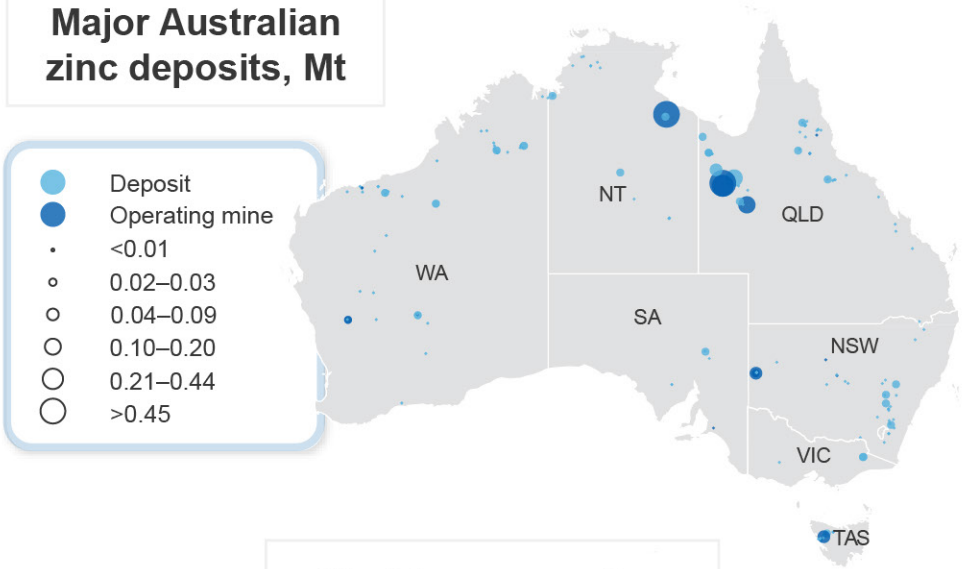
# Zinc

30 Zn 65.38

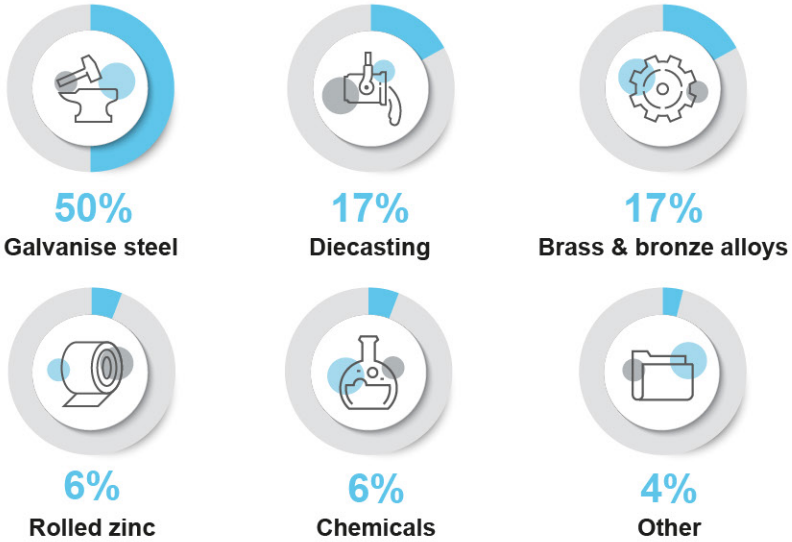
## Major Australian zinc deposits, Mt




## Zinc facts

- **Zinc ore** was used in ancient Greece to produce brass
- Zinc **fights infection** in our bodies and is used in wound-care & sunscreen
- World consumption per capita is **2kg**
- Zinc is an **emerging battery mineral**

## World consumption

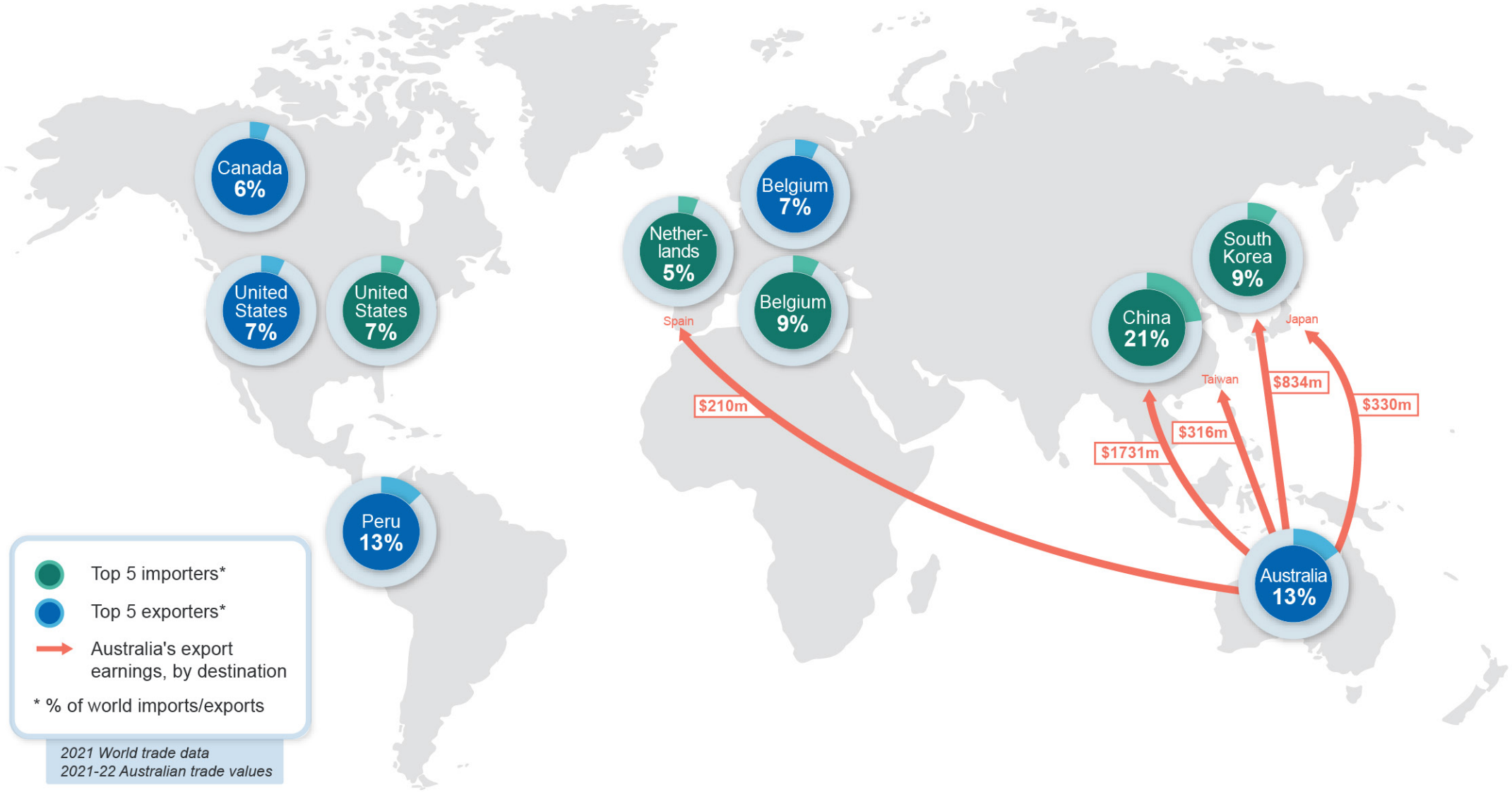



## Australia's zinc

- **3rd largest producer** in the world in 2021
- **29%** of world's known **zinc resources** held
- **2nd largest exporter** in the world in 2021

# Zinc

## Trade map | September 2022



## 14.1 Summary

- The LME zinc spot price is forecast to average around US$3,600 a tonne in 2022, with supply pressured by reduced production of refined zinc in Europe. Prices are forecast to ease over the outlook to around US$3,000 a tonne by 2024, as supply pressure ease.
- Encouraged by high prices, Australia's zinc production is forecast to rise by 5.0% per year to around 1.4 million tonnes by 2023–24 (see Australia section).
- Australia's zinc export earnings are forecast to peak at $5.3 billion in 2022–23, before easing in 2023–24 to $4.7 billion.

