europe and US continue to grow exponentially. Around 580,000 plug-in electric vehicles were sold within China alone in 2017[1].

Australia stands to benefit from large deposits of lithium and Australia's close proximity to China, a world leader in battery manufacturing. Western Australia in particular contains large deposits of spodumene, a lithium rich rock that can be further refined into spodumene concentrate, and further into lithium carbonate or lithium hydroxide. Most of the lithium product produced in Australia is contracted to Chinese companies, even expansions which have yet to be fully committed have signed contracts for most of the future capacity to Chinese firms. This demonstrates the demand for lithium is incredibly strong and will continue to strengthen over the next ten years as companies seek to secure supply.

Australia's first lithium mine was the Greenbushes mine in Western Australia, owned by Tianqi Lithium and Albemarle. It is the world's largest lithium mine. The mine contains the highest grade hard rock lithium in the world. The operators have announced a two-stage expansion at Greenbushes. An increase in annual production capacity from 650 to 1,350 tonnes per annum by June quarter 2019 and then to 1,950 tonnes per annum by December 2020. The increased production levels at Greenbushes will be processed by lithium hydroxide processing plants to be built at Kemerton and Kwinana.

The Kemerton lithium hydroxide plant being developed by Albemarle will have a capacity of 100,000 tonnes per year. The Kwinana plant, being developed by Tianqi Lithium, has a capacity of 24,000 tonnes per annum (commissioned early 2019) with stage-two expanding this to 48,000 tonnes per annum of lithium hydroxide.

[1] Global EV Outlook 2018: Towards cross-model electrification, International Energy Agency (2018).

A number of other lithium mines have been established in Australia over recent years. These include mines at Mt Marion, Wodgina, Mt Cattlin, Bald Hill and Pilgangoora, all in Western Australia. A mine has also been established in the Northern Territory, known as the Finniss project.

The world's largest known resource of hard rock lithium is located at the Wodgina mine, operated by Mineral Resources Australia. Development of the Wodgina mine is proceeding in three stages:

- export of direct shipping ore;
- construction of a spodumene concentrate plant; and
- construction of a lithium hydroxide processing plant.

MR Australia may sell 50 per cent of the Wodgina lithium project to Albemarle, subject to the relevant approvals process in 2019. Mt Marion lithium mine is currently producing around 700,000 wmt of mined ore per quarter.

Altura Mining (ATM) has been ramping up production at Pilgangoora in Western Australia. The mine produced 42,400 wmt of lithium concentrate by the June quarter 2019 and 105,000 wmt for 2018-19. Further increases are expected beyond 2018-19.

Galaxy Resources operates the Mt Cattlin mine in Western Australia. The mine produced 56,000 dmt of lithium concentrate in June 2019, with annual production guidance set at 180,000 to 210,000 dmt. Reserves were recently upgraded for Cattlin by Galaxy Resources.

A new lithium development, known as Mt Holland, is being developed by Covalent Lithium. The development consists of a mine and concentrator at Mt Holland and a refinery at Kwinana. The spodumene concentrate produced at the mine will be shipped to the refinery in Kwinana to produce around 45,000 tonnes per annum of battery-grade lithium hydroxide.

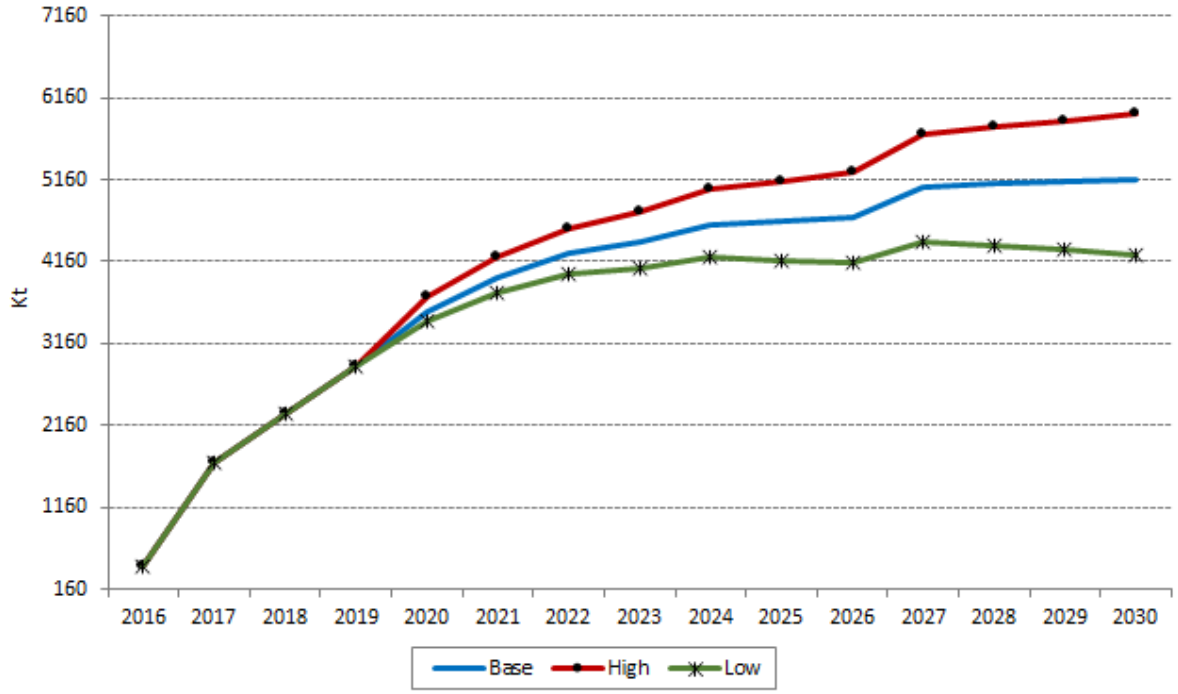
Another major project in Western Australia is Pilbara Minerals' Pilgangoora Lithium-Tantalum project. Reserve upgrades suggest this mine could produce 1,200 tonnes of spodumene concentrate for around 15 years.

