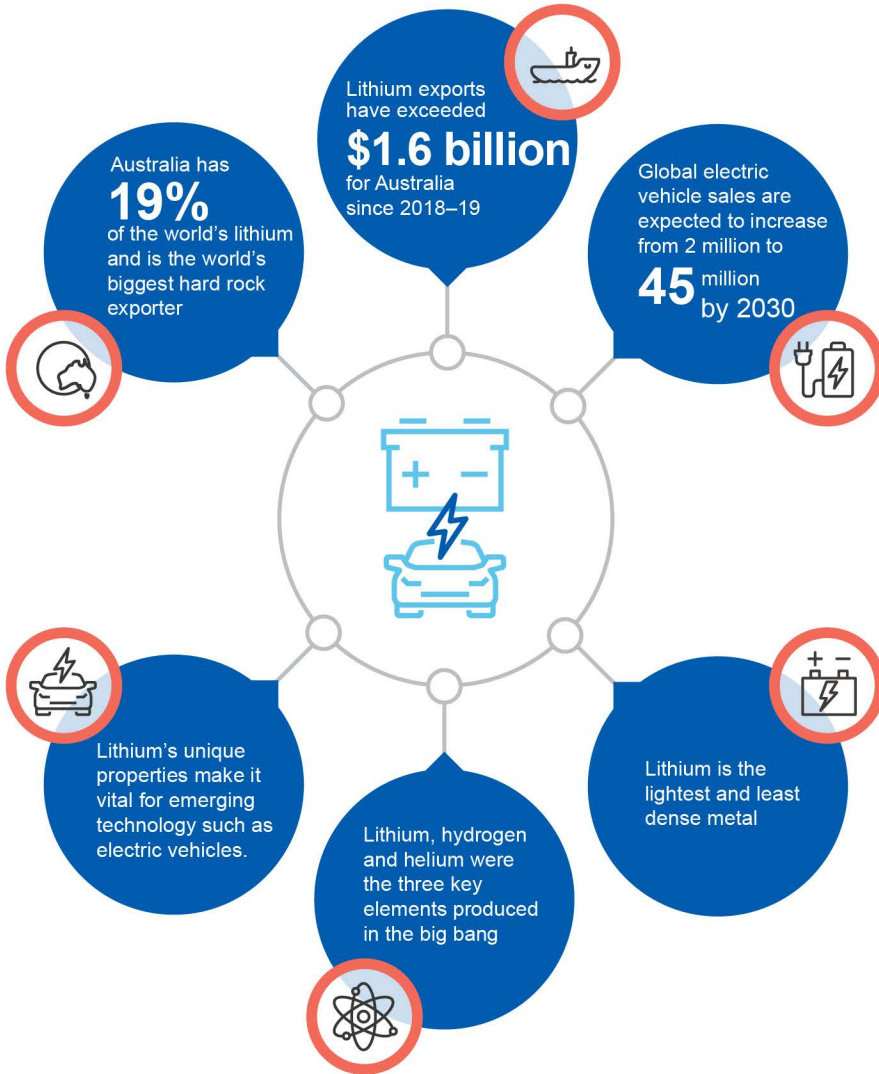


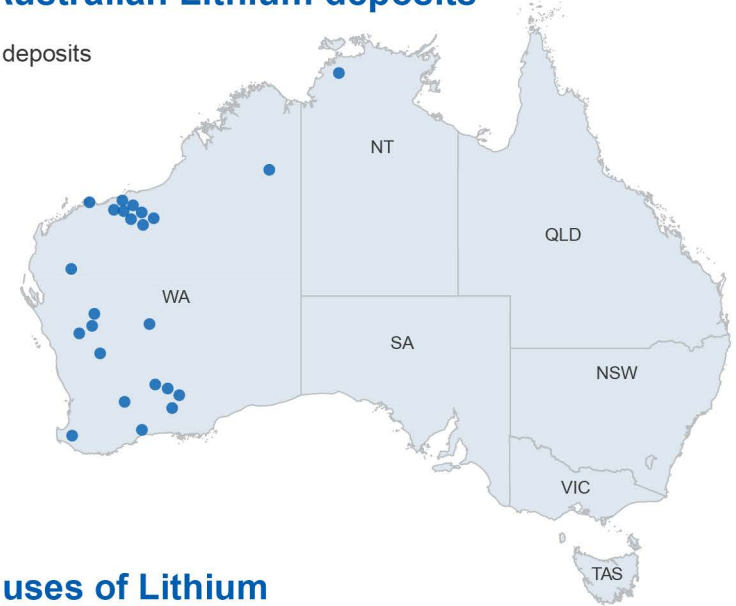
Lithium

Resources and Energy Quarterly December 2019

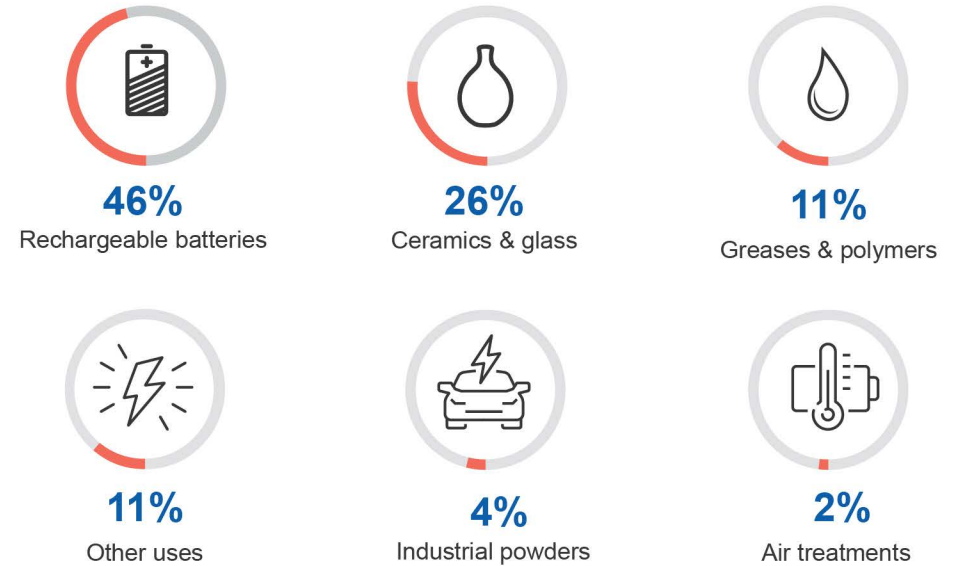


Major Australian Lithium deposits

● Lithium deposits



Global uses of Lithium



15.1 Summary

- The spot lithium hydroxide price has eased from US\$16,139 a tonne in 2018 to about US\$11,000 a tonne in late 2019. Prices are expected to ease further in 2020 — to a forecast US\$9,500 a tonne — before recovering to about US\$10,925 a tonne in 2021.
- Australian lithium production is expected to increase from 249,000 tonnes (lithium carbonate equivalent) in 2018–19 to 289,000 tonnes in 2020–21. Growth reflects product improvements with the CGP2 expansion at Greenbushes, and other possible expansions.
