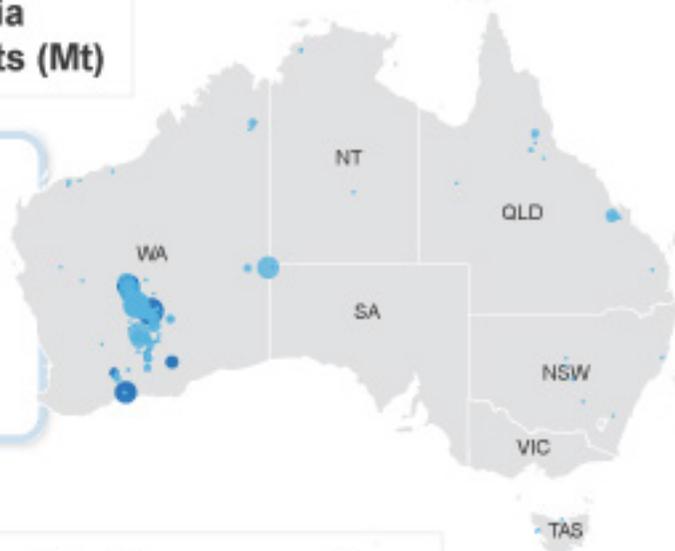
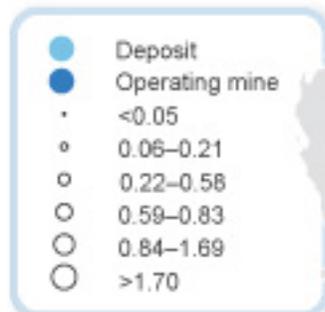


# Nickel

## Major Australia nickel deposits (Mt)



## World consumption



## Nickel facts



Nickel is used in the US, UK and Euro coins



Nickel has a growing role in electric vehicle batteries



Nickel is magnetic at room temperature and is fully recyclable



Nickel is the second most abundant element in the Earth's core after iron

## Australia's nickel



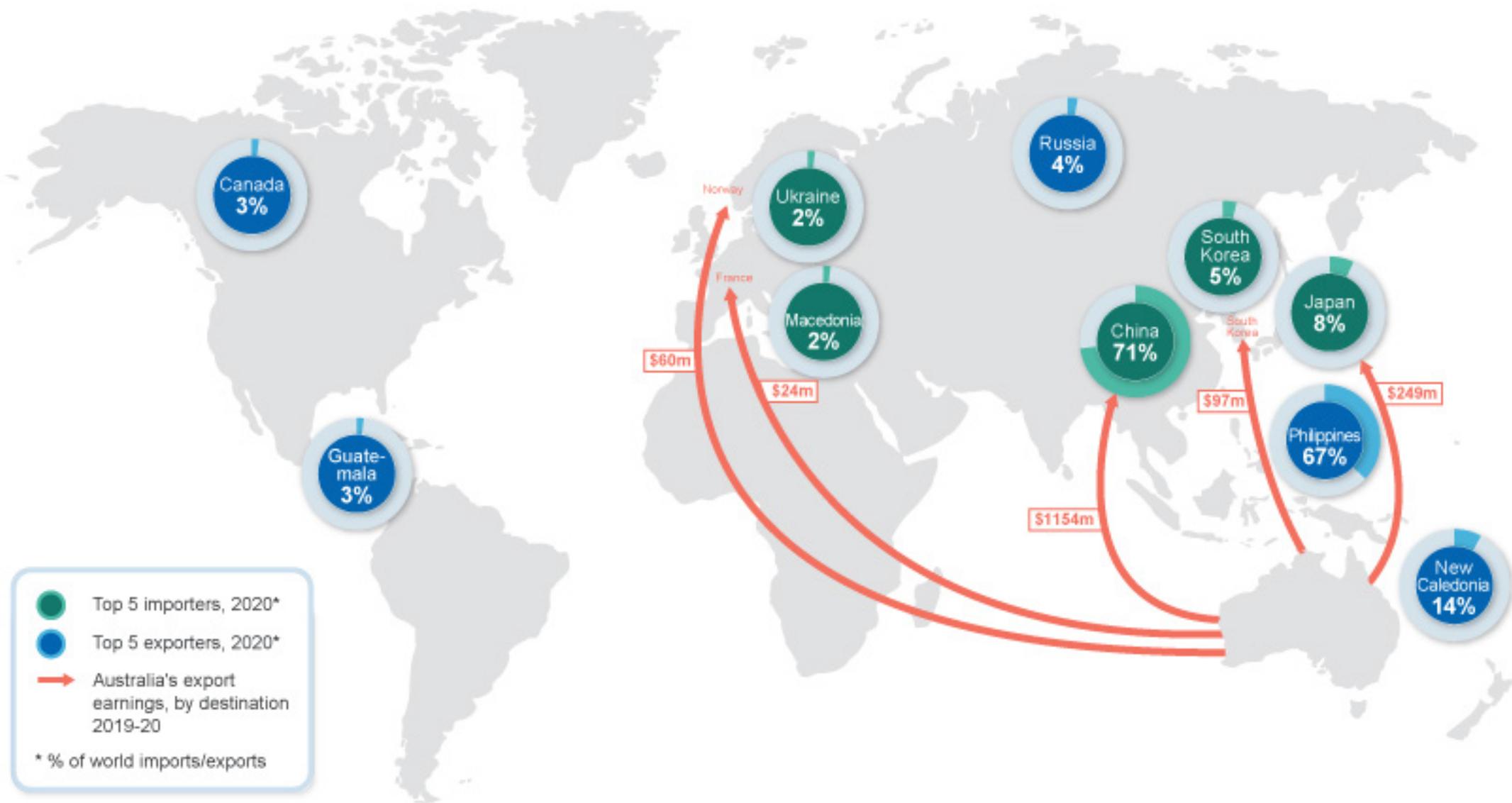
Australia has 22% of world nickel resources



