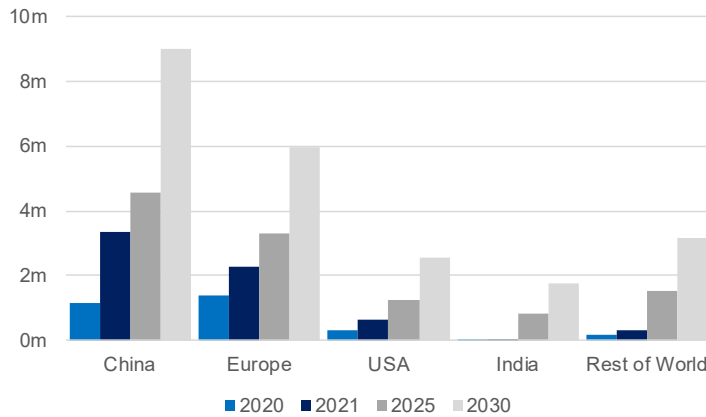




WESTERN AUSTRALIA BATTERY AND CRITICAL MINERALS PROFILE – February 2023

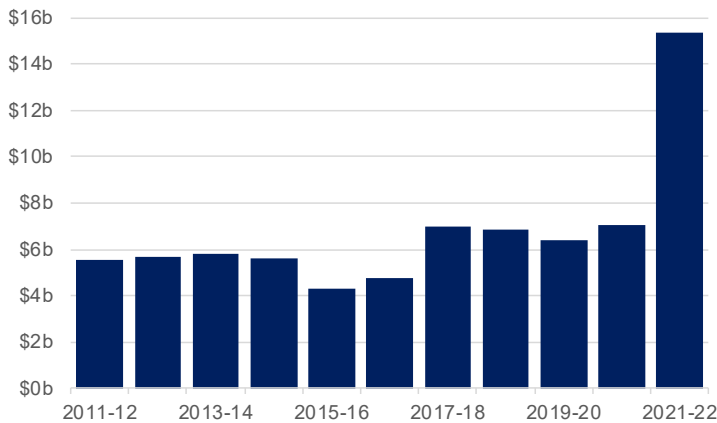
Electric car sales outlook¹: calendar years



m = Million. ¹ Sales of battery electric vehicles, plug-in hybrid vehicles and fuel cell electric vehicles under the Stated Policies Scenario, which includes existing policies and measures and policy ambitions and targets that have been legislated by governments to support the deployment of electric vehicles.
Source: International Energy Agency, Global EV Outlook 2022 (Annual).

- Global demand for minerals used in rechargeable batteries is increasing because of their use in electronics, energy storage and electric vehicles.
- Global electric car sales more than doubled to 6.6 million in 2021, mainly driven by China. Battery electric vehicles accounted for 71% of global electric car sales in 2021.
- In 2021, there were 16.5 million electric cars on the road globally, of which 68% were battery electric vehicles.
- Under the International Energy Agency's (IEA) Stated Policies Scenario, 200 million electric cars are projected to be on the road by 2030, with global electric car sales rising from 6.6 million in 2021 to 22.4 million in 2030, by which point they would account for over 20% of new car sales.
- Lithium and nickel are the major minerals used to make electric vehicle batteries, along with cobalt, graphite and manganese. Copper and rare earths are required for electric vehicle motors and charging infrastructure.
- Under its Stated Policies Scenario, the IEA projects global lithium demand will be four times higher in 2030 than in 2021 and nickel and cobalt demand will be 60% and 45% higher, respectively, over the same period.

Battery and critical minerals¹ sales from Western Australia: financial years



Kt = Thousand tonnes. ¹ Lithium (spodumene concentrate), nickel, cobalt, manganese, copper and rare earths.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual); and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia has significant resources of battery and critical minerals and already produces many of these minerals for export.
- Western Australia's battery and critical minerals are mainly exported to China, other markets in Asia (Japan, South Korea), Europe (Norway, Germany, Spain) and the United States.
- The value of Western Australia's battery and critical minerals sales rose 117% to \$15.3 billion in 2021-22.
- Western Australia's battery and critical minerals industry contributed \$363 million in royalties in 2021-22, an increase of 84% from 2020-21.
- Direct full-time equivalent employment in Western Australia's battery and critical minerals industry rose 20% to 15,491 in 2021-22.
- The estimated value of exploration expenditure for battery and critical minerals in Western Australia rose 11% to \$660 million in 2022.

Western Australia's battery and critical minerals industry

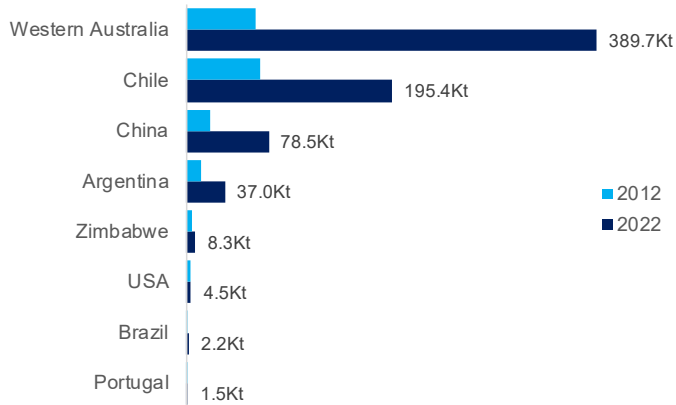
- [Lithium](#)
- [Nickel](#)
- [Cobalt](#)
- [Manganese](#)
- [Copper](#)
- [Rare earths](#)

- Western Australia's lithium, cobalt and nickel exports are mostly used in battery manufacturing, although some exports are for other uses.
- New investment in battery and critical minerals processing is expected to result in Western Australia moving further down the value chain and exporting more minerals specifically for battery manufacturing. For example, Western Australia currently exports lithium mainly as spodumene concentrate, but will soon start exporting lithium hydroxide in greater volumes.
- This report provides information on the battery and critical minerals industry, including:
 - global reserves and production
 - global demand and prices
 - Western Australia's reserves, production, sales, royalties and employment.



Lithium

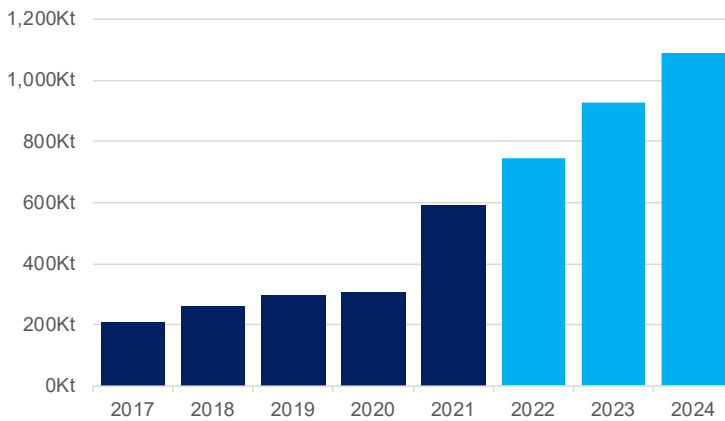
Lithium supply¹: calendar years



Kt = Thousand tonnes. ¹ Lithium carbonate equivalent (LCE) production. LCE is a benchmark product for the different lithium products of concentrate, carbonate, hydroxide, chloride and direct shipping ore. Source: S&P Global Market Intelligence (Annual).

- Western Australia is the largest lithium supplier in the world, accounting for 54% of global supply in 2022, followed by Chile (27%).
- Western Australia accounted for 100% of Australia's lithium production in 2022.
- Global lithium supply almost quadrupled to 717,000 tonnes of lithium carbonate equivalent between 2012 and 2022, with supply from Western Australia contributing 61% of the increase.
- In 2022, lithium carbonate equivalent supply from:
 - Western Australia rose 31% to 390,000 tonnes
 - Chile rose 31% to 195,000 tonnes
 - China rose 23% to 79,000 tonnes
 - Argentina rose 17% to 37,000 tonnes.

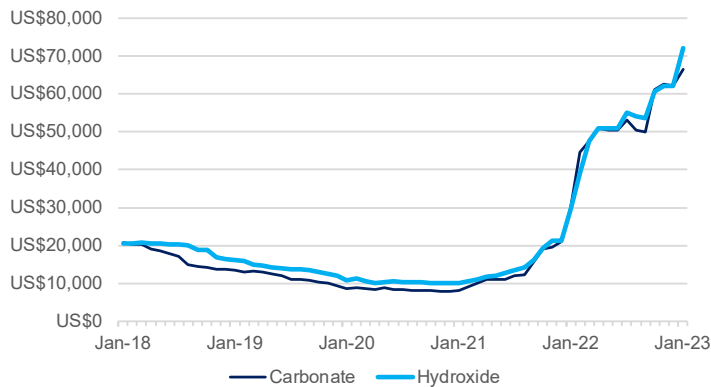
Lithium demand¹: calendar years



Kt = Thousand tonnes. ¹ Demand is ahead of consumption by around 12 months due to time taken to manufacture batteries. Source: Office of the Chief Economist, Resources and Energy Quarterly (Quarter).