## 14.2 World consumption

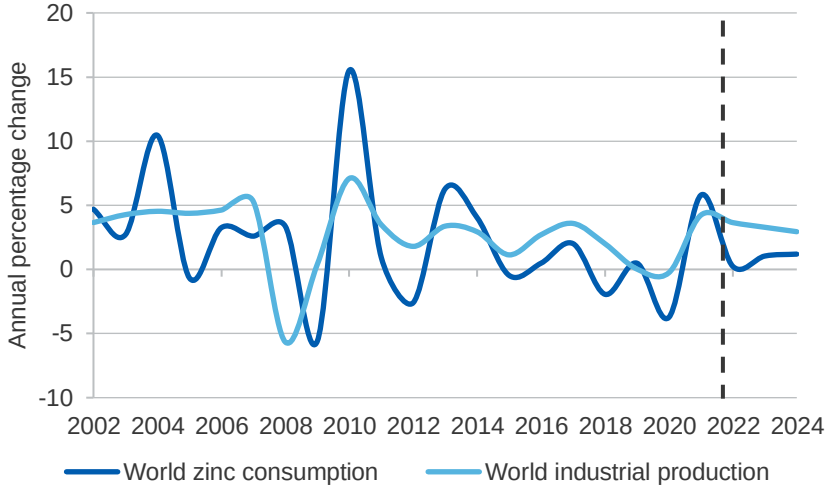
### Diminishing global growth weakens world zinc demand

Zinc consumption tends to follow the world industrial production cycle, given its primary role in galvanising steel (Figures 14.1 and 14.2), and its heavy use in construction and vehicle production. World refined zinc consumption fell by 3.0% year-on-year in the June quarter 2022, as industrial activity in China and Europe slowed. Year-on-year consumption fell in China (12.5%), the EU (1.8%) and ex-China Asia (1.8%), but rose in the United States (7.7%).

The outlook for industrial growth has weakened since the June 2022 REQ (see *Macroeconomic Outlook* chapter), and this will weigh on zinc demand during the outlook period.

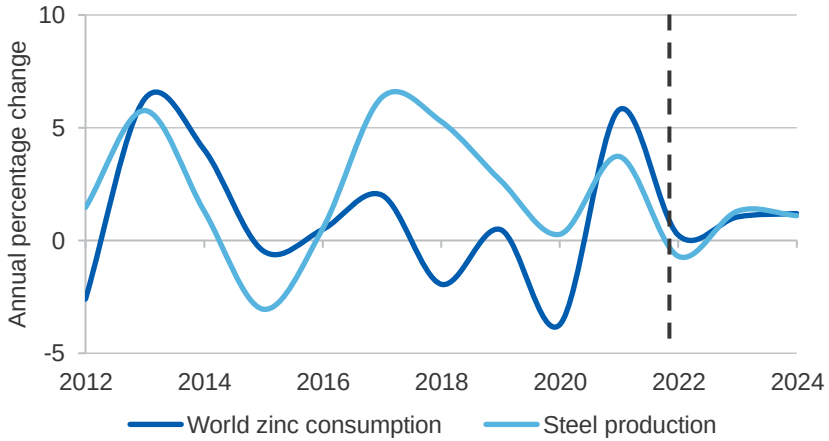
Consumer demand is softening, as most central banks around the world hike rates to rein in inflation. The Chinese residential property sector has continued to struggle, and it weakened further during the middle of 2022, as the government's zero COVID policy triggered a slowdown in the Chinese economy. Falling demand for new residential property has created cash flow issues for many Chinese property developers, in some cases forcing work to be paused for construction projects. The Chinese authorities have recently taken further measures to support the sector.

**Figure 14.1: World zinc consumption vs industrial production**




Source: International Lead Zinc Study Group (2022); CPB Netherlands Bureau for Economic Policy Analysis (2022); Department of Industry, Science and Resources (2022).

**Figure 14.2: Steel production vs world zinc consumption**




Source: International Lead Zinc Study Group (2022); World Steel Association (2022); Department of Industry, Science and Resources (2022).

Global vehicle sales fell 16% year-on-year in the June quarter 2022. Sales and production for the automotive sector was slowed by lockdowns in China over the quarter — Shanghai recorded no new vehicle sales over the month of April. However, the sector is likely to rebound in the second half of 2022, supporting zinc demand. Semiconductor prices, which rose sharply over the COVID-19 pandemic, began to normalise as global demand for consumer electronics slowed, easing supply bottlenecks. While consumer confidence has weakened globally, pent up demand for consumer vehicles will sustain sales, as manufacturers catch up to long backlog of orders. Over the longer term, the adoption of electric vehicles is expected to support sales

Demand for zinc from infrastructure spending is softening the fall in demand from other sectors. China has issued RMB 3.4 trillion of special-purpose local bonds over the first half of 2022 to fund additional infrastructure spending to stimulate its slowing economy. Infrastructure spending relating to the global energy transition is rising globally, with policies such as the US Inflation Reduction Act and the EU Next Generation package are driving investments. These investment is expected to support demand for zinc, which is a key input to wind turbines and solar panels. Interest in zinc batteries is on the rise and have the potential to drive additional demand.

Over the outlook period, world zinc use is forecast to grow an average of 0.9% per year, from 14.0 million tonnes in 2021 to 14.4 million tonnes in 2024 (Table 14.1). Demand growth will be driven by higher infrastructure spending and by the global transition to low emissions technologies.

## 14.3 World production

### Global mine production falls from COVID related disruptions

World mine zinc production fell 2.9% year-on-year in the June quarter 2022, driven by declines in Peru, China and Australia.

Peruvian mine production fell by 21% year-on-year in the June quarter 2022, due to lower ore grade at the Antamina and Cerro Lindo mines, and the closure of the Iscaycruz mine last year.

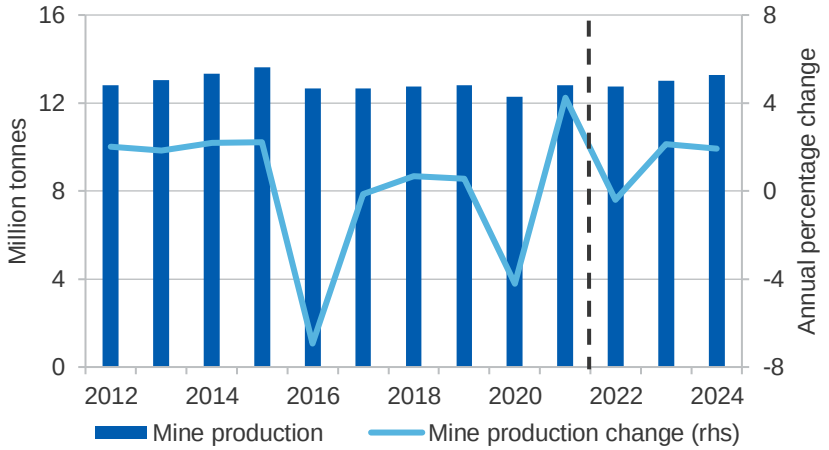
Chinese mine production fell by 5.4% year-on-year in the June quarter 2022, impacted by containment measures associated with the country's zero COVID policy.

Zinc output from Australian mines rose 3.3% quarter-on-quarter but fell by 9.3% year-on-year. Output has been impacted by high levels of COVID related absenteeism since the Omicron outbreak in the March quarter.

### Mine production to rise over the outlook period

World mine output is forecast to fall to 12.7 million tonnes in 2022. Over the outlook period, mine output is forecast to rise by an average of 1.3% per year to 13.3 million tonnes by 2024, as miners respond to elevated zinc prices and face fewer COVID-related operational disruptions (Figure 14.3). Global mine production capacity is expected to increase over the outlook period, as new mines and mine expansions come online.

**Figure 14.3: World zinc mine production, metallic content**




Source: International Lead Zinc Study Group (2022); Department of Industry, Science and Resources (2022).

The largest new projects expected to add to mining production capacity over the outlook period are located in Russia, Kazakhstan, Mexico and Australia. China, the world's largest producer of zinc ore, is also expected to expand production across smaller mines.

The Ozernoye mine in Russia is expected to begin operating in 2023, and by 2024 could be producing up to 330,000 tonnes of zinc per year — about 2.6% of global zinc ore production in 2021. While some markets may be closing to Russian ore exports, more can be sold to Chinese and Indian refiners.

Kazzinc's Zhairem mine in Kazakhstan began operating in 2021. The mine is expected to ramp up to its nameplate capacity of 160,000 tonnes of zinc per year by 2023.

Grupo Mexico's Buenavista mine in Mexico is expected to begin operating in 2023, ramping up to its maximum capacity of 120,000 tonnes of zinc per year by 2025.

New Century Resources' Century mine in Australia restarted in 2018, and has since produced 120,000 tonnes of zinc per year. An expansion project is underway to boost output to 230,000 tonnes of zinc per year by 2024.

### World refinery production falls as energy price rises

World zinc refined production was unchanged in quarterly terms in the June quarter 2022, but fell by 2.4% year-on-year to 3,385 kilo tonnes. The fallout from the Russian invasion of Ukraine threatens to create a global energy shortage over the Northern Hemisphere winter and has pushed up global energy prices. Zinc refining capacity is being taken offline in Europe, as the continent absorbs the brunt of the energy price shock.

Production fell by 8.7% year-on-year in the European Union in the June quarter 2022. Smelters that have temporarily ceased production include the Portovesme smelter in Italy, which closed in November 2021, and the Budel smelter in the Netherlands, which closed in September 2022. Other European smelters are operating at reduced capacity, and tight energy supply over the Northern Hemisphere winter could result in more closures.