Typically produces over 200,000 tonnes a year



Contributes more than \$3.8b to the economy



## Summary

- Nickel prices are expected to average US\$24,875 in 2022, over declining stocks of battery grade material and the Russian invasion of Ukraine. Prices are expected to ease in the medium term, before facing upward pressure from significant demand from electric vehicle manufacturing. The forecast nickel price in 2027 is US\$21,100 (in real terms) by 2027.
- Australia's export volumes are forecast to rise from 273,000 tonnes in 2021–22 to 326,000 tonnes in 2026–27. Higher nickel prices may incentivise further expansion in nickel production to capitalise on the movement towards low-emission technologies.
- Export earnings are forecast to be stable as higher export volumes offset lower nickel prices. Australia's export earnings are forecast at \$7.0 billion in 2021–22, and at \$7.3 billion (in real terms) in 2026–27.

### 13.1 World consumption

#### Economic recovery leads nickel demand higher

Global nickel demand rebounded in 2021, as the world economy recovered from the impact of the COVID-19 pandemic. Stainless steel production, the main use for nickel, rose 13% year-on-year, led by China (up 7.5% to 33.8 million tonnes) and Indonesia (up 86% to 5.0 million tonnes). Indonesia overtook India to become the second largest producer of stainless steel.

However, stainless steel production saw some challenges in 2021. Global energy shortages during the second half of 2021 impacted output, especially in China. Production in China is expected to be further subdued in March quarter 2022 in the provinces surrounding the 2022 Winter Olympics in Beijing, but are expected to recover in the latter half of 2022.

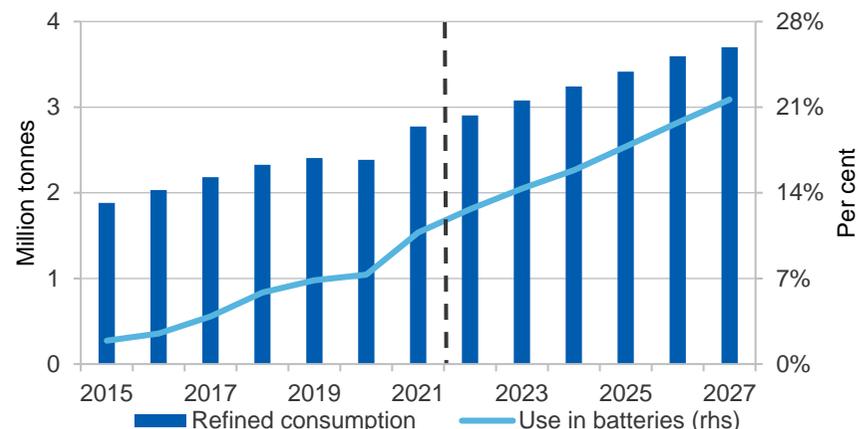
Total nickel demand rose by 16% year-on-year in 2021 to reach 2.8 million tonnes. Nickel demand growth is expected to temper in 2022, as global growth rates normalise following the COVID-19 rebound. Total nickel demand is forecast to reach 2.9 million tonnes in 2022, growing to almost 3.1 million tonnes in 2023. Nickel consumption is expected to grow at an average rate of 3.7% a year to reach 3.4 million tonnes in 2027.