- Lithium is mainly used in rechargeable batteries for mobile phones, laptops, digital cameras and electric vehicles. Rechargeable batteries account for 80% of the world's consumption of lithium.
- World lithium demand rose 94% to 592,000 tonnes in 2021.
- The Australian Government's Office of the Chief Economist forecasts annual world lithium demand will rise 84% between 2021 and 2024 to 1,091,000 tonnes.

Lithium prices¹: months

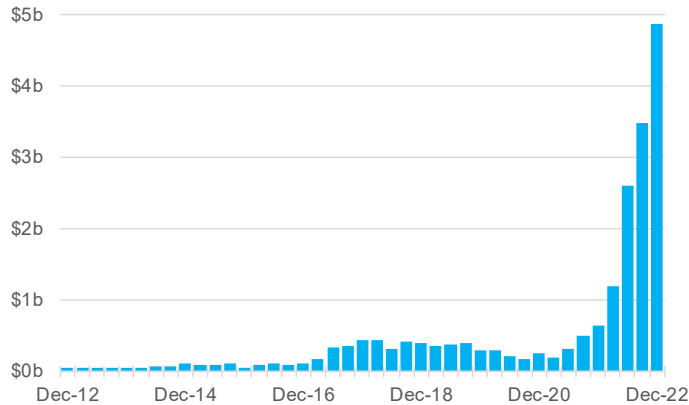


¹ US dollars a tonne. Asia, Cost, insurance and freight (CIF). ² Unit price of Western Australia's spodumene exports (free on board) converted to US dollars using the monthly average exchange rate. Source: S&P Global Market Intelligence/Benchmark Minerals (Month).

- Lithium prices increased to record high levels in 2022.
- For lithium carbonate, the annual average price rose from US\$13,313 a tonne in 2021 to US\$51,083 a tonne in 2022. The monthly average price rose 7% to US\$66,500 a tonne in January 2023.
- For lithium hydroxide, the annual average price rose from US\$14,500 a tonne in 2021 to US\$51,333 a tonne in 2022. The monthly average price rose 16% to US\$72,000 a tonne in January 2023.
- For lithium spodumene², the annual average price rose from US\$612 a tonne in 2021 to US\$3,116 a tonne in 2022. The monthly average price fell 13% to US\$3,753 a tonne in December 2022.
- The Office of the Chief Economist forecasts the annual average price of:
 - lithium spodumene will be US\$4,010 a tonne in 2023 and US\$3,130 a tonne in 2024
 - lithium hydroxide will be US\$61,220 a tonne in 2023 and US\$48,450 a tonne in 2024.



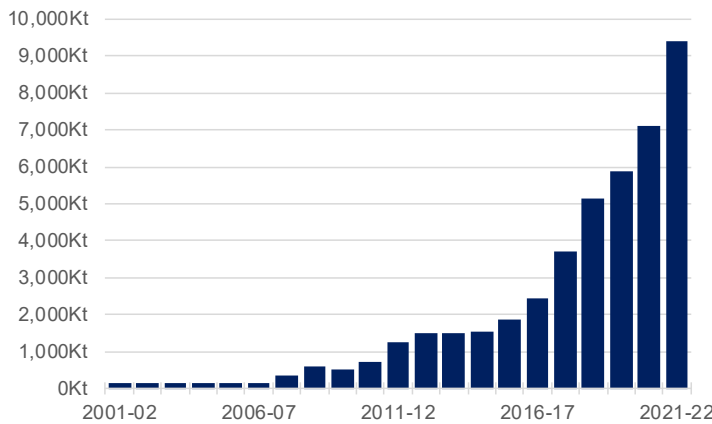
Lithium¹ exports from Western Australia: quarters



¹ May include other crude minerals.
Source: Based on data from ABS 5368.0 International Trade in Goods and Services, Australia (Monthly).

- Western Australia exports lithium mainly as spodumene concentrate for further processing.
- China is Western Australia's largest market for lithium, accounting for 97% of the State's lithium exports in 2022. Other lithium export markets in 2022 included Belgium, South Korea, United States, Netherlands and Japan.
- Western Australia exported \$4.9 billion of lithium in the December quarter 2022, 40% more than in the previous quarter.
- The value of Western Australia's lithium exports rose from \$1.7 billion in 2021 to \$12.2 billion in 2022.
- Western Australia has started producing lithium hydroxide and will start exporting it in greater volumes in 2023. The newly built Kwinana and Kemerton processing plants each have a capacity to produce around 25,000 tonnes of lithium hydroxide a year, supplied by lithium concentrate from the Greenbushes and Mt Marion mines. Additional trains are also being built at these plants that will double their production capacities.

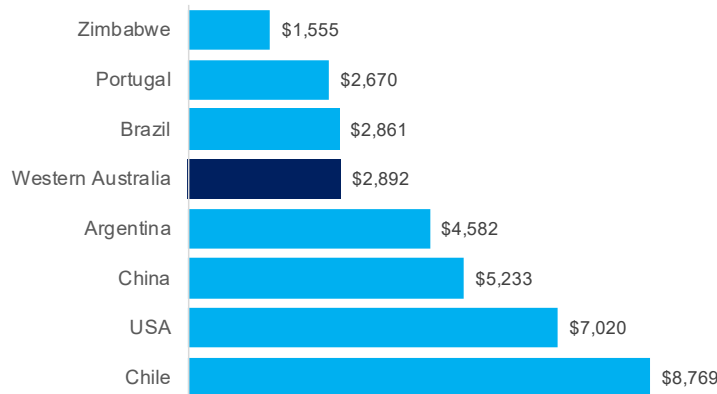
Lithium resources in Western Australia¹: financial years



Kt = Thousand tonnes. ¹ Estimated based on 99% of Australia's identified lithium resources.
Source: Based on data from ABS 5204.0 Australian System of National Accounts (Annual), Geoscience Australia, Australia's Identified Mineral Resources (Annual); and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia has large lithium reserves, accounting for 24% of the world's lithium reserves in 2021.
- Chile has the largest lithium reserves, accounting for 41% of the world's lithium reserves in 2021.
- Western Australia's estimated economic demonstrated lithium resource has increased rapidly over the past 5 years due to increased expenditure on lithium exploration.
- In 2021-22, Western Australia's estimated economic demonstrated lithium resource rose 32% to 9,382,000 tonnes. This resource could sustain the State's lithium production for 28 years at 2021-22 production rates.

Lithium production costs per unit¹: 2022 calendar year

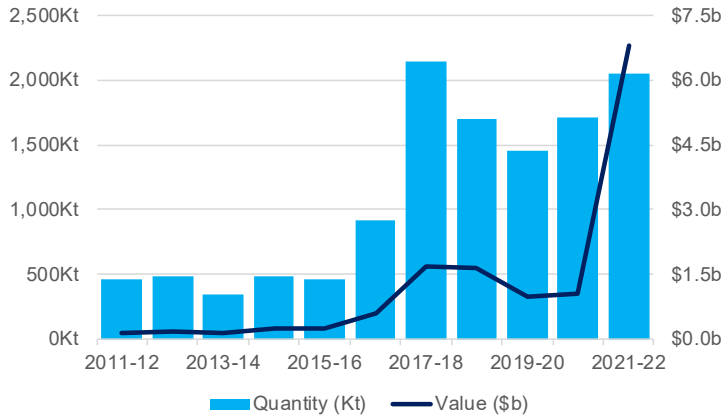


¹ Total cash costs per tonne of lithium carbonate equivalent (LCE) in US dollars. LCE is a benchmark product for the different lithium products of concentrate, carbonate, hydroxide, chloride and direct shipping ore.
Source: S&P Global Market Intelligence (Annual).

- Western Australia's lithium producers are among the world's lowest-cost producers and produce lithium at a much lower cost than the world's other major producers in Chile, China and Argentina. The cost competitiveness of Western Australia's lithium producers is mainly due to relatively low costs for royalties, chemicals, onsite services and energy.
- The average total cash cost of Western Australia's lithium production was US\$2,892 a lithium carbonate equivalent in 2022, below the world average of US\$4,846 a lithium carbonate equivalent.
- Western Australia produces lithium at a much lower cost than its major competitor in Chile.
- In 2022, Western Australia's average total cash cost of lithium production was 67% lower than Chile's average total cash cost of US\$8,769 a lithium carbonate equivalent.