- Rising mine output and lithium hydroxide refining are forecast to increase export revenue to \$1.6 billion by 2020–21.

15.2 Prices

Lithium price outlook varies with product

The lithium market is experiencing excess supply, which has boosted inventories and weighed on prices for the past year. Oversupply is expected until the end of the outlook period (Figure 15.1 & Box 16.1 *Major Projects* chapter). However, the impacts are likely to differ depending on the type of lithium product, destination and how refinery plants ramp up.

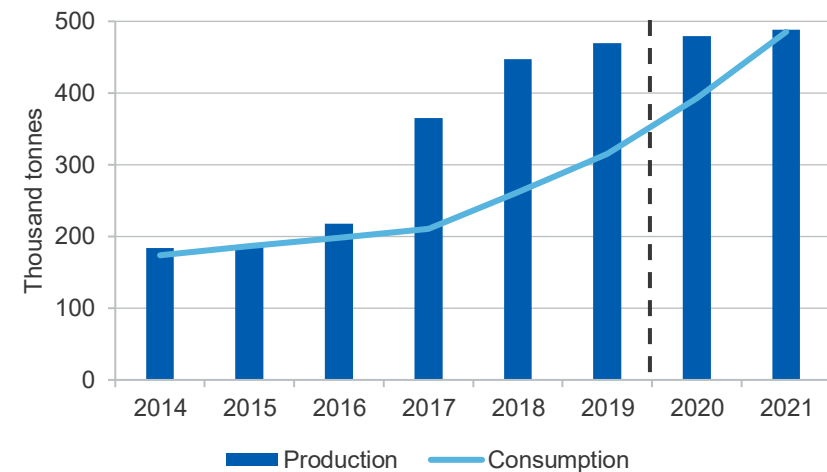
Lithium carbonate price declines

Contract and spot prices for battery-grade lithium carbonate have fallen noticeably over 2019. Spot prices in November were about US\$7,700 a tonne, including cost, insurance and freight (CIF) to China, compared with over US\$12,000 a tonne less than a year ago.