#### EV sales a boon for nickel prospects

Despite the global automotive chip shortage, electric vehicle (EV) demand exceeded expectations in 2021. EVs have more modern computer chips than their internal combustion engine counterparts, and so were prioritised by chipmakers. At 6.5 million total sales in 2021, EV sales doubled year-on-year. By 2027, annual EV sales are expected to hit 24 million.

With more sales — and a desire for bigger battery packs — nickel use in batteries is expected to be a dominant driving force of nickel demand over the outlook period. 360,000 tonnes of nickel was used in batteries in 2021 (11% of total demand), up from 200,000 tonnes in 2020. By 2027, batteries are expected to account for 22% of total nickel demand.

Figure 13.1: Forecast nickel consumption



Source: International Nickel Study Group (INSG); Wood Mackenzie; Department of Industry, Science, Energy and Resources (2022)

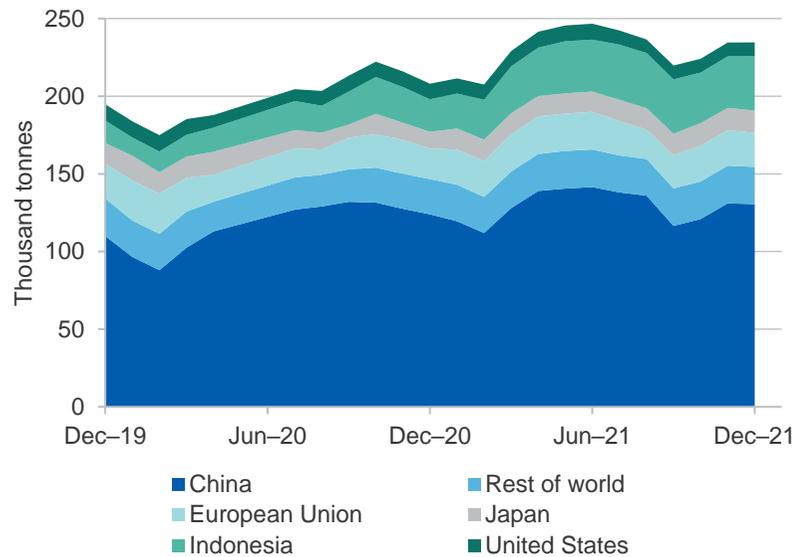
That said, the recent surge in EV sales has created some of its own pressure. The cost per kilowatt-hour (kWh) of battery packs is expected to rise in 2022, off the back of surging battery metal prices. Lithium hydroxide prices more than doubled in 2021, while nickel is facing its own price pressures following the Russian invasion of Ukraine. It is expected that price parity of EVs will occur when battery costs reach US\$100 per kWh. If the price of battery metals remain elevated, this would push the ‘tipping

point' for EV adoption later, creating some softening for nickel in battery demand. Alternative battery chemistries that do not use nickel are also emerging — see [Prices](#) section.

### Stainless still strong into the future

While use in batteries is the driving force for nickel demand over the outlook period, stainless production is still expected to be strong. Stainless production is expected to grow at an average annual rate of 3.1% to 2027, with total production approaching 73 million tonnes.

**Figure 13.2: Composition of world nickel consumption**



Source: International Nickel Study Group; Department of Industry, Science, Energy and Resources (2022)

The majority of stainless steel growth is expected to come from the major producers — China, Indonesia and India. Indonesia's ore export ban has propelled it to second in the world for stainless steel exports, forcing China to import more stainless from Indonesia and more ore — for its own stainless production — from the Philippines. Currently, 71% of stainless steel comes from these three countries; this is expected to grow to 75% of global production by 2027.