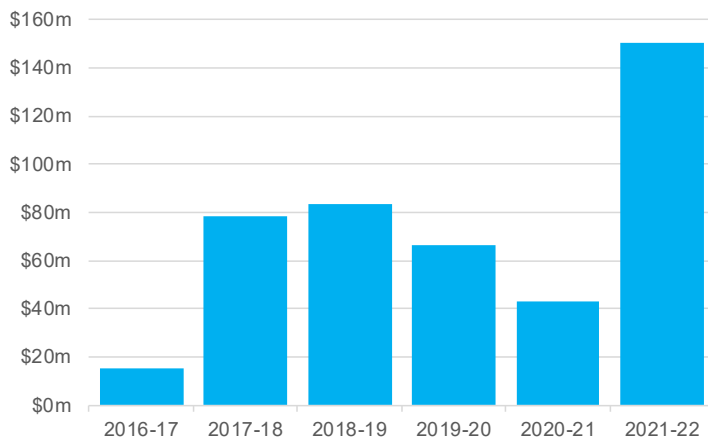
Lithium¹ sales from Western Australia: financial years



Kt = Thousand tonnes. ¹ Spodumene concentrate.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Greenbushes is Western Australia’s largest lithium mine, accounting for 51% of the State’s lithium production in 2022. Other major lithium mines included Mt Marion (15%), Pilgangoora (14%), Wodgina (14%) and Mt Cattlin (6%).
- The quantity of Western Australia’s lithium sales rose 20% to 2,045,000 tonnes in 2021-22.
- The value of Western Australia’s lithium sales increased by more than six times to \$6.8 billion in 2021-22.
- Western Australia’s third lithium hydroxide plant is under construction at Kwinana as part of the Mt Holland project, due for completion in 2025. The plant will have the capacity to produce 50,000 tonnes a year of lithium hydroxide.
- Trains 1 and 2 at the Wodgina lithium mine restarted in 2022 after the mine went into care and maintenance in November 2019. Train 3 is planned to restart in 2023 and a fourth train and hydroxide plant are being considered.
- Bald Hill is another lithium mine that restarted production in 2022 although it needs Commonwealth Government approval to return to full production.
- The Kathleen Valley lithium project was sanctioned for development in August 2022 and is targeting first spodumene production in mid-2024.

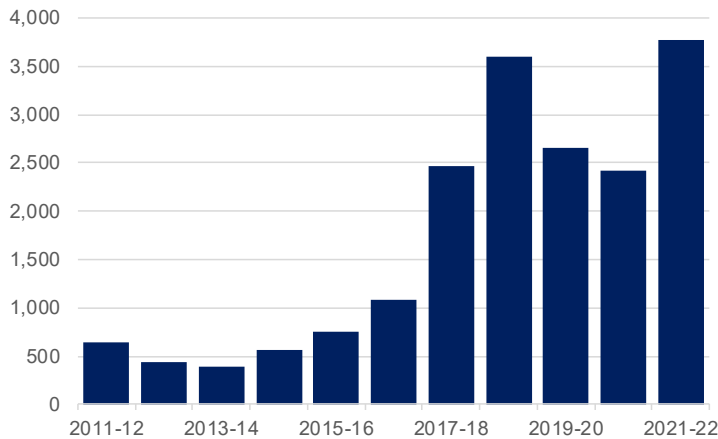
Lithium royalty revenue in Western Australia: financial years



Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia has a 5% royalty rate on the value of lithium concentrate (spodumene) feedstock.
- Lithium accounted for 1.2% of Western Australia’s royalty revenue (including North West Shelf grants) in 2021-22.
- Lithium royalties in Western Australia rose 247% to \$150 million in 2021-22.

Lithium employment in Western Australia¹: financial years



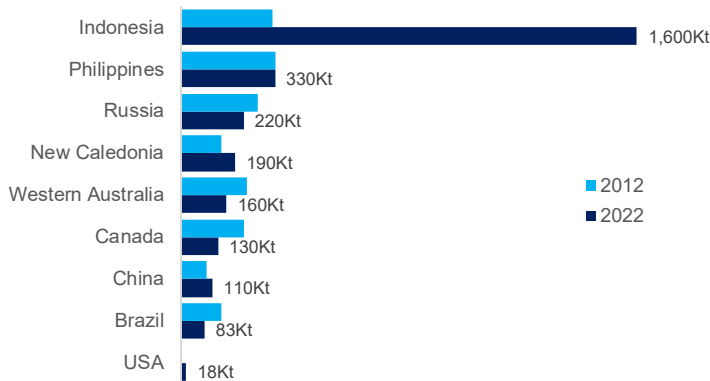
¹ Direct employment. Full-time equivalent (average on site).
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Direct full-time equivalent employment in Western Australia’s lithium industry rose 56% to 3,782 in 2021-22.
- Western Australia’s largest employing lithium mine sites in 2021-22 were:
 - Greenbushes (889)
 - Pilgangoora (861)
 - Mt Marion (525)
 - Yilgarn (401).



Nickel

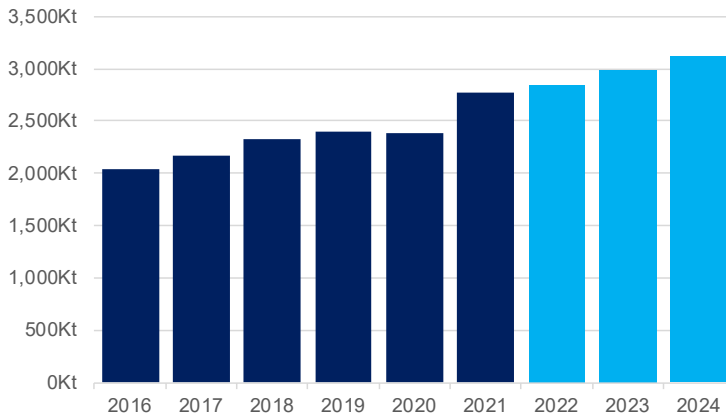
Nickel supply¹: calendar years



Kt = Thousand tonnes. ¹ Mine production.
Source: US Geological Survey, Mineral Commodity Summaries (Annual).

- Western Australia is the 5th largest nickel supplier in the world, accounting for 5% of global supply in 2022.
- Indonesia is the largest nickel supplier in the world, accounting for 48% of global supply in 2022, followed by the Philippines (10%).
- Western Australia accounted for 100% of Australia's nickel production in 2022.
- Global nickel supply rose 57% to 3.3 million tonnes between 2012 and 2022, mainly driven by supply from Indonesia.
- In 2022, nickel supply from:
 - Indonesia rose 54% to 1.6 million tonnes
 - Philippines fell 15% to 330,000 tonnes
 - Russia rose 7% to 220,000 tonnes
 - New Caledonia rose 2% to 190,000 tonnes
 - Western Australia rose 6% to 160,000 tonnes.

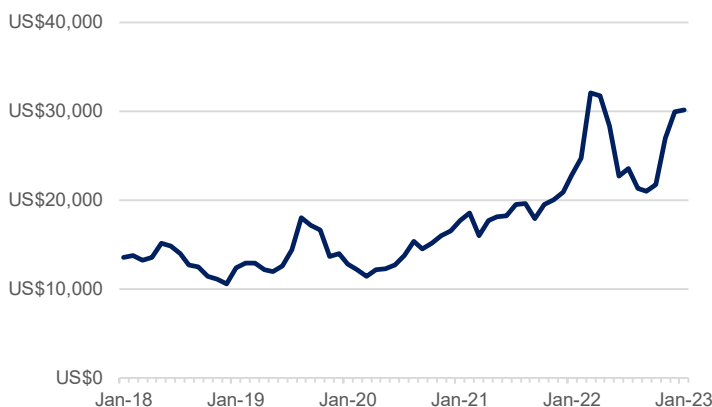
Nickel consumption: calendar years



Kt = Thousand tonnes.
Source: Office of the Chief Economist, Resources and Energy Quarterly (Quarter).

- Nickel is mainly used to make stainless steel, accounting for 65% of the world's consumption of nickel. However, the use of nickel in electric vehicle batteries is growing. Around 15% of the world's nickel is consumed in batteries, including rechargeable batteries for electronics, power tools, transport and emergency power supply.
- World nickel consumption rose 16% to 2,772,000 tonnes in 2021.
- The Office of the Chief Economist forecasts world nickel consumption will rise 13% to 3,120,000 tonnes between 2021 and 2024.

Nickel prices¹: months

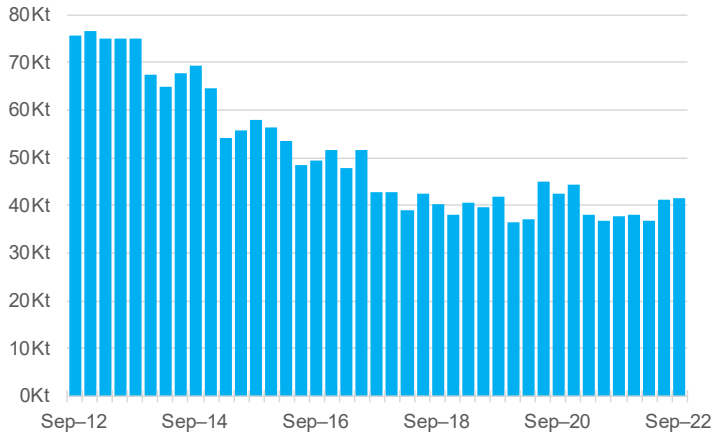


¹ US dollars a tonne. London Metal Exchange (LME) Cash.
Source: S&P Global Market Intelligence/Thomson Reuters (Month).

- Nickel prices rose sharply in late 2022 as demand for stainless steel strengthened in China with the lifting of COVID-19 restrictions.
- The monthly average nickel price rose 1% to US\$30,153 a tonne in January 2023.
- The annual average nickel price rose 37% to US\$25,558 a tonne in 2022.
- The Office of the Chief Economist forecasts the annual average price of nickel will be US\$21,563 a tonne in 2023 and US\$19,938 a tonne in 2024.



