



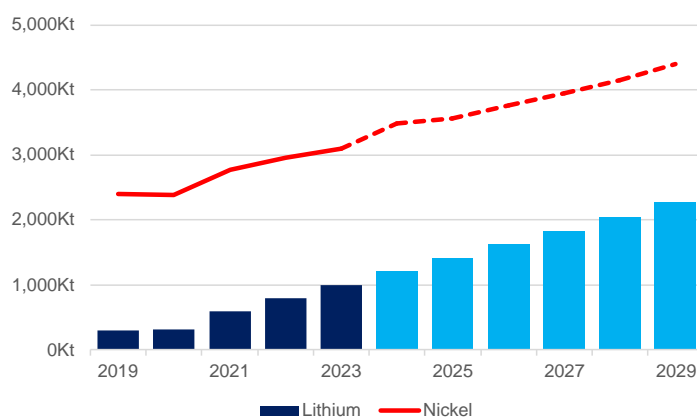
WESTERN AUSTRALIA BATTERY AND CRITICAL MINERALS PROFILE – May 2024

Overview

Battery minerals are minerals used in rechargeable batteries, such as lithium, nickel, cobalt, graphite, manganese, high purity alumina, tin, tantalum, magnesium, and vanadium. The definition of critical minerals is more subjective; jurisdictions use different definitions based on the minerals they deem to be critical to their economy and industries of strategic importance, as well as how sensitive certain minerals are to changes in global supply. The Australian Government maintains the [Critical Minerals List and Strategic Materials List](#) for Australia. Minerals on these lists are essential to Australia's net-zero transition, advanced manufacturing, defence technologies and capabilities, and broader strategic applications. These minerals also have geological resource potential in Australia, are in demand from strategic international partners and are vulnerable to supply chain disruption.

Of the minerals included on Australia's critical and strategic minerals lists, this profile focuses on lithium, nickel, cobalt, and rare earth elements. These minerals are produced in significantly large quantities in Western Australia and are the main minerals used in manufacturing rechargeable batteries, electric vehicle and wind turbine motors, and other high technology devices.

Demand outlook¹



Note – Forecasts start in 2024. Kt = Thousand tonnes of lithium carbonate equivalent. ¹ Consumption of nickel and cobalt and demand of lithium. Demand is ahead of consumption by around 12 months due to the time taken to manufacture batteries.

Source: Office of the Chief Economist, Resources and Energy Quarterly.

- The global push to meet net-zero emissions targets and sustainable development goals is creating more demand for battery and critical minerals.
- World lithium demand rose 26% to 1 million tonnes in 2023. The Office of the Chief Economist forecasts annual world lithium demand will rise 126% to 2.3 million tonnes between 2023 and 2029.
- World nickel consumption rose 5% to 3.1 million tonnes in 2023. The Office of the Chief Economist forecasts world nickel consumption will rise 42% to 4.4 million tonnes between 2023 and 2029.
- World cobalt consumption rose 12% to 209,000 tonnes in 2023. S&P Global Market Intelligence forecasts world cobalt consumption will rise 68% to 351,000 tonnes between 2023 and 2028.
- Electric vehicles are a major driver of battery minerals demand. In 2023, global electric car sales rose 35% to 14 million. Under the International Energy Agency's Stated Policy Scenario, electric vehicle battery demand will grow four-and-a-half times by 2030, and almost seven times by 2035, compared to 2023.

Western Australia's battery and critical minerals industry

Western Australia accounts for a large proportion of the world's production and resources of many battery and critical minerals. Western Australia produces around half of the world's lithium and is among the top six global producers of nickel, cobalt, and rare earths. Western Australia produces almost all of Australia's lithium, nickel, cobalt, and rare earths.

Western Australia is also moving further up the battery and critical minerals value chain.

- Western Australia has started producing lithium hydroxide from processing plants in Kwinana and Kemerton. These plants have the capacity to produce around 25,000 and 50,000 tonnes of lithium hydroxide a year respectively. A third lithium hydroxide plant is under construction at Kwinana as part of the Mt Holland project. This plant will have the capacity to produce 50,000 tonnes a year of lithium hydroxide, starting in 2025.
- Nickel West, Western Australia's largest nickel operation, started producing nickel sulphate for lithium-ion batteries in September 2021. The plant at Kwinana can produce 100,000 tonnes of nickel sulphate a year.