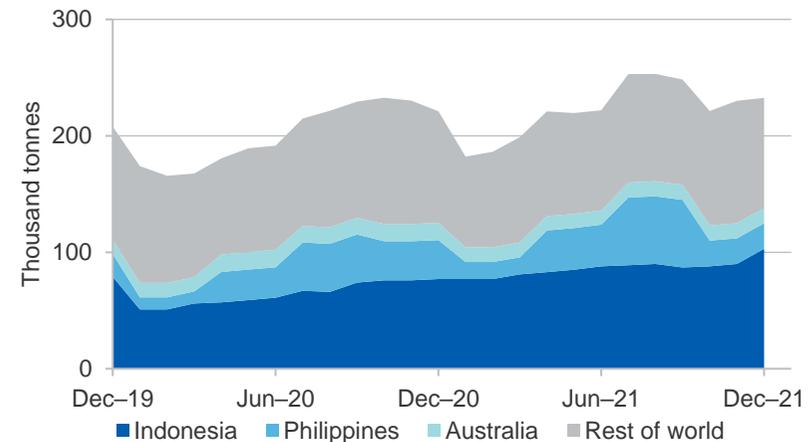
## 13.2 World production

### Mine production ramps up

Global nickel mined production grew by 8.8% year-on-year in 2021, as production returned to normal and mines started to operate at their regular capacity following COVID-19 containment measures. Mined production is forecast to grow by 11% to almost 3.0 million tonnes in 2022, largely driven by increased mine production in Indonesia to feed domestic nickel pig iron (NPI) production. Mine production is projected to grow an average 4.2% a year over the outlook period, to reach 3.4 million tonnes in 2027.

Canadian mine output in the December quarter 2021 rose 58% quarter-on-quarter, as operations at Vale's Sudbury plant normalised following significant protest activity in the September quarter 2021. Canadian mine output is expected to remain stable to 2027.

**Figure 13.3: Composition of world mined nickel production**



Source: International Nickel Study Group; Department of Industry, Science, Energy and Resources (2022)

Russian mine production rose 22% quarter-on-quarter in the December quarter 2021, as operations at Nor Nickel return to normal following flooding in early 2021. Russian mine production is forecast to increase at an average rate of 5% annually to 2027.

Production in the Philippines decreased dramatically in the December quarter 2021 due to poor weather. Mine output fell 62% quarter-on-quarter to 66,000 tonnes, and is expected to remain subdued into 2022, as ore reserves are depleted. Mine output in the Philippines is expected to remain stable to 2027.

Already the largest producer of mined nickel, mine production in Indonesia is expected to grow as new refinery capacity in Indonesia creates a market for domestic mined output (Figure 13.3). Indonesia is expected to account for over half (52%) of global mine output in 2027, up from 45% in 2022.

#### Refined production: can matte conversion outshine HPAL?

Lithium-ion batteries have conventionally used nickel sulphates derived from higher quality, Class 1 compositions of nickel sulphides. However, sulphide deposits are much less abundant than laterite deposits, resulting in a shortage of Class 1 nickel. Currently, Class 1 nickel — which has a minimum purity of 99.8% — accounts for less than 25% of total finished nickel supply.

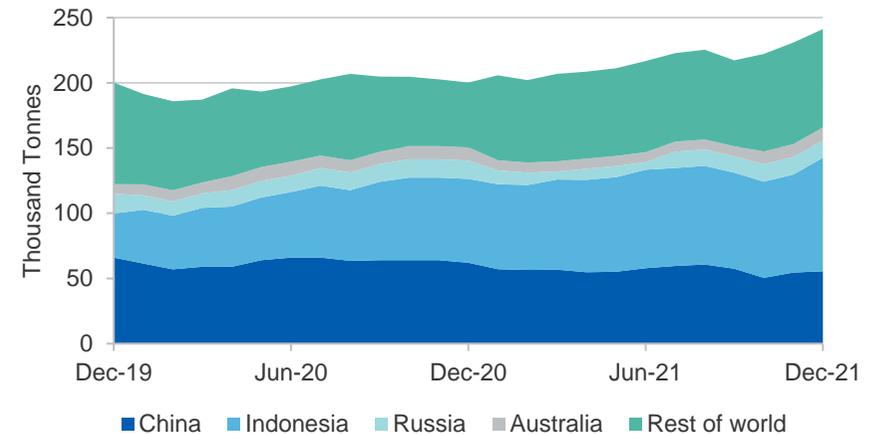
It is widely expected that production from sulphide ores will struggle to meet the demands of the battery sector. High Pressure Acid Leach (HPAL) projects are touted as one solution, but are plagued with high capital costs and operational problems. Negative Environmental, Social and Governance (ESG) risks are also a factor, and EV manufacturers are wary of tarnishing their green credentials.

