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Further information

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Foreword

Australian resource and energy exports are forecast to set a record of \$464 billion in 2022–23. This is the result of a new wave of surging bulk commodity revenues: the second such wave to benefit Australia in the past 2-3 years.

The first extraordinary wave in Australian resource and energy export revenue came in 2021, as iron ore prices pushed to record highs. Ongoing problems with Brazilian iron ore supply combined with strong iron ore demand from China.

The latest wave of bulk commodity revenues came from the spectacular surge in energy prices in 2022, mainly originating from the fallout over Russia's invasion of Ukraine. Gas/LNG and (metallurgical and thermal) coal prices easily surpassed previous record highs, as many Northern Hemisphere nations scrambled to secure alternatives to Russian supplies.

Bans on Russian exports of oil and other fossil fuels by most advanced Western nations have now taken effect. Transport and infrastructure constraints will likely prevent a full diversion of Russian energy exports to nations with no sanctions. The net result is a drop in world energy supply, as some Russian output becomes stranded. Russia has recently moved to cut oil exports. Barring much weaker demand, the prices of energy commodities are likely to remain relatively high over the outlook period.

LNG earnings are forecast at \$91 billion in 2022–23, as high LNG prices more than offset the impact of slightly weaker LNG export volumes. This is three times the revenue of 2020–21. Record prices will see thermal coal exports reach \$65 billion this financial year, up from around \$16 billion in 2020–21.

Energy prices have generally fallen sharply in recent months, as the world economy slows and supply chains reorganise further. COVID- and weather-induced supply disruptions among major producers are also easing, lowering prices. Australian resource and energy export earnings are thus set to fall noticeably.

A number of factors suggest our resource and energy export earnings should nevertheless hold at relatively healthy levels over the outlook period. Firstly, the end of China's zero-COVID policy will likely trigger a pick up in sales to China, given that nation's large share of world usage and the pent-up demand resulting from three years of COVID-19 restrictions. Low unemployment/underemployment in Western nations is likely to persist for some years, stoking the demand for resource and energy commodities. Third, the global energy transition is expected to boost our exports of lithium and base metals. Lithium product exports are expected to exceed \$18.5 billion in 2022–23, up from \$4.9 billion in 2021–22. Lithium and base metals (and their raw material inputs) will account for almost as much export revenue as all coal types by 2027–28. India's appetite for resource/energy commodities is likely to show strong growth over the outlook period, as the nation develops. Australia is well placed to supply India with these products. Finally, stranded Russian commodity production should help sustain Australian resource and energy commodity exports.

After 2023–24, earnings from LNG and thermal coal are likely to fall back towards pre-COVID levels. However, thermal coal miners are likely to enjoy relatively high prices over the outlook period, as a lack of spending to bring on new supply matches the impact of diminishing world demand.

The La Niña weather pattern has ended and the Indian Ocean Dipole has normalised. Together, this means there is a much lower chance of wetterthan-normal conditions in eastern Australia in 2023–24 — and thus less likelihood of disruptions to the mining/transportation of bulk commodities. These disruptions helped drive coal prices higher in 2022. Statistically, a La Niña weather pattern is unlikely in the first few years of the outlook period. The other risks to the forecast for Australia's resource and energy export earnings after 2022–23 are evenly skewed. Markets have priced in weaker world economic growth and the loss of some Russian resource and energy commodity output from world supply in 2023. Should inflation prove harder to tame, central banks may have to hold monetary policy tighter — and for longer — risking slower than expected growth and thus lower commodity demand.

Overview







Australia's resource and energy exports, A\$billion (real prices)



SOURCE: ABS; OCE

1.1 Summary

- High energy commodity prices and strength in the US dollar have driven another surge in export earnings. After a record \$422 billion in 2021–22, resource and energy export earnings are forecast to lift to \$464 billion in 2022–23, before falling back over the outlook period.
- Energy commodity prices continue to unwind from the war-driven spike of 2022, as energy markets and usage rearranges. But with China ending its COVID lockdowns, commodity prices should level out in 2023.
- By 2028, the export value of lithium and base metals (and their raw material inputs) will equal the export value of all coal types combined.

1.2 Macroeconomic, policy, trade and other factors

World economic growth has continued to slow in recent months, but the abrupt ending of China's zero-COVID policy in late 2022 has seen an improvement in sentiment in resource and energy commodity markets. Notwithstanding Western trade sanctions on Russia, global supply chains have been clearing, helping to lower goods inflation. Periodic supply problems could emerge, as China is hit by outbreaks of COVID infections. Central banks have continued to raise official interest rates, to try to make sure that medium/long term inflation expectations don't rise unacceptably. Robust labour markets in many major economies are cooling gradually, reducing wage pressures.

It is likely to take some quarters before the Chinese economy grows strongly on the back of pent-up consumer demand: fresh COVID-19 outbreaks will likely cause significant disruption throughout 2023. As Chinese economic growth picks up, the chances of a soft landing in the world economy in 2023 rise. China's current relatively low inflation rate gives the Chinese authorities better scope to stimulate the domestic economy than other major economies. Such measures would support global resource and energy commodity prices in the first half of the outlook period. Less favourable demographic trends and the debt problems beleaguering the Chinese property sector will likely hamstring the demand for metals over the same period. India is likely to grow as a source of resource and energy commodity demand over the outlook period, as the economy grows and develops further.

The European economy is recovering from the spike in energy prices that did much to hurt both sentiment and activity in 2022. Since the December 2022 *REQ*, the US Federal Reserve has slowed the pace of monetary tightening further, as the US inflation rate starts to fall back from 30-year highs. Services inflation remains a problem though; with further Fed rate hikes thus likely, the US dollar will remain well supported. A slowing in core inflation pressures in major economies seems likely over the first half of the forecast horizon. This should allow the major Western central banks to cease monetary tightening in 2023.

The impacts of the COVID-19 pandemic and the Russian invasion of Ukraine are likely to fade over the forecast period. The IMF forecasts world GDP growth of 2.9% in 2023 and 3.1% in 2024, down from growth of 3.4% in 2022. World growth of 3.3% is forecast over the rest of the outlook period — down from the 2000-19 average of 3.8%. The IMF expects China to grow by 5.2% in 2023 and 4.5% in 2024.

The loss of much of the Western European market — the largest and closest pre-invasion market for Russia's energy exports — prohibitions on the transfer of key technology and equipment to Russian industry, and the withdrawal of Western investment, will all weigh heavily on Russian exporters over the outlook period. China and India will benefit from relatively cheap Russian fossil fuel supply. Unlike crude oil sales, Russia will find it more difficult to sell diesel and other refined oil products to China and India, since those countries have their own large oil refining operations.

The ongoing fallout from the Russian invasion of Ukraine is expected to see energy prices remain elevated in 2023 at least. With many nations pushing to achieve net zero by/before 2050, low investment in new fossil fuel supply will act to keep fuel prices relatively high, despite poor demand.

Resources and Energy Quarterly March 2023

The high price of fossil fuels is likely to accelerate the push towards low emission technologies over the outlook period. Commodities used in low emission technologies (lithium, copper and nickel) also seem set to trade at relatively high prices, as supply struggles to keep up with demand.

The recent trend towards trade blocs will likely intensify over the outlook period. Investment flows will help cement these trends. An example will be the large amount of US gas liquefaction capacity coming onstream in the first half of the outlook period: the US will become the world's largest LNG supplier, likely displacing Russian fossil fuels sales to the West. Many nations/regional blocs will continue to seek to become self sufficient in critical technologies and commodities, as a way of enhancing national security.

The US Inflation Reduction Act will be a major driver of this trend. But economic nationalism will come at a cost to the world economy: rather than the lowest-cost producers/manufacturers (usually China) dominating world production, output of critical technologies and commodities will consume more of the world's resources and be much more diversified than at present.

The Australian dollar has regained some of the ground lost against the US dollar in the first ten months of 2022. The AUD/USD is assumed to head towards the mid USD0.70's over the first half of the outlook period, and then average USD0.75 (its post float average) over the rest of the forecast horizon.

Higher global interest rates pose a downside risk to global economic activity — and thus Australian resource and energy exports — in the early part of the outlook period. Geopolitical tensions are likely to remain an ongoing risk to the outlook for world economic growth — and hence resource and energy commodity demand. War and the threat of war, impact adversely on household and business confidence. Falling confidence tends to see expenditure on 'big ticket' items deferred as a precaution. Big ticket items (vehicles, plant, buildings) often have a large metal content.

1.3 Export values

Australia's export values are forecast to be \$464 billion in 2022-23

In the March quarter 2023, the Resources and Energy Export Values Index rose by 13% from the March quarter 2022; a rise in volumes added to the impact of a gain in prices.

Despite a slowing world economy, resource and energy exports of \$464 billion in 2022–23 are set to easily break last year's record of \$422 billion (Figure 1.1). However, exports are forecast to fall to \$378 billion (real terms) in 2023–24, as commodity prices settle back at levels seen before the recent spikes.

As prices gradually start to level out in 2025–26, so too will the decline in resource and energy earnings (Figure 1.2).

Figure 1.1: Australia's resource and energy export values/volumes



Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)





Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Figure 1.3: Resource and energy export prices, AUD terms



Notes: The export price index is based on Australian dollar export unit values (EUVs, export values divided by volumes); the export price index is a Fisher price Index, which weights each commodity's EUV by its share of total export values.

Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Energy shortages have eased and the world economy is slowing

The slowdown in the world economy and the re-organisation and improvement in energy commodity supply has reduced generally reduced commodity prices. In Australian dollar terms, the OCE's Resources and Energy Commodity Price Index fell by 6% (preliminary estimate) in the March quarter 2023, but was up 2% on a year ago. In US dollar terms, the index fell by 2% in the quarter, to be down 3% on a year ago. Resource export prices (Australian dollar terms) fell by 2% in the year to the March quarter 2023, while energy commodity prices rose by 6% (Figure 1.3).

1.4 Prices

Since the December 2022 *Resources and Energy Quarterly*, resource and energy prices have generally fallen, as fears grow of a world slowdown. The iron ore price has bucked the trend, and remains well above the cycle low of November 2021. Expectations of a lift in Chinese demand have added to the impact of supply issues in major exporting nations (Figure 1.4). Prices are likely to fall over the outlook period, as world supply lifts faster than world demand.

Figure 1.4: Bulk commodity prices



Weaker demand and improved supply have seen Australian thermal coal prices fall sharply in early 2023, but they are high in historical terms. Bad weather and flooding in major producing regions added to the impact of high demand for non-Russian cargoes in 2022. Prices are expected to fall over the outlook period, as trade flows re-organise further and supply lifts. Metallurgical coal prices are high, as the market looks to stronger future Chinese demand. Prices are likely to fall from here, as supply lifts.

Oil prices have steadied in a US\$70-90 a barrel range in recent months. The end of zero-COVID in China has seen consumption forecasts raised. Artificial and operational constraints on OPEC+ supply continue, keeping the market tight. Spot LNG prices have dropped back to levels seen before the Russian invasion of Ukraine, helped by a warmer than normal Northern Hemisphere winter. Prices are likely to be elevated in the first half of the outlook period, as some Russian gas output is stranded.

The price of gold has risen significantly since the last REQ, helped by a small number of bank failures. Record central bank net purchases in 2022 are unlikely to be repeated over the forecast period. The price is likely to fall modestly in the next five years, as real bond yields hold their gains.

Figure 1.5: Base metal prices



Base metal prices have risen, as hopes of a soft landing in the world economy add to the impact of low inventories. The loss of some Russian supply (especially nickel and aluminium) from world markets would boost prices (Figure 1.5). Prices should be flat over the forecast period, as supply slowly catches up with demand and stockpiles stop falling.

1.5 Export volumes

March quarter export volumes rose marginally

The Resources and Energy Export Volumes Index (preliminary estimate) rose 0.3% in the March quarter 2022 from the December quarter, and was 6% higher than a year before.

Within this total, resource commodity volumes fell by 0.3% in the year to the March quarter 2023, while energy commodity volumes rose by 4.8% (Figure 1.6).

Energy exports were impacted by production and transport problems in the March quarter 2022, lowering the base: operational, weather and COVID-19 related workforce issues were central to these disruptions.

Figure 1.6: Resource and energy export volumes



Source: Department of Industry, Science and Resources (2023)

In volume terms, resource exports are likely to show further significant growth over the outlook period, particularly in 2023 and 2024. The volume of energy exports has been constrained by weather conditions and problems associated with the pandemic. High prices will likely cause some demand destruction in the outlook period, and the global energy transition will also impact adversely on export volumes.

1.6 Contribution to growth and investment

Mining output grew strongly while the overall economy grew modestly

Australia's real Gross Domestic Product rose by 0.5% in the December quarter 2022, to be up 2.7% from the December quarter 2021. Mining value-added rose by 3.2% in the December quarter, to be up 4.8% over the previous year (Figure 1.7). The quarterly gain was driven by rises in Iron Ore Mining (up by 4.8%), Oil and Gas Extraction (up by 1.0%), Exploration and Mining Support Services (up by 2.5%) and Other Mining (up by 0.9%). The rises were partly offset by a fall in Coal Mining (down by 1.4%), due to continued wet weather and flooding on the East Coast.

Figure 1.7: Contribution to quarterly growth, by sector



Source: ABS (2023) Australian National Accounts, 5206.0

In the coming five years, while the resource sector will make a significant contribution to real GDP growth, the contribution of the energy sector may diminish. The disruptions to production of the past few years — due to the COVID-19 pandemic and weather-related issues — are likely set to ease. Coal and LNG producers will benefit from relatively high prices. Metal production (ferrous and non-ferrous) should experience healthy growth.

Mining investment is picking up

The latest ABS Private New Capital Expenditure and Expected Expenditure survey shows that Australia's resources industry invested \$12.3 billion in the December quarter 2022. This was up 10.0% from the December quarter 2021. In quarterly terms, investment rose across the board: for oil and gas, metal ores, coal, and other mining (Figure 1.8). The December quarter is typically a strong one for capex.

Figure 1.8: Mining capex by commodity, not seasonally adjusted



Notes: Other mining includes non-metallic mineral mining and quarrying and exploration and other mining support services; chart data is in nominal, original terms Source: ABS (2023) Private New Capital Expenditure and Expected Expenditure, 5625.0

Expenditure for equipment, plant and machinery softened in the December quarter, but investment in buildings and structures rose (Figure 1.9).

Spending on equipment, plant and machinery has risen steadily since 2016, with spending on buildings and structures rising more recently.



Figure 1.9: Mining industry capital expenditure by type, quarterly

Notes: Chart data is in nominal terms, seasonally adjusted. Source: ABS (2023) Private New Capital Expenditure and Expected Expenditure, 5625.0

Forward expectations suggest that total mining industry investment in 2022–23 will be higher than in 2021–22 (Figure 1.10). The first estimate for 2023–24 has been released, and suggests the mining industry will invest \$41 billion over the year. This is 7% higher than the first estimate for 2022–23, but is below the fourth estimate (estimates tend to gain with each update). Strong prices for gold and various minerals used in low-emissions technology have supported a recent uptick in investment.

Exploration expenditure (adjusted for inflation) edged down to \$930 million in the December quarter 2022. Exploration has been trending down since mid-2022, but remains well above the recent low of \$783 million recorded in the June quarter 2020. Notwithstanding the December quarter decline, exploration spending remains solid, and generally aligned to the recent positive trend for capital spending (Figure 1.11) reflecting a solid outlook for minerals used in low emission technologies.

Figure 1.10: Mining industry capital expenditure, fiscal year



Notes: Chart data is in nominal terms

Source: ABS (2023) Private New Capital Expenditure and Expected Expenditure, 5625.0

Figure 1.11: Mining capital expenditure vs exploration (real, quarterly)



1.7 Revisions to the outlook

The estimate for Australia's resources and energy exports in 2022–23 is \$5 billion higher than the forecast contained in the December quarter 2022 *Resources and Energy Quarterly.* The forecast for 2023–24 (nominal prices) is up by \$4 billion from the same report (Figure 1.12). This upward revision has been driven by a lift in forecast iron ore and metallurgical coal earnings and a weaker than expected exchange rate against the US dollar (AUD/USD). Thermal coal earnings have been revised down, partly in light of the sharp price falls of recent months.

Iron ore earnings in 2022–23 have been revised up by \$8 billion, and by \$7 billion in 2023–24. The revisions reflect forecasts of a shallower fall in prices than envisioned in the December 2022 REQ. Chinese iron ore demand in 2023 is likely to be stronger than previously expected. Further out, earnings are expected to decline at a similar rate and at a similar time as envisaged in March 2022.





Source: Department of Industry, Science and Resources (2023)



Figure 1.13: Australia's major resources and energy commodity exports, 2022–23 dollars % change from 2021–22 CAGR % change from 2021–22

■ 2021–22 ■ 2022–23 f ■ 2027–28 z Notes: f forecast. EUV is export unit value.

Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Table 1.1: Outlook for Australia's resources and energy exports in nominal and real terms

Exports (A\$m)	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^f	2025–26 ^f	2026–27 ^f	2027–28 ^f	CAGR ^g %
Resources and energy	421,618	464,267	395,320	346,369	328,767	337,715	335,865	-3.7
- real ^b	452,036	464,267	378,017	321,022	296,738	297,380	288,537	-7.2
Energy	204,056	238,265	185,473	157,047	139,017	136,865	129,787	-7.3
- real ^b	218,777	238,265	177,355	145,554	125,473	120,519	111,498	-10.6
Resources	217,563	226,002	209,847	189,322	189,750	200,850	206,078	-0.9
- real ^b	233,259	226,002	200,662	175,468	171,265	176,861	177,039	-4.5

Notes: **b** In 2022–23 Australian dollars; **f** forecast; **g** growth rate on 2022-23 levels. Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Table 1.2: Australia's resource and energy exports, selected commodities

	Prices					Export volumes				Real export values, A\$b, 2022–23 prices		
	Unit	2021–22	2022-23 ^f	2027–28 ^f	Unit	2021–22	2022–23 ^f	2027–28 ^f	2021–22	2022–23 ^f	2027-28 ^f	
Iron ore	US\$/t	119	97	69	Mt	874	887	989	142	121	74	
LNG	A\$/GJ	16	21	13	Mt	83	82	80	76	91	45	
Metallurgical coal	US\$/t	387	296	185	Mt	163	164	172	72	63	30	
Thermal coal	US\$/t	245	313	103	Mt	196	182	195	50	65	19	
Gold	US\$/oz	1,832	1,798	1,713	t	248	269	323	25	25	20	
Crude oil	US\$/bbl	91	89	75	kb/d	290	274	299	15	13	10	
Copper	US\$/t	9,645	8,406	9,954	kt	808	873	970	13	13	15	
Alumina	US\$/t	381	345	350	Mt	17,739	17,571	18,381	9.6	8.8	8.1	
Aluminium	US\$/t	2,891	2,388	2,391	kt	1,368	1,369	1,404	6.1	4.9	3.8	
Lithium	US\$/t	1,488	4,104	2,700	kt	2,248	3,080	4,462	5.3	19	19	
Zinc	US\$/t	3,506	3,124	2,841	kt	1,220	1,378	1,546	4.8	4.7	3.8	
Nickel	US\$/t	23,594	24,414	21,313	kt	159	164	215	4.7	5.0	4.2	
Uranium	US\$/lb	45	51	67	t	4,933	5,697	7,915	0.6	0.8	1.2	

Notes: a Export data covers both crude oil and condensate; f forecast. Price information: Iron ore fob (free-on-board) at 62 per cent iron content estimated netback from Western Australia to Qingdao China; Metallurgical coal premium hard coking coal fob East Coast Australia; Thermal coal fob Newcastle 6000 kc (calorific content); LNG fob Australia's export unit values; Gold LBMA PM; Alumina fob Australia; Copper LME cash; Crude oil Brent; Aluminum LME cash; Zinc LME cash; Nickel LME cash; Lithium spodumene ore.

Source: ABS (2023) International Trade in Goods and Services, Australia, Cat. No. 5368.0; LME; London Bullion Market Association; The Ux Consulting Company; US Department of Energy; Metal Bulletin; Japan Ministry of Economy, Trade and Industry; Department of Industry, Science and Resources (2023)

Macroeconomic Outlook



Global GDP and economic change in 2022



Global overview

- In 2022, global economic activity increased by 3.4%.
- Growth is expected to slow to 2.9% in 2023 and 3.1% in 2024.

Global risks

The world macroeconomic environment improved slightly in early 2023.

- Inflation rates look to have peaked in key markets, and energy shortages and COVID-related disruptions have eased.
- Tighter fiscal and monetary conditions in most major economies — aimed at curbing still-high inflation rates are expected to slow global economic growth over 2023 and early 2024.



SOURCE: IMF; ABS; OCE

2.1 Summary

- The world macroeconomic environment improved slightly in early 2023, as inflation rates look to have peaked in key markets, and as energy shortages and COVID-related disruptions eased.
- However, tighter fiscal and monetary conditions in most major economies — aimed at curbing still-high inflation rates — are expected to slow global economic growth over 2023 and early 2024. The potential for spreading instability in global financial markets following recent volatility in the US and European banking sectors poses a downside risk to the global outlook.
- In January 2023, the IMF forecast the world economy to grow by 2.9% in 2023 and 3.1% in 2024, down from 3.4% in 2022. The 2023 forecast represented an upward revision of 0.2 percentage points from the previous forecast (published in October 2022).

2.2 World economic outlook

Tighter fiscal and monetary conditions weighing on global growth.

The International Monetary Fund (IMF) forecasts the world economy to grow by 2.9% in 2023, rising to 3.1% in 2024 after growth of 3.4% in 2022 (Figure 2.1). This represents an upward revision of 0.2 percentage points in 2023, and a downward revision of 0.1 percentage points in 2024 from the October 2022 World Economic Outlook.

A substantial divergence between the performance of advanced and emerging economies is expected by the IMF over the next two years. After recording growth below the global average last year — for the first time in more than 40 years — China's economy is expected to exceed 5% growth this year. However, the US and European economies are expected to slow in 2023.

While the global economic uncertainty triggered by the fallout from Russia's invasion of Ukraine is set to continue into 2023, a number of downside risks to the global outlook have moderated in recent months. Headline inflation appears to have peaked in several countries, China has removed many COVID-19 restrictions, and energy prices have fallen sharply.

20 15 10 5 0 -5 -10 -15 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 -World US EU China Japan

Figure 2.1: GDP growth forecasts

Source: IMF (2023)

Global price pressures are expected to fall further in the coming months, as supply chain pressures ease and shipping costs fall as global consumer demand continues to weaken.

Weaker consumer demand in the US and Europe will also weigh on growth of manufacturing exporters — including China, Japan and Korea.

Labour markets remain resilient, with near full employment conditions persisting in many major advanced and emerging economies. Labour market tightness has been reflected in decade-high wage growth across advanced economies. However, job vacancy-to-unemployment ratios have moderated across several advanced economies in recent months, pointing to a modest easing in labour demand across economies.

Over the 5-year outlook, growth rates for the global economy are expected to return to around the long-run average of 3.2–3.3% a year. Faster growth in emerging economies is expected to support global growth rates. However, population ageing in China is expected to weigh on growth in

coming years, with growth in China's economy of around 4.5% projected by the IMF over the outlook to 2027–28 (Figure 2.1). Advanced economies are projected to return to their lower pre-pandemic growth trajectories, reflecting their demographic profiles and economic maturity.

In the latter half of the 5-year outlook period, world economic growth should receive a boost from investment in the global energy transition, as governments and businesses focus on 2030 emissions targets.

Despite the moderation in some downside risks in recent months the global outlook remains highly uncertain. The IMF notes that key risks include the potential for China's recovery to stall if low population COVIDimmunity and limited hospital capacity results in widespread adverse health consequences. China's vulnerable real estate market remains a risk to its financial stability. Another source of global economic vulnerability stems from the risk of the war in Ukraine escalating, and the potential for further geopolitical fragmentation. Tighter monetary policy remains a risk if inflation pressures, particularly in services, prove more persistent than expected. Finally, the potential for spreading instability in global financial markets following recent volatility in the US and European banking sectors poses a downside risk to the global outlook.

Global industrial production and trade weaken as orders drop

Global industrial production and trade growth dipped in the December quarter 2022, due in part to COVID-related shutdowns in China. Global trade recorded negative year-on-year growth in the final two months of 2022, the first falls since 2020. Weaker demand for goods in advanced economies, especially electronic equipment, has seen exports from China, South Korea and other east Asian economies fall in recent months. However, growth in world industrial output remained positive, albeit very weak (Figure 2.2).

Forward indicators of manufacturing activity indicate a recovery in 2023. The JP Morgan global manufacturing Purchasing Managers Index (PMI) slipped into negative territory (signalling contraction) in the final quarter of last year driven by falls in the US, Eurozone, China and Japan. However, the outlook strengthened in February 2023, as the Chinese economy recovered. Results for individual countries are discussed below.

30 56 25 55 Annual per cent change 20 54 15 53 Index 52 10 5 51 50 0 49 -5 -10 48 Dec-20 May-21 Oct-21 Mar-22 Aug-22 Jul-20 Jan-23 PMI (Manufacturing, rhs) — Industrial production Merchandise trade

Figure 2.2: World industrial production, trade and PMI

Notes: PMI data is to February 2023; IP and trade data only available to December 2022. Source: IHS Markit (2023); CPB Netherlands Bureau for Economic Policy Analysis (2023)

Global supply chain pressures normalising

Global supply chain pressures continue to moderate. The Global Supply Chain Pressure Index — a composite measure of cross-border transportation costs, delivery times, and order backlogs — continued the sharp falls over the past year, falling to below the historical average in February 2023 (Figure 2.3). The fall in the index was broad-based, with the largest negative contribution from European Area delivery times.

Global freight costs continue to decline, with the average price for a 40-foot shipping container (Drewry's composite World Container Index) falling to US\$1,800 in March 2023. Freight costs are down more than four-fifths from the peaks of over US\$10,000 in late 2021, but remain around 25% higher than average 2019 (pre-pandemic) rates.



Figure 2.3: Global supply chain pressure index

Source: Bloomberg (2023); New York Federal Reserve (2023)

As goods/energy prices ease, the focus shifts to services inflation

Headline inflation has been falling in major economies, due to reductions in energy prices and the easing of lingering supply-demand imbalances and supply chain bottlenecks. In January 2023, the IMF forecast global inflation to fall from 8.8% last year to 6.6% in 2023 and 4.3% in 2024. However, inflation would remain above pre-pandemic levels, which were around 3.5%. As inflation rates continue to be well above central bank targets in most economies, reining in inflation continues to be the primary concern for policymakers in most economies.

US CPI, for example, has fallen for eight consecutive months since the peak in June 2022. US core inflation — which excludes food and energy — has also begun to ease, driven by falling goods inflation. Eurozone inflation, while still high, has also peaked, with sharp monthly reductions in recent months driven by falling energy prices (Figure 2.4). In contrast to easing goods inflation, services inflation — particularly housing and consumer services — has increased in the US, and will be a key focus for American policymakers over the year.



Figure 2.4: Consumer Price Indices — US, Europe and OECD

Source: Bloomberg (2023); Board of Governors of the Federal Reserve System (2023); U.S. Bureau of Economic Analysis (2023); OECD (2023)

Monetary policy tightening by central banks continues, although some have slowed the pace of tightening. The US Federal Reserve lifted rates by 25 basis points at its February and March meetings, following a 50 basis points increase in December and four consecutive 75 basis point increases during 2022.

The European Central Bank (ECB) raised its key policy rate by 50 basis points in February and again in March. In announcing the March rate increase, which was announced days after a plunge in the value of Credit Suisse, the ECB stated that it was monitoring current market tensions closely and indicated that it was ready to respond if required to preserve financial stability in the euro area.

Market pricing is consistent with expectations that policy rates will peak around mid-2023 and then decline later in the year.

2.3 Major trading partners' economic outlook

The outlook for Australia's major trading partners remains weak, with their GDP growth in 2023 forecast by the RBA to be around 3.5%, well below its pre-pandemic decade average.¹ Slower growth in Australia's major trading partners will reduce demand for Australia's exports. However, the expected recovery in China's economy and ongoing development in India will support resource and energy export earnings over the outlook period. Macroeconomic developments for selected economies are provide below.

Chinese GDP expected to rebound in 2023 as economy reopens

China's economy grew by 2.9% year-on-year in the December quarter 2022 (Figure 2.5). Aside from the lockdown-affected June quarter 2022, this was the slowest year-on-year growth since the 2020 pandemic recession. The December quarter result reflected weak exports and consumption (both government and household), which weighed on the substantial contribution from manufacturing and infrastructure investment. The weak result partly reflected the impact of COVID-19 restrictions in November, and disruptions due to surging COVID-19 cases in December.

Weakness in residential investment, sales and prices continues to weigh on economic activity. In the year to December 2022, the value of sales of residential buildings fell by over 25%, while new house prices fell (year-onyear) for the 9th consecutive month in January. In volume terms (measured in square metres of floor space), newly started residential property fell 40% in 2022, and residential building sales were down 27%.

Chinese authorities have continued efforts to support growth in the property sector, by building on the substantial fiscal and monetary policy backing provided in 2022 — particularly through additional infrastructure spending. In February, the People's Bank of China (PBC) injected around 500 billion yuan into one-year medium-term lending facility (MLF) loans to support banking system liquidity. The stimulus follows multiple cuts during 2022 to key policy rates.

The Government announced a growth target of around 5% for 2023 in the government work report released at the opening of the National People's Congress in March. Following the Congress, the PBC again reduced the bank reserve requirement ratio — the amount of funds banks have to hold in reserve — following a similar cut in December. The PBC stated the March cut was aimed at maintaining liquidity and ensuring the money supply increases in line with nominal economic growth. The government also eased restrictions on developers' access to finance, and financial institutions were encouraged to boost lending for infrastructure projects (see December 2022 *Resources and Energy Quarterly*).

Figure 2.5: China contributions to quarterly real GDP



Notes: Consumption is made up of both household and government sectors. Source: Bloomberg (2023); National Bureau of Statistics of China (2023)

China's industrial production was relatively weak in December, up 1.3% year-on-year. This was the weakest result since the April-May shutdowns, with rising COVID infections and containment measures a key worry for Chinese companies. China's Caixin General Manufacturing PMI indicated that manufacturing returned to growth in February, recording the first

¹ RBA Statement on Monetary Policy — February 2023.

improvement in business conditions in 7 months. The February PMI result was the highest reading in more than a decade, with businesses reporting a strong rebound in both production and new orders driven by rising customer demand.

The return to more normal business operations in early 2023, and hopes that the economy and new business will rebound, helped lift business confidence. Among manufacturers surveyed, optimism was the highest recorded since early 2021.

Passenger vehicle production weakened in the final months of 2022, down 16% year-on-year in December. Vehicle sales were also down, although the decline was less marked than in production.

The IMF forecasts Chinese GDP growth of 5.2% in 2023 — reflecting improving mobility — and 4.5% in 2024. China is expected to grow at around 4.5% a year over the 5-year outlook period. However, the IMF warns that declining business dynamics and slow progress on structural reforms could slow Chinese growth over the medium term.

Demographic change will increasingly weigh on China's economic growth. In January, China's National Bureau of Statistics released data showing China's population fell in 2022, the first annual fall since the Great Leap Forward in 1961. Population aging and a shrinking workforce has seen China's old-age dependency ratio — total elderly population relative to the working-age population — rose from 10% in 2000 to 19% in 2021. Over the outlook period, China is expected to continue to look to shift toward quality- rather than quantity-oriented consumption-led growth.

Bank of Japan maintains accommodative stance as inflation rises

Japan's GDP increased by 0.4% year-on-year in the December quarter 2022, down from 1.5% in the September quarter. Net trade contributed to growth, with exports increasing and imports declining for the first time since 2021.

Slowing growth in its major trading partners and higher inflation, hold downside risks for Japan's economy. Japan's core inflation — which excludes fresh food but includes fuel costs — was 4% in December 2022,

exceeding the Bank of Japan (BoJ) inflation target of 2% for the ninth month in a row.

Inflationary pressures are being driven by higher raw material costs, particularly for imported materials — in the context of a weak yen which lost substantial value over the course of last year. The BoJ has maintained its accommodative monetary policy, and continues to hold the 10-year Japanese Government bond yield unchanged at -0.1%. In December, the BoJ announced that it would increase its regular monthly purchases of Japanese Government bonds while allowing yields on 10-year bonds to trade in a wider band to improve bond market functioning.

Japanese industrial production growth has been volatile, due to the base effects from COVID-related disruptions in 2021. In December, industrial output declined slightly in year-on-year terms, consistent with the post-pandemic trend — which has seen zero growth over the past two years. In addition, machinery orders, which have experienced similar levels of volatility, also fell for the third consecutive month in December (Figure 2.6).

Manufacturing conditions continued to weaken in early 2023. The Jibun Bank Japanese Manufacturing PMI remained in negative (contractionary) territory in January for the 3rd month in a row. The index has been falling steadily over the past year. Contributing to the weakness was subdued international demand for Japanese manufactures, with falling sales to customers across Asia — although this was mitigated to some extent by increased demand for Japanese goods from Europe.

Looking ahead, the IMF forecasts Japan's economic growth to rise to 1.8% in 2023, on the back of continued monetary and fiscal policy support. Business investment is expected to be supported by high corporate profits from the weaker yen (and hence higher prices received for exports) as well as delays in implementing some previous projects. However, as the effects of past stimulus fade, growth is expected to slow in 2024. In the latter half of the outlook period, growth is expected to settle below 0.5%, as Japan's demographic trends of an ageing and declining population and shrinking workforce continue to slow GDP growth.



Figure 2.6: Japan industrial production and machinery orders

Eurozone economies face slower growth

Following surprisingly robust Eurozone GDP growth in the first few quarters of 2022, growth fell to zero in the December quarter 2022 (quarter-on-quarter) to leave it 1.8% higher year-on-year (Figure 2.7). Among the larger economies, Germany grew by 0.9%, France by 0.5% and Italy by 1.4%.

Despite the moderation in energy prices in recent months, European manufacturers — in particular energy-intensive metal smelting, refining and fabrication operations — remain very exposed to high energy prices. Industrial production in the Eurozone fell by 1.7% year-on-year in December 2022, down from 2.8% growth in November. While a drop in production was anticipated, the decline was larger than market expectations.

Leading indicators have improved in recent months. In February, the Eurozone Composite PMI Index increased to 52.0, the strongest result since May 2022. The improvement reflected an acceleration in service sector growth and improved supply chains. New orders increased, while input costs increased at a slower pace. Business confidence was the highest it has been since before the Russian invasion of Ukraine, as concerns about a potentially deep recession, spiralling energy prices and rising inflation, eased in the new year.

Figure 2.7: Eurozone GDP and Composite PMI (quarterly)



Notes: PMI for March quarter 2023 is average of January and February results. Source: Bloomberg (2023)

In February 2023, the Eurozone manufacturing PMI fell to 48.5, the 8th consecutive 'contractionary' result. However, manufacturing output rose for the first time since May 2022. The pickup reflected improved supply chains, with delivery times shortening for the first time in 2 years. Optimism among manufacturers about the year-ahead outlook also lifted, with future output expectations at their most upbeat since Russia's invasion of Ukraine.

As noted above, the European Central Bank (ECB) raised its key policy rate by 50 basis points in February and again in March.

In January, the IMF lifted its forecast of European growth in 2023 by 0.2 percentage points to 0.7%. This reflected lower wholesale energy prices and additional announcements of fiscal purchasing power support — in the form of energy price controls and cash transfers. Growth in 2024 is expected to pickup to an estimated 1.6%. Over the remainder of the outlook to 2028, economic growth is projected to trend toward a longer-run annual level of about 1.7%.

South Korea's exports fall as global semiconductor demand plunges

South Korea's GDP increased by 1.3% year-on-year in the December quarter 2022. A sharp fall in exports — which have been the largest contributor to Korea's GDP growth over the past two years — weighed heavily on growth (Figure 2.8). The fall in exports also reflected base effects, due to the surge in real exports in the December quarter 2021.



Figure 2.8: South Korea contributions to quarterly real GDP

Source: Bloomberg (2023)

South Korea's industrial production fell sharply in the final months of 2022, down over 7% year-on-year in December 2022. Exports of computer chips

declined by over 40% year-on-year in February, due to slowing demand and falling prices. South Korea's manufacturing PMI improved slightly in January, but remained in contraction territory for the 7th consecutive month. The negative January result was due to large falls in output and new orders, due to weak demand in domestic and foreign markets.

South Korean inflation increased slightly to 5.2% year-on-year in January, defying the general downward trend since inflation peaked at 6.3% in July 2023. The Bank of Korea raised its benchmark interest rate by an additional 25 basis points to 3.5% in January, for a cumulative gain of 3 percentage points since August 2021.

In January, the IMF lowered its forecast of South Korean economic growth to 1.7% in 2023 (down from 2.6% in 2022), a downward revision of 0.3 percentage points. Growth is expected to return to 2.6% in 2024, decreasing to 2.3% a year by 2028.

US labour market resilience continues

In year-on-year terms, the US economy grew by 0.9% in the December quarter 2022. This growth was primarily driven by personal consumption, as private investment made its first negative contribution to GDP in over two years. Faster growth in US exports, combined with slower growth in imports, meant that net exports contributed to overall GDP growth (yearon-year) for the first time since the onset of the pandemic (Figure 2.9).

US labour market resilience continues, with nonfarm payroll employment rising by 311,000 in February 2023. While the unemployment rate rose slightly in February, at 3.6% it remains close to the 53-year low achieved in January. The resilient labour market continues to support spending. However, US personal consumption spending — the main driver of GDP growth since mid-2021 — fell in the final months of 2023. Total inflation-adjusted spending on goods and services fell month-on-month in November and December 2022. Spending recovered strongly in January 2023, rising by 1% in real terms. However, the latest rebound may be short lived, with retail sales falling in February (month-on-month) as sales of furniture, cars and clothing and spending in restaurants and bars fell.



Figure 2.9: US contributions to quarterly real GDP

Source: Bloomberg (2023)

US housing demand has weakened further, with home sales around 35% lower than at the start of 2022. Advertised rents have fallen in recent months, which should see the rapid inflation of rents evident over the past year begin to moderate later in the year.

The US net private saving rate has fallen from the record rates achieved during the pandemic (Figure 2.10). Despite a slight pickup in the savings rate in the December quarter 2022, US Bureau of Economic Analysis data indicates the current savings rate is the lowest since the declines seen during the global financial crisis in 2009. Credit card balances have been rising sharply over the past year, with total US credit card debt reaching record levels of almost US\$1 trillion in February 2023.

US households, particularly those in the top half of the income distribution, are estimated to continue to hold a buffer of excess savings. Despite drawdowns in savings over the past year, this is likely to help them navigate higher prices and the tightening rate cycle.²

Figure 2.10: US personal consumption and net private savings



Notes: Personal Consumption Expenditures; seasonally adjusted data; January 2016 =100; Net Private Savings: seasonally adjusted annual rate (quarterly data). Source: FRED Economic Data (2023)

US industrial production fell by 0.2% year-on-year in February, the first negative result since the recovery commenced in early 2021. The US Manufacturing PMI dropped sharply late last year, and remained weak in early in 2023. The deterioration in manufacturers' operating conditions reflects sharp falls in output and new orders, as domestic and external demand weakens.