In the medium to long term, other significant lithium deposits are likely to be developed to meet increasing demand for battery storage used in electric vehicles, home storage and portable devices such as smart phones and laptops. The demand for lithium is currently strong and will continue to strengthen in the near term. Lithium producers are continuing to investigate the expansion of current operations and the development of new deposits. While some have yet to receive a final investment decision, options for proposed capacity are already being met.

The new Western Australian operations and production expansions over the next three years will help bring total Western Australia production to over 4,500 kt per annum by 2022.

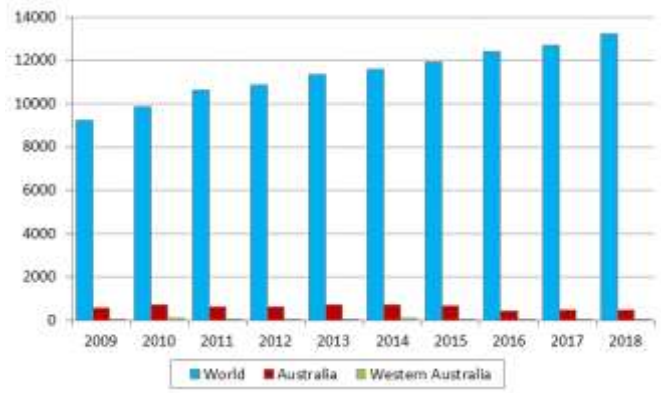
Figure 28 shows the forecasts for lithium production for Western Australia to 2030 by scenario.

Figure 28: Western Australian lithium production to 2030 by scenario (kt)



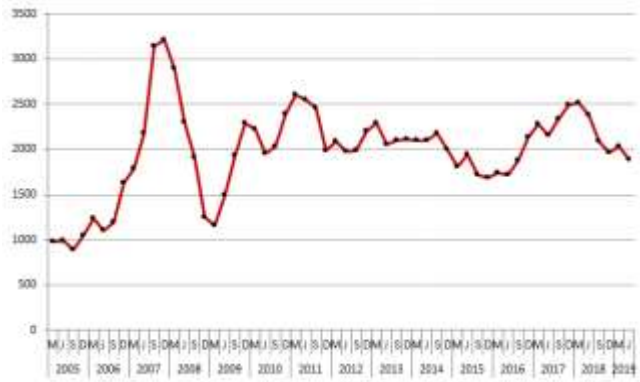
10. Lead

Figure 29: Lead production (kt)



Source: Office of Chief Economist.

Figure 30: Lead nominal price (US$/mt)



Source: World Bank, August 2019.

World lead production was 11.6 million tonnes in 2018. Lead is usually extracted from base metal mine in combination with zinc, silver and copper. The largest lead producing companies in the world are Glencore Xstrata, BHP, Teck and the Doe Run Company.

Major lead producing countries in the world are China, Australia, the United States and Mexico. Around 80 per cent of all lead is used in batteries and around 60 per cent in car batteries. Whilst lithium-ion batteries may eventually replace lead-acid batteries, global demand for lead remains relatively strong. Aside from batteries, lead has other industrial applications in weights, undersea cables, solders and radiation protection.

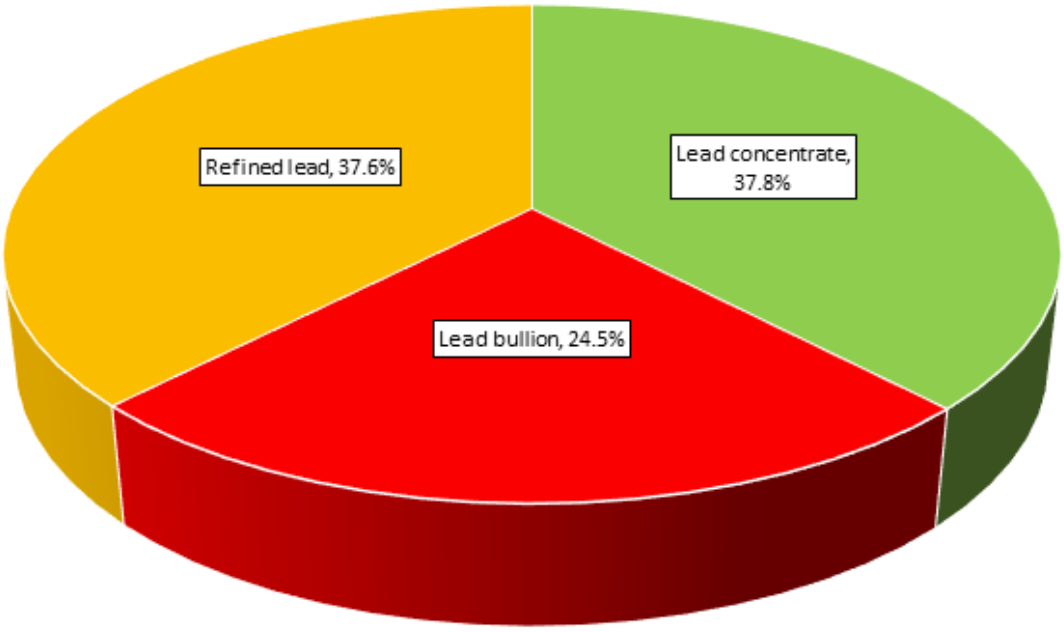
Global lead prices rose to over US$2,500/mt in late 2017, but has since retreated to slightly below US$2,000/mt.

