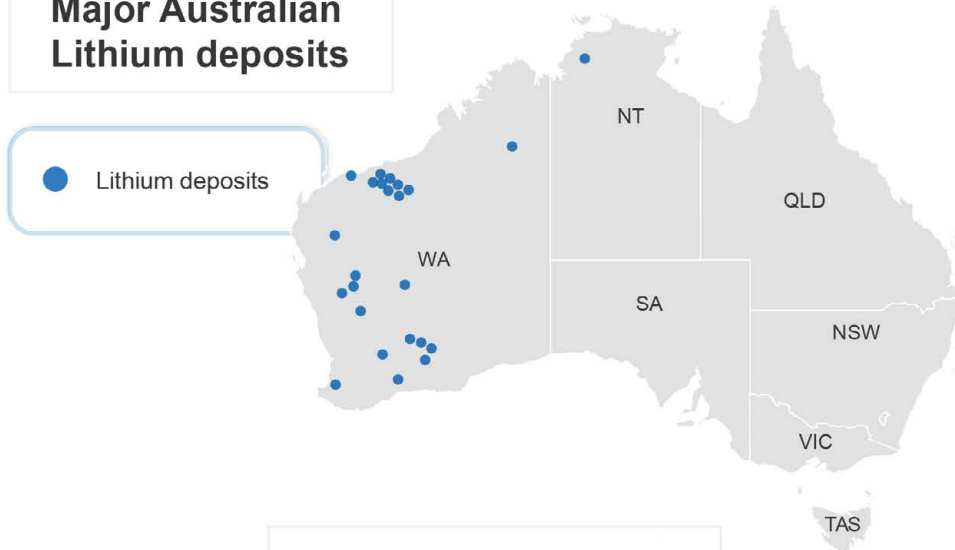
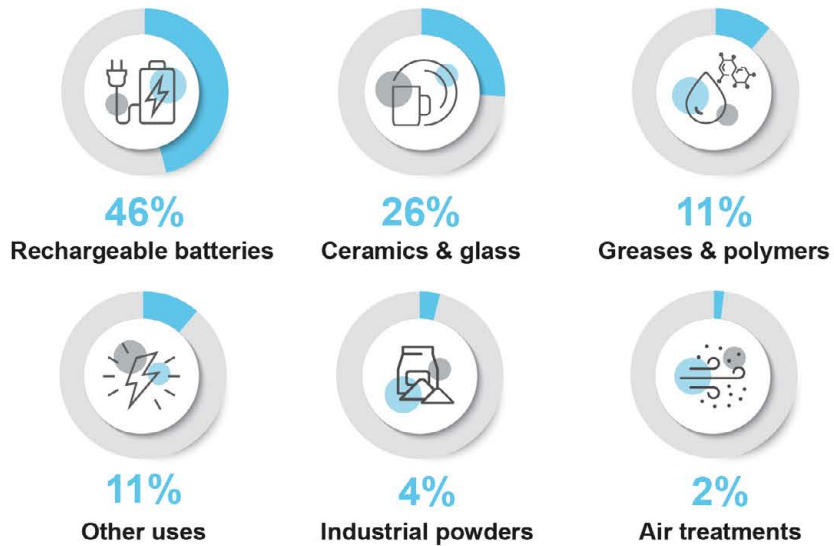


Lithium

Major Australian Lithium deposits



World consumption



Lithium facts



Electric vehicle sales are expected to increase from 2m to 28m by 2030



Lithium exports are tipped to decline to A\$1b in 2019–20



Australia has 30% of the world's lithium resources



Lithium refining commenced at Kwinana (WA)

Australia's lithium



15.1 Summary

- The lithium hydroxide price (delivered to China) eased by 18 per cent, from US\$9,410 a tonne to US\$7,750 a tonne over the December quarter. Prices are projected to rise to around US\$10,400 a tonne in 2025 (in real terms) amidst higher electric vehicle uptake, with shortages possible from 2023.
- Australian production is expected to rise from 244,000 tonnes (lithium carbonate equivalent) in 2018–19 to 393,000 tonnes in 2024–25, after a sharp pullback in late 2019 and early 2020 due to falling prices.
- After dipping from \$1.6 billion in 2018–19 to \$0.6 billion (in real terms) in 2020–21, rising lithium hydroxide production is projected to drive export earnings to \$3.0 billion (in real terms) by 2024–25.