Recently, the conversion of NPI to matte has arisen as a solution to this problem. On 24 January, Tsingshan announced that the first batch of nickel matte was on its way from Indonesia to China for use as feedstock for battery precursors, reducing the need to dissolve briquettes for nickel sulphate. Tsingshan is expected to supply around 100,000 tonnes in total to two Chinese firms in 2022, and several other firms have also announced intentions to convert NPI to matte in 2022.

NPI is produced in relative abundance when compared to class 1 nickel from sulphide ores. However, the economics — and environmental credentials — of NPI to matte to battery grade material, is unproven. NPI

production is relatively energy intensive even before accounting for its conversion to matte.

**Figure 13.4: Composition of world refined nickel production**



Source: International Nickel Study Group; Department of Industry, Science, Energy and Resources (2022)

NPI is produced in relative abundance when compared to class 1 nickel from sulphide ores. However, the economics — and environmental credentials — of NPI to matte to battery grade material, is unproven. NPI production is relatively energy intensive even before accounting for its conversion to matte. As a result, it is unlikely that US and European producers will look to such projects to source battery grade nickel. That said, China accounts for around half of the EV market, and may be less deterred if it provides a cheaper route for battery precursor production.

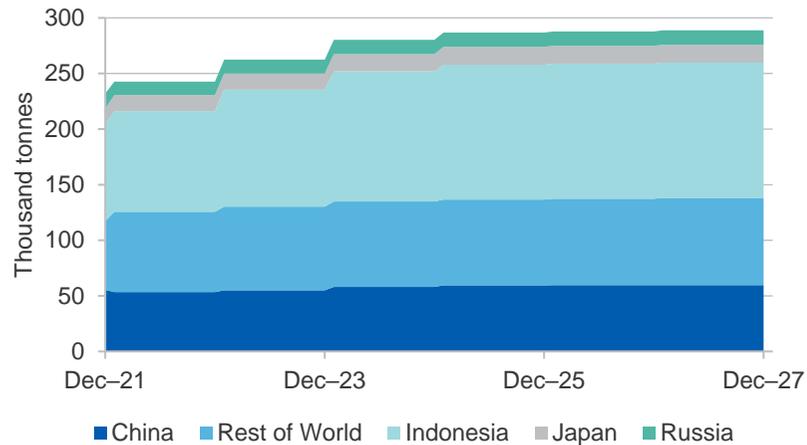
#### Indonesia refines its nickel market

Indonesia's bans on nickel ore exports — in order to promote production and export of value-added products — has long been discussed. However, 2020 and 2021 have really been the turning point for Indonesian refined production to reach maturity, largely with the help of Chinese investment (Figure 13.4). In 2022, Indonesia is expected to continue this trend,

growing by 24% to over 1.1 million tonnes, growing to 1.5 million tonnes by 2027 (Figure 13.5).

Chinese investment has not stopped at processed nickel (ferronickel, NPI and matte) but has continued into stainless steel with two large producers now operating. Several HPAL operations are either operating or soon to begin production, producing mixed hydroxide precipitate (MHP) for battery grade material required by Chinese EV makers.

**Figure 13.5: Forecast composition of world refined nickel production**



Source: International Nickel Study Group; Department of Industry, Science, Energy and Resources (2022)

### 13.3 Prices

#### Nickel prices soar due to near-record decline in inventories

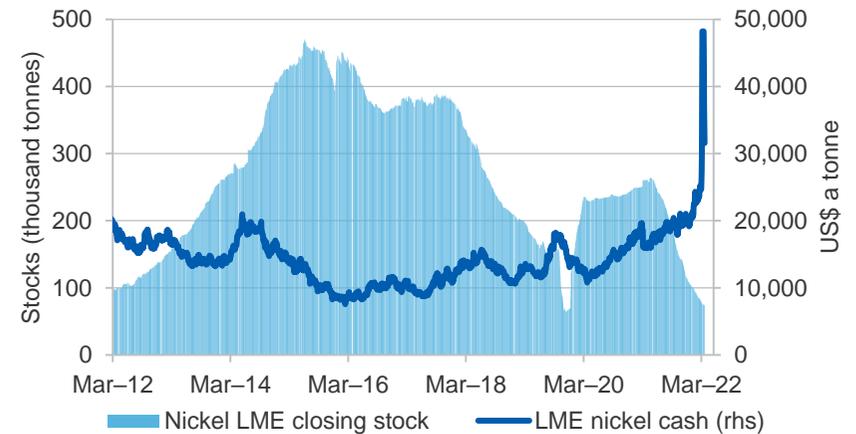
Nickel’s strong price growth in 2021 continued into March quarter 2022, off the back of positive sentiment surrounding EV demand, low exchange inventories and the Russian invasion of Ukraine. Inventories at London Metals Exchange (LME) warehouses have fallen steadily over the past 12 months, from a high of 265,000 tonnes in April 2021, to just 81,000 tonnes on 23 February 2022. Over the same time period, the LME nickel price has risen from US\$16,151 to \$24,887 — an increase of 54%.