Production and resources: 2023

Mineral ¹	Production			Resources	
	WA global ranking	WA share of AUS (%)	WA share of world (%)	WA share of AUS (%)	WA share of world (%)
Cobalt	4	100	2	70	13
Copper	>13	13	0.5	8	1
Graphite	n.a.	n.a.	n.a.	17	n.a.
Lithium	1	97	47	99	26
Manganese	8	17	3	70	11
Nickel	6	98	4	90	21
Rare earths	4	100	8	50	3
Vanadium	n.a.	n.a.	n.a.	62	20
Zinc	>11	5	0.4	7	2
Zircon	3	35	11	34	25

Note – Western Australia's global rankings and world shares presented in the table may differ from similar content in other parts of this report due to a different data source. n.a. not applicable or available. ¹ Includes a selection of minerals for which Western Australia has a significant share of global production or resources.

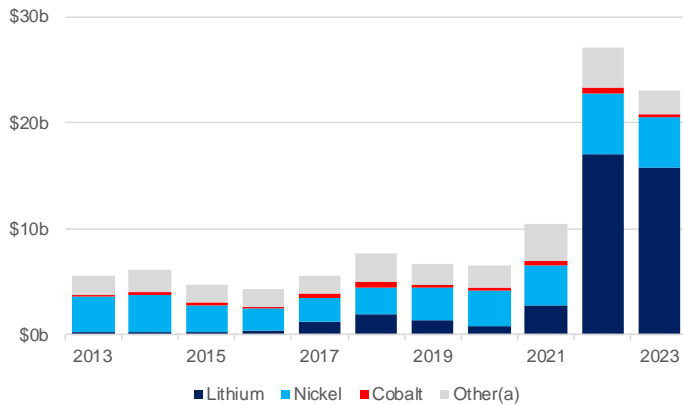
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files; Geoscience Australia, Australia's Identified Mineral Resources; and US Geological Survey, Mineral Commodity Summaries.

Note on lithium volumes: As lithium is produced as different compounds, lithium volumes can be reported in different units. This profile reproduces the information from other sources as originally reported. As a guide, the lithium content of lithium carbonate is around 19 per cent, so volumes reported in lithium carbonate equivalent are around 5.3 times higher than volumes reported in lithium content.



Contribution to the Western Australian economy

Sales value

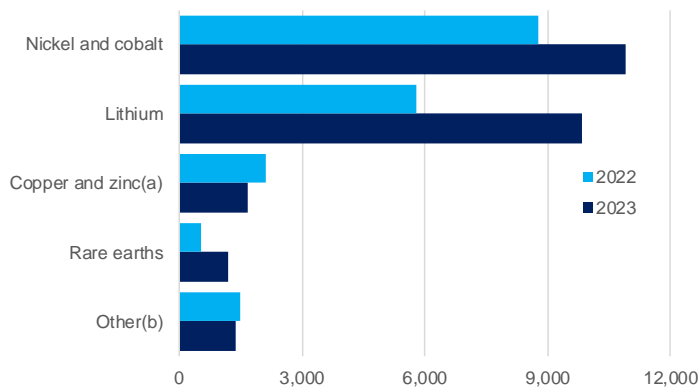


Note – The value of some minerals in the 'other' category is not included in the total for some years due to confidentiality restrictions. (a) Includes copper, zircon, zinc, manganese, rare earths, platinum group elements, silica sands, tantalum, tin and chromite.

Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files; and WA Department of Jobs, Tourism, Science and Innovation.

- Lithium (spodumene) accounted for 69% of the value of Western Australia's battery and critical minerals sales in 2023, with nickel accounting for 20% and cobalt 1%.
- While the value of rare earths sales is not available for 2023, rare earths sales in 2022 accounted for 3% of the value of Western Australia's battery and critical minerals sales.
- Price falls for some minerals in 2023 led to the value of Western Australia's battery and critical minerals sales falling 15% to \$23.0 billion in 2023.
- In 2023, the value of sales for:
 - lithium (spodumene) fell 7% to \$15.8 billion
 - nickel fell 19% to \$4.7 billion
 - cobalt fell 50% to \$258 million.
- The fall in 2023 came after a 159% increase in the value of battery and minerals sales in 2022 to \$27.1 billion.