As with other valuable basic metals, recycling is a dominant source of lead world-wide. This constrains the growth in mine production of lead. Lead recycling accounts for over 50 per cent of world production (i.e. secondary lead production). Lead can be recycled indefinitely.

Australian lead production was around 470 kt in 2018-19, well down on production levels of over 700 kt in 2013-14 and 2014-15. Australian lead production is concentrated in Queensland, accounting for 65 per cent of lead content produced in 2018-19. New South Wales, Tasmania and the Northern Territory accounted for another 33 per cent of lead production in 2018-19. Western Australia only accounted for 2 per cent of Australian production in 2018-19.

The total value of Australian lead exports in 2018 was $1.6 billion. These exports include lead concentrate, led bullion and refined lead.

Figure 31: Percentage share of Australian lead exports by type, 2018 (per cent)



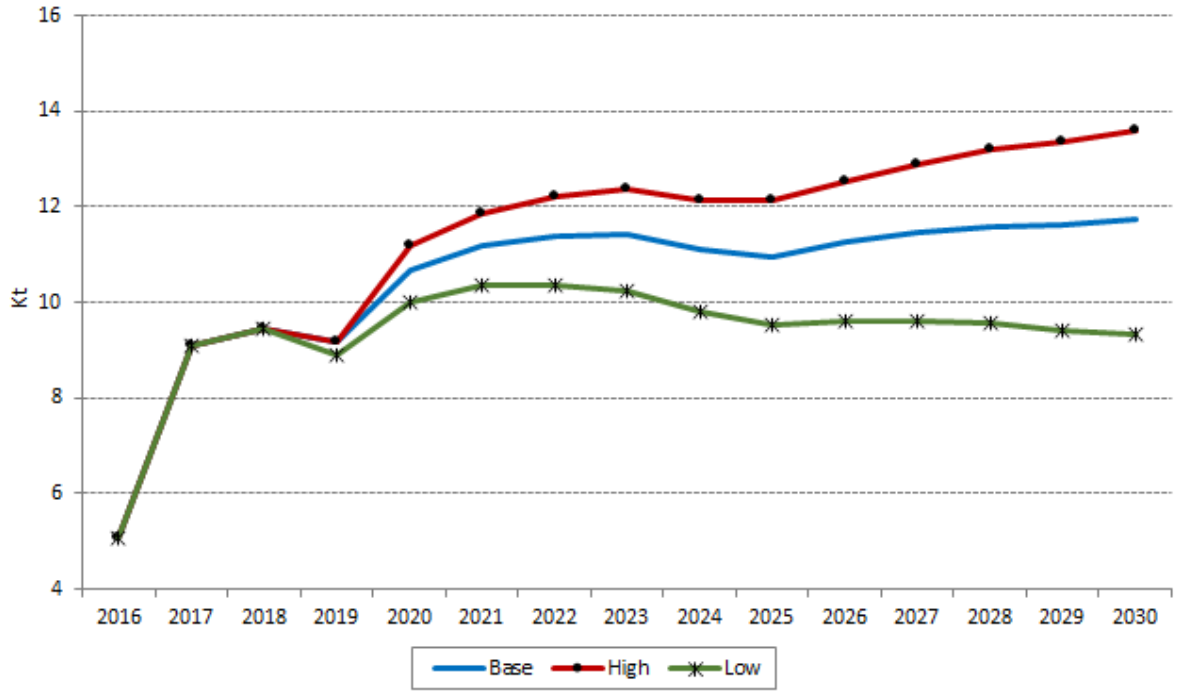
Source: Office of Chief Economist.

Australian exports of lead concentrate were 243 kt in 2018. The major markets were China (48.9 per cent), South Korea (27.8 per cent), Japan (17.8 per cent) and the European Union (5.5 per cent). Lead bullion exports by Australia were 109 kt in 2018, all being sent to the United Kingdom. Australian refined lead exports were 105 kt in 2018, with the major markets being India (41.2 per cent), Thailand (21.3 per cent) and Vietnam (24.9 per cent).

Australian lead production is expected to increase over 2019 and 2020 by around 10 per cent overall. Australia has significant reserves of lead located in New South Wales, Queensland and the Northern Territory. In 2016, the Economic Demonstrated Resources of lead in Australia were around 35 million tonnes, compared to Australian production of lead mine concentrate of 0.7 million tonnes in 2018-19.

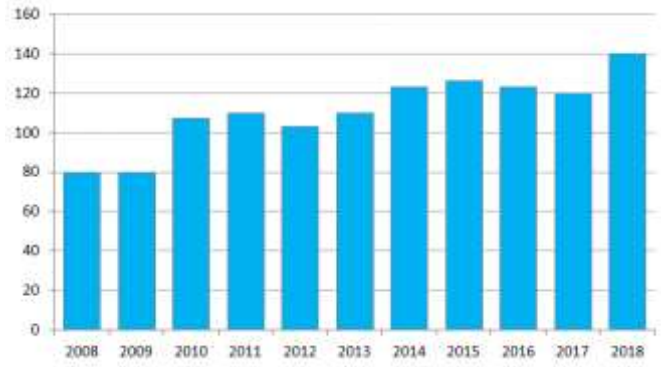
Figure 32 shows the forecasts for lead production for Western Australia to 2030 by scenario.