Lithium hydroxide pricing depends on destination

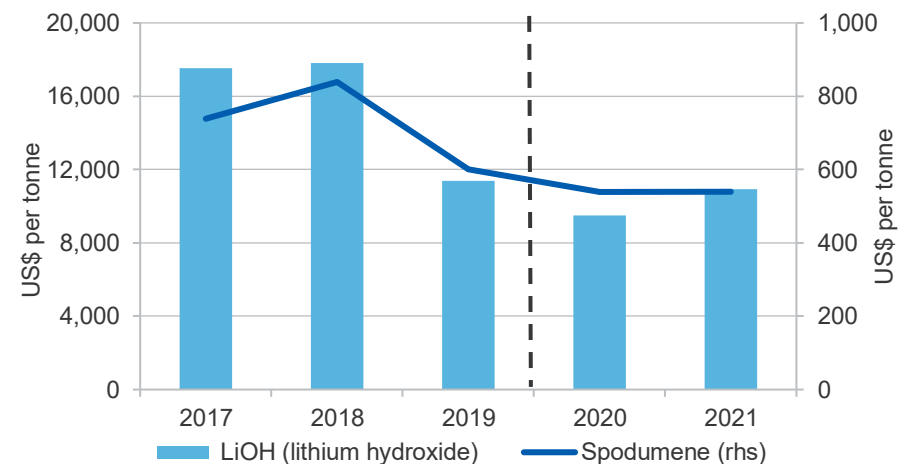
Battery-grade lithium hydroxide for contract and spot sales has followed similar trends to carbonate, with prices down over the past year — from US\$15,000 a tonne to US\$8,100 (in China) and US\$12,000 (in South Korea and Europe). Prices between markets diverged from mid-2019. The falls have led some producers to push supply to the premium market. Prices are projected to turn in late 2021 or early 2022, as consumption catches up with supply (Figure 15.2).

Figure 15.1: Lithium production and use



Source: Roskill (2019); Department of industry, Innovation & Science (2019)

Figure 15.2: Price of spodumene ore and lithium hydroxide



Source: Roskill (2019); Department of Industry, Innovation and Science (2019)

Spodumene inventory large, prompting production pullback

Spodumene concentrate, the feedstock for lithium hydroxide, is expected to face oversupply during the outlook period. Some producers have published guidance of US\$560–US\$600 a tonne for spodumene concentrate. Spodumene prices vary with product quality and comparison with spot is not simple in this nascent market.

A recent sharp pullback in spodumene supply will help ease downward price pressure in the short term, with an expected rise in future demand providing longer term support. In the meanwhile, producers have focussed on improving product quality in an attempt to offset declining prices and the flat outlook for prices over the next couple of years.

15.3 World consumption

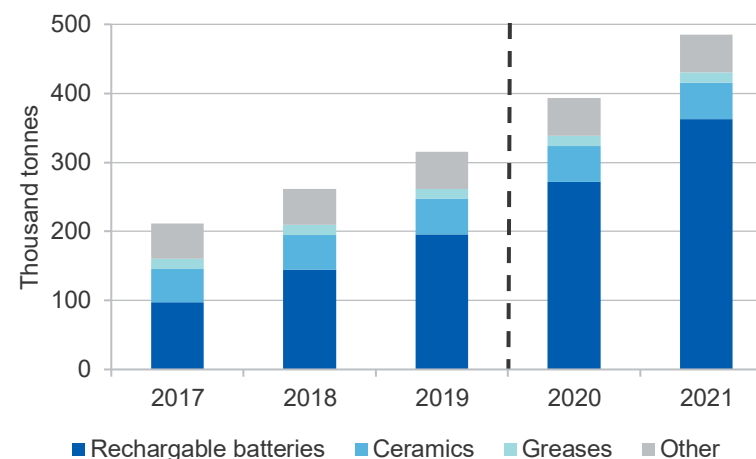
Demand is rising, with battery producers drawing on hard rock and brine

