# WESTERN AUSTRALIA BATTERY MINERALS PROFILE – April 2022

**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 Sustainable Development Scenario. The Sustainable Development Scenario is a similar, but slightly less optimistic scenario for limiting global warming compared to the Net Zero Emissions by 2050 Scenario, which results in around 15 million fewer global electric car sales in 2030. The Sustainable Development Scenario provides a breakdown of electric car sales by market.

Source: International Energy Agency, Global EV Outlook and Data Explorer 2021 (Annual).

* Global demand for minerals used in rechargeable batteries is increasing because of their increased use in electronics, energy storage and electric vehicles. The International Energy Agency (IEA) projects global demand for battery minerals could be six times higher by 2050 than in 2020.
* Lithium-ion batteries are made from mostly lithium, graphite, nickel, cobalt and manganese. The use of copper and rare earths in electric vehicle motors and associated batteries and charging infrastructure is also expected to increase significantly in the longer term.
* By the end of 2020, more than 20 countries had targets to phase out internal combustion engines over the next 10 to 30 years, including China, Japan, Singapore and many European countries.
* In 2021, there were 17 million electric cars on the road globally, of which two-thirds were battery electric vehicles. Under its Net Zero Emissions by 2050 Scenario, the IEA projects 300 million electric cars will be on the road by 2030; and global electric car sales would increase from 3 million in 2020 to 56 million in 2030, by which point they would account for 60% of new car sales.
* Global electric car sales more than doubled to 6.75 million in 2021, mainly driven by China, Europe and North America. Battery electric vehicles accounted for 71% of global electric car sales in 2021.

**Battery minerals1 sales from Western Australia:**

**Calendar 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’s battery minerals are mainly exported to China, as well as other markets in Asia (Japan, South Korea), Europe (Norway, Germany, Spain) and to the United States.
* The value of Western Australia’s battery minerals sales rose 48% to $9.3 billion in 2021. This was driven by an increase in prices for lithium and other battery minerals, which increased sharply in 2021 due to higher demand from an increase global electric car sales.
* Western Australia’s battery minerals industry contributed $270 million in royalties in 2021, an increase of 26% from 2020.
* Direct full-time equivalent employment in Western Australia’s battery minerals industry rose 11% to 13,374 in 2021.
* The outlook for investment in Western Australia’s battery minerals industry is positive. The estimated value of the State’s battery minerals exploration expenditure rose 62% to $627 million in 2021.

**Western Australia’s battery minerals industry**

* [Lithium](#_Lithium)
* [Nickel](#_Nickel)
* [Cobalt](#_Cobalt)
* [Manganese](#_Manganese)
* [Copper](#_Copper)
* [Rare earths](#_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 minerals processing will result in Western Australia moving further down the value chain and exporting more minerals specifically for battery manufacturing. Western Australia has exported lithium mainly as spodumene concentrate in the past, but has now started exporting lithium hydroxide.
* This report provides information on Western Australia’s battery 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 Mine production.

Source: US Geological Survey, Mineral Commodity Summaries (Annual).

* Western Australia is the largest lithium supplier in the world, accounting for 52% of global supply in 2021, followed by Chile (25%).
* Western Australia accounted for 100% of Australia’s lithium production in 2021.
* Global lithium supply tripled to 105 thousand tonnes between 2011 and 2021, with supply from Western Australia contributing 62% of the growth.
* In 2021, lithium supply from:
	+ Western Australia rose 39% to 55 thousand tonnes.
	+ Chile rose 21% to 26 thousand tonnes.
	+ China rose 5% to 14 thousand tonnes.
	+ Argentina rose 5% to 6 thousand tonnes.

**Lithium demand1: Calendar years**

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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 around 45% of the world’s consumption of lithium, with 26% of lithium consumed in ceramics and glass manufacturing.
* World lithium demand rose 72% to 526 thousand tonnes in 2021.
* The Office of the Chief Economist forecasts world lithium demand will almost triple to 1,493 thousand tonnes between 2021 and 2027.