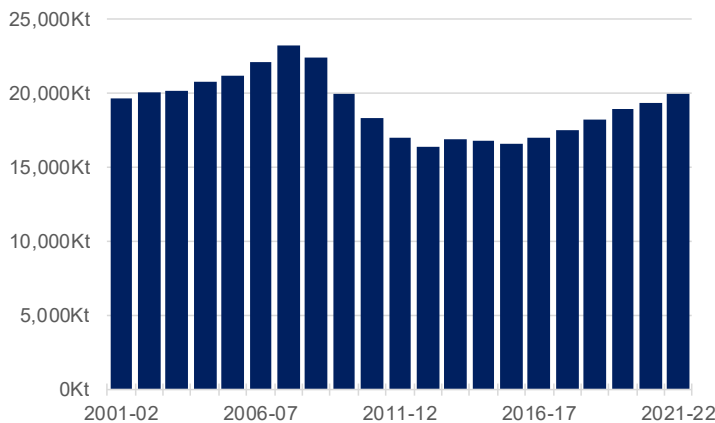
Nickel production¹ from Western Australia: quarters



Kt = Thousand tonnes. ¹ Nickel content from mine production.
Source: Office of the Chief Economist, Resources and Energy Quarterly (Quarter).

- Nickel West is Western Australia's largest nickel operation and includes the Mt Keith and Leinster mines, the Kambalda Concentrator, Kalgoorlie Smelter (matte) and Kwinana Refinery (powder and briquettes). Many other miners sell nickel ore to Nickel West for processing.
- The Mt Keith and Leinster mines accounted for a combined 38% of Western Australia's paid nickel mine production in 2022.
- Murrin Murrin is Western Australia's largest nickel mine, accounting for 20% of the State's paid nickel mine production in 2022. Other major nickel mines included Nova-Bollinger (13%), Ravensthorpe (10%), Forrestania (9%), South Kambalda (7%) and Savannah (3%).
- Western Australia produced 41,000 tonnes of nickel in the September quarter 2022, 0.1% more than in the previous quarter and 10% more than a year ago.
- The quantity of Western Australia's nickel production fell 5% to 154,000 tonnes in 2021-22, mainly due to lower nickel production at the Mt Keith, Nova-Bollinger and Forrestania mines.

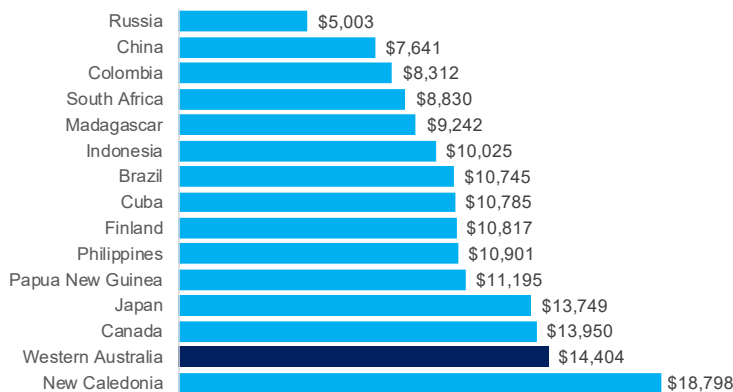
Nickel resources in Western Australia¹: financial years



Kt = Thousand tonnes. ¹ Estimated based on 89% of Australia's identified nickel resources.
Source: Based on data from ABS 5204.0 Australian System of National Accounts (Annual), Geoscience Australia, Australia's Identified Mineral Resources (Annual); and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia has large nickel reserves, accounting for 20% of the world's nickel reserves in 2021.
- Indonesia has the largest nickel reserves, accounting for 22% of the world's nickel reserves in 2021.
- Western Australia's estimated economic demonstrated nickel resource has increased moderately over the past 5 years.
- In 2021-22, Western Australia's estimated economic demonstrated nickel resource rose 3% to 19,936,000 tonnes. This resource could sustain the State's nickel production for 100 years at 2021-22 production rates.
- The value of Western Australia's nickel and cobalt exploration expenditure rose 30% to \$241 million in 2021-22.

Nickel production costs per unit¹: 2022 calendar year

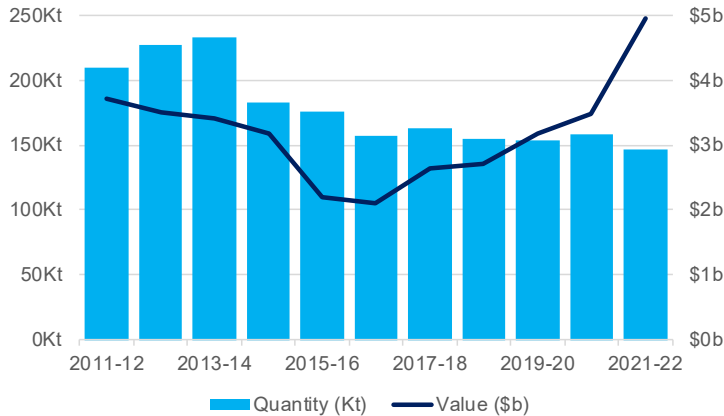


Note – Excludes countries with smaller production volumes.
¹ Total cash costs per tonne of paid nickel production in US dollars on a co-product or shared cost basis.
Source: S&P Global Market Intelligence (Annual).

- Western Australia's nickel producers are among the world's highest-cost producers, mainly due to relatively high costs for labour, energy and inland transport and shipping.
- The average total cash cost of Western Australia's nickel production was US\$14,404 a tonne in 2022, above the world average of US\$10,979 a tonne.
- Despite high production costs, Western Australia's nickel production is competitive because of low impurities.
- Less than half of the world's current nickel production is suitable for battery manufacturing. Battery manufacturing requires nickel that is at least 99.8% pure. High-grade nickel is mainly found in nickel sulphide deposits, which are in abundance in Western Australia.



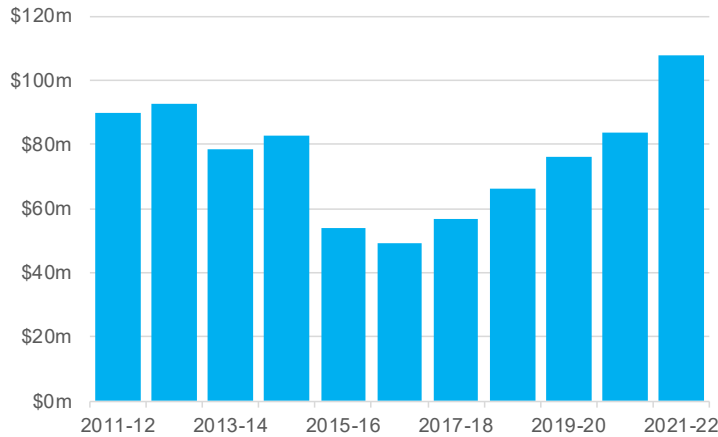
Nickel sales from Western Australia: financial years



Kt = Thousand tonnes.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Nickel produced in Western Australia is mainly exported to global battery material suppliers. Over 85% of Nickel West's nickel production is sold to battery material suppliers.
- The quantity of Western Australia's nickel sales fell 7% to 147,000 tonnes in 2021-22.
- The value of Western Australia's nickel sales rose 42% to \$4.9 billion in 2021-22.
- In September 2021, nickel sulphate production for lithium-ion batteries started from a newly built plant on the site of the existing Kwinana nickel refinery. There are plans to double the capacity of the 100,000 tonnes a year facility in coming years.
- China is Western Australia's largest market for nickel exports, accounting for 64% of the State's nickel exports in 2021-22. Other major nickel export markets in 2021-22 included Japan (17%) and South Korea (10%).

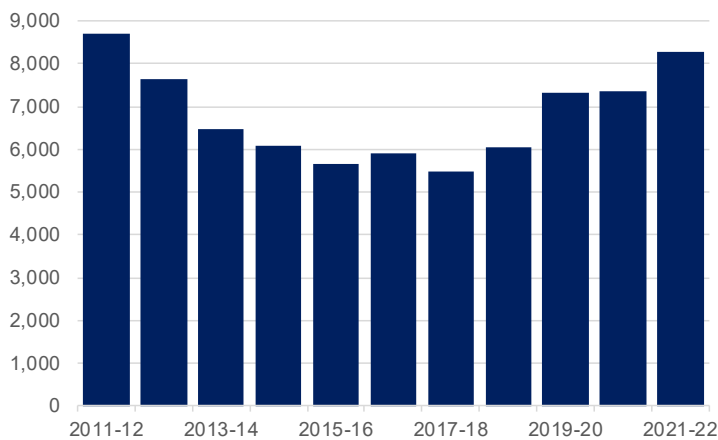
Nickel royalty revenue in Western Australia: financial years



Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia has a 2.5% royalty rate on the value of nickel sold.
- Nickel accounted for 0.8% of Western Australia's royalty revenue (including North West Shelf grants) in 2021-22.
- Nickel royalties in Western Australia rose 29% to \$108 million in 2021-22.