Employment¹

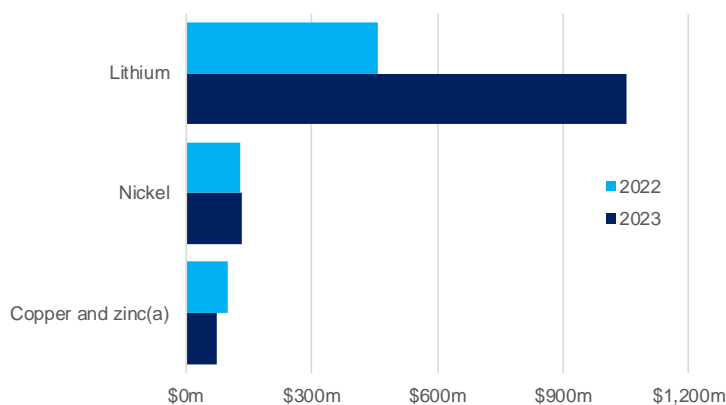


¹ Direct full-time equivalent (FTE). Includes operational and construction employment. (a) Includes lead. (b) Includes manganese, silica and silica sand, zircon, phosphate, vanadium, and magnesite.

Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files; and WA Department of Jobs, Tourism, Science and Innovation.

- Direct full-time equivalent (FTE) employment in Western Australia's battery and critical minerals industry rose 34% to 25,008 in 2023.
 - Direct FTE employment in the nickel industry rose 25% to 10,920 in 2023.
 - Direct FTE employment in the lithium industry rose 70% to 9,844 in 2023.
 - Direct FTE employment in the rare earths industry rose 122% to 1,198 in 2023.

Royalty revenue



(a) Includes lead.

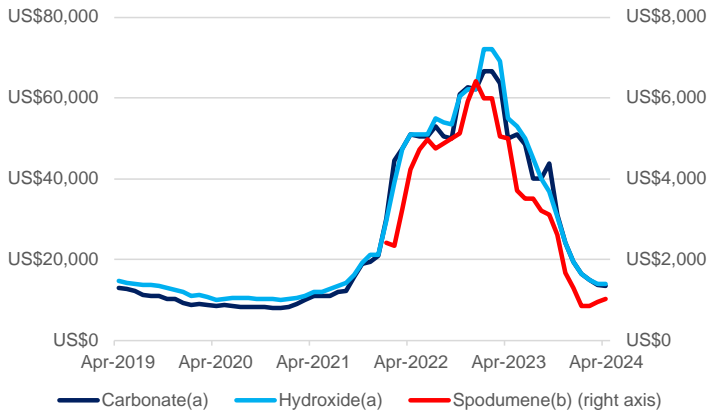
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files.

- Western Australia has a 5% royalty rate on the value of lithium concentrate (spodumene) feedstock.
- Lithium accounted for 8% of Western Australia's royalty revenue (including North West Shelf grants) in 2023.
- Lithium royalties rose 130% to \$1.0 billion in 2023.
- Western Australia has a 2.5% royalty rate on the value of nickel sold. The nickel industry is currently receiving support through the WA Government's Nickel Financial Assistance Program, which provides a 50% rebate on royalties paid on nickel sales each quarter between March 2024 to June 2025, if the average price of nickel in concentrate is below US\$20,000 a tonne for a given quarter.
- Nickel accounted for 1% of Western Australia's royalty revenue (including North West Shelf grants) in 2023.
- Nickel royalties rose 3% to \$132 million in 2022-23.



Prices

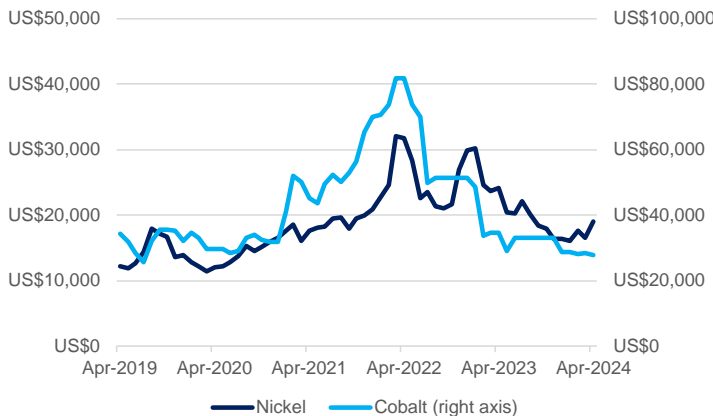
Lithium prices¹



¹ Price per tonne. (a) Cost, insurance, and freight Asia. (b) Concentrate free-on-board Australia.
Note – Spodumene concentrate prices are available from January 2022.
Source: S&P Global Market Intelligence.