China, the largest zinc refiner globally, recorded a fall of 0.8% year-on-year in production over the June quarter 2022, with output affected by the country's zero COVID policy. Refined zinc production in China is expected to be depressed through to the September quarter 2022, with ongoing localised COVID lockdowns affecting production. Additionally, the drought and heatwave in south-western China has reduced hydropower generation and raised energy demand for cooling. This has led to power rationing and the temporary closures of zinc smelters in the Sichuan province.

In 2022, refined output is forecast to grow by 0.2% to 13.9 million tonnes, with refined production constrained as a result of high energy prices, particularly in Europe. Over the outlook period, refined production from primary and secondary sources is expected to increase by 1.4% a year, reaching 14.4 million tonnes in 2024. The majority of new capacity added is expected to be in China, but smelters reopening in Europe will also contribute to growth in production.

## 14.4 Prices

### Tight supply to sustain high prices

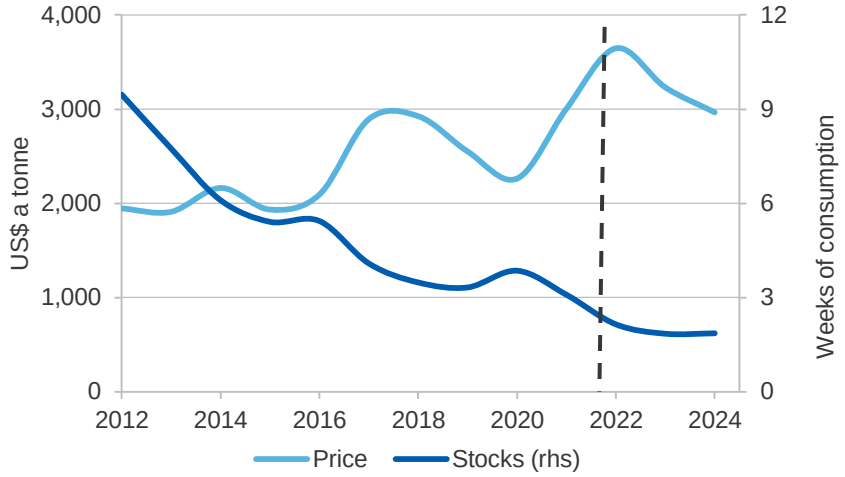
The London Metal Exchange (LME) spot zinc price fell to US$2,900 a tonne in early July, over concerns of a weakening macroeconomic environment. This was a drop of US$1,000 a tonne from the peak in early June. However, the price rallied to US$3,600 a tonne in early August, as the outlook for mine supply deteriorated and as high energy prices threatened further zinc refining closures/cutbacks in Europe.

Mine supply showed ongoing weakness, as output from major producers fell due to COVID-related disruptions (Figure 14.4). High energy prices have kept benchmark treatment costs of zinc concentrates to remain at $230/t in the June quarter 2022, which may rise further if energy costs lift.

LME stocks fell below 70 kilo tonnes in early August, from 81 kilo tonnes at the end of the March quarter 2022. Stocks are low in the US and Europe, with the vast majority of inventory stored in Asian warehouses.

With supply likely to remain tight, the LME zinc spot price is forecast to average US$3,600 a tonne in 2022, falling to $3,000 a tonne by 2024. Prices are expected to decline from the current high levels, as more mining and refining capacity comes online.

**Figure 14.4: Zinc prices and stocks**




Source: LME (2022); International Lead Zinc Study Group (2022); Department of Industry, Science and Resources (2022).

## 14.5 Australia's exports and production

### High prices to drive export earnings over the outlook period

Australia's combined export earnings for both concentrates and refined metals are estimated to have reached $4.5 billion in 2021–22. Higher zinc prices in the first half of 2022 have boosted export values.

Australia's export earnings are forecast to increase to around $5.3 billion in 2022–23 due to high prices, increased production and lower shipping costs, before falling to around $4.7 billion in 2023–24, as improving zinc supply on the global market pushes down prices.

### Australia's mine production falls due to COVID workforce disruptions

COVID cases continue to create workforce disruptions in Australian mines over the June quarter 2022. As a result, Australia's mined zinc output fell by 9.3% year-on-year in the quarter.

Production at Glencore's Australian operations, including Mt Isa in Queensland and McArthur River in the Northern Territory, fell 12% year-on-year to 141 kilo tonnes in the June quarter 2022. The fall was mainly due to COVID-related workforce disruptions.

Production for MMG's Australian operations, including Dugald River in Queensland and Rosebery in Tasmania, fell by 8.0% year-on-year to 53 kilo tonnes over the June quarter 2022. Production fell at the Rosebery mine, due to COVID-related workforce disruptions and lower ore grades.

In the June quarter 2022, production at New Century's Century Tailings Reprocessing rose by 9.8% quarter-on-quarter, after the ball mill motor was repaired in late February. Production was virtually unchanged over the year, at 32 kilo tonnes.

South32's Cannington operation in Queensland fell by 21% year-on-year to 15 kilo tonnes in the June quarter 2022, due to planned maintenance.

### Concentrate exports rose while refined exports declined

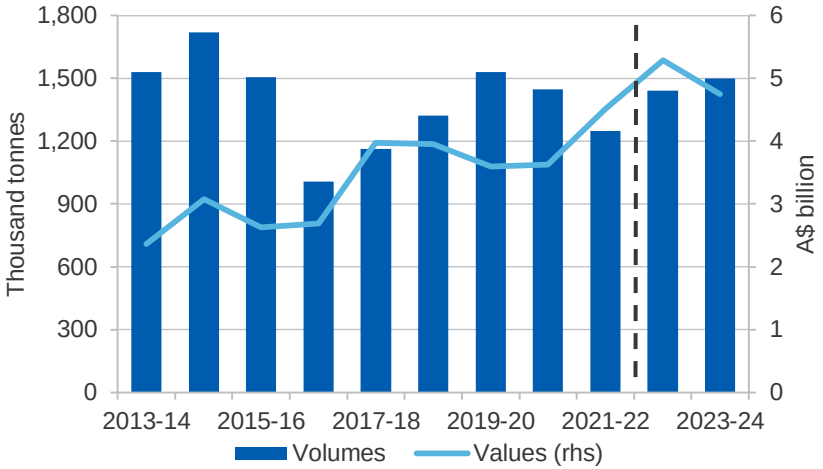
In the June quarter 2022, Australia's zinc concentrate export volume fell 22% year-on-year to 197 kilo tonnes, and refined zinc export volumes fell 34% year-on-year to 69 kilo tonnes (Figure 14.5). However, the value of zinc concentrate exports rose by 15.1% year-on-year to $723 million, and zinc refined export value rose 8.9% year-on-year to $417 million.

China is the largest market for Australian zinc concentrate exports. In the June quarter 2022, the value of Australia's concentrate exports to China was virtually unchanged year-on-year at $278 million.

Low refined zinc demand in China and closures of zinc refineries in Europe saw increasing refined zinc trade flow to European and US markets. The value of refined zinc exports to China fell 80% year-on-year in the June quarter 2022 to $25 million.

Australian refined zinc found other buyers: the value of refined zinc exports to the US rose to $74 million in the June quarter 2022, compared to an average of $3 million per quarter in 2021. Taiwan became the largest market for Australian refined zinc, with the value of refined zinc exports rising by 22% year-on-year to $85 million.

**Figure 14.5: Australia's zinc exports, metallic content**




Source: ABS (2022) International Trade in Goods and Services, 5368.0; Wood Mackenzie (2022); Department of Industry, Science and Resources (2022).

## Australia's mine production is expected to increase over the outlook period

Australia's output is expected to grow over the outlook period, with mine output forecast to lift from 1.3 million tonnes in 2021–22 to 1.4 million tonnes in 2023–24. The gains will be driven by higher production at operations at Dugald River, Golden Grove, and the Century mine.

## Project development

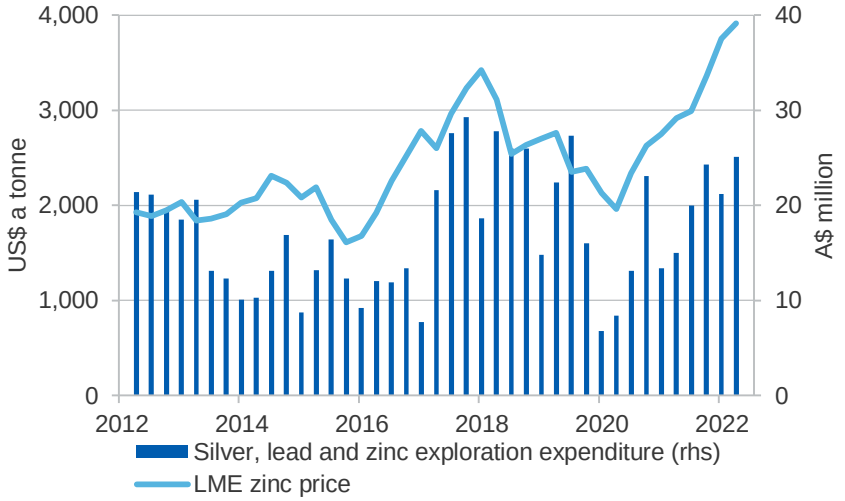
New Century is examining several hard rock resources beyond the current tailings retreatment operation, which is due to end in 2027. New Century believes hard rock resources have the potential to extend mine life to 2030, and are mostly contained on the existing mining lease.