This rundown in stocks and upward price pressure continued following the Russian invasion of Ukraine, with the price rising to \$29,609 (4 March) and \$48,201 (7 March) soon after the invasion and stocks dwindling to just 77,000 tonnes.

Then, on 8 March 2022, the price of nickel spectacularly doubled to over US\$100,000 due to a reported short squeeze. As a result, the LME halted all trading and cancelled the trades made on the day to avoid further volatility. The LME reopened to trading on 16 March, and as at 17 March the nickel price has fallen to US\$42,150. The LME has instituted daily price change limits of 8% on both the upside and downside in order to ensure stability and avoid another short squeeze event.

The nickel (spot) price is estimated to have averaged US\$26,000 a tonne in the March quarter 2022. Nickel prices are expected to moderate in the second half of 2022, however prices are still expected to average US\$24,875 for the year. The nickel market is expected to be balanced in 2023, with prices to fall to around US\$21,250. The market balance is then forecast to trend into deficit looking forward to 2027, given the large increase in nickel needed for batteries, with prices forecast to reach \$US21,100 a tonne (in real terms).

**Figure 13.6: Nickel spot price and stock at exchanges**



Source: Bloomberg (2022); Department of Industry, Science, Energy and Resources (2022)

### EV demand shows no sign of slowing down

The dominant theme for nickel over the forecast period is the rapid growth in passenger EVs. EV sales were 6.5 million sales worldwide in 2021, and are forecast at 9.1 million in 2022, and could reach 22 million in 2027. By this time, use in batteries as a proportion of total nickel demand is forecast to increase from 13% to 22%. This robust demand from the battery sector is forecast to keep prices strong over the outlook period.

However, downside risks exist within nickel's use in batteries. Added to a delay to the 'tipping point' (see Consumption section), alternate battery chemistries are emerging that have no nickel. Lithium Iron Phosphate (LFP) batteries are popular among Chinese manufacturers, with favourable cost and safety considerations over Nickel-Manganese-Cobalt batteries. LG has recently started using LFP technology, voicing price volatility of materials as a concern. That said, the prolific growth in EV demand will hold nickel in high demand. European manufacturers show preference towards nickel-based batteries, with some manufacturers lifting nickel intensity within their battery packs to raise energy density. Further, battery packs have grown by 7% since 2019, in order to satisfy consumer demand for higher range EVs, putting further upward pressure on demand.

### Risks exist, but are unlikely to force forecasts off track

Emerging trends within the battery market are the largest source of upside and downside risks to the nickel price over the outlook period. The extent to which EV sales and battery technology differ from expectations will affect prices. Higher nickel prices may make nickel-free batteries more tempting, or consumers may delay purchasing EVs if battery packs get more expensive. Both scenarios would ease upward price pressures.

Likewise, HPAL and NPI-to-matte conversion for battery grade material has stepped in when markets expect a shortage of nickel from sulphide production. More capacity is expected from both HPAL and NPI-to-matte projects in Indonesia later in 2022. Chinese scrap markets also pose a downside usage risk — every 1% gain in the scrap ratio lowers Chinese primary demand by 1,000 tonnes. Chinese firms may be keen to lift scrap ratios to strengthen their 'green credentials', given NPI's carbon footprint.