- Lithium prices declined sharply in 2023 due to a large increase in global supply and slowing demand for lithium from China's passenger plug-in electric vehicle sector.
 - For lithium spodumene, the monthly average price in April 2024 was US\$1,018 a tonne, 8% higher than the previous month, but 80% lower than a year ago.
 - For lithium carbonate, the monthly average price in April 2024 was US\$13,500 a tonne, 2% lower than the previous month and 73% lower than a year ago.
 - For lithium hydroxide, the monthly average price in April 2024 was US\$14,000 a tonne, unchanged from the previous month but 75% lower than a year ago.
- In 2023, the annual average price of lithium spodumene fell 15% to US\$3,730 a tonne and the annual average price of lithium hydroxide fell 25% to US\$50,288 a tonne.
- The Australian Government's Office of the Chief Economist forecasts the annual average price of:
 - lithium spodumene will be US\$1,139 a tonne in 2024 and US\$1,379 a tonne in 2025.
 - lithium hydroxide will be US\$15,870 a tonne in 2024 and US\$18,393 a tonne in 2025.

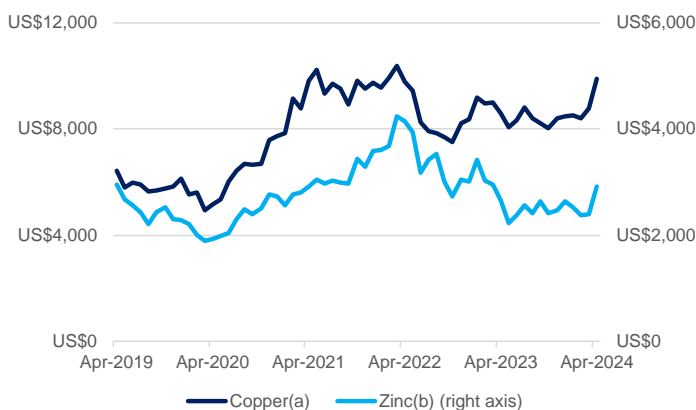
Nickel and cobalt prices¹



¹ Price per tonne. London Metal Exchange (LME) Cash.
Source: S&P Global Market Intelligence.

- Nickel and cobalt prices declined sharply in 2023 as global supply increased and demand from China's passenger plug-in electric vehicle sector weakened.
 - The monthly average nickel price in April 2024 was US\$19,065 a tonne, 15% higher than the previous month but 21% lower than a year ago.
 - The monthly average cobalt price in April 2024 was US\$27,721, 2% lower than the previous month and 20% lower than a year ago.
- The annual average nickel price fell 16% to US\$21,470 a tonne in 2023. The Office of the Chief Economist forecasts the annual average nickel price will be US\$16,954 a tonne in 2024 and US\$17,650 a tonne in 2025.
- The annual average cobalt price fell 47% to US\$35,015 a tonne in 2023. S&P Global Market Intelligence forecasts the annual average price of cobalt will be US\$34,266 a tonne in 2024 and US\$37,595 a tonne in 2025.

Copper and zinc prices¹



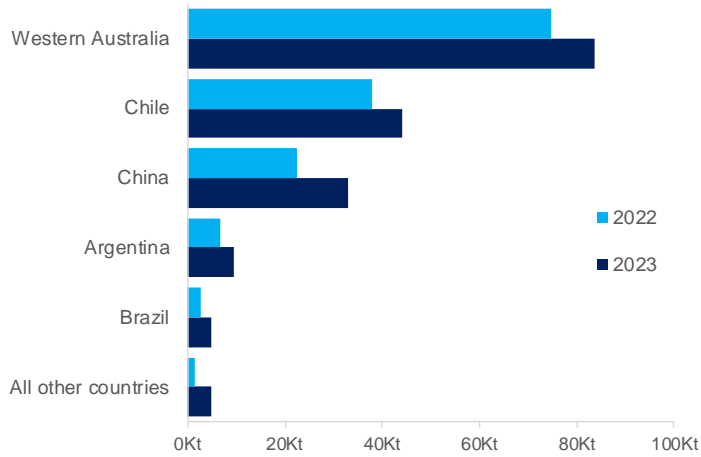
¹ Price per tonne. (a) London Metal Exchange (LME) Grade A Cash. (b) London Metal Exchange (LME) Special High Grade (SHG) 99.995% Cash
Source: S&P Global Market Intelligence.