Figure 32: Western Australian lead production to 2030 by scenario (kt)



11. Cobalt

Figure 33: World cobalt production (metric tonnes '000)

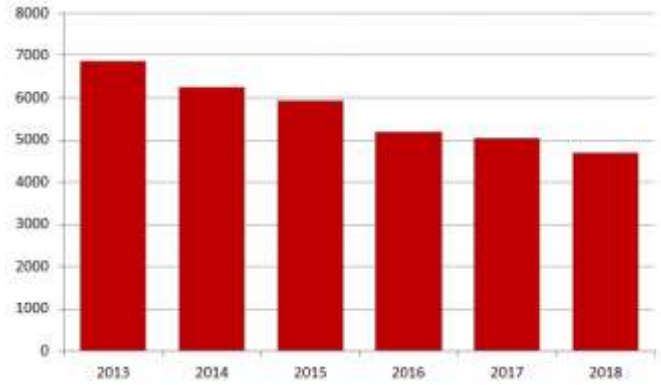


Source: Statista, 2019.

Figure 34: Cobalt nominal price (A$/tonne)

Source: DMIRS.

Figure 35: Australian cobalt production (metric tonnes)



Source: Statista, 2019.

World mine production of cobalt in 2018 was 140,000 metric tonnes. The Democratic Republic of Congo (DRC) is the world's largest producer of cobalt, accounting for around 60 per cent of global production. The DRC has large reserves of cobalt and is likely to remain the dominant world market's producer for the foreseeable future. This is despite the fact that cobalt mining in the DRC has been linked to human rights abuses, including child labour.

Australian cobalt production fell from 5,034 metric tonnes in 2017 to 4,700 metric tonnes in 2018. Australian production of cobalt is around 4 per cent of world production. In Australia, cobalt is produced as a by-product of copper and nickel mining. Australia's nickel mines are concentrated in Western Australia, around the Kalgoorlie and Leonora regions. Small amounts of cobalt have been produced in other states of Australia.

Cobalt prices rose rapidly between 2016 and late 2017 from around US$15 per pound in 2016 to over US$40 per pound by late 2017. Prices have since fallen sharply in response to the emergence of excess supply conditions.

The surge in interest in cobalt comes from the development of the lithium-ion battery, largely driven by the expected growth in the electric vehicle markets world-wide. Other uses for cobalt include as a colour additive (glass, porcelain), corrosion resistant applications and alloys (stainless steel, engines).

Panoramic Resources restarted its Savannah mine in Western Australia in late 2018 that produces nickel, copper and cobalt. At full production the mine would produce 800 tonnes of cobalt per annum.

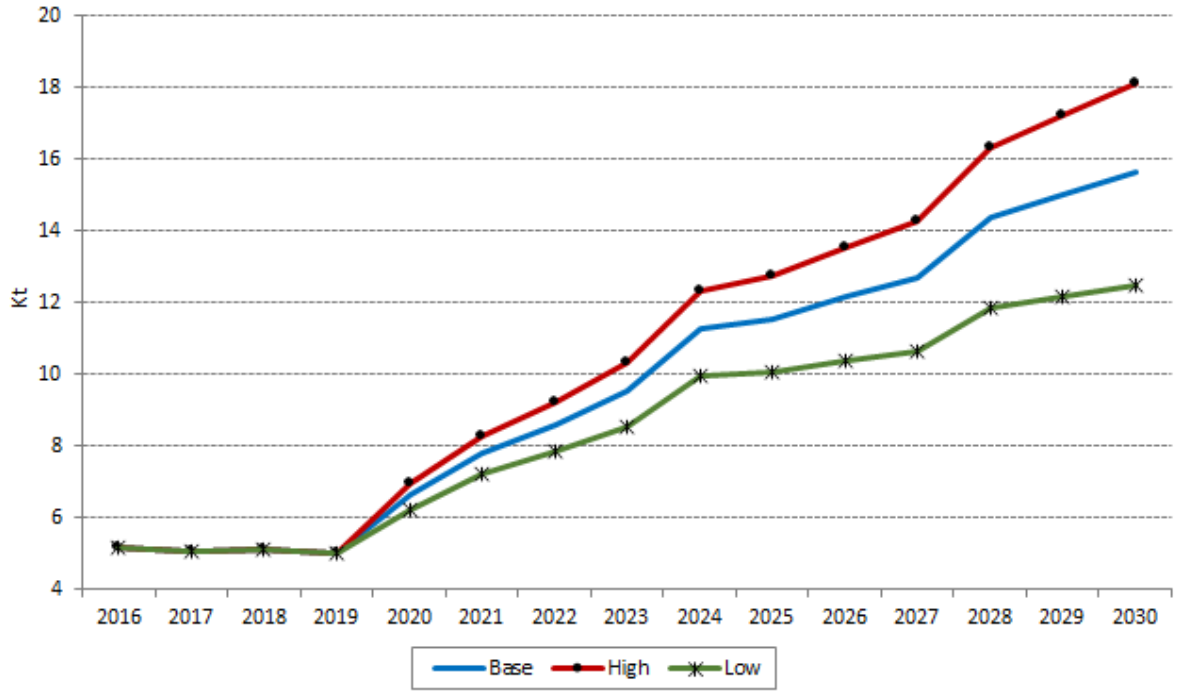
A large number of prospective projects producing cobalt have emerged since the surge in the price of cobalt following its huge potential in batteries. These projects are in New South Wales, Queensland, South Australia and Western Australia. Amongst these are:

- Australian Mines Limited (AUZ). Australian Mines has four major sites, two in Queensland and two in New South Wales. The Sconi Cobalt-Nickel-Scandium project in Queensland has estimated reserves of 1,405,000 tonnes of nickel sulphate and 209,000 tonnes of cobalt sulphate. Australian Mines also owns the Bell Creek Nickel-Cobalt project. In New South Wales Australian Mines has cobalt at its Flemington and Thackaringa projects.
- Aeon Metals (AML) has identified a significant copper-cobalt deposit at its flagship site at Walford Creek in Queensland. Drilling results in 2019 indicated potentially strong copper and cobalt recovery rates.
- Ardea Resources (ARL) is intending to develop the Goongarrie Nickel Cobalt project in Western Australia. This site is north of Kalgoorlie and could potentially also contain gold deposits.
- A-cap Energy (ACB) has a prospective nickel-cobalt deposit known as the Wiluna Cobalt-Nickel Project (Wilconi project) in Western Australia.
- Artemis Resources (ARV) has the Carlow Castle development, a gold, copper and cobalt deposit in Western Australia; and
- the Ausmex Mining Group (AMG) holds highly prospective gold, copper and cobalt prospects in the Cloncurry suite of tenement holdings in Queensland.

Western Australia is projected to remain the main producer of cobalt within Australia over the 2020s decade, however, production start-ups post 2020 are assumed to occur in New South Wales and Queensland.

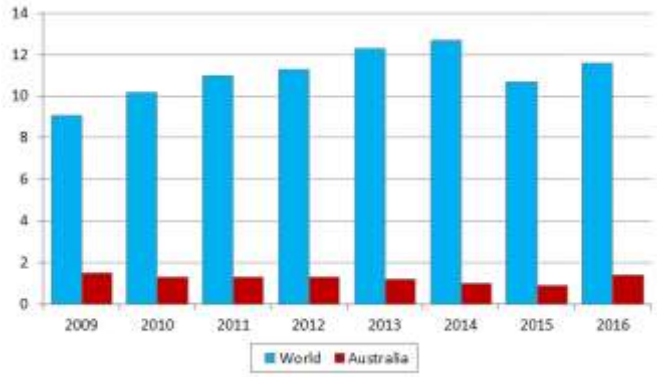
Figure 36 shows the forecasts for cobalt production for Western Australia to 2030 by scenario.

Figure 36: Western Australian cobalt production to 2030 by scenario (kt)



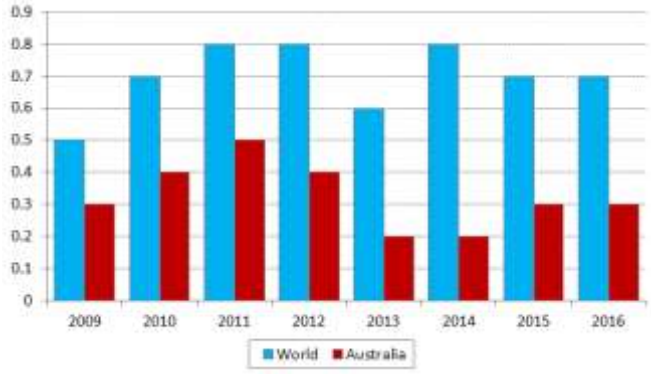
12. Mineral sands

Figure 37: Production of ilmenite, world and Australia (Mt)



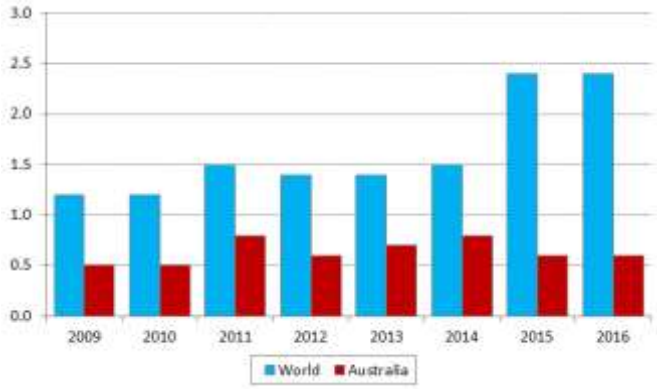
Source: Geoscience Australia.

Figure 38: Production of rutile, world and Australia (Mt)



Source: Geoscience Australia.

Figure 39: Production of zircon, world and Australia (Mt)



Source: Geoscience Australia.

Figure 40: Western Australian production of mineral sands (kt)

Source: DMRIS (WA) and NIEIR estimates.

Figure 41: Rutile price (A$/t)

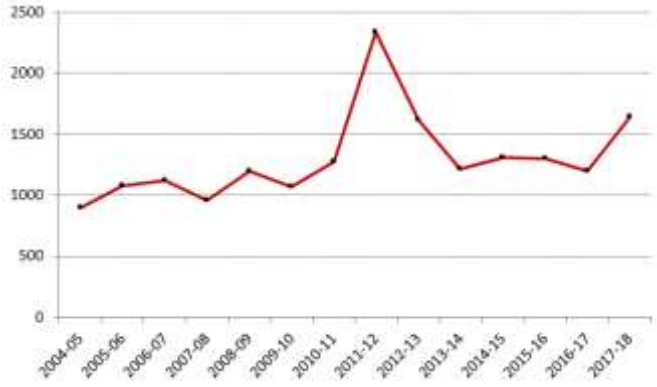
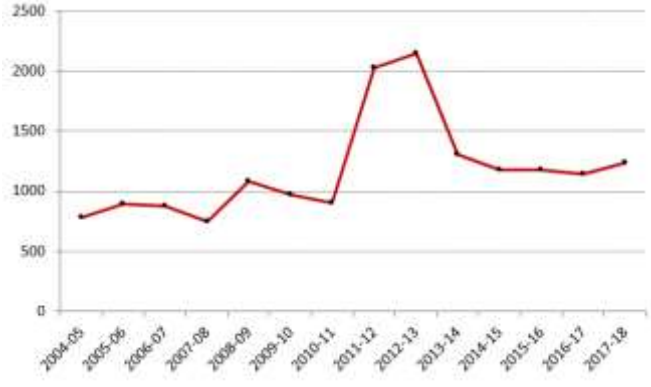


Figure 42: Zircon price (A$/t)



Mineral sands are heavy minerals usually found on old beach, river or dune sands. The most important heavy minerals are rutile, ilmenite, zircon and monazite. Other minerals that can also be mined from mineral sands sites are garnet, magnetite, sapphire, diamond and staurolite.