Century Zinc earlier reported positive results from their feasibility study of potential operations at Silver King and East Fault Block. The company is targeting a financial investment decision in the second half of 2022, and possible first production in the second half of 2023. The company estimates the project will generate additional zinc production of 35 kilo tonnes a year.

## Exploration expenditure increased significantly in 2021-22

Exploration expenditure for silver, lead and zinc rose 67% year-on-year in the June quarter 2022 (Figure 14.6). Exploration expenditure slumped in 2020 — due to the COVID pandemic — but recovered as zinc prices rose over 2021 and 2022. Exploration expenditure is expected to see continued strength with zinc prices expected to remain high over 2022 and 2023.

**Figure 14.6: Quarterly exploration expenditure and zinc price**




Source: ABS (2022) Mineral and Petroleum Exploration, Australia, 8412.0; Company reports; Department of Industry, Science and Resources (2022).

## Revisions to the outlook

Compared with the June 2022 *Resources and Energy Quarterly*, forecasts for zinc export revenue are up 15% to $5.3 billion in 2022–23, and up 24% to $4.7 billion in 2023–24. The increases are due to the upward revision to forecasts for zinc prices and export volumes over the outlook period.

Additionally, we have revised our historical refined zinc export volume and values. We have conducted a routine reassessment and updated how we map the export statistical items under the Australian Harmonized Export Commodity Classification to the revised series.

## Table 14.1: Zinc outlook

| | | | | | | Annual percentage change | | |
|---|---|---|---|---|---|---|---|---|
| **World** | **Unit** | **2021** | **2022[f]** | **2023[f]** | **2024[f]** | **2022[f]** | **2023[f]** | **2024[f]** |
| Production | | | | | | | | |
| – mine | kt | 12,778 | 12,746 | 13,016 | 13,266 | -0.3 | 2.1 | 1.9 |
| – refined [a] | kt | 13,841 | 13,875 | 14,153 | 14,413 | 0.2 | 2.0 | 1.8 |
| Consumption | kt | 14,033 | 14,080 | 14,227 | 14,397 | 0.3 | 1.0 | 1.2 |
| Closing stocks | kt | 809 | 603 | 530 | 545 | -25.4 | -12.2 | 2.9 |
| – weeks of consumption | | 3.0 | 2.2 | 2.0 | 2.0 | -25.2 | -10.9 | -1.2 |
| Price | | | | | | | | |
| – nominal | US$/t | 3,005 | 3,643 | 3,231 | 2,966 | 21.2 | -11.3 | -8.2 |
| | USc/lb | 136 | 165 | 147 | 135 | 21.2 | -11.3 | -8.2 |
| – real [b] | US$/t | 3,237 | 3,643 | 3,135 | 2,815 | 12.5 | -13.9 | -10.2 |
| | USc/lb | 147 | 165 | 142 | 128 | 12.5 | -13.9 | -10.2 |
| **Australia** | **Unit** | **2020–21** | **2021–22** | **2022–23[f]** | **2023–24[f]** | **2021–22** | **2022–23[f]** | **2023–24[f]** |
| Mine output | kt | 1,327 | 1,257 | 1,337 | 1,395 | -5.3 | 6.3 | 4.3 |
| Refined output | kt | 458 | 490 | 500 | 500 | 7.0 | 2.1 | 0.0 |
| Export volume | | | | | | | | |
| – ore and concentrate [c] | kt | 2,118 | 2,033 | 2,158 | 2,282 | -4.0 | 6.2 | 5.8 |
| – refined | kt | 496 | 313 | 443 | 444 | -36.8 | 41.6 | 0.0 |
| – total metallic content | kt | 1,447 | 1,249 | 1,442 | 1,500 | -13.7 | 15.5 | 4.0 |
| Export value | | | | | | | | |
| – nominal | A$m | 3,623 | 4,509 | 5,284 | 4,746 | 24.4 | 17.2 | -10.17 |
| – real [d] | A$m | 4,049 | 4,824 | 5,284 | 4,554 | 19.1 | 9.5 | -13.8 |

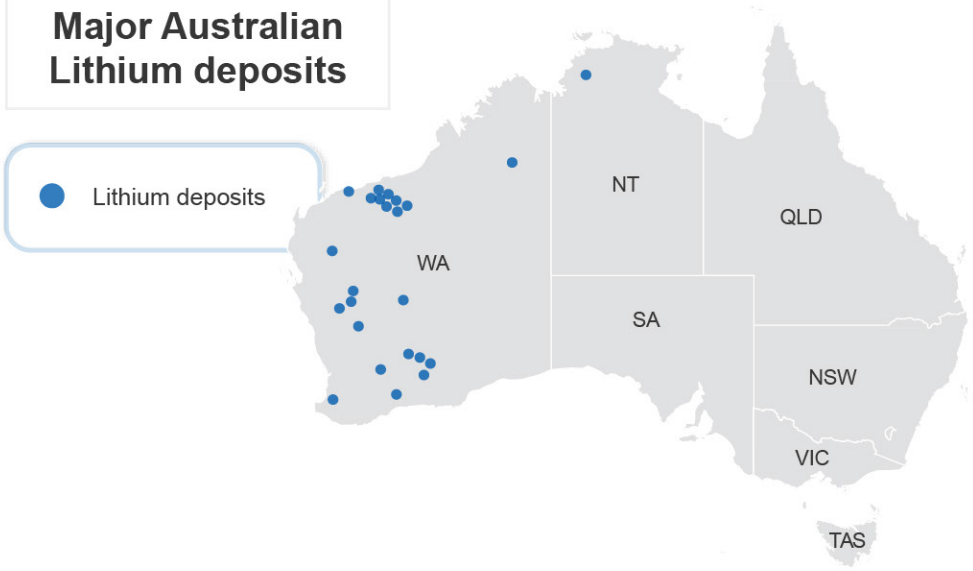
Notes: **a** Includes secondary refined zinc; **b** In 2022 US dollars; **c** Quantities refer to the gross weight of all ores and concentrates; **d** In 2021–22 Australian dollars; **f** Forecast.

Source: ABS (2021) International Trade in Goods and Services, Australia, Cat. No. 5368.0; Company reports; Department of Industry, Science and Resources (2021); International Lead Zinc Study Group (2021); Wood Mackenzie (2021); LME (2021).

# Lithium

3 Li 6.94

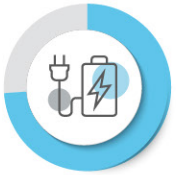
## Major Australian Lithium deposits




## Lithium facts

- Lithium metal is **so light it floats on water**
- **Electric vehicle sales** are expected to grow tenfold by 2030
- Australian lithium exports will more than double over the next 5 years
- May 2022: Australia's 1st continuous **production of lithium hydroxide**

## World consumption



**75%**
**Rechargeable batteries**

**13%**
**Ceramics & glass**

**8%**
**Other uses**

**4%**
**Greases & polymers**

## Australia's lithium

**Biggest exporter** in the world

**46%** of **world's lithium production,** 2020

**In 2022/23 production ramp up** planned for 2 refineries

## 15.1 Summary

- Spodumene prices are forecast to rise from an average US$598 a tonne in 2021 to US$2,730 a tonne in 2022, and US$3,280 a tonne in 2023 before moderating to US$2,490 in 2024. We expect lithium hydroxide prices to lift from US$17,370 a tonne in 2021 to US$38,575 a tonne in 2022 and US$51,510 in 2023, and moderate to US$37,650 by 2024.
- Australia's lithium production is forecast to grow from 247,000 tonnes of lithium carbonate equivalent (LCE) in 2020–21 to 387,000 tonnes in 2022–23 and 469,000 tonnes of LCE in 2023–24.
- Australia's lithium export earnings are forecast to increase by more than ten-fold in just two years from $1.1 billion in 2020–21 to $13.8 billion in 2022–23, and ease to $12.9 billion by 2023–24.

## 15.2 World demand

### Global demand for lithium grows as electric vehicle sales take off

Global lithium demand continued to grow strongly in the June quarter 2022, driven by rising demand for electric vehicle batteries. Despite faltering global economic growth in the June quarter, sales and production of electric vehicles (EVs) continued their rapid growth trend.

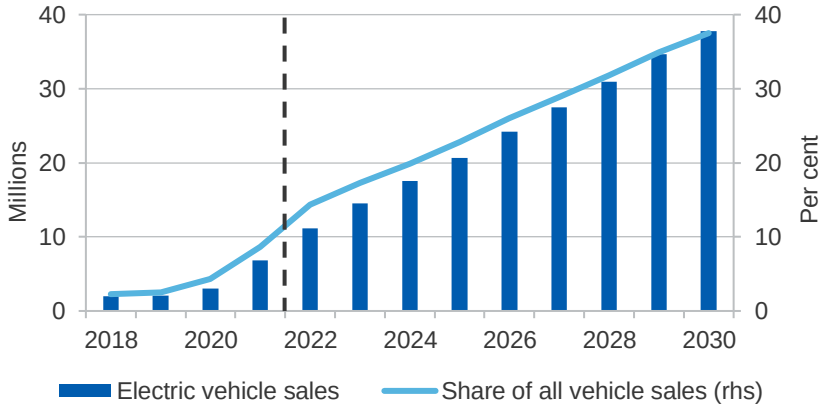
Global sales of all types of EVs increased 36% in the year to June 2022 compared with the same period in 2021 — with Chinese sales up 110%, European sales up 6%, and North American sales up 27%.