Nickel employment in Western Australia¹: financial years



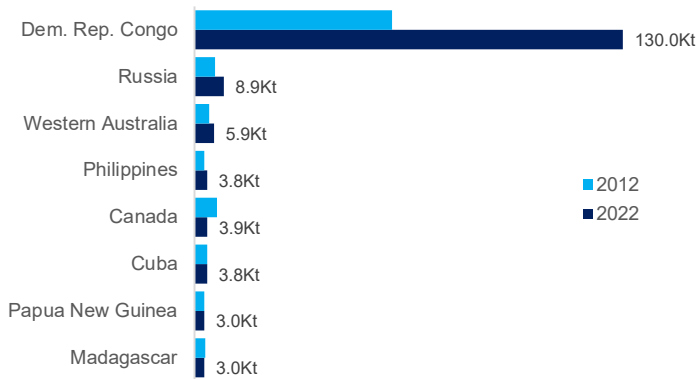
¹ Direct employment. Full-time equivalent (average on site).
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Direct full-time equivalent employment in Western Australia's nickel industry rose 13% to 8,297 in 2021-22.
- Western Australia's largest employing nickel mines and processing sites in 2021-22 were:
 - Murrin Murrin (1,613)
 - Ravensthorpe (1,061)
 - Leinster (760)
 - Mt Keith (622).



Cobalt

Cobalt supply¹: calendar years



Kt = Thousand tonnes. ¹ Mine production.
Source: US Geological Survey, Mineral Commodity Summaries (Annual).

- Western Australia is the 3rd largest cobalt supplier in the world, although accounted for only 3% of global supply in 2022.
- The Democratic Republic of Congo (DRC) is by far the largest cobalt supplier in the world, accounting for 68% of global supply in 2022, followed by Russia (5%).
- Western Australia accounted for 100% of Australia's cobalt production in 2022.
- Global cobalt supply rose 73% to 190,000 tonnes between 2012 and 2022, mainly driven by increased supply from the DRC and Indonesia. Supply decreased significantly from China and Canada over this period.
- In 2022, cobalt supply from:
 - the DRC rose 9% to 130,000 tonnes
 - Russia rose 11% to 8,900 tonnes
 - Western Australia rose 11% to 5,900 tonnes.

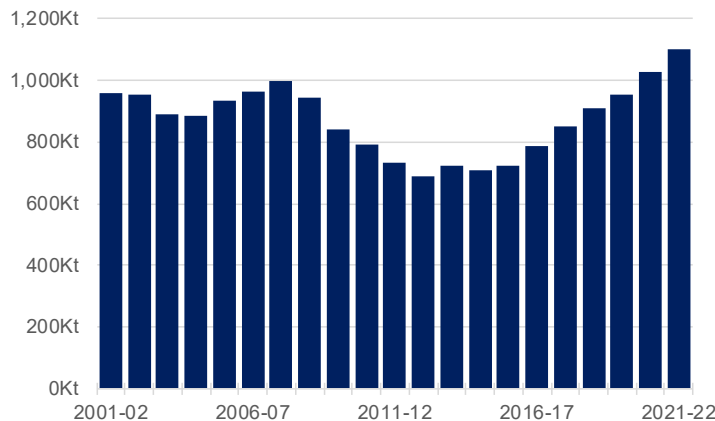
Cobalt prices¹: months



¹ US dollars a tonne. London Metal Exchange (LME) Cash.
Source: S&P Global Market Intelligence/Thomson Reuters (Month).

- Cobalt is mainly used in rechargeable battery electrodes, as well as superalloys to make gas turbine blades and aircraft engines. Over 80% of the world's consumption of cobalt is for manufacturing rechargeable batteries. China's cobalt demand is expected to fall in coming years as more of its electric vehicle batteries are made from high-nickel, low-cobalt chemistries.
- Cobalt prices fell in January 2023 as demand for electric vehicles and electronics weakened during the Chinese New Year holiday. The monthly average cobalt price fell 6% to US\$48,580 a tonne in January 2023.
- The annual average price of cobalt rose 21% to US\$63,269 a tonne in 2022.
- S&P Global Market Intelligence forecasts the annual average price of cobalt will be US\$53,956 a tonne in 2023 and US\$60,395 a tonne in 2024.

Cobalt resources in Western Australia¹: financial years

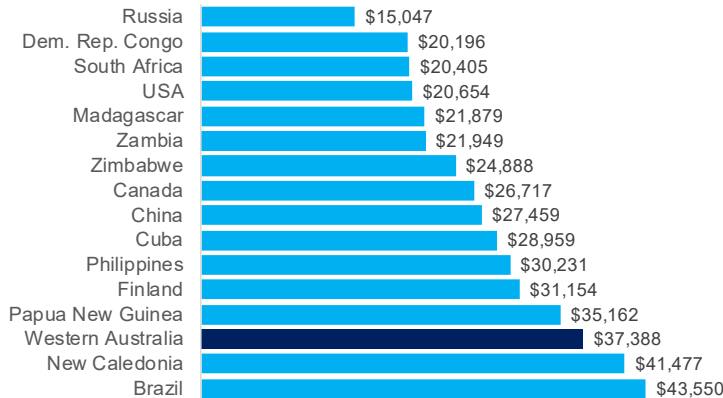


Kt = Thousand tonnes. ¹ Estimated based on 66% of Australia's identified cobalt resources.
Source: Based on data from ABS 5204.0 Australian System of National Accounts (Annual), Geoscience Australia, Australia's Identified Mineral Resources (Annual), and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia has large cobalt reserves, accounting for 13% of the world's cobalt reserves in 2021.
- The DRC has the largest cobalt reserves, accounting for 46% of the world's cobalt reserves in 2021.
- Western Australia's estimated economic demonstrated cobalt resource has increased steadily over the past 5 years.
- In 2021-22, Western Australia's estimated economic demonstrated cobalt resource rose 7% to 1,099,000 tonnes. This resource could sustain the State's cobalt production for 207 years at 2021-22 production rates.



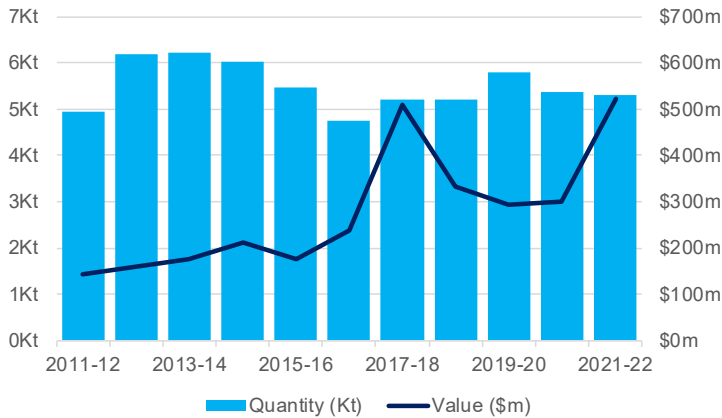
Cobalt production costs per unit¹: 2022 calendar year



¹ Total cash costs per tonne of paid cobalt production in US dollars on a co-product or shared cost basis.
Source: S&P Global Market Intelligence (Annual).

- Western Australia's cobalt producers are among the world's highest-cost producers, mainly due to relatively high costs for onsite services and labour.
- The average total cash cost of Western Australia's cobalt production was US\$37,388 a tonne in 2022, above the world average of US\$22,549 a tonne.
- Western Australia's close proximity to major cobalt markets in Asia reduces shipping costs relative to some of its competitors. The average cost of inland transport and shipping for Western Australian cobalt producers was US\$5,612 a tonne in 2022, 8% lower than the world average of US\$6,098 a tonne.

Cobalt sales from Western Australia: financial years



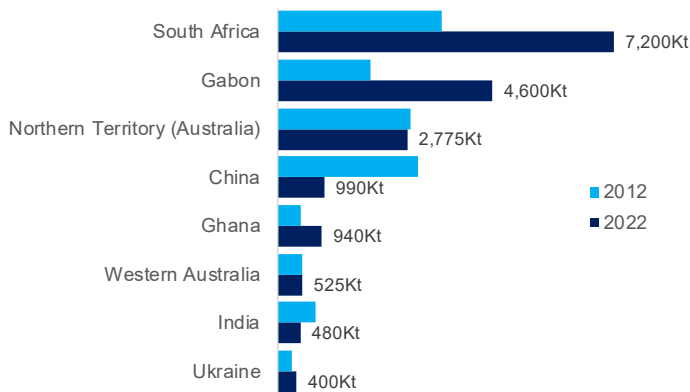
Kt = Thousand tonnes.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia's cobalt production mainly comes from the State's major nickel mines.
- In 2022, Murrin Murrin accounted for 60% of Western Australia's paid cobalt mine production, followed by Ravensthorpe (18%) and Nova-Bollinger (10%).
- The quantity of Western Australia's cobalt sales fell 1% to 5,300 tonnes in 2021-22.
- The value of Western Australia's cobalt sales rose 74% to \$522 million in 2021-22.
- Mt Thirsty is a major cobalt deposit proposed for development in Western Australia, which could produce 19,000 tonnes of cobalt a year and 25,000 tonnes of nickel a year if developed.