The world consumed 315,000 tonnes of lithium carbonate equivalent (LCE) in 2019. Consumption is forecast to grow by over 20 per cent a year to reach 485,000 tonnes by 2021, based on growing uptake of electric vehicles and improvements in battery capacity (Figure 15.3). Increasing battery manufacturing in China, as well as increased trade, may involve a supply combination of both carbonate (in which lithium is evaporated from brines for conversion into hydroxide) and spodumene concentrate (derived from hard rock) for hydroxide conversion. However, spodumene has a cost advantage over carbonate for hydroxide conversion in most cases.

South Korea is the main importer of battery-grade lithium carbonate, followed by Japan and the US. South Korea sources most of its input from Chile and some from China. Lithium carbonate supply chains continue to mature, with strong links between China, Japan, and South Korea.

Battery-grade hydroxide trade is dominated by sales into South Korea and Japan, with supplies from China, Chile and Argentina. China's exports of hydroxide are mainly directed to Japan and Korea. The US exports hydroxide largely to Japan. Trade was strong in the first half of 2019, buttressing prices somewhat from the declines in other lithium product markets.

Figure 15.3: Lithium usage by product



Notes: 'Other' includes polymers, glass, powders, primary batteries and air treatments.
Source: Roskill (2019); Department of Industry, Innovation and Science (2019)

Numerous offtake customers have also positioned themselves on the share registers of lithium producers. Producers are also going up the value chain through corporate deals. Recent examples include Mineral Resources' sell down of Wodgina to Albemarle (to obtain hydroxide processing), and Pilbara Minerals joint venture negotiations with POSCO for a lithium carbonate and hydroxide conversion facility in South Korea. This is potentially leading to indirect vertical integration of inputs to manufacturers and thus consolidating supply chains.

China is the key to critical mass on electric vehicles

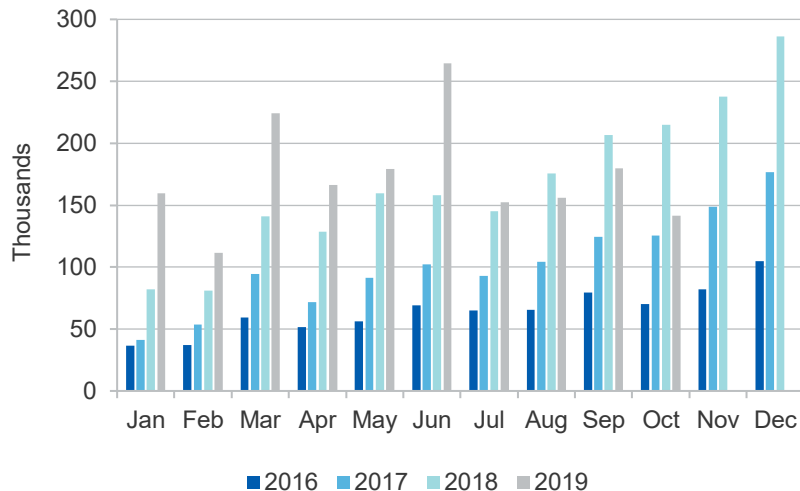
Demand for electric vehicles has declined over the past few months (Figure 15.5), partly as a result of declining consumer confidence and some cuts to Chinese government purchase incentives.

Electric vehicles are the main driver for lithium demand (Figure 15.5), with forecasts varying widely, based on Chinese uptake. Electric vehicle makers are on the cusp of making very competitive offerings (US\$20,000), allowing them to expand outside of the high-end vehicle market.

However, China's population base, its siting of local manufacturers (Volkswagen, BYD, etc.) and its preference for short commute distances make it well placed for larger scale electric vehicle uptake. Thus it is shaping up as a key market for determining critical mass for affordable electric vehicles. Volkswagen is constructing two electric vehicle factories in China (at Foshan and Anting), with possible first production in 2020. Ultimate capacity of these two factories is 600,000 vehicles per annum. Additionally, Tesla has commenced trial production in Shanghai with planned capacity of 150,000 vehicles that may benefit from subsidies for locally produced vehicles having a range over 400 kilometres.