In China, total EV sales have averaged almost half a million vehicles a month so far in 2022, reaching a peak of 650 thousand vehicles in June. Overall, auto production and supply chains in China have now largely recovered from the COVID lockdowns, when EV sales fell to just over 300 thousand vehicles in April 2022.

In May, the Chinese Government cut purchase taxes on some low-emission passenger vehicles by 50%, while some municipal governments have also provided subsidies and incentives to encourage EV purchases. Global passenger EV sales are expected to continue to grow strongly, albeit at a slower rate than in 2021 — when passenger EV sales more than doubled to an estimated 6.8 million vehicles. Passenger EV sales are expected to hit 11.2 million in 2022 and 14.5 million in 2023 (Figure 15.1).

Key global automakers continue to accelerate plans to transition to EVs by developing new product lines and converting existing manufacturing capacity. The global market share for passenger EVs has quadrupled since 2019, with EV sales representing about 9% of the car market in 2021 (Figure 15.2). Strong underlying demand and EV manufacturers' declarations of further increases in production, imply that EV sales could reach almost 40% of vehicle sales annually by 2030.

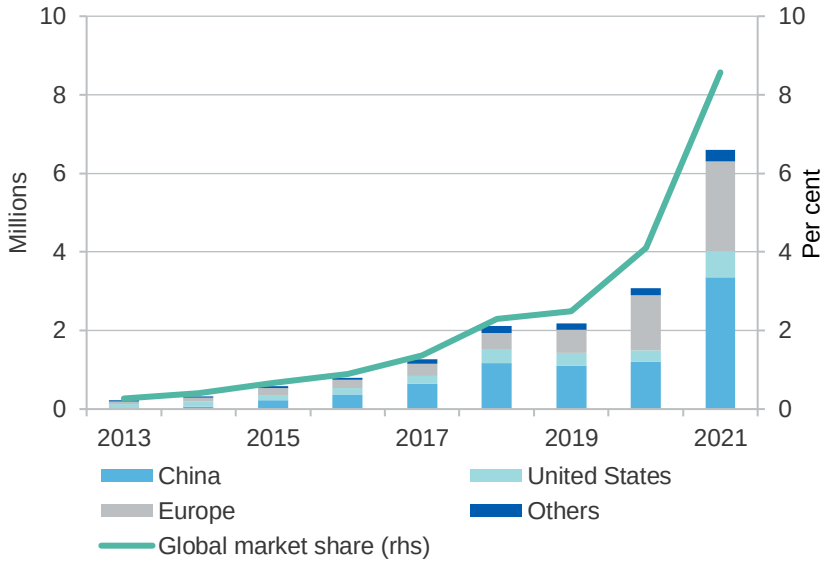
**Figure 15.1: Long term electric vehicle sales projections**




Source: Wood Mackenzie (2022), Department of Industry, Science and Resources (2022); IEA (2022).

World demand for lithium is estimated to increase from 583,000 tonnes of lithium carbonate equivalent (LCE) in 2021 to 724,000 tonnes in 2022 (Table 15.1). Over the following two years, demand is forecast to rise by over 40%, reaching 1,058,000 tonnes by 2024. Asia remains the major source of demand for lithium, despite the spread of new battery manufacturing capacity into Europe and the US.

## Figure 15.2: Electric vehicle sales by country




Source: IEA (2022).

China's EV subsidy program for passenger vehicles, which had been scheduled to conclude by the end of 2021, was extended to the end of 2022 earlier this year. Compared to a similarly priced internal combustion engine (ICE) passenger car model, the Chinese government subsidy provides a saving to customers of about 10,000 yuan. It has been reported that the Chinese government is now looking to continue the incentives next year.

Supply chain issues that plagued EV manufacturers and battery makers late in 2021 and earlier this year have eased somewhat. But supply remains tight, with reports of delivery timeframes for key EV models being pushed well into 2023. Higher prices for lithium as well as other key battery materials (such as nickel, graphite and cobalt) are putting pressure on battery costs.

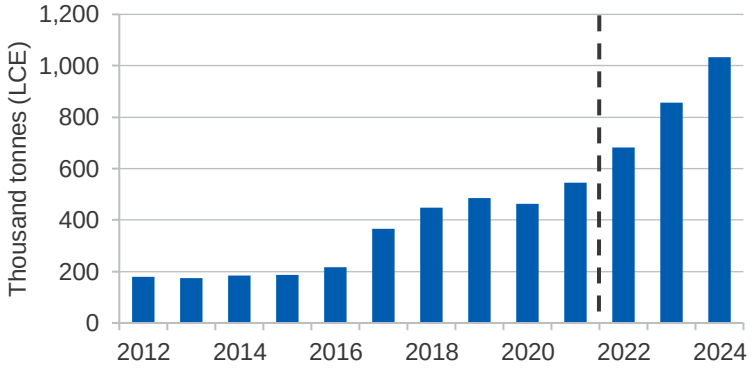
## 15.3 World production

### Global lithium production rising, but supply gap remains

World output was 546,000 tonnes LCE in 2021, and is forecast to reach 682,000 tonnes in 2022 and 1,034,000 tonnes in 2024 (Figure 15.3). This rapid growth — of over 80% in three years — is forecast to be met by gains in output by Australia (see section below), Chile (via expansions to Albemarle and SQM brine operations) and Argentina (via new and expanded brine operations by Livent, Allkem and Minera Exar).

Total supply from mine and brine operations is currently insufficient to meet demand. While new lithium projects are being developed, the supply gap will take time to close. Stockpile size is hard to ascertain, with some estimates of 4-8 weeks for spodumene. Ongoing tight supply conditions are forcing lithium processors and battery makers to pay record prices.

## Figure 15.3: Global lithium production




Source: Department of Industry, Science and Resources (2022); Wood Mackenzie (2022).

### Global race for new lithium production speeds up

A number of expansions and new projects have been announced in recent months. In addition to ongoing expansions to brine operations in Chile, state-owned mining firm Codelco is undertaking exploration in the Salar de Maricunga, with drilling due for completion early next year.

In Canada, three new lithium projects in Quebec are expected to start production in 2023, with a combined production of over 50,000 tonnes of LCE. Looking further ahead, the reopening of the Whabouchi mine, also in Quebec, is expected to add production of 52,500 tonnes a year from 2025. Mexico has created a state-run company to mine lithium after nationalising lithium resources in April. The company is scheduled to start operations within the next six months. While several companies hold contracts to explore potential lithium deposits, Mexico does not yet produce lithium.

Europe and North America are looking to reduce their dependency on Chinese imports and develop their own lithium production. In August, the US Government's *Inflation Reduction Act of 2022* came into effect. The Act contains provisions to promote the clean energy transition including significant incentives to purchase EVs.

Under the Act, a new EV will only be eligible for tax credits when at least 40% of the battery's critical minerals are extracted or processed from: the US, a free trade agreement partner such as Australia, or recycled in North America. This content requirement applies only to the minerals in the batteries, rather than the entire EV, and includes minerals such as lithium, nickel, cobalt and graphite. The content requirements increase progressively over time, reaching 100% by 2029. From 2024 onwards, the Act also stipulates that eligibility for the tax credits also depends on battery minerals or components not being sourced from 'foreign entities of concern'.

Zimbabwe's Premier African Minerals is expected to start shipping spodumene concentrate from its Zulu lithium mine to China by March 2023, with the long-term goal of producing around 50,000 tonnes a year.

In July, Argentina's Government revealed that Ultra Argentina SRL and China's Zangge Mining have committed $290 million to explore, develop and process the nation's lithium deposits. The Government expects about $4.2 billion of investment in its lithium sector over the next 5 years, which would help double output in 2023, and reach 175,000 tonnes in 2025.

Interest in recycling continues to rise, with recycling projects announced in many nations. However, large scale operations will take time to establish. Stronger lithium prices, combined with rising volumes of used EV batteries, should improve the economics of recycling projects.

## 15.4 Prices

### Record spodumene spot prices rolling into contract prices

Shortages of spodumene, lithium hydroxide and lithium carbonate continue to push spot prices to new records. Spot spodumene concentrate averaged about US$4,720 per tonne in August 2022 (SC6.0, CIF China).[1] This was up slightly from July, representing a ten-fold increase from the US$418 a tonne recorded in January 2021.

Spot prices for lithium hydroxide (delivered to China) averaged US$70,300 a tonne in August 2022, down slightly from the April peak of US$74,688, but still more than eight times the US$7,984 average of January 2021.