As noted earlier, the US Federal Reserve continues to lift rates, with the 25 basis point increase in March lifting the target range to 4.75–5%. However, in announcing the March increase Chair Powell noted that the Fed had changed its language on rate increases, no longer stating in its guidance that it anticipated ongoing rate increases would be appropriate to quell inflation. Projections of the policy rate required to achieve the Fed's inflation target were revised up at the December 2022 meeting to a median of 5.1 per cent and remained stable in March 2022.

² The Federal Reserve, Excess Savings during the COVID-19 Pandemic, October 2022.

In January 2022, the IMF upgraded its forecast for US economic growth for 2023 by 0.4 percentage points to 1.4%, reflecting carry-over effects from domestic demand resilience in 2022. Growth in 2024 was revised down slightly, due to the steeper path of Federal Reserve rate increases, — which the IMF expects to peak at just over 5% in 2023.

Over the rest of the outlook period to 2028, annual US economic growth is projected to trend toward a lower, longer-run level of about 1.9%. Factors affecting growth over this period will include future revenue and spending measures — employed to address significant increases in public debt — rising healthcare costs and population ageing. The global energy transition will also reshape the post-pandemic economy. The latter will also be affected by a range of measures included in the 2022 *Inflation Reduction Act*, which will ramp up over the outlook period.

India's GDP slows as manufacturing weakens

India's GDP growth slowed to 4.4% year-on-year in the December quarter 2022, down from 6.3% in the September quarter (Figure 2.11). The growth was below market expectations (4.6%) and was supported by growth in agriculture and mining. Falls in manufacturing along with weaker private consumption demand weighed on growth.

Despite falling in January, India's PMI recorded its 19th month of expansion and remained above the long-run average — with production and domestic and foreign new orders continuing to rise. Price pressures faced by manufacturers were at a 3-month high, due to higher prices for energy, metals and electronics, but remained well below the long-run average.

India's retail price inflation remained above the Reserve Bank of India (RBI) target rate of 2–6% for the second consecutive month in February, reflecting higher food prices and housing costs while fuel prices remained elevated. The RBI raised interest rates in February, the sixth increase since May last year. The RBI is expected to continue with interest rate increases this year, dampening growth in domestic spending and investment.

Figure 2.11: India quarterly GDP and monthly CPI



Source: Bloomberg (2023)

The IMF forecasts India's economic growth to slow to 6.1% in 2023, down from 6.8% in 2022. Growth is then forecast to pick up to 6.8% in 2024, driven by resilient domestic demand despite external headwinds due to softer external demand (resulting from slower global growth). Further out, the IMF expects India's GDP growth will likely average just over 6.0% a year. This reflects a resumption of the healthy growth trajectory seen in the decade before the COVID-19 shock — where favourable demographics and rapid development helped push India's economy to among the fastest growing in the world.

Table 2.1: Key IMF GDP assumptions

	2022	2023 ^a	2024 ^a	2025 ^a	2026 ^a	2027 ^a	2028 ^a
Economic growth ^b							
Advanced economies	2.7	1.2	1.4	1.9	1.9	1.7	1.7
Australia	3.6	1.6	1.7	2.0	2.2	2.3	2.3
Eurozone	3.5	0.7	1.6	2.2	2.0	1.7	1.7
France	2.6	0.7	1.6	1.8	1.7	1.4	1.4
Germany	1.9	0.1	1.4	2.2	1.8	1.3	1.3
Japan	1.4	1.8	0.9	0.9	0.5	0.4	0.4
New Zealand	2.3	1.9	2.0	2.2	2.3	2.4	2.4
South Korea	2.6	1.7	2.6	2.6	2.5	2.3	2.3
United Kingdom	4.1	-0.6	0.9	2.3	2.2	1.5	1.5
United States	2.0	1.4	1.0	1.8	2.1	1.9	1.9
Russia	-2.2	0.3	2.1	1.0	0.8	0.7	0.7
Emerging economies	3.9	4.0	4.2	4.3	4.3	4.3	4.3
ASEAN-5 ^d	5.2	4.3	4.7	5.2	5.1	5.0	5.0
China ^e	3.0	5.2	4.5	4.6	4.6	4.6	4.6
India	6.8	6.1	6.8	6.8	6.5	6.2	6.2
Latin America	3.9	1.8	2.1	2.5	2.5	2.4	2.4
Middle East	5.0	3.2	3.5	3.6	3.6	3.6	3.6
World ^c	3.4	2.9	3.1	3.4	3.3	3.2	3.2

Notes: a Assumption. Data for 2025–2027 are from October 2022 WEO database. Growth rates for 2028 are assumed equal to 2027 growth rates. b Year-on-year change. India projections are based on fiscal years, starting in April; **c** Calculated by the IMF using purchasing power parity (PPP) weights for nominal country gross domestic product. d Indonesia, Malaysia, Philippines, Thailand and Vietnam. e Excludes Hong Kong.

Sources: IMF (2022, 2023) World Economic Outlook; Bloomberg (2023).

Table 2.2: Exchange rate and inflation assumptions

	2022	2023 ª	2024 ª	2025 ª	2026 ^a	2027 ^a	2028 ^a
AUD/USD exchange rate	0.69	0.71	0.75	0.75	0.75	0.75	0.75
Inflation rate ^b							
United States	8.0	3.5	2.2	2.0	2.0	2.0	2.0
	2021–22	2022–23 ª	2023–24 ª	2024–25 ª	2025–26 ª	2026–27 ^a	2027–28 ª
Australia	7.2	4.6	3.2	2.7	2.5	2.5	2.5

Notes: a Assumption; **b** Average.

Sources: ABS (2023) Consumer Price Index, 6401.0; Bloomberg (2023); Department of Industry, Science and Resources; RBA (2023); IMF (2023).

Resources and Energy Quarterly March 2023

Steel





World consumption, 2019



Steel facts



SOURCE: WSA; ABS; OCE

Steel TRADE MAP





SOURCES: ABS; ITC Comtrade

3.1 Summary

- World steel production fell 3.7% year-on-year in 2022. Outbreaks of the pandemic in China constrained economic activity, exacerbating weakness in the country's property sector. Energy and raw materials shortages (due to fallout from Russia's invasion of Ukraine) also hampered other major steel producers' output.
- Global steel consumption is forecast to grow 1.6% in 2023. The global economic slowdown is expected to persist this year. However, a reopening of the Chinese economy — following the easing of COVIDrelated restrictions — should help to bolster world steel demand.
- Over the outlook period to 2028, extensive levels of infrastructure and non-residential construction activity are expected to support annual growth of 1.5% in world steel demand. Growth in steel production will be strongest in countries such as India and the US, and regions such as South East Asia and the Middle East.

3.2 World production and consumption

Fall in 2022 world steel production, the first since 2015

World steel output fell 3.7% to 1.88 billion tonnes in 2022 (Figure 3.1), as global economic growth moderated from the COVID-recovery peak in 2021. Inflationary pressures saw monetary policy tightened across most major economies, exacerbating the slowdown as 2022 ended.

Outbreaks of the COVID-19 pandemic in China and ongoing weakness in the country's residential property sector, saw a fall in steel output from the world's largest producer. Fallout from Russia's invasion of Ukraine also adversely impacted steel production in many of nations/regions outside of China in 2022, with raw materials shortages and high energy prices contributing to weaker industrial output (Figure 3.2) and forced production cuts amongst large producers such as the EU, US, and Japan, as well as a significant loss of production capacity in Ukraine.

India was one of the few big producers to increase output in steelmaking in 2022, rising more than 5.5%.

Figure 3.1: Global annual steel production



Notes: **z** projections

Source: World Steel Association (2023); DISR (2023)

Figure 3.2: World manufacturing PMI and industrial output



Notes: JPMorgan Global Manufacturing Index; a reading above 50 indicating an overall increase compared to the previous month, and below 50 an overall decrease Source: World Steel Association (2023); S&P Global (2023); Bloomberg (2023)



Figure 3.3: World industrial and steel production

Source: World Steel Association (2023); Wood Mackenzie (2023); DISR (2023)

Global steel demand expected to make a modest recovery in 2023

With world economic activity expected to slow further this year, growth in global industrial production is forecast to moderate to 2.6%. This is expected to dampen the recovery in global steel demand in 2023 (Figure 3.3). Risks are skewed to the downside. Tightening monetary policy across most major economies remains a key challenge in the near term, particularly the lagged impact on private sector spending and investment. The adverse impact on steel demand of persistently elevated energy prices is also a key risk.

However, these challenges will be at least partially offset by the recent reopening of China's economy following a pandemic-affected 2022. With China relaxing its dynamic zero-COVID policy from November, and introducing new measures intended to revive its sluggish property sector, the country is expected to see a mild recovery in steel demand in 2023. By sector, global construction activity picked up as the year turned, and is expected to maintain momentum this year. The Americas, Middle East and African regions continue to see the strongest overall conditions, while activity in both the Asia Pacific region and Europe saw some rebound (from comparatively weaker levels) in the December quarter. Global construction activity continues to be driven primarily by infrastructure, with higher interest rates increasingly stymieing the private residential (and to a lesser extent, the private non-residential) sectors.

Global manufacturing activity returned to expansionary territory in February, with a JP Morgan Global Manufacturing PMI reading of 50.0. Continued declines for major economies such as the US, Europe and Japan, were offset by growth in emerging Asian nations, as well as the reopening of the Chinese economy. With the rates of decline in global output and new orders slowing, there are hopes that the downturn in the sector has now passed its worst. Rising business optimism over the reopening of China's economy is also expected to provide a boost in coming months.

The global auto industry is expected to see further recovery in 2023, despite ongoing challenges from supply chain disruptions, deteriorating economic conditions and weakening demand. In December, S&P Global Mobility forecast a 4.0% increase (year-on-year) in units produced in 2023. However, a return to pre-pandemic levels is not expected until 2025 at the earliest. While semi-conductor shortages have improved, the issue is expected to remain a challenge over the next few years. Weakening global demand will also remain a key risk through this year.

Infrastructure-related construction to propel world steel demand to 2028

Global steel demand is projected to grow 1.5% annually over the outlook period. Growth is expected to be highest in regions such as South and South East Asia (particularly India), the Middle East, and North America (particularly the US and Mexico) (Figure 3.4).

Construction — representing about 50% of world steel demand — is expected to see solid growth over the outlook period. This will be spurred by considerable levels of infrastructure investment pledged across many

major nations in the last few years. This includes the US\$1.2 trillion Bipartisan Infrastructure Framework, as well as India's US\$1.3 trillion National Infrastructure Pipeline to 2025.

Global steel production is forecast to grow by around 1.6% annually to 2028. This includes around 140 million tonnes from new capacity — either underway or planned over the next couple of years — with large-capacity projects slated for Asia, North America, Europe and the Middle East. By process, Blast Furnace-Basic Oxygen Furnace steelmaking (favouring iron ore and metallurgical coal as inputs) is expected to make up around 58% of new global supply, and more than 85% of new capacity in Asia over the next few years.

China's steel demand reliant on reopening and improving property sector

Chinese steel consumption is estimated to have fallen by around 2.3% in 2022. Following outbreaks of the COVID-19 pandemic from March, China implemented a dynamic zero-COVID policy, significantly curbing industrial activity and domestic travel over the rest of the year. This culminated in economic growth in the June quarter falling to its weakest result since 2020 COVID lows, and sluggish manufacturing activity through much of 2022 (Figure 3.5).

The impact of this slowdown on steel demand was exacerbated by China's deteriorating residential property sector, which accounts for around 35-40% of the country's total steel consumption. In 2022, new construction starts in China's residential property sector were around 40% lower than in 2021 (Figure 3.5).

With the government moving away from its dynamic zero-COVID policy as the year turned, the Chinese economy is expected to see a return to more normal levels of economic activity in coming months, supporting the country's (and global) steel demand in 2023. However, the recent wave of new COVID-19 cases remains a near-term barrier to this recovery.

Infrastructure is expected to be a significant driver of construction activity in China in 2023. As much as RMB4.76 trillion (US\$680 billion) in local government special purpose bonds — primarily used for infrastructure spending — were issued in 2022. The government has also instructed its





Notes: * Growth is total growth in percentage terms over the period; Rest of Asia ex. China, Japan, South Korea, Taiwan, and India Source: World Steel Association (2023); DISR (2023)

Figure 3.5: China – major steel end-users





Figure 3.6: China's residential property sector pipeline

Notes: * Floor space reported on a cumulative calendar year basis in million squares metres. China's property data combines Jan and February monthly data (reported in February) Source: NBS (2023); Bloomberg (2023)

Figure 3.7: China credit cycle



Notes: * China Infrastructure Investment Y-o-Y 3-Month Moving Average; **China Fixed Asset Investment Real Estate Cumulative Source: NBS (2023); Bloomberg (2023) various policy banks (the Agricultural Development Bank of China, China Development Bank, and the Export-Import Bank of China) to increase lending for infrastructure projects.

The Chinese government also continues to take steps to ensure the stability of its property sector, with 16 new policy measures announced in November last year. However, despite current efforts, the outlook for China's residential property sector remains subdued, with real estate investment and new home sales down around 8% and 25% year-on-year, respectively at the end of 2022 (Figure 3.6). The stabilisation (and recovery) of this sector remains a critical factor in China's overall level of steel demand in 2023.

The People's Bank of China (PBoC) has also sought to address weakness in China's property sector and the broader economy, cutting the Medium-Term Lending Facility Rate and Reserve Requirement Ratio multiple times through 2022. The easing of monetary conditions has yet to see a meaningful pick up of credit growth in the broader economy, with Bloomberg's China's Credit Impulse (measuring new loans compared with broader GDP) falling back into negative territory in December (Figure 3.7), and total social financing (a broad measure of credit in liquidity in the economy) still deeply negative at the end of 2022.

China's total steel production is projected to decline slightly over the outlook period to 2028 (Figure 3.8). China has nominated 2030 as its target date for peak steel (output), however is expected to achieve this in the next few years — as structural factors temper the economy's steel demand requirements. In 2022, China announced its first decline in population, and with real estate constituting as much as 25% of the Chinese economy, weakness in the country's property sector will continue to diminish the country's near-term steel demand.

Russian invasion of Ukraine creating long-term loss of steel supply

Russian and Ukrainian steel production collectively represented around 5% of global supply in 2021.

Ukrainian steel production is estimated to have fallen by around 70% (year-on-year) in 2022, with a significant share of the country's

steelmaking capacity impacted. Russia's control of the Black Sea from early 2022, and strikes on improvised supply chain networks, have also continued to restrict export capability of major Ukrainian steel producers. As of early 2023, Ukraine is seeking to expand its current grain export agreement to include steel products, however any recovery in ferrous exports is expected to be partial and play out over several years.

Russian steel production is estimated to have fallen by around 6% in 2022. EU sanctions in effect from March last year have seen Russia increasingly diverting exports of iron ore and steel to Asia away from Europe. This includes China, with iron and steel imports from Russia more than doubling in 2022, and Indian imports of Russian steel rising several-fold over the same period. Despite the redirection, Russia's total steel exports are estimated to have fallen substantially in 2022.

The rising impact of the war, and broader sanctions on Russia appears to be driving weaker domestic economic activity. Russia's industrial output fell for an eighth consecutive month in December (down 4.3% year-on-year). Sanctions on Russia — particularly its access to financing and capital investment — are expected to act as a long-term constraint on Russian iron and steel exports, leading to some loss of supply over the outlook period to 2028.

Energy and raw materials shortages impacting global (ex China) output

Ex-China steel output is estimated to have fallen by around 5.7% in 2022. Energy and raw material shortages have had a deleterious impact on manufacturing activity across many major economies in 2022. This saw weak (or no) growth in industrial production — particularly in the EU, Japan and South Korea — over much of the year (Figure 3.9).

The weakening global outlook in recent months has also seen a marked drop in steel prices across major markets, particularly flat steel products such as HRC (Figure 3.10). Meanwhile, the ongoing push for infrastructure and non-residential commercial construction has maintained rebar prices at elevated levels in most major markets through 2022 (Figure 3.11).

Figure 3.8: China annual steel production



Notes: z projections

Source: World Steel Association (2023); Department of Industry, Science and Resources (2023)

Figure 3.9: Industrial production — EU, US, Japan and S Korea



Source: Bloomberg (2023)

European steel market continues to face negative outlook in 2023

Steel output in the EU — the world's second largest steel-producing region — is estimated have fallen by around 10% in 2022. Europe has continued to experience supply chain disruptions and high energy prices since Russia's invasion of Ukraine, contributing to rising inflationary pressures in the region. This has impacted downstream, steel-intensive industries in the region, including the construction and automotive sectors.

The S&P Global Eurozone Construction Total Activity Index remained in contractionary territory in early 2023, though with the rate of falls slowing across all three sub-sectors (housing, commercial and infrastructure). The rate of input-cost inflation also appears have cooled in recent months, though new orders remain weak given the high level of economic uncertainty still present in the market. Government housing support schemes and public construction works are expected to provide some support to activity through 2023, though growth will be moderated by the persistence of elevated energy prices (relative to historical levels), and the impact of rising interest rates on residential and commercial construction.

The European auto industry continues to face challenging conditions in 2023. High energy prices, parts shortages and falling global trade are all impacting manufacturers. The current global economic slowdown is also expected see demand destruction overtake supply shortages as the primary factor affecting regional production in 2023.

Over the outlook period to 2028, EU steel production is forecast to see a moderate level of growth, though will remain below its pre-pandemic peak. The majority of the EU's current or planned steel capacity developments are aimed at replacement (rather than additional) supply, with a particular focus on the shift toward, EAF-based, lower-emissions facilities (Figure 3.12).

Figure 3.10: HRC steel prices



Source: Bloomberg (2023)

Figure 3.11: Rebar steel prices



Source: Bloomberg (2023)

India and South East Asia to see impressive growth over outlook to 2028

In contrast with many other major economies, Indian steel output expanded in 2022, rising more than 5.5%. This was led by high levels of construction activity across all three sub-sectors (residential, commercial and infrastructure). However, rising inflationary pressures remain a nearterm risk to this momentum this year. The Reserve Bank of India is expected to continue with interest rate rises in 2023, in turn threatening a dampening of household and commercial activity this year.

Over the outlook period to 2028, India is projected to see some of the strongest growth in steel output globally (Figure 3.12). This follows the Indian Government's target to double national production capacity to 300 million tonnes by 2030–31. The country is expected to add more than 60 million tonnes in new steel production capacity by 2025, much of it based in states such as Odisha, Karnataka and Chhattisgarh. On the demand side, strong expansions are projected in India's residential and commercial sectors, as well as a significant increase in infrastructure spending — as part of the country's \$1.5 trillion National Infrastructure Pipeline to 2025.

South East Asia is also expected to see a substantial increase in total steel output over the outlook period. Current and planned projects suggest as much as 50 million tonnes in new steel production capacity is expected to come online in the region in coming years. This includes sizeable projects in Vietnam, Philippines, and Malaysia. Many of these projects also reflect the growing presence of Chinese investment in steelmaking capacity in the region (through the Belt and Road Initiative), including Panhua Group's new 10 million tonne per annum (Mtpa) facility in the Philippines' Misamis Province, Sarawak Iron and Steel's 10Mtpa facility in Malaysia, and Hebel Bishi Steel Group's 3Mtpa facility in Indonesia.

Japan and South Korean steel output faced with global trade headwinds

Japan and South Korea saw steel output in 2022 contract by 7.4% and 6.6%, respectively. In Japan, semiconductor (as well as other parts) shortages constrained auto production last year, with total automotive output falling by 1.7% year-on-year. Japan also saw a weakening of its

broader manufacturing sector, with industrial production falling by 2.8% year-on-year in December.

Japan is expected to see a return to positive GDP growth in 2023, as pandemic-related restrictions are unwound and domestic economic activity recovers. However, rising raw material and energy costs, and a depreciating yen are expected to restrain the recovery in steel output in 2023. Over the outlook period, Japan is expected to see relatively flat growth in steel production through to 2028 (Figure 3.12).

South Korea continued to face increasingly difficult conditions through 2022, with GDP easing to growth of just 1.4% year-on-year in the December quarter. This was led by weakness in exports (down close to 10% year-on-year in December), and domestic industrial production (down 7.3% over the same period). The fall in exports, combined with a surge in energy imports, has seen South Korea record 11 consecutive months of trade deficits, its longest streak since the 1997–98 Asian Financial Crisis.

With growth in South Korea's economy expected to slow further in 2023, a rebound in the country's steel output is expected to be very limited this year. The global economic slowdown is forecast to further quell Korea's export-oriented industries, while tightening monetary conditions are expected to dampen residential construction activity. Over the outlook, South Korean steel production is expected to grow modestly (Figure 3.12).

New infrastructure and manufacturing to drive growth in US steel output

US steel production fell by around 6.2% in 2022. Inflationary pressures, supply chain disruptions and tightening monetary conditions, all weighed on US construction activity through 2022 — particularly the residential property sector. Manufacturing activity also slackened through 2022, with industrial production for the sector falling 0.9% year-on-year in December (compared with growth of 7.4% earlier in the year in February).

The outlook for US steel demand in 2023 remains positive, albeit with downside risks. Easing supply chain constraints are expected to boost automotive output in 2023, and new government initiatives — such as the *CHIPS and Science* and *Inflation Reduction* Acts — should lend support to domestic manufacturing activity. However, with the US manufacturing PMI

falling deep into contractionary territory in early 2023, and new orders slumping, challenges in the near term remain. Demand destruction — due to the global economic slowdown — is another critical risk in 2023.

US steel production is projected grow reasonably strongly over the outlook period to 2028 (Figure 3.12). This will include around 13 million tonnes of new (primarily EAF-based) steel production capacity, to be brought online

by 2025. The new projects will continue the broader shift of steelmaking capacity — away from traditional hubs in the north — toward new locations in southern states. Domestic demand will also be driven by the US\$1.2 trillion *Infrastructure and Jobs Act*, which includes US\$550 billion in new federal government investment.



Figure 3.12: Other major producers — annual steel production

Notes: z projections

Source: World Steel Association (2023); Department of Industry, Science and Resources (2023
Table 3.1: World steel consumption and production

			N	Aillion tonnes				
Crude steel consumption	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
China	969	978	983	977	971	969	966	-0.1
European Union	160	158	165	168	170	173	177	1.7
India	118	124	131	141	150	160	170	6.3
United States	103	106	110	114	117	119	122	2.9
Other Asia ^a	114	117	121	123	126	129	133	2.6
Japan	62	62	64	65	66	67	68	1.5
Middle East	57	58	60	62	64	64	65	2.4
South Korea	54	54	55	56	56	57	58	1.2
Russia	43	43	42	42	43	44	46	0.9
World steel consumption	1,903	1,934	1,980	2,005	2,031	2,057	2,083	1.5
Crude steel production	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
China	1,013	1,015	1,012	1,008	1,003	998	992	-0.3
European Union	137	142	148	149	150	151	153	1.9
India	125	131	140	149	161	173	175	5.8
Japan	89	92	93	93	93	92	93	0.7
United States	81	89	90	93	93	94	95	2.8
Russia	72	72	73	73	73	73	74	0.5
South Korea	66	69	71	72	72	72	73	1.7
Other Asia ^a	60	65	74	83	86	91	92	7.4
World steel production	1,879	1,930	1,967	1,993	2,019	2,044	2,070	1.6

Notes: **a** Asia ex. China, India, Japan, South Korea and Taiwan; **f** Forecast; **r** Compound annual growth rate; **z** Projection Source: World Steel Association (2022); Department of Industry, Science and Resources (2022)

Iron Ore





World consumption, 2022



Iron ore facts



working with iron for

at least 5,000 years



to the industrial revolution

SOURCE: American Chemical Society; Science Daily; Focus Economics; WSA; ITC Comtrade; GA

Iron Ore trade map





4.1 Summary

- Spot iron ore prices have rebounded strongly in early 2023, after falling more than 50% in the second half of last year. The higher prices reflect a partial recovery in Chinese steel production, and an anticipated rise in China's steel demand this year — as the economy reopens with the end of the government's dynamic zero-COVID policy in late 2022.
- Australian export volumes increased by 1.5% (year-on-year) in 2022 to 884 million tonnes. With further greenfield supply expected to come online from established and emerging producers in the next few years, export volumes are forecast to increase by 1.9% annually over the outlook period to 2028.
- Lower prices projected over the outlook period will see Australia's iron ore export earnings (in real terms) moderate from \$121 billion in 2022– 23 to around \$100 billion in 2023–24, and to \$75 billion by 2027–28.

4.2 Prices

Iron ore price rallies on impact of reopening of China's economy in 2023

Following a fall in iron ore prices to a low of around US\$85 a tonne in November last year, the benchmark iron ore spot price (basis 62% Fe fines CFR Qingdao) has recovered to average around US\$115 a tonne in the March quarter 2023 (Figure 4.1).

In China, renewed outbreaks of the pandemic from March last year saw the country implement a dynamic zero-COVID policy which drastically curbed economic and industrial activity through much of 2022. Along with ongoing weakness in China's residential property sector, this led to a considerable fall in China's steel and iron ore demand in 2022 (Figure 4.2).

Weaker steel demand prompted a 1.6% fall in China's iron ore imports in 2022. This included reduced imports from major trade partners such as Brazil, South Africa, and Canada. Imports from India fell by more than 70%, with the Indian government introducing new export taxes on low grade iron ore in early 2022. By contrast, China's imports of Australian iron ore rose by more than 5.0% over the same period (Figure 4.3).





Notes: China import Iron ore fines 62% Fe spot (CFR Tianjin port) Source: Bloomberg (2023) China import prices; World Steel Association (2023)

Figure 4.2: China's monthly steel consumption



Notes: Annual percentage change based on cumulative steel consumption April to March each calendar year

Source: Bloomberg (2023); NBS (2023)



Figure 4.3: China's iron ore imports

Source: Bloomberg (2023)

20

0

2017

Source: Bloomberg (2023)



2020

Weekly port stocks •••••• 5 year average

2021

2022

2023

Figure 4.4: China's weekly iron ore port stocks

However, with the Chinese government moving away from its zero-COVID policy late last year, the Chinese economy is increasingly expected to return to normal activity levels in 2023. Supporting this recovery will be the significant levels of infrastructure investment allocated in 2022, and new government policies intended to alleviate weakness in its property sector. These trends are expected to support construction activity, and steel and iron ore demand in China through 2023 (see *Steel* chapter).

Restocking of iron ore and steel inventories by Chinese steel mills is also expected to provide support for iron ore demand in the first half of this year. While as of early March, China's portside iron ore inventories remained at historically average levels (Figure 4.4), reported inventories in Chinese steel mills remained low compared with previous years. And in preparation for the post-Lunar holiday ramp up in steel production, steel mills have reported increased purchases of iron ore in recent months.

The typical season ramp up in China's steel production in the March and June quarters each year may be assisted by the improved profit margins currently faced by mills. Average margins turned positive for Chinese steelmakers in early 2023. And the lifting of winter production curbs — typically in place through much of the March quarter to manage pollution levels in northern China — should also boost ferrous demand in the next few months.

With ex-China steelmaking expected to make a moderate recovery in 2023 — following a 5.7% fall year-on-year in 2022 — this should provide support for iron ore demand and prices in other ferrous markets. This is expected to include a rise in iron ore imports for major purchasers in Europe, East and South East Asia and the Middle East, with blast furnace steelmaking output forecast to rise close to 6% in 2023.

Risks to this global demand recovery remained skewed to the downside, with a more pronounced global economic slowdown risking further weak conditions in the steelmaking sector. A stabilisation of China's residential property sector is also a critical factor in global iron ore demand this year. The spot price for 62% Fe iron ore fines (FOB) for calendar 2023 is estimated to average around US\$100 per tonne (Figure 4.5).

2018

2019

Prices to ease over outlook on slower demand growth and more supply

With China projected to see a mild decline in total steel production over the outlook, this should see a softer rate of growth (0.9% annually) in global iron ore demand in coming years. This is expected to see a moderation in iron ore prices over the outlook period to 2028.

China — accounting for around 57% of global iron ore demand in 2022 — faces a number of key structural drivers that are expected to contribute to this lower demand growth. The foremost of these is China's stated aim to reach peak steel output by 2030, with the country expected to achieve this within the next few years. As well as contributing to the country's net zero emissions ambition, China's efforts to reduce aggregate steel output are expected to support a longer-term shift in its economy away from investment-led (and toward consumption-led) growth.

China also faces a falling total (and working age) population, with the country announcing its first decline in population in over six decades in 2022. This is expected to prompt a more modest rate of growth for the Chinese economy in coming years compared with prior decades. And with real estate sector constituting as much as 25% of the Chinese economy, weakness in the country's property sector will continue to diminish the country's near-term steel demand. This is expected to see China's iron ore demand decline by around 1% annually over the outlook period to 2028.

However, growing steel demand and production capacity in regions such as emerging Asia and the Middle East are projected to see strong growth in ex-China iron ore consumption over the outlook period. This includes more than 100 million tonnes of integrated (Blast Furnace-Basic Oxygen Furnace) steelmaking expected to come online in the next few years in Asia alone. This is expected to see ex-China demand for iron ore rise by around 3.2% per annum over the outlook.

On the supply side, the world's two largest producers — Australia and Brazil — are expected to continue to collectively grow export volumes by 3.2% per annum over the outlook period. This follows a ramp up of greenfield projects for major Australian miners, and major expansions planned by Brazilian

Figure 4.5: Iron ore price outlook, quarterly



Notes: China import iron ore fines 62% Fe spot (FOB) Source: Bloomberg (2023); Department of Industry, Science and Resources (2023)

producers Vale, CSN and others. New supply from emerging producers in Africa will also contribute to annual growth of around 3% in global trade of iron ore (see *World Trade* section).

From an estimated average price of around US\$100 per tonne (FOB) in 2023, the benchmark iron ore price is projected to average around US\$63 per tonne (in real terms) by 2028 (Figure 4.5).

Portside sales of iron ore in China are expected to continue to as a relatively small though important form of access for global trade of iron ore over the outlook period, as will the settlement of trades in Chinese renminbi (as opposed to US dollars). In mid-2022, BHP delivered its first shipment of a spot trade of RMB-based iron ore, with other major producers (such as Rio Tinto and Fortescue) also reporting a significant increase in portside sales over the period. Last year also saw the introduction of a new RMB-backed futures contract for China portside fines by CME Group. These developments align with the broader objective set out by China in its 14th five year plan (2021-25) to promote the international use of the RMB, particularly in the trade of commodities.

4.3 World trade

Falls in iron ore demand in 2022 offset by key supply shocks

Global trade in iron ore is estimated to have fallen by more than 5% in 2022. This included significant declines by a number of major importing economies, reflecting the sizeable fall in world steel production over the period (see *Steel* chapter).

The world's biggest consumer of iron ore, China — representing around 60% of global iron ore consumption — saw a drop in steel production in 2022, with outbreaks of the COVID-19 pandemic restraining economic and industrial activity, and adding to residential property weakness.

Amongst other major steelmaking nations, raw materials shortages and high energy prices contributed to weaker industrial output, and forced production cuts amongst large producers such as the EU, US, and Japan. This resulted in ex-China iron ore consumption falling more than 8% in 2022.

Supply side disruptions limited the impact on prices of weakened demand over the period. These disruptions included substantial falls in iron ore exports by major producers such as Brazil (down 4.1%), South Africa (down 15%) and India (down more than 50%, see *India* section). Fallout from Russia's invasion also saw a 50% fall in Ukrainian iron ore exports over the period (see *Ukraine* section). This contributed to a fall in global iron ore exports of 5.6% in 2022. Amongst the major producers, only Australia managed to grow exports over the period, rising 1.5% year-on-year (see *Australia* section).

Global iron ore trade to see continued growth over the outlook

Global supply is expected to grow by 3.1% annually over the outlook period to 2028, with new supply coming online in Australia, Brazil and Africa over that time.

Australia is projected to see continued ramp up of greenfield projects from established producers such as Rio Tinto, BHP and Fortescue, as well as emerging producers such as Mineral Resources Limited and Atlas Iron. Over the outlook period, Australia's iron ore exports are projected to rise at an average annual rate of 1.9% to reach just under 1 billion tonnes by 2028 (see *Australia* section for more detail).

Total iron ore shipments from Brazil fell by around 4.1% year-on-year in 2022. This included a 1.6% fall in output of Vale, Brazil's largest producer. As well as adverse weather in the first half of the year (across all three of its systems), the company continued to experience licensing delays for mines associated with its northern operations throughout 2022.

As a result, Vale has set guidance for 2023 production at 310-320 million tonnes (compared with 310 for 2022). Late last year, the company also stepped away from its aim to return to pre-2019 production levels of 400 million tonnes per annum. Instead, the company has guided 340-360 million tonnes per annum by 2026, and continues to emphasise a 'quality over quantity' approach to its production. Most of this new production will come from the company's S11D expansion in its northern system.

Over the outlook period to 2028, Brazil is still expected to grow iron ore exports by around 6% annually. This will include Vale's S11D expansion, as well as new and expanded output of a number of other producers, including CSN's Casa de Pedra mine, and IndoSino's Amapa high grade concentrate.

Global iron ore exports (ex Australia and Brazil) are projected to grow by around 3% over the outlook period to 2028. New supply from Canada (from Champion Iron's Bloom Lake Phase 2 expansion) and recovering supply from Ukraine, are expected to offset depleting projects of other major producers. Global supply will be bolstered by new projects coming out of Africa, including the 150 million tonne per annum plus Simandou mine (see *Simandou* section).

Russian invasion prompts supply cuts and reorganisation of iron ore trade

The Russian invasion of Ukraine has seen a significant loss of iron ore supply in 2022, as well as a reorganisation of supply chains into Europe and Asia. In 2022, Ukraine's exports of iron ore production nearly halved. While most of the nation's iron ore mines are located outside major conflict zones, Russia's control of several of Ukraine's major steelmaking provinces saw domestic iron ore output increasingly directed towards exports in the first half of the last year. With Russian iron ore products shunned by European buyers, this saw Ukraine become the European Union's largest supplier of iron ore in the early days of the invasion.

However, Russian strikes against Ukraine's improvised export network (primarily through Romania and Poland) and ongoing control of the Black Sea, saw a continued decline in Ukrainian ferrous exports — particularly in the second half of the year.

Ukraine's iron ore exports are projected to remain below pre-invasion levels in coming years. This is expected to see the loss of around 30% of the global high-grade iron ore pellet market. This has significant implications for major export markets for these products, such as the European Union and China. Stronger conditions in one or both of these producers in 2023 (and beyond) may see higher premiums emerge for these products.

With Russia ceasing the publication of trade data in April last year, an exact estimate of the country's iron ore exports in 2022 remains difficult. However, corresponding trade data from major partners shows a reorganisation of Russian exports away from Europe and toward new markets in South East Asia, Africa and the Middle East.

In addition to iron and steel import bans (see *Steel* chapter), a number of major European steelmakers have announced the removal of Russian materials (such as iron ore) from their steel supply chains. As a result, imports of Russian iron ore by the European Union are estimated to have fallen by one-third (year-on-year) in 2022.

With the loss of one of its biggest trade partners, Russia's exports of iron ore are expected to remain below pre-invasion levels over the outlook period. The redirection of Russia's trade to new markets is likely to be constrained by logistical issues in shipping to these regions, as well as ongoing self-sanctioning by other non-European steel producers.

China's iron ore trade expected to be increasingly managed by CMRG

China's new state-owned company China Minerals Resources Group (CMRG) has this year commenced negotiations on iron ore supply on behalf of a number of China's major steelmakers. The Group was established in July last year, and was widely seen as an effort by the Chinese government to guarantee the supply of important mineral resources — including by establishing a single, central purchasing platform for iron ore.

Early reports indicate CMRG is expected to manage purchases on behalf of China's 20 largest steelmakers, who account more than 50% of the country's annual steel production. This includes purchase discussions with major producers, such as Rio Tinto, Vale and BHP.

CMRG is expected to play an increasing role in contract negotiations and price setting in the global iron ore market over the outlook period.

Terms now agreed for Guinea's Simandou, first output targeting 2025

Development of the 150 million tonnes per annum Simandou mine is expected to resume from March this year, following a halt to the project by Guinea's transitional government in July 2022. The halt led to the formation of a new company, La Compagnie du TransGuinéen (CTG) — a joint venture (JV) between Winning Consortium, Rio Tinto and the Guinean Government.

The JV was tasked with overseeing the mine's construction and the delivery of a new port and other transport infrastructure required to bring the mine to production and enable exports. In January this year, Rio Tinto agreed terms with Joint Venture partners to develop this infrastructure.

Delivery is expected to be bound to the requirements set by the Guinean Government in March last year, with all infrastructure (which will include more than 650 kilometres of railway and development of a new deep-water port) to be finished by 2024, and commercial production to begin by the

second quarter of 2025. This is expected to include a ramp up in the subsequent few years toward full production of between 150 and 200 million tonnes.

India reverses new export tax on low-grade ore, but supply to remain tight

In November last year, the Indian government scrapped a 50% export tax on low grade (<58% Fe) iron ore it introduced in early 2022, and cut the tax rate (from 50% to 30%) for iron ore concentrates. At the time, the new (and higher) tax rates were seen as an effort to retain iron ore for its domestic steelmaking industry, and manage input price pressures.

India has historically been seen as a price-sensitive iron ore exporter, with domestic miners incentivised to export in times of high seaborne prices. However, with considerable growth projected for India's steelmaking industry over the outlook period, the lower export tariffs are not expected to lead to a significant boost in India's iron ore exports over this period.

4.4 Australia

Rising export volumes offset lower prices in 2022 and over the outlook

Australia's iron ore export earnings totalled \$124 billion in 2022, a 20% fall from 2021. The decline reflects lower iron ore prices over the period, with the unit export price in 2022 around 25% lower compared with the previous year. In volume terms, Australia exported 884 million tonnes of iron ore in 2022, up 1.5%. This follows the ongoing ramp up of Rio Tinto's Gudai-Darri, BHP's South Flank and Fortescue's Eliwana (Figure 4.7).

Rio Tinto shipped around 324 million tonnes of iron ore in 2022. This was 1% higher than previous year. As well as further improvements in supply chain performance, the company has continued to ramp up its new Gudai-Darri mine. For 2023, Rio Tinto has set a guidance of 320–335 million tonnes (unchanged from 2022). This includes an expectation of Gudai-Darri reaching full capacity during the year.

Rio Tinto is also projecting continued expansion of its iron ore production over the outlook period to 2028. In September last year, the company announced an intention to develop its Western Range project (in





Notes: * Based on company's reporting of production, not shipments Source: ABS (2023) International Trade, Australia, 5368.0; Company reports

Figure 4.7: Australia's iron ore export volumes and values



Source: ABS (2023) International Trade, Australia, 5368.0; Department of Industry, Science and Resources (2023)

partnership with China Baowu Group). This project will sustain production from its existing Paraburdoo hub, and is expected to produce 25 million tonnes per year.

Construction is forecast to begin in early 2023, with first production by 2025. The company also expects to complete an Order of Magnitude study on its Rhodes Ridge prospect (in a joint venture with Wright Prospecting) this year. The study will consider an initial plant capacity of up to 40 million tonnes per annum, with potential first output toward the end of this decade.