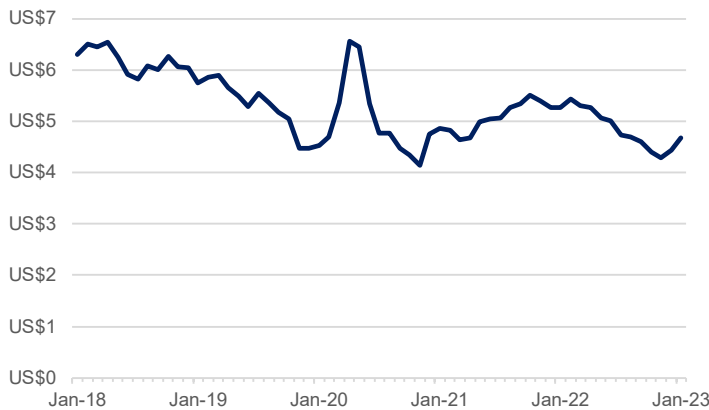
Manganese

Manganese supply¹: calendar years



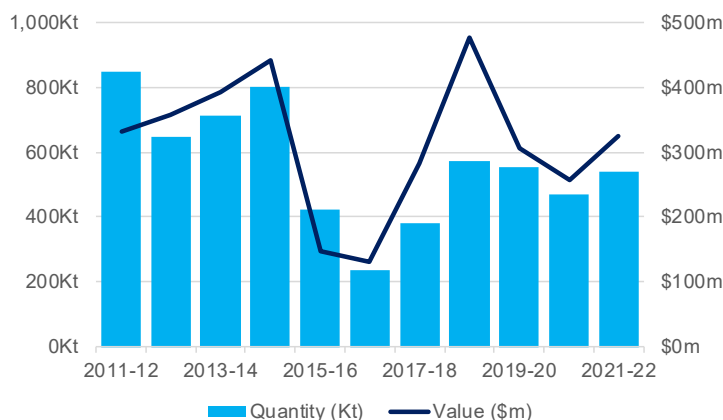
Kt = Thousand tonnes. ¹ Mine production.
Source: US Geological Survey, Mineral Commodity Summaries (Annual).

Manganese prices¹: months



¹ US dollars a dry tonne. Minimum 32% manganese and 20% iron content, Tianjin (China)-South Africa.
Source: S&P Global Market Intelligence/Thomson Reuters (Month).

Manganese sales from Western Australia: financial years



Kt = Thousand tonnes.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia is the 6th largest manganese supplier in the world, accounting for 3% of global supply in 2022.
- South Africa is the largest manganese supplier in the world, accounting for 36% of global supply in 2022, followed by Gabon (23%) and the Northern Territory (14%).
- Western Australia accounted for 16% of Australia's manganese production in 2022.
- Global manganese supply rose 25% to 20 million tonnes between 2012 and 2022, mainly driven by increased supply from South Africa and Gabon. Manganese supply from China, Brazil and India fell significantly over the same period.
- In 2022, manganese supply from:
 - South Africa was steady at 7.2 million tonnes
 - Gabon rose 6% to 4.6 million tonnes
 - Northern Territory rose 1% to 2.8 million tonnes
 - Western Australia 0.2% to 525,000 tonnes.

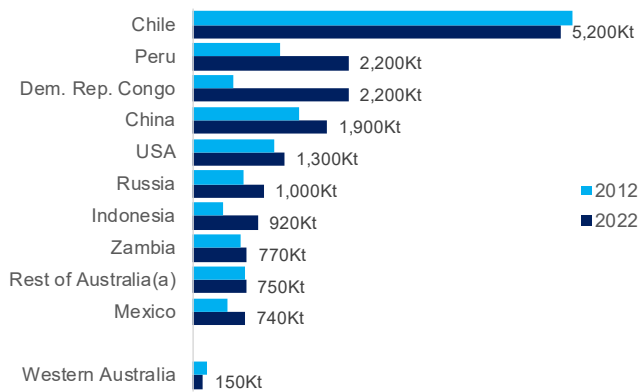
- Manganese is mostly used in steel production. There is increasing demand for manganese from the battery manufacturing industry as electrolytic manganese dioxide and electrolytic manganese metal are used in the production of rechargeable electric vehicle batteries.
- After trending down for most of 2022, manganese prices started to recover in late 2022 as world crude steel production increased.
- The monthly average manganese price rose 5% to US\$4.68 a tonne in January 2023.
- The annual average price of manganese fell 4% to US\$4.88 a tonne in 2022.

- Western Australia's manganese production comes from the Woodie Woodie and Butcherbird mines.
- Woodie Woodie returned to its full-scale production of 1.3 to 1.5 million tonnes a year in October 2017, after being put on care and maintenance in February 2016.
- Butcherbird started operating in 2021 at a capacity of 365,000 tonnes a year. Production capacity is being expanded to 1 million tonnes a year in 2022 and a feasibility study is underway to produce high-purity manganese sulphate monohydrate by 2025.
- In 2021-22, the quantity of Western Australia's manganese sales rose 15% to 539,000 tonnes.
- The value of Western Australia's manganese sales rose 26% to \$324 million in 2021-22.
- Direct full-time equivalent employment in Western Australia's manganese industry rose 4% to 561 in 2021-22, with Woodie Woodie employing 507 workers and Butcherbird employing 54 workers.



Copper

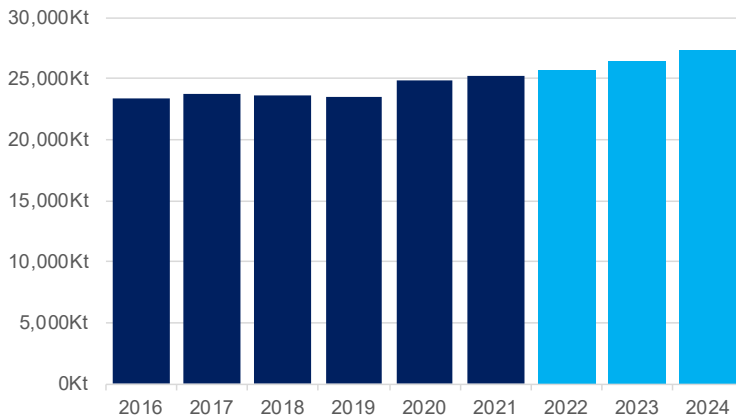
Copper supply¹: calendar years



Kt = Thousand tonnes. ¹ Mine production. (a) Mainly South Australia, New South Wales and Queensland.
Source: US Geological Survey, Mineral Commodity Summaries (Annual).

- Western Australia is not a major global copper supplier, ranking well outside the top 10 global suppliers in 2022.
- Chile is the largest copper supplier in the world, accounting for 24% of global supply in 2022, followed by Peru (10%) and the DRC (10%).
- Western Australia accounted for 18% of Australia's copper production in 2022.
- Global copper supply rose 37% to 22 million tonnes between 2012 and 2022, mainly driven by supply from the DRC, Peru and Indonesia.
- In 2022, copper supply from:
 - Chile fell 7% to 5.2 million tonnes
 - Peru fell 4% to 2.2 million tonnes
 - DRC rose 26% to 2.2 million tonnes
 - China fell 1% to 1.9 million tonnes
 - Western Australia fell 1% to 150,000 tonnes.

Copper consumption: calendar years



Kt = Thousand tonnes.
Source: Office of the Chief Economist, Resources and Energy Quarterly (Quarter).

- Copper is used in building construction, power generation and transmission, electronic product manufacturing and in the production of industrial machinery and transport vehicles. Building and infrastructure construction accounts for 45% of the world's consumption of copper, with 31% of copper consumed in equipment manufacturing and 12% of copper consumed in transport vehicles.
- Electric vehicle motors, batteries and charging infrastructure require significant amounts of copper. Electric vehicles require five times more copper than vehicles with internal combustion engines.
- World copper consumption rose 1% to 25,251,000 tonnes in 2021.
- The Office of the Chief Economist forecasts world copper consumption will rise 8% to 27,297,000 tonnes between 2021 and 2024.

Copper prices¹: months

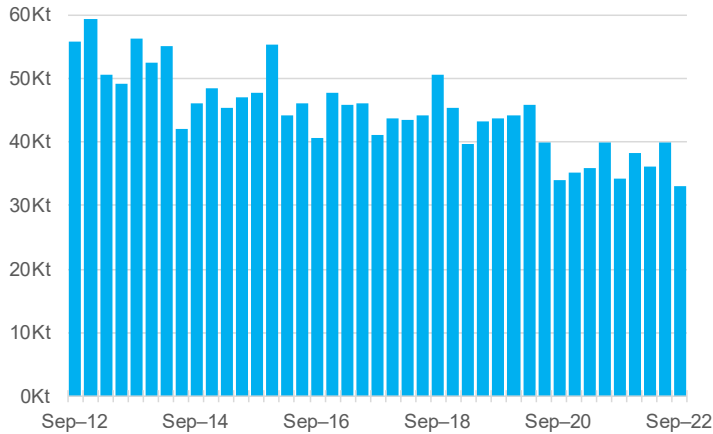


¹ US dollars a tonne. London Metal Exchange (LME) Grade A Cash.
Source: S&P Global Market Intelligence/Thomson Reuters (Month).

- Copper demand will be supported by its use in renewable energy technology and battery storage in the longer term.
- Copper prices have recovered strongly since late 2022 as the outlook for global economic conditions improved and China eased its COVID-19 restrictions.
- The monthly average copper price rose 10% to US\$9,200 a tonne in January 2023.
- The annual average copper price fell 7% to US\$8,742 a tonne in 2022.
- The Office of the Chief Economist forecasts the annual average price of copper will be US\$8,100 a tonne in 2023 and US\$7,870 a tonne in 2024.