Supply disruptions in August (due to extended power cuts in Sichuan province, amidst an intense heatwave) added pressure to lithium prices in China. Sichuan produces more than 20% of China's lithium.

As most Australian producers have historically utilised long term contracts, prices received take time to adjust to shifts in spot prices. High average prices reported by Australian producers indicate spot prices are now flowing more rapidly into contract prices. ABS trade data indicate that average realised prices (which reflect a mix of contract and spot priced exports) have increased strongly so far in 2022, as processors seek to ensure supply is sufficient to meet expected demand.

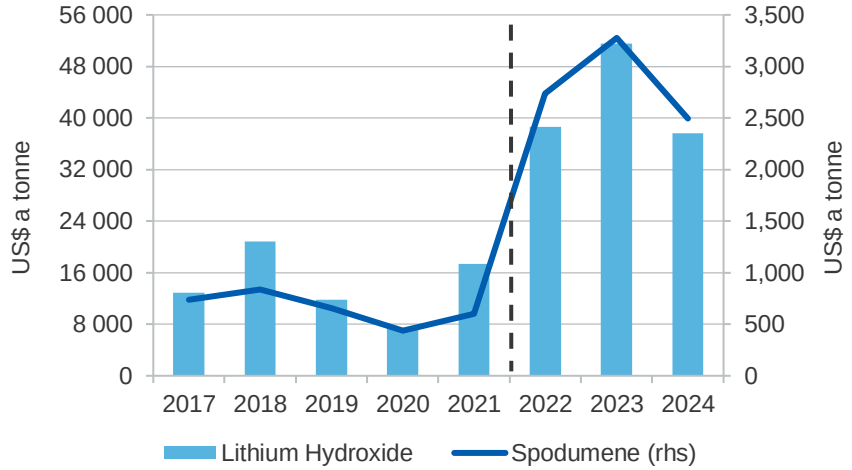
Spodumene prices are forecast to rise from an average of US$598 a tonne in 2021 to US$2,730 a tonne in 2022, as record spot prices feed through

[1] The SC6.0 CIF China price is an industry accepted reference price. The actual spodumene concentrate grade produced and shipped by Australia's lithium producers varies, and is often lower than the 6% lithium content. Hence, when companies report prices received they adjust the actual price received to generate a 6% 'reference' price.

into contract prices (Figure 15.4). Prices are expected to remain high in historic terms over the outlook, averaging US$3,280 a tonne by 2023 before moderating to US$2,490 in 2024.

The lithium hydroxide price is forecast to rise from US$17,370 a tonne in 2021 to US$38,575 a tonne in 2022. Prices are expected to peak in 2023 at over US$50,000 a tonne before moderating to average around US$37,600 in 2024.

### Figure 15.4: Spodumene concentrate/lithium hydroxide prices




Notes: Lithium hydroxide price is for higher-priced battery grade product.

Source: Wood Mackenzie (2022); Department of Industry, Science and Resources (2022).

Rapid price movements and the relative immaturity of the market will likely lead to ongoing uncertainty. Risks to the lithium price forecasts are balanced over the outlook period. While expansions to production are already underway in Australia and overseas, there are long lead times for lithium mine and brine operations. Moreover, the potential for delays in bringing such large volumes of lithium into production, mean risks remain of persistent supply shortages over the next few years.

However, one of the drivers of recent high spot prices appears to be a push by refiners and battery makers to build up inventories, due to concerns about global supply chains. The lack of data on global lithium stocks makes it difficult to judge how well battery producers have built up stockpiles. If these concerns ease, prices could moderate more rapidly over the outlook period. Prices may also ease if global economic growth slows more rapidly than recent IMF forecasts suggest it will.

## 15.5 Australia

### Lithium set to become a $10 billion-plus export industry within a year

Record spodumene prices are estimated to have lifted export revenue from $1.1 billion in 2020–21 to $4.9 billion in 2021–22. Production from lithium hydroxide refineries is forecast to steadily add to earnings over the outlook period, lifting total annual lithium export revenue to an estimated $12.9 billion in 2023–24.

The emergence of what is likely to be Australia's newest $10 billion-plus export industry occurred in three quite distinct stages (Figure 15.5).

From 2013–14 to 2017–18 the industry built capacity. Production volumes and export revenues rose from under $200 million to $1.7 billion — a more than eightfold increase.

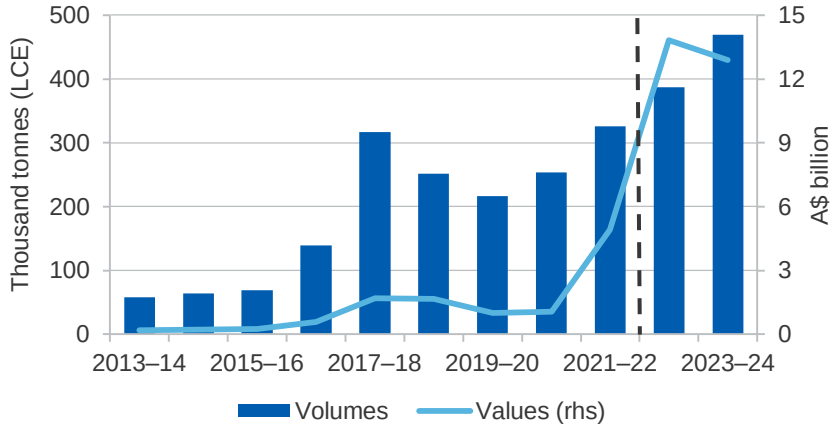
Over the next three years, global demand lost momentum and prices and revenues plunged. This fall tested the resilience of businesses, with some facilities relegated to care and maintenance.

But as global battery manufacturers and automakers reassessed their requirements over the course of 2021, demand for lithium took off again. This third stage holds even stronger growth prospects than the first, with Australia's lithium export revenues forecast to grow from $1.1 billion in 2020–21 to $13.8 billion in 2022–23 — a tenfold increase in just two years.

While much of the forecast export growth is price driven, Australia's production capacity is also forecast to grow strongly over the outlook. Expected annual average growth of over 20% a year will see production rise from 247,000 tonnes of LCE in 2020–21 to 387,000 tonnes in 2022–23, and 469,000 tonnes in 2023–24 (Figure 15.5).

Over the forecast period, export volumes of spodumene concentrate are forecast grow by more than one-third. From 2.3 million tonnes in 2021–22, spodumene concentrate exports are forecast to increase to 3.2 million tonnes in 2023–24.

### Figure 15.5: Australia's exports of lithium




Notes: Export values include revenue from spodumene concentrate and lithium hydroxide. Lithium volumes include total exports of spodumene concentrate and lithium hydroxide converted to LCE.

Source: Company reports; WA Department of Mines, Industry Regulation and Safety (2022), Wood Mackenzie (2022); Department of Industry, Science and Resources (2022).

## Producers ramp up production and exports

Talison Joint Venture's three operational plants at Greenbushes produced a combined total of 338,000 tonnes of spodumene concentrate in the June quarter 2022. This was up by 25% from the March quarter 2022. Tailings Retreatment Plant production continued to ramp up following completion of construction in the March quarter. The company has announced that chemical grade plant 2 has also continued to ramp up, with improved throughput, recovery and production. Further ramp up and optimisation is expected in coming quarters.

Pilbara Minerals produced 127,236 dry metric tonnes (dmt) of spodumene concentrate output in the June quarter 2022. This was an increase of 56% from the March quarter (81,431 dmt). The company stated the strong quarterly result was achieved despite being impacted by COVID-19 and associated labour shortages across the mining sector. Total spodumene produced in 2021–22 was 377,902, a 34% gain from 2020–21.

The company states that following completion of the Pilgan Plant improvement project, production capacity is now estimated to be in the range of 360–380 kilotonnes per annum (ktpa) of spodumene. The Ngungaju Plant produced first concentrate from the fines circuit in early June. Ore throughput has continued to increase and ramp up to the planned 180–200ktpa (dmt) concentrate production rate is expected to be achieved during the September quarter 2022.

Final investment decision was taken for a $300 million incremental 100ktpa capacity increase for the Pilgan plant during the June quarter — which will bring total production up from 580 ktpa to 680 ktpa. The 'P680' Project includes $50 million of pre-investment capital to assist with the proposed next phased expansion – with a targeted production capacity of up to 1Mtpa. FID for the P1000 Project is targeted for late December 2022.

Pilbara Minerals stated that the average realised spodumene sales price achieved in the June quarter 2022 was US$3,911 per dmt (6% CIF China basis). This was a substantial increase on the March quarter 2022 price of around US$2,650/dmt. The June quarter average price excludes a 5,000 dmt cargo sold via pre-auction on the Battery Metal Exchange in late June 2022 for just over US$7,000 dmt (6% CIF China basis), with shipment for this cargo expected in August 2022. Pilbara Minerals sold another 5,000 dmt cargo at auction for around US$7,700 in September 2022.