- Copper and zinc prices tend to follow the global industrial production cycle given their use in construction, and transport and equipment manufacturing. Both copper and zinc prices fell in 2023 as demand weakened for copper from Europe and advanced Asia's construction and manufacturing sectors and for zinc from China's property market.
 - The monthly average copper price in April 2024 was US\$9,892 a tonne, 13% higher than the previous month and 15% higher than a year ago.
 - The monthly average zinc price in April 2024 was US\$2,915, 22% higher than the previous month and 10% higher than a year ago.
- The annual average copper price fell 4% to US\$8,469 a tonne in 2023. The Office of the Chief Economist forecasts the annual average price of copper will be US\$8,340 a tonne in 2024 and US\$8,827 a tonne in 2025.
- The annual average zinc price fell 24% to US\$2,660 a tonne in 2023. The Office of the Chief Economist forecasts the annual average price of zinc will be US\$2,593 a tonne in 2024 and US\$2,646 a tonne in 2025.



Lithium

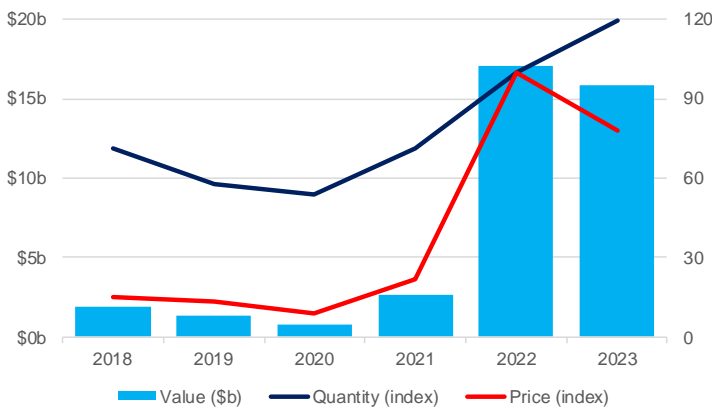
Lithium supply¹



Kt = Thousand tonnes. ¹ Lithium content from mine production.
Source: US Geological Survey, Mineral Commodity Summaries.

- Lithium is mainly used in rechargeable batteries (for mobile phones, laptops, digital cameras and electric vehicles), which accounts for 80% of the world's consumption of lithium.
- Western Australia is the largest lithium supplier in the world, accounting for 47% of global supply in 2023.
- Other major lithium suppliers in 2023 were Chile (24%), China (18%), Argentina (5%) and Brazil (3%).
- In 2023, lithium supply from:
 - Western Australia rose 12% to 83,500 tonnes
 - Chile rose 16% to 44,000 tonnes
 - China rose 46% to 33,000 tonnes
 - Argentina rose 46% to 9,600 tonnes
 - Brazil rose 86% to 4,900 tonnes.
- The average total cash cost of Western Australia's lithium production was US\$4,520 a lithium carbonate equivalent in 2023, below the world average of US\$9,714 a lithium carbonate equivalent. In 2023, Western Australia's average total cash cost of lithium production was 81% lower than Chile's average total cash cost of US\$23,478 a lithium carbonate equivalent and 45% lower than China's average total cash cost of US\$8,219 a lithium carbonate equivalent.

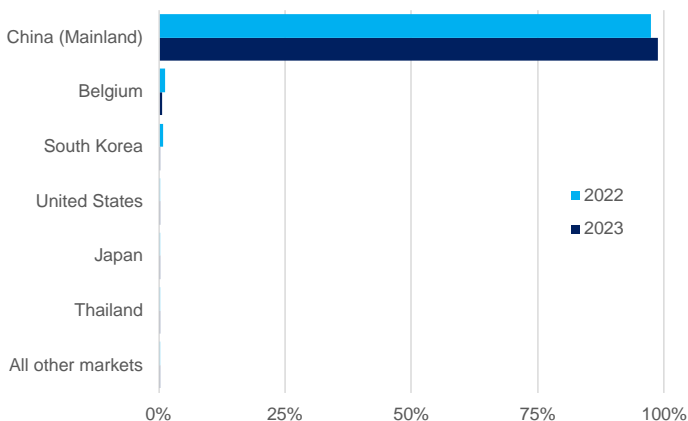
Western Australia's lithium¹ sales



¹ Spodumene concentrate. Index 100.0 = 2022.
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files.