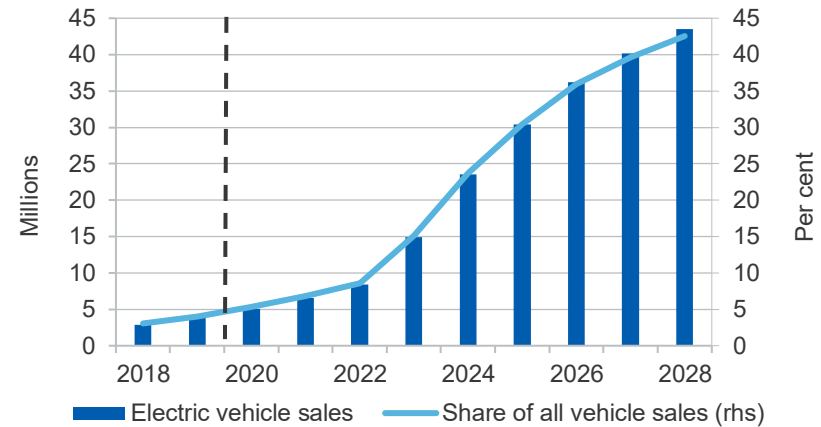
China is also understood to be testing the use of older lithium batteries as storage devices in the powering of mobile communication towers. If successful, this may further underpin consumption, without initially eating into primary lithium demand via recycling.

Figure 15.4: 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 (Nov 2019)

Figure 15.5: Long-term electric vehicles sales projection



Source: Department of Industry, Innovation and Science (2019)

15.4 World production

Production rising based on hard rock expansions

World lithium production is estimated to have grown to 470,000 tonnes in 2019, up 18 per cent on 2018. Production is forecast to rise further, reaching 489,000 tonnes in 2021, on the back of spodumene, or hard rock, expansions in Australia, Canada and Brazil.

The shift towards hard rock sources for lithium continues, but has been slightly tempered by recent cutbacks in spodumene production from some producers in Western Australia. However, brine producers have also faced difficulties in recent months. In South America, Albemarle's La Negra has been experiencing production setbacks, with output now 5 per cent below the company's forecast. The company has delayed works on La Negra III & IV. Earlier concerns regarding water consumption from the Atacama at Salar de Atacama appear to have been managed for the moment. However, the water draw on the region includes BHP's Escondida and Antofagasta's Zaldívar copper mines. Both hard rock in Australia and brine in South America continue to be important sources of ore (Figure 15.6), although future expansion will more likely be hard rock based.

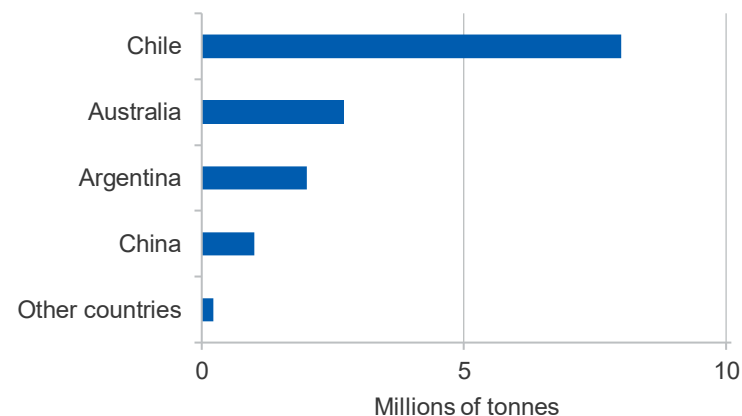
Some producers are still positioning for future market share. Despite short term oversupply concerns, producers such as Sociedad Química y Minera de Chile (SQM), continue to position themselves for future demand. SQM holds existing brine operations in South America, but is also undertaking assessment of the Mt Holland project in conjunction with Wesfarmers (see *Major Projects* chapter), along with an associated proposed lithium hydroxide plant in Kwinana. During the last downturn in the lithium market (earlier in the decade), SQM also expanded their brine operations. Albemarle have announced pullbacks from their primary materials expansion, but are currently constructing a value-adding lithium hydroxide refinery at Kemerton.