Reference to leucoxene refers to a fine granular alteration of titanium minerals. It consists mainly of rutile or anatase. Leucoxene is formed through the weathering of ilmenite.

The titanium-bearing minerals such as rutile and ilmenite are mainly used in the production of titanium dioxide pigment. They can also be blended to produce high-grade titanium metals, used by the aerospace industry. Zircon can be used as an opacifier for glazes on ceramic tiles and in the foundry industry.

Geoscience Australia reported large ore reserves of mineral sands at December 2016 amounting to 56.5 Mt, 6.7 Mt and 20 Mt of ilmenite, rutile and zircon, respectively, in Australia. Australia has much larger inferred resources of these three minerals.

Australia is ranked as a top mineral sands producer in the world. It is ranked first for rutile and zircon, and third for ilmenite.

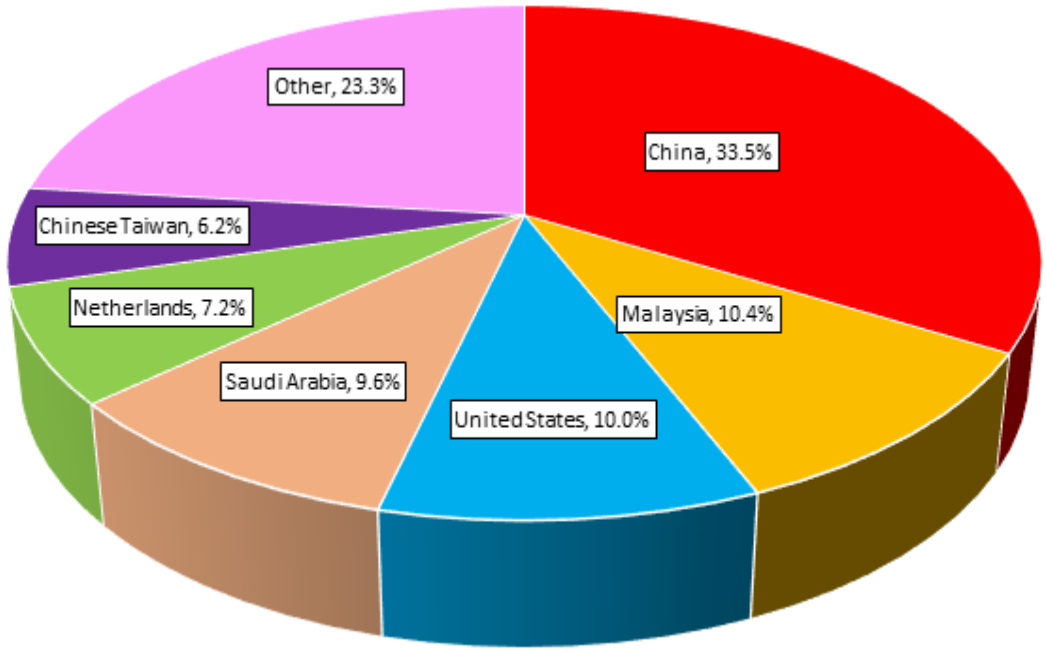
Iluka Resources operates major mineral sands mines and processing plants in Australia and other countries.

Doral Mineral Sands is a mining and processing operation near Bunbury in Western Australia. Doral has secondary processing at Rockingham near Perth. Doral's mine produces 110,000 tonnes of ilmenite, 15,000 tonnes of zircon and 5,000 tonnes of leucoxene.

MZI Resources (MZI) has a heavy mineral sands mine at Keysbrook, south of Perth. The full year production in 2017-18 was 76,800 tonnes of saleable production, including 20,600 tonnes of zircon concentrate.

Western Australian mineral sands exports totalled $1.0 billion in 2017-18. The main destinations for mineral sands exports were China (33.5 per cent), Malaysia (10.4 per cent), the United States (10.0 per cent) and Saudi Arabia (9.6 per cent).

Figure 43: Percentage share of Western Australian mineral sands exports, 2017-18 (per cent)



Source: DMIRS (WA).

In Western Australia two major mineral sands projects have been commissioned recently, namely:

- Image Resources' Boonanarring mineral sands project was commissioned in late 2018. This mine is expected to produce 89,000 tonnes of ilmenite, 32,000 tonnes of zircon, 9,000 tonnes of rutile and 5,400 tonnes of leucoxene; and
- Iluka Resources commissioned its Cataby mineral sands project in the June quarter 2019. Iluka has forecast production of 370,000 tonnes of chloride ilmenite, 50,000 tonnes of zircon and 30,000 tonnes of rutile per year.