- Greenbushes is Western Australia's largest lithium mine. In 2023, the Greenbushes mine accounted for 51% of the State's lithium production, followed by Pilgangoora (17%), Wodgina (12%), Mt Marion (11%) and Mt Cattlin (6%).
- In 2023, the value Western Australia's lithium sales fell 7% to \$15.8 billion, as a result of the:
 - average unit price of sales falling 22%
 - quantity of sales rising 20% to 3.3 million tonnes.
- Spodumene concentrate production capacity is expanding in Western Australia:
 - The Kathleen Valley lithium project was sanctioned for development in August 2022 and is targeting first production in mid-2024.
 - The P1000 expansion of the Pilgangoora lithium operation was sanctioned in March 2023 and will increase the project's production by 47% to 1 million tonnes a year.
 - A final investment decision on Train 4 at the Wodgina lithium mine is expected in 2024.

Western Australia's lithium¹ export markets



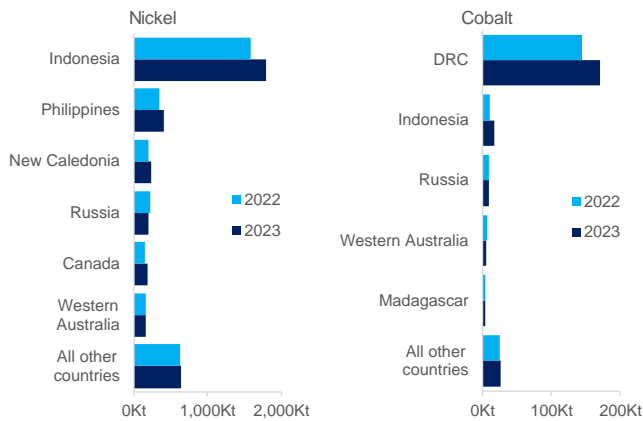
¹ Spodumene concentrate.
Source: Based on data from International Trade in Goods and Services, Australia.

- Western Australia exports lithium mainly as spodumene concentrate for further processing.
- The value of Western Australia's lithium exports rose 52% to \$18.4 billion in 2023.
- Almost all Western Australia's lithium exports go to China. In 2023, China accounted for 99% of the State's lithium exports.



Nickel and cobalt

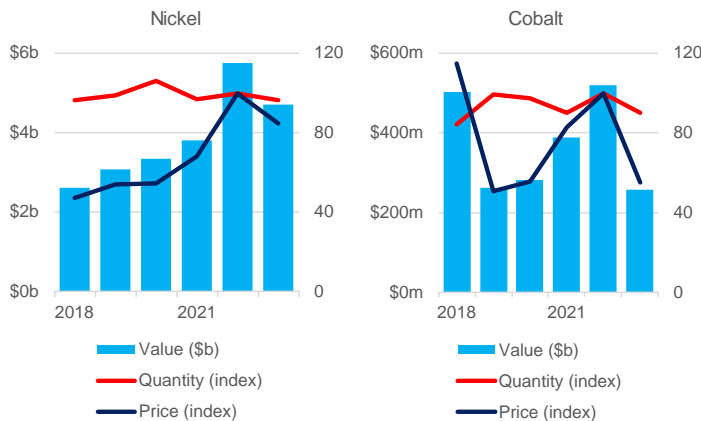
Nickel and cobalt supply¹



DRC = Democratic Republic of Congo. Kt = Thousand tonnes. ¹ Nickel and cobalt content from mine production. Source: US Geological Survey, Mineral Commodity Summaries.