**Lithium prices1: Months**

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1 US dollars a tonne. Asia, Cost, insurance and freight (CIF).

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* Lithium prices have risen sharply over the past year due to higher demand for lithium from an increase global electric vehicle sales.
* The average monthly lithium carbonate price rose 7% to US$47,500 a tonne in March 2022.
* The average monthly lithium hydroxide price rose 22% to US$47,500 a tonne in March 2022.
* In 2021, the annual average price of lithium:
	+ Spodumene rose 52% to US$638 a tonne.
	+ Hydroxide rose 138% to US$17,369 a tonne.
* The Office of the Chief Economist forecasts the annual average price of:
	+ Lithium spodumene will be US$1,325 a tonne in 2022 and US$915 a tonne in 2027.
	+ Lithium hydroxide will be US$27,620 a tonne in 2022 and US$14,855 a tonne in 2027.

**Lithium exports from Western Australia: Quarters**



Source: ABS 5368.0 International Trade in Goods and Services, Australia (Monthly).

* Western Australia mainly exports lithium spodumene concentrate to China for further processing.
* China is Western Australia’s largest market for lithium exports, accounting for 94% of the State’s lithium exports in 2021. Other lithium export markets in 2021 were Belgium, South Korea, United States and Spain.
* Western Australia exported $643 million of lithium in the December quarter 2021, 30% more than in the previous quarter and 156% more than a year ago.
* In 2021, the value of Western Australia’s lithium exports rose 74% to $1.7 billion.
* Western Australia started producing lithium hydroxide in 2021, which will be exported in greater quantities in 2022. The newly built Kwinana and Kemerton processing plants each have a capacity to produce around 25 thousand tonnes of lithium hydroxide a year, supplied by lithium concentrate from the Greenbushes, Wodgina 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 95% of Australia’s identified lithium resources.

Source: 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 2020-21, Western Australia’s estimated economic demonstrated lithium resource rose 35% to 8,447 thousand tonnes.
* Western Australia’s estimated economic demonstrated lithium resource of 8,447 thousand tonnes in 2020‑21 could sustain the State’s lithium production for 39 years at 2020‑21 production rates.

**Lithium production costs per unit1: 2021 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, Mine Economics Model (Annual).

* Western Australia’s lithium producers are among the world’s lowest cost producers, mainly due to relatively low costs for chemicals, onsite services, royalties and energy.
* The average total cash cost of Western Australia’s lithium production was US$1,878 a lithium carbonate equivalent in 2021, below the world average of US$2,840 a lithium carbonate equivalent.
* Western Australia produces lithium at a much lower cost than its major competitor in Chile.
* In 2021, Western Australia’s average total cash cost of lithium production was 57% lower than Chile’s average total cash cost of US$4,379 a lithium carbonate equivalent.

**Lithium1 sales from Western Australia: Calendar 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 58% (189 thousand tonnes of LCE) of the State’s lithium production in 2021. Other major lithium mines include Mt Marion (21% or 69 thousand tonnes of LCE), Pilgangoora (11% or 36 thousand tonnes of LCE) and Mt Cattlin (9% or 29 thousand tonnes of LCE).
* The quantity of Western Australia’s lithium sales rose 34% to 1,986 thousand tonnes in 2021, mainly due to lithium production more than doubling at the Greenbushes mine.
* The value of Western Australia’s lithium sales more than tripled to $2.6 billion in 2021.
* Western Australia’s third lithium hydroxide plant is under construction at Kwinana, as part of the Mt Holland project that is due for completion in 2024. The plant will have the capacity to produce 50 thousand tonnes a year of lithium hydroxide. Train 1 at the Wodgina lithium mine is due to restart in May 2022 (Train 2 in July 2022), after the mine was put into care and maintenance in November 2019. Bald Hill is another lithium mine that could restart in 2022. Mt Marion lithium mine is also being expanded in 2022.