BHP's iron ore output was around 285 million tonnes in calendar 2022 (on a 100% basis), up 0.3%. This reflected improved supply chain performance and the ongoing ramp up of its new South Flank mine. The company left its 2022–23 production guidance unchanged at 249–260 million tonnes (equating to 293–306 million tonnes on a 100% basis). This includes the further ramp up of South Flank, which BHP expects to reach its nameplate capacity (of 80 million tonne per annum) by the end of 2023, as well as its port debottlenecking project (PDP1). Through these two projects, the company expects to reach (and exceed) annual shipments of 300 million tonnes over the next few years. The company is also exploring options for growing output to 330 million tonnes per annum in the second half this decade, with studies expected to be completed in the 2024–25 fiscal year.

Fortescue's total iron ore exports were around 193 million tonnes in the 2022 calendar year, 4.4% higher year-on-year. The result was underpinned by the continued ramp up of its Eliwana project, which was running at its nameplate production capacity of 30 million tonnes per annum in April last year. Fortescue has retained its 2022–23 fiscal year production guidance at 187–192 million tonnes. This is expected to include first output of its 22 million tonnes per annum Iron Bridge Magnetite project in the March quarter this year, set to deliver high grade 67% Fe magnetite.

In February, the company also signed an agreement with the Gabonese Government to develop the Belinga Iron Ore Project, with more than 1 billion tonnes of high-grade iron ore reserves. Production is expected to start from the second half of this year, with an initial capacity of up to 2 million tonnes per year. The company expects this project will supplement its existing Pilbara-based productions.

In August last year, Mineral Resources Limited announced it had reached FID on its Onslow Iron Project. The first stage of this project will target 30 to 35 million tonnes per annum, with first ore targeted by December of this year.

Moderating prices to see Australian export earnings fall over the outlook Higher production volumes and stable prices are forecast to see Australia's iron ore export earnings of around \$121 billion in 2022–23.

Moderating prices over the outlook period are forecast to lead to lower earnings for iron ore, with total export value of \$98 billion in 2023–24, and falling to around \$75 billion by 2027–28 (both in real terms) (Figure 4.8).

Exploration eased from near decade-highs in December quarter 2022

A total of \$175 million was spent on iron ore exploration in the December quarter 2022 (Figure 4.9). This was 13% lower compared with the previous quarter, however remained around 35% above the same period in 2021. Exploration has remained elevated in recent quarters, following iron ore prices reaching historical highs in the first half of 2021.

Revisions

Forecast export earnings for 2022–23 (in nominal terms) have been revised up from \$113 billion in the December 2022 *Resources and Energy Quarterly* to \$121 billion in this edition. This reflects higher-thananticipated prices in late 2022 and early 2023. Export earnings in 2023–24 have also been revised up, from \$95 billion in the December 2022 *Resources and Energy Quarterly* to \$103 billion in this edition.

Compared with the March 2022 *Resources and Energy Quarterly*, forecast Australian earnings in 2026–27 (in nominal terms) are little changed at around \$75 billion.



Figure 4.8: Australian iron ore exploration expenditure

Source: ABS (2023) Catalogue 8412.0

Table 4.1: World trade in iron ore

	Million tonnes								
	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR	
World trade	1,566	1,595	1,636	1,659	1,702	1,752	1,790	2.3	
Iron ore imports									
China	1,107	1,104	1,101	1,075	1,054	1,042	1,040	-1.0	
Japan	107	110	112	111	111	110	111	0.7	
European Union	114	118	123	125	125	125	126	1.7	
South Korea	69	75	77	78	78	75	79	2.3	
Rest of Asia ^a	53	62	78	99	109	122	124	15	
India	7	10	17	31	58	84	90	>100	
Iron ore exports									
Australia	884	896	914	935	961	989	989	1.9	
Brazil	344	355	378	401	431	461	491	6.1	
South Africa	58	59	60	61	62	62	62	1.1	
Canada	55	57	59	61	63	63	63	2.3	
Ukraine	23	24	25	25	25	25	25	1.4	

Notes: a Excludes China, Japan, South Korea, Taiwan and India; s Estimate; f Forecast; r Compound annual growth rate Source: World Steel Association (2022); International Trade Centre (2022); Department of Industry, Science and Resources (2022)

Table 4.2: Iron ore outlook

	Million tonnes								
World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Prices ^a									
– nominal	US\$/t	103	100	80	72	69	69	69	-6.3
– real ^b	US\$/t	107	100	78	69	65	64	63	-8.5
Australia	Unit	2021–22	2022-23 ^f	2023-24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR ^r
Production									
– Steel °	Mt	5.8	5.7	5.8	5.8	5.8	5.8	5.8	0.1
– Iron ore ^g	Mt	929	956	977	1,008	1,031	1,060	1,075	2.5
Exports									
Steel ^c	Mt	0.81	1.13	0.98	1.08	1.02	1.05	1.04	4.2
– nominal value	A\$m	1,047	1,236	993	850	708	696	665	-7.3
– real value ⁱ	A\$m	1,122	1,236	949	788	639	613	571	-11
Iron ore ^h	Mt	874	887	912	927	948	975	989	2.1
– nominal value	A\$m	132,489	121,058	102,852	87,654	83,757	84,920	86,303	-6.9
– real value ⁱ	A\$m	142,047	121,058	98,350	81,240	75,598	74,777	74,142	-10

Notes: a Spot price, 62% iron content, fob Australian basis; b In 2022 US dollars; c Crude steel equivalent; Crude steel is defined as the first solid state of production after melting. In ABS Australian Harmonized Export Commodity Classification, crude steel equivalent includes most items from 7206 to 7307, excluding ferrous waste and scrap and ferroalloys; f forecast; g In wet metric tonnes; h In dry metric tonnes; i In 2022–23 Australian dollars; r Compound annual growth rate; s Estimate Source: ABS (2022) International Trade in Goods and Services, Australia, 5368.0; Bloomberg (2022); World Steel Association (2022); company reports; Department of Industry, Science and

Resources (2022)

Metallurgical Coal





Australia's metallurgical coal sector

World consumption



Metallurgical coal facts



Metallurgical coal is primarily used to make steel



Contains more carbon and less ash & moisture than thermal coal





Basic oxygen furnaces use met coal as a raw material

SOURCE: WSA; GA

Metallurgical Coal TRADE MAP



5.1 Summary

- Metallurgical coal prices have lifted in recent months, supported by a pickup in global steelmaking. Reduced supply disruptions are expected to moderate price pressures in the short-term. The Australian premium hard coking coal price is projected to fall from an average US\$377 a tonne in 2022, to around US\$160 a tonne (in real terms) by 2028.
- Higher production is expected to lift Australia's exports, from 163 million tonnes in 2021–22 to 172 million tonnes by 2027–28 (see Australia section).
- Australia's metallurgical coal export earnings are forecast to track with price movements, peaking at \$72 billion in 2021–22 before falling back to under \$30 billion (in real terms) by 2027–28.

5.2 World trade

Metallurgical coal imports have trended up recently, reaching the highest level for six months in January 2023. Ongoing price weakness in late 2022 (relative to H1 2022) seems to have encouraged re-stocking by steel mills. Some miners have also been diverting unwashed product into the extremely tight thermal coal market. Imports have risen across most countries and regions (including Asia and Europe) over the year to January 2023, while persistent weather events have continued to disrupt supply from Australia and other exporters.

As a result, price have picked up in recent months. However, the price outlook remains uncertain, with conditions in global steel markets still fragile (see *steel* chapter), and subject to significant uncertainties in automotive markets, manufacturing, and real estate. Infrastructure packages recently passed in the US will likely not reach full roll-out in 2024. The market is looking to a pick up in growth in the Chinese economy, including in steel-consuming industries.

World metallurgical coal trade is forecast to increase from 299 million tonnes in 2022 to 312 million tonnes by 2028 (Figure 5.1). Within the forecast period, growth in trade is expected to be minimal in 2023, with momentum building in 2024 and 2025.

Figure 5.1: Metallurgical coal imports



Notes: f forecast s estimate; z projection

Source: McCloskey (2023); Department of Industry, Science and Resources (2023)

5.3 World imports

Chinese metallurgical coal imports are likely to have peaked

China generally draws significantly on domestic production and overland transport from Mongolia, and has increased its inputs from these sources in recent years. However, seaborne imports have grown in recent months, rising to 2.54 million tonnes in January, up from December's 2.30 million and only slightly below the 2.60 million from January 2022.

Truck and rail cargos from Mongolia rose in 2022 and early 2023, but have not been sufficient to rebuild stocks in mills across China's north. Metallurgical coal stocks remain generally tight across China, with steelmaking in China lifting slightly in January despite a holiday period in the month.

Chinese companies have resumed imports of Australian coal after trade impediments previously reduced exports to zero for more than two years. This resumption may lead to some easing in China's domestic price premium for high grade product over time. Initial trade flows began in February, and in mid-February rose to around half the level recorded prior to the informal import restrictions.

China's use of metallurgical coal remains subject to countervailing trends. China's domestic housing sector continues to face high indebtedness, with interventions growing as the Chinese Government attempts to stabilise the housing market. Recent announcements include a plan to inject more liquidity and ease deposit requirements for potential buyers. Weakness in the real estate sector could be partly offset by (modest) strength in China's automotive sector, which appears to have stabilised in recent quarters. Government investment, which typically targets steel-focused infrastructure, remains substantial, but no new measures were announced in the latest congress of the Chinese Communist Party. A shift towards greater use of EAF production may also marginally reduce metallurgical coal dependency over the longer term.

Chinese imports are expected to ease back by 11 million tonnes (to 41 million tonnes) in 2023, rising again in 2024. Imports will then ease in subsequent years, down to 39 million tonnes by 2028. This follows the expected trajectory of the global economy and Chinese steelmaking — which typically tracks it closely. Imports to China have long been volatile, due to its high export focus; small movements in global steel use often driving substantial swings in China's metallurgical coal imports.

India's metallurgical coal imports are rising in line with its steelmaking

Indian metallurgical coal imports were steady at just over 6 million tonnes in the month of January: a relatively strong result and just over a million tonnes higher than a year ago.

Indian steelmaking was temporarily suppressed by a surge in metallurgical coal prices early in 2022. The subsequent easing of these prices (alongside some pent up consumer demand) pushed up steel demand again in late 2022. The Indian government continues to place a high priority on developing its domestic steel industry, and has removed the export duty on steel in an attempt to increase India's role as a global supplier. Growth in Indian steel production has been strong, with more than 10 million tonnes produced in most months of 2022. Recent growth in

Indian steel production has been largely met from domestic metallurgical coal supply. India's metallurgical coal needs are likely to grow, with steelmakers pressing ahead with US\$11 billion worth of steel projects, many of which are likely to be completed within the outlook period.

Indian imports of metallurgical coal are expected to grow over the outlook period (Figure 5.1), accelerating in the latter years as policy efforts to develop a larger domestic steel industry are realised. Imports are projected to rise from 60 million tonnes in 2022 to about 85 million tonnes by 2028.

Conditions remain mixed among other importers

Metallurgical coal demand in other regions remains subject to mixed conditions. In South Korea, metallurgical coal imports are expected to remain at around the current level until the mid-2020s, easing slightly towards the end of the outlook. Japanese imports are expected to edge down steadily through the outlook period, with some older steelmaking capacity withdrawing from the market. Metallurgical coal imports to the EU are expected to remain stagnant, with the loss of steelmaking in recent years unlikely to be regained.

5.4 World exports

Global exports of metallurgical coal have been restrained in recent months by downturns in steelmaking and in metallurgical coal prices. While this has reversed (in part) at the time of writing, it is not clear that very recent price growth will persist, or that the global economy will continue to expand at the current pace. At the present time, global supply is sufficient to meet demand, though short-term disruptions remain a prospect.

US exports have lifted, but may lose steam again in 2023

US metallurgical coal exports are estimated to have lifted by about 2 million tonnes (to 43 million tonnes) in 2022 (Figure 5.2), due in part to the surge in prices during H1 2022. Production lifted by around 5% in 2022, but still remained short of its level of 2019. Exports are expected to remain largely steady over the outlook period, easing slightly in 2024 as prices fall, but then rising back to 45 million tonnes by 2028.

Some metallurgical coal has been diverted into thermal coal markets in recent quarters, as the price premium normally available to metallurgical coal has reversed in a way not seen before. The gradual correction to this over recent months may see a shift back to greater metallurgical coal exports from the US. This should be supported by higher output from the Longview mine, and a full resumption of shipping from the Curtis Bay terminal, which faced months of disruptions following an explosion.

Exports from Canada are set to rise, as a new mine ramps up

Canadian metallurgical coal exports are rising, largely due to the restart of Canada Coal's Grand Cache mine — shut down in 2020, due to COVID disruptions. Production is expected to recommence in H1 2023, ramping up to 2 million tonnes annually. Elsewhere, Glencore's proposed mine in British Columbia was blocked in December, with regulators citing 'adverse environmental effects'. The mine would have produced around 3 million tonnes of metallurgical coal at full production.

Canadian exports are expected to remain robust (at around 29 million tonnes) in 2023 and 2024, then ease slightly due to lower prices and early-stage mine depletions. Canadian metallurgical coal exports are projected to be around 25 million tonnes by 2028 (Figure 5.2).

Exports from Africa are recovering

Mozambique is a small exporter, but has solid growth prospects over the outlook period. The country's exports fell in 2020 and 2021, as low prices forced much of the nation's high cost production out of the market. However, Vulcan Resources' large Moatize has concluded upgrades on its preparation plant upgrade and logistics corridors, and is expected to lift production over time.

On balance, exports are expected to rise strongly in percentage terms from 4 million tonnes in 2021 to around 7 million tonnes by 2028, with growth 'front-loaded' to the early part of the outlook period.

Russian exporters face a difficult outlook

Russian metallurgical coal exports are expected to decline over the outlook period, following the country's commencement of war against

Ukraine and the subsequent sanctions applied by many Western nations in response. However, the drop is likely to be less significant than that experienced by Russia's thermal coal exporters.

Western sanctions could affect Russian export infrastructure, by curbing access to parts and expertise needed to upgrade (or even maintain) the vast rail and port corridors which run through the country's east and connect it to its export markets. Limited rail capacity allocation into 2023 (amidst a preference for higher value cargo) will likely act as a general curb on Russian coal exports, with prospects for any additional allocations becoming increasingly limited. However, any change to prioritisation could have considerable implications for coal exports from 2023.

Growth in exports to China, India and other South Asian nations is not expected to absorb the loss of markets in Europe, Japan, or South Korea. Russian exports are expected to fall from 30 million tonnes in 2021 to 28 million tonnes by 2023, holding at that level for two years and then gradually recovering towards the end of the outlook period.



Figure 5.2: Metallurgical coal exports

Notes: f forecast s estimate; z projection

Source: McCloskey (2023); Department of Industry, Science and Resources (2023)

Mongolia's exports are becoming more efficient and expansive

Chinese investment has helped Mongolian coal exporters transition to a more reliable and scalable export model through a pivot from truck-based shipping to rail. The launch of three railway lines in 2022 should underpin long-term structural growth in Mongolian exports, which are projected to rise from 20 million tonnes in 2022 to 28 million tonnes by 2028.

The structure of Mongolian export contracts is likely to change, with Erdenes-Tavantolgoi JSC (Mongolia's largest state-owned coal company) announcing that future sales would be based on auctions on the Mongolian Stock Exchange. Previously, sales were organised through direct contracts with Chinese buyers, but anti-corruption protests have triggered policy changes. The government plans to start a more transparent bidding process before the end of the March quarter. The outcome is likely to increase costs for Chinese buyers (and revenue for sellers).

5.5 Prices

Recent growth in metallurgical coal prices is expected to unwind

Metallurgical coal prices have recently lifted to their highest level since mid-2022, amidst a less pessimistic outlook for China and other major economies. A global recession was considered a growing risk following large spikes in global energy prices due to the Russian invasion of Ukraine. With central banks determined to arrest surging inflation, worries grew over a monetary squeeze. With energy prices now falling again, it appears the worst fears for the global economy may not be realised. Steel markets have strengthened recently as confidence improved.

Prices are expected to ease slowly over the outlook period, with the largest fall expected in 2023 as supply conditions (notably in Australia) improve and normalise. The end of the La Niña cycle should allow waterlogged mines and disrupted terminals and rail to resume full output. However, further flooding would likely hold prices up for longer, and oceanic temperatures have become an emerging issue for exporters.





Notes: 'Low Vol' is low volatility coking coal.

Source: McCloskey (2023); Department of Industry, Science and Resources (2023)

Figure 5.4: Metallurgical and thermal coal prices, quarterly



Oceans remained heated for longer than usual after the last La Niña event, resulting in high rainfall persisting for longer than expected. A repeat of this phenomena presents a risk to seaborne metallurgical coal supply.

Prices will also be subject to sudden shifts on the demand side. The possibility of a renewed global downturn remains in play – amidst a complex slew of issues including COVID, war in Ukraine, higher consumer debt, and weakness in global real estate markets. Should the downturn prove to be unexpectedly fast or severe, the effects on global steelmaking (and metallurgical coal trade by extension) could be significant.

Metallurgical coal demand remains subject to mostly downside risks which could drive prices below expectations. However, supply side factors create countervailing upside risks, with the most significant influence in recent times being weather disruptions. On balance, it is expected that supply disruptions will ease from the March quarter 2023, while global demand remains relatively solid. Indian demand is expected to grow over time. Chinese import demand is expected to soften, but this owes more to higher domestic production than to any serious slowdown in steelmaking. Prices for Australian hard coking coal are projected to decrease from US\$377 a tonne in 2022 to around US\$160 a tonne in 2028 (in real terms), representing a shift towards their pre-2021 level (Figures 5.4 and 5.5).

5.6 Australia

Metallurgical coal export earnings have risen despite supply issues

While global demand has firmed up in recent months, Australian supply continues to face disruptions. Weather events have resulted in persistent outages across transport infrastructure, including rails and terminal facilities. Mines have been regularly waterlogged, requiring extensive dewatering efforts. Rains have continued to affect transport links in Queensland, leading to extended queues at ports. A train accident on the line to Gladstone Port halted some transportation and added to price pressure briefly, though prices subsequently stabilised.



Figure 5.5: Australia's metallurgical coal export values, monthly

Source: ABS (2023) International Trade, Australia 5454.0

Figure 5.6: Australia's metallurgical coal exports



Source: ABS (2023) International Trade, Australia 5454.0; Department of Industry, Science and Resources (2023)

On the upside, metallurgical coal exports will likely benefit over time from a solid pipeline of investments, with new output expected from a range of projects including Ironbark, Goonyella, Vickery, Olive Downs and Hillalong. In February 2023, Illawarra Metallurgical Coal also announced a new plan to invest US\$248 million to implement a single, more efficient longwall configuration at its Appin mine.

Slow declines in prices are not expected to result in large changes to metallurgical coal export earnings over the outlook period. Weather events remain the most significant forecast risk, especially in light of the prevalence of such events over the last two years. Weather events have countervailing effects on export earnings: volumes typically fall unpredictably, but Australia's importance as an exporter means that global prices almost always rise.

Earnings have been highly volatile in quarterly terms over recent years, and profits have been affected by damage to mines and infrastructure. The passing of La Niña should restore a degree of normality to Australian exports, with earnings risks shifting towards global demand and geopolitics. Global factors could include further developments in the war in Ukraine, potential new outbreaks of COVID-19, and policy decisions among key trading partners such as India (which is seeking to build a stronger domestic steel industry), and China (which is seeking to reduce its dependency on imports).

Higher production in New South Wales and (especially) Queensland is expected to lift Australia's exports, from 163 million tonnes in 2021–22 to 172 million tonnes by 2027–28. Metallurgical coal export earnings surged to \$72 billion in 2021–22 (Figure 5.6), but are projected to ease to around \$30 billion by 2027–28 (in real terms), with much of the price fall behind this already having taken place.

Coal exploration expenditure has increased

Australia's coal exploration expenditure increased to \$70 million in the December quarter: 30% higher through the year. Coal prices were still at historically high levels in the December quarter, and exploration may edge down in 2023 as prices correct. Metallurgical coal retains a stronger

overall investment climate, with thermal coal producers facing challenges with finance, insurance and long-term global demand. Recent growth in coal exploration is thus likely to have been dominated by metallurgical coal (Figure 5.7).



Figure 5.7: Australian coal exploration expenditure and prices

Source: ABS (2023); McCloskey (2023)

Revisions to the outlook for Australian metallurgical coal exports

The 2022–23 forecast for aggregate export earnings is largely unchanged from the December 2022 release. The 2023–24 forecast has been revised up by \$4 billion.

The 2022–23 forecast for aggregate export earnings has been revised up by \$6 billion from the December 2022 release. The changes reflect a shift in long-term price expectations, which have risen slightly over the last year.

Table 5.1: World trade in metallurgical coal

	Unit	2022 ^s	2023 ^f	2024 ^z	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
World trade	Mt	299	304	309	314	317	316	312	0.7
Metallurgical coal imports									
China	Mt	52	41	45	46	44	42	39	-4.7
India	Mt	60	68	71	71	78	83	86	6.2
Japan	Mt	43	41	41	41	40	40	39	-1.6
European Union	Mt	36	36	36	36	36	36	36	0.0
South Korea	Mt	36	36	36	36	35	34	33	-1.1
Metallurgical coal ex	ports								
Australia	Mt	161	171	172	172	176	175	170	1.0
United States	Mt	43	44	43	44	45	45	45	0.6
Canada	Mt	29	29	27	27	27	27	25	-2.6
Russia	Mt	29	28	28	28	29	29	29	0.0
Mongolia	Mt	20	23	26	28	28	28	28	5.5
Mozambique	Mt	6	7	7	7	7	7	7	1.1

Notes: **f** Forecast; **s** Estimate.

Source: IEA (2023) Coal Information; McCloskey (2023); Department of Industry, Science and Resources (2023)

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Table 5.2: Metallurgical coal outlook

World	Unit	2022	2023 ^f	2024 ^z	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Contract prices ^e									
- nominal	US\$/t	372	300	235	210	191	188	179	-11.5
- real ^d	US\$/t	385	300	230	201	180	173	161	-13.5
Spot prices ^g									
- nominal	US\$/t	364	299	233	208	189	188	178	-11.3
- real ^d	US\$/t	377	299	228	199	178	173	160	-13.3
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^z	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR ^r
Production ^s	Mt	169	174	178	178	178	184	177	0.9
Export volume	Mt	163	164	172	172	172	178	172	0.9
- nominal value	A\$m	67,588	63,308	50,076	41,536	37,418	35,827	34,504	-10.6
 real valueⁱ 	A\$m	72,464	63,308	47,884	38,496	33,773	31,548	29,642	-13.8

Notes: d In 2023 US dollars. e Contract price assessment for high-quality hard coking coal. i In 2022–23 Australian dollars. s Estimate f Forecast z Projection. g Hard coking coal fob Australia east coast ports.

Source: McCloskey (2023); ABS (2023) International Trade in Goods and Services, Australia, 5368.0; Department of Industry, Science and Resources (2023)

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Thermal Coal





World consumption



Thermal coal facts







Mines are **open cut or underground** depending on the deposit's geology

4

SOURCE: IEA; GA

Thermal Coal TRADE MAP





6.1 Summary

- Thermal coal prices have eased recently, but remain elevated amidst persistent weather disruptions, market impacts from the war in Ukraine, and struggles among thermal coal miners to access finance and insurance. The price of 6,000 kcal Newcastle coal is expected to decline from US\$371 a tonne in 2022, to around \$US90 by 2028 (in real terms) as some of these factors ease.
- Mine closures and openings are expected to remain largely in balance over the outlook period, with Australian thermal coal exports sitting at around 195 million tonnes out to 2027–28 (see *Australia* section).
- Falling prices are expected to result in export values easing from a record \$65 billion forecast for 2022–23, to a more typical level of around \$19 billion (real terms) by 2027–28.

6.2 World trade

Thermal coal trade patterns have been shifting for some years, with demand orienting away from OECD markets and towards Asia. This trend was briefly disrupted following the commencement of Russia's invasion of Ukraine. Sanctions by some countries against Russian gas and coal exports created risks of a potential energy deficit in parts of Europe. This risk was exacerbated by the closure of German nuclear plants and drought-driven shortfalls in hydro generation. Since the invasion of Ukraine, coal use in Europe has risen from 15% to 16% of the electricity mix, with 26 coal plants temporarily reactivated. Coal imports to Europe rose, but the bulk of these imports were stockpiled and not used because most of Europe experienced a warm and mild winter. Coal imports to Europe declined in the December quarter and are expected to fall in 2023, as efforts to shift away from coal get underway again.

As global imports of thermal coal peaked, prices for high-grade thermal coal have begun to decline — falling by around half over the last two months and reaching their lowest level for more than a year in March 2023. High European coal inventories and gas storage will continue to erode coal prices in the short-term. Over the longer term, rising nuclear

energy use in Eastern Europe and construction of new LNG terminals in Western Europe will further dampen European coal imports.

Thermal coal imports are expected to rise in parts of Asia over the shortterm as coal plant constructions complete. Global coal imports are expected to lift marginally to a four-year peak in 2024, before declining for the rest of the outlook. The previous peak in coal imports (recorded in 2019) exceeds anything expected over the outlook period, meaning that the overall peak in global thermal coal trade is likely to have passed.

Longer-term shifts in coal supply chains (notably the decline in imports to China and Europe, and the rise in other parts of Asia) are expected to resume. However, thermal coal demand has become fragile — increasingly vulnerable to potential government policy changes in its remaining growth spots.

Though risks have risen, it is still expected that seaborne thermal coal trade will hold at over one billion tonnes annually until the final year of the outlook period. Overall supply and demand are expected to remain largely in balance.

6.3 World imports

China's coal imports are expected to decline from 2022

Thermal coal imports to China have entered a period of structural decline. The Chinese government has placed a priority on reducing import dependence, and has announced a range of associated policy measures. These include increased focus on expanding domestic coal production, more rapid deployment of LNG, nuclear power and renewables, and the installation of coal-by-wire technology — which increases the efficiency of transportation for domestically-produced coal power. Policy efforts to address pollution and carbon emissions have also hardened in recent years, with coastal regions (where large shares of the Chinese population reside) shifting towards increased nuclear and gas generation. Imports rose briefly in the March quarter 2023 amidst rebounding industrial activity, but are expected to fall over 2023 as a whole, and in subsequent years. China will continue to require coal until after 2050. However, the end of coal imports could come much sooner, with domestic supply potentially matching domestic use by the 2030s. China has pioneered expansive use of coal-to-liquids technology, and the use of this technology in coastal regions may mean that seaborne coal may retain a competitive advantage in certain parts of the Chinese market. However, all forms of coal imports remain subject to future policy choices and priorities of the Chinese government.

Different policies across China's regions add to potential volatility. Hong Kong has led progress in reducing emissions, cutting its coal imports by around half between 2000 and 2020. Two significant coal plants (Lamma and Castle Peak) are being converted to gas-fired units, which should reduce coal imports further over the outlook period. Technology and policy measures trialled in Hong Kong have potential to scale up across other regions of China, adding to potential downside risks for Chinese thermal coal imports.

High inventory levels will constrain Chinese imports over the next few months. Lower inland rainfall could provide some mitigation, by constraining hydro output at facilities connected to the Yangtze River. However, imports are expected to be in structural decline from 2023, with falls expected in every subsequent year of the outlook period. Thermal coal imports to China are expected to decline by around one-third (from 244 million tonnes to 150 million tonnes) between 2022 and 2028 (Figure 6.1).

India is becoming increasingly dominant in global coal markets

India is moving in the opposite direction to China, expanding its thermal coal imports steadily in recent years. India is expected to become the predominant global importer by the end of the outlook period. The Indian government has committed to huge expansions in the country's power grid to connect regions which currently lack access to electricity. Much of this deployment has already been undertaken and, in conjunction with growing industrial activity, is expected to lift Indian coal use substantially over the next 5-10 years.

It is not expected that India's domestic coal output will grow in proportion to its needs. In recent years, significant deposits (including 42 coal blocks) have been auctioned for development. But development will take time, especially in light of global caution around new thermal coal mines and relatively low interest from offshore investors. Recent falls in global coal prices have lifted the competitiveness of imports against domestic production.

Growing electricity demand has kept inventories tight in many parts of India, potentially adding to risks of sudden shortages or outages. Transportation of coal to power plants has been hampered by rail capacity limits, and the usual September-October inventory rebuild was slowed by higher domestic electricity use. Power producers are entering a highdemand period with less than two weeks of coal consumption in reserves. Thus, the brownouts experienced in 2022 (when inventory shortages led to power outages in some areas) could re-occur unless India can expand its imports and co-ordinate internal coal movements at the required scale.

Indian imports are expected to grow substantially in the short-term, with a slowdown in the pace of growth towards the end of the outlook period. Imports are expected to reach around 260 million tonnes (more than 100 million tonnes above China's expected level) by 2028.

Japan's coal imports remain elevated due to the closure of nuclear plants

Thermal coal imports by Japan are likely to be increasingly affected by the policy measures the nation has deployed to try to meet its emissions targets. Deployment of solar power has increased rapidly since 2018, and the government has released plans to close 100 coal plants over the next seven years. A total of US\$100 million will also be invested to help reorient coal-fired plants to use hydrogen and ammonia. Substantial investments have been committed to develop carbon capture technology, and to assist other countries in the region to reduce their emissions.

While the scope of emissions-reduction policy measures is now substantial, the bulk of the impact on coal imports is likely to play out towards the end of the outlook period. Japan faces competing needs at present, balancing issues associated with high gas prices and security of supply against its commitment to reduce coal use. There is potential for some emissions reduction policies to be delayed, though the scope for this is limited given most proposed coal-fired power plants have already been formally cancelled.

The completion of remaining coal-fired power plant builds is expected to largely offset coal plant closures during the first half of the outlook period. Thermal coal imports (and broader use within Japan) are expected to fall more rapidly after 2024, with further acceleration over the 2030s as the nation's older plants are closed at greater scale.

The pace of decline may increase further if Japan accelerates its re-opening rate for nuclear plants. Japan's growth in coal use and imports (Figure 6.3) has left it highly exposed to global commodity prices, and the recent surge in gas and coal prices is expected to provide more momentum to the re-opening process for nuclear plants. Of 54 nuclear plants that were in operation prior to 2011, 44 remain offline, and the remaining 10 have faced intermittency issues as a result of additional safety checks and maintenance requirements. The Japanese government is prioritising a swift opening of 7 more reactors, with least 15 expected to be reconnected over the outlook period. Ultimately, 26 or 27 are expected to come back online.

The pace of renewables deployment adds another variable to thermal coal usage. Japan's current plans involve doubling its renewables share of generation to 26-28% by 2030. This may present engineering and logistical challenges, but a successful rollout on this scale would likely produce a noticeable decline in coal imports towards the end of the outlook period.

On balance, Japanese coal imports are expected to hold largely steady at around 130 million tonnes annually to 2025, with declines commencing in the final three years of the outlook period.

Taiwan's thermal coal imports have peaked

Taiwanese coal imports declined by around 8% over 2022, with a brief surge in the September quarter being offset by declines towards the end of

Figure 6.1: Thermal coal imports



■ 2019 ■ 2020 ■ 2021 ■ 2022e ■ 2023f ■ 2024f ■ 2025z ■ 2026z ■ 2027z ■ 2028z

Note: e Estimate f Forecast; z projection

Source: IHS (2023); IEA (2023) Coal Market Report; Department of Industry, Science and Resources (2023)

Figure 6.2: India's thermal coal imports, monthly



Source: IHS (2023)

the year. Taiwan's plans to expand its coal fleet have been shelved, and the government is now pushing ahead with plans to replace existing coal capacity with gas; targeting a reduction in the coal share of generation from 40% (in 2020) to 30% (by 2025).

Three of Taiwan's five coal plants were commissioned more than 30 years ago, and will face retirement in the medium term — even in the absence of further policy measures. Taiwan's thermal coal imports are expected to fall about 12% (to 53 million tonnes) by 2028, with more rapid declines likely to follow.

South Korea's energy mix is broadening, with coal imports likely to fall

South Korea is currently committed to achieving net zero carbon emissions by 2050, and the resulting policy measures are expected to constrain coal imports. South Korea's Ministry of Trade, Industry and Energy has announced a proposal to cut coal-fired power generation by around half (from 42% to 22%) between 2018 and 2030. At the time of writing, the share of coal power has fallen by around 5 percentage points, with the shift from coal running largely on schedule.

This shift may not affect coal imports much in the near-term. In part, this is because emissions reduction targets still allow for new coal capacity to be deployed as a replacement for old and less efficient capacity. Several plants currently under construction are expected to be completed over coming years, though plants still at the planning stage have been shelved. Coal-fired generation capacity in South Korea is expected to grow over the next 2-3 years, but actual coal burning is not likely to change noticeably.

A new government was elected in South Korea in 2022, and has committed to dumping the previous government's plans to phase out nuclear power. Instead, the new government has announced plans to expand nuclear generation's share from 27% to 30% by 2030. South Korea has an advantage in nuclear deployment given its expertise in construction and its relatively streamlined regulations. The planned expansion in nuclear capacity is expected to cut annual thermal coal imports by up to 2 million tonnes from 2030. Thermal coal imports to South Korea held steady over 2022 (Figure 6.3), but the accelerated deployment of gas, renewables, biomass, ammonia and nuclear energy, are expected to see thermal coal imports level out and then fall over the second half of the outlook period. Imports are projected to fall from 90 million tonnes in 2022 to 86 million tonnes by 2028.

Figure 6.3: Japan, South Korea and Taiwan's thermal coal imports



Source: IHS (2023)

South/South East Asia imports are set to grow

Smaller South Asian countries represent most of the remaining growth markets for thermal coal. The pipeline of proposed coal capacity in these countries has fallen sharply (by 63% between 2015 and 2021), but the region still has a sizeable volume of coal plants under construction. South Asian countries (excluding India) currently import around 150 million tonnes of thermal coal a year, with solid growth (to around 175 million tonnes) expected over the next few years.

Malaysia has large and modern coal-fired power plants, which have achieved a competitive advantage over gas plants in the nation. This advantage persisted following the fallout from the Russian invasion of Ukraine, when gas prices spiked to record levels. Annual thermal coal imports are expected to hold at just over 30 million tonnes through the outlook period.

The Philippines has a relatively mixed electricity generation profile, with around 35% of generation sourced from coal, another 35% from oil and gas, and the rest from renewables. Both coal and renewables are set to expand over coming years, as the government seeks to build capacity and reduce cost. The government has announced plans to expand renewable generation to 35% of power generation by 2030, and then to 50% by 2040.

Several coal-fired power plants remain under construction, but those at the planning stage have been largely abandoned. The Philippines has faced difficulties in its coal generation sector since 2020. This is partly due to the COVID-19 pandemic, and partly due to a brief coal export freeze announced by Indonesia in early 2022 — which prompted a search for alternative sources.

Primary risks over the outlook period include potential renewed waves of COVID-19, and the prospect that coal-fired power plant constructions delayed by the pandemic will not resume as swiftly as planned. On balance, it is expected that thermal coal imports will grow by around one-fifth (to 37 million tonnes) by 2028. Risks are tilted to the downside given uncertainties over the coal plant construction timetable (Figure 6.4).

In Thailand, coal-fired power plant builds have largely halted, and the proposed Krabi and Thepa plants have been on hold for almost 5 years. The government's Power Development Plan seeks to halve coal's share of power generation (to 10%) between 2018 and 2030, and this policy effectively rules out any new coal builds. However, some small growth in imports is expected over the outlook period, as the post-COVID economic recovery and economic growth (notably in the nation's large cement sector) push existing domestic coal-fired power output closer to full capacity.

Vietnam has become a more significant global coal importer, due to its additional coal-fired power plant deployments and inaccessible domestic reserves. While most proposed coal-fired power plants have been shelved, some remain under construction. Their completion is expected to push imports up by more than one-fifth to over 50 million tonnes by 2028.

This projection remains subject to risks, given some plant constructions have fallen behind schedule due to COVID-19 disruptions and the lack of funding for some coal-fired power projects. If funding issues remain, or if official policy becomes less supportive of coal development, Vietnam's coal imports may peak earlier (in 2025 or 2026) at about 45 million tonnes.

Figure 6.4: South and South East Asia thermal coal imports



Source: IEA (2023); Department of Industry, Science and Resources (2023); IHS (2023)

6.4 World exports

Global thermal coal supply chains have changed following China's informal trade impediments with Australia, and in the wake of widespread sanctions against Russia. The impact on coal producers has been mitigated by strong prices and short-term rises in seaborne demand. Australian miners successfully redirected output to other markets in 2020, but Russian exporters have not had the same success. The withdrawal of Russian coal from markets has favoured Australia, which has long been Russia's primary competitor among the higher coal grades. This advantage has diminished in recent months, as European nations managed to fill inventories amidst a relatively warm winter. However, Australia retains a solid outlook over the next five years, with weakening global demand likely to affect lower grades of coal initially (Figure 6.5).

Figure 6.5: Thermal coal exports



■2019 ■2020 ■2021 ■2022e ■2023f ■2024f ■2025z ■2026z ■2027z ■2028z

Notes: e Estimate f Forecast; z projection

Source: IHS (2023); IEA (2023) Coal Information; ABS (2023); Department of Industry, Science and Resources (2023)

Indonesia's exports remain firm despite temporary disruptions

Indonesia remains well ahead of other exporters in volume terms, accounting for almost half of global thermal coal exports. Indonesian coal is low-cost, but also skews towards the lower calorific grades. While this makes Indonesian coal unsuitable for some markets, others (notably in Asia) have developed power plants specifically suited to Indonesian coals. While this has added to short term demand, it also anchors Indonesian coal exports increasingly within the South-Asian region, making it subject to government and policy decisions among its neighbours.

Indonesian coal sometimes faces competition between export and domestic markets. Domestic coal use in Indonesia is expected to increase by almost half by 2050, and domestic sources are expected to be tapped increasingly for this purpose. In January 2022, shortages in domestic coal markets prompted the Indonesian government to briefly freeze exports. Indonesia's coal reserves are enormous and accessible, but exploitation presents some logistical challenges given Indonesia's widely dispersed islands and unusual geography.

A longer-term risk may come through the gradual decline in global coal use, which will hit the lower coal grades sooner. China's imports of Indonesian coal are likely to fall, in line with China's broader trend away from imported coal. Higher demand from domestic users and nearby South Asian nations are likely to absorb Indonesian output for some time yet. But over the longer term, coal markets are likely to gravitate towards higher grades of coal, as efforts to reduce carbon emissions and transform global energy markets continue.

Indonesian exports are expected to have achieved solid growth in 2022, with more expansion expected in 2023 as recent weather disruptions ease with the passing of the La Niña cycle. Exports are forecast to reach almost 470 million tonnes in 2023, largely holding steady through the remainder of the outlook period as new supply meets growing domestic use. Declines in Indonesian coal exports are expected from the late 2020s and early 2030s, accelerating over time.

Russia's exports face sharp decline in the wake of its war on Ukraine

Russian coal exports have fallen sharply as a result of the fallout from its invasion of Ukraine. Sanctions closed off access to European and Japanese markets, and increasing restrictions in South Korea and elsewhere are expected to further shrink the quantity of Russian coal in global markets. Capacity to direct coal exports to alternative markets will be limited by recent decisions to allocate freight rail capacity to higher-value products.