IGO states that it expects the chemical grade spodumene concentrate transfer price for the September and December quarters this year to be US$4,187. This is more than double the price of US$1,770 a tonne for the March and June quarters.

Output from Mt Marion (owned 50% by Mineral Resources and 50% by Jiangxi Ganfeng Lithium Co. Limited) totalled 128,000 dmt of spodumene concentrate in the June quarter 2022, with an average realised price of US$2,645 a tonne (up about 35% on the March quarter). In April 2022, the joint venture announced a decision to lift spodumene production at Mt Marion from 450,000 to 600,000 tonnes per annum of mixed-grade concentrate, targeting an annual plant capacity of 900,000 tonnes by end 2022 (equal to 600,000 tonnes of 6% spodumene concentrate).

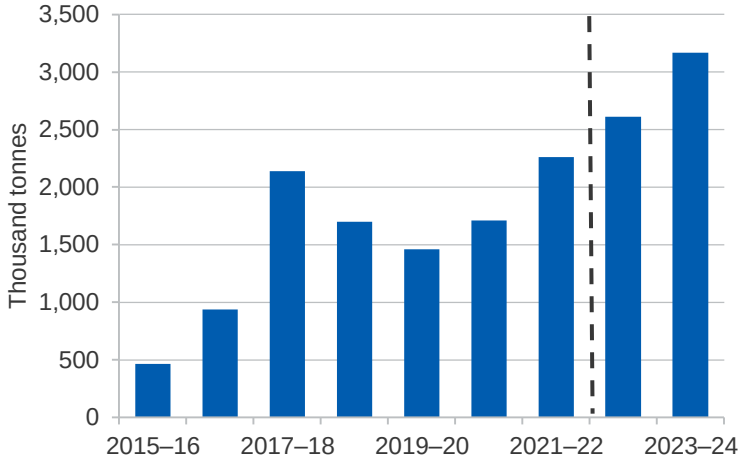
Mineral Resources and Albemarle stated that the restart of Wodgina saw first spodumene concentrate from Train 1 delivered in May, with 20,000 dmt produced in the June quarter. The restart of Train 2 progressed as scheduled, with first spodumene concentrate delivered in July.

Allkem's Mt Cattlin mine produced 24,845 dmt of spodumene concentrate in the June quarter, contributing to the record financial year production of 193,563 dmt in 2021–22. The average spodumene realised price received in the June quarter was US$4,992 per dmt, more than double the price of US$2,178 achieved in the March quarter.

Site construction continues at Core Lithium's Finniss Project near Darwin, following receipt of environmental approval for the BP33 underground mine. The project is expected to produce 160 ktpa of spodumene concentrate, and has offtake agreements with Ganfeng Lithium, Sichuan Yahau and a binding term sheet with Tesla. In July, the company reported a 28% increase in the Mineral Resource Estimate following drilling and exploration undertaken in the 2021 drilling season. The company reports that development is on schedule for first export of lithium ore by the end of 2022, and first spodumene concentrate production in 2023.

Liontown's Kathleen Valley deposit near Kalgoorlie received FID in the June quarter 2022. The project is expected to deliver about 500 ktpa of spodumene concentrate in the first year, rising to about 700 ktpa by year 6. Production is expected to start in the June quarter 2024. Offtake agreements are in place for about 90% of Kathleen Valley's start-up capacity, including tier-1 customers Ford, Tesla and LG Energy Solution.

**Figure 15.6: Spodumene exports**




Source: Wood Mackenzie (2022); Department of Industry, Science and Resources (2022).

## Australia's hydroxide refineries on verge of commercial production

Following the key milestone of first production of battery grade lithium hydroxide in May, the Kwinana lithium hydroxide refinery (51% Tianqi and 49% IGO) recommenced production in June after a planned three-week shutdown. IGO stated that production of battery grade hydroxide has allowed the start of the product qualification process with offtake partners, with an expected completion time of 4-8 months.

The company expects Train 1 production to ramp up concurrently with the qualification process over the coming quarters, in anticipation of the plant reaching commercial production during 2022–23. Construction of Train 2 has been partially completed, with the decision for the recommencement of construction to be made by the end of 2022. Each train has a capacity of 24,000 tonnes a year.

First product from Train 1 of the Kemerton lithium hydroxide plant (Albermarle 60%, Mineral Resources 40%) was delivered in early July 2022. Mechanical completion and commencement of production at

Kemerton's Stage 2 — which will produce an additional 25,000 tonnes a year — is targeted for the December quarter 2022.

Pilbara Minerals' joint venture with POSCO for the production of lithium hydroxide in South Korea was completed in April. During the June quarter, detailed engineering, procurement, site preparation and road works commenced. The joint venture plans to source over 300,000 tonnes a year of spodumene concentrate from the Pilgangoora operations.

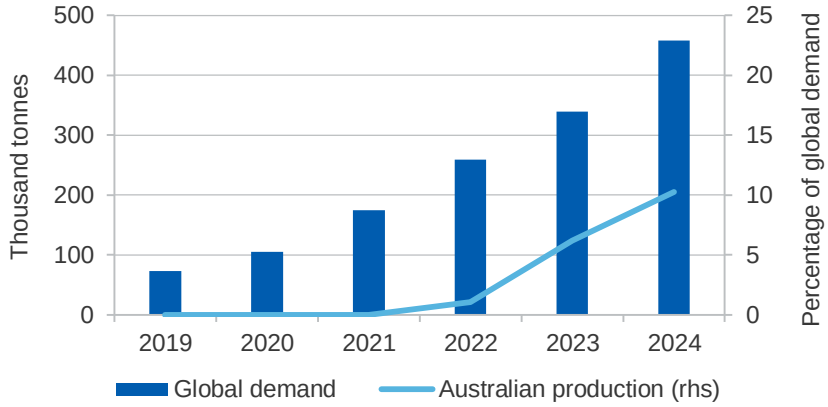
Construction of Covalent Lithium's (Wesfarmers 50%, SQM 50%) Kwinana lithium hydroxide refinery progressed in the June quarter 2022. The refinery is forecast to start in 2024 — making 50,000 tonnes of lithium hydroxide a year. The refinery will source spodumene from Mt Holland, where construction of the village and aerodrome has been completed, and pre-strip mining and construction of the concentrator is underway.

By 2024, Australia may have about 10% of global lithium hydroxide refining capacity (Figure 15.7), rising to about 20% of global lithium refining by 2027. There are a number of risks to the strong forecast growth for Australian lithium production and revenue over the outlook. Delays to approval and construction of new mine and processing plants, as well as difficulties achieving ramp up to full output, would see slower growth in spodumene output volumes and export values. For Australia's emerging lithium hydroxide refining sector, more unanticipated delays or technical challenges associated with achieving required product grade, purity and consistency, could delay output and exports.

China dominates the EV battery supply chain, producing three-quarters of all lithium-ion batteries, and holds around 70% of cathode production capacity and 85% of anode production (Figure 5.8). Over half of lithium, cobalt and graphite processing and refining capacity is located in China. This situation is not expected to change rapidly. The IEA states that the majority of the supply chain is likely to remain Chinese through to 2030. In the case of battery production, China accounts for 70% of new global production capacity announced for the period to 2030 (IEA 2022).

Australian businesses are expected to continue their expansion into higher value-added activities over the outlook period. Potential avenues include growth up the battery value chain, from mining and refining into precursor chemicals for cathodes, electrolyte production battery anode plants, battery cell research/production, and battery manufacturing (Figure 15.9).

### Figure 15.7: World and Australian lithium hydroxide output

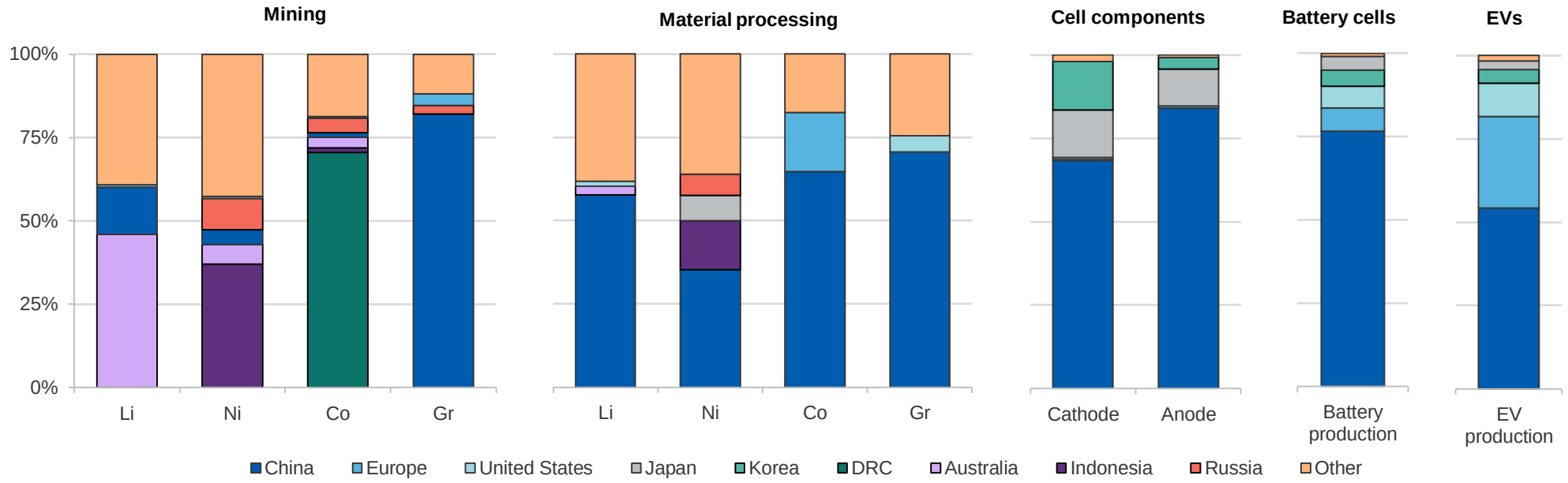



Source: Wood Mackenzie (2022); Department of Industry, Science and Resources (2022)