15.2 Prices

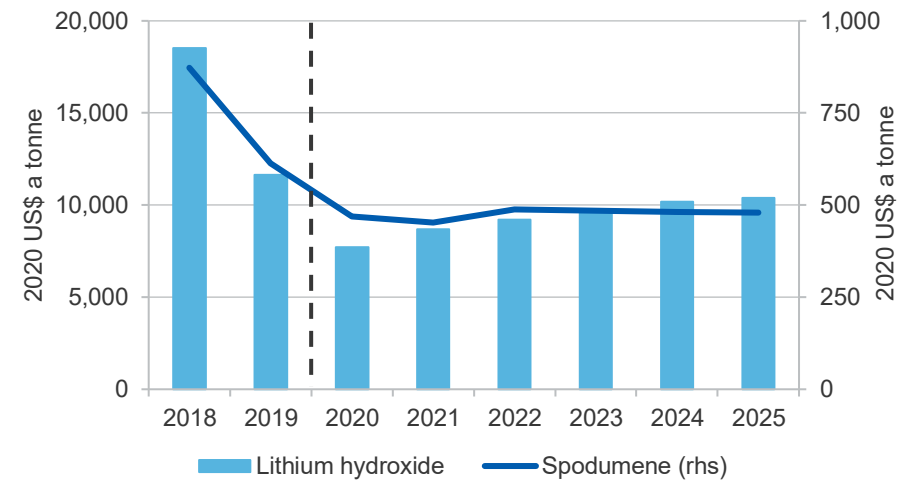
Lithium prices have declined across the board

Lithium carbonate prices (delivered to China) declined by 14 per cent over the December quarter. The price averaged US\$7,110 a tonne in 2019, down 39 per cent from 2018. This compared with price declines into Europe of 13 per cent for the quarter and 30 per cent for 2019 to US\$11,150 a tonne delivered.

Lithium hydroxide prices (delivered to China) declined by 18 per cent over the quarter and by 49 per cent over 2019 (average US\$7,750 a tonne). This compared with price declines into Europe of 20 per cent for the quarter and 33 per cent for the year (US\$10,000 a tonne delivered).

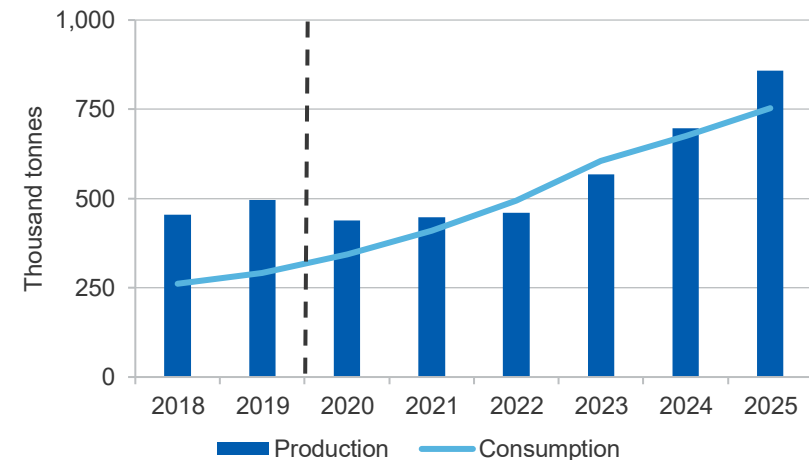
Spodumene prices (delivered to China) declined by 4.6 per cent over the December quarter, and by 24 per cent in 2019 based on a price average of US\$515 a tonne, taking the total decline from the July 2018 peak to 44 per cent. Prices vary based on lithium content and types of impurities. The sharp pullback in Australian production in recent months has helped ease downward pressure on prices. The market is expected to tighten over the second half of the outlook period, with prices expected to rise after 2021 (Figure 15.1).