The Russian government has previously announced plans to upgrade freight rail in the east of country, including the large Baikal-Amur and Tran-Siberian lines. If successful, this upgrade would increase coal freight capacity by 70 million tonnes to 180 million tonnes by 2024. However, sanctions against Russia have affected access to essential equipment and parts. In conjunction with shortages of labour and finance, this may delay the infrastructure upgrades for some time, potentially indefinitely.

In structural terms, Russian exports retain significant advantages, being low cost and high quality. However, exports are expected to remain low over the outlook period, affected by sanctions and reduced access to investment and equipment. Russian coal will be viewed as risky for years to come, and new trade patterns are unlikely to form around it. Coal exports are expected to fall by about 25% to 130 million tonnes per annum by 2028. Russian coal supply to its traditional markets in Western Europe is not expected to recover in the foreseeable future. Beyond the outlook period, growth is contingent on investments in eastern rail and the subsequent redirection of exports to Asia. It is not clear when or how such investment will happen.

US exports have picked up, but are expected to lose ground again

US coal exporters are generally high cost and of middling calorific quality, with heavy dependency on the shrinking Atlantic market. Coal exports are expected to ease over time, though US coal producers will have incentives to seek new export markets given the even more rapid decline in the country's domestic coal use.

US thermal coal exports rose following the Russian invasion of Ukraine, when brief shortages led to increased prices. These gains are not expected to persist as the market shifts back to normal settings, with the US now expected to resume its traditional role as a marginal supplier. US thermal coal exports are projected to ease from around 35 million tonnes in 2022 to around 30 million tonnes by 2028, with coal producers fighting to keep mines open in the face of high costs and declining demand.

Colombian exports are not expected to recover fully

Colombian mines have recently been affected by errant weather and the La Niña cycle, though these issues now appear to be passing. Rain has blocked the largest rail lines (Cerrejón and Fenoco), and recent protests by traditional owners have led to further constraints. Mine output has nonetheless risen in some areas, with output at Cerrejón almost tripling in 2022. The fall in Russian exports also helped Colombian miners, who often compete in European markets. This boost is now receding, as European demand corrects, but there are prospects for expansion into Asian markets.

Several mines owned by CNR and Prodeco have closed, but a re-opening is in prospect, with new owners being sought in some cases. This is expected to hold coal exports steady at about 47 million tonnes. However, Colombian exports remain relatively vulnerable, with growth increasingly contingent on government policy support.

South African exports are lifting

South African exports grew during the second half of 2022, as expanded European and Indian demand and high global prices created more opportunities. However, falling prices and a correction in European demand have taken out some the price premium previously enjoyed by South African exporters, and technical issues at the Richards Bay coal terminal have constricted South Africa's ability to capitalise on the brief growth in global demand.

The Richards Bay terminal remains the dominant platform for South African coal exports, and recent issues with maintenance, vandalism, and damage to railings that feed the port have had affected its export capacity. Some exporters have attempted to push their product out through different ports, but infrastructure constraints have prevented any sizeable redirection. Over the outlook period, it is expected that capacity constraints at Richards Bay will ease, and that a greater share of exports will shift towards Asia — especially India, which is seeking alternative sources of higher quality coal for industrial use. Exports are expected to increase from around 68 million tonnes in 2022, to 74 million tonnes by 2028.

Canadian exports are expected to hold steady through the outlook

Canadian exports are expected to largely hold steady through the outlook period. Exports from Canada largely originate at the Vista mine and Coal Valley, both in Alberta. The latter was closed during the COVID-19 pandemic, but recommenced operations in late 2021 and ramped up in 2022. However, Canadian government policy mandates an end to thermal coal exports by 2030, and the government has announced that no new thermal coal mines will approved.

Exports are expected to edge up marginally in the short term, to just over 6 million tonnes annually. However, falling demand in traditional markets will place pressure on exports in the second half of the outlook period. Current policy will also lead to a cessation of exports just beyond the end of the outlook period.

6.5 Prices

Prices are expected to decline, but not to the levels of 2020

The recent decline in global thermal coal prices is expected to continue, with the 'premium price gap' between coal grades partly unwinding, as the temporary factors behind the price surge of mid-2022 ease (Figure 6.6).

Prices are expected to decline further over the outlook period, primarily as a result of an easing in disruptive weather conditions and the gradual adjustment of global markets to the war in Ukraine. The build-up of European stocks and Chinese port inventories is expected to provide a buffer against price peaks of the kind seen in 2021 and 2022. The main risk to prices lies in a hard landing in the world economy. A recession would impact on industrial production and the demand for power.

The recent decline in high-grade coal prices may be partly mitigated in April, when a South Korean ban on the use of Russian high-energy coal takes its full effect. High-grade coal produced in Australia retains a stronger outlook than lower grade coals, with the price premium potentially increasing again over time.



Notes: NAR = Net as received. Source: IHS (2023). NAR = Net as received.

Figure 6.7: Thermal coal price forecast



Source: IHS (2023)

Figure 6.6: Thermal coal prices — Australian vs Indonesian

Thermal coal producers face increasing challenges in bringing new supply to markets. Access to finance and insurance for new mines remains difficult, and the rapid decline in construction of new coal-fired power plants means that the future of coal burning is bound to the lifetime operation of plants already built.

Low investment and greater difficulty with access to finance and insurance are expected to ensure supply remains relatively tight, keeping prices for 6,000kcal thermal coal over US\$100 a tonne through most of the outlook period. The reduction of the timeframe for thermal coal use, and the increasing time required to bring new mines online, make future investment contingent on extremely high profits. Consequently, the sector is expected to remain in a permanent higher price phase, with shortages of investment now baked in (Figure 6.7). This will benefit existing coal miners through the outlook period, but will also reduce the competitiveness of coal relative to other energy sources, potentially hastening its decline.

Prices for 6,000 kcal Newcastle coal are expected to decline from US\$371 a tonne in 2022 to around \$US90 by 2028 (in real terms). This would still leave prices well above their 2020 nominal average of US\$58 a tonne.

6.6 Australia

Australian thermal coal exporters continue to face disruptions

Australian coal producers were obliged to restructure their supply chains following the commencement of China's informal import restrictions. Australian coal was rapidly redirected towards alternative markets including Japan, Korea, Taiwan and Europe in 2021. High coal prices in the wake of the Russian invasion of Ukraine provided a windfall, insulating coal exporters at a time of significant uncertainty.

China is now withdrawing its informal import restrictions. In early January 2023, several utilities (and a significant Chinese steelmaker) were informed they would be permitted to resume imports of Australian coal. The government-backed China Energy Investment Corporation announced an order for Australian coal shortly after, and miners such as Coronado

have also been approached by Chinese buyers. Buyer restrictions have subsequently been removed more broadly.

While some resumption of coal trade with China is taking place, it is unlikely that exports will return fully to pre-2019 patterns. Chinese thermal coal imports are now on a declining path, and Australian exporters are expected to largely hold to their new and more diverse supply chains. Companies considering entry to the Chinese market may require higher prices to offset the risks of re-exposure to the Chinese market. Rebuilding trade linkages is expected to take time, though talks between buyers and sellers are now underway.

An easing in supply issues should see exports edge up. Persistent weather disruptions, exacerbated in 2022 by a renewed La Niña season, have affected exports for eight consecutive quarters. These disruptions persisted into the March quarter 2023, with Port Waratah Coal Services (which operates several significant terminals) reporting a fall of more than 30% year-on-year in January. The company cited ongoing poor weather and difficulty obtaining labour. Mines that feed the associated ports have also been affected by poor weather, with some remaining waterlogged well into the March quarter.

Exports have also faced disruptions linked to the COVID-19 pandemic — which has affected both the mining and shipment of thermal coal. Environmental protests and clashes over land use in coal-rich areas (notably the Hunter Valley of NSW, where coal use competes with agriculture and tourism) have also affected output, resulting in court challenges and delays in approvals.

The NSW Government has announced a new domestic reservation policy, requiring that 10% of coal mined in the State be reserved for domestic use. Initially, this applied to the 12 coal mines which already supplied to domestic power plants. However, requirements were subsequently extended to cover mines that supply the export market. Mines will be required to reserve between 7-10% of output. The reservation is expected to marginally constrain export volumes from NSW thermal coal mines in the short-term. Currently, around 15 million tonnes of coal is contracted

within NSW through long-term arrangements. The policy will raise the total in reserve to over 20 million tonnes. NSW currently exports around 140 million tonnes of coal each year, so the changes are expected to have a relatively modest effect in volume terms.

Most disruptions affecting coal exports are short-term in nature, and resumption of more normal conditions should support a recovery in exports to match the pre-2019 levels by 2025. Expanded output from New Hope projects, and ramp-ups at other mines in NSW and Queensland (mostly notably the Carmichael operations) will push exports up. However, some mines are also close to depletion, and the closure of at least eight such mines over the next five years likely will offset growth from elsewhere. New thermal coal projects are few, and are not expected to offset the closure of mines after 2028, when exports are expected to start declining. High prices have not resulted in a large expansion in the investment pipeline for thermal coal in Australia, and a significant rise at this point in the price cycle is unlikely.

Although spot prices have fallen (Figure 6.8), higher contract prices are likely to support strong revenue for most coal producers over the next 6-12 months. Price negotiations with buyers in Japan have resulted in annual benchmark prices above US\$370 a tonne for high grade thermal coal. Contract prices are expected to shift back over the outlook period, in line with general declines in spot prices across all grades of thermal coal. However, prices should remain high in historical terms.

Export volumes are expected to hold steady over the outlook period (Figure 6.9), with disruptions easing in the short-term, and mine closures and openings largely offsetting each other. Thermal coal exports are forecast to move from 196 million tonnes in 2021–22 to 195 million tonnes by 2027–28. Prices will likely remain volatile, and subject to a general easing. With volumes steady and prices down, export values are forecast to fall from a \$65 billion record in 2022–23 to a more typical level of \$19 billion by 2027–28.





Source: McCloskey - IHS (2023)





Revisions to the outlook for Australian thermal coal exports

The forecast for export earnings has been revised down by around \$11 billion in 2022–23 and 2023–24. Revisions reflect a sharper than expected fall in thermal coal prices, which effectively 'frontloads' the forecast price fall. The fallout from the Russian invasion of Ukraine continues to add to price pressures over the medium term.

The forecast for earnings in 2026–27 has been revised up by \$4 billion from the estimate contained in the March 2022 edition. This reflects the likelihood that prices will remain at a higher floor, due to the ongoing deterioration in the long term outlook for thermal coal demand.
Table 6.1: World trade in thermal coal

	Unit	2022 ^s	202 3 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR ^r
World trade	Mt	1,036	1,031	1,033	1,027	1,023	1,004	977	-1.0
Thermal coal imports	;								
Asia	Mt	833	852	861	866	876	867	847	0.3
China	Mt	244	205	181	174	174	166	150	-7.8
India	Mt	164	215	243	252	259	262	258	7.8
Japan	Mt	132	132	131	130	128	125	123	-1.1
South Korea	Mt	90	90	89	89	88	86	86	-0.6
Thermal coal exports									
Indonesia	Mt	457	468	466	464	461	456	456	0.0
Australia	Mt	178	193	198	199	200	196	196	1.6
Russia	Mt	164	145	142	140	137	133	130	-3.8
Colombia	Mt	46	47	50	50	50	49	47	0.5
South Africa	Mt	68	69	72	73	73	74	74	1.4
United States	Mt	35	37	37	37	35	33	31	-2.0

Notes: **f** Forecast; **s** Estimate; **z** projection

Source: International Energy Agency (2023); IHS Markit (2023); Department of Industry, Science and Resources (2023)

Table 6.2: Thermal coal outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Contract prices ^b									
- nominal	US\$/t	375	245	193	141	115	114	111	-18.3
- real ^c	US\$/t	375	239	184	131	105	103	98	-20.1
Spot prices ^d									
– nominal	US\$/t	359	212	173	129	105	105	99	-19.3
- real ^e	US\$/t	371	212	169	124	99	97	90	-21.1
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Production	Mt	237	238	247	250	246	245	241	0.3
Export volume	Mt	196	182	197	199	200	199	195	-0.1
- nominal value	A\$m	46,258	64,977	43,893	34,509	26,098	23,206	22,450	-11.4
- real value ^h	A\$m	49,595	64,977	41,972	31,983	23,555	20,434	19,287	-14.6

Notes: **b** refers to benchmark Japanese Fiscal Year 6322kcal GAR thermal coal contract reference price; **c** In current JFY US dollars; **d** fob Newcastle 6000 kcal net as received; **e** In 2023 US dollars; **f** Forecast; **h** In 2022–23 Australian dollars; **s** estimate; **z** projection

Source: ABS (2023) International Trade in Goods and Services, Australia, Cat. No. 5368.0; IHS (2023); NSW Coal Services (2023); Queensland Department of Natural Resources and Mines (2023); Company Reports; Department of Industry, Science and Resources (2023)

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Gas





Global gas use by sector, 2020



LNG facts







SOURCE: IEA; GIIGNL; NexantECA; ABS; OCE

LNG TRADE MAP





SOURCE: World Gas Model; ABS

7.1 Summary

- Australia's LNG export revenues are forecast to reach \$91 billion in 2022–23, on record high global energy prices and a lower Australian dollar. As global energy markets reorganise, earnings are forecast to fall steadily (in real terms) — to \$45 billion by 2027–28.
- LNG prices have completely reversed the dramatic rise seen after the Russian invasion of Ukraine. Spot prices for Asian LNG are forecast to average US\$21 MMBtu in 2023 and 2024, as global gas markets reorganise following the curtailment of Russian pipeline gas supply to Europe. Prices are projected to ease to \$16/ MMBtu after 2026, as new US and Qatari facilities come online.
- After reaching 83 Million tonnes (Mt) in 2021–22, Australia's LNG export volumes are forecast to stabilise at 80 Mt, as output from Pluto LNG train two offsets falling production from the Northwest Shelf.

7.2 World trade

Australian export earnings rise amidst global volatility

Global LNG trade reached an estimated 395 Mt in 2022, an increase of 5.5% from 2021. Europe has now emerged as the key driver of import growth — and is forecast to maintain this position across the outlook period. Rising European demand will likely come at the expense of Asian consumption, which is typically more price sensitive.

Throughout 2022, many Asian buyers were priced out of the market by European importers. Other buyers, mainly in China, appear to have resold their contracted US cargoes to European markets to arbitrage the higher European prices (Figure 7.1). Remarkably, record-warm winter temperatures and a steady flow of LNG imports from the US, has seen European storage reach its highest levels in recent history, alleviating the risk of an immediate gas shortfall and easing pressure on LNG prices.

Global gas markets are forecast to remain tight and volatile until the end of 2024, as Europe continues using LNG to compensate for lost Russian pipeline gas. However, tight supply conditions are forecast to ease in 2025 and 2026, as new US and Qatari liquefaction facilities come online.



Figure 7.1: Global LNG demand forecasts, 2021–28

Notes: 2021 and 2022 figures based on historical data. Source: Department of Industry, Science and Resources (2023), Nexant ECA (2023)

Figure 7.2: Global LNG supply forecasts, 2021–28



Notes: 2021 and 2022 figures based on historical data. Source: Department of Industry, Science and Resources (2023); Nexant ECA

7.3 World imports

Warm temperatures and LNG imports bolster European energy security

The fallout from Russia's illegal invasion of Ukraine has fundamentally altered global gas market supply chains. This transformation has been most apparent in Europe, where Russia has historically supplied approximately 40% of the continent's gas demand. However, as the invasion stalled in March 2022, Russia began repudiating its contractual obligations to supply Europe with its gas.

In 2022, European imports of Russian pipeline gas more than halved, falling to 65 billion cubic metres (bcm) from 143 bcm in 2021 (Figure 7.3). There are indications that Gazprom began to materially reduce Europe's gas supplies in the months leading up to the February 2022 invasion. According to data from ENTSO-G, total Russian pipeline exports to Europe in H2 2021 were 23% below the five-year historical average. Falling pipeline imports contributed to lower gas injections into European storage inventories during the 2021 summer refilling season, which created a tangible risk of a gas shortage during the 2021–22 winter heating season (Figure 7.4).

The reduced gas flows in 2021, combined with the record low storage inventories, created an urgent need for Europe to source offsetting volumes of natural gas from global LNG markets. In 2022, European LNG imports rose 59% to 125 Mt, with most imports coming from the United States (Figure 7.5). The swing in US LNG imports was enabled by flexible contracts that allow buyers to redirect contracted volumes elsewhere should the circumstances demand. In this instance, with China's demand adversely impacted by COVID-19 lockdowns, Chinese buyers of US LNG were able to resell their contracted volumes to Europe at a premium to their contracted price.

The steady flow of US LNG and record-high winter temperatures reduced the drawdown of European storage inventories over the 2022-23 winter. These two conditions eliminated the risk of an immediate shortage and have improved the likelihood of healthy storage injections over the 2023 refilling period.

Figure 7.3: Russian Pipeline Exports to Europe, 2021–23



Notes: Includes all Russian pipeline exports to Europe that transit through Ukraine, Poland, Turkey, and Germany. Five-year intervals were calculated between 2016 and 2020. Source: ENTSOG Transparency Platform (2022); Department of Industry, Science and Resources (2023)

Figure 7.4: European Storage Inventories, 2021–22



Source: Bloomberg (2023); Eurostat (2023); Note: Five-year average calculated between 2016 and 2020.



Figure 7.5: European LNG imports by source, 2020–22

Notes: Other producers include Algeria, Nigeria and Trinidad and Tobago Source: Kpler (2022)

Europe is now forecast to capture most of the world's growing LNG supply over the outlook period. European LNG imports are forecast to reach 142 Mt in 2023 (up ~100% on 2021 volumes) as Germany, Belgium, Italy, and Greece commission new LNG import facilities to offset lost Russian pipeline gas. Imports are also projected to rise to 178 Mt by 2028, as new pipeline interconnectors in the Czech Republic, Bulgaria, and Slovakia allow LNG importing countries to export gas to Eastern and Central European markets.

However, a key uncertainty over the outlook is whether Europe will decide to underwrite investment in LNG *export* facilities by signing long-term sale and purchase agreements (SPA) with LNG suppliers. SPAs typically require buyers to commit to taking LNG cargoes over a 15-year period. But buyers underwriting new plants may need to consume LNG well into the 2040s — since constructing a new facility typically takes four to five years.

If Europe cannot fully contract its future LNG demand, it will need to continue to rely on volatile and expensive LNG spot markets to safeguard its energy security.

High prices and lockdowns weigh on China's LNG imports

China's gas consumption declined for the first time on record in 2022. The lower result was entirely due to falling LNG imports, which declined 26% year-on-year to 59 Mt. China's gas supply from domestic production and pipeline imports all recorded steady growth, but this was not enough to offset the fall in LNG (Figure 7.6).

Australia's LNG exports to China fell by 30% in 2022, to 22 Mt from 31 Mt in 2021. China's LNG imports from Russia rose 35% year-on-year in 2022 to 6 Mt, as European countries sanctioned Russian exports in response to that country's illegal invasion of Ukraine. Russia now supplies roughly 9% of China's LNG (Figure 7.7).

High prices, COVID-19 lockdowns and cheaper gas substitutes weighed down China's LNG demand in 2022. The largest decline in gas consumption appears to have been concentrated in the electricity sector, which accounts for roughly one quarter of Chinese gas consumption. Gaspowered generators in southern China halted spot sales of LNG in 2022, and instead relied on long-term, contracted supply. Other Chinese buyers resold excess LNG onto international markets to arbitrage the price differentials between long-term contracts and LNG spot prices.

China has recently emerged as the largest source of growth in LNG demand, and its purchasing decisions have had a crucial influence on global market developments. However, the prospect of lower economic growth, volatile prices and alternative Russian gas imports is casting doubt on LNG's future role in the Chinese economy. Chinese pipeline imports from Russia are forecast to rise five-fold to 78 bcm by 2028 (from 15 bcm in 2022) as the Power of Siberia 2 pipeline comes online over the outlook period. Meanwhile, Chinese LNG imports are forecast to be steady until 2026, as Europe and Southeast Asia consume marginal LNG supplies. Chinese LNG imports are not projected to exceed 2021 volumes until 2027, when new LNG facilities come online in Qatar and the US.





Source: Bloomberg (2023); National Bureau of Statistics of China (2023)

Figure 7.7: Chinese LNG imports by volume and source



Japan's imports buttressed by contractual arrangements

Japan imported 72 Mt of LNG in 2022, down 2.6% from 2021, with Australia supplying nearly half (30 Mt) of Japan's imports (Figure 7.8). Japan's long-term contracts saw resilient LNG imports amidst record-high LNG spot prices, but many of these contracts are set to expire over the outlook period.

Japan, historically the world's largest LNG importer, became increasingly reliant on LNG following the Fukushima accident in 2011. However, high and volatile LNG prices have prompted Japan to reconsider its dependence on gas generation. As a result, Japan has prioritised the reopening of seven nuclear reactors over the outlook period. Meanwhile, public opinion is also becoming more supportive of nuclear technology. Surveys show that 58% of the Japanese public supports the restart of nuclear power, which could lay the foundation for further nuclear buildouts.

Figure 7.8: Japanese LNG Imports



Japan obtains almost all of its gas via LNG imports — approximately twothirds of which is consumed in the power generation sector. However, Japan's LNG imports are projected to fall from 72 Mt in 2022 to 69 Mt in 2023, as gas-powered generators face increased competition from nuclear, coal-powered, and renewable generation. According to METI, Japan plans to reduce gas' share of total electricity generation from 38% in 2022 to 27% by 2030, while the share of nuclear power could go from 6% to 22% over the same period.

Korean imports remain steady amidst high prices

South Korea's LNG imports rose by 0.9% year-on-year to 47 Mt in 2022. Australian exports to South Korea rose to 11 Mt (up 1.2 Mt from 2021). South Korea sources all its gas from LNG imports, over half (55%) of which is consumed to generate electricity. Of the remainder, 16% is used by the industrial sector (typically as a chemical feedstock or source of industrial heat), and 26% is used in the commercial and residential sectors.

The South Korean Government has plans to increase the share of nuclear generation in the energy sector to mitigate the impact of high energy prices on the country's trade deficit (see Uranium chapter). As a result, Korean LNG demand is forecast to fall to 40 Mt by 2025 as new nuclear power plants ramp up electricity production. However, LNG demand growth will likely return after 2026, as new US and Qatari supply places downward pressure on global prices.

ASEAN LNG demand to triple over the outlook period

ASEAN has historically been an important supplier of LNG in Asia, with Malaysia and Indonesia dominating exports. The two countries have been operating large liquefaction facilities on the island of Borneo and in West Papua since the 1980s. In both cases, the liquefaction facilities were primarily used to supply electricity markets in Northeast Asia; and in 2022, ASEAN's combined LNG exports reached 40 Mt.

However, LNG import demand in Southeast Asia is projected to rise threefold over the outlook period. ASEAN will need additional LNG imports to offset falling domestic gas production, lower inter-regional pipeline imports and growing electricity demand. Higher LNG imports are now projected to offset ASEAN's LNG exports by 2027, turning the region into a net importer of the fuel for the first time in its history.

ASEAN's LNG imports are forecast to double (from 18 Mt in 2022 to 34 Mt) by 2025, driven by higher demand in Thailand, Singapore, and the Philippines. Imports are then projected to rise to 63 Mt by 2028 due to lower pipeline imports into the Malaysian peninsular and growing gas demand in Western Indonesia.

Thailand and Singapore have historically relied on pipeline imports from Myanmar and Indonesia. However, the gas fields fuelling these pipeline imports are reaching the end of their economic life, as are those located within the Gulf of Thailand. Similarly, Malaysian pipeline imports from Indonesia are forecast to end after 2026 as Indonesia upstream gas reserves in Sumatra also deplete. As a result, Malaysia will also need additional LNG imports to compensate for this lost pipeline gas. Across the three countries, rising LNG imports will be consumed almost exclusively in the power generation sector.

Steady demand growth in South Asia

South Asian imports fell 16% to 31 Mt in 2022, amidst high and volatile spot prices (Figure 1). However, rising gas demand in the power sector is forecast to lift the region's LNG demand to 40 Mt in 2025 and to 50 Mt by 2028. After ASEAN and Europe, South Asia is the only other region forecast to experience demand growth for LNG over the outlook period.

Import growth will be concentrated primarily in Bangladesh and Pakistan. The two countries will need to use LNG imports to offset falling domestic gas production and service growing needs in the power generation sector and in industry. Meanwhile, Indian gas demand is forecast to rise over the next five years but increasing coal bed methane production in the country's eastern provinces will fuel most of this additional consumption.

7.4 World exports

US LNG redirected to Europe amidst market reorganisations

US LNG exports have expanded sharply over the last decade and have driven most of the growth in the global LNG trade. Between 2018 and 2021, US LNG exports grew by 50% per annum, rising from 22 Mt to 70 Mt. However, the US buildout has slowed recently, with 2022 exports growing by only 10%.

US LNG cargoes have been crucial to European efforts to replace lost Russian gas. US LNG exports to Europe increased by over 120% year on year in 2022, rising from 24 to 53 Mt per annum. Destination flexibility provisions within US LNG supply contracts were the critical enabler of the shift, as Asian buyers opted to redirect cargoes to the more lucrative European markets (See Figure 7.10).

US LNG production is forecast to grow to 93 Mt by 2025, as Freeport LNG returns online and new trains at Calcasieu and Sabine Pass ramp up to full production. Three more facilities are currently under construction (Golden Pass, Plaquemines LNG Phase 1, and Corpus Christi Liquefaction Stage 3) with a combined nameplate capacity of 40 Mt. The three new liquefaction facilities are projected to lift US LNG production to 134 Mt by 2028.

The US Energy Information Agency has advised that eight additional US LNG projects have completed Front-End Engineering and Design (FEED) and are targeting a Final Investment Decision (FID) over the outlook period. These eight facilities have a combined nameplate capacity of over 108 Mt per annum and, if successful, could increase US LNG capacity to over 250 Mt beyond the outlook period.

However, the progress of these facilities to the construction phase may depend on the willingness of LNG buyers to underwrite them with longterm contracts (that contain firm commitments to take the LNG that the facilities will make).



Figure 7.9: US LNG exports by destination, 2016–22



Figure 7.10: Global LNG Supply forecast, 2022–28



Source: NexantECA (2023) US Energy Information Agency (2023), Department of Industry, Science and Resources (2023)

Larger Qatari volumes on the horizon

The volume of Qatari exports has been stable at approximately 80 Mt for the last decade. Qatar's LNG production is concentrated at a single facility at Ras Laffan, which has 18 dedicated LNG trains. The Qatari Government has repeatedly stated that Qatar cannot materially boost its LNG supply in the short term, despite high prices and strong global demand for LNG.

Qatar is projected to expand its LNG export capacity in the coming years, by constructing six additional LNG trains at Ras Laffan. The new trains, fuelled with gas from Qatar's North Field East, are projected to raise Qatar's LNG exports to 108 Mt in 2026 and to 127 Mt in 2028. Demand for the new LNG has been high, with Qatar's Energy Minister, Saad Bin Sherida Al-Kaabi, predicting that all the new volumes will be contracted out by the end of 2023.

7.5 Prices

Russia sends global gas prices to historic levels

Global LNG prices have exhibited significant volatility over the last two years. In the second half of 2021, a post-COVID recovery in global gas demand coincided with Russian efforts to limit pipeline exports to Europe, resulting in lower European gas storage inventories (see Europe chapter). As a result, between June and October 2021, LNG prices soared by over 192% — from US\$12/MMBtu to US\$35/MMBtu — as European gas buyers scoured global LNG markets for uncontracted cargoes.

The high prices and volatility accelerated further following the illegal invasion of Ukraine in 2022, as Russia began to starve Europe of its remaining pipeline imports (see Figure 7.3). Prices peaked in August 2022, averaging US\$54/MMBtu (five times the historical average) after Russia suspended flows along Europe's largest gas pipeline — Nord Stream 1.

But remarkably, a steady flow of LNG imports from the United States (Figure 7.9) and record-warm winter temperatures have seen European storage inventories reach their highest levels in recent history, alleviating the risk of an immediate gas shortfall and easing pressure on LNG prices.





Notes: ANEA is the Argus Northeast Asia LNG spot price DES (Delivered Ex Ship), which includes shipping and insurance. Dutch TTF is the Dutch Title Transfer Facility gas price. Source: Argus (2023); Bloomberg (2023)

Prices to remain high and volatile until 2025

Prices are forecast to remain elevated and volatile until 2025, as LNG markets remain tight following the stranding of Russian pipeline gas supply previously destined for Europe. As a result, Europe will depend on US LNG imports to offset lost Russian pipeline volumes and partially rely on Chinese companies reselling contracted US volumes to the bloc. Given the high seasonality of European gas demand and uncertainty surrounding Chinese LNG demand, this will inevitably create future challenges for gas markets.

Global LNG export facilities must continue operating near full capacity to ensure Europe can make adequate injections into their storage inventories. However, at such high utilisation rates, liquefaction facilities may lose the flexibility needed to manage seasonal spikes in gas demand. Accordingly, intense buyer competition could re-emerge during winter and summer peak demand periods as rising prices fail to elicit supply responses from maxed-out liquefaction facilities. On the other hand, should Europe succeed in refilling its inventories ahead of the 2023–24 winter heating period, demand for spot LNG could temporarily fall and result in large discounts on cargoes sold between peak demand periods (typically at the tail-end of the March and September quarters). Thereafter, market conditions are expected to ease regardless, as US's Golden Pass and Plaquemine's LNG ramp up during 2025 and as Qatar's North Field East comes online in 2026 (Figure 7.2).

High oil prices continue to support LNG earnings

Around 80-90% of Australian LNG exports are sold under long-term contracts that link the price of LNG to the Japanese Customs Crude (JCC) oil price (with a three to six-month lag, depending on contractual arrangements). LNG contract prices in the December quarter 2022 reflected Brent oil prices from the June (US\$113 a barrel) and September (US\$89 a barrel) quarters, which were considerably higher than the corresponding quarters in 2021. Uncertainty around Chinese oil demand and the impact of sanctions on Russian crude have created upside risks to the oil price forecast in 2023, which will help support Australian LNG export earnings. As a result, oil-linked LNG contract prices are expected to average US\$13/MMBtu between 2023 and 2024. Prices are projected to gradually ease down to US\$12/MMBtu in 2025, before averaging about US\$11 MMBtu over the rest of the outlook period.

7.6 Australia

Australian LNG export volumes reach new records

Australia's LNG export volumes set a record in 2022, reaching 81.5 Mt (up 0.5% from 2021). The strong result was driven by record-high utilisation rates on Australia's West coast facilities amidst high international LNG prices. For example, Wheatstone, Gorgon, and Pluto LNG (one-third of Australia's total LNG capacity) are estimated to have operated at a combined utilisation rate of 110% in 2022.

The impressive result was enough to offset lost production at Darwin LNG due to field depletion in the Bayu-Undan basin and at Prelude LNG, which experienced unplanned outages throughout the year.

Figure 7.12: LNG spot and contract prices, 2019–28



Notes: ANEA is the Argus Northeast Asian spot price. LNG prices are DES (Delivered Ex Ship). The long-term oil-linked contract price is indicative and is estimated at 14% of the 3-month lagged JCC oil price plus shipping.

Source: Argus (2023); Bloomberg (2023); Department of Industry, Science and Resources (2023)

Export volumes are forecast to rise further to 82.5 Mt in 2023 — based on the assumption that Prelude LNG returns to a normal production profile and existing facilities maintain their current utilisation rates. Volumes are forecast to temporarily dip to 77 Mt in 2025, as the legacy gas fields supplying the Northwest Shelf decline.

Thereafter, rising production from Darwin LNG — once the Barossa gas field has been brought online — and the gradual ramp-up of Pluto's second LNG train in 2026 is projected to lift Australia's export volumes back to 81 Mt by 2028.

Australia's LNG earnings rise amidst tight global energy markets

Australian LNG export earnings reached \$90 billion in 2022, up 82% from 2021. This marks the highest yearly earnings on record from Australian

LNG exports. Earnings in the December quarter of 2022 reached an alltime quarterly record of \$27 billion, up 46% from December 2021. Export earnings are forecast to reach \$91 billion in FY2022–23, driven by elevated spot LNG and oil price-linked contract prices and high LNG production — enabling Australia's producers to sell more of their output at spot market prices.

Australia's earnings from LNG are forecast to moderate considerably after FY2024-25, assuming global energy markets reorganise further in response to the fallout from Russia's invasion of Ukraine. Earnings are forecast to fall to \$57 billion in FY24–25 and then ease to \$45 billion in 2027–28 (in real terms). Key uncertainties for the forecast include the relative composition of spot and contract sales in Australian exporter's sales portfolios, seasonal fluctuations in demand that could cause spot sale earnings to rise in one financial year relative to another, and the long-term status of stranded Russian gas.

Revisions to the outlook

Australian LNG export earnings for 2022–23 have been revised up by \$1 billion to account for a higher proportion of Australia's LNG exports being sold at spot LNG prices relative to oil-linked contract prices.

Compared with the March 2022 *Resources and Energy Quarterly*, forecasts for LNG export revenue are up 12% to \$51 billion in 2026–27. The difference is due to the upward revision to long-term LNG prices over the outlook period.





Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Figure 7.14: Yearly price/volume contributions to LNG exports



Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Table 7.1: Gas outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^f	2026 ^z	2027 ^z	2028 ^z	CAGR
JCC oil price ^a									
– nominal	US\$/bbl	102.7	87.9	86.2	79.3	76.4	75.5	74.9	-5.1
- real ^h	US\$/bbl	106.3	87.9	84.3	76.0	71.8	69.5	67.6	-7.3
Asian LNG spot price ^g									
– nominal	US\$/MMBtu	33.2	21.1	20.5	17.4	16.0	15.7	15.7	-11.8
- real ^h	US\$/MMBtu	34.4	21.1	20.1	16.6	15.1	14.4	14.1	-13.8
Gas production ^s	bcm	4,093	4,108	4,185	4,266	4,394	4,456	4,504	1.6
Gas consumption ^s	bcm	4,078	4,123	4,187	4,276	4,373	4,452	4,517	1.7
LNG trade ^{ds}	Mt	394	415	430	445	494	537	545	5.6
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^f	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Production ^b	bcm	162	163	161	155	154	159	157	-0.6
– Eastern market	bcm	60	57	56	53	52	51	50	-2.9
- Western market	bcm	86	91	89	86	83	87	85	-0.1
– Northern market ^c	bcm	17	15	16	17	19	21	21	3.9
LNG export volume ^d	Mt	83	82	81	78	78	82	80	-0.7
- nominal value	A\$m	70,571	90,727	73,360	61,504	56,756	58,421	52,574	-4.8
- real value ^e	A\$m	75,663	90,727	70,149	57,004	51,226	51,444	45,166	-8.2
LNG export unit value ⁹									
- nominal value	A\$/GJ	16.1	21.0	17.2	14.9	13.7	13.5	12.5	-4.1
- real value ^e	A\$/GJ	17.2	21.0	16.4	13.8	12.4	11.9	10.7	-7.6
- nominal value	US\$/MMBtu	12.3	15.2	13.3	11.8	10.9	10.7	9.9	-3.5
- real value ^e	US\$/MMBtu	13.2	15.2	12.7	10.9	9.8	9.4	8.5	-7.0

Notes: a JCC stands for Japan Customs-cleared Crude; b Production includes both sales gas and gas used in the production process (i.e., plant use) and ethane. Historical gas production data was revised in the June quarter 2017 to align with Australian Petroleum Statistics; c Gas production from Bayu-Undan Joint Production Development Area is not included in Australian production. Browse basin production associated with the Ichthys project is classified as Northern market; d 1 Mt of LNG is equivalent to approximately 1.36 bcm of gas; e In 2021–22 Australian dollars; f Forecast; g 1 MMBtu is equivalent to 1.055 GJ; h In 2022 US dollars; r Average annual growth between 2021 and 2027 or 2020–21 and 2026–27; z Projection. Source: ABS (2022) International Trade in Goods and Services, 5368.0; Department of Industry, Science, Energy and Resources (2022); Company reports; Nexant (2022) World Gas Model.

Oil





World consumption, 2022



Oil facts



Around **2/3** of Australia's **crude and condensate production** comes from the **Carnavon basin**, offshore from WA





SOURCE: GA; OCE; ABS; IEA; Bloomberg; DCCEEW

8.1 Summary

- Oil prices are expected to rise in the first half of 2023, averaging US\$88

 a barrel over the year, before coming down over the rest of the outlook
 period. Global economic growth is expected to pick up as the energy
 crisis eases and China lifts pandemic restrictions. The Brent crude price
 (in real terms) is expected to fall to around US\$68 a barrel by 2028.
- Australia's crude and condensate production volumes are expected to be relatively steady over the outlook period to reach around 329,000 barrels a day by 2027–28.
- Australia's crude and condensate export earnings (in real terms) are expected to fall over the outlook period as prices decline, from \$13.4 billion in 2022–23 to \$9.8 billion in 2027–28.

8.2 World consumption

Consumption to rebound as macroeconomic outlook improves

Oil consumption fell by 0.1% year-on-year in the December quarter 2022. High oil and oil product prices (as a result of the fallout from the Russian invasion of Ukraine) caused significant demand destruction. The consumption of naphtha, normally used an as industrial solvent, is estimated to have fallen 28% year-on-year for European OECD members, and 10% for Asian OECD members. Diesel consumption for European members of the OECD is estimated to have fallen 5.8% year-on-year. While some of this decline reflects weaker consumer demand, increased fuel efficiency and adoption of electric vehicles also contributed.

Energy prices softened towards the end of December, when it became apparent that warm temperatures over the European winter would substantially reduce demand for oil to gas switching. Lower energy prices are expected to oil/oil product demand recover in 2023. Global oil consumption is forecast to rise by 1.8% to 101.8 million barrels per day (Figure 8.1) in 2023, exceeding the levels recorded in 2019. Consumption growth is expected to be underpinned by the reopening of China from pandemic restrictions, and by the ongoing recovery of global air travel. In China, oil consumption began to recover in the December quarter 2022, after the country lifted pandemic restrictions in December. Oil consumption was 1.6% lower year-on-year, improving on a fall of 4.9% year-on-year in the September quarter 2022. The bulk of recovery in consumption is expected to materialise over 2023; passenger car usage is expected to rise, and pent up demand is expected to drive road transport fuel consumption and jet fuel consumption. Industrial production in China is also expected to grow, driving consumption of naphtha and LPG.

Figure 8.1: Global oil consumption, OECD and non-OECD



Source: Department of Industry, Science and Resources (2023); International Energy Agency (2023)

Jet fuel to support oil consumption as electric vehicles displace demand

World oil consumption growth is expected to slow over the outlook period, as electric vehicles (EVs) replace internal combustion engine vehicles, lowering the demand for petrol and diesel — which currently makes up around half of global oil consumption. EVs are rapidly gaining market share in the passenger vehicle market (see *Lithium* chapter), as battery technologies improve and costs decline. The shift in composition of vehicle stocks towards EVs will likely accelerate over time, resulting in a corresponding acceleration in the reduction of petrol and diesel demand.