## Revisions to the outlook

Forecast export revenue over the outlook has been revised up substantially. This reflects sustained record prices, faster than expected pass-through of spot prices to contract prices and new Australian production and trade data. Export revenue in 2021–22 has been revised up, from $4.1 billion in the June 2022 *Resources and Energy Quarterly* to $4.9 billion. Further out, 2022–23 has been lifted from $7.8 billion to $13.8 billion, and 2023–24 from $9.4 billion to $12.9 billion.

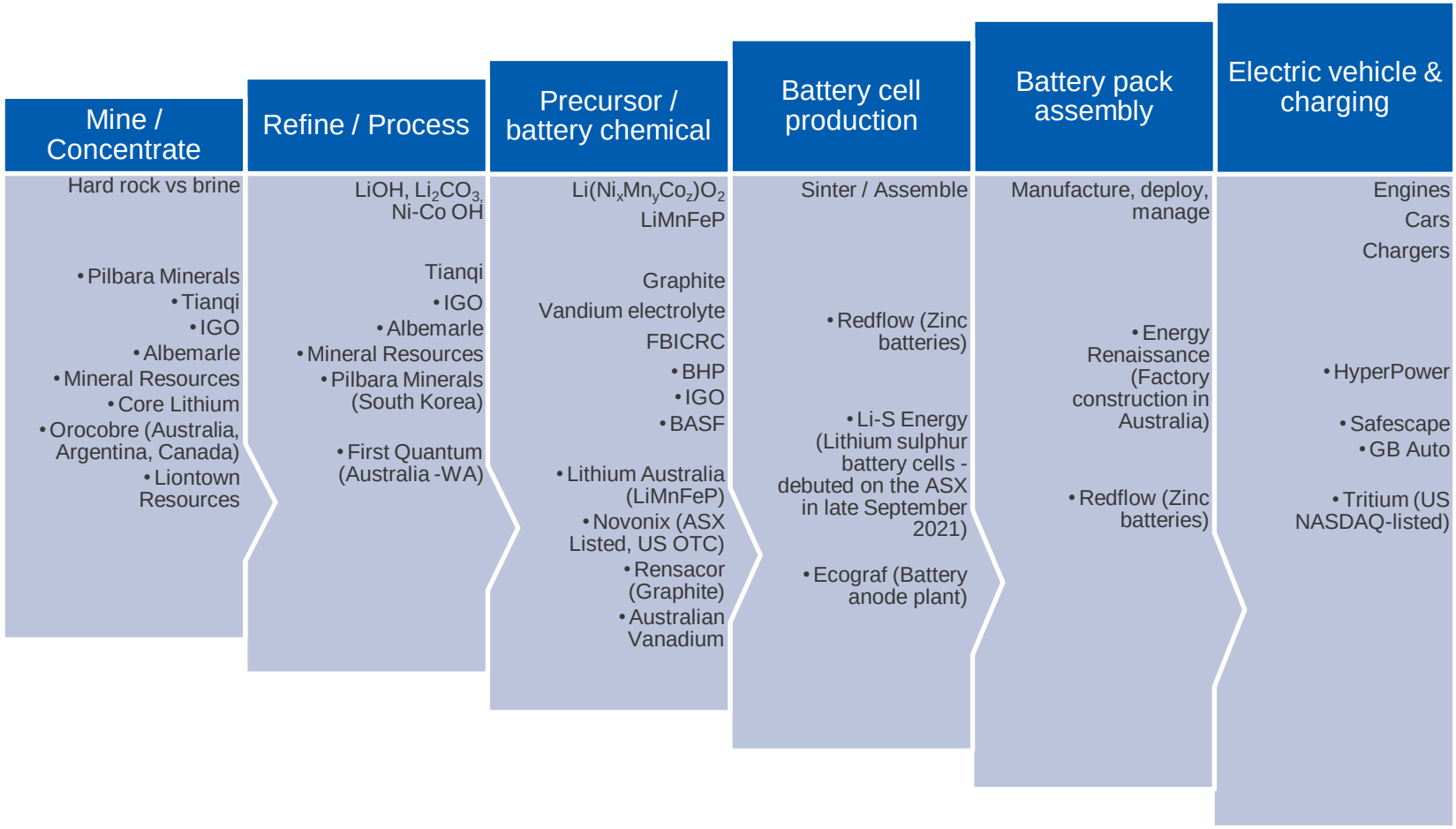
## Figure 15.8: Geographical distribution of the global EV battery supply chain




Notes: Li = lithium; Ni = nickel; Co = cobalt; Gr = graphite; DRC = Democratic Republic of Congo. Geographical breakdown refers to the country where the production occurs. Mining is based on production data. Material processing is based on refining production capacity data. Cell component production is based on cathode and anode material production capacity data. Battery cell production is based on battery cell production capacity data. EV production is based on EV production data. Although Indonesia produces around 40% of total nickel, little of this is currently used in the EV battery supply chain. The largest Class 1 battery grade nickel producers are Russia, Canada and Australia.

Source: IEA 2022, *Global Supply Chains of EV Batteries*. DISR 2022 (global lithium mining shares).

**Figure 15.9: Global lithium-ion battery value chain (+ zinc and vanadium batteries for large scale storage)**




Notes: Redflow is ASX listed and is currently producing zinc batteries offshore. Zinc and vanadium batteries are suitable for large scale storage.

Source: BloombergNEF (2021), *Australasian Institute of Mining and Metallurgy: Thought leadership conference*, September 2021; Future Battery Industry Co-operative Research Centre (2021).

## Table 15.1: Lithium outlook

| | | | | | | Annual percentage change | | |
|---|---|---|---|---|---|---|---|---|
| **World** | **Unit** | **2021** | **2022[s]** | **2023[f]** | **2024[f]** | **2022[s]** | **2023[f]** | **2024[f]** |
| Lithium production [a] | kt | 546 | 682 | 856 | 1,034 | 24.9 | 25.6 | 20.7 |
| Lithium demand | kt | 583 | 724 | 864 | 1,058 | 24.2 | 19.3 | 22.5 |
| Spodumene price | | | | | | | | |
| – nominal | US$/t | 598 | 2,730 | 3,280 | 2,490 | 357.0 | 19.8 | -23.8 |
| – real [b] | US$/t | 644 | 2,730 | 3,180 | 2,370 | 324.3 | 16.3 | -25.5 |
| Lithium hydroxide price | | | | | | | | |
| – nominal | US$/t | 17,370 | 38,575 | 51,510 | 37,650 | 122.1 | 33.5 | -26.9 |
| – real [b] | US$/t | 18,710 | 38,575 | 49,990 | 35,730 | 106.2 | 29.6 | -28.5 |
| **Australia** | **Unit** | **2020–21** | **2021–22[s]** | **2022–23[f]** | **2023–24[f]** | **2021–22[s]** | **2022–23[f]** | **2023–24[f]** |
| Mine production [a] | kt | 247 | 335 | 387 | 469 | 35.9 | 15.3 | 21.3 |
| Spodumene export volume [c] | kt | 1,711 | 2,264 | 2,609 | 3,166 | 32.3 | 15.3 | 21.3 |
| Export value | | | | | | | | |
| – nominal value [d] | A$m | 1,055 | 4,907 | 13,836 | 12,877 | 365.2 | 182.0 | -6.9 |
| – real value [e] | A$m | 1,179 | 5,250 | 13,836 | 12,355 | 345.4 | 163.5 | -10.7 |

Notes: **a** Lithium Carbonate Equivalent (LCE) — a measure of the quantity of refined product; **b** In 2022 US dollars; **c** Includes spodumene concentrates exported — mostly 6 per cent $Li_2O$ concentrate — plus spodumene concentrate used to produce lithium hydroxide for export; **d** Revenue from spodumene concentrate as well as lithium hydroxide; **e** In 2022–23 Australian dollars; **s** Estimate; **f** Forecast.

Source: Company reports; Department of Industry, Science and Resources (2022); Wood Mackenzie (2022); Government of Western Australia Department of Mines, Industry Regulation and Safety (2022).