Figure 15.1: Prices of spodumene ore and lithium hydroxide



Source: Roskill (2019); Brokers (2019), Department of Industry, Science, Energy and Resources (2020)

Figure 15.2: Lithium production and consumption



Source: Roskill (2019); BloombergNEF (2020); Department of Industry, Science, Energy and Resources (2020)

15.3 World consumption

Strong consumption growth is likely over the outlook period

Global lithium consumption is projected to rise from 291,000 tonnes (lithium carbonate equivalent) in 2019 to around 750,000 tonnes by 2025 (Figure 15.2).

Tesla and Volkswagen are increasingly competing with each other

China has increased its electric vehicle target to 25 per cent of all new automobile sales by 2025, despite a slowdown of sales in 2019 (caused by cuts to subsidies). Electric vehicle sales in China recovered by the end of 2019 (Figure 15.3). India is also moving to establish a full electric vehicle production chain. Battery cell and pack manufacturing has started up in India, with the country seeking to expand into the battery manufacture and chemicals industries. Meanwhile multiple vehicle manufacturers are attempting large scale roll outs with models designed for the mass market.

Tesla began production of its Tesla 3 at its Shanghai factory in late 2019, with order books filling rapidly. Production was halted initially with the COVID-19 outbreak but resumed in mid-February 2020. The factory was originally scheduled to produce 100,000 vehicles per year by end 2020, but may now achieve 150,000 per year. Volkswagen's Anting factory, near Shanghai has started 'pre-production', with full production set for October 2020. Volkswagen have planned capacity of 600,000 vehicles per year split between two factories in China.

Outside China, Tesla is sourcing battery cells from Panasonic. In China, Tesla are pursuing batteries through Contemporary Amperex Technology Company Limited, with battery supply tightening for other vehicle manufacturers. But Tesla is currently recruiting for engineers in battery cell manufacturing, in order to avoid the risk of battery constraints as it increases its volumes of vehicle manufacturing.

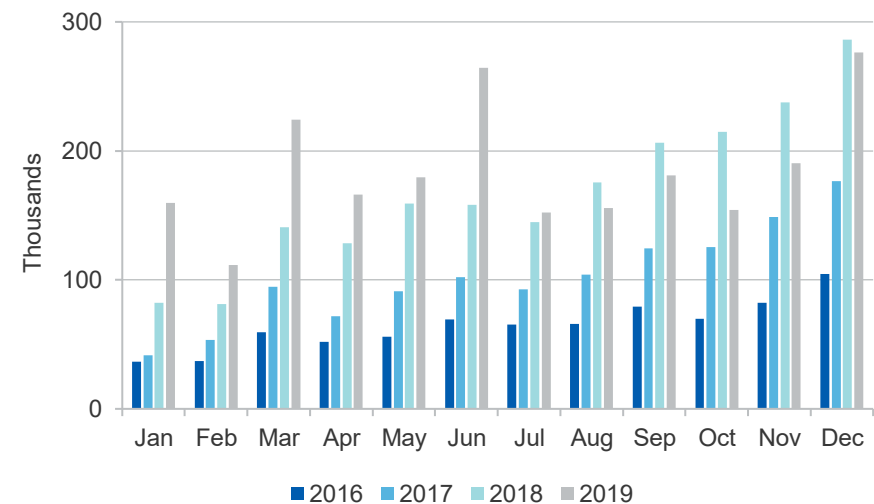
Whilst COVID-19 has been slowing down production in China, it has presented an opportunity for Volkswagen, who might otherwise have been battery constrained. Volkswagen is now planning to deliver their ID.3 into the market in the United Kingdom in late March 2020, ahead of schedule.

The United Kingdom accelerated its banning of internal combustion engines from 2040 to 2035. The ban excludes hybrid vehicles.

Vehicle makers continue to focus on battery prices to drive down vehicle costs and drive vehicle volumes up (Figure 15.4). Barring changes in technology, the majority of battery costs are the material inputs. Major off-take partners for the Mt Holland mine in Australia were listed as LG, Mitsui and Tesla, but the financial investment decision on the project has been put on hold until the first quarter of 2021. It is worth noting that in early automotive history Ford invested in mining.