In OECD countries, the share of EVs sold in the passenger vehicle market is expected to double to around 20% between 2022 and 2024. This is forecast to drive a net decline in oil consumption in these countries from 2026. Uptake in non-OECD countries is expected to be slower, with the exception of China where EVs are also rapidly gaining market share.

In contrast to road transport, low-carbon substitutes such as electric and hydrogen technologies are not viable for air travel, as the relatively low energy density of batteries, or a tank for the hydrogen, adds too much additional mass to a plane. Energy-dense fuels such as synthetic hydrocarbon fuels are under development, but the IEA's net zero scenario in the *Energy Technology Perspectives 2023* found this type of fuel could only meet one-quarter of the sector's final energy consumption by 2050. Similarly, naphtha could be displaced by synthetic fuels, but the level of displacement is expected to be negligible over the outlook period.

World oil consumption will be supported by growing demand for jet fuel. The International Air Transport Association found that globally, kilometres travelled by paying passengers in 2022 had recovered to just 68.5% of 2019 levels before the pandemic. This suggests there is substantial room for further recovery, with passenger volumes expected to surge over 2023 and 2024. Jet fuel demand growth is expected to converge on the pre-pandemic trend, when (between 2009 and 2019) world jet fuel consumption grew an average of 3.6% per year.

8.3 World production

US crude to meet growing demand while Russian output falls

World oil production is estimated to have risen by 3.4% year-on-year in the December quarter 2022, with producers responding to recovering global demand. OPEC members have driven the growth despite targeted cuts in October and November. Producers from North America and non-OPEC Latin America also reported higher output.

Following its February 2023 meeting, OPEC announced that production targets would be unchanged from the levels agreed in November, despite a less pessimistic demand outlook. In February, Russia announced that it

will cut output in March 2023 by 500 kilo barrels per day (kb/d), or around 5% of Russian production. The cut may be an attempt by Russia to boost prices. It is also possible that Western bans on technology exports may be starting to erode productivity at Russian oil fields.

The G7, the EU and Australia imposed price caps on Russian crude and refined products from 5 December 2022 and 5 February 2023 respectively, by preventing the sale of insurance for Russian oil cargoes if they are sold at a price above the cap. Russian oil exports are now largely carried by a fleet of older tankers operating outside of the Western shipping system, which are not constrained by the price caps. Where this fleet of ships is not able to provide sufficient capacity to carry Russian products, European vessels subject to the price cap have been engaged as needed.

World oil production is forecast to grow by 1.8% in 2023 (Figure 8.2), despite constrained output from OPEC producers. Much of the output growth in 2023 will be driven by higher shale oil production in the United States.

Figure 8.2: Global oil production, OPEC and non-OPEC



Source: Department of Industry, Science and Resources (2023); International Energy Agency (2023).

Forecasts from the US Energy Information Administration suggests US crude production could grow around 3% per year over 2023 and 2024 — an increase of around 400 kb/d per year. This growth is much lower than in the peak years of the shale oil revolution, when US crude oil production grew by around 800 kb/d per year (2012-2019). Investors remain cautious around potential investment in new oil capacity.

Between 2025 and 2028, world production growth is forecast to slow to 0.5% per year, as EV adoption increases. US production growth is expected to slow further beyond 2025, but it is expected to remain one of the largest sources of new supply over the outlook period.

New supply is also expected from Guyana in South America. After a series of discoveries from 2008, offshore production in Guyana began in 2019, and output reached 370 kb/d in 2022. Projects currently in the pipeline could more than double production capacity in Guyana by 2025.

8.4 Prices

Demand destruction contributed to price falls following war in Ukraine

Prices rose to US\$134 a barrel on 8 March 2022 (Figure 8.3), following Russia's invasion of Ukraine, over concerns that sanctions may result in the loss of Russian oil from world markets. A weakening macroeconomic outlook then dominated oil price moves in the second half of 2022, with prices falling to an average of US\$81 a barrel in December. Oil demand fell in China with the implementation of strict COVID-19 containment measures, leading to a sharp decline in transportation, consumer spending and industrial production. High energy prices and interest rate hikes saw industrial production and consumer spending weaken in Europe and the US.

The price cap of US\$60 a barrel on Russian crude (imposed in early December) contributed to price weakness. Russian export grade Ural oil traded at an average of around \$43 a barrel in January and February, and was largely sold to buyers in India and China. However, some portion of Russian crude has likely been sold at a price higher than the price caps, with ongoing reports of cargoes being transferred at sea to mask the origin

of the product, and extensive use of tankers not using western financial services to carry Russian petroleum exports.

Figure 8.3: Brent oil price, daily - 2021 to 2023



Stronger demand to push prices up in 2023

Brent crude rose to an average of US\$83 a barrel over January and February, amidst rising demand. The Brent crude price is forecast to average \$90 a barrel over 2023, with prices reflecting demand factors including the removal of COVID restrictions in China and improved demand in Europe.

The price of Brent crude is projected to decline (in real terms) to US\$68 a barrel by 2028 (Figure 8.4). The fall is expected to be driven by rising production outside of OPEC, particularly in North America, combined with slowing demand growth — as the world transitions to low emission technologies.

US efforts to refill its Strategic Petroleum Reserve should lend support to oil prices — in the first half of the outlook period at least. The US government has announced it is targeting a price of about US\$67-72 a

barrel for delivery in 2024 or 2025. These purchases may be brought forward if prices weaken faster and further than expected.

Figure 8.4: Price outlook



Source: Bloomberg (2023); Department of Industry, Science and Resources (2023)

8.5 Australia

Export earnings to fall as prices decline

Australian crude oil and condensate export earnings rose 8.6% year-onyear to A\$3.7 billion in the December quarter 2022. Prices were moderately higher in the quarter compared to the period immediately prior to the Russian invasion of Ukraine.

Most Australian exports over the quarter were shipped to Singapore, South Korea and China, with exports to China seeing rising quarter on quarter as COVID restrictions were relaxed.

Real exports earnings are expected to fall by 11% to A\$13.4 billion in 2022–23 (Figure 8.5), as prices decline from very high levels seen following the Russian invasion of Ukraine. Real export values are forecast

to fall further over the next two years, and then steady out to A\$9.8 billion by 2027–28.

Figure 8.5: Australian oil and condensate exports



Notes: Includes crude oil and condensate but excludes LPG. Source: Australian Bureau of Statistics (2023); Department of Industry, Science and Resources (2023).

Delays over investment decision casts uncertainty over outlook

In the December quarter 2022, Australian crude oil and condensate production reached 314 kb/d, up 11% on the September quarter 2022. Driving the rise was increased production at the Ichthys project — after disruptions over the September quarter. Output is forecast to continue at around 300 kb/d until 2026, when the Dorado oil and gas field in offshore Western Australia may provide additional supply.

A final investment decision for the Dorado oil and gas field was expected in the second half of 2022, but the decision has been delayed. Further delays seem possible, with Carnarvon Energy divesting a 10% stake in the project to Taiwan's CPC Corporation in February 2023. If the project proceeds, it could bring around 90 kb/d of additional production capacity online.

EV adoption to drive lower Australian refined consumption

Australia's consumption of refined oil products rose by 7.5% year-on-year in the December quarter of 2022, driven by a 94% increase in jet fuel consumption. This reflected the opening of Australia's international borders in November 2021. Compared to pre-pandemic (December 2019) levels, consumption was 4.0% lower, with petrol 7.9% lower and jet fuel 22% lower. Demand is not forecast to reach pre-COVID levels during the outlook period. Australia is expected to follow the pattern of OECD consumption, despite a relatively low uptake of EVs. However, jet fuel consumption is expected to grow along with the demand for air travel.

Australia's two remaining refineries are expected to have their operation extended, with plans to extend the Lytton plant announced in April 2022 and plans to extend the Geelong plant announced in January 2023. Australian refined production is expected to remain at around 250 kb/d over the outlook period. In 2021, falling demand linked to COVID restrictions resulted in two of Australia's refineries closing down. The remaining two refineries signed contracts with the Federal Government to remain open until at least 2027, in exchange for a subsidy on each litre of refined product sold.

Exploration

Australia's petroleum exploration expenditure was \$240 million in the December quarter 2022 (seasonally adjusted basis), down 20% year-on-year. Offshore exploration fell 31% year-on-year to \$78 million, while onshore exploration spending decreased by 14% to \$162 million (Figure 8.6). Onshore exploration tends to have a more consistent profile, with an

ongoing need for exploration to maintain existing coal-seam gas production.

Figure 8.6: Petroleum exploration expenditure



Source: Australian Bureau of Statistics (2023) Mineral and Petroleum Exploration, 8412.0.

Revisions to forecasts

Since the December 2022 *Resources and Energy Quarterly*, the forecast for Australia's crude and condensate export earnings has been revised down, by 13% (to \$13.4 billion) in 2022–23, and by 9% (to \$11.6 billion) in 2023–24. This reflects a lower oil price forecast, and changes in production driven by ongoing disruptions at Prelude.

Compared with the March 2022 *Resources and Energy Quarterly*, the forecast for crude and condensate export revenue in 2026–27 has been revised down by 4% (to \$11.5 billion). This reflects delays to the final investment decision for the Dorado project.

Table 8.1: Oil Outlook

World	Unit	2022	2023 ^f	2024 ^z	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR '
Production ^a	mb/d	100	102	103	104	105	105	105	0.9
Consumption ^a	mb/d	100	102	103	104	105	105	105	0.9
WTI crude oil price									
Nominal	US\$/bbl	95	85	82	76	74	73	72	-4.4
Real ^b	US\$/bbl	98	85	81	73	69	67	65	-6.6
Brent crude oil price									
Nominal	US\$/bbl	100	88	86	79	76	76	75	-4.7
Real ^b	US\$/bbl	103	88	84	76	72	70	68	-6.9
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^z	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR ^r
Crude and condensate									
Production ^{ac}	kb/d	336	309	297	298	299	319	329	-0.4
Export volume ^a	kb/d	290	274	259	262	263	286	299	0.5
 Nominal value 	A\$m	14,031	13,390	12,138	10,986	10,373	11,096	11,478	-3.3
 Real value^h 	A\$m	15,044	13,390	11,606	10,182	9,362	9,771	9,860	-6.8
Imports ^a	kb/d	180	189	190	188	186	185	183	0.3
LPG production ^{acd}	kb/d	107	88	86	86	85	84	82	-4.4
Refined products									
– Refinery production ^{ac}	kb/d	266	256	254	252	250	248	246	-1.3
 Export volume^{ae} 	kb/d	8	6	5	5	4	4	4	-12.7
 Import volume^a 	kb/d	743	838	847	853	854	854	852	2.3
- Consumption ^{acg}	kb/d	934	1,008	994	993	992	992	991	1.0

Notes: **a** The number of days in a year is assumed to be 365, and a barrel of oil equals 158.987 litres; **b** In 2023 calendar year US dollars; **c** Historical production data was revised in the December quarter 2021 to align with the Australian Petroleum Statistics **d** Primary products sold as LPG; **e** Excludes LPG; **f** Forecast; **g** Domestic sales of marketable products, including imports; **h** In 2022-23 financial year Australian dollars; **r** Compound annual growth rate (per cent), for the period from 2022 to 2028 or for the equivalent financial years. **s** estimate.

Source: ABS (2023) International Trade in Goods and Services, Australia, Cat. No. 5368.0; International Energy Agency (2023); EnergyQuest (2023); US Energy Information Administration (2023); Department of Industry, Science, Energy and Resources (2023).

Uranium





World consumption



Uranium facts



Originally formed in supernovae more than 6 billion years ago



Nuclear plants can supply electricity to 4-5 million people on only 2km² land





SOURCE: Live Science: World Nuclear Association: GA: OCE

9.1 Summary

- Uranium prices are forecast to lift, from US\$51 a pound in 2022 to above US\$60 a pound by 2028 (in real terms). This is expected to encourage stronger production from Kazakhstan, Australia, Canada and Namibia.
- Australian exports are forecast to increase, from 4,933 tonnes in 2021–22 to almost 8,000 tonnes by 2027–28 (see Australia section).
- Price and volume growth is expected to increase uranium export values, from \$605 million in 2021–22 to around \$1.2 billion (in real terms) by 2027–28.

9.2 World consumption

Prices have steadied around US\$50 a pound, with more gains expected

Global uranium markets have continued to tighten. Geopolitical factors, including the Russian invasion of Ukraine, have led to renewed concerns over potential disruptions to supply, and a consequent push towards greater supply security. Uranium prices held around US\$50 a pound through most of 2022, and have maintained this level so far in 2023.

Nuclear deployments continue to expand, with a temporary decline in reactor constructions in 2022 (Figure 9.1) expected to be reversed in 2023. Supply chains have adjusted successfully, as utilities reduce exposure to Russian sources following the invasion of Ukraine. Uranium consumption is expected to grow steadily, supported by higher demand in China and other parts of Asia, Eastern Europe, and the Middle East (Figure 9.2).

South Korea's new government, elected in 2022, has reversed the previous government's plans to phase out nuclear power. Instead, the new government has announced plans to expand nuclear generation's share from 27% to 30% by 2030, and to 35% by 2035. South Korea has advantages in nuclear deployment, given its expertise and relatively streamlined regulations. Further development of domestic nuclear energy could flow on to future export opportunities, with South Korea's construction of reactors in the United Arab Emirates serving as a good model.

Figure 9.1: Growth in world nuclear power generation





Source: International Energy Agency (2023); World Nuclear Association (2023); Department of Industry, Science and Resources (2023)

Japan appears to be accelerating its rate of reactor reconnections. Only ten of Japan's 54 reactors have been reconnected since 2011, but Japan's Government is prioritising a swift opening of 7 more, with at least 15 expected to be reconnected over the outlook period. The Government has announced Cabinet approval for more new reactors to be constructed, and for operational life on existing reactors to be extended an extra 20 years (to 60 years). Surging coal and gas prices have added momentum to reopenings and constructions, as Japan seeks to reduce its vulnerability to global commodity prices. Nuclear plants are less vulnerable to commodity price swings, since uranium makes up only a small proportion of running costs, and only small amounts of mined material are needed.

Nuclear plant builds continue in Eastern Europe, with unit 3 of Slovakia's Mochovce nuclear plant connecting to the grid at the end of January 2023. Unit 2 of Belarus's Ostrovets plant is scheduled to begin testing by April.

A French bill intended to support a more rapid expansion of new reactors has passed through the National Assembly (the country's lower house) and is now under review in the Senate. The bill follows an earlier announcement by President Macron for the construction of six new EPR2 reactors, with potentially more to follow.

In Canada, the Port Hope reactor in Ontario has had its operating licence renewed for another 20 years. In the US, the Vogtle 3 reactor has reached criticality and is expected to commence generation shortly.

In Belgium, the Doel 4 and Tihange 3 reactors have extended their operational time for another ten years, following an agreement between the Belgian Government and French utility Engie.

9.3 World production

Production is building, with short-term and long-term growth expected

With new reactor deployments growing, stronger investment in supply will likely be needed to avoid a supply deficit emerging towards the end of the outlook period. While uranium costs are only a small share of overall costs for nuclear power, the current price trajectory provides strong incentives to potential suppliers, and is likely encourage greater investment in uranium

Figure 9.2: World uranium consumption and inventories (U3O8)



Source: International Energy Agency (2023); World Nuclear Association (2023); Ux Consulting (2023)

Figure 9.3: Uranium price outlook



Source: Cameco Corporation (2023) Uranium Spot Price; Ux Consulting (2023) Uranium Market Outlook

production over time. In the short term, this will likely be met through higher output from traditional suppliers. New output is expected from Australia's re-opened Honeymoon mine (from 2024), while Canada's large McArthur River mine is expected to resume full operation in the same year. Kazakhstan has tactically reduced output, but could restore it again if prices continue to lift.

By the second half of the outlook period, output growth will depend on new projects. Many of these are likely to be in Africa. African energy ministers met at the 2022 International Atomic Energy Agency General Conference to discuss ways for Africa to expand its role in global uranium markets. Africa has high quality, shallow deposits, and rising prices will support their exploration and development.

9.4 Prices

Prices are expected to rise steadily, and potentially rapidly

Following years of weakness, uranium prices rose sharply in early 2022 and stabilised at around US\$50 a pound subsequently. This growth reflects changing market fundamentals, with supply constrained by years of low investment. Prices are expected to lift to above US\$60 a pound by 2028, (real terms) as demand growth outpaces supply. Risks remain largely to the upside, with the price outlook heavily influenced by the rate of development for new deposits (Figure 9.3).

9.5 Australia

Higher prices and volumes will boost export earnings

Australian output is currently limited to two mines, but more are in prospect. Boss Energy's Honeymoon mine, which is restarting from care and maintenance, is expected to produce around 1,100-1,200 tonnes of uranium per year for at least ten years, with first production expected in late 2023 or early 2024.

Conservation plans for the sandhill dunnart at Deep Yellow's Mulga Rock site have now received formal approval, bringing start-up for the proposed mine a step closer.

Both mines are expected to commence and to reach their full output during the outlook period. Extra production and higher prices are expected to eventually double Australia's uranium export values, with earnings reaching around \$1.2 billion (in real terms) by 2027–28 (Figure 9.4, Table 1).

Uranium exploration has risen steadily, following the lift in prices. Uranium miners spent \$12 million on exploration in the December quarter 2022. This compares to \$3 million spent in the December quarter 2021.

Figure 9.4: Australia's uranium exports



Source: Department of Industry, Science and Resources (2023)

Revisions to the outlook

Export earnings forecasts have been revised down by \$60 million in 2022–23 (compared with forecasts in the December edition). Forecasts for 2023–24 are largely unchanged from the December REQ. Forecasts for export earnings in 2026–27 have been revised up by \$300 million from those in the March quarter 2022 edition of the REQ.

The changes reflect an evolution in the price outlook, with less price pressure in the short-term, but a build-up of price pressures beyond 2025.

Table 9.1: Uranium outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Production	kt	58.8	63.8	69.7	70.8	73.9	75.6	77.0	4.6
Africa ^b	kt	9.6	9.6	10.1	10.1	11.3	10.9	11.6	3.2
Canada	kt	9.1	11.3	12.9	12.9	12.9	13.4	13.8	7.3
Kazakhstan	kt	25.4	26.9	29.8	29.7	30.8	31.6	31.2	3.5
Russia	kt	3.1	3.5	3.7	3.9	4.1	4.2	4.2	5.2
Consumption	kt	76.3	78.7	82.9	82.7	85.5	89.0	90.4	2.9
China	kt	11.3	13.6	13.3	14.4	17.2	22.6	20.9	10.8
European Union 28	kt	17.8	19.8	19.6	18.9	19.9	18.7	19.9	1.8
Japan	kt	1.6	1.9	2.9	2.9	2.9	2.9	2.9	10.2
Russia	kt	7.9	6.5	7.0	6.7	6.5	7.3	8.4	0.9
United States	kt	20.7	19.7	21.5	21.3	21.3	21.3	21.3	0.4
Spot price	US\$/lb	49.8	54.3	59.3	60.9	62.6	65.1	67.3	5.1
real ^c	US\$/lb	51.6	54.3	58.0	58.4	58.9	59.9	60.7	2.8
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Mine production	t	4,485	5,697	5,855	6,060	6,420	7,090	7,915	9.9
Export volume	t	4,933	5,697	5,855	6,060	6,420	7,090	7,915	8.2
- nominal value	A\$m	564	786	870	896	989	1,130	1,341	15.5
- real value ^d	A\$m	605	786	832	830	893	995	1,152	11.3
Average price	A\$/kg	114.4	137.9	148.7	147.8	154	159	169	6.8
- real ^d	A\$/kg	122.6	137.9	142.2	137.0	139	140	146	2.9

Notes: **b** Includes Niger, Namibia, South Africa, Malawi and Zambia; **c** In 2022 US dollars; **d** in 2022–23 Australian dollars; **s** estimate; **f** forecast; **z** projection; **r** Compound annual growth rate Source: Department of Industry, Science and Resources (2023); Cameco Corporation (2023); Ux Consulting (2023) Uranium Market Outlook

Gold





Jewellery consumer markets, 2022



Gold facts





The US holds the largest stockpile of gold reserves, at 8,133 tonnes



55% gold use was in jewellery fabrication, 23% in investment



Gold only makes up 3 parts per billion of the Earth's outer layer

SOURCE: World Gold Council; GA; OCE

Gold trade map





Resources and Energy Quarterly March 2023

10.1 Summary

- Gold prices averaged US\$1,801 an ounce in 2022, with a surge in price early in the year reversed by higher bond yields and the strong US dollar over the second half. Prices are forecast to decline in real terms, from around US\$1,800 an ounce in 2023 to US\$1,550 an ounce in 2028.
- Australian gold mine production rose 2.4% to 315 tonnes in 2022. Production is forecast to increase to a peak of 336 tonnes in 2024–25, as new projects and expansions of existing projects come online (see Australia section).
- Gold earnings are forecast to decline in real terms, from \$25 billion in 2021–22 to around \$20 billion in 2027–28, as rising export volumes are offset by the impact of lower gold prices in real terms.

10.2 World consumption

World gold consumption increased in 2022 to an 11-year high

World gold demand increased by 18% year-on-year to 4,740 tonnes in 2022, the highest level since 2011. This increase was driven by record central bank net purchases, which more than offset net outflows from gold-backed exchange-traded funds (ETFs).

Official sector buying (central banks and other government financial institutions) increased by 152% year-on-year to a record high of 1,136 tonnes in 2022 (Figure 10.1). Most of these purchases were undeclared, meaning country details are unavailable. According to World Gold Council data for declared purchases, emerging market central banks accounted for much of the buying. The largest net purchases were reported by Türkiye (148 tonnes) and China (62 tonnes). Egypt and the Middle Eastern countries including Qatar, Iraq, and the United Arab Emirates, collectively purchased 138 tonnes over the year.

ETF outflows over the year reached 110 tonnes (US\$3 billion) in 2022, as a strong start to the year (driven by rising geopolitical risk) was followed by eight months of consecutive outflows. Rising bond yields — following aggressive interest rate increases from most central banks for much of the

Figure 10.1: Net official sector purchases



year, particularly the US Federal Reserve — caused significant outflows from gold ETFs, and contributed to lower gold prices.

Consumer demand for gold (jewellery, gold coins and bars) was steady in 2022, helping to partially offset strong ETF outflows. Jewellery demand fell by 2.9% year-on-year to 2,086 tonnes in 2022, driven by weaker Chinese consumption and higher domestic prices for many nations.

Jewellery demand in China was down by 15% year-on-year at 571 tonnes in 2022, 16% below the 10-year average. Chinese demand was affected by COVID-related mobility restrictions throughout the year. Higher domestic gold prices, combined with COVID restrictions in the December quarter 2022, resulted in the weakest December quarter since 2009.

Jewellery consumption in India declined by 1.7% year-on-year to 600 tonnes in 2022. This decline was impressive given high domestic prices, with 2022 consumption still above the 10-year average.

Retail investment in gold bars and coins rose by 2.2% year-on-year in 2022, with investors buying 1,217 tonnes. Demand was helped by surging global inflation, with increased buying from Europe, Russia, Türkiye and the Middle East offsetting weaker demand from India and China.

Lower official sector demand to push gold consumption lower in 2023

After a very strong 2022, world gold consumption is forecast to decrease by 7.8% to about 4,400 tonnes in 2023. The decline will be driven largely by lower official sector buying — which will remain historically high (Figure 10.2).

Official sector buying in 2023 is forecast to remain elevated, at 750 tonnes — 48% higher than forecast in the December 2022 *Resources and Energy Quarterly*. Investment demand (gold-backed ETFs or bar and coin holdings) is expected to increase marginally in 2023, supported by ongoing geopolitical and economic uncertainty. Forecast declines in prices later in the year (due to higher real interest rates) are also expected to lead investment flows into ETFs.

Jewellery consumption in 2023 is forecast to be higher year-on-year, with demand in China and India expected to recover from low levels in 2022. China's reopening and expected economic rebound are forecast to support stronger Chinese consumer sentiment in 2023, following a year interspersed with major COVID-related disruptions to retail consumption activity.

Gold consumption to grow over the long-term

World gold consumption is projected to increase by an average of 1.1% a year after 2023, to reach 4,600 tonnes by 2028. Demand growth is projected to be largely driven by increasing jewellery consumption, with increasing investment demand and technological usage contributing to a lesser extent (Figure 10.2).

Jewellery consumption is projected to grow by an average of 3.5% a year from 2023 onwards, to reach almost 2,600 tonnes by 2028. Consumption will be supported by improvements in consumer sentiment and rising incomes. Lower gold prices and a weaker US dollar should see the strongest period of consumption come in 2024 and 2025 — particularly in the key markets of China and India.

Figure 10.2: World gold demand by sector



Notes: Jewellery fabrication includes jewellery consumption and the change in jewellery inventory. Investment includes ETFs, bars and coins. Technology includes gold used in the electronic, dentistry and other industrial sectors.

Source: World Gold Council (2023); Metals Focus (2023); Department of Industry, Science and Resources (2023)

Investment demand is projected to grow marginally over the forecast period, to reach about 1,200 tonnes by 2028. Institutional investment and retail demand are expected to pick up, as real interest rates decline over the medium term. Bar and coin demand are projected to remain strong, as lower forecast prices support buying activity near the elevated levels of 2022.

Official sector demand is projected to moderate to around 500 tonnes a year over the long-term, following relatively elevated demand levels in 2022 and 2023. Buying activity is expected to be strongly driven by emerging market central banks, which will continue to diversify their reserves with gold.

10.3 World production

World supply increased in 2022

World gold supply increased by 1.5% year-on-year to 4,755 tonnes in 2022, driven by a 1.2% rise in global mine production. Global mine production rose to a 4-year high of 3,612 tonnes in 2022, driven largely by increased production in China, further supported by increases in South America, West Africa and Australia.

Production in China — the world's largest gold producing country — rose by 13% year-on-year to 374 tonnes in 2022, as mining operations in Shandong province returned to normal. Shandong's provincial government halted operations in 2021, to enable safety inspections to take place.

In Australia — the second-largest gold producing country — output increased by 2.4% year-on-year in 2022, to 315 tonnes (see Australia section).

Production in Russia — the world's third-largest gold producer — declined by 8% year-on-year to 304 tonnes. This was due to a combination of lower grades at several major mines and lower production — due to rising costs, shortages of equipment and reduced financing (due to sanctions by many Western nations).

West African production increased strongly due to increases in Ghana (up by 7%), Guinea (up by 6%) and Mauritania (up by 138%) where resumed operations at Tasiast mine raised production year-on-year by 11 tonnes.

Gold recycling activity in 2022 was marginally higher year-on-year, as a strong first half of the year — driven by high prices — offset a weaker second half.

World supply to stabilise after peaking in 2024

Global gold supply is forecast to rise by 0.5% a year to 4,800 tonnes by 2024, driven by higher world gold mine production. World gold mine production is forecast to rise on average by 1.8% a year by 2024 to 3,750 tonnes, led by increases in Canada, Australia and South America.

Gold production increases will be particularly large in Canada, with the 11 tonnes per year Côté project and the 10 tonnes per year Blackwater project commencing operations in the next two years. However, continued environmental regulations and industry consolidation in China will see production fall over the medium-term.

Partially offsetting increases in mine production, gold recycling activity is forecast to decline on average by 3.9% a year by 2024 due to lower forecast gold prices.

From 2025, world gold supply is projected to be relatively steady at just below 4,800 tonnes (Figure 10.3). Global mine production is projected to ease from a 2025 peak above 3,750 tonnes to just above 3,700 tonnes by 2028. Consecutive years with prices forecast below US\$1,700 an ounce are expected to cause some higher-cost producers to cease production or expansion plans. Rising gold prices after 2025 are projected to drive increased recycling activity, offsetting the gradual decline in mine production.



Figure 10.3: World gold supply

Note: Net producer hedging is not included.

Source: Department of Industry, Science and Resources (2023); Metals Focus (2023); World Gold Council (2023).

10.4 Prices

Gold prices tracked flat on average in 2022

The London Bullion Market Association (LBMA) gold price averaged US\$1,801 an ounce in 2022, up from US\$1,800 an ounce in 2021.

Gold prices rallied strongly early in the year, due to rising inflation in advanced economies and strong safe-haven demand (following the Russian invasion of Ukraine). As a result, prices averaged US\$1,873 an ounce over the first half of 2022.

The second half of 2022 was then dominated by central banks responding to higher-than-expected inflation with an aggressive tightening of monetary policy — ceasing bond-buying programs and hiking official interest rates.

Government bond yields climbed strongly, on expectations of future interest rate increases. Rising bond yields tend to undermine gold's appeal to institutional and retail investors as a secure asset to hedge against inflation or other risks. This is because increases in the yield of a US (or other credible government) Treasury bond raise the so-called market "riskfree rate" and increase the opportunity cost of holding gold.

The US inflation-indexed ("real") Treasury bond yield, which has historically held an inverse correlation with gold prices, reached its highest level since 2009 (Figure 10.4). This relationship has weakened sharply since the beginning of the Russian invasion of Ukraine — due to prices being lifted by heightened safe-haven demand for gold — and led to the US dollar becoming the dominant driver of gold prices (Figure 10.5).

Sharp interest rate increases in the United States relative to other major currency hubs (such as Europe, Japan and the United Kingdom) resulted in strong demand for the US dollar. As a result, the US dollar rallied consistently throughout much of the year, reaching a 40-year high (in real, trade-weighted terms) in September and October 2022.

The combination of high real bond yields and a persistently strong US dollar put downward pressure on USD gold prices, averaging US\$1,729 an ounce over the second half of 2022.





Figure 10.5: Gold price and the US dollar since March 2022

Gold prices to fall in 2023 and 2024

Real gold prices are forecast to fall by 6.1% a year over 2023 and 2024, due to pressure from high real interest rates (as global inflation eases).

Gold prices increased in late 2022 and early 2023 to an initial peak of around US\$1,930 an ounce, as both the US dollar and real bond yields declined. This was driven by market expectations that the US Federal Reserve would cut interest rates from mid-2023, to support a weakening US economy. Prices briefly came under pressure in February as rate expectations increased following higher-than-expected inflation data, however this reversed in March as US inflation fell to 6.0% — its lowest since September 2021.

Most recently gold prices have rallied through the end of the March quarter 2023 to nearly US\$2,000 an ounce. Prices have been supported by strong safe-haven buying following problems with several tier 2 US banks. This has also coincided with lower market expectations for US interest rates and a weakening of the US dollar, also supporting gold prices.

The risks to this short-term price outlook are evenly balanced. The extent to which any future financial stability concerns emerge presents an upside risk to forecast gold prices. Persistent global inflation could result in a higher-than-expected rise in official interest rates, leading to a steeper than forecast decline in gold prices — as the opportunity cost of holding gold increases. Should global inflation decline more quickly than expected (due to slowing economic activity), interest rates may begin to ease sooner than anticipated, leading to higher gold prices (particularly if the US dollar weakens more than forecast).

Gold prices to decline over the long-term

From 2025 onwards, gold prices are projected to decline in real terms by around 1.4% a year, to reach an average of US\$1,555 an ounce in 2028. Prices falls expected to be partially offset by growth in institutional investment — as real interest rates decline — and easing supply growth.

An assumed appreciation in the Australian dollar against the US dollar over the forecast period is projected to drive the Australian dollar gold price lower in real terms, from around A\$2,700 an ounce in 2022 to around A\$2,100 an ounce in 2028 (Figure 10.6).

There are notable risks to the gold price assessment over the longer term. The continued fallout from Russia's invasion of Ukraine has supported safe-haven buying over the past year, however it is uncertain how long this buying will continue. An escalation in the conflict is likely to have a pronounced impact on safe-haven demand for gold, lifting prices. On the other hand, a significant de-escalation would see geopolitical worries ease, and likely lead to a reduction in gold prices.

Further to this, the duration and volume of further official sector gold buying remains uncertain, given the lack of information regarding which country(s) is purchasing most of this gold. If the recent episode of goldbuying represents a structural shift in official sector purchasing — for example, if emerging market central banks are seeking permanently higher shares of gold in their reserves — this will drive demand, and therefore prices, higher than forecast.



Figure 10.6: US and Australian dollar gold prices

Source: Department of Industry, Science and Resources (2023); LBMA (2023) Gold price PM

10.5 Australia's trade, production and exploration

Australian gold exports rose despite lower volumes in 2022

Australia's gold exports increased marginally year-on-year to \$23.5 billion in 2022. The increase was driven by higher Australian dollar gold prices, which offset a 7.8% decline in export volumes. Export volumes fell despite an increase in mine production — a trend that has persisted since June quarter 2021. December quarter 2022 exports of 45 tonnes were the lowest quarterly export volume since December quarter 1989. Weakness has been driven by declines in exports from Western Australia (which has accounted for 96% of Australian exports on average over the past 10 years), and to a lesser extent New South Wales.

Australia exported \$7.2 billion of gold to China in 2022, up 3.6% from 2021. Gold exports to India were 36% lower at \$1.5 billion. Australian exports to the financial hubs (US, UK, Switzerland, Hong Kong and Singapore) were collectively worth \$11.6 billion in 2022 — a 15% increase year-on-year. Notably, within the financial hubs, exports to Hong Kong rose by 68% to \$5.0 billion in 2022.

Australian gold exports to decline over the long-term

Australian gold export earnings are forecast to increase by 9.5% to \$25.4 billion in 2022–23, as export volumes recover from low levels due to increased mine production.

Australian gold export earnings are then forecast to decline in real terms from 2023–24 onwards, as higher export volumes are offset by lower real prices (Figure 10.7). Export volumes are projected to peak in 2024–25 and decline over the medium-term, in line with the forecast peak in Australian mine production during the outlook period.

Australian gold mine production increased in 2022

Australia's gold industry produced 315 tonnes of mined gold in 2022, up by 2.4% year-on-year. Production in the first half of the year was adversely affected by labour shortages, operational/logistical issues (such as delays to road haulage) related to COVID-19 outbreaks. Miners cited fewer

Figure 10.7: Australian gold exports



Sources: ABS (2023); Department of Industry, Science and Resources (2023).

impacts from these disruptions over the second half of the year, however, cost pressures on operations and expansions became increasingly reported later in the year.

Calidus' 2.8 tonnes per year Warrawoona Project achieved first gold in May 2022, reached nameplate capacity and declared commercial production in December 2022.

Red 5's 5.5 tonnes per year King of the Hills gold project in WA achieved first gold in June 2022, and declared commercial production in December 2022. King of the Hills has become the company's main processing hub, taking in ore from its Darlot project.

Production at Newcrest's Cadia mine in NSW increased by 8.2% year-onyear to 20 tonnes in 2022. This year-on-year increase was largely a result of planned maintenance (to replace the plant's SAG mill motor) from July 2021 to November 2021.

AngloGold Ashanti produced 7.2 tonnes of gold from its Sunrise Dam operation in 2022, a slight increase year-on-year (due to higher recovered

grades). Meanwhile, production from its Tropicana Joint Venture with Regis Resources was around 14 tonnes, up 15% on 2021. AngloGold Ashanti attributed the increases at Tropicana to improvements in both processing tonnage and grade.

Production at BHP's Olympic Dam declined by 2.5% to 4.5 tonnes in 2022. The impact of a weaker first half of the year was unable to be offset by record H2 2022 production, achieved after completing debottlenecking initiatives during the year.

Australian gold mine production to peak in 2024–25

Australian gold production is forecast to rise to a peak of 334 tonnes in 2024–25, as significant new projects and existing mine expansions come online. Production will continue to ramp up for recently commenced projects such as the King of the Hills project, the Norseman project, and the Warrawoona Gold Project.

Bellevue Gold's 5.7 tonnes per year Bellevue gold mine in WA is expected to come online in the second half of 2023. Newcrest and Greatland Gold's 5.0 tonnes per year Havieron project is expected to come online in 2024, with an updated feasibility study forthcoming.

Northern Star Resources' Super Pit gold operation will begin long-term expansion in 2024, growing to 675,000 ounces by 2027–28.

Australian gold production is projected to stabilise at around 325 tonnes from 2026–27, as several projects reach end of life. Weaker gold prices from 2024 to 2026 will pressure margins for higher cost producers and new projects.

Weaker than expected gold prices present a downside risk to the forecasts of Australian gold production (see Prices section). Much weaker prices would see more high-cost Australian producers cease or cut back their operations. On the other hand, should Australian dollar gold prices perform better than forecast, cost pressures facing producers may be less of a constraint, enabling higher production than forecast.

Gold exploration expenditure fell in 2022

Australia's gold exploration expenditure decreased by 5% year-on-year to \$1.5 billion in 2022 (Figure 10.8). As a result, gold's share of Australian mineral exploration expenditure declined to 38% in 2022, down from 44% a year earlier. Western Australia remained the centre of gold exploration activity in Australia, accounting for 72% of total gold exploration expenditure. This year-on-year decline in total gold exploration expenditure was largely driven by declines in Victoria (down by 18%) and New South Wales (down by 16%).



Figure 10.8: Australian gold exploration expenditure

Source: ABS (2023)

Revisions to the outlook

Forecast US dollar gold prices have been revised up across the board, due to persistent strength in prices and upward revisions to gold demand across the forecast profile. By extension, Australian dollar gold prices have been revised up across the profile.

Australia's forecast gold export earnings have been revised down by 4.7% for 2022–23 compared with the December 2022 *Resources and Energy Quarterly*. This mostly reflects the weak result for exports in December quarter 2022, as Australian dollar gold prices have been revised up.

Compared with the March 2022 *Resources and Energy Quarterly*, forecast Australian earnings are lower (in nominal terms) from 2023–24 onwards, due primarily to lower forecast export volumes. Earnings are projected to be 6.2% lower in 2026–27 at around \$24 billion.
Table 10.1: Gold outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^f	2026 ^z	2027 ^z	2028 ^z	CAGR
Total demand	tonnes	4,741	4,373	4,408	4,548	4,531	4,576	4,622	-0.4
Fabrication consumption ^b	tonnes	2,498	2,497	2,706	2,835	2,856	2,889	2,924	2.7
Mine production	tonnes	3,612	3,684	3,747	3,754	3,747	3,739	3,732	0.5
Price °									
- nominal	US\$/oz	1,801	1,804	1,680	1,662	1,682	1,703	1,723	-0.7
- real ^d	US\$/oz	1,864	1,804	1,643	1,594	1,581	1,568	1,555	-3.0
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^f	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Mine production	tonnes	308	320	326	336	334	327	325	0.9
Exports									
– volume	tonnes	248	268	325	334	333	325	323	4.6
- nominal value	A\$m	23,200	25,397	24,480	23,739	23,820	23,576	23,754	0.4
- real value ^e	A\$m	24,874	25,397	23,409	22,002	21,499	20,760	20,407	-3.2
Price									
– nominal	A\$/oz	2,529	2,633	2,345	2,212	2,230	2,257	2,284	-1.7

Notes: **b** includes jewellery consumption and industrial applications; **c** London Bullion Market Association PM price; **d** In 2023 US dollars; **e** In 2022–23 Australian dollars; **s** Estimate; **f** Forecast. **r** Compound annual growth rate for the period from 2022 to 2028, or from 2021–22 to 2027–28; **z** Projection; Gold export volume contains ash, waste and scrap gold, of which the metal content is unknown.