## 13.4 Australia

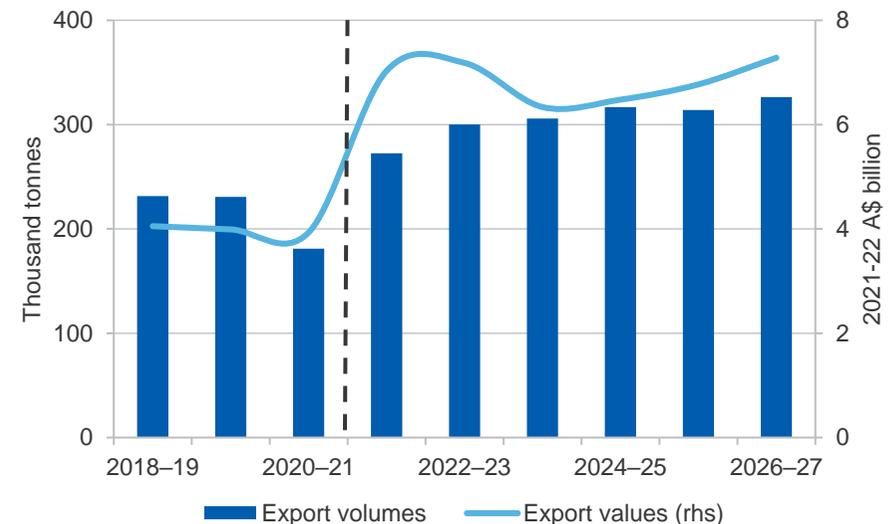
### Exports expected to rise over outlook

Nickel export volumes are expected to rebound, after falling to 181,000 tonnes in 2020–21. Export volumes are expected to grow to 273,000 tonnes in 2021–22, increasing further to 326,000 tonnes by 2026–27.

Nickel export earnings are forecast to rise to \$7.0 billion in 2021–22 off the back of 13-year record prices (Figure 13.7). Export earnings are expected to soften into 2023–24 as the nickel price retreats, however will be supported by stronger export volumes.

Continued growth in exports will likely depend upon the increasing demand for battery-grade material by EV manufacturers. Export earnings are expected to remain steady over the next few years, and are expected to reach \$7.3 billion (in real terms) in 2026–27.

**Figure 13.7: Australia's real exports stable over the outlook period**



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

### Australia's production set to expand as new production comes online

Australia's nickel production is expected to rise from 2021–22, driven by strong prospects for consumption growth in EV battery manufacturing and higher prices. Mine production is forecast to lift from 162,000 tonnes in 2020–21 to 182,000 tonnes in 2021–22, up by 16%. Mine production is expected to increase at an average rate of 6.2% a year to 226,000 tonnes to 2026–27.

Poseidon Nickel have completed the maiden resource report for Golden Swan in the December quarter 2021, and have signed a MoU with Pure Battery Technology to investigate a battery metal refinery hub in Kalgoorlie. Work on the bankable feasibility study is ongoing. This project recently received a grant under the Australian Government's Modern Manufacturing Initiative to grow the local critical minerals processing and clean energy industries.

Western Area's Odysseus mine continues to move ahead, with its nickel offtake tender process nearing completion. Output at their Forrestania operations have improved from September quarter figures, through higher production and mined grades at Spotted Quoll.

Mincor delivered its first batch of nickel ore to BHP for processing at the Nickel West Kambalda concentrator. Work is also progressing at the Cassini orebody, with first ore expected by the end of the March quarter 2022. The mine is forecast to produce 71,000 tonnes of nickel with a peak production of 16,000 tonnes a year.

Queensland Pacific Metals also secured a non-binding letter of support from Export Finance Australia in December 2021 for its Townsville Energy Chemicals Hub project. The hub will import high grade nickel laterite ore from New Caledonia for processing, and have binding offtake agreements in place for its nickel and cobalt products.

### Outlook for Australia's refined nickel production

Australia's refinery output is forecast to rise from 105,000 tonnes in 2020–21 to 129,000 tonnes in 2022–23. December quarter production for First Quantum's Ravensthorpe operations was impacted by the delayed

transition to the Shoemaker Levy orebody and unplanned maintenance at the power plant main steam pipe. Skilled labour availability and high sulphur prices also pose operational challenges, however this should abate in the June quarter 2022 as Western Australia opens its borders.

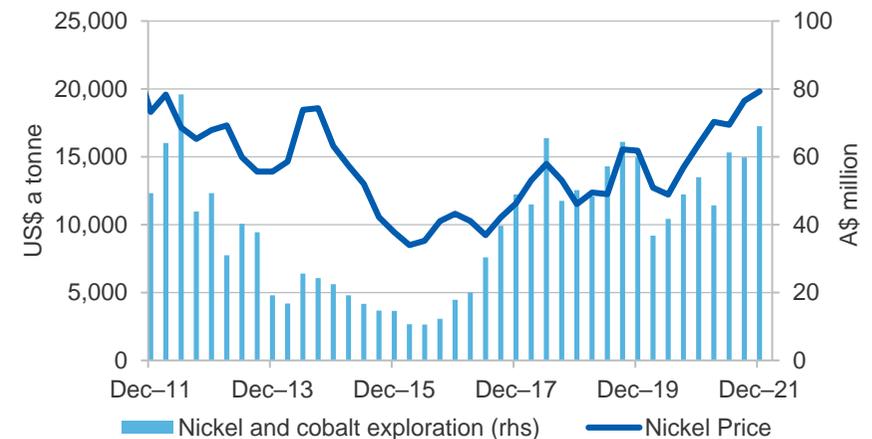
BHP's Nickel West project delivered its first batch of nickel sulphate from its Kwinana refinery in the December quarter 2021. The expansion will ramp up over 2022 to add 100,000 tonnes annual capacity for nickel sulphate refining to the Kwinana refinery.