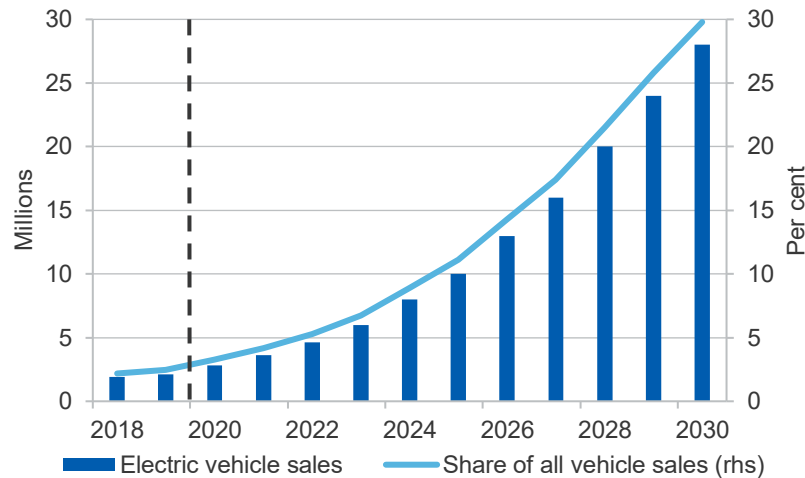
Electric vehicle sales are expected to expand significantly over the longer term as manufacturers develop facilities and the prices reach the 'crossover' point which will make electric vehicles cheaper than internal combustion vehicles. This draws closer at mid US\$20,000's. In battery terms, the crossover is mooted at US\$100 a kilowatt hour.

Figure 15.3: World monthly electric vehicle sales



Source: Inside electric vehicles (2019) Monthly Sales Scorecard until post July 2019. These are based on reconciled monthly or quarterly sales data by major plug-in automakers & matthewturner.co.uk/wp (Jan 2020).

Figure 15.4: Long-term electric vehicles sales projection



Source: International Energy Agency (2019), BloombergNEF (2019), Department of Industry, Science, Energy and Resources (2020)

15.4 World production

Production is set to grow rapidly over the outlook period

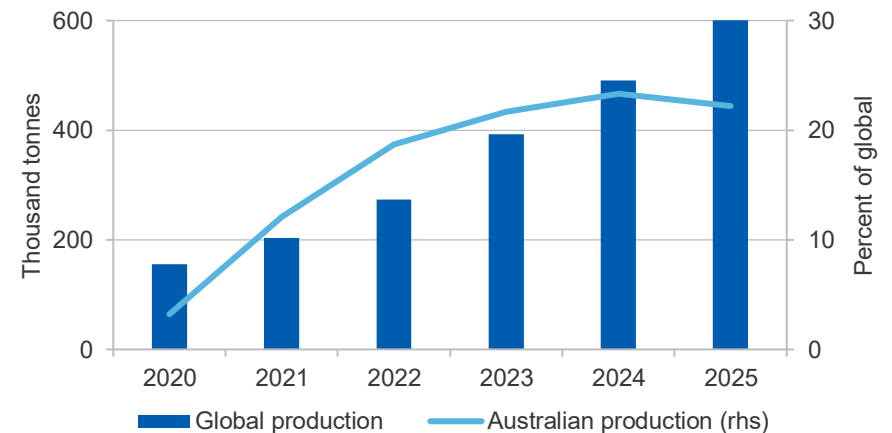
At 495,000 tonnes of lithium carbonate equivalent in 2019, production exceeded consumption considerably, leading to a price drop and some rapid pull backs in production in Australia and elsewhere. Nemaska has recently filed for bankruptcy, stalling their Whabouchi spodumene project in Quebec. However not all news was supply negative: Rio Tinto is assessing a lithium borate deposit, Jadar, in Serbia. An FID is reportedly due in 2021. ASX-listed Galaxy is pursuing development of its Chile lithium brine assets, along with existing production from Olaroz in Argentina. South American production is growing, but continues to face significant water issues in the Atacama region, with one tonne of lithium requiring 70,000 litres of water. Less water-intensive methods of extraction via ion-exchange beads and nano-filtration are being trialled for brine deposits as well.

World production is projected to rise to 858,000 tonnes (lithium carbonate equivalent) by 2025. However, given the current level of over-supply, and the rapidly accelerating scale of vehicle manufacture capacity, producers are likely to pay close attention to offtake agreements, vertical integration opportunities and strategic considerations before embarking on expansion.