Source: ABS (2023) International Trade, 5464.0; London Bullion Market Association (2023) gold price PM; World Gold Council (2023); S&P Market Intelligence (2023); Department of Industry, Science and Resources (2023).

Aluminium



Primary aluminium top consumer markets, 2022



Aluminium facts





2-3 tonnes of bauxite is required to produce one tonne of alumina







SOURCE: BNEF; International Aluminium Institute; WBMS; ABS; OCE

Aluminium TRADE MAP



11.1 Summary

- Slower world growth is likely to push primary aluminium prices lower in 2023, to an average of US\$2,462 a tonne. However, with low aluminium inventories and growing demand for new energy-efficient cars and technologies, aluminium prices are projected to reach US\$2,505 a tonne by 2025, before falling to US\$2,230 a tonne in 2028 (in real terms).
- Australia's primary aluminium output is projected to reach 1.6 million tonnes a year from 2023–24 and beyond. Over the outlook period to 2028, Australia's alumina output is projected to remain at about 21 million tonnes a year. The expansion of the Bauxite Hills mine, and the commissioning of Aurukun bauxite project in Queensland, are expected to boost Australian bauxite output to 119 million tonnes a year by 2027–28 (see Australia section).
- The ramp up of high purity alumina (HPA) output is expected to add \$1 billion a year to Australia's aluminium, alumina and bauxite (AAB) exports from 2024–25. Australian AAB exports are projected to reach \$16 billion (in real terms) by 2027–28.

11.2 World consumption

China led higher alumina and bauxite consumption in 2022

World aluminium consumption in 2022 was almost unchanged from 2021 at 68 million tonnes (Figure 11.1). Over this period, consumption in China, the world's largest primary aluminium consuming country, rose by 2.3% year-on-year. A rise in the use of aluminium in China's automotive sector (helped by the Chinese government's stimulus package) contributed to a jump in Chinese aluminium demand in 2022.

Over this period, primary aluminium consumption also grew in the United States (up 6.2% year-on-year), India (up 22% year-on-year), and South Korea (up 1.5% year-on-year). The growth in primary aluminium consumption partly reflects increased aluminium use in new, energy-efficient car models. However, European consumption was hit by the impact of the Russian invasion of Ukraine, including rising energy and vehicle fuel costs in 2022. Vehicle sales in Europe fell by 9.9% year-on-

year (to 12.5 million units), reducing aluminium demand. Over this period, demand for aluminium in Spain and France fell by 40% and 5.9% year-on-year to 483,000 and 620,000 tonnes, respectively.

Figure 11.1: World primary aluminium consumption



Notes: ROW: Rest of the world

Source: World Bureau of Metals Statistics (2023); Wood Mackenzie (2023); Macquarie Bank (2023); Department of Industry, Science and Resources (2023)

World secondary/recycled aluminium consumption rose by 4.9% year-onyear in 2022 to nearly 25 million tonnes (Figure 11.2), propelled by higher primary aluminium prices.

Automotive makers in Asia, Europe and the US sourced secondary rather than primary — aluminium in order to cut costs. In Asia, secondary aluminium consumption in Japan and South Korea increased by 3.8% and 6.3% year-on-year in 2022, respectively, while in the US, secondary aluminium consumption increased by 5.4% year-on-year. Amongst major European purchasers, demand for secondary aluminium in Germany and Italy rose by 11% and 14% year-on-year in 2022, respectively.



Figure 11.2: World secondary aluminium consumption

Notes: ROW: Rest of the world

Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023)



Figure 11.3: World alumina consumption

Notes: ROW: Rest of the world Source: Department of Industry, Science, Energy and Resources (2023) World alumina usage increased by 2.3% year-on-year to 134 million tonnes in 2022, driven by higher global aluminium production (Figure 11.3). China remained the world's largest alumina consumer, accounting for 59% of global alumina consumption, and contributed most to this increase (up 4.4% year-on-year). Outside of China, alumina consumption in India and the UAE rose by 4.8% and 12% year-on-year in 2022, respectively.

World bauxite usage rose by 7.4% year-on-year in 2022 to 385 million tonnes, propelled by increased global alumina production (Figure 11.5). China remained the world's largest bauxite consuming country, accounting for 55% of global bauxite consumption.

Aluminium, alumina and bauxite demand to rise over the medium term

Demand for primary aluminium in 2023 is expected to be primarily driven by China, as the reopening of China's economy lifts demand for primary aluminium. As a result, global primary aluminium consumption is forecast to increase by 2.2% in 2023, to nearly 70 million tonnes (Figure 11.1).

Beyond 2023, world primary aluminium consumption is projected to grow at an annual average rate of 2.1% to nearly 78 million tonnes by 2028 (Figure 11.1).

A significant driver of aluminium demand is expected to come from world automakers, seeking to reduce vehicle weight by increasing the use of aluminium — which is 10-40% lighter than steel. Electric vehicle makers are particularly focused on reducing vehicle weight, since it impacts heavily on the recharging range.

It is estimated that EV sales will rise from 10.7 million units in 2022 to 30 million units in 2028. With an estimated average aluminium content of 250 kilograms per electric vehicle, aluminium usage in EVs is projected to increase from 2.7 million tonnes in 2022 to about 7.6 million tonnes in 2028 (Figure 11.4).

World secondary aluminium demand is forecast to increase by 6.3% yearon-year in 2023 to 26 million tonnes. After 2023, world demand is projected to increase at 4.9% a year over the outlook period (Figure 11.2). Rising primary aluminium prices and the use of low carbon aluminium are expected to be the drivers of higher secondary aluminium consumption.

In February 2023, Japanese packaging manufacturer Toyo Seikan Group Holdings Limited and a compatriot integrated aluminium manufacturer entered into a business alliance aimed at promoting the recycling of aluminium beverage cans.

In line with world primary aluminium production, world alumina usage is forecast to grow by 3.2% year-on-year in 2023 to 138 million tonnes. After 2023, world alumina demand is projected to rise at an average annual rate of 2.5% over the outlook period (Figure 11.3). Alumina demand is driven by primary aluminium production, which is projected to lift by an average 1.8% a year between 2024 and 2028.

World bauxite usage is forecast to increase by 2.3% in 2023 to 394 million tonnes. After 2023, world bauxite demand is projected to rise at an average annual rate of 2.4% over the outlook period (Figure 11.5). Bauxite demand is driven by alumina production, which is projected to lift by an average 2.5% a year between 2024 and 2028.

11.3 World production

Aluminium, alumina and bauxite output grew in 2022

In 2022, world primary aluminium output increased by 1.8% year-on-year. This was propelled by higher output from China — the world's largest primary aluminium producer — which rose by 4.0% (Figure 11.6). China's primary aluminium producers raised output in response to the removal of power restrictions and improved power supply in the second half of 2022.

Amongst other major producers, primary aluminium output in the United Arab Emirates (UAE) increased by 9.6% year-on-year in 2022, driven by the commission of new reduction cells at Emirates Global Aluminium's Al-Taweelah aluminium smelter. Production also rose in Iran — by 25% year-on-year — driven by the ramp up of production at the 1.0 million tonnes per year SALCO aluminium smelter.



Figure 11.4: Global EV sales and aluminium demand

Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023)

Figure 11.5: World bauxite consumption



Notes: ROW: Rest of the world

Source: Department of Industry, Science and Resources (2023)

Notes: EV sales include all types of EV

In Europe, primary aluminium production fell significantly in 2022 including France (down by 22% year-on-year), Germany (down by 33%) and Romania (down by 34%). The fallout from Russia's invasion of Ukraine — including a spike in energy prices — was the main contributor to the fall in production.

World secondary aluminium production increased by 1.9% year-on-year in 2022 to nearly 34 million tonnes, propelled by higher output from China and the US (Figure 11.7). Over this period, China's secondary aluminium production rose by 4.7% year-on-year, while the US secondary aluminium production rose by 4.9% year-on-year.

World alumina supply rose by 7.4% year-on-year to 152 million tonnes in 2022, driven by higher output in China (Figure 11.8). Production in China rose by 5.9% year-on-year, as Chinese refiners raised output to accommodate higher aluminium production. Outside of China, Indonesia's alumina output rose by 71% year-on-year in 2022, propelled by production ramp-up at the 300,000 tonnes a year Tayan alumina refinery. Alumina production in Australia — the world's second largest alumina producer — fell by 5.4% in 2022, due to lower production at Rio Tinto's Yarwun refinery.

World bauxite production increased by 7.6% in 2022 to 396 million tonnes, propelled by higher output in Guinea — the world's second largest bauxite producer (Figure 11.9). Over this period, bauxite production in Guinea increased by 13% year-on-year to 99 million tonnes, as the ramp up of production capacity continued. Output in Australia — the world's largest bauxite producing country — decreased by 0.9% year-on-year to 102 million tonnes in 2022 (see Section 11.4 Australia's exports and production).

Aluminium, alumina and bauxite output set to rise over the outlook period

World primary aluminium output is forecast to grow by 3.7% year-on-year to nearly 71 million tonnes in 2023 (Figure 11.6). The gain is expected to be driven by production ramp-up in China and India, as well as the restart of idled capacity in Europe.





Notes: ROW: Rest of the world

Source: World Bureau of Metals Statistics (2022); Macquarie (2022); Department of Industry, Science, Energy and Resources (2022)

Figure 11.7: World secondary aluminium production



Notes: ROW: Rest of the world

Source: International Aluminium Institute (2023); World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)



Figure 11.8: World alumina production

Notes: ROW: Rest of the world

Source: World Bureau of Metals Statistics (2023); CRU (2023); Department of Industry, Science and Resources (2023)

Figure 11.9: World bauxite production



Notes: ROW: Rest of the world

Source: World Bureau of Metals Statistics (2023); Department of Industry, Science and Resources (2023)

China's primary aluminium output is forecast to reach 42 million tonnes by 2023, up 4.0% year-on-year. Outside of China, primary aluminium production in India is forecast to increase by 5.0% year-on-year to reach 4.3 million tonnes in 2023. Aluminium Dunkerque, which operates the Dunkerque aluminium smelter in France, has started bringing back production capacity that was idled in 2022 due to high energy costs.

After 2023, world primary aluminium production is projected to rise by 1.8% a year over the outlook period, reaching 77 million tonnes by 2028 (Figure 11.6). The gains will be driven by China, as more output is produced from greenfield aluminium smelters. China's primary aluminium production is projected to reach nearly 45 million tonnes by 2028. This is edging closer to the capacity cap of 45 million tonnes per year, a policy introduced by the Chinese Government in 2017, in response to environmental and oversupply concerns. As China edges closer to its primary aluminium capacity cap, other primary aluminium producing nations — such as India, Canada, Brazil and the UAE — will get the chance to fill any market gaps that develop.

Outside of China, the Alba Aluminium smelter in Bahrain completed a prefeasibility study for its Line 7 expansion project in the September quarter 2022. It is highly likely that the proposed Line 7 project will commence in 2023. Once completed, it will increase the smelter's output from 1.56 million tonnes in 2021 to 1.68 million tonnes in 2024.

World secondary aluminium output is forecast to increase by 4.6% yearon-year in 2023 to 35 million tonnes, driven by higher output from China (up by 10% year-on-year) and the US (up by 9.4% year-on-year). After 2023, world secondary aluminium is projected to rise at 4.7% a year, reaching 45 million tonnes by 2028 (Figure 11.7).

According to a report — *Making Net-Zero Aluminium Possible: An Industry Backed 1.5*°C *Aligned Transition Strategy* — released in September 2022 by Mission Possible Partnership, carbon emissions from secondary aluminium is about 97% lower than emissions from the production of primary aluminium from bauxite.

World alumina output is forecast to grow by 3.2% year-on-year to 157 million tonnes in 2023, driven by rising output from new/existing refineries in China, Australia, Brazil and India (Figure 11.8). Australian output is forecast to rise by 5.9% year-on-year to nearly 21 million tonnes in 2023, driven by improved operating performance by alumina refineries.

After 2023, world alumina output is projected to rise by 2.5% a year over the outlook period, reaching 178 million tonnes by 2028 (Figure 11.8). The gains are forecast to be driven by China, Australia, India, and Indonesia. This will include China Aluminium Company and the Indonesian jointventure partners' 2 million tonnes a year Mempawah alumina refinery in Indonesia is expected to come online in 2024. In August 2022, the eastern Indian state of Odisha approved Adani's 4 million tonnes a year alumina refinery project. The cost of the project is estimated to be US\$5.2 billion. Start and completion dates for the project are still unknown.

World bauxite output is forecast to grow by 2.4% year-on-year to 405 million tonnes in 2023 (Figure 11.9). The gains are expected to be driven by the ramp up of new capacity in Guinea, where output is forecast to increase by 5.9% year-on-year in 2023 to 105 million tonnes. Indonesian production is forecast to fall by 33% in 2023, as the bauxite export ban — scheduled to start in June 2023 — will have an impact on the country's bauxite production. Production at the Tayan bauxite operation and the Ketapang bauxite operation are forecast to fall by 79% and 33% year-on-year in 2023 to 0.7 and 7.2 million tonnes, respectively.

After 2023, world bauxite production is projected to increase by 2.5% a year, reaching 458 million tonnes by 2028 (Figure 11.9). Australia and Guinea are expected to contribute most to this rise. In Guinea, Alliance Mining Commodities launched the 1.5 billion tonnes (estimated reserve) Koumbia bauxite project in mid-February 2023. A recent feasibility study found that the project is commercially viable, and will require a capital investment of over US\$1 billion. Work on construction of a 1 million tonne a year bauxite mine in the southern Lao province of Sekong began on 19 December 2022. The mine is expected to operate for 50 years. A start date is not available at the time of writing.

Green aluminium, alumina and bauxite

'Low carbon' aluminium is expected to become more popular over the outlook period. Producers across the globe are also expected to increase their use of renewable energy. Countries with an abundance of cheap, reliable renewable energy will be the most desirable investment destinations for aluminium producers.

In the Middle East, Europe and Asia, investing in solar and wind farms has intensified over the last few years. In Australia, Rio Tinto, Alcoa and South32 are working to replace fossil fuels with renewable sources at their alumina operations.

Alcoa's Wagerup alumina refinery in Western Australia (WA) is the first in Australia to trial a steam recycling technology aimed at reducing emissions. In November 2022, the trial found the technology was feasible, and in February this year, the company announced the project has progressed to the next stage with the installation of a 4 megawatt MVR module at Wagerup.

Under a collaboration agreement with Marubeni Corporation from Japan, Rio Tinto supplies low carbon aluminium to Marubeni to meet growing consumer demand. The first batch is high purity aluminium produced from the renewable-powered smelter operation in New Zealand.

In China, the government vowed to include carbon emissions from aluminium smelting into the national emissions trading scheme (ETS). Linking carbon emissions to publicly traded carbon prices is a way to encourage low carbon aluminium.

In Europe, aluminium producers are expected to increase the use of renewable sources to produce low carbon aluminium. In 2023, Norsk Hydro in Norway will start supplying Mercedes-Benz Group with low carbon aluminium — defined as having a carbon footprint below 3.0 kilograms CO2 per kilogram of aluminium. Mercedes-Benz will use the Hydro REDUXA 3.0 aluminium product in its EQS platform of electric vehicles and in other models.

The share of secondary aluminium output in the total global aluminum output is forecast to rise from 33% in 2022 to 37% in 2028. Over the same period, the share of primary aluminium output in total global aluminium output is to fall from 67% in 2022 to 63% in 2028 (Figure 11.10).



Figure 11.10: Share of global primary aluminium and secondary aluminium output

Source: International Aluminium Institute (2023); World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)

11.4 World trade

Weak aluminium and alumina exports in 2022

World primary aluminium exports fell by 7.7% year-on-year in 2022 to 14 million tonnes, largely due to lower exports from Russia (Figure 11.11). The fallout from the Russian invasion of Ukraine reduced Russian primary aluminium exports by 37% year-on-year in 2022. Despite no direct sanctions on Russian aluminium by the US and other western nations, Russia's share of world primary aluminium exports fell from 14% in 2021 to 9.5% in 2022.

Offsetting the fall in aluminium exports from Russia was higher primary aluminium exports from China, with the country's primary aluminium exports increasing 20-fold in 2022. Of this, 30% was exported to the Netherlands, 17% to Turkiye and 15% to South Korea.

World secondary aluminium exports fell by 8.4% year-on-year to 2.0 million tonnes in 2022, driven by lower exports from Europe (Figure 11.11). Rising energy costs in Europe stunted primary aluminium output, forcing European aluminium users to turn to secondary aluminium as a substitute. Exports from Italy and Poland fell by 9.0% and 8.1% year-on-year in 2022, respectively.

World alumina exports declined by 6.9% year-on-year to nearly 41 million tonnes in 2022 (Figure 11.11). Over this period, exports from Australia — the world's largest alumina exporter — declined by 6.5% year-on-year. This followed a 5.4% fall in Australian alumina production over the same period (see Australia's exports and production). Offsetting the decline in Australia's alumina exports from Australia was an increase in exports from China, rising 206% year-on-year in 2022.

World bauxite exports increased by 0.3% year-on-year to nearly 154 million tonnes in 2022. This was propelled by a 3.9% year-on-year rise in Guinea — the world's largest bauxite exporter (Figure 11.11). Over the same period, bauxite exports from Australia — the world's second largest bauxite exporter — increased by 1.6% year-on-year, while exports from Brazil and Indonesia decreased by 17% and 10%, respectively.

In January 2023, the Indonesian Government confirmed that it will ban bauxite exports from 1 June 2023. The decision is reported to be part of the government's efforts to support domestic supply chains and increase the country's alumina production. The decision is likely to benefit Australian bauxite exporters, with tighter global supply expected to push up bauxite prices. However, the Indonesian's determination to raise its alumina refining capacity is likely to impact Australia's status as the world's largest alumina exporter.



Figure 11.11: World aluminium, alumina and bauxite exports

Source: World Bureau of Metal Statistics (2023); UN Comtrade (2023); Department of Industry, Science and Resources (2023)

Lower output led to higher aluminium imports in Europe and the US

World primary aluminium imports rose by 1.1% year-on-year in 2022 to 21 million tonnes, driven by higher imports from Europe and the US (Figure 11.12).

In Europe, primary aluminium output declined in 2022, due to energy shortages and higher power costs, with many nations turning to imports to meet primary aluminium demand. This saw German and Netherlands imports rise 12% and 21%, respectively.

In the US, primary aluminium imports rose by 6.1% year-on-year, primarily due to lower primary aluminium production.

World secondary aluminium imports fell by 2.4% year-on-year in 2022 to 3.2 million tonnes, due to lower imports from the Netherlands and Poland (Figure 11.12). In the Netherlands, secondary aluminium imports in 2022 fell by 16% year-on-year to 395,000 tonnes. Over this period, secondary aluminium imports from Poland decreased by 3.2% year-on-year to 361,000 tonnes.



Figure 11.12: World aluminium, alumina and bauxite imports

Source: World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)

World alumina imports fell by 16% year-on-year in 2022 to 33 million tonnes, due to a 39% year-on-year fall in alumina imports from China (Figure 11.12). Imports fell due to higher Chinese alumina production.

World bauxite imports rose by 8.8% year-on-year in 2022 to 152 million tonnes, driven by higher imports from China — the world's largest bauxite importer (Figure 11.12). China imported nearly 126 million tonnes of bauxite in 2022, a 17% year-on-year rise from 2021.

Over this period, Guinea was the largest supplier of bauxite to China accounting for 56% of China's total bauxite imports, followed by Australia (accounting for 27%), and Indonesia (accounting for 15%).

The US Government has imposed 200% tariffs on aluminium imports from Russia from 10 March 2023. As Russia accounts around 2% of US primary aluminium imports, the impacts from increased tariffs on Russian aluminium are expected to be limited. US primary aluminium importers would easily source their supply from countries such as Canada and Australia.

11.5 Prices

Aluminium prices rose slightly in 2022

Aluminium prices were highly volatile in 2022, driven by the Russia-Ukraine war, China's zero-COVID policy, as well as growing recessionary fears in the second half of the year. The London Metal Exchange (LME) aluminium spot price averaged US\$2,708 a tonne in 2022 (Figure 11.13), reaching a 34-year high of US\$3,985 a tonne on 7 March 2022, as the market reacted to the Russian invasion of Ukraine. However, rising concerns over COVID lockdowns in China, and the impact of rising interest rates, then saw prices fall sharply over the rest of 2022.

Supply cuts (due to rising input costs) led to a fall in primary aluminium stocks in 2022. LME stocks fell by 52% year-on-year to 450,300 tonnes. Shanghai Future Exchange stocks fell by 70% to 95,881 tonnes. LME off-warrant stocks fell by 30% year-on-year to 239,386 tonnes (Figure 11.14).

The free on board (FOB) Australian alumina price grew by 2.9% year-onyear to US\$377 a tonne in 2022 (Figure 11.3). The growth was driven by higher alumina demand, as world aluminium output rose by 1.7% in 2022.

China's reopening lifts aluminium price forecasts in 2023

In China, the removal of COVID-19 containment measures and the relaxation of regulations on lending in November 2022 are expected to provide some support for global primary aluminium demand and prices in 2023. China is the world's largest aluminium consuming country, accounting for almost 60% of global primary aluminium demand.

In 2023, the LME aluminium spot price is forecast to fall by 9.1% year-onyear to average US\$2,462 a tonne (in real terms) (Figure 11.13). Slowing world growth is expected to be a significant driver of lower aluminium prices. The free on board (FOB) Australian alumina price is forecast to decrease by 1.1% in 2023 to average US\$360 a tonne (Figure 11.13).

A risk to the 2023 price assessment is the ongoing tightening of monetary policy by major central banks. The higher interest rates go, the softer will be the global economy.





Source: LME (2023); Department of Industry, Science and Resources (2023)

Figure 11.14: Exchange aluminium stocks



Source: London Metal Exchange (2023); Bloomberg (2023)

The price and the availability of energy will continue to have a heavy influence on aluminium/alumina prices. There will be more turbulence in aluminium prices if coal prices remain high and/or hydropower shortages in China return. Gas shortages in Australia and concerns around energy security in Europe could also impact on production and prices.

Higher aluminium and alumina prices in the short term

After 2023, the LME aluminium price is projected to rise to average US\$2,505 a tonne in real terms in 2025, before falling to average US\$2,229 a tonne in real terms in 2028 (Figure 11.13). Growing demand for new, energy-efficient cars and technologies will boost aluminium usage. This is projected to see the FOB Australian alumina price increase to US\$369 a tonne in real terms in 2025, before falling to average US\$326 a tonne in real terms in 2028 (Figure 11.13).

11.6 Australia's exports and production

Higher aluminium prices drove aluminium and alumina exports in 2022

A 9.3% year-on-year rise in the LME aluminium price in 2022 and stronger demand for primary aluminium boosted Australian primary aluminium export values by 13% year-on-year to \$5.9 billion in real terms in 2021. Australia's aluminium, alumina and bauxite (AAB) exports increased by 9.0% year-on-year in 2022 to nearly \$18 billion in real terms, driven by higher primary aluminium prices.

Primary aluminium exports to South Korea increased by 88% year-on-year in 2022 to \$1.3 billion (in real terms). Australian primary aluminium exports to the US (in real terms) rose by 48% year-on-year in 2022 to \$625 million.

Australian alumina export volumes fell by 6.5% year-on-year to 17 million tonnes in 2022. However, high prices led to export values rising by 8.1% over the same period to \$9.3 billion (in real terms).

Australian bauxite export volumes increased by 1.6% year-on-year to nearly 36 million tonnes in 2022, but export values fell by 15% year-on-year over the same period to nearly \$1.2 billion (in real terms).

A weak earnings year for Australia's AAB exports in 2022-23

An expected fall in aluminium and alumina prices in 2023 is likely to reduce earnings for Australian aluminium smelters, alumina refiners and bauxite miners. Australia's AAB exports are forecast to decrease by 10% in 2022–23 (in real terms) to \$16 billion (Figure 11.15).



Figure 11.15: Australian aluminium/alumina/bauxite exports

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

High purity alumina to add more income to Australia

After 2022–23, Australia's AAB exports are projected to be about \$16 billion a year (real terms) over the outlook period. The primary aluminium price is projected to be relatively high in the outlook period (Figure.11.15). It is estimated that high purity alumina (HPA) will add about \$1.0 billion of export income to Australia's AAB exports from 2024–25 and onwards.

The addition of HPA to Australia's critical minerals list in 2022 reflects its broad-ranging economic and strategic importance. HPA is used in the automotive and aerospace sectors, and is an important component of

high-performance electronics and optics. HPA is also a key input for ensuring the stability of lithium-ion batteries. As the world's second-largest producer, and the world's largest exporter of smelting grade alumina, Australia is well placed to build capacity in HPA.

There are 4 HPA major projects in Australia, with a total estimated capacity of around 28,000 tonnes a year. Phase 1 (of three phases) of the 9,000 tonnes a year HPA refining project in Kwinana (jointly funded by Alcoa and FYI Resources) progressed to the committed stage in 2022. In February 2023, Alcoa announced the termination of the joint development project, making uncertain the progress of the last two stages of the project.

King River Resources' 9,000 tonnes a year project, also in Kwinana, is currently at the feasibility stage. Commercial production is expected to start in 2025. Another HPA project is Alpha HPA's 10,000 tonnes a year Gladstone facility. The project is expected to come online in 2024.

Australia's alumina, aluminium and bauxite production fell in 2022

In 2022, Australia's primary aluminium output fell by 3.4% year-on-year to 1.51 million tonnes. This was primarily due to a 10% year-on-year decline (to 450,000 tonnes) at Rio Tinto's Boyne Island smelter in Queensland, and a 2.1% decline (to 185,000 tonnes) at Rio Tinto's Bell Bay aluminium smelter in Tasmania. Australia's alumina output fell by 5.4% year-on-year in 2022 to nearly 20 million tonnes, due to a 6.2% year-on-year fall (to 6.4 million tonnes) at Rio Tinto's QAL and Yarwun alumina refineries in Queensland. Australia's bauxite output fell by 0.2% year-on-year in 2022 to nearly 103 million tonnes, due to a 2.2% year-on-year decline (to nearly 12 million tonnes) at Rio Tinto's Gove mine in the Northern Territory.

Higher bauxite output over the outlook period

Portland Aluminium smelter's return to full capacity is expected to boost Australia's primary aluminium output to 1.6 million tonnes a year from 2023–24 (Figure 11.16). Absent major disruptions, Australia's alumina output is projected to remain about 21 million tonnes a year (Figure 11.16).

At the time of writing, it is unknown when Alcoa will receive an approval from the WA Government to clear 9,000 hectares of forest to mine enough

bauxite to increase the output of its Pinjarra alumina refinery from 5.0 to 5.25 million tonnes a year.

Australia's bauxite output is projected to increase at 2.8% a year between 2023–24 and 2027–28, reaching 119 million tonnes in 2027–28 (Figure 11.16). The expansion of Metro Mining's Bauxite Hills mine in Queensland from 3.5 million tonnes a year to 6 million tonnes a year, and the commissioning of Glencore Bauxite Resources and Mitsubishi's 8.0 million tonnes a year Aurukun bauxite project in Queensland (estimated start of commercial operation in 2025) are the main drivers of this increased output.

Australia's operating costs are below the world average

Figure 11.17 shows the operating cash costs of aluminium smelters in select major primary aluminium producing nations. Australian smelters' operating costs are below the world average, and those in the US and China (of US\$2,327 a tonne in 2023). Figure 11.18 shows the operating cash costs of alumina refinery in selected major alumina producing nations. Australian refiners' operating costs are below the world average of US\$377 a tonne in 2023. Figure 11.19 shows the operating cash costs of bauxite mine in selected major bauxite producing nations, including Australia, Guinea, China, Brazil and Indonesia. Australian miners' operating costs are below the world average of US\$21 a tonne in 2023.

Revisions to the outlook

The forecast for Australia's AAB export earnings in 2023–24 has been revised up \$2.1 billion from the December 2022 *Resources and Energy Quarterly (REQ)*. The revision reflects a smaller than expected fall in aluminium prices in 2023, and the inclusion of Australian aluminium waste and scrap exports. 2023–24 earnings are forecast at \$16.5 billion, compared to \$14.4 billion in the December 2022 *REQ*.

Compared with the March 2022 *Resources and Energy Quarterly*, forecast Australian earnings in 2026–27 (in nominal terms) has been revised up by 11% to \$19.0 billion. This reflects the inclusion of HPA and aluminium waste and scrap.



Figure 11.16: Australian alumina/aluminium/bauxite output

Source: Department of Industry, Science, Energy and Resources (2023)

Figure 11.17: Aluminium smelter total operating cash costs







Source: CRU (2023)

Figure 11.19: Bauxite mine total operating cash costs



Source: Wood Mackenzie (2023)

Table 11.1: Aluminium, alumina and bauxite outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR ^r
Primary aluminium									
Production	kt	68,308	70,826	72,643	73,677	75,532	77,001	77,426	2.1
Consumption	kt	68,435	69,954	72,630	73,798	75,258	76,388	77,539	2.1
Prices aluminium ^c									
- nominal	US\$/t	2,708	2,462	2,530	2,613	2,522	2,386	2,470	-1.5
- real ^d	US\$/t	2,803	2,462	2,475	2,505	2,370	2,197	2,229	-3.7
Prices alumina spot									
- nominal	US\$/t	365	360	375	385	369	349	362	-0.1
- real ^d	US\$/t	377	360	367	369	347	322	326	-2.4
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Production									
Primary aluminium	kt	1,525	1,505	1,564	1,571	1,560	1,561	1,560	0.4
Alumina	kt	20,138	19,938	20,816	20,972	20,858	20,924	21,128	0.8
Bauxite	Mt	102.3	103.8	106.6	109.4	110.7	118.7	118.7	2.5
Consumption									
Primary aluminium	kt	241	187	204	205	204	204	204	-2.7
Exports									
Primary aluminium	kt	1,368	1,369	1,407	1,414	1,404	1,404	1,404	0.4
- nominal value	A\$m	5,710	4,938	4,798	4,836	4,879	4,570	4,477	-4.0
- real value ^e	A\$m	6,121	4,938	4,588	4,482	4,403	4,025	3,846	-7.5
Alumina	kt	17,739	17,571	18,110	18,246	18,146	18,204	18,381	0.6
- nominal value	A\$m	8,977	8,821	9,074	9,198	9,290	9,383	9,477	0.9
- real value ^e	A\$m	9,625	8,821	8,676	8,525	8,385	8,263	8,142	-2.8
Bauxite	kt	35,957	37,567	40,306	43,056	44,408	52,408	52,408	6.5
- nominal value	A\$m	1,177	1,250	1,414	1,533	1,615	1,944	1,983	9.1
- real value ^e	A\$m	1,262	1,250	1,352	1,421	1,458	1,712	1,703	5.1
Total value									
- nominal value	A\$m	16,854	16,187	16,582	17,905	18,696	18,966	19,178	2.2
- real value ^e	A\$m	18,069	16,187	15,856	16,594	16,874	16,701	16,476	-1.5

Notes: Total nominal and real values of Australian exports include primary aluminium, aluminium waste and scrap, alumina, high purity alumina and bauxite. **c** LME cash prices for primary aluminium; **d** In 2023 calendar year US dollars; **e** In 2022–23 financial year Australian dollars; **f** Forecast; **r** Average annual growth between 2022 and 2028 or 2021–22 and 2027–28; **z** Projection; Source: ABS (2023) International Trade in Goods and Services, 5368.0; Bloomberg (2023); London Metal Exchange (2023); Department of Industry, Science and Resources (2023); World Bureau of Metal Statistics (2023).

Copper





World consumption



Copper facts



contains up to 5x more copper than equivalent ICE cars



China consumes half of the world's

SOURCE: ABS, GA, WBMS, Wood Mac.

Copper TRADE MAP





Resources and Energy Quarterly March 2023

12.1 Summary

- Copper prices are forecast to average US\$9,000 a tonne in 2022, as new supply meets rising demand. Prices are projected to grow to US\$9,200 a tonne (in real terms) in 2028 as demand from the energy transition outweighs future production growth.
- Australia's copper exports are projected to grow from 868,000 tonnes in 2022–23 to around 970,000 tonnes in 2027–28, supported by additional production from new mines and mine expansions (see *Australia section*).
- As output grows and prices strengthen, Australia's copper export earnings are projected to grow — from \$13 billion in 2022–23 to \$15 billion (in real terms) in 2027–28.

12.2 World consumption

China to lead economic growth, copper consumption in the near term

China's manufacturing sector appears to be recovering from renewed outbreaks of the COVID-19 pandemic, following the easing of previous strict containment policies. China's Caixin manufacturing PMI increased to 51.6 in February, up from 49.2 in January. It is expected that COVID-19 infections will normalise by mid-2023, boosting copper consumption over the second half of 2023. The relaxation of the zero COVID-19 policy is likely to unleash a wave of pent up demand after three years of COVID restrictions.

While construction completions remain relatively weak, there was some improvement over the December quarter 2022. There remains significant uncertainty within the sector, but government support (and stronger economic activity as the year progresses) should see completions rise.

Consumption in other advanced nations faces inflation/recession risks

As inflation appears to moderate in most advanced nations, there is hope that central banks will slow — and eventually cease — monetary tightening regimes. Further, energy prices have declined sharply, which is another positive sign for base metal demand. That said, rate hikes by the

major central bank are slowing economic activity, creating significant risks for near-term copper consumption.

Copper consumption in 2023 is expected to increase by 2.1% to reach 26 million tonnes.

Figure 12.1: Refined copper consumption



Source: World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)

Application in the energy transition to support consumption

The worldwide energy transition towards low emissions technologies is expected to positively impact copper consumption over the outlook period. Copper's conductivity, malleability and durability make it vital to electric vehicles (EVs), EV charging infrastructure, batteries, and renewable energy generation.

Sales of EVs approached 11 million in 2022 (up 60% annually). EV sales are projected to grow three-fold to around 30 million units by 2028 (see *lithium* chapter). The proliferation of EVs also necessitates significant growth in public and private charging infrastructure; by 2030, 10% of refined copper consumption will be accounted for by use in EVs, batteries and charging equipment.

In addition to being the largest growth market for EVs (accounting for half of EV sales in 2022), China is pushing ahead with energy generation and transmission. A record 125 gigawatts (GW) of combined wind and solar capacity were installed in 2022, and China aims to install a further 160GW of wind and solar capacity in 2023.

Renewable energy sources in Europe are of increasing importance, given the efforts underway to avoid future dependency on Russian fossil fuels. While Germany added 2.4 gigawatts of onshore wind capacity in 2022, the country remains behind its target of hitting 80% of electricity from solar and wind by 2030. EU nations will likely need to accelerate installations of renewable energy sources by the middle of the decade, adding significantly to copper demand towards the end of the outlook period.

Copper consumption is expected to grow at an average rate of 2.7% a year over the outlook period to reach over 30 million tonnes in 2028.

Asia ex-China to grow copper consumption over the outlook

India and the ASEAN nations have strong growth potential over the medium and long term. Comparatively higher wages and other input costs in China are driving end-use demand to shift to these markets, with diversification away from China becoming a key non-monetary incentive for some nations. Further, India has implemented import tariff duties to protect its domestic copper 'semis' (semi-finished products, such as cable, wire, and tube) market, while also committing to a significant number of infrastructure investments.

Higher recycling needed to feed consumption

With significant demand growth expected over the outlook period, and with mined production growth likely to slow (see *Production* section), it is projected that a market deficit will emerge. The role of secondary copper consumption will therefore become increasingly important in balancing the market and moderating prices.

While recycled copper contributes around 30% of total copper end use, this proportion has been falling over the past decade. Increasing recycled copper's share of end use consumption to 2012 levels — to around 35%

— would provide the market with the equivalent of 5 large greenfield copper projects. Further, there are non-economic benefits of increasing scrap usage; recycled copper requires 85% less energy than primary production, lowering the emissions intensity of the sector.

Reaching higher levels of scrap utilisation will likely require supportive government policies from the major economies at all stages of the recycling process.

12.3 World production

Mined copper production grows despite disruptions

Global mined copper production hit almost 22 million tonnes in 2022 — up 0.8% from a year earlier. Mined copper supply was below expectations due to a myriad of supply disruptions across the year. Mined copper production in Chile fell by 5.2% in 2022, while production in Peru improved 4.9% year-on-year (Figure 12.2).

Figure 12.2: Mined copper production



Source: World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)

Supply disruptions accelerated over December and January, adding to the risk that production losses for 2023 will be even greater than in 2022. Recent disruptions include widespread protests in Peru, especially in major copper-producing regions, a fire at Ventanas Port (Chile), heavy rainfall in Indonesia and contractual disputes at Cobre Panama (Panama) and Dikuluwe-Mashamba (Democratic Republic of Congo).

Considering these disruptions, global mined copper production is forecast to grow 5.4% to almost 23 million tonnes in 2023. While it is possible that supply disruptions could alleviate, risks to global mined copper production are skewed to the downside.

Mined production growth to slow by middle of the outlook period

Mined copper production is expected to average 2.0% over the outlook period, with production projected at 24 million tonnes by 2028. Growth is weighted to the first half of the outlook period driven by increases in production from Chile and Peru; growth in mined copper production is expected to slow towards the second half of the outlook period.

Challenges facing mine operators include declining ore grades, higher production costs, aging facilities and increased environmental and social scrutiny. Declines in the quality of deposits will also mean that most new projects in the development pipeline lack the scale and cost advantages of existing mega projects.

Copper prices and the prices of co-products — such as cobalt — are important determinants of mine approvals, and higher prices could incentivise more mine expansions and restarts over the outlook period. That said, higher capex costs (after the recent burst of inflation) and higher financing costs (from higher interest rates) present risks to approvals.

Refinery output growth slowing

World refined copper production growth was sluggish in 2022, as high energy prices in Europe and strict lockdowns in China hampered production. Output increased by 1.5% to 25 million tonnes, compared with growth of 3.3% in the previous year (Figure 12.3). Refined copper production growth is expected to track increases in mined production, growing by 5.4% to 26 million tonnes in 2023. World refined production is projected to increase at an average 2.0% over the outlook period, reaching over 28 million tonnes in 2028. New refinery capacity is expected to come online in China, Peru, Russia, and Indonesia, though this is weighted to the first half of the outlook period.

Refined copper production faces expansion challenges, concentrate shortages and electricity cost pressures, increasingly tight emissions and sulphur capture limits, as well as generally tighter approval processes.

At this stage, the risk to Russian refined copper production of the fallout from the Russian invasion of Ukraine is low. Russia only accounts for around 4% of the global refined market, and while the US has issued sanctions on Russian aluminium, no sanctions against Russian copper have been issued to date.

Figure 12.3: Refined copper production



Source: World Bureau of Metal Statistics (2023); Department of Industry, Science and Resources (2023)

12.4 Prices

China reopening lifts prices

After falling through the middle of 2022, copper prices have rebounded since November 2022, coinciding with the Chinese government's decision to unwind strict COVID-19 containment measures. Optimism about the state of the global economy has also provided support to copper prices.



Figure 12.4: Exchange inventories of copper vs spot price

The LME spot price is estimated to average US\$9,000 a tonne in the March guarter 2023, roughly the average expected in 2023.