Hydroxide production ramping up

Production of battery materials continues to rise, with additional hydroxide capacity coming online in China. Tesla has grown its battery material suppliers from one to three, and may soon produce in the US as well. Australia joined the ranks of lithium hydroxide producers with the commissioning of stage one of Tianqi's Kwinana refinery. However, stage two has been put on hold, in order to focus on the ramp up of stage one. Nemaska's Whabaouchi commercial lithium plant in Quebec was to produce lithium hydroxide. However, it may be put into care and maintenance later in the year, subject to finance negotiations with Pallinghurst.

Novel production is now starting to appear in non-lithium operations. Among the pioneers are Rio Tinto, who are planning pilot plant work to test lithium recovery from processing discharge from their Boron Mine in the US. Lithium extraction may also be trialled from fluids used in geothermal power at Vulcan energy's plant in Germany. Production from these facilities is not likely to be significant for some years, but is expected to grow over time, as companies seek new ways to utilise their sunk capital.

Figure 15.6: World lithium reserves



Source: US Geological Survey (2019); Department of Industry, Innovation & Science (2019)

15.5 Australia

Spodumene production likely to rise over outlook period

Australian production of spodumene increased by 20 per cent over 2017–18 to 2018–19 (1.1 million tonnes to 1.3 million tonnes). Large gains occurred as a result of direct shipments of ore that did not require conversion to spodumene concentrate as new operations opened. Spodumene production is forecast to increase from a forecast 1.6 million tonnes in 2019–20 to around 1.9 million tonnes by 2020–21, though this depends in part on financial investment decisions and timing for the Mt Holland mine (Figure 15.7).

Short-term cutbacks have affected spodumene production

Galaxy Resources announced changes for Mt Cattlin in October 2019. The changes include cuts in mining, whilst maintaining guidance for spodumene production with the assistance of stockpiles. Additionally, Galaxy recently acquired Alita's debt. Alita recently went into administration, with their main asset being the Bald Hill lithium mine. However, a third party has since secured and paid out the debt.

Wodgina has been placed on care and maintenance by Mineral Resources and Albemarle, after having completed the sell down of the project to Albemarle to gain access to Kemerton's hydroxide processing. SQM, which has voiced intention to keep pursuing development despite the market downturn, is due to make a final investment decision on the path for Mt Holland and its associated Kwinana lithium hydroxide refinery early in 2020. This may place Mt Holland into production just when the market is clearing spodumene inventory.

Deteriorating conditions in the market have led producers to concentrate on product quality. Mt Marion (Mineral Resources) has been concentrating on producing one higher grade product, as an alternative to higher and lower grade concentrates. Greenbushes chemical grade plant (2) upgrade has also been based on improving product quality. Meanwhile Pilbara Minerals' and Altura's Pilgangoora projects have been ramping up.

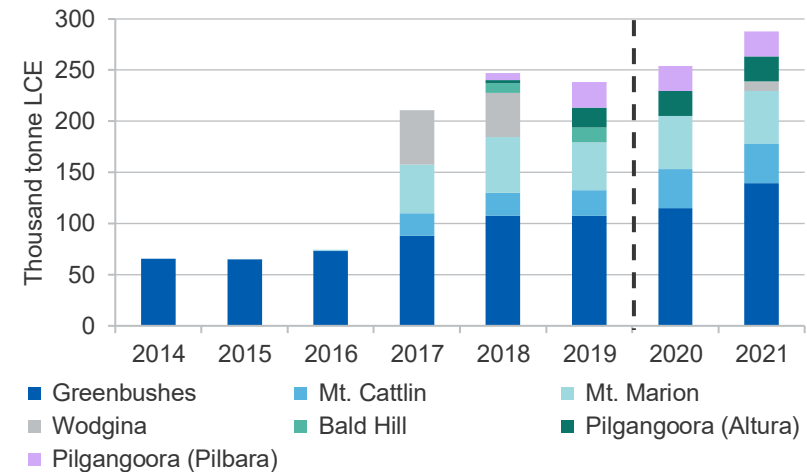
Lithium hydroxide commences onshore and possibly offshore

Tianqi's Kwinana lithium hydroxide plant commenced production in September 2019. Albemarle's and Mineral Resources have advised that their Kemerton lithium hydroxide plant is due to commence production in 2021. Pilbara Minerals are also in the process of negotiating a joint venture (JV) with POSCO for the construction of a 40,000 tonne per annum lithium hydroxide and carbonate conversion facility in South Korea. The terms sheet indicates existing offtake would be directed to the JV.