Australia's refinery production is projected to rise to 139,000 tonnes in 2026–27, growing at an average 4.9% a year from 2020–21 figures. However, stronger increases in refined nickel production are likely, should nickel prices remain strong through the mid-2020s.

### Exploration expenditure at a nine-year high

In the December quarter 2021, nickel and cobalt exploration expenditure increased to \$69 million — up 15% quarter-on-quarter and 28% year-on-year. This increase is likely due to speculation of a sharp rise in demand for nickel used in EV batteries, with miners seeking new deposits of minerals that will drive the world's low emissions transition (Figure 13.8).

Figure 13.8: Nickel and cobalt exploration continues to expand



Source: Source: ABS (2022) International Trade in Goods and Services, 5368.0

### Revisions to the outlook

The forecast for Australia's nickel export earnings have been revised higher since the December 2021 *Resources and Energy Quarterly*. Export earnings are up by \$1.8 billion (to \$7.0 billion) for 2021–22, and up by \$2.6 billion (to \$7.4 billion) for 2022–23, due to increases in the nickel price (due to concerns around supply and the Russian invasion of Ukraine).

For 2025–26, export earnings are \$7.5 billion (in nominal terms) compared to \$7.2 billion as forecast in the March 2021 *Resources and Energy Quarterly*, primarily due to an upward revision of export volumes.

**Table 13.1: Nickel outlook**

World	Unit	2021	2022 <sup>f</sup>	2023 <sup>f</sup>	2024 <sup>z</sup>	2025 <sup>z</sup>	2026 <sup>z</sup>	2027 <sup>z</sup>	CAGR <sup>r</sup>
Production									
–mine	kt	2,668	2,972	3,210	3,363	3,437	3,433	3,406	4.2
–refined	kt	2,611	2,912	3,125	3,317	3,387	3,397	3,408	4.6
Consumption	kt	2,774	2,949	3,074	3,192	3,275	3,363	3,440	3.7
Closing stocks	kt	484	447	498	623	734	768	736	7.9
–weeks of consumption		9.1	7.9	8.4	10.1	11.7	11.9	11.1	4.1
Prices LME									
–nominal	US\$/t	18,468	24,875	21,250	20,250	21,313	22,750	23,875	5.4
	USc/lb	838	1 128	964	919	967	1 032	1 083	5.4
–real <sup>b</sup>	US\$/t	19,107	24,875	20,698	19,225	19,740	20,591	21,116	2.6
	USc/lb	867	1 128	939	872	895	934	958	2.6
Australia	Unit	2020–21	2021–22 <sup>f</sup>	2022–23 <sup>f</sup>	2023–24 <sup>z</sup>	2024–25 <sup>z</sup>	2025–26 <sup>z</sup>	2026–27 <sup>z</sup>	CAGR <sup>r</sup>
Production									
– mine <sup>c</sup>	kt	162	182	233	236	237	226	226	6.2
– refined	kt	105	114	129	135	139	139	139	4.9
– intermediate	kt	29	27	30	30	30	33	48	9.7
Export volume	kt	181	273	300	306	317	314	326	11.5
– nominal value	A\$m	3,804	7,031	7,406	6,707	7,032	7,534	8,305	17.2
– real value <sup>d</sup>	A\$m	3,932	7,031	7,182	6,335	6,478	6,771	7,281	13.9

Notes: **b** In 2022 calendar year US dollars; **c** Quantities refer to gross weight of all ores and concentrates; **d** In 2021–22 financial year Australian dollars; **f** Forecast; **r** Average annual growth between 2021 and 2027 or 2020–21 and 2026–27; **z** Projection.

Source: ABS (2022) International Trade, 5465.0; LME (2022) spot price; World Bureau of Metal Statistics (2022) World Metal Statistics; Department of Industry, Science, Energy and Resources (2022)