**Lithium royalty revenue in Western Australia:**

**Calendar 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 0.4% of Western Australia’s royalty revenue(including North West Shelf grants) in 2021.
* Lithium royalties in Western Australia rose 29% to $60 million in 2021.

**Lithium employment in Western Australia1: Calendar 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 31% to 2,513 in 2021.
* Western Australia’s largest employing lithium mine sites in 2021 were:
	+ Greenbushes (747).
	+ Pilgangoora (604).
	+ Mt Marion (478).
	+ Mt Cattlin (259).

## 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 6% of global supply in 2021.
* Indonesia is the largest nickel supplier in the world, accounting for 37% of global supply in 2021, followed by the Philippines (14%).
* Western Australia accounted for 99% of Australia’s nickel production in 2021, with Tasmania accounting for the rest.
* Global nickel supply rose 50% to 2.7 million tonnes between 2011 and 2021, mainly driven by supply from Indonesia and the Philippines.
* In 2021, nickel supply from:
	+ Indonesia rose 30% to 1 million tonnes.
	+ Philippines rose 11% to 370 thousand tonnes.
	+ Russia fell 12% to 250 thousand tonnes.
	+ New Caledonia fell 5% to 190 thousand tonnes.
	+ Western Australia fell 5% to 160 thousand tonnes.

**Nickel consumption: Calendar years**

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Kt = Thousand tonnes.

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

* Nickel is mainly used in the manufacture of stainless steel, accounting for around 70% of the world’s consumption of nickel. However, the use of nickel in electric vehicle batteries is growing. Around 5% 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 2,774 thousand tonnes in 2021.
* The Office of the Chief Economist forecasts world nickel consumption will rise 24% to 3,440 thousand tonnes between 2021 and 2027.

**Nickel prices1: Months**



1 US dollars a tonne. London Metal Exchange (LME) Cash.

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* Nickel prices have risen sharply over the past year because of strong nickel demand from stainless steel and electric vehicle battery manufacturers, and supply constraints including recent supply disruptions related to trade sanctions imposed on Russia for its invasion of Ukraine.
* The average monthly nickel price rose 30% to US$32,093 a tonne in March 2022.
* In 2021, the annual average price of nickel rose 34% to US$18,468 a tonne.
* The Office of the Chief Economist forecasts the annual average price of nickel will be US$24,875 a tonne in 2022 and US$23,875 a tonne in 2027.

**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, which includes the Mt Keith and Leinster mines, the Kambalda Concentrator, Kalgoorlie Smelter (matte) and Kwinana Refinery (powder and briquettes). Many other nickel producers sell ore to Nickel West for processing.
* Mt Keith (19% or 28 thousand tonnes) and Leinster (18% or 27 thousand tonnes) accounted for 37% of Western Australia’s paid nickel mine production in 2021.
* Murrin Murrin is Western Australia’s largest nickel mine, accounting for 27% (41 thousand tonnes) of the State’s paid nickel mine production in 2021. Other major nickel mines include Nova-Bollinger, Ravensthorpe and Forrestania.
* Western Australia produced 42 thousand tonnes of nickel in the December quarter 2021, 14% more than in the previous quarter, although 7% less than a year ago.
* The quantity of Western Australia’s nickel production fell 9% to 154 thousand tonnes in 2021, mainly due to less nickel produced at Mt Keith, Nova-Bollinger and Forrestania.

**Nickel resources in Western Australia1: Financial years**



Kt = Thousand tonnes. 1 Estimated based on 90% of Australia’s identified nickel resources.

Source: 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 2020-21, Western Australia’s estimated economic demonstrated nickel resource rose 3% to 19,800 thousand tonnes.
* Western Australia’s estimated economic demonstrated nickel resource of 19,800 thousand tonnes in 2020-21 could sustain the State’s nickel production for 99 years at 2020-21 production rates.
* The value of Western Australia’s nickel and cobalt exploration expenditure rose 41% to $216 million in 2021.