- Nickel is mainly used to make stainless steel. Around 15% of the world's nickel is consumed in batteries.
- Western Australia's nickel production is based on high-grade nickel sulphide deposits, which is better suited for refining for battery manufacturing. Over 85% of Nickel West's production is sold to battery material suppliers.
- Western Australia is the 6th largest nickel supplier in the world, accounting for 4% of global supply in 2023. Nickel supply from Western Australia rose 2% to 156,200 tonnes in 2023.
- Indonesia is by far the largest nickel supplier in the world, accounting for 50% of global nickel supply in 2023.
- Cobalt is mainly used in rechargeable battery electrodes. Over 80% of the world's consumption of cobalt is for manufacturing rechargeable batteries.
- Western Australia is the 4th largest cobalt supplier in the world, despite accounting for only 2% of global supply in 2023. Cobalt supply from Western Australia fell 21% to 4,600 tonnes in 2023.
- The DRC is by far the largest cobalt supplier in the world, accounting for 74% of global cobalt supply in 2023.

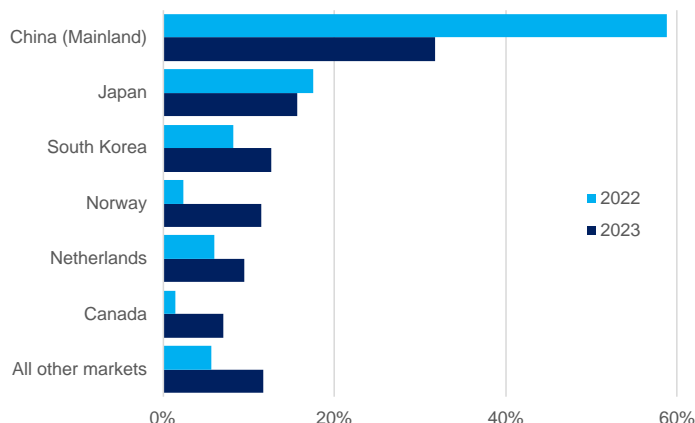
Western Australia's nickel and cobalt sales



Index 100.0 = 2022
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files.

- Nickel West is Western Australia's largest nickel operation with its Mt Keith and Leinster mines accounting for 30% of the State's paid nickel mine production in 2023.
- Murrin Murrin is Western Australia's largest nickel mine, accounting for 21% of the State's paid nickel mine production in 2023. The Murrin Murrin mine also accounted for 67% of the State's paid cobalt mine production in 2023.
- In 2023, the value Western Australia's nickel sales fell 19% to \$4.7 billion, as a result of the:
 - average unit price of sales falling 15%
 - quantity of sales falling 4% to 149,000 tonnes.
- In 2023, the value Western Australia's cobalt sales fell 50% to \$258 million, as a result of the:
 - average unit price of sales falling 45%.
 - quantity of sales falling 10% to 5,200 tonnes.

Western Australia's nickel export markets¹



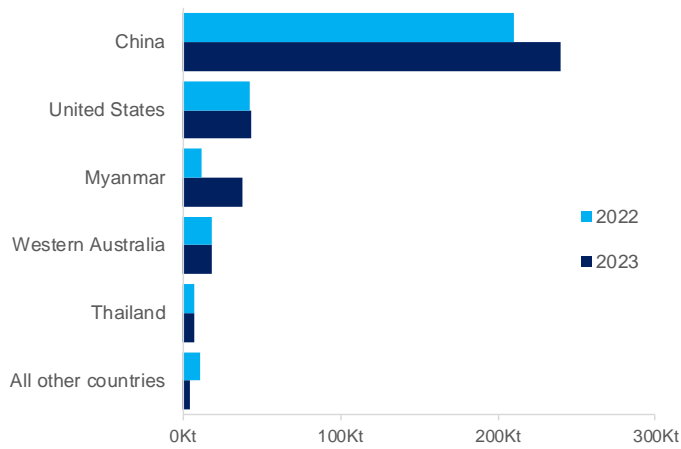
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files.

- China is Western Australia's largest market for nickel exports, accounting for 32% of the State's nickel exports in 2023. Other major nickel export markets in 2023 included Japan (16%) and South Korea (13%).
- China's share of Western Australia's nickel exports fell from 59% in 2022 to 32% in 2023, while Japan's share fell from 18% 2022 to 16% in 2023.
- South Korea's share of Western Australia's nickel exports rose from 8% in 2022 to 13% in 2023.
- Norway (2% to 12%), Canada (1% to 7%) and the Netherlands (6% to 10%) had significantly large increases in their shares of Western Australia's nickel exports between 2022 and 2023.