Revisions to the outlook

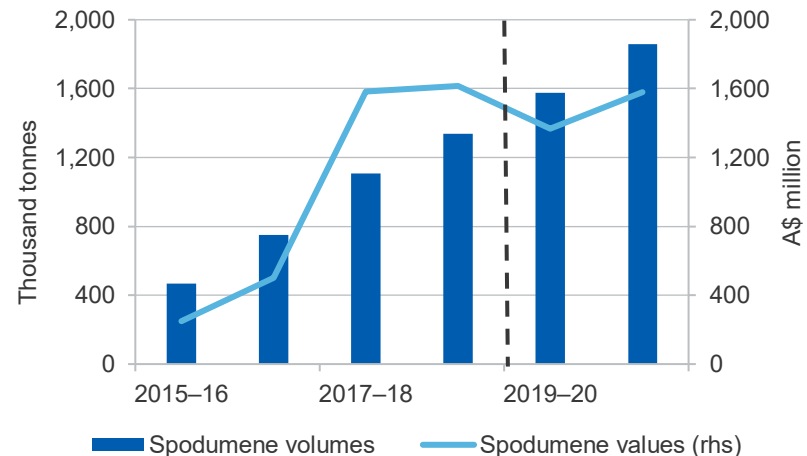
Since the September 2019 *Resources and Energy Quarterly*, prices for spodumene and lithium hydroxide have decreased noticeably. Spodumene price forecasts are now 10 per cent lower for 2020 and flat for 2021, and lower than improving for lithium hydroxide, reflecting the product outlook. Volumes for spodumene in 2020–21 are forecast to rise by 16 per cent despite recent cutbacks (Figure 15.8). As a result, export revenue for lithium (spodumene and hydroxide) is forecast to rise to \$1.6 billion in 2020–21.

Figure 15.7: Australian spodumene ore production



Source: Company reports, Roskill (2019); Department of Industry, Innovation & Science (2019)

Figure 15.8: Australian spodumene concentrate exports



Source: Roskill (2019); Department of Industry, Innovation & Science (2019)

Table 15.1: Lithium Outlook

World	Unit	2018	2019 ^s	2020 ^f	2021 ^f	Annual percentage change		
						2019 ^s	2020 ^f	2021 ^f
Lithium production ^a	kt	447	470	479	489	5.0	2.0	2.0
Consumption	kt	261	315	393	485	20.6	24.8	23.5
Stocks	kt	638	793	879	883	24.2	10.8	0.4
– weeks of consumption		127.0	130.9	116.3	94.6	3.1	-11.2	-18.7
Spodumene price								
– nominal	US\$/t	839	600	539	540	-28.5	-10.2	0.2
– real ^b	US\$/t	854	600	528	518	-29.7	-12.0	-1.9
Lithium hydroxide price								
– nominal	US\$/t	17,817	11,400	9,500	10,925	-36.0	-16.7	15.0
– real ^b	US\$/t	18,126	11,400	9,305	10,480	-37.1	-18.4	12.6
Australia	Unit	2017–18	2018–19	2019–20 ^f	2020–21 ^f	2018–19	2019–20 ^f	2020–21 ^f
Mine production ^a	kt	251	249	243	289	-1.0	-2.3	18.9
Export volume ^c	kt	1,105	1,338	1,576	1 859	21.1	17.7	18.0
– nominal value	A\$m	1,582	1,616	1,366	1,579	2.1	-15.5	15.6
– real value ^d	A\$m	1,636	1,643	1,366	1,550	0.5	-16.9	13.5

Notes: **a** Lithium Carbonate Equivalent. This is a measure of the quantity of refined product produced from spodumene ore; **b** In 2019 calendar year US dollars; **c** Spodumene concentrates – 2017-19 products included direct ship ore, 4% Li₂O concentrate and 6% Li₂O concentrate, thereafter 6% Li₂O concentrate; **d** In 2019-20 financial year Australian dollars, direct ship ore increasing 2018-19 value; **f** Forecast; **s** Estimate.

Sources: Department of Industry, Innovation and Science (2019); Company reports; Roskill (2019); Government of Western Australia Department of Mines, Industry Regulation and Safety (2019)