**Nickel production costs per unit1: 2021 calendar year**



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, Mine Economics Model (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$11,478 a tonne in 2021, above the world average of US$8,727 a tonne.
* Despite high production costs, Western Australia’s nickel production is competitive because of high nickel content and 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: Calendar 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.
* 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 thousand tonnes a year facility in coming years.
* China is Western Australia’s largest market for nickel exports, accounting for 65% of the State’s nickel exports in 2021. Other major nickel export markets in 2021 included Japan (15%) and South Korea (10%).
* The quantity of Western Australia’s nickel sales fell 9% to 150 thousand tonnes in 2021, mainly due to less nickel produced at Mt Keith, Nova-Bollinger and Forrestania.
* The value of Western Australia’s nickel sales rose 11% to $3.7 billion in 2021.

**Nickel royalty revenue in Western Australia:**

**Calendar 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 0.6% of Western Australia’s royalty revenue(including North West Shelf grants) in 2021.
* Nickel royalties in Western Australia rose 17% to $87 million in 2021.

**Nickel employment in Western Australia1: Calendar 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 7% to 8,069 in 2021.
* Western Australia’s largest employing nickel mine and processing sites in 2021 were:
	+ Murrin Murrin (1,667).
	+ Ravensthorpe (1,151).
	+ Kwinana refinery (586).
	+ Nova-Bollinger (546).

## 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 2021.
* The Democratic Republic of Congo (DRC) is by far the largest cobalt supplier in the world, accounting for 71% of global supply in 2021, followed by Russia (4%).
* Western Australia accounted for 100% of Australia’s cobalt production in 2021.
* Global cobalt supply rose 73% to 170 thousand tonnes between 2011 and 2021, mainly driven by increased supply from the DRC. Supply decreased significantly from China and Canada over this period.
* In 2021, cobalt supply from:
	+ The DRC rose 22% to 120 thousand tonnes.
	+ Russia fell 16% to 7.6 thousand tonnes.
	+ Western Australia fell 1% to 5.6 thousand tonnes.

**Cobalt prices1: Months**

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1 US dollars a tonne. London Metal Exchange (LME) Cash.

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* Cobalt prices have risen sharply over the past year because of strong cobalt demand from electric vehicle battery manufacturers and supply constraints.
* The average monthly cobalt price rose 11% to US$81,841 a tonne in March 2022.
* In 2021, the annual average price of cobalt rose 67% to US$52,434 a tonne.
* S&P Global Market Intelligence forecasts the annual average price of cobalt to fall 3% to US$51,063 a tonne in 2022, as supply increases from mine expansions in the DRC.

**Cobalt resources in Western Australia1: Financial years**



Kt = Thousand tonnes. 1 Estimated based on 69% of Australia’s identified cobalt resources.

Source: 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 2020-21, Western Australia’s estimated economic demonstrated cobalt resource rose 6% to 1,049 thousand tonnes.
* Western Australia’s estimated economic demonstrated cobalt resource of 1,049 thousand tonnes in 2020-21 could sustain the State’s cobalt production for 191 years at 2020‑21 production rates.
* The value of Western Australia’s nickel and cobalt exploration expenditure rose 41% to $216 million in 2021.

**Cobalt production costs per unit1: 2021 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, Mine Economics Model (Annual).

* Cobalt is produced as a co-product of nickel production in Western Australia.
* Western Australia’s cobalt producers are among the world’s highest cost producers, mainly due to relatively high costs for chemicals and labour.
* The average total cash cost of Western Australia’s cobalt production was US$25,978 a tonne in 2021, above the world average of US$17,263 a tonne.
* Western Australia’s close proximity to major cobalt markets in Asia reduces shipping costs relative to some of its competitors.
* In 2021, Western Australian cobalt producer’s average cost of inland transport and shipping of US$4,210 a tonne was 20% lower than the world average of US$5,236 a tonne.