Inventory levels rebound in 2023

After being near decade-low levels since late 2021, exchange warehouse inventories recovered to around 332,000 tonnes at the end of February 2023. A build-up of inventories corresponding to Chinese New Year activities is typical, so the next few months will be more indicative of the underlying tightness in the world copper market.

Shortages to push prices higher by the end of the outlook period

Prices are expected to remain relatively stable towards the middle of the outlook period, as new supply from Chile and Peru matches rising demand. However, it is forecast that demand will outpace supply from 2026, resulting in market deficits and upward pressure on prices. Higher production costs (partly due to declining ore grades), higher capex and higher financing costs (see *production* section) will add to upward pressure on prices.

Higher scrap utilisation will be required to curb the supply gap and slow price increases. However, the pace and overall amount of scrap which can be fed back into the product cycle is limited, and there are likely to be higher levels of volatility over the outlook period as a result.

The copper spot price is projected to reach US\$9,200 a tonne (in real terms) by 2028. Prices will remain sensitive to the balance in world copper markets, which will in turn be affected by the pace of world economic growth, the pace of low-emissions technology uptake, and the speed at which copper supply reacts to price movements.

Figure 12.5: Price and inventories forecast



Source: LME (2023) official cash price; Bloomberg (2023)

12.5 Australia

Higher volumes support export earnings

Export volumes are forecast to increase by 7.5% in 2022–23, reaching 868,000 tonnes. As a result, export earnings for 2022–23 are forecast to increase to almost \$13 billion.

Production to continue to grow over the outlook period

Mined production is projected to grow at an average rate of 3.0% over the outlook period, reaching 927,000 tonnes in 2027–28. Oz Minerals' West Musgrave project is the most significant new project in the outlook period, adding around 41,000 tonnes of copper capacity per year to mined production. While there is a projected fall in Australian output in 2027–28, there are several large projects with a completed definitive feasibility study that could come online near the end of the outlook period. A forecast world copper market deficit and higher prices are likely to incentivise production from these projects, adding a potential upside to production forecasts.

Exports to rise steadily out to 2027-28

In addition to rising output, higher prices are likely to lift Australia's copper export earnings over the outlook period. Exports are projected to surpass \$15 billion (in real terms) by 2027–28, an average annual rise of 2.5%.

Copper exploration falls, but still historically high

Copper exploration expenditure fell by 13% quarter-on-quarter to \$150 million in the December quarter 2022 (Figure 12.7). Expenditure is still well above levels of the 2010s.

Revisions to the outlook

Since the December 2022 *Resources and Energy Quarterly*, the forecast for Australia's copper export earnings in 2022–23 and 2023–24 have been revised up by \$0.6 billion and \$0.3 billion respectively, due to forecasts for higher prices and export volumes. Compared to the March 2022 *Resources and Energy Quarterly*, export earnings in 2026–27 have been revised up by approximately \$1.6 billion (in nominal terms), due to an upward revision in copper price projections.



Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Figure 12.7: Australian copper exploration expenditure



Source: ABS (2022)

Table 12.1: Copper outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Production									
-mine	kt	21,538	22,701	23,427	23,826	24,016	24,136	24,257	2.0
-refined	kt	25,308	26,675	27,528	27,996	28,220	28,361	28,503	2.0
Consumption	kt	26,050	26,448	27,195	28,159	29,012	29,786	30,521	2.7
Closing stocks	kt	942	1 348	1 595	1 544	1 441	1 268	1 131	3.1
-weeks of consumption		1.9	2.6	3.0	2.9	2.7	2.4	1.9	3.3
Prices LME									
-nominal	US\$/t	8,815	8,961	8,811	8,703	9,310	9,686	10,196	2.5
	USc/lb	400	406	400	395	422	439	462	2.5
-real ^b	US\$/t	9,124	8,961	8,619	8,342	8,748	8,919	9,201	0.1
	USc/lb	414	406	391	378	397	405	417	0.1
Australia	USc/lb Unit	414 2021–22	406 2022–23 f	391 2023–24 f	378 2024–25^z	397 2025–26 ²	405 2026–27 ²	417 2027–28 ^z	0.1 CAGR ^r
Australia Mine output	USc/lb Unit kt	414 2021–22 775	406 2022–23^f 832	391 2023–24 ^f 868	378 2024–25^z 941	397 2025–26^z 980	405 2026–27² 958	417 2027–28^z 927	0.1 CAGR r 3.0
Australia Mine output Refined output	USc/lb Unit kt kt	414 2021–22 775 362	406 2022–23^f 832 427	391 2023–24^f 868 435	378 2024–25² 941 404	397 2025–26² 980 299	405 2026–27² 958 225	417 2027–28^z 927 225	0.1 CAGR ^r 3.0 -7.6
Australia Mine output Refined output Exports	USc/lb Unit kt kt	414 2021–22 775 362	406 2022–23^f 832 427	391 2023–24^f 868 435	378 2024–25² 941 404	397 2025–26² 980 299	405 2026–27² 958 225	417 2027–28^z 927 225	0.1 CAGR ^r 3.0 -7.6
Australia Mine output Refined output Exports –ores and cons ^c	USc/lb Unit kt kt kt	414 2021–22 775 362 1,641	406 2022–23^f 832 427 1,586	391 2023–24 ^f 868 435 1,696	378 2024–25 ² 941 404 2,105	397 2025–26² 980 299 2,672	405 2026–27² 958 225 2,871	417 2027–28^z 927 225 2,752	0.1 CAGR ^r 3.0 -7.6 9.0
Australia Mine output Refined output Exports –ores and cons ^c –refined	USc/lb Unit kt kt kt kt	414 2021–22 775 362 1,641 330	406 2022–23 ^f 832 427 1,586 418	391 2023–24 ^f 868 435 1,696 428	378 2024–25 ² 941 404 2,105 397	397 2025–26² 980 299 2,672 293	405 2026–27² 958 225 2,871 221	417 2027–28^z 927 225 2,752 221	0.1 CAGR' 3.0 -7.6 9.0 -6.5
Australia Mine output Refined output Exports -ores and cons ^c -refined -total metallic content	USc/lb Unit kt kt kt kt kt	414 2021–22 775 362 1,641 330 808	406 2022–23 ^f 832 427 1,586 418 868	391 2023–24 ^f 868 435 1,696 428 907	378 2024–25 ² 941 404 2,105 397 980	397 2025–26 ² 980 299 2,672 293 1,021	405 2026–27 ² 958 225 2,871 221 1,000	417 2027–28 ^z 927 225 2,752 221 970	0.1 CAGR' 3.0 -7.6 9.0 -6.5 3.1
AustraliaMine outputRefined outputExports-ores and consc-refined-total metallic contentExport value	USc/lb Unit kt kt kt kt	414 2021–22 775 362 1,641 330 808	406 2022–23 ^f 832 427 1,586 418 868	391 2023–24 [†] 868 435 1,696 428 907	378 2024–25 ² 941 404 2,105 397 980	397 2025–26² 980 299 2,672 293 1,021	405 2026–27² 958 225 2,871 221 1,000	417 2027–28 ^z 927 225 2,752 221 970	0.1 CAGR' 3.0 -7.6 9.0 -6.5 3.1
AustraliaMine outputRefined outputExports-ores and consc-refined-total metallic contentExport value-nominal	USc/lb Unit kt kt kt kt kt	414 2021–22 775 362 1,641 330 808 12,128	406 2022–23 ^f 832 427 1,586 418 868 12,806	391 2023–24 ^f 868 435 1,696 428 907 13,469	378 2024–25 ² 941 404 2,105 397 980 14,339	397 2025–26 ² 980 299 2,672 293 1,021 16,294	405 2026–27 ² 958 225 2,871 221 1,000 17,363	417 2027–28 ^z 927 225 221 970 17,543	0.1 CAGR' 3.0 -7.6 9.0 -6.5 3.1 6.3

Notes: **b** In 2023 calendar year US dollars; **c** Quantities refer to gross weight of all ores and concentrates; **d** In 2022–23 financial year Australian dollars; **f** Forecast; **r** Average annual growth between 2022 and 2028 or 2021–22 and 2027–28; **z** Projection.

Source: ABS (2023) International Trade, 5465.0; LME (2023) spot price; World Bureau of Metal Statistics (2023) World Metal Statistics; Department of Industry, Science, Energy and Resources (2023).

Nickel



World consumption



Nickel facts

recyclable



Earth's core after iron

SOURCE: ABS, GA, INSG, Wood Mac

13.1 Summary

- Nickel prices are expected to average US\$24,200 a tonne in 2023, as increased production from Indonesia cools prices. Prices are expected to ease over the outlook period to around US\$19,900 a tonne in real terms in 2028.
- Recent high prices have boosted Australia's nickel export earnings, which are forecast to reach \$5.0 billion in 2022–23. Export earnings are projected to fall to \$4.2 billion in 2027–28 (in real terms) as a result of lower realised export prices.
- Australia's export volumes are estimated to rise from 164,000 tonnes in 2022–23 to 215,000 tonnes in 2027–28 as new supply comes online.

13.2 World consumption

Growth in nickel demand to strengthen in 2023

Nickel consumption grew 5.0% to 2.9 million tonnes in 2022, as a strong December quarter offset weakness in the first three quarters of the year. Consumption growth was largely driven by higher battery production, with consumption in stainless steel (traditionally the largest use for nickel) flat over the year. Nickel consumption in China grew by 11% in 2022, despite strict COVID-19 containment measures weighing down significant parts of its economy. This growth offset declines in Europe, while other major nickel consuming nations were flat (Figure 13.1).

Consumption growth for stainless steel production is expected to lift in 2023, in addition to accelerating growth in production of battery technology. Nickel demand is forecast to grow 9.3% to 3.2 million tonnes in 2023 as a result.

Growth in nickel demand is projected to remain robust in subsequent years, driven by both stainless steel and battery production. Nickel consumption is forecast to reach 3.8 million tonnes by 2028 — an average annual growth rate of 4.7% over the outlook period.





Source: International Nickel Study Group (INSG); Department of Industry, Science and Resources (2023)

Battery demand on the charge

Electric vehicle (EV) sales grew to almost 11 million units in 2022 — an increase of around 60% year-on-year (Figure 13.2). Sales growth is expected to average 19% annually over the outlook period, reaching over 30 million units by 2028. As a result, the proportion of nickel that is used in batteries is expected to increase over the outlook period. In 2018, 5% of global nickel consumption was battery demand; by 2022, this had grown to 15%, and is expected to reach 25% by 2028.

The price of battery packs is a key risk to these forecasts. The cost of battery packs rose 7% in 2022, attributed to rising battery metal prices. According to Bloomberg New Energy Finance, battery prices are likely to remain high in 2023 before starting to fall in 2024.



Figure 13.2: EV sales vs proportion of primary nickel usage in batteries

Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023)

Nickel-free battery tech presents challenges

As EV sales grow rapidly, nickel-based batteries (mainly nickel-cobaltmanganese, or NCM) face growing competition from nickel-free alternatives such as lithium iron phosphate (LFP) batteries. LFP batteries made up 36% of EV sales in 2022, up from 24% in the year prior.

LFP batteries are cheaper and tend to be less prone to thermal management issues than NCM batteries. There are also fewer social licence risks for LFP batteries, given the mining issues that exist for nickel and cobalt. However, NCM batteries are more energy dense, which gives them a weight (and therefore range) advantage over LFP batteries.

The regional distribution of EV sales will also play a factor; 60% of Chinese EVs have an LFP battery, while Europe and the US favour EVs with NCM batteries. Further, battery manufacturers who persist with NCM are moving to higher nickel chemistries, supporting nickel demand.

13.3 World production

Indonesia to lead mined nickel output growth over the outlook period

Global mined nickel production is forecast to rise by 7.2% in 2023 to 3.4 million tonnes, with Indonesia accounting for four-fifths of this increase. Indonesia will continue to lead global mined production growth out to 2028, when it is projected to reach almost 3.8 million tonnes, though growth is weighted to the first half of the outlook period.

With global mined production heavily dependent on Indonesian supply, downside risks are heavily concentrated. Risks include possible supply bottlenecks and a high reliance on Chinese demand; any disruption to this could induce producers to ease back on planned supply growth.

Further, Indonesia's nickel reserves are exclusively laterite ores, which present technical challenges in refining to battery grade nickel. This increases the energy required and waste material generated from refining; extracting nickel from Indonesian laterites produces about twice the level of waste tailings) relative to comparable sulphide nickel mines in Australia.

Figure 13.3: Composition of world mined nickel production, monthly



Source: International Nickel Study Group (2023); Department of Industry, Science and Resources (2023)

Refined nickel production to exhibit strong growth to 2028

Refined nickel production grew by 16% to 3.0 million tonnes in 2022 (Figure 13.4). Over half of the increase came from nickel pig iron production, with nickel sulphate making up a third of the production increase. Indonesia leads in NPI production (74% of world production) while China is dominant in nickel sulphate production (80% of world production).

Refined nickel production is forecast to grow to 3.3 million tonnes (up 7.6% year-on-year) in 2023, with market leaders Indonesia and China accounting for the lion's share of production growth.

Indonesia and China are set to lead growth in refined production over the outlook period, with global refined nickel production forecast to grow by 3.6% on average over the outlook period to reach 3.7 million tonnes by 2028. Countries such as Finland, Canada and South Korea are also expected to exhibit strong rates of growth in refined nickel production, although from a much smaller base.

Figure 13.4: Composition of world refined nickel production



Source: International Nickel Study Group (2023); Department of Industry, Science and Resources (2023)

Sulphate production to lead nickel's charge

The 'invention' of nickel pig iron (NPI) can be considered as the biggest revolution of the nickel market in recent history. While NPI production only became economically viable in the mid-2000s, half of all nickel produced in 2022 was in the form of NPI. This has also had a dramatic effect on ferronickel production, which now only accounts for one tenth of nickel production.

Nickel in chemicals (NIC) — namely nickel sulphate, or NiSO₄ — presents another revolution for nickel producers, due to its role as an input for battery cathode production. After doubling its market share over the past five years, NIC production is set to increase further (in line with EV sales) and make up almost a quarter of all nickel production (Figure 13.5). By 2028, NIC production is set to overtake production of LME-deliverable nickel products (briquettes and cathode) — which will make up less than one fifth of the world nickel market.



Figure 13.5: Nickel sulphate to grow market share

Notes: bri + cath = briquettes + cathode; other category includes oxide sinter, pellets and powder.

Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023)

13.4 Prices

Poor liquidity is supporting higher LME prices

Prices averaged around US\$25,700 a tonne in 2022 — a rise of 34% yearon-year. Growth was driven by the Russian invasion of Ukraine, as well as the fallout of the suspension of the LME nickel market.

Nickel prices are likely to average US\$26,300 a tonne in the March quarter 2023, with a steep fall — from late February — offsetting a strong start to the year. The continuation of price volatility likely reflects poor liquidity in the market, rather than any significant market developments. Traders are yet to fully regain confidence in the LME nickel market following the week-long suspension of trading in March 2022, with trading volumes remaining at just 30% of their pre-suspension levels.

Historically low inventories are also a contributing factor and raise the likelihood of price spikes when a significant threat to supply arises. Inventories as at the end of February stand at 44,0000 tonnes — 45% lower than at the same point last year (Figure 13.6).

Figure 13.6 Nickel spot price and stock at exchanges



Increased supply and a 'return to normal' to cool prices

LME pricing is assumed to eventually return to a level commensurate with market fundamentals. Over 2023, the LME nickel price is forecast at US\$24,200 a tonne (as more supply comes online), falling further to US\$21,800 a tonne in 2024. Significant risks exist both on the upside (volatility continues longer than expected) and downside (production ramps up quicker than expected).

Continued demand growth coupled with slowing global production is projected to move the market into deficit beyond 2027. That said, prices will still be lower than current levels at US\$19,900 a tonne (in real terms) in 2028 (Figure 13.7).

Long term forecast risks are skewed to the upside, considering nickel's importance in the transition to net zero emissions. While most nations and auto manufacturers are phasing out internal combustion engine vehicles beyond 2030, more ambitious action would see demand brought forward and put upward pressure on prices.

Figure 13.7 Forecast real nickel price



Source: Bloomberg (2023); Department of Industry, Science and Resources (2023)

13.5 Australia

Mine production to grow strongly over the outlook period

After falling in 2021–22, due to the impacts of weather and labour shortages, Australian mined nickel production is forecast to increase by 8.3% in 2022–23 and reach 167,000 tonnes.

Several nickel projects at the committed stage are set to come online during the outlook period, including Cosmos (IGO) and West Musgrave (Oz Minerals). The West Musgrave project is set to commence production in 2025, with a nameplate capacity of 35,000 tonnes of nickel production an annum — becoming one of the largest nickel mines in Australia.

Mined production is expected to peak at 253,000 tonnes in 2025–26, before falling to 235,000 tonnes in 2027–28.

Refined production steady over the outlook

With no new committed refinery projects, refined nickel production is forecast to be steady at 105,000 tonnes over the outlook period. That said, several battery metal projects exist that are targeting first production by 2025. These include the Sunrise Project in New South Wales, the Townsville Energy Chemical Hub in Queensland and the WA pCAM Hub in Western Australia. These projects will not increase the volume of refined output, but will move Australia's nickel output further up the value chain.

Earnings to peak this year as prices ease over outlook

Export volumes are set to track movements in production levels over the outlook period. Export volumes are forecast to increase to 164,000 tonnes in 2022–23 and peak at 230,000 tonnes in 2025–26, before easing out to 2028 (215,000 tonnes).

Strong nickel prices over the past year have lifted nickel export earnings, which are forecast to grow by 14% to reach \$5.0 billion in 2022–23. Softening nickel prices are expected to outweigh the increase in nickel export volumes over subsequent years, with export earnings projected to decrease to \$4.2 billion (in real terms) by 2027–28 (Figure 13.8).

Figure 13.8: Australia's exports to grow over the outlook period



Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023)

Figure 13.9: Nickel and cobalt exploration still strong





Exploration expenditure hits record levels

Nickel and cobalt exploration expenditure increased by 11% from the September quarter 2022 to hit a record \$88 million in the December quarter 2022. Exploration expenditure increased by 29% in year-on-year terms from the December quarter 2021 (Figure 13.9).

Revisions to the outlook

Compared to the December 2022 *Resources and Energy Quarterly*, nickel export volumes have been revised down to reflect a slower ramp up in Australian mined production.

Export earnings have been revised down by \$0.1 billion in 2023–24 as a result, with a weaker exchange rate offsetting some of the decrease in export volumes.

The Office of the Chief Economist has revised its nickel export methodology since the March 2022 *Resources and Energy Quarterly* (see the September edition). Export earnings are \$3.4 billion lower (in nominal terms) as a result.

Table 13.1: Nickel outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Production									
-mine	kt	3,161	3,389	3,517	3,636	3,735	3,767	3,766	3.0
-refined	kt	3,024	3,253	3,443	3,578	3,664	3,722	3,739	3.6
Consumption	kt	2,911	3,183	3,423	3,530	3,668	3,787	3,834	4.7
Closing stocks	kt	443	513	533	581	576	512	418	-0.3
-weeks of consumption		7.9	8.4	8.1	8.6	8.2	7.0	5.7	-4.9
Prices LME									
-nominal	US\$/t	25,696	24,200	21,750	20,125	20,000	20,625	22,063	-2.3
	USc/lb	1 166	1 098	987	913	907	936	1 001	-2.3
-real ^b	US\$/t	26,597	24,200	21,275	19,291	18,793	18,992	19,909	-4.5
	USc/lb	1 206	1 098	965	875	852	861	903	-4.5
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR
Production									
– mine ^c	kt	154	167	202	230	253	246	235	7.7
- refined	kt	98	103	105	105	105	105	105	1.1
- intermediate	kt	31	29	29	30	30	30	30	-0.9
Export volume	kt	159	164	188	211	230	224	215	5.4
Export value									
- nominal value	A\$m	4,405	4,958	4,888	4,731	4,870	4,820	4,937	2.1
- real value ^d	A\$m	4,723	4,958	4,674	4,385	4,395	4,244	4,241	-1.7

Notes: b In 2023 calendar year US dollars; c Quantities refer to gross weight of all ores and concentrates; d In 2022–23 financial year Australian dollars; f Forecast; r Average annual growth between 2022 and 2028 or 2021–22 and 2027–28; z Projection.

Source: ABS (2023) International Trade, 5465.0; LME (2023) spot price; World Bureau of Metal Statistics (2023) World Metal Statistics; Department of Industry, Science, Energy and Resources (2023).

Zinc





World consumption



Zinc facts



Zinc trade map





SOURCE: ILZSG; ABS

14.1 Summary

- The LME zinc spot price is forecast to average around US\$3,100 a tonne in 2023. Demand is expected to rebound as China's economy picks up pace and as energy prices ease. From just over US\$3,000 at present, the zinc price is expected to fall gradually (in real terms) over the outlook period to around US\$2,600 by 2028.
- Australia's zinc production is forecast to rise by 2.5% per year to around 1.5 million tonnes by 2027–28. High prices have encouraged strong exploration expenditure, which will support long run production growth (see *Australia* section).
- Australia's zinc export earnings (in real terms) are forecast to decline from \$4.7 billion in 2022–23 to \$3.8 billion in 2027–28 as prices normalise.

14.2 World consumption

Recovery of world zinc demand slowed with weaker manufacturing activity

Zinc consumption tends to follow the world industrial production cycle, given its primary role in galvanising steel (Figure 14.1), and its heavy use in the construction and automotive sectors. World refined zinc consumption fell by 2.7% year-on-year in the December quarter 2022. Over the same period, consumption fell in the European Union (-8.3%), ex-China Asia (-16%) and China (-0.5%), though was offset by increases in the US (29%). High energy prices and falling consumption slowed global manufacturing activity and dragged on zinc demand over the quarter, while consumption in the US grew with a lift in construction spending.

Global vehicle production continues to recover from supply chain bottlenecks. However, some producers continue to report difficulties with microchip supply, primarily in Asia. Sales in the December quarter 2022 remained around 9.5% lower compared to before the pandemic (December quarter 2019). While supply for leading edge computer chips have normalised, shortages remain for chips manufactured on mature nodes. Supply of mature node chips tends to be inelastic, as they are typically sold with slim margins while new fabs face high capital costs.

China is the world largest consumer of zinc, and demand in the December quarter 2022 was supported by additional government infrastructure spending from local government special purpose bonds issued over 2022. Consumption also benefitted from the lifting of pandemic restrictions in December. However, ongoing weakness in China's property market has moderated the recovery of zinc demand, despite the Chinese government's 16 new policy measures to ease credit in the sector and credit rules under the "three red lines" policy expected to be relaxed.

The outlook for growth in world industrial production has improved modestly since the December 2022 *Resources and Energy Quarterly* (see *Macroeconomic Outlook* chapter), and zinc demand growth is expected to pick up over 2023. Inflation began to subside in Europe and the US, and with COVID cases in China having likely peaked in January, China's economic recovery will accelerate.

Figure 14.1: Zinc consumption vs industrial and steel production



Source: International Lead Zinc Study Group (2023); CPB Netherlands Bureau for Economic Policy Analysis (2023); World Steel Association (2023); Department of Industry, Science and Resources (2023).

Energy transition to drive zinc demand while Chinese growth slows

World zinc usage is forecast to grow on average 1.8% per year (Table 14.1), with more rapid increases in the first half of the outlook period as consumption growth recovers from pandemic-related supply disruptions and high energy prices ease.

Longer term zinc demand growth from China is expected to slow. Chinese government policies on the residential property market signals a preference to prevent excessive increases in property values. This suggests that the post-COVID recovery in China will likely not see growth in the sector return to its previous heights. Low birth rates saw China's population fall in 2022 for the first time since 1961, and urbanisation rates have been falling since 2010. This suggest that urban population growth will slow, dampening demand for residential and infrastructure construction. China's economy is also expected to increasingly transition towards services to drive growth, reducing the need for further strong investment in zinc-intensive infrastructure projects.

The global energy transition is expected to support demand for zinc, due to its role as a key input to wind turbines, solar panels and electric vehicles. Spending on the deployment of these technologies is supported by policies such as the US Inflation Reduction Act and the EU Green Deal. Developments in zinc battery technology also have the potential to drive additional demand.

14.3 World production

Global mine production to recover from COVID related disruptions

World mined zinc production fell by 3.0% year-on-year in the December quarter 2022, due to lower production in China and Canada. A growing stock of surplus concentrate discouraged miners from increasing output over the quarter. The closure of European smelters reduced global zinc refining capacity and contributed to rising treatment costs. Concentrates flowed to China, where the treatment price for imported concentrates rose with demand to US\$275 a tonne in January, compared to an average of US\$221 over 2022. Chinese mine production in the quarter was 7.1% lower year-on-year, with operations still impacted by COVID restrictions. Canadian output halved year-on-year, with several mines closed after reaching end of life. Australian mines in the quarter rose 2.9% year-on-year as production recovers from COVID-related operational disruptions.

World mine output is forecasted to grow by 2.0% per year (on average), as new mines and mine expansions come online. The production gains are expected to be largest over the first half of the outlook period, as operations recover from COVID-related disruptions. (Figure 14.2).

Civil unrest threatens Peruvian mine output in 2023. So far, the focus of the impact of (often) violent anti-government protests by local communities has been on Peru's copper production. However, disruptions to zinc output in Peru — the world's 2nd largest miner of zinc — remain a significant risk.

The largest new projects expected to add to mining production capacity over the outlook period are located in Russia, Kazakhstan, the Democratic Republic of Congo and South Africa.

Figure 14.2: World zinc mine production, metallic content



Source: International Lead Zinc Study Group (2023); Department of Industry, Science and Resources (2023).
Projects in Russia and Kazakhstan are being delayed: fallout from the Russian invasion of Ukraine has led to difficulty in sourcing equipment. Imports of Russian zinc have been disrupted by sanctions, and some businesses have withdrawn operations in the region.

China, the world's largest producer of zinc ore, is expected to expand production across smaller mines.

European smelter closures limits world refined zinc production

World refined zinc production fell by 5.1% year-on-year in the December quarter 2022. Refined zinc production in the European Union (EU) declined further in the December quarter 2022, falling by 23% year-onyear. European energy prices have eased with mild winter weather in Europe reducing energy demand for heating, but remain higher than prior to the Russian invasion of Ukraine. This resulted in high costs and closure of some zinc smelters across Europe over all or part of the quarter.

Production in China — the largest zinc refiner globally — rose by 2.1% year-on-year in the December quarter 2022. The fall in production capacity in Europe saw excess concentrates flow towards China. Chinese smelters increased production in response to higher treatment prices, as operational disruptions from COVID restriction eased.

Among the smaller refining nations, metal production in Canada fell by 43% year-on-year in the December 2022 quarter. Equipment deterioration led to the Valleyfield smelter operating at reduced capacity.

European smelters are likely to reopen gradually over 2023 and 2024, with the pace of the reopening dependent on energy market conditions. However, droughts in south-west China could tighten zinc refinery capacity. Some zinc refineries in Yunan province, where about 20% of Chinese refined capacity is located, had to close over March 2023 due to power shortages from low hydro power generation.

Over the outlook period, refined production from primary and secondary sources is expected to rise by 2.3% a year. The majority of new capacity is expected to be in China.

14.4 Prices

Price rallies as China lifts COVID-19 restrictions

The London Metal Exchange (LME) zinc spot price averaged about \$3,600 a tonne in 2022. Zinc prices rose strongly in mid 2022, when surging energy prices forced European production cuts, while changes in the macroeconomic outlook drove volatility in H2 2022. Low stock levels also led to a heightened sensitivity of price to changes in demand/supply. Prices rose from US\$2,900 a tonne in November to US\$3,300 in January, as China eased COVID restrictions. LME stocks fell to 17 thousand tonnes at end January, with all inventory now in Asian warehouses. (Figure 14.3)

The real LME zinc spot price is forecast to average about US\$3,100 a tonne in 2023, supported by a less pessimistic macroeconomic outlook and low stock levels.

The real price is forecast to fall over to outlook period to about \$2,600 a tonne by 2028, as rising supply eases market tightness.



Figure 14.3: Zinc prices and stocks

Source: LME (2023); International Lead Zinc Study Group (2023); Department of Industry, Science and Resources (2023).

14.5 Australia's exports and production

Export earnings to fall as price declines despite growing domestic output

Australia's export earnings for both concentrates and refined zinc (combined) rose 6.4% year-on-year to A\$1.2 billion in the December quarter 2022. The increase is attributable to the sale of surplus refined zinc stocks built up over 2022 to buyers in the US — refined zinc export value to the US rose to around A\$280 million, from \$2 million in the December quarter 2021. The shifting of zinc concentrate trade away from Europe reorientated Australian concentrate exports towards China. Around 80% of zinc concentrates exported in the December quarter 2022 were sold to China, comparing to around 50% over the 2021–22 financial year.

Australia's real export earnings for both concentrates and refined zinc (combined) are estimated to fall to \$4.7 billion in 2022–23, as price falls from record highs recorded during the first half of 2022. (Figure 14.4) Australian real export earnings are forecast to fall further over the outlook period to \$3.8 billion in 2027–28, with price expected to continue to fall as a result of an easing in global supply shortages.

Australian mine output rose 2.9% year-on-year in the December quarter 2022. Impacts on output from COVID-related absenteeism eased with the end of mandatory isolation requirements in October; operations were affected at a number of major mines following the Omicron outbreak in the March quarter 2022. Quarter on quarter, output at Glencore's Australian operations, including Mt Isa and McArthur River, rose by 10 thousand tonnes, while production at 29 Metal's Golden Grove mine rose by 5 thousand tonnes.

Australian mine output is expected to grow an average of 2.5% per year over the outlook period. Output growth over the next two years will be driven by expansion of the Century mine, while high levels of exploration expenditure will underpin investment in domestic production capacity over the medium term.

Refined production is expected to increase to around 460 thousand tonnes a year by 2024–25. The Townsville refinery is undertaking an expansion

project, but delays with commissioning the project has disrupted production over 2022.



Figure 14.4: Australia's zinc exports, metallic content

Source: ABS (2023) International Trade in Goods and Services, 5368.0; Department of Industry, Science and Resources (2023).

Exploration expenditure for silver, lead and zinc rose 12% year-on-year in the December quarter 2022. Exploration expenditure slumped in 2020 — due to the COVID pandemic — but recovered as zinc prices rose over 2021 and 2022. Exploration expenditure is expected to moderate with zinc prices returning to a lower level.

Revisions to the outlook

Compared to the December 2022 *Resources and Energy Quarterly*, 2022–23 and 2023–24 export values are down by 0.4% and 0.8% respectively, due to a small downward revision to the price forecast.

Compared with the March 2022 *Resources and Energy Quarterly*, forecasts for zinc export revenue are up 35% to \$4.2 billion in 2026–27. The difference is due to the upwards revision to zinc production given the strong zinc exploration expenditure over 2022.

Table 14.1: Zinc outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR
Production									
– mine	kt	12,489	12,689	13,059	13,371	13,607	13,822	14,040	2.0
– refined ^a	kt	13,286	13,816	14,190	14,508	14,755	14,982	15,211	2.3
Consumption	kt	13,592	13,867	14,170	14,458	14,704	14,929	15,155	1.8
Closing stocks	kt	640	589	609	659	710	763	819	4.2
- weeks of consumption		2.4	2.2	2.2	2.4	2.5	2.7	2.8	
Price									
- nominal	US\$/t	3,540	3,110	2,978	2,822	2,812	2,823	2,868	-3.4
	USc/lb	161	141	135	128	128	128	130	-3.4
– real ^b	US\$/t	3,664	3,110	2,913	2,705	2,642	2,599	2,595	-5.6
	USc/lb	166	141	132	123	120	118	118	-5.6
Australia	USc/lb Unit	166 2021–22	141 2022–23 f	132 2023–24 f	123 2024–25^z	120 2025–26 ²	118 2026–27 ²	118 2027–28 ^z	-5.6 CAGR ^r
Australia Mine output	USc/lb Unit kt	166 2021–22 1,257	141 2022–23 f 1,323	132 2023–24 ^f 1,393	123 2024–25² 1,401	120 2025–26^z 1,408	118 2026–27^z 1,435	118 2027–28^z 1,461	-5.6 CAGR ^r 2.5
Australia Mine output Refined output	USc/lb Unit kt kt	166 2021–22 1,257 435	141 2022–23^f 1,323 389	132 2023–24^f 1,393 440	123 2024–25² 1,401 460	120 2025–26^z 1,408 460	118 2026–27² 1,435 460	118 2027–28^z 1,461 460	-5.6 CAGR ^r 2.5 0.9
Australia Mine output Refined output Export volume	USc/lb Unit kt kt	166 2021–22 1,257 435	141 2022–23^f 1,323 389	132 2023–24 ^f 1,393 440	123 2024–25² 1,401 460	120 2025–26^z 1,408 460	118 2026–27² 1,435 460	118 2027–28^z 1,461 460	-5.6 CAGR' 2.5 0.9
Australia Mine output Refined output Export volume – ore and concentrate ^c	USc/lb Unit kt kt kt	166 2021–22 1,257 435 2,033	141 2022–23 ^f 1,323 389 2,273	132 2023–24 ^f 1,393 440 2,379	123 2024–25² 1,401 460 2,353	120 2025–26² 1,408 460 2,369	118 2026–27² 1,435 460 2,427	118 2027–28^z 1,461 460 2,485	-5.6 CAGR' 2.5 0.9 3.4
Australia Mine output Refined output Export volume – ore and concentrate ^c – refined	USc/lb Unit kt kt kt	166 2021–22 1,257 435 2,033 313	141 2022–23 ^f 1,323 389 2,273 347	132 2023–24 ^f 1,393 440 2,379 400	123 2024–25 ² 1,401 460 2,353 420	120 2025–26² 1,408 460 2,369 420	118 2026–27² 1,435 460 2,427 420	118 2027–28^z 1,461 460 2,485 420	-5.6 CAGR ^r 2.5 0.9 3.4 5.0
Australia Mine output Refined output Export volume – ore and concentrate ^c – refined – total metallic content	USc/lb Unit kt kt kt kt	166 2021–22 1,257 435 2,033 313 1,220	141 2022–23 ^f 1,323 389 2,273 347 1,381	132 2023–24 ^f 1,393 440 2,379 400 1,478	123 2024–25 ² 1,401 460 2,353 420 1,486	120 2025–26² 1,408 460 2,369 420 1,493	118 2026–27 ² 1,435 460 2,427 420 1,519	118 2027–28 ^z 1,461 460 2,485 420 1,546	-5.6 CAGR' 2.5 0.9 3.4 5.0 4.0
Australia Mine output Refined output Export volume - ore and concentrate ^c - refined - total metallic content Export value	USc/lb Unit kt kt kt kt kt	166 2021–22 1,257 435 2,033 313 1,220	141 2022–23 ^f 1,323 389 2,273 347 1,381	132 2023–24 ^f 1,393 440 2,379 400 1,478	123 2024–25 ² 1,401 460 2,353 420 1,486	120 2025–26² 1,408 460 2,369 420 1,493	118 2026–27 ² 1,435 460 2,427 420 1,519	118 2027–28^z 1,461 460 2,485 420 1,546	-5.6 CAGR' 2.5 0.9 3.4 5.0 4.0
Australia Mine output Refined output Export volume - ore and concentrate ^c - refined - total metallic content Export value - nominal	USc/lb Unit kt kt kt kt kt	166 2021–22 1,257 435 2,033 313 1,220 4,506	141 2022–23 ^f 1,323 389 2,273 347 1,381 4,695	132 2023–24 ^f 1,393 440 2,379 400 1,478 4,559	123 2024–25 ² 1,401 460 2,353 420 1,486 4,292	120 2025–26 ² 1,408 460 2,369 420 1,493 4,195	118 2026–27 ² 1,435 460 2,427 420 1,519 4,275	118 2027–28 ^z 1,461 460 2,485 420 1,546 4,374	-5.6 CAGR ^r 2.5 0.9 3.4 5.0 4.0

Notes: a Includes secondary refined zinc; b In 2023 US dollars; c Quantities refer to the gross weight of all ores and concentrates; d In 2022–23 Australian dollars; f Forecast; r Compound annual growth rate; s estimate; z Projection

Source: ABS (2023) International Trade in Goods and Services, Australia, Cat. No. 5368.0; Company reports; Department of Industry, Science, Energy and Resources (2023); International Lead Zinc Study Group (2023); LME (2023).

Lithium





World consumption



Lithium facts



SOURCE: GA; Wood Mac

15.1 Summary

- Spodumene prices are estimated to rise to an average US\$4,350 a tonne in 2023, from an average of US\$3,110 a tonne in 2022. Prices should then moderate to US\$2,760 in 2024 and \$2,440 in 2028. Lithium hydroxide prices are expected to lift from US\$44,090 a tonne in 2022 to US\$61,520 in 2023, before moderating to US\$36,220 by 2028.
- Australia's lithium production is forecast to grow from 333,000 tonnes of lithium carbonate equivalent (LCE) in 2021–22 to 431,000 tonnes in 2022–23. By 2027–28, LCE tonnage will be double 2021–22 levels, at 661,000 tonnes.
- In 2022–23, Australia's export earnings are forecast to more than triple

 from \$5.3 billion in 2021–22 to \$18.6 billion. They are then expected to decline to \$11.8 billion in 2024–25 in real terms, before picking up later in the decade to reach \$19 billion by 2027–28.

15.2 World demand

Global electric vehicle market continues to drive lithium demand

Global lithium demand continues to grow rapidly, driven by surging demand for electric vehicle (EV) batteries. Demand for lithium batteries accounted for almost 80% of all lithium use in 2022. This is expected to reach 90% by the end of the outlook period, as EVs gain market share in the world passenger car market.

EV uptake continues to be driven by a combination of falling EV prices, rapidly widening choice of models, and ongoing government measures (although government incentives are being wound back in some countries).

Global sales of all types of passenger-EVs rose by more than 40% in 2022 — with growth in the Chinese market accounting for around three quarters of global growth. Growth in sales in other markets, including in Europe and North America, also increased, albeit at more modest rates (Figure 15.1).

The robust growth in EV sales over the past year was achieved despite several challenges. Surging prices for lithium and other battery raw materials (such as nickel, graphite and cobalt) have pushed up battery costs, which in turn have put upward pressure on EV prices. BNEF estimates that after more than a decade of declines, average prices for lithium-ion battery packs increased by 7% in real terms in 2021, to around \$150/kWh. Further, the supply chain issues that plagued EV manufacturers and battery makers between late 2021 and early 2022 have moderated, but remain a major impediment to increased production. Delivery timeframes for some EV models continue to be delayed, with some models being pushed out to 2024.

China's market experienced a sluggish end to 2022 and early 2023 largely attributed to increased uncertainty associated with the end of the zero-COVID policy. Additionally, China ended subsidies for electric vehicle sales in December 2022. The Government originally planned to phase out the support scheme by the end of 2020, but extended it until the end of December 2022 (in response to the pandemic). In response, automakers (including Tesla) have increased discounts to Chinese customers to maintain sales.

Figure 15.1: Electric vehicle sales (all types) by country



Source: Wood Mackenzie (2023).

Policies to promote EV uptake have also been implemented in many other countries. In the United States, the *Inflation Reduction Act* of 2022 (with funding of US\$391 billion) contains provisions to promote the clean energy transition, including significant incentives to purchase EVs.