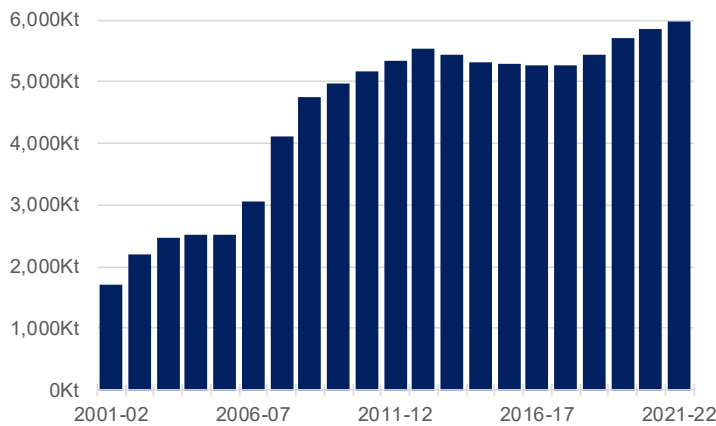
Copper production¹ from Western Australia: quarters



Kt = Thousand tonnes. ¹ Copper content from mine production.
Source: Office of the Chief Economist, Resources and Energy Quarterly (Quarter).

- Western Australia's copper production mainly comes from mines that also produce gold and nickel.
- The DeGrussa copper-gold mine is Western Australia's largest copper mine, accounting for 35% of the State's paid copper mine production in 2022. However, copper production ended at the DeGrussa mine in the September quarter 2022 due to resource depletion.
- Boddington, Western Australia's largest gold mine, is also the State's second largest copper mine, accounting for 32% of the State's paid copper mine production in 2022.
- Other major copper mines in Western Australia are the Golden Grove copper-gold mine (12%), Telfer gold-copper mine (10%) and Nova-Bollinger nickel-copper mine (7%).
- Western Australia produced 33,000 tonnes of copper in the September quarter 2022, 17% less than in the previous quarter and 3% less than a year ago.
- In 2021-22, the quantity of Western Australia's copper production rose 2% to 149,000 tonnes, mainly due to higher copper production at DeGrussa and Telfer in early 2022.

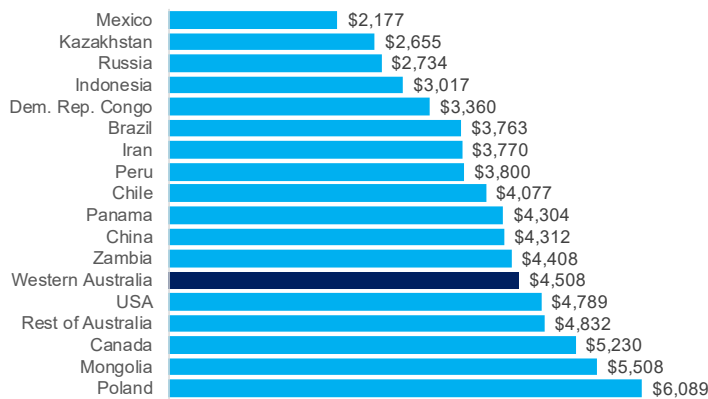
Copper resources in Western Australia¹: financial years



Kt = Thousand tonnes. ¹ Estimated based on 6% of Australia's identified copper resources.
Source: Based on data from ABS 5204.0 Australian System of National Accounts (Annual), Geoscience Australia, Australia's Identified Mineral Resources (Annual); and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia's copper reserves accounted for less than 1% of the world's copper reserves in 2021.
- Chile has the largest copper reserves, accounting for 23% of the world's copper reserves in 2021.
- Western Australia's estimated economic demonstrated copper resource has increased by 10% over the past 3 years.
- In 2021-22, Western Australia's estimated economic demonstrated copper resource rose 2% to 5,970,000 tonnes. This resource could sustain the State's copper production for 41 years at 2021-22 production rates.
- The value of Western Australia's copper exploration expenditure rose 73% to \$255 million in 2021-22.

Copper production costs per unit¹: 2022 calendar year

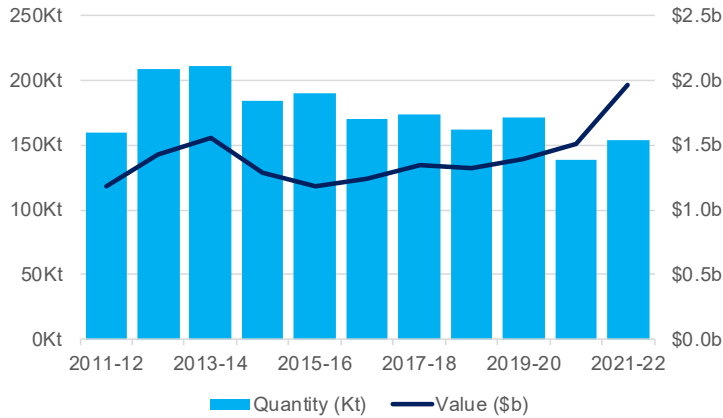


Note – Excludes countries with production volumes lower than Western Australia.
¹ Total cash costs per tonne of paid copper production in US dollars on a co-product or shared cost basis.
Source: S&P Global Market Intelligence (Annual).

- Western Australia's copper producers produce copper at higher than the world average cost per unit.
- The average total cash cost of Western Australia's copper production was US\$4,508 a tonne in 2022, above the world average of US\$3,988 a tonne.
- Western Australia's copper production has relatively high costs for onsite services and labour, but relatively low costs for energy and chemicals.



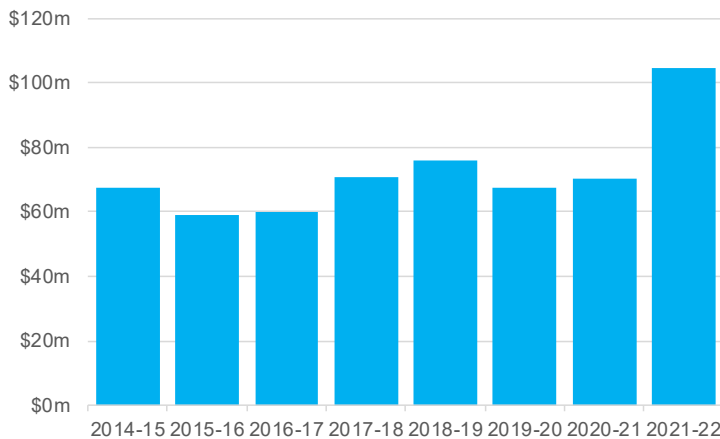
Copper sales from Western Australia: financial years



Kt = Thousand tonnes.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Copper produced in Western Australia is exported mainly as concentrates for further refining in overseas facilities.
- South Korea is Western Australia's largest market for copper, accounting for 27% of the State's copper exports in 2021-22. Other major copper export markets in 2021-22 were the Philippines (24%) and Japan (22%). China was Western Australia's largest market for copper prior to imposing import restrictions on Australian copper in 2020.
- The quantity of Western Australia's copper sales rose 11% to 153,000 tonnes in 2021-22.
- The value of Western Australia's copper sales rose 30% to \$2.0 billion in 2021-22.
- The West Musgrave copper project was sanctioned for development in September 2022. The project will produce 32,000 tonnes of copper concentrate a year, starting in the second half of 2025.
- Western Australia has a number of proposed copper projects that if developed would add around 60,000 tonnes of annual copper production from 2026. Proposed projects include Caravel, Winu and Sulphur Springs.

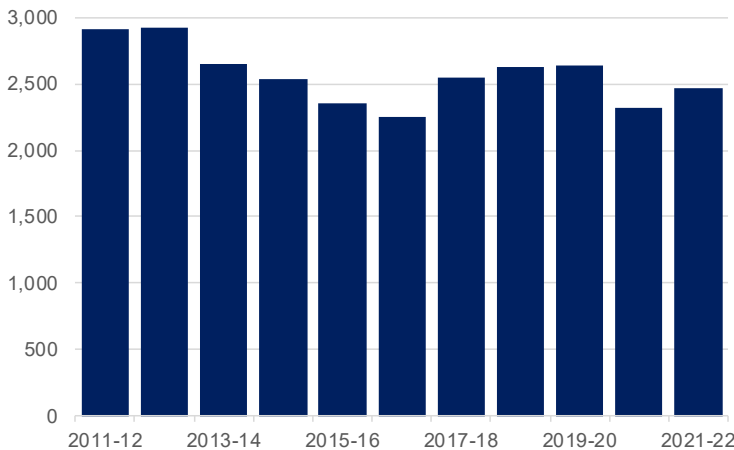
Copper royalty revenue in Western Australia: financial years



Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia has a 5% royalty rate on the value of copper sold as concentrate.
- Copper accounted for 0.8% of Western Australia's royalty revenue (including North West Shelf grants) in 2021-22.
- Copper royalties in Western Australia rose 48% to \$105 million in 2021-22.