**Cobalt sales from Western Australia: Calendar years**



Kt = Thousand tonnes.

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

* 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.
* Western Australia’s cobalt production mainly comes from the State’s major nickel mines.
* In 2021, Murrin Murrin accounted for 72% (3.4 thousand tonnes) of Western Australia’s paid cobalt mine production, followed by Ravensthorpe, Nova-Bollinger, Mt Keith and Leinster.
* The quantity of Western Australia’s cobalt sales fell 6% to 5.3 thousand tonnes in 2021.
* The value of Western Australia’s cobalt sales rose 35% to $380 million in 2021.
* Mt Thirsty is Western Australia’s most advanced proposed cobalt mine. If developed, this mine could produce 19 thousand tonnes of cobalt a year and 25 thousand tonnes of nickel a year.

## Manganese

**Manganese supply1: Calendar years**



Kt = Thousand tonnes. 1 Mine production.

Source: US Geological Survey, Mineral Commodity Summaries (Annual).

* Western Australia has the world’s 5th largest manganese reserves, accounting for 8% of the world’s manganese reserves in 2021, behind South Africa, Brazil, the Northern Territory and Ukraine.
* Western Australia is the 8th largest manganese supplier in the world, accounting for 3% of global supply in 2021.
* South Africa is the largest manganese supplier in the world, accounting for 37% of global supply in 2021, followed by Gabon (18%) and the Northern Territory (14%).
* Western Australia accounted for 16% of Australia’s manganese production in 2021.
* Global manganese supply rose 25% to 20 million tonnes between 2011 and 2021, mainly driven by increased supply from South Africa and Gabon.
* In 2021, manganese supply from:
	+ South Africa rose 14% to 7.4 million tonnes.
	+ Gabon rose 9% to 3.6 million tonnes.
	+ Northern Territory fell 0.2% to 2.8 million tonnes.
	+ China fell 3% to 1.3 million tonnes
	+ Western Australia fell 5% to 523 thousand tonnes.

**Manganese prices1: Months**



1 US dollars a dry tonne. Minimum 32% manganese and 20% iron content, Tianjin (China)-South Africa.

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* 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.
* Manganese prices have fallen in recent months, as world crude steel production has decreased, including in China.
* The average monthly manganese price fell 2% to US$5.31 a tonne in March 2022.
* In 2021, the annual average price of manganese rose 1% to US$5.07 a tonne.

**Manganese sales from Western Australia: Calendar years**



Kt = Thousand tonnes.

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

* Western Australia’s manganese production comes from the Woodie Woodie and Butcherbird mines.
	+ Woodie Woodie returned to 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 thousand tonnes a year. The mine 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, the quantity of Western Australia’s manganese sales fell 4% to 523 thousand tonnes.
* The value of Western Australia’s manganese sales was $303 million in 2021.
* Direct full-time equivalent employment in Western Australia’s manganese industry rose 10% to 568 in 2021. Woodie Woodie employed 503 workers and Butcherbird employed 65 workers in 2021.

## Copper

**Copper supply1: Calendar years**

160Kt

720Kt

750Kt

810Kt

820Kt

830Kt

1,200Kt

1,800Kt

1,800Kt

2,200Kt

5,600Kt

Western Australia

Mexico

Rest of Australia(a)

Indonesia

Russia

Zambia

USA

China

Dem. Rep. Congo

Peru

Chile

2011

2021

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 2021.
* Chile is the largest copper supplier in the world, accounting for 27% of global supply in 2021, followed by Peru (10%).
* Western Australia accounted for 18% of Australia’s copper production in 2021.
* Global copper supply rose 30% to 21 million tonnes between 2011 and 2021, mainly driven by supply from the DRC, Peru and China.
* In 2021, copper supply from:
	+ Chile fell 2% to 5.6 million tonnes.
	+ Peru rose 2% to 2.2 million tonnes.
	+ DRC rose 13% to 1.8 million tonnes.
	+ China rose 5% to 1.8 million tonnes
	+ Western Australia rose 2% to 160 thousand tonnes.