Rare earths

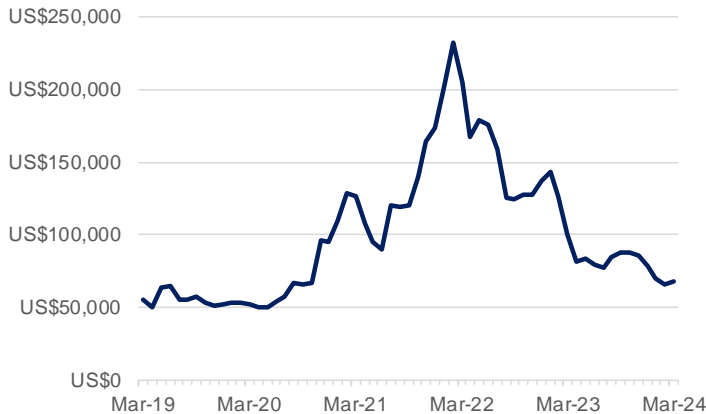
Rare earths supply¹



Kt = Thousand tonnes. ¹ Rare earth oxide equivalent content from mine production.
Source: US Geological Survey, Mineral Commodity Summaries.

- 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.
- Western Australia is the 4th largest rare earths supplier in the world, accounting for 8% of global supply in 2023.
- China is by far the largest rare earths supplier in the world, accounting for 69% of global supply in 2023, followed by the United States (12%) and Myanmar (11%).
- In 2023, rare earths supply from:
 - China rose 14% to 240,000 tonnes
 - United States rose 2% to 43,000 tonnes
 - Myanmar rose from 12,000 tonnes to 38,000 tonnes
 - Western Australia was steady at 18,000 tonnes
 - Thailand was steady at 7,100 tonnes.

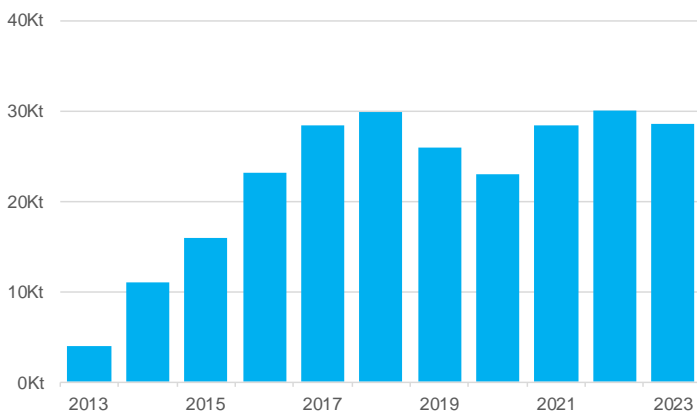
Neodymium prices¹



¹ US dollars a tonne.
Source: WA Department of Jobs, Tourism, Science and Innovation based on data from Trading Economics.

- Prices for rare earths rose sharply in 2020 and 2021 as demand outstripped supply. Demand was high due its use in decarbonisation-based applications. However, as global production of rare earths has ramped up over the past two years, especially in China, the price of rare earths has fallen back to near pre-2020 levels.
- The monthly average neodymium price fell 3% to US\$67,821 a tonne in March 2024.
- The annual average neodymium price fell 43% to US\$92,912 a tonne in 2023.

Western Australia's rare earths sales



Kt = Thousand tonnes. Note – Sales values for rare earths are not available for most years due to data confidentiality restrictions, except for 2018, 2020, 2021 and 2022.
Source: WA Department of Energy, Mines, Industry Regulation and Safety, Resource Data Files.

- Western Australia's rare earths production mainly comes from the Mt Weld mine.
- The quantity of Western Australia's rare earths sales fell 5% to 29,000 tonnes in 2023.
- The value of Western Australia's rare earths sales in 2022 was \$801 million (the value for 2023 is not available).
- Production capacity of the Mt Weld mine is being expanded to supply a rare earths processing plant under construction in Kalgoorlie. The plant will produce 38,000 tonnes of rare earths carbonate a year by 2025.
- Other rare earths projects in Western Australia include:
 - The Yangibana rare earths project (15,000 tonnes a year starting in late 2024).
 - The Eneabba rare earths refinery (20,000 tonnes a year starting in 2025).
 - The Browns Range Stage 2 proposed development (3,000 tonnes a year).