There are well advanced and prospective projects for Western Australia, including:

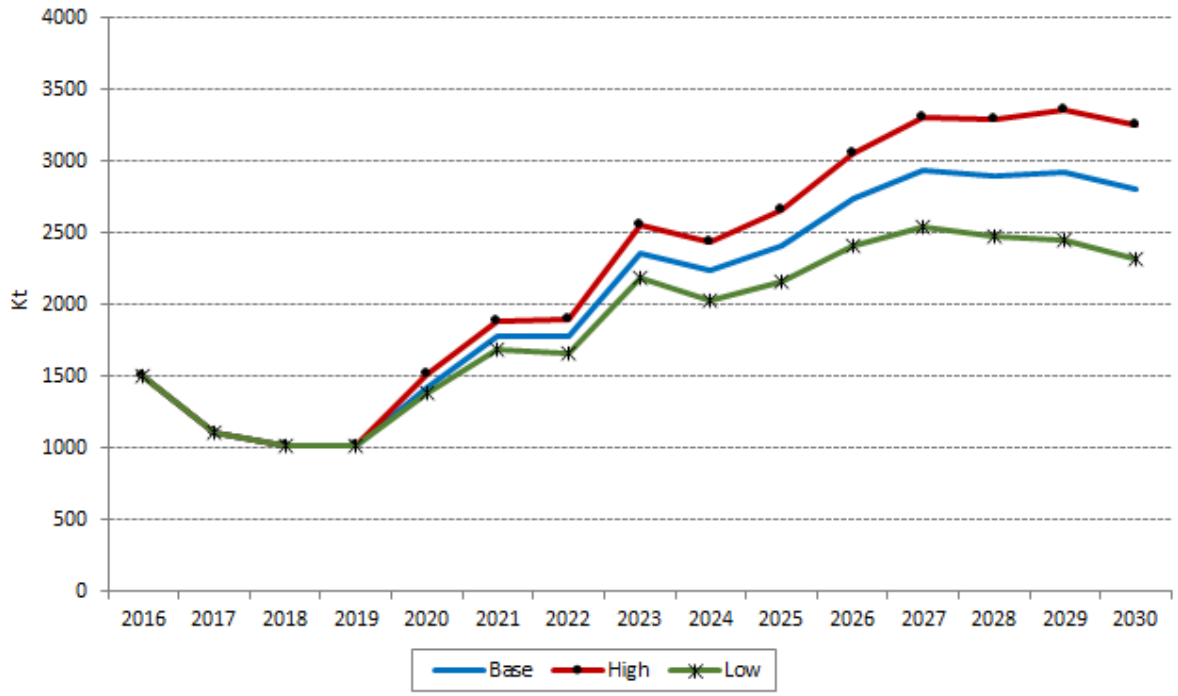
- Sheffield Resources' Thunderbird mineral sands project near Derby. Estimated new capacity is 114,000 tonnes of zircon, 439,000 of ilmenite and 30,000 tonnes of leucoxene; and
- Diatreme Resources' Cyclone zircon project which may become possible post 2021.

There are also a number of prospective mineral sands projects in New South Wales and Victoria. The largest of these is Illuka Resources' Balranald project in New South Wales. New production capacity has been estimated at 450,000 tonnes of ilmenite, 170,000 tonnes of zircon and 130,000 tonnes of rutile. Again, this project is unlikely to proceed until post 2021.

The world class Thunderbird mineral sands project could proceed over the next two years. Sheffield Resources has also announced significant additional resources at the Night Train mineral sands deposit, a tenement close to the Thunderbird project.

Figure 44 shows the forecasts for mineral sands production for Western Australia to 2030 by scenario.

Figure 44: Western Australian mineral sands production to 2030 by scenario (kt)



13. Commodity production forecasts

Tables 4 to 6 summarise the production outlooks for the Base, High and Low scenarios, respectively, for Western Australia on a calendar year basis.

Table 4 Western Australian commodity production forecasts for the Base scenario

Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2016	13.8	178.7	193.3	846.5	203.1	78.4	440.5	5.1	5.1	1502.6
2017	13.8	178.7	202.3	877.3	178.9	85.4	1706.6	9.1	5.0	1105.9
2018	13.5	183.9	211.0	892.4	148.5	90.8	2300.0	9.4	5.1	1011.8
2019	13.8	192.9	212.0	882.8	175.1	106.3	2871.1	9.2	5.0	1016.1
2020	14.0	198.2	218.3	895.7	189.8	114.7	3557.7	10.7	6.6	1426.7
2021	14.1	217.7	213.9	904.0	208.2	125.7	3968.1	11.2	7.8	1773.4
2022	14.5	231.2	204.3	940.2	234.0	133.8	4262.9	11.4	8.6	1772.4
2023	14.5	219.0	205.5	948.3	267.6	134.9	4396.4	11.4	9.5	2357.0
2024	14.5	239.3	193.8	952.8	289.0	133.4	4618.2	11.1	11.3	2232.1
2025	14.5	202.0	199.1	965.5	299.9	130.6	4657.1	11.0	11.6	2403.2
2026	14.5	191.8	213.7	982.0	284.9	129.5	4703.0	11.3	12.1	2735.3
2027	14.5	196.7	214.3	1000.8	273.9	134.3	5075.0	11.5	12.7	2930.8
2028	14.5	198.3	218.2	1006.3	293.0	134.7	5104.2	11.6	14.4	2896.2
2029	14.5	208.5	213.7	1027.4	309.0	135.2	5126.3	11.6	15.0	2923.3
2030	14.5	220.4	212.5	1049.5	325.0	135.6	5149.5	11.7	15.6	2809.8

Source: NIEIR.