**Copper consumption: Calendar years**

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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 around 45% of the world’s consumption of copper, with 30% of copper consumed in equipment manufacturing and 12% of copper consumed in transport vehicles.
* Electric vehicle motors and associated batteries and charging infrastructure require significant amounts of copper. Electric vehicles require 5 times more copper than vehicles with internal combustion engines.
* World copper consumption rose 2% to 25,304 thousand tonnes in 2021.
* The Office of the Chief Economist forecasts world copper consumption will rise 11% to 28,054 thousand tonnes between 2021 and 2027.

**Copper prices1: Months**



1 US dollars a tonne. London Metal Exchange (LME) Grade A Cash.

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* Copper prices have remained high over the past year, following a period of sharp growth as construction activity was stimulated to support economic recovery from the COVID-19 pandemic. Delays in new mine developments have also contributed to high prices over the past year, with significant additional supply not expected until 2023. Copper demand will be supported in the longer term by its use in renewable energy technology and battery storage.
* The average monthly copper price rose 5% to US$10,368 a tonne in March 2022.
* In 2021, the annual average price of copper rose 51% to US$9,315 a tonne.
* The Office of the Chief Economist forecasts the annual average price of copper will be US$9,699 a tonne in 2022 and US$8,998 a tonne in 2027.

**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, as well as nickel.
* The DeGrussa copper-gold mine is Western Australia’s largest copper mine, accounting for 48% (65 thousand tonnes) of the State’s paid copper mine production in 2021.
* Boddington, Western Australia’s largest gold mine, is also the State’s second largest copper mine, accounting for 21% (29 thousand tonnes) of the State’s paid copper mine production in 2021.
* Other major copper mines in Western Australia include the Golden Grove copper‑gold mine, Nova-Bollinger nickel‑copper mine and Telfer gold‑copper mine.
* Western Australia produced 38 thousand tonnes of copper in the December quarter 2021, 12% more than in the previous quarter and 9% more than a year ago.
* In 2021, the quantity of Western Australia’s copper production fell 6% to 145 thousand tonnes, mainly due to less copper produced at DeGrussa and Telfer.

**Copper resources in Western Australia1: Financial years**



Kt = Thousand tonnes. 1 Estimated based on 6% of Australia’s identified copper resources.

Source: 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 moderately over the past 3 years.
* In 2020-21, Western Australia’s estimated economic demonstrated copper resource rose 1% to 5,700 thousand tonnes.
* Western Australia’s estimated economic demonstrated copper resource of 5,700 thousand tonnes in 2020-21 could sustain the State’s copper production for 42 years at 2020‑21 production rates.
* The value of Western Australia’s copper exploration expenditure rose 88% to $256 million in 2021.

**Copper production costs per unit1: 2021 calendar year**



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, Mine Economics Model (Annual).

* Copper is produced as a co‑product of gold and nickel production in Western Australia.
* The average total cash cost of Western Australia’s copper production was US$3,150 a tonne in 2021, below the world average of US$3,269 a tonne.
* Western Australia’s copper production has relatively low costs for energy and chemicals, but relatively high onsite and labour costs.

**Copper sales from Western Australia: Calendar 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 exports, accounting for 27% of the State’s copper exports in 2021. Other major copper export markets in 2021 were the Philippines (25%) and Japan (20%). China was Western Australia’s largest export market for copper prior to China imposing import restrictions on Australian copper in 2020.
* The quantity of Western Australia’s copper sales rose 0.3% to 149 thousand tonnes in 2021.
* The value of Western Australia’s copper sales rose 37% to $1.8 billion in 2021.
* Western Australia has a number of proposed copper projects that if developed, would add around 90 thousand tonnes of copper production from 2025. Proposed projects include Caravel – Stage 1, Winu and Sulphur Springs.