Major global automakers continue to accelerate plans to transition to EVs, by developing new product lines and converting existing manufacturing capacity. The global market share for passenger EVs has increased fivefold since 2019, with EV sales representing about 14% of the car market in 2022 (Figure 15.2). Strong underlying demand and EV manufacturers' declarations of further production increases, imply that EV sales could reach about 40% of vehicle sales over the next decade.



Figure 15.2: Long term passenger EV sales projections

Source: Wood Mackenzie (2023), Department of Industry, Science and Resources (2023); IEA (2023).

World demand for lithium is estimated to increase from 814,000 tonnes of lithium carbonate equivalent (LCE) in 2022 to almost 1 million tonnes in 2023 (Table 15.1). Demand is forecast to more than double over the following 5 years, reaching over 2 million tonnes by 2028. Despite the spread of new battery manufacturing capacity into Europe and the US, Asia remains the major source of demand for lithium.

Major structural shifts are required for the global automotive industry to support the increasing transition to EVs over the outlook period. As the EV industry continues the move from start-up to scale-up, global supply chains must be developed. This includes battery and cathode plants, as well as lithium refining facilities. Supporting infrastructure — including charging station networks and service industries — will need to be built up. Underpinning all of this will be substantial growth in resource projects, to provide the required lithium and other critical minerals. All of this requires substantial investment and technical knowledge. In view of the magnitude of these structural adjustments and the major economic, logistical and technological challenges they pose for businesses and governments, periods of over- and under-supply of lithium and other critical minerals are likely over the outlook period.

15.3 World production

Lithium supply gap closing as global production ramps up

World output was 737,000 tonnes LCE in 2022, and is estimated to reach 964,000 tonnes in 2023 and 1,167,000 tonnes in 2024 (Figure 15.3). This rapid growth is forecast to be met by gains in output by Australia (see section below), Chile (via expansions to SQM and Albemarle brine operations) and Argentina (via new and expanded brine operations by Allkem, Livent and Minera Exar). Over the 5-year outlook, key sources of added supply include China, Brazil, Canada, DRC, Mali and Zimbabwe.

The large supply gap evident over the past 2 years is expected to narrow, as additional supply from mine and brine operations in Australia and overseas comes online. However, prices are likely to remain volatile, given the immaturity of the lithium market and the potential for shortages — due to low lithium stockpiles. While stockpiles remain hard to ascertain — with some estimates of an average of 4-8 weeks for spodumene for hydroxide refiners — some refiners may have allowed stocks to run down in recent months, in order to minimise purchases of spodumene at recent high prices.

New mines selling direct shipped ore to generate early cashflow

The strong demand outlook for lithium chemicals is attracting capital to build global supply. Several expansions and new projects have been announced over the past year, with exploration and drilling activities picking up in many countries over recent months. A key supply trend that has re-emerged is direct shipped ore (DSO) — with shipments of DSO from assets in Namibia and Core Lithium commencing in the latter half of 2022. The production and sales of DSO were last seen in 2017 and 2018, when several mining projects were striving for early cash flow to help finance further development. Following these DSO sales, spodumene concentrate prices declined sharply, which led to a build-up of significant stocks that took over two years to deplete.

Record lithium prices allow miners to sell DSO with lithium concentrations as low as 1–2% for prices well above what a 6% spodumene concentrate sold a few years ago. Absorbing DSO into the supply chain will result in challenges for Chinese producers, who first need to concentrate the ore before it can be processed in lithium refineries. Market analysts note that if the practice of selling DSO continues when prices decline, stocks may build up again in China, putting further downward pressure on spodumene prices.

In China, additional domestic lithium mineral supply is being developed in lepidolite mining, for aggregation into spodumene concentrate (in Jiangxi province). In recent years, there has also been extensive investment in upstream mining and downstream conversion. Hunan Province is expected to contribute additional lepidolite supply, with several local integrated mining and conversion projects in the planning stages. Environmental, social and governance (ESG) issues are expected to affect the speed of Chinese lepidolite mine development. Concerns about unlicensed and environmentally damaging mining saw the Chinese Government order investigations and temporary closures of several ore processing operations in Yichun, Jiangxi province. It has been reported that the investigations threaten up to 13% of global lithium supply. It is unclear how long these shutdowns will last.

Figure 15.3: Global lithium production



Source: Department of Industry, Science and Resources (2023); Wood Mackenzie (2023).

High lithium prices are driving smaller, lesser-known projects around the world to speed up production. Production in the southern cone of Africa is likely to rise in 2023. Late last year, production started in the Arcadia project in Namibia. Although some projects are likely to be marginal (in both cost competitiveness and size), rising global lithium demand means they will likely have a place in the supply chain over the outlook period.

Around the world, actions by governments to shore up lithium supplies and other critical mineral supply chains for strategic purposes are gaining momentum. In November 2022, the Canadian Government ordered three Chinese companies to divest their investments in Canadian critical minerals, citing national security. As noted earlier, in the United States, the *Inflation Reduction Act* of 2022 contained several provisions to strengthen critical mineral supply chains. The EU has proposed the *Critical Raw Materials Act* to help boost supplies of critical minerals — including lithium and rare earths — and reduce dependency on nations such as China. Draft legislation released in March indicates the EU aims to set up a central purchasing agency for critical materials to encourage member states to speed up approvals processes for new mines and processing plants. In January 2023, it was reported that Germany had signed an

agreement with Argentina designed to help its manufacturers secure lithium supplies and is seeking a similar deal with Chile — the world's second-largest supplier of lithium after Australia.

Interest in recycling continues to rise around the globe. However, recycling currently only accounts for around 2% of total supply and will need to increase substantially to make an appreciable contribution to addressing the expected supply shortages over the outlook period. To date, recycling has yet to be established on a large scale. Rising volumes of used EV batteries, combined with higher lithium prices, should strengthen the economics of recycling projects over the latter part of the outlook period.

15.4 Prices

Lithium prices have peaked and begun to fall to more sustainable levels

Spot prices for lithium commodities have eased since the start of the year, after reaching record highs late last year. Spot spodumene concentrate averaged about US\$5,920 per tonne in February 2023. This was more than double the average spot price for February 2022, and a more than tenfold increase in the prices in February 2021 (Figure 15.4). In February 2023, the spot lithium hydroxide price (delivered to China) averaged around US\$65,600 a tonne, down about 12% from US\$74,130 in January 2023. The slide in lithium hydroxide prices continued into March, with daily spot prices falling below US\$60,000 for the first time since February 2022.

As most Australian producers have historically utilised long-term contracts, prices received take time to adjust to shifts in spot prices. However, prices reported by Australian producers confirm spot prices are now flowing more rapidly into contract prices.

An increasing number of contracts for spodumene concentrate are seeing prices linked to battery-grade lithium hydroxide prices via a degree of margin sharing. For example, in February Pilbara Minerals announced its first sale of spodumene using a new commercial model based on a lithium hydroxide tolling arrangement. Under the agreement (made to a chemical converter), Pilbara Minerals will receive the lithium hydroxide price for the product sold less an agreed amount for conversion and other costs. One implication of this trend is that changes in hydroxide prices are likely to flow through to spodumene prices more quickly than the 3–6 month lags which have characterised price trends in recent years (Figure 15.4).

9 90 8 80 US\$-tonne ('000) US\$-tonne ('000) 7 70 6 60 5 50 40 4 3 30 2 20 10 1 0 0 Feb 19 Feb 20 Feb 21 Feb 22 Feb 23 Feb 18 Spodumene Lithium hydroxide

Figure 15.4: Lithium spot prices

Notes: CIF China. Spodumene is 5–6% content Source: Bloomberg (2023).

ABS trade data indicate that average realised prices (a mix of contract and spot priced exports) have risen strongly since early 2022, as processors sought to ensure that supply was sufficient to meet likely demand.

Average realised spodumene prices are forecast to rise from \$3,110 a tonne in 2022 to US\$4,350 a tonne in 2023 (in real terms), due to the resetting of contract prices in late-2022 (Figure 15.5). Over the next two years, as new spodumene suppliers come on stream, prices are expected to decline to more sustainable levels — around \$1,700 in 2025.

Prices are expected to pick-up over the latter half of the 5-year outlook period, as the additional global lithium supply is absorbed by rising global demand. Demand will rise as countries look towards their 2030 emissions targets, and as EV market penetration accelerates in Europe, the United States and other advanced economies.

The lithium hydroxide price is estimated to average about US\$61,500 a tonne in 2023, before moderating to US\$43,000 in 2024. Over the latter half of the outlook, lithium hydroxide prices are expected to moderate as global supply grows.



Figure 15.5: Spodumene concentrate/lithium hydroxide prices

Notes: Lithium hydroxide price is for higher-priced battery grade product. Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023).

Rapid price movements and the immaturity of the global lithium market mean the outlook remains very uncertain. Risks to the lithium price forecasts are balanced over the outlook period. The biggest downside risk to lithium demand in the short term is a plunge in the growth rate of Chinese EV sales. Given China's key role in driving lithium demand over recent years, a substantial slowdown in Chinese demand this year would put rapid downward pressure on prices for all lithium chemicals. While demand in the US and Europe continues to grow, these EV markets are not yet sufficiently large and mature to absorb the slack. One of the drivers of the surge in spot prices in 2021–2022 was a push by refiners and battery makers to build inventories, due to concerns about global supply chains. As these concerns continue to ease, prices could moderate more rapidly over the outlook period. Prices may also ease if global economic growth slows more sharply than the IMF has forecast, or if China's economic recovery is weaker than expected.

Upside price risks include the potential for delays in scheduled mine expansions. While many expansions are already underway in Australia and overseas, there are long lead times for lithium mine and brine operations. Moreover, the potential for delays in bringing such large volumes of lithium into production, means risks remain of persistent supply shortages over the next few years. Finally, EV uptake in advanced economies could accelerate more rapidly than expected, as EVs gain more widespread acceptance among motorists and countries implement policies to increase uptake.

15.5 Australia

Annual lithium exports forecast to approach \$19 billion this year

Production from lithium hydroxide refineries is forecast to build steadily over the outlook period. The strong rise in spodumene prices that saw Australia's export revenue surge from \$1.2 billion in 2020–21 to a record \$5.3 billion in 2021–22 (in real terms), is expected to contribute to a more than tripling of export earnings in 2022–23 — to an estimated \$18.6 billion.

Prices are expected to moderate from the record highs over the outlook period. Australia's total lithium exports are forecast to remain stable in 2023–24 at \$18.6 billion in real terms as higher volumes offset falling prices. Exports are then expected to fall to about \$12 billion in the following two years. Exports are expected to recover to \$19 billion (in real terms) by the end of the outlook period.

While much of the forecast growth in exports over the next two years will be price-driven, Australia's production capacity is also forecast to grow strongly. Annual average growth of over 12% a year is forecast, which will see production rise from 333,000 tonnes of LCE in 2021–22 to 431,000 tonnes in 2022–23 and 661,000 tonnes in 2027–28 (Figure 15.6). Export volumes of spodumene concentrate are forecast to rise from 2.2 million tonnes in 2021–22 to 4.5 million tonnes in 2027–28.



Figure 15.6: Australia's exports of lithium

Notes: Export values include revenue from spodumene concentrate and lithium hydroxide. Lithium volumes include total exports of spodumene concentrate and lithium hydroxide. Source: Company reports; Wood Mackenzie (2023); Department of Industry, Science and Resources (2023), WA Department of Mines, Industry Regulation and Safety (2022),

China accounts for the overwhelming majority of Australia's lithium exports. In 2021–22, 96% of Australia's lithium exports were exported to China — predominantly spodumene concentrate — in both value and volume terms. Belgium was the next largest export destination, accounting for only 2.3% of Australia's lithium export volumes, followed by South Korea (0.9%) and the United States (0.7%). Monthly trade data confirm these export shares have remained largely unchanged into 2022–23 (Figure 15.7).

The EV battery supply chain relies heavily on China, which makes 75% of all lithium-ion batteries, and holds about 70% of cathode production capacity and 85% of anode output. Further, over half of lithium, cobalt and graphite processing/refining capacity is located in China (see December 2022 *Resources and Energy Quarterly*). As countries look to cut their dependency on Chinese imports and develop their own lithium and battery production, export opportunities will rise for Australian producers. However, the likely rate and magnitude of any resulting changes to Australia's export markets remain subject to considerable uncertainty.

Figure 15.7: Australia's spodumene exports, by country



Source: ABS (2023).

Production and exports continued to expand in December quarter

Talison Lithium's 3 operational plants at Greenbushes produced a combined record total of 379,000 tonnes of spodumene concentrate in the December quarter 2022. This was up by 5% from the September quarter. The average realised price for total spodumene sales during the December quarter was US\$3,984 a tonne (FOB Australia). In January 2023, the company announced that the sales price for spodumene will reset quarterly, and reference the average price of 4 price reporting

agencies over the preceding quarter, less a 5% bulk sales discount. IGO states that on this basis, it expects the reported price for chemical grade spodumene sold in the March 2023 quarter to be US\$5,957 a tonne FOB.

Greenbushes is undertaking several capital spending projects, which IGO expects will increase installed production capacity from approximately 1.5Mtpa to around 2.5Mtpa over the next 4 years. The construction of the Chemical Grade Plant 3, which will have a production capacity of 500,000 tonnes of spodumene concentrate, is scheduled for completion in the second half of 2025.

Pilbara Minerals produced 162,151 dry metric tonnes (dmt) of spodumene concentrate output in the December quarter 2022. This was an increase of 10% from the September quarter. The company announced that construction of the 'P680' Project has commenced, with a revised capital cost estimate of A\$404 million — reflecting higher material, equipment and labour costs. Commissioning is targeted for the September quarter 2023, with full capacity targeted for the end of the year. In November, Pilbara Minerals announced that it had secured a 10-year debt facility of up to \$250 million from the Australian Government (through the Export Finance Australia and Northern Australia Infrastructure Facility agencies) to support the P680 Expansion Project.

Pilbara Minerals' Board also approved pre-FID funding of A\$38.3 million for the P1000 Expansion Project to support front-end engineering design and procurement of equipment. The company is targeting FID during the March 2023 quarter. Pilbara Minerals stated that the average realised spodumene sales price achieved in the December quarter 2022 was US\$6,273 per dmt (SC6% CIF China basis). This was a 30% gain on the September quarter 2022 price of around US\$4,813/dmt, and included both existing offtake agreements and spot sales.

Output from Mt Marion (50% Mineral Resources and 50% Jiangxi Ganfeng Lithium) totalled 121,000 dmt of spodumene concentrate in the December quarter 2022, with an average realised price of US\$3,262 a tonne (SC6). The joint venture has announced that the timing of the Mt Marion

expansion of production capacity to 900ktpa has been pushed back slightly, due to the delayed supply of processing equipment and labour shortages. Ramp-up to full production is expected from July 2023.

Mineral Resources and Albemarle stated that the mining and processing at Wodgina has continued to ramp up, with 92,000 dmt of spodumene concentrate produced in the quarter.

Allkem's Mt Cattlin mine produced 34,010 dmt of spodumene concentrate in the last six months of calendar 2022. Production volumes were weaker than expected, due to continued tightness in the Western Australian labour market, COVID-19 absenteeism and temporary changes to mineralisation (which created processing difficulties).

Figure 15.8: Australian spodumene exports



Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023).

Following FID in 2022, construction has ramped up at Liontown's Kathleen Valley project. The project is expected to deliver about 500,000 tonnes of spodumene concentrate in the first year, rising to about 700,000 tonnes a year by year 6. First production is expected in mid-2024.

Core Lithium's Finniss Project achieved first production of spodumene concentrate in February, with first shipment from the Darwin Port expected by the end of April 2023.

Australia's lithium hydroxide industry to take off in 2023

In late 2022, the Kwinana lithium hydroxide refinery (51% Tianqi and 49% IGO) started commercial production of battery grade lithium hydroxide in Train 1. The company announced a revised ramp-up schedule in January 2023, with Train 1 now expected by IGO to operate between 60% and 70% throughput capacity by the end of 2023. In December 2022, IGO announced that independent testing had confirmed the operation's product meets the required standards for the lithium-ion battery industry. Product qualification with offtake partners continues. The company noted that significant progress is underway on Train 2, with commissioning expected in 2024. Each train has a capacity of 24,000 tonnes a year.

Kemerton Train 1 lithium hydroxide plant (Albemarle 60%, Mineral Resources 40%) is now producing lithium hydroxide, which is currently undergoing qualification. Kemerton's Stage 2 — which will produce an additional 25,000 tonnes a year — has achieved mechanical completion and is progressing through the commissioning stage.

Construction of Covalent Lithium's (Wesfarmers 50%, SQM 50%) Kwinana lithium hydroxide refinery is progressing. The refinery is forecast to start in the first half of 2025. The refinery will source spodumene from Mt Holland. Construction of the concentrator is now over 70% complete, and first production is expected in the first half of 2024.

By the end of 2024, Australia could have up to 10% of global lithium hydroxide refining capacity, rising to over 20% of global lithium refining by 2028 (Figure 15.9). However, there are risks over the outlook. These include approval and construction delays for new mines and processing plants and difficulties achieving ramp up to full output. There are also technical challenges associated with achieving the required product grade, purity and consistency, which could delay output and exports.



Figure 15.9: World and Australian lithium hydroxide output

Source: Wood Mackenzie (2023); Department of Industry, Science and Resources (2023).

Australian businesses are expected to continue their expansion into higher value-added activities over the 5-year outlook period. Potential avenues include moves up the battery value chain, from mining and refining into precursor chemicals for cathodes, electrolyte production, battery anode plants, battery cell research, and battery manufacturing (Figure 15.10).

Revisions to the outlook

Forecast export revenue in 2022–23 has been revised up from \$16.1 billion in the December 2022 *Resources and Energy Quarterly* to \$18.6 billion, reflecting rapid price rises and faster than expected pass-through of spot prices to contract prices.

Compared to the March 2022 *Resources and Energy Quarterly,* exports in 2026–27 have been revised up substantially — from \$7.7 billion to \$20.5 billion (nominal) — reflecting a large and sustained uplift in expected prices.

Mine / Concentrate	Refine / Process	Precursor / battery chemical	Battery cell production	Battery pack assembly	Electric vehicle & charging
Hard rock vs brine • Pilbara Minerals • Tianqi • IGO • Albemarle • Mineral Resources • Core Lithium • Orocobre (Australia, Argentina, Canada) • Liontown Resources	LiOH, Li ₂ CO ₃ Ni-Co OH IgO • Albemarle • Mineral Resources • Pilbara Minerals (South Korea) • First Quantum (Australia -WA)	Li(Ni _x Mn _y Co _z)O ₂ LiMnFeP Graphite Vandium electrolyte FBICRC •BHP •IGO •BASF •Lithium Australia (LiMnFeP) •Novonix (ASX Listed, US OTC) •Rensacor (Graphite) •Australian Vanadium	Sinter / Assemble • Redflow (Zinc batteries) • Li-S Energy (Lithium sulphur battery cells - debuted on the ASX in late September 2021) • Ecograf (Battery anode plant)	Manufacture, deploy, manage • Energy Renaissance (Factory construction in Australia) • Redflow (Zinc batteries)	Engines Cars Chargers • HyperPower • Safescape • GB Auto • Tritium (US NASDAQ-listed)

Figure 15.10: Global lithium-ion battery value chain (+ zinc and vanadium batteries for large scale storage)

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

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

Table 15.1: Lithium outlook

World	Unit	2022	2023 ^f	2024 ^f	2025 ^z	2026 ^z	2027 ^z	2028 ^z	CAGR ^r
Lithium production ^a	kt	737	964	1,167	1,382	1,646	1,892	2,067	18.7
Lithium demand	kt	814	989	1,169	1,373	1,620	1,860	2,130	17.4
Spodumene price									
-nominal	US\$/t	3,005	4,350	2,820	1,810	2,200	2,700	2,700	-1.8
-real ^b	US\$/t	3,110	4,350	2,760	1,740	2,070	2,490	2,440	-4.0
Lithium hydroxide price									
-nominal	US\$/t	42,600	61,520	43,900	33,390	38,270	42,300	40,140	-1.0
-real ^b	US\$/t	44,090	61,520	42,940	32,010	35,960	38,950	36,220	-3.2
Australia	Unit	2021–22	2022–23 ^f	2023–24 ^f	2024–25 ^z	2025–26 ^z	2026–27 ^z	2027–28 ^z	CAGR ^r
Mine production ^a	kt	333	431	502	562	609	639	661	12.1
Spodumene export volume ^d	kt	2,248	3,080	3,389	3,794	4,111	4,314	4,462	12.1
Export value									
-nominal ^e	A\$m	4,899	18,598	19,409	12,692	13,347	20,536	22,090	28.5
–real ^c	A\$m	5,253	18,598	18,560	11,763	12,047	18,083	18,977	23.9

Notes: a Lithium Carbonate Equivalent (LCE) — a measure of the quantity of refined product; b In 2023 US dollars; c In 2022–23 Australian dollars; d Includes spodumene concentrates exported — mostly 6 per cent Li₂O concentrate — plus spodumene concentrate used to produce lithium hydroxide for export; e Revenue from spodumene concentrate as well as lithium hydroxide; f Forecast; r compound annual growth; z Estimate.

Source: ABS (2023), Company reports; Department of Industry, Science and Resources (2023); Government of Western Australia Department of Mines, Industry Regulation and Safety (2022); Wood Mackenzie (2023).

Trade summary charts and tables

Figure 16.1: Industry shares of GDP



Source: ABS (2022) Australian National Accounts, National Income, Expenditure & Production, 5204.0

Figure 16.2: Principal markets for Australia's resources and energy exports, 2022–23 dollars



Note: Some country details have been confidentialised by the Australian Bureau of Statistics. Source: ABS (2023) International Trade in Goods and Services, 5368.0

Figure 16.3: Principal markets for Australia's resources exports, 2022–23 dollars



Note: Some country details have been confidentialised by the Australian Bureau of Statistics. Source: ABS (2023) International Trade in Goods and Services, 5368.0

Figure 16.4: Principal markets for Australia's energy exports, 2022–23 dollars



Note: Some country details have been confidentialised by the Australian Bureau of Statistics. Source: ABS (2023) International Trade in Goods and Services, 5368.0



Figure 16.5: Principal markets for Australia's total exports, 2022–23 dollars

Note: Some country details have been confidentialised by the Australian Bureau of Statistics. Source: ABS (2023) International Trade in Goods and Services, 5368.0

Figure 16.6: Australia's total imports by country of origin, 2022–23 dollars



Note: Some country details have been confidentialised by the Australian Bureau of Statistics. Source: ABS (2023) International Trade in Goods and Services, 5368.0

Figure 16.7: Proportion of goods and services exports by sector



Source: ABS (2023) Balance of Payments and International Investment Position, 5302.0

Figure 16.8: Proportion of merchandise exports by sector



Source: ABS (2023) Balance of Payments and International Investment Position, 5302.0

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
Japan	\$m	11,531	13,411	9,499	7,849	25,537
South Korea	\$m	3,483	4,396	3,235	2,876	7,311
Taiwan	\$m	3,013	3,647	2,715	2,307	7,115
Vietnam	\$m	150	766	1,184	797	1,810
Malaysia	\$m	876	1,043	608	627	1,535
Thailand	\$m	434	462	491	580	866
Total	\$m	26,475	29,935	23,187	17,927	49,595

Table 16.1: Principal markets for Australia's thermal coal exports, 2022–23 dollars

Source: ABS (2023) International Trade in Goods and Services, 5368.0

Table 16.2: Principal markets for Australia's metallurgical coal exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
India	\$m	11,115	12,964	8,523	8,488	22,396
Japan	\$m	8,515	8,830	6,923	5,312	15,151
South Korea	\$m	4,299	4,640	3,452	3,059	10,110
Netherlands	\$m	2,100	2,066	1,413	991	4,398
Taiwan	\$m	2,266	2,995	2,268	1,492	4,253
China	\$m	9,819	11,404	11,126	1,868	0
Total	\$m	44,300	50,321	38,969	25,965	72,464

Source: ABS (2023) International Trade in Goods and Services, 5368.0

	Unit					
Singapore	\$m	1,376	2,244	1,548	1,860	1,621
Thailand	\$m	811	800	384	100	696
South Korea	\$m	422	347	156	102	235
China	\$m	1,533	748	866	690	197
Indonesia	\$m	739	1,162	1,175	181	169
Malaysia	\$m	686	1,891	1,153	737	50
Total	\$m	8,156	10,461	10,252	8,325	15,044

Table 16.3: Principal markets for Australia's crude oil and refinery feedstocks exports, 2022–23 dollars

Note: Department of Industry, Science and Resources estimates based on International Trade Centre data.

Source: ABS (2023) International Trade in Goods and Services, 5368.0; International Trade Centre (2023) International Trade Statistics

Table 16.4: Principal markets for Australia's LNG exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
Japan	\$m	17,010	24,459	22,677	13,044	26,634
China	\$m	11,206	20,160	18,522	12,740	22,986
South Korea	\$m	4,322	6,120	5,873	3,743	12,335
Taiwan	\$m	876	2,702	2,951	2,505	7,953
Singapore	\$m	1,331	1,426	1,183	972	2,407
Malaysia	\$m	426	1,006	1,656	559	602
Total	\$m	36,228	57,344	54,081	34,129	75,663

Note: Department of Industry, Science and Resources estimates based on International Trade Centre data.

Source: ABS (2023) International Trade in Goods and Services, 5368.0; International Trade Centre (2023) International Trade Statistics

Table 16.5: Principal markets for Australia's iron ore exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
China	\$m	58,748	73,188	96,484	139,774	116,121
Japan	\$m	6,249	6,639	8,009	10,168	10,997
South Korea	\$m	4,227	5,382	7,080	10,115	8,892
Taiwan	\$m	1,447	2,039	2,135	3,438	2,995
Indonesia	\$m	52	50	31	45	41
India	\$m	351	274	24	11	37
Total	\$m	71,962	89,432	117,053	171,303	142,047

Source: ABS (2023) International Trade in Goods and Services, 5368.0

Table 16.6: Principal markets for Australia's aluminium exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
Japan	\$m	1,610	1,522	1,156	1,071	1,613
South Korea	\$m	989	885	1,295	1,014	1,103
Taiwan	\$m	383	338	410	466	662
United States	\$m	217	970	281	287	639
Thailand	\$m	438	452	330	390	559
Indonesia	\$m	214	138	109	124	175
Total	\$m	4,704	4,804	4,201	4,214	6,121

Source: ABS (2023) International Trade in Goods and Services, 5368.0

Table 16.7: Principal markets for Australia's copper exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
China	\$m	4,416	4,159	4,310	3,076	2,100
South Korea	\$m	340	788	741	1,472	1,475
Malaysia ^a	\$m	1,020	1,431	938	952	1,030
India	\$m	982	512	527	701	1,009
Japan ^a	\$m	1,788	2,114	2,419	19	19
Philippines ^a	\$m	196	705	410	0	0
Total	\$m	9,906	11,266	11,617	12,811	13,003

Note: a exports of ores and concentrates to these countries have been confidentialised since June 2020.

Source: ABS (2023) International Trade in Goods and Services, 5368.0.

Table 16.8: Principal markets for Australia's gold exports, 2022–23 dollars

	Unit	2017–18	2018–19	2019–20	2020–21	2021–22
China	\$m	3,444	5,849	937	2,271	8,769
Hong Kong	\$m	9,429	5,040	3,802	1,579	5,246
India	\$m	857	667	75	1,651	2,067
Switzerland	\$m	1,283	1,339	2,161	2,115	2,014
Singapore	\$m	1,356	1,833	1,619	3,284	1,723
United States	\$m	86	147	3,504	4,409	1,481
Total	\$m	22,614	21,757	27,759	29,232	24,874

Source: ABS (2023) International Trade in Goods and Services, 5368.0



Appendix A Definitions and classifications

A.1 Exchange rates

In this report, the AUD/USD exchange rate (Australian dollar relative to the US dollars) is based on the median of economic forecasters at the time that the report is prepared. The source is the Bloomberg survey of economic forecasters.

World commodity prices are typically denominated in US dollars, and exchange rate movements can have a significant effect on the actual outcomes of commodity prices and export earnings. A change in the value of the US dollar against other floating international currencies can influence movements in world resources and energy prices. A change in the Australian dollar against the US dollar will impact on export earnings for domestic commodity exporters and producers. There is substantial uncertainty surrounding any exchange rate forecast, with changes to exchange rates influenced by changes in financial market sentiment, sometimes resulting in strong volatility.

A.2 Conversion to real dollars

Nominal values and prices are converted to real dollars using Australian and US consumer price indexes (CPI). The Australian and US CPI forecasts are based on the median of economic forecasters at the time that the report was prepared. The source is the Bloomberg survey of economic forecasters.

A.3 Time periods

The terms 'estimate', 'forecast' and 'projection' refer to different time periods in this report. Estimate refers to a time period that has passed, but for which full historical data is not yet available, while 'forecast' and 'projection' refer to different periods in the future. It is important to distinguish between different future time horizons, as factors affecting production, consumption and prices in the short-term differ from factors affecting these components in the medium to long-term. Forecasts also become increasingly imprecise over longer time horizons, due to increased risk and uncertainty. For these reasons, the Department of Industry, Science and Resources' Office of the Chief Economist (DISR OCE) uses different terminology to distinguish between short-term forecasts and medium to long-term projections, as outlined in *Table A2*.

Table A1: OCE terminology for different time periods/horizons

Period	Years	Terminology
Historical	Time period has passed but complete data for the period is not yet available	Estimate
Short-term	1 to 2 years	Forecast
Medium-term	3 to 5 years	Projection
Long-term	Beyond 5 years	n/a

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

A.4 Commodity classifications

The DISR OCE defines exports for each commodity by a selected set of 8digit Australian Harmonised Export Commodity Classification (AHECC) codes. Where possible, the choice of AHECC codes is based on alignment with international trade data, to ensure that direct comparisons can be made. For example, groupings for various commodities are aligned with classifications used by the International Energy Agency, World Steel Association, International Nickel Study Group, International Lead and Zinc Study Group, International Copper Study Group and World Bureau of Metal Statistics. In this report, benchmark prices and Australian production and exports are forecast for 21 commodities, as shown in *Table A2*. In estimating a total for Australia's resources and energy exports, the remaining commodities, defined as 'other resources' and 'other energy', are forecast as a group.

Table A2: Resources and energy commodities groupings and definitions

	Resources (non-energy)	Energy
Definition	Resource commodities are non-energy minerals and semi-manufactured products produced from non- energy minerals	Energy commodities are minerals and petroleum products that are typically used for power generation
Australian Harmonised Export Commodity Classification (AHECC) chapters	25 (part); 26 (part); 28 (part); 31 (part); 73 (part); 74; 75; 76; 78; 79; 80; 81	27 (part)
Commodities for which data is published, forecasts are made and analysed in detail in this report	Aluminium; alumina; bauxite; copper; gold; iron ore; crude steel; nickel; zinc, lithium	Crude oil and petroleum products; LNG; metallurgical coal; thermal coal; uranium

Notes: The AHECC chapter is the first two digits of the trade code. Groupings are made at the 8-digit level. Source: Department of Industry, Science and Resources (2022)

Appendix B Glossary

Term	Description
A\$	Australian dollar
ABS	Australian Bureau of Statistics
AHECC	Australian Harmonized Export Commodity Classification
AISC	All-In Sustaining Cost — an extension of existing cash cost metrics and incorporates costs related to sustaining production.
Base metals	A common metal that is not considered precious (includes aluminium, copper, lead, nickel, tin, zinc)
Bbl	Barrel
Bcm	Billion cubic metres
Benchmark	A standard specification used to price commodities.
BF and BOF	Blast furnace and basic oxygen furnace — used in an integrated steelmaking process that uses iron ore and coal.
Bulks	Non-liquid and non-gaseous commodities shipped in mass and loose (iron ore, coal, bauxite)
CAGR	Compound annual growth rate
Capex	Capital expenditure
CFR	Cost and freight — Seller clears exports, and pays freight.
CIF	Cost, Insurance, and Freight
Coal Seam Gas (CSG)	Natural gas found in coal seams. Also known as Coal Bed Methane (CBM)
Coke	Made by heating coal at high temperatures without oxygen, and used to reduce iron ore to molten iron saturated with carbon, called hot metal

Conventional gas	Natural gas that can be produced from reservoirs using traditional techniques. Contrasts with unconventional gas.
COVID-19	2019 Novel Coronavirus
СРВ	CPB Netherlands Bureau for Economic Policy Analysis
CPI	Consumer Price Index — measures quarterly changes in the price of a basket of goods and services which account for a high proportion of expenditure by the CPI population group (i.e. metropolitan households).
Crude steel	Steel in the first solid state after melting, suitable for further processing or for sale.
DES	Delivered Ex Ship — price of LNG including shipping and insurance.
DISR	Department of Industry, Science and Resources
DMO	Domestic Market Obligation — a policy to reserve energy commodities for domestic usage
DRC	Democratic Republic of the Congo
ECB	European Central Bank
Economic growth	An increase in the capacity of an economy to produce goods and services, compared from one period of time to another. It is measured in nominal or real gross domestic product (GDP).
EIA	The United States Energy Information Administration
EAF	Electric arc furnace — a furnace that melts steel scrap using the heat generated by a high power electric arc.
ETF	Exchange Traded Fund — an exchange traded fund that allows investors to invest in gold on the exchange.
EUV	Export unit value — export value/volumes exported
EV	Electric vehicle
f	Forecast — a two year outlook
FEED	Front end engineering design
FID	Final investment decision

FOB	Free on board — seller clears export, buyer pays freight.
GAD	Gross air dried basis — For measuring coal quality.
GAR	Gross as received basis — For measuring coal quality.
GBP	Great Britain Pounds
GDP	Gross Domestic Product — measures the value of economic activity within a country/group.
GFC	Global Financial Crisis — the period of extreme stress in global financial markets and banking systems between mid-2007 and early 2009.
GJ	Gigajoule
GST	Goods and Services Tax — a value-added tax levied on most goods and services sold for domestic consumption.
HCC	Hard coking coal — The best grade of metallurgical coal used in the steel production process. Australian hard coking coal is regarded as the industry benchmark.
IEA	International Energy Agency
IMF	International Monetary Fund — an international organisation that promotes international financial stability and monetary cooperation.
IMO	International Maritime Organisation
IP	Industrial Production — measures the output of the industrial sector that comprises mining, manufacturing, utilities and construction.
IPO	Initial public offering — a process of offering shares of a private corporation to the public in a new stock issuance.
ISM	US Institute for Supply Management
ISM	Institute of Supply Management
JCC	Japan Customs-cleared Crude (or Japan Crude Cocktail) — average price of crude oil imported by Japan and a common price index in long-term LNG contracts.
JFY	Japanese fiscal year
kcal/kg	Kilocalories per kilogram

kt	Thousand tonnes
ktpa	Kilotonnes per annum
LBMA	London Bullion Market Association
LCE	Lithium Content Equivalent
Li OH	Lithium Hydroxide
LME	London Metal Exchange
LNG	Liquefied natural gas
LNY	Lunar New Year
LPG	Liquefied petroleum gas
LVPCI	Low volatile pulverised coal injection — a type of low volatile coal used in the PCI process
m	Million
MMbtu	Million British thermal units
Mt	Million tonnes
mtpa	Million tonnes per annum
MW	Megawatts
Nameplate capacity	The theoretical maximum annual production capacity
NAR	Net as received basis — For measuring coal quality
NDRC	China's National Development and Reform Commission
NEV	New energy vehicle — term used for plug-in electric vehicles eligible for public subsidies (battery electric vehicles and plug-in hybrid vehicles)

OCE	Office of the Chief Economist
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries, a formal alliance of 14 countries to collaborate to manage the world oil market
OPEC+	Informal term for agreements between OPEC and ten other oil-producing countries (which are not members of OPEC)
Oz	Ounce
PCE	Personal Consumption Expenditure — a measure of the changes in price of consumer services and goods.
PCI	Pulverised coal injection — PCI coal is used for its heat value and injected directly into blast furnaces as a supplementary fuel, which reduces the amount of coke required.
PCI	Pulverised coal injection — a process used in blast furnace operations
PM	The afternoon price of gold set at 3.00pm each business day at the London Bullion Market Association
PMI	Purchasing Managers Index — an indicator of economic health for manufacturing and service sectors.
PPP	Purchasing Power Parity — a way of measuring economic variables in different countries that equalise the purchasing power of different currencies
RoW	Rest of world
S	Estimate — Incomplete data or subject to revision
Shale gas	Natural gas found in shales
SDR	Special drawing right
SHFE	Shanghai Futures Exchange
SSCC	Semi-soft coking coal — A type of metallurgical coal used in the steel production process alongside hard coking coal, but results in a lower coke quality and more impurities.
Tariff	A tax on imports or exports that is used by governments to generate revenue or to protect domestic industries from competition.
Tight gas	Natural gas found in low quality reservoirs

TWI	Trade Weighted Index — a measure of the foreign exchange value of the US dollar against a basket of major foreign currencies.
U3O8	Triuranium octoxide — a compound of uranium.
UAE	United Arab Emirates
UK	United Kingdom
Unconventional gas	Natural gas that is more difficult to extract, including coal seam gas, shale gas and tight gas. Contrasts with conventional gas.
US	United States
US\$	United States dollar
WEO	The International Energy Agency's World Energy Outlook
WTI	West Texas Intermediate crude oil price
Z	Projection of a five year outlook

About this edition

The *Resources and Energy Quarterly* (REQ) contains forecasts for the value, volume and price of Australia's major resources and energy commodity exports.

A 'medium term' (five year) outlook is published in the March quarter edition of the *Resources and Energy Quarterly*. Each June, September and December edition of the *Resources and Energy Quarterly* features a 'short term' (two year) outlook for Australia's major resource and energy commodity exports.

Underpinning the forecasts/projections contained in the *Resources and Energy Quarterly* is the outlook for global resource and energy commodity prices, demand and supply. The forecasts/projections for Australia's resource and energy commodity exporters are reconciled with this global context. The global environment in which Australia's producers compete can change rapidly. Each edition of the *Resources and Energy Quarterly* factors in these changes, and makes alterations to the forecasts/projections by estimating the impact on Australian producers and the value of their exports. The *Resources and Energy Quarterly* publication uses IMF economic growth forecasts as the basis of its world growth forecasts.

In this report, commodities are grouped into two broad categories, referred to as 'resources' and 'energy'. 'Energy' commodities comprise metallurgical and thermal coal, oil, gas and uranium. 'Resource' commodities in this report are all other mineral commodities.

Unless otherwise stated, all Australian and US dollar figures in this report are in nominal terms. Inflation and exchange rate assumptions are provided in tables 2.1 and 2.2 in the *Macroeconomic outlook* chapter.

Information in this edition of the *Resources and Energy Quarterly* is current as of 24 March 2023.

Publication	Expected release date	Outlook period final year
June 2023	3 July 2023	Australian data: 2024–25 World data: 2025
September 2023	3 October 2023	Australian data: 2024–25 World data: 2025
December 2023	18 December 2023	Australian data: 2024–25 World data: 2025
March 2024	1 April 2024	Australian data: 2028–29 World data: 2029

Resources and Energy Quarterly publication schedule

Source: Department of Industry, Science and Resources (2023)