Copper employment in Western Australia¹: financial years



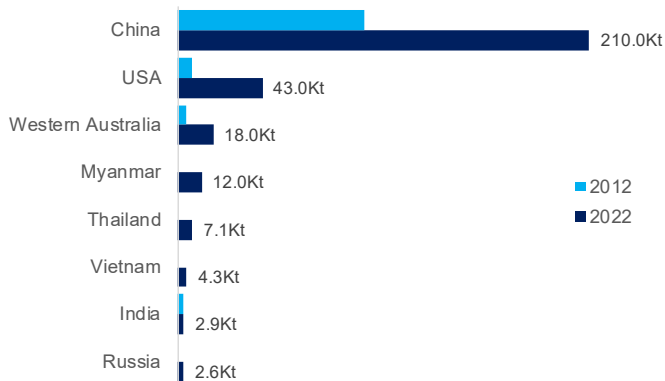
¹ Direct employment. Full-time equivalent (average on site).
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Direct full-time equivalent employment in Western Australia's copper industry rose 7% to 2,471 in 2021-22.
- Western Australia's largest employing copper mine sites in 2021-22 were:
 - Golden Grove (885)
 - DeGrussa (532)
 - Jaguar (305).



Rare earths

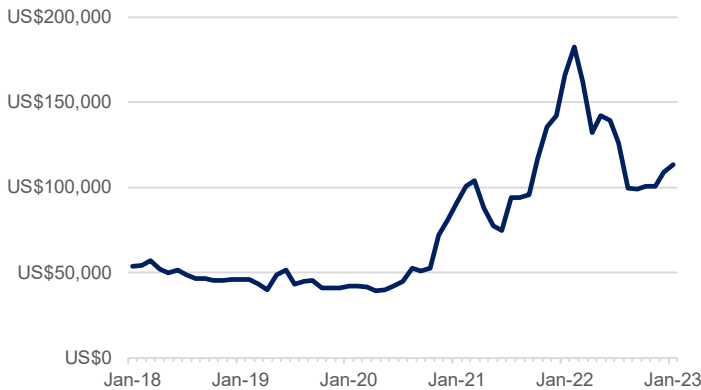
Rare earths supply¹: calendar years



Kt = Thousand tonnes. ¹ Rare earth oxides mine production.
Source: US Geological Survey, Mineral Commodity Summaries (Annual).

- Western Australia is the 3rd largest rare earths supplier in the world, accounting for 6% of global supply in 2022.
- China is by far the largest rare earths supplier in the world, accounting for 70% of global supply in 2022, followed by the United States (14%).
- Western Australia accounted for 100% of Australia's rare earths production in 2022.
- Global rare earths supply almost tripled to 300,000 tonnes between 2012 and 2022, mainly driven by increased supply from China and the United States.
- In 2022, rare earths supply from:
 - China rose 25% to 210,000 tonnes
 - United States rose 2% to 43,000 tonnes
 - Western Australia fell 25% to 18,000 tonnes.

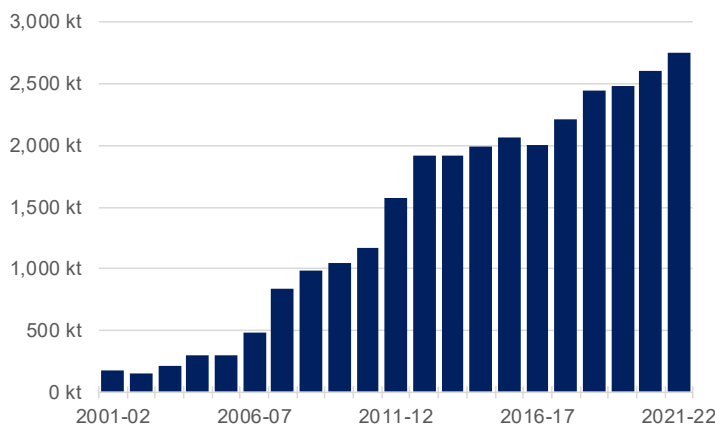
Neodymium prices¹: months



¹ US dollars a tonne. Oxide 99% China Free on board (FOB).
Source: S&P Global Market Intelligence/Thomson Reuters (Month) and WA Department of Jobs, Tourism, Science and Innovation.

- Rare earths are used in high-tech consumer products and defence applications.
 - Neodymium is used in electric vehicle motor magnets and wind turbines.
 - Praseodymium is used in aircraft engines.
 - Cerium is used in catalytic converters for cars.
 - Lanthanum is used in lenses for cameras and telescopes.
- Neodymium prices have risen over the four months to January 2023.
- The monthly average neodymium price rose 4% to US\$113,342 a tonne in January 2023.
- The annual average price of neodymium rose 29% to US\$130,016 a tonne in 2022.

Rare earths resources in Western Australia¹: financial years

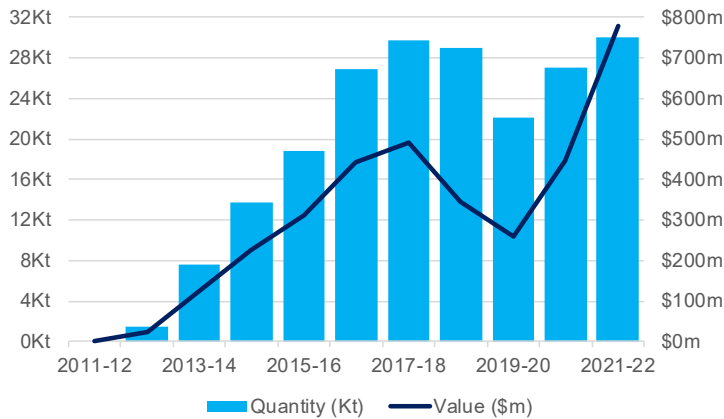


Kt = Thousand tonnes. ¹ Estimated based on 60% of Australia's identified rare earths resources.
Source: Based on data from ABS 5204.0 Australian System of National Accounts (Annual), Geoscience Australia, Australia's Identified Mineral Resources (Annual); and WA Department of Jobs, Tourism, Science and Innovation.

- Western Australia's rare earths reserves accounted for less than 1% of the world's rare earths reserves in 2021.
- China has the largest rare earths reserves, accounting for 35% of the world's rare earths reserves in 2021.
- Western Australia's estimated economic demonstrated rare earths resource has increased steadily over the past 5 years.
- In 2021-22, Western Australia's estimated economic demonstrated rare earths resource rose 5% to 2,749,000 tonnes. This resource could sustain the State's rare earths production for 110 years at 2021-22 production rates.



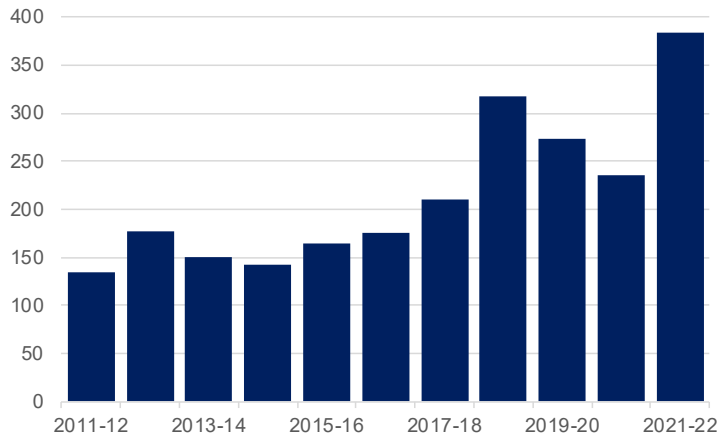
Rare earths sales from Western Australia: financial years



Kt = Thousand tonnes.
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Western Australia is one of the world’s largest rare earths producers outside of China, with production mainly coming from the Mt Weld mine.
- In 2021-22, the quantity of Western Australia’s rare earths sales rose 11% to 30,000 tonnes.
- The value of Western Australia’s rare earths sales rose 74% to \$779 million in 2021-22.
- The production capacity of the Mt Weld mine is being expanded by 12,000 tonnes of neodymium praseodymium equivalent a year by 2025.
- A rare earths processing plant is being constructed in Kalgoorlie to process rare earths concentrate from the Mt Weld mine. The plant will produce 38,000 tonnes of rare earths carbonate a year by 2025.
- In April 2022, the proposed Eneabba rare earths refinery was sanctioned for development, after receiving a \$1.25 billion loan from the Federal government. Construction of the 20,000 tonnes a year facility is expected to start in 2022 with first production in 2025.
- Early construction works started on the Yangibana rare earths project in 2022. The project is targeting first production in late 2024 (15,000 tonnes a year).
- The Browns Range Stage 2 project is another proposed rare earths development in Western Australia (3,000 tonnes a year). The Browns Range pilot plant operated between 2018 and 2021.

Rare earths employment in Western Australia¹: financial years



¹ Direct employment. Full-time equivalent (average on site).
Source: WA Department of Mines, Industry Regulation and Safety, Resource Data Files (Bi-Annual).

- Direct full-time equivalent employment in Western Australia’s rare earths industry rose 63% to 383 in 2021-22.
- Western Australia’s largest employing rare earths mine and processing sites in 2021-22 were:
 - Mt Weld (197).
 - Kalgoorlie Processing Plant (75).
 - Browns Range (45).