**Copper royalty revenue in Western Australia:**

**Calendar 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 0.6% of Western Australia’s royalty revenue(including North West Shelf grants) in 2021.
* Copper royalties in Western Australia rose 39% to $89 million in 2021.

**Copper employment in Western Australia1: Calendar 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 5% to 1,984 in 2021.
* Western Australia’s largest employing copper mine sites in 2021 were:
	+ Golden Grove (894).
	+ DeGrussa (547).
	+ Jaguar (311).

## 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 4th largest rare earths supplier in the world, accounting for 8% of global supply in 2021.
* China is by far the largest rare earths supplier in the world, accounting for 60% of global supply in 2021, followed by the United States (15%).
* Western Australia accounted for 100% of Australia’s rare earths production in 2021.
* China was the world’s only major rare earths supplier 10 years ago, with some supply from India and Brazil.
* Global rare earths supply doubled to 280 thousand tonnes between 2011 and 2021, mainly driven by supply from the United States and China, with smaller increases in supply from many other countries.
* In 2021, rare earths supply from:
	+ China rose 20% to 168 thousand tonnes.
	+ United States rose 10% to 43 thousand tonnes.
	+ Myanmar fell 16% to 26 thousand tonnes.
	+ Western Australia rose 5% to 22 thousand tonnes.

**Rare earths prices1: Months**

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1 US dollars a tonne. Oxide 99% China Free on board (FOB).

Source: Thomson Reuters/S&P Global Market Intelligence (Month).

* Rare earths are used in high-tech consumer products and defence applications. Praseodymium is used in aircraft engines. Neodymium is used in electric vehicle motor magnets and wind turbines. Cerium is used in catalytic converters for cars. Lanthanum is used in camera and telescope lenses.
* The average monthly praseodymium price rose 10% to US$159,000 a tonne in February 2022.
* The average monthly neodymium price rose 10% to US$182,500 a tonne in February 2022.
* The average monthly cerium price of US$1,465 a tonne was unchanged in February 2022.
* The average monthly lanthanum price of US$1,425 a tonne was unchanged in February 2022.
* In 2021, the annual average price of:
	+ Praseodymium rose 106% to US$95,500 a tonne.
	+ Neodymium rose 102% to US$101,179 a tonne.
	+ Cerium fell 10% to US$1,487 a tonne.
	+ Lanthanum fell 11% to US$1,463 a tonne.

**Rare earths resources in Western Australia1: Financial years**



Kt = Thousand tonnes. 1 Estimated based on 30% of Australia’s identified rare earths resources.

Source: 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 4 years.
* In 2020-21, Western Australia’s estimated economic demonstrated rare earths resource rose 5% to 1,304 thousand tonnes.
* Western Australia’s estimated economic demonstrated rare earths resource of 1,304 thousand tonnes in 2020-21 could sustain the State’s rare earths production for 56 years at 2020‑21 production rates.

**Rare earths sales from Western Australia: Calendar 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.
* A rare earths processing plant is being constructed in Kalgoorlie to process rare earths concentrate from the Mt Weld mine. The plant is expected to produce 11 thousand tonnes of mixed rare earths carbonate a year.
* 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 thousand tonnes a year facility is expected to start in 2022 with first production in 2025.
* Other proposed rare earths projects in Western Australia include Yangibana (15 thousand tonnes a year) and Browns Range – Stage 2 (3 thousand tonnes a year). The Browns Range pilot plant operated between 2018 and 2021.
* In 2021, the quantity of Western Australia’s rare earths sales rose 24% to 28.4 thousand tonnes.
* The value of Western Australia’s rare earths sales more than doubled to $569 million in 2021.

**Rare earths employment in Western Australia1:**

**Calendar 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 37% to 240 in 2021.
* Western Australia’s largest employing rare earths mine and processing sites in 2021 were:
	+ Mt Weld (164).
	+ Browns Range (43).
	+ Kalgoorlie Processing Plant (31).