Medium term – carbonate versus hydroxide

Lithium carbonate is likely to remain well supplied, but the demand for lithium hydroxide may exceed supply by 2023. Lithium hydroxide is suitable for use in batteries with high levels of nickel cathode. However, Tesla announced a move to using lithium phosphate batteries in China, rather than the nickel cobalt chemistry that is still used in its US factories. This chemistry is suitable for shorter travel ranges typical in China. Sociedad Quimica y Minera de Chile (SQM) at Salar Del Carmen in Chile produce lithium hydroxide and carbonate. Piedmont in the US and Keliber in Finland also plan to produce lithium hydroxide by 2025. Australia's share of global lithium hydroxide output (Figure 15.5) hinges on project development plus transport issues from potential moisture absorption.

Figure 15.5: World lithium hydroxide production



Source: BloombergNEF (2020), Department of Industry, Science, Energy and Resources (2020)

15.5 Australia

Production forecast to dip before recovering

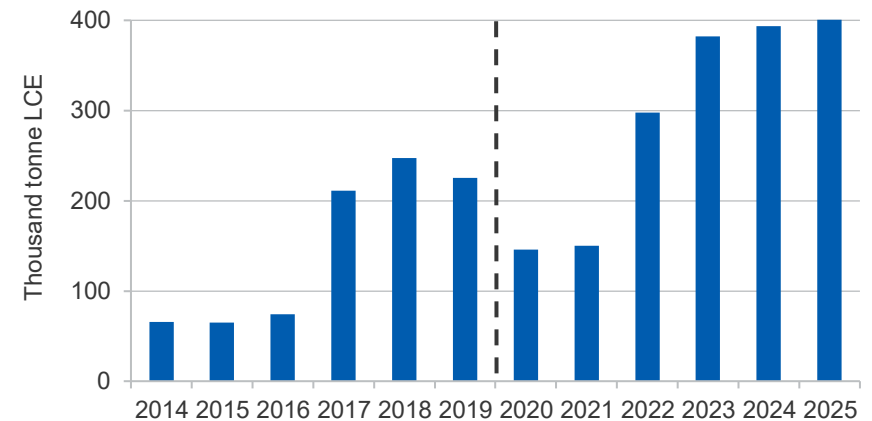
Production is forecast to swing sharply over the outlook period. After a price induced slowdown in the short term, there is likely to be a strong recovery in 2022 and 2023 (Figure 15.6), as the demand for lithium and, in particular, lithium hydroxide rises. There are likely to be a number of significant discussions between miners and manufacturers, given vehicle manufacturers needs for low-cost batteries to gain economies of scale.

Production forecasts are particularly difficult to make as a result of the suspension of two major projects (Mt Holland and Wodgina) and the shift to 'care and maintenance' for Bald Hill and possibly Mt Marion. Production has also been scaled back at Mt Cattlin and Pilgangoora (Pilbara Minerals). This leaves Greenbushes still operating normally, while Pilgangoora (Altura) has just undertaken operational refinancing.

Spodumene production in Australia has scaled back sharply in recent quarters, but capacity to refine lithium hydroxide is ramping up. Export earnings are projected to more than double by 2025, as world battery production increases and the demand for lithium hydroxide leads to shortfalls in the market (Figure 15.7). Australian producers are forecast to ramp up production, as Kwinana, Kemerton and Mt Holland's associated Kwinana production plant are commissioned. However, there are commissioning risks for some plants. Export earnings forecasts do not include any incremental income to Pilbara Minerals from the development of offshore hydroxide and or carbonate processing with POSCO in Korea.

The key risk to the forecast is that margins in the production of lithium hydroxide will not be sufficient to attract capital. Whilst lithium hydroxide is a high value product, it is costly to produce. Margins between lithium carbonate and lithium hydroxide are around US\$500 a tonne (on a tonne for tonne basis). This, coupled with direct conversion from spodumene to hydroxide, may make it less attractive for lenders, and lead to more de-risking via joint ventures. Europe is investing heavily to try to reduce its reliance on Asia for battery chemicals and battery cells which may present opportunities for Australian producers.