Table 5 Western Australian commodity production forecasts for the High scenario

Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2016	13.8	178.7	193.3	846.5	203.1	78.4	440.5	5.1	5.1	1502.6
2017	13.8	178.7	202.3	877.3	178.9	85.4	1706.6	9.1	5.0	1105.9
2018	13.5	183.9	211.0	892.4	148.5	90.8	2300.0	9.4	5.1	1011.8
2019	13.8	192.9	212.0	882.8	175.1	106.3	2871.1	9.2	5.0	1016.1
2020	14.5	208.4	228.3	937.6	199.3	120.3	3738.4	11.2	6.9	1512.2
2021	14.6	231.3	225.1	952.2	220.7	132.9	4212.4	11.9	8.3	1882.5
2022	15.0	248.3	216.3	996.7	250.4	142.7	4571.3	12.2	9.2	1900.6
2023	15.1	237.6	218.8	1011.7	289.1	145.0	4761.8	12.4	10.3	2552.9
2024	15.1	262.3	207.5	1022.9	315.1	144.6	5051.8	12.1	12.3	2441.6
2025	15.1	223.7	214.4	1043.0	330.1	142.7	5144.6	12.1	12.8	2654.7
2026	15.1	214.6	231.4	1067.4	316.5	142.6	5246.0	12.5	13.5	3051.1
2027	15.2	222.2	233.4	1094.5	307.0	149.1	5715.5	12.9	14.3	3300.7
2028	15.2	226.3	239.1	1107.3	331.4	150.7	5803.4	13.2	16.3	3292.9
2029	15.2	240.3	235.4	1137.5	352.6	152.4	5883.8	13.4	17.2	3355.3
2030	15.2	256.5	235.4	1168.9	374.2	154.0	5966.0	13.6	18.1	3255.3

Source: NIEIR.

Table 6	Western Australian commodity production forecasts for the Low scenario									
Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2016	13.8	178.7	193.3	846.5	203.1	78.4	440.5	5.1	0.0	1502.6
2017	13.8	178.7	202.3	877.3	178.9	85.4	1706.6	9.1	0.0	1105.9
2018	13.5	183.9	211.0	892.4	148.5	90.8	2300.0	9.4	0.0	1011.8
2019	13.8	192.9	212.0	882.8	175.1	106.3	2871.1	8.9	2.5	1016.1
2020	13.5	191.9	213.4	875.7	185.6	111.4	3443.8	10.0	6.2	1380.8
2021	13.5	208.1	206.5	872.6	201.0	120.6	3785.3	10.3	7.2	1691.6
2022	14.0	218.3	194.7	895.9	223.0	126.7	4005.1	10.4	7.8	1664.7
2023	13.9	204.1	193.3	892.0	251.7	126.1	4067.3	10.2	8.6	2180.7
2024	13.9	220.1	179.8	884.4	268.2	123.1	4206.2	9.8	10.0	2032.5
2025	13.9	183.4	182.3	884.2	274.6	118.9	4174.6	9.5	10.0	2153.8
2026	13.9	171.9	193.1	887.2	257.4	116.2	4148.0	9.6	10.4	2411.7
2027	13.8	173.9	191.0	891.8	244.1	118.9	4403.0	9.6	10.6	2543.1
2028	13.8	172.9	191.8	884.3	257.5	117.6	4354.8	9.6	11.9	2470.6
2029	13.8	179.3	185.2	890.2	267.7	116.3	4299.9	9.4	12.2	2452.5
2030	13.8	186.9	181.5	896.3	277.6	115.0	4245.2	9.3	12.5	2316.4

Source: NIEIR.

14. Commodity price forecasts

NIEIR conducted a survey of public world commodity price forecasts from major economic institutions. The survey presented in Table 7 was completed in August 2019, and was used to inform the commodity production outlook. Forecasters are particularly bullish on the metals that stand to benefit from the emerging electric vehicle and battery storage markets.

Table 8 also contains price forecasts for lithium carbonate out to 2021. These were prepared by NIEIR and the Office of the Chief Economist based on supply and demand characteristics of the forecast lithium market.

Based on mean expectations, world prices are expected to strengthen in 2020 for copper, nickel and gold. Prices for these commodities fall back slightly in 2021. World prices for alumina, iron ore and zinc are expected to fall in 2020.

Table 7 Survey of world commodity price forecasts, August 2019

	Iron ore (US$ per tonne)			Gold (US$ per ounce)			Copper (US$ per tonne)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
2017	74	74	74	1293	1293	1293	6342	6342	6342
2018	69	69	69	1246	1246	1246	6411	6411	6411
2019	74	80	92	1261	1330	1405	6118	6282	6480
2020	54	72	109	1287	1361	1443	6047	6566	7329
2021	58	64	68	1260	1318	1375	5851	6503	7411

	Nickel (US$ per tonne)			Zinc (US$ per tonne)			Alumina (US$ per tonne)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
2017	10700	10700	10700	2972	2972	2972	0	359	0
2018	12875	12875	12875	2869	2869	2869	0	482	0
2019	12266	12575	12817	2084	2647	2870	0	375	0
2020	12290	13129	13856	2300	2472	2596	0	356	0
2021	11605	12829	13775	2128	2333	2453	0	348	0

Note: Real prices (2019$). Forecast prices from 2019 to 2021.
Source: Office of the Chief Economist (June 2019), The World Bank (April 2019), National Australia Bank (June 2019), Trading Economics (2019), WA Treasury 2019-20 Budget (iron ore only), Australian Government Treasury 2019-20 Budget (iron ore only).

Table 8 World Lithium price forecast (US$ per tonne)

	2018	2019	2020	2021
Office of Chief Economist	16,505	14,080	11,730	11,957
NIEIR	16,505	14,080	12,040	10,020

Note: 2019 prices.
Source: Office of Chief Economist, June 2019.