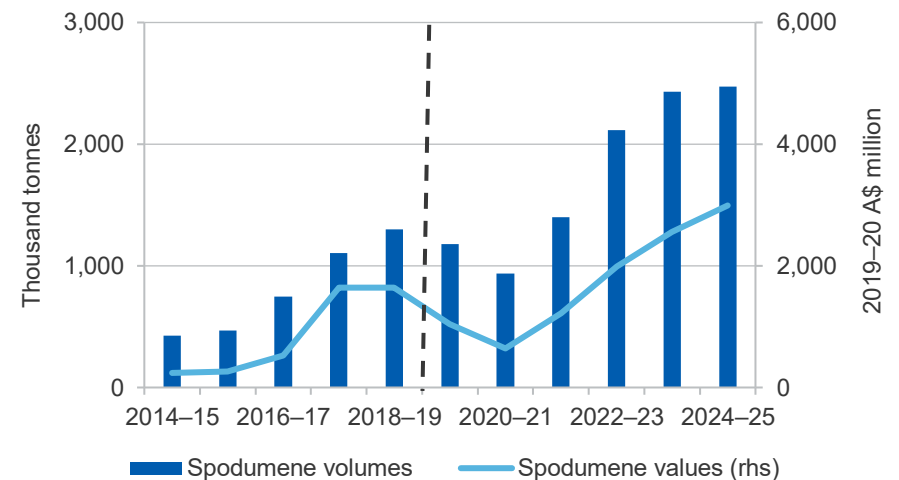
Figure 15.6: Australian spodumene ore production



Notes: Lithium hydroxide is not included.

Source: Company reports, Roskill (2020), Department of Industry, Science, Energy and Resources (2020)

Figure 15.7: Australian spodumene concentrate exports



Notes: Income figures include lithium hydroxide and spodumene volumes contain hydroxide.

Source: Company reports, Roskill (2020), Department of Industry, Science, Energy and Resources (2020).

Table 15.1: Lithium Outlook

World	Unit	2019 ^s	2020 ^f	2021 ^f	2022 ^f	2023 ^z	2024 ^z	2025 ^z	CAGR ^r
Lithium production ^a	kt	495	439	447	461	567	697	858	9.6
Consumption	kt	291	343	409	493	606	675	753	17.2
Stocks ^b	kt	624	720	758	725	686	708	813	4.5
– weeks of consumption		111.5	109.0	96.3	76.4	58.9	54.5	56.1	-10.8
Spodumene price									
– nominal	US\$/t	600	469	462	510	519	527	536	-1.9
– real ^c	US\$/t	613	469	452	488	485	482	479	-4.0
Lithium hydroxide price									
– nominal	US\$/t	11,400	7,700	8,855	9,625	10,290	11,130	11,620	0.3
– real ^c	US\$/t	11,645	7,700	8,673	9,212	9,627	10,180	10,391	-1.9
Australia	Unit	2018–19	2019–20 ^f	2020–21 ^f	2021–22 ^f	2022–23 ^z	2023–24 ^z	2024–25 ^z	CAGR ^r
Mine production ^a	kt	244	191	141	224	339	382	393	8.3
Export volume ^d	kt	1,298	1,177	935	1,398	2,116	2,428	2,474	11.3
– nominal value	A\$m	1,616	1,041	657	1,273	2,119	2,801	3,355	13.0
– real value ^e	A\$m	1,646	1,041	644	1,222	1,986	2,561	2,992	10.5

Notes: **a** Lithium Carbonate Equivalent. This is a measure of the quantity of refined product produced from spodumene ore; **b** Stockpile estimates possibly inaccurate due to changing specifications; **c** In 2020 calendar year US dollars; **d** Spodumene concentrates: 2018–19 products included direct ship ore, 4 per cent Li₂O concentrate and 6 per cent Li₂O concentrate, thereafter 6 per cent Li₂O concentrate; **e** In 2019–20 financial year Australian dollars, direct ship ore increasing 2018–19 value; **f** Forecast; **r** Compound annual growth rate; **s** Estimate; **z** Projection.

Source: Department of Industry, Science, Energy and Resources (2020); Company reports; Roskill (2020); Government of Western Australia Department of Mines, Industry Regulation